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STRESS ANALYSIS OF LOFT PENETRATIONS 1A, 2A, 3F, 5A-F, 7A, 9A, 17A-B, 20A-C, 21-A

R. J. Beers Jr.



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EG&G Idaho, Inc.

LOFT TECHNICAL REPORT - LTR 1217-6 Report No. RE-A-78-175

Date: \_SEPTEMBER 28. 1978

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## INTERNAL TECHNICAL REPORT

Title:

STRESS ANALYSIS OF LOFT PENETRATIONS 1A, 2A, 3F, 5A-F, 7A, 9A, 17A-B, 20A-C, 21-A

Organization:

Author: R. J. Beers Jr./

APPLIED MECHANICS

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EGEG Idaho, Inc.

LOFT TECHNICAL REPORT LOFT PROGRAM

FORM EG&G-229 (Rev. 12-76)	
STRESS ANALYSIS OF LOFT PENETRATIONS	REPORT NO. LTR 1217-6
1A, 2A, 3F, 5A-F, 7A, 9A, 17A-B, 20A-C, 21-A	RE-A-78-175
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#### ABSTRACT

A stress analysis has been completed for the LOFT piping nozzles penetrating through the containment vessel in accordance with the 1965 edition of Section III of the ASME Boiler and Pressure Vessel Code[1]. LOFT Specification S-1[6] states that the 1965 edition, including the addenda through the summer 1966 issue, be used. Stresses in the containment wall and in the nozzles result from mechanical and thermal loads on the piping that penetrate the nozzles. The mechanical loads were compiled in LTR 1217-7<sup>[2]</sup> and the temperature gradients were provided by the Thermal Analysis Branch[3].

This analysis indicates that the nozzles and the containment wall are adequate to sustain the given mechanical and thermal loads. Therefore, it is recommended that paragraph number S1-04, section M of LOFT specification S-1[6] be revised to list the nozzle loads presented in Table 3, page A-3a.

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## STRESS ANALYSIS OF LOFT PENETRATIONS 1A, 2A, 3F, 5A-F, 7A, 9A, 17A-B, 20A-C, 21-A

#### I. INTRODUCTION

A stress analysis has been completed for the LOFT piping nozzles penetrating through the containment vessel in accordance with the 1965 edition of Section III of the ASME Boiler and Pressure Vessel Code<sup>[1]</sup>. LOFT Specification S-1<sup>[6]</sup> states that the 1965 eidition, including the addenda through the summer 1966 issue, be used. A stress analysis of the containment vessel wall and of the nozzles is included in this report. A tabulation of the nozzles analyzed, the maximum pipe temperature at the nozzle and the loads on the nozzles is given in Table 1. (See page A-2)\*

\*All the nozzles listed in Table 1 were analyzed in this report except Nozzle S-3E which was analyzed in Reference 4.

#### II. DISCUSSION

The mechanical loads on the containment vessel at the penetrations were compiled in LTR 1217-7<sup>[2]</sup>. These loads are from piping that penetrate the nozzles. They are either a combination of deadweight, thermal expansion and operating basis earthquake (OBE) or deadweight and safe shutdown earthquake (SSE), whichever leads to the highest stress in the containment wall.

A Biyjaard analysis<sup>[5]</sup> was completed for each size of nozzle penetrating the containment wall (see Appendix A). To be conservative, the highest force and moment that each nozzle size had was used for the analysis. Numbers that are circled in Table 2, page A-3, indicate these loads. For fatigue analysis, the appropriate stress concentration factors were applied.

Two of the nozzles have pipes penetrating them with high (above  $250^{\circ}F$ ) operating temperatures. For these nozzles, thermal stresses combined with mechanical stresses were calculated in Appendix B. Thermal stresses arise from temperature gradients between the pipe and the nozzle. These gradients were provided by the Thermal Analysis Branch<sup>[3]</sup>.

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#### III. RESULTS

The maximum primary plus secondary stress in the containment wall due to mechanical loads is 22,440 psi which is less than the allowable stress, 3 S<sub>m</sub> = 68,220 psi. With peak stresses added on, the maximum allowable number of cycles is 110,000.

The maximum primary plus secondary stress in the nozzles due to thermal plus mechanical loads is 14,000 psi which is less than the allowable, 3 S<sub>m</sub> = 53,850 psi. With the peak stresses added on, the maximum allowable number of cycles is 100,000.

Nozzles S-3E and S-5E are both cone shaped nozzles with similar dimensions and both operating at high temperatures (S-3E  $@530^{\circ}F$  and S-5E  $@407^{\circ}F$ ). John Canders (Reference 4) performed a finite element analysis on nozzle S-3E and arrived at a maximum stress of 34,254 psi which is much less than the allowable of 52,500 psi. Since the two nozzles have similar dimensions, nozzle S-3E operates at a higher temperature than nozzle S-5E, and the mechanical loads are higher on S-3E, stresses in S-5E will also be less than the allowable stress values.

#### IV. CONCLUSION

This analysis indicates that the nozzles and the containment wall are adequate to sustain the given mechanical and thermal loads.

#### V. RECOMMENDATION

It is recommended that paragraph number S1-04, Section M of LOFT Specification S-1<sup>[6]</sup> be revised to list the nozzle loads presented in Table 3, page A-3a.

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#### VI. REFERENCES

- 1. American Society of Mechanical Engineers, <u>ASME Boiler and Pressure</u> Vessel Code, Section III, New York, 1965.
- D. F. McFadden, "Recalculation of Loads on LOFT Penetrations 1A, 2A, 3F, 5A-F, 7A, 9A, 11C, 17A-B, 20A-C, 21A", LTR 1217-7, RE-A-78-176, to be published.
- 3. W. C. Townsend letter to R. Beers, "Containment Penetration Temperature Profile at Weld", WCT-21-78, August 3, 1978.
- 4. John Canders, "LOFT Main Steam Line Containment Vessel Penetration Nozzle (S-3E) Stress and Fatigue Life Analysis", LTR 1217-5, RE-A-78-162, to be published.
- 5. K. R. Wichman, A. G. Hopper and J. L. Mershon, "Local Stresses in Spherical and Cylindrical Shells Due to External Loadings", Welding Research Council Bulletin No. 107, New York, 1965.
- Idaho Nuclear Corporation, "Containment Vessel", LOFT Specification S-1, Contract No. AT (10-1)-1160 (Job No. 20), Revision 12, August 17, 1970.
- 7. Bruno A. Boley, and Jerome H. Weiner, <u>Theory of Thermal Stresses</u>, John Wiley and Sons Inc., New York, 1960.
- 8. Raymond J. Roark, and Warren C. Young, <u>Formulas for Stress and Strain</u>, McGraw Hill Book Co., 1975.
- 9. American Society of Mechanical Engineers, <u>ASME Boiler and Pressure</u> <u>Vessel Code</u>, Section III, Subsection NB, 1977.

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### APPENDIX A

### STRESSES IN THE CONTAINMENT VESSEL DUE TO MECHANICAL LOADS

A-i

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#### LVR1217 6

A-1

#### 1.0)LOADS ON THE CONTRINMENT VESSEL

FORLES AND MOMENTS ON THE CONTAIMENT VESSEL CAN BE FOUND IN TABLE 1. THE LOADS IN TABLE 1 WERE GATHERED AND PRESENTED IN REFERENCE 2. THESE LOADS ARE EITHER A COMBINATION OF DEADWEIGHT + THERMAL EXPANSION + OPERATING BASIS EARTHQUAKE (OBE) OK DEADWEIGHT + SAFE SHUTDOWN EARTHQUAKE (SSE), WHICHEVER LEADS TO THE HIGHEST STRESS IN THE CONTAINMENT VESSEL.

A BIY JAAKO ANALYSIS WAS COMPLETED FOR EACH SIZE OF NOZZLE PENETRATING THE CONTAINMENT WALL. TO BE CONSERVATIVE, THE HIGHEST LOAD THAT EACH NOZZLE SIZE HAD, WAS USED FOR THE ANALYSIS. NUMBERS THAT ARE CIRCLED IN TABLE Z INDICATE THESE LOAPS

STRESS CONCENTRATION FACTORS : FOR THE NOZZLES THE MINIMUM SIZE OF WELD TO THE CONTAINMENT VESSEL IS 1/2" THE SMALLER THE WELD, THE SMALLER THE FILLET RADIUS WHICH LEADS TO A HIGHER STRESS CONCENTRATION FACTOR. THEREFORE IT WILL BE CONSERVATIVE TO USE 1/2" WELD TO PETERMINE THE STRESS CONCENTRATION FACTORS FOR ALL THE NOZZLES.



T = VESSEL THICKNESS

R = FILLET RADIUS

ENTERING  $\frac{R}{T} = \frac{.9}{.75} = .51$  ON THE GRAPH ON PAGE 68 OF REF 5

Kn=1.75 Kb=1.50

#### 2.0 STRESSES IN THE CONTAINMENT WALL

TWO TYPES OF STRESSES WERE CALCULATED, PREMARY PLUS SECONDARY STRESS INTENSITIES (PM+Q) (Pages A-6 THROUGH A-17) WHICH IS THE STRESS DUE TO MAXIMUM LOADS; AND PREMARY PLUS SECONDARY STRESS INTENSITIES (PEAK) (Pm + Q+F) (PAGES A-18 THROUGH A-29) WHICH IS THE STRESS DUE TO MAXIMUM LOADS AND THEN MULTIPLIED BY THE APPROPRIATE STRESS CONCENTRATION FALTORS.

TABLE 1 [2]

A NOZZLE S-3E WAS ANALYZIEDIN REFERENCE 4.

<b></b>	11-5	ROUNDER	UP TO EVEN 500 16
F -	691	ROUTE C	10 TO EVEN 5000 IN-165

NOZZLE	DIA	TEMP	LOADS	AT CON	TAINMEN	r (x our	, Z UP)	
No,		OPERATIONS	F,	Fy	Fz	Mx	My	Me
20C	10"	70°	500	500	500	5000	35,000	20,000
ZOB	10''	220°	500	500	500	-5000	15,000	-5,000
20 A	10"	Z20°	500	500	500	-5000	10,000	-5000
21 A	12"	100	19,500	19,500	-13,500	51,000	125,000	175,000
7 A	12"	100°	5,500	2,000	- 500	15,000	-15,000	-115,000
17.A	12"	70°	500	500	500	10,000	- 25,000	~10,000
17 B	12"	1200	500	500	-500	15,000	-5,000	-25,000
112	12"	2500	500	- 500	- 500	5,000	-20,000	-10,000
9 A	16".	/00°	-5,500	5,500	-1000	-30,000	-220,000	-130,000
SF	16"	150°	1,500	- 5,000	3000	-250,000	269,000	- 220 <sub>1</sub> 011
5 A	16"	1100	17,000	- 3,000	1000	10,000	170,000	205,000
5B	16"	1800	1,000	500	-2000	-5,000	-35,000	- 55,000
56	16"	1000 .	- 500	500	- 500	-5,000	- 20,000	-10,000
5 D	16"	1000	500	500	- 500	10,000	-10,000	5,000
5Ē	1811	:107°	3,000	500	-1,000	90,000	-30100D	- 65,000
3E <sup>\$\$</sup>	s 29"	5300	58,006	10,500	- 3000	275,000	505,000	305,000
ZA	24"	1000	2,000	1,500	- 2,500	30,000	-90,000	55,000
3F	29"	70°	500	500	500	5,000	10,000	- 5,000
IA	30"	250 <sup>0</sup>	1,000	1,000	-1,500	10,000	-170,000	- 90,000

LTR1217 6 - A-2

LTR1217 6

NOZZLE	DÌA	TEMP LOADS AT CONTAINMENT (X OUT, ZUP)											
No,		OPERATOR	F <sub>x</sub>	Fy	Fe	Mx	My	Me					
20C	10"	700	500	600	500	6000	35,000	20,000					
,ZOB	. 10"	220°	500	500	500	-5000	15,000	-5,000					
.20 A	10"	220°	500	500	500	-5000	10,000	-5000					
21 A	12"	'(())	19,500	19,500	-13,500	51,000	125,000	175,000					
7 A	12"	100°	5,500	2,000	- 200	15,000	-15,000	-115,000					
17A	12"	70°	500	500	500	10,000	-25,000	40,000					
17 B	12"	1200	500	500	-500	15,000	-5,000	-25,000					
116	12"	2500	500	- 500	- 500	5,000	-20,000	-16,000					
· 9 A	16"	/00°	-5,000	5,500	-1000	-30,000	-220,000	-130,000					
SF	16"	150°	1,500	- 5,000	3000	-250,000	260,000	- 200, 000					
5 A	1611	1100	17,000	- 3,000	1000	10,000	170,000	205,000					
5 B	16"	1800	1,000	500	-2000	-5,000	-35,000	- 55,000					
· 5 C	16"	1000	- 500	500	- 500	-5,000	- 20,000	000101-					
5D	16"	1000	500	500	- 500	000 101	-10,000	5,000					
5Ē	1811	1070	3000	E.500	-1,00D	90,000	-30,000	- 65,00					
3E <sup>\$</sup>	s 29"	ઽ૩૦°	58,000	10,500	- 3000	275,000	505,000	305,000					
ZA	24"	1000	2,000	1,500	-2,500	30,000	-90,000	55,000					
3F	29"	70 <sup>0.</sup>	500	Śao	500	SICOD	10,000	- 5,000					
1 A	30"	250°	(1,000)	1,000	0-1,500	10,000	170,000	90,000					

F-165 ROUNDER UP TO EVEN 500 16

M- IN-165 ROUNDED UP TO EVEN 5000 IN-165

TABLE Z [2]

A HOZZLE S-3E WAS ANHLYZIED IN REFERENCE 4.

1 701212	6 EX	TERNAL	LOR	3. ON 7	THE NO	EELE	6
	- HT I						
	Nozele	Fa		Fa	mx	May	Ma
	IA	1000	1000	1,500	10,000	170,000	90,000
	ZA	2,000	1,500	2,500	30,000	90,000	55,000
	3F	2,000	1,500	2,500	30,000	90,000	<sup>6</sup> 55,000
•	SA	17,000	5,500	3,000	-250,000	260,000	430,000
•	5 B	000171	5,500	3,000	250,000	260,000	430,000
,	SC	17,000	5,500	3,000	250,000	260,000	930,000
•	SD	17,000	5,500	3,000	250,000	260,000	430,000
	SE	3,000	500	1,000	90,000	30,000	65,000
	SF	17,000	5,500	3,000	250,000	260,000	430,000
	7A	19,500	19,500	13,500	51,000	125,000	175,000
м.,	7A	17,000	5,500	3,000	250,000	260,000	930,000
	17A	19,500	19,500	13,500	51,000	125,000	175,000
	176	19,500	19,500	13,500	51,000	125,000	175,000
	20A	· 5'00 ··	500	500	5,000	35,000	20,000
	208	500	500	500	5,000	35,000	20,000
	206	500	500	500	5,000	35,000	20,000
. l	21A	19,500	19,500	13,500	51,000	125,000	175,000
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S. A.

TABLE

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2.1) PRIMARY PLUS SECONDARY STRESS INTENSITIES

SINCE THIS WORK IS A MODIFICATION OF WORK THAT USED THE 1265 EPT TION OF THE ASME BOILER AND PRESSURE VESSEL CODE USED THE 1965 EDITION WILL BE USED IN THIS REPORT.

REVIEWING THE BIY AARD ANALYSES OF EACH SIZE OF HOZZLE, THE MAXIMUM STRESS INTENSITY RESULTS IN THE 16" NOZZLE, PUE TO THE LIMITED AMOUNT OF PATA POINTS THROUGH THE THICKNESS OF THE VESSEL WALL, THIS VALUE IS THE LINEAR IZED STRESS INTENSITY,

Pm + Q = PRIMARY + SECONDARY STRESS

Pm +Q = 22, 440 psr (SEE PAGEA-11)

LOFT SPECIFICATION S-1[6] STATES THE CONTAINMENT VESSEL IS COMPOSED OF SA-212, GRADE B CARBON STEEL WITH A DESIGN TEMPERATURE OF 260°F.

Sm = DESIGN STRESS INTENSITY

Sm = 22,740 psi (SEE REFI)

Pm+Q<35m (SEE REF 1)

### Pm+Q=22,440 PSI < 35m= 68,220 PSI

THEREFORE, THE REQUIREMENTS FOR PRIMARY + SECONDARY STRESS ARE SATIS FIED

2.2) PRIMARY PLUS SECONDARY STRESS INTENSITIES (PEAK)

REVIEWING THE BIY'S HAR D ANALYSES WITH STRESS CONCENTRATION FACTORS CONSIDERED, THE MAXIMUM PRIMARY + SECONDARY + PEAK STRESS RESULTS FROM THE 16" NOTELE. AGAIN, DUE TO THE LIMITED AMOUNT OF DATA POINTS THROUGH THE VESSEL WALL, THIS VALUE FOUNDS THE LENEARISED STRESS INTENSITY WHICH EQUALS THE COMBINED PEAK STRESS INTENTITES

P. + Q + F = 33,920 PST (SEE PAGEAZ3)

**1R**12176

THE MAXIMUM STRESS, WILL FLUCIUATE BETWEEN 0:0 PSI AND 33,920 PSI,

THEREFORE SA = 33,920 - 0.0 Z

5A - 6960 PSI

ENTERING SA ON THE FATIGUE CURVE FOR CARBON STEEL (SEE REF. , PAGE 19),

THE MAXIMUM # OF CYCLES = 110,000 CYCLES

FROM LOFT SPECIFICATION S-1, [6] THE MAXIMUM HUMBER OF FATIGUE CYCLES ON ANY NOZZLE IS 10,000. SINCE THIS IS LESS 40,000 FATIGUE CRITERION IS SATISFIED

See How

1 2 90.00 7 9

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$\frac{2C}{P} = \frac{M_{\pi}}{P} = -C $	$\frac{K_{b}\left(\frac{m_{K}}{P}\right)\cdot\frac{bP}{T^{2}}}{\left(\frac{m_{K}}{P}\right)\cdot\frac{bP}{T^{2}}}$	œ	20	+ .20	26	1.20	20	+. 20	20	1.20
4A Me / Rm <sup>2</sup> /3 2	$\frac{1}{1} \frac{Kn\left(\frac{1}{Mc}, Rm^{2}/\beta\right) \cdot R}{Kb\left(\frac{1}{Mc}, Rm^{2}}\right) \cdot -}$						01	01	1.01	+.01
4B Ns 1.5	$\frac{Me}{Rm/S} \frac{Me}{R}$	m/3T2 <u>ML</u>					51	+.54 377	<b>T</b> .54	54 3000
2B or <u>Ma</u> 1 2B-1 <u>ML Rm/3</u>	$\frac{1}{100} \frac{1}{M_{\rm H}} \frac{1}$	6ML m/T <sup>2</sup>	- 1.72	+1.77	+1.72	17				
Add algebraiculty for summa of X stressis, 17 x =	Itan	·.	-1.98	1.88	1.50	-1.54	79	.76	.31	-36
Shear stress due to Tarsian, MT	7.0x = 7x0 =	<u>Μτ</u> 2π r <sup>2</sup> Τ	+.oz	4.07	+.02.	t.oz	+.0Z	+.02	50.+	50, t
Shear storse due to lood, Vc	1x0 ÷		+.0Z	+_0Z	07					
to load, VL Add Algebraically for symmi	F x O						-oz	_oz	50. 1	\$ .07
DI shear stresses, T 200 COMBINED STRESS INTER	<u>i.</u> 1517¥, S		<u>, 09</u>	.04	0	0	0	6	.09	.01
1) When $\sigma_{c5} \in \sigma_{\pi}$ have like signs	s = ½ [τφ + ΰ <sub>π</sub>	$\sqrt{(1)c_k - v_m F + 4F^2}$	1.98	1.88	.1.50	1.54	1.34	1.26	. 66	.70
2) When Tyle O	s in largent of 165, 11	$\sigma_{\rm s}$ at $\sigma_{\rm s} = \sigma_{\rm s}$	KSI	KZI	K51	1221	KSI	KSI.	K2T	KSĪ
	1	• • •	1		1. 1			ł	1	

 $N_L/(M_L/R_m^2\beta)$  so determined by  $(C_L)$  from Table 8 (see para. 4.3).

4.3 Calculation of Stresses

4.2.2.5.2: When considering bending moment  $(M_i)$ :  $\beta = K_L \sqrt[3]{\beta_1 \beta_1^2}$  where  $K_L$  is given in Table 8.

4.3.1 STRESSES RESULTING FROM RADIAL LO P.

**4.3.1.1** Circumferential Stresses  $(\sigma_{\phi})$ ;

Step 1. Using the applicable values of  $\beta$  an

	ΙF	8	:	108.01	
MC=	COEFS		0.26	4071.43 67.88 4664 70	
175000.00	20-	0.07	COEFS	4004.12	
ML= 125000.00	COEFS		20-	SUMS	
MT=	3H=	2.50	COEFS	-12800.66 10282.25	
51000.00	COEFS	,	20-1= 0.18	-3335.45	
VC= 19500 00	48=	2.40	COEFS	-12748.10 10148.23	
17500.00	OEFS		3C= 35.00	-3388.02 1222.59	P
13500.00	B=	0.07	COEFS.		+ D
	:0EFS		4U= 45.00	SHEARS	
T=	:B-1=	0.07		128.84 591.15	
RO=	COEFS		v 926.59-	409.26	
6.00 · ····	20-	0.10	113.14	719.99	·
RM= 420.90	COEFS		258.60	-462.31	,
	20-1-	0.10	3263.31 	-280.42	• •
(N= 1.00	COEFS		SUMS	538.10	5
<b= .<="" td=""><td>00-</td><td>8.00</td><td></td><td></td><td>112</td></b=>	00-	8.00			112
1.00	COEFS		-/335.74 5999.77		17
GAMMA= 240.51	40=	2.10	-1/503.40 15423.95		<u>O</u>
	COFFS		-4215.90		
. <b>1</b>					
					···.

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•		بيا سنار و الارد الدرايين	Japie 5-Compu	lation Sheet for	Local S	liusses	in Cylinc	trical Sh	ciis				
• .	12" (	DIA.	NDZZLE	Pm+G	<sup>2</sup> L	TR12	217	6 -	; ;	P MI Ma	•	1	A-9.
· ·	<ol> <li>Applied Loac Radial loc Circ. Mom Long. Mor Torsion M Shear Loc Shear Loc</li> <li>Geometry Vessel th Attachme Vessel re</li> </ol>	is" id, 1 idnt, 1 idnent, 1 idd, idd, nickness, nt rudius, adius,	$P = \frac{12,500}{15,000}$ $M_{C} = \frac{125,000}{15,000}$ $M_{L} = \frac{125,000}{15,000}$ $M_{L} = \frac{125,000}{15,000}$ $M_{L} = \frac{125,000}{15,000}$ $M_{L} = \frac{1.75}{10,000}$ $I_{L} = \frac{1.75}{10,000}$	3. Geometr 7 /} Stress ( a) m b) be *NOTE: accorde	ic Paramer <u>Rm</u> (0.875) - 1 (0.875) - 1 Concentrat mbrane loc nding load Enter ell ince with s	ion due to am ion due to od, Kn , Kb force volu ilgn convo	012		Z Du DL AU T AL	M, Cu CL ICAL SI		JND HMENT	
[	From Re	od curves	Compute obsolute	volues of	STRESS	ES - il lo	nd is oppo	sile that s	hawn, rev	rrse signs	shown .		•
	Fig. N	for .	stress and enter	result	Au	<u> </u>	Βυ	BL	<u> </u>	CL	<u> </u>	DL	
	3C P.H		(M(3) 6P	· · · · · · · · · · · · · · · · · · ·	9Z	<u>.92</u>	9z	92	<del>-</del> .92	9z	92	92	
•		= .24	$\frac{Kb\left(\frac{1}{P}\right)\cdot\frac{1}{T^2}}{T^2}$	• · ·	-9.93	+993	-9.93	+9.93	-933	+9.93	-9.93	<u>+9.93</u>	
	3 A <u>N</u> e."	C Z.5	$K_{n}\left(\frac{NC^{5}}{M_{c}\cdot R_{m}^{2}/3}\right) \cdot \frac{M_{c}}{R_{m}^{2}/3}$	<u>.</u> Кт				<u>I</u> K	11	11	<b>4</b> _∥	+.11	
el I	1. 1. Mc	<u>0.10</u> Rm/i	$K_{b}\left(\frac{M_{C}}{M_{c}/R_{m}/3}\right) \cdot \frac{6M_{c}}{R_{m}/3}$	c 172					6.53	4	+655	6.53	
¥:	38 N		$K_{n}\left(\frac{NC}{ML/Rm^{2}/\delta}\right) = \frac{ML}{Rm^{2}/\delta}$			76	+.26	+.26	M			IK.	
	18 or 18_1	0 007 Pm/1 -	$K_{b}\left(\frac{M_{C}}{M_{1}-R_{m}/3}\right) = \frac{6M_{1}}{R_{m}/3}$	L	-324	+ 5.26	+ 5.26	-3.26	<u>MAR</u>	XV.			
	Add algebraical of Ø stresses, (	lly for summati でめ ±	ien	· · · · · · · · · · · · · · · · · · ·	-		5 24	4.00		1< 47	- - - 	7 4 0	
	4C N	-45	$K_n \left(\frac{N_n}{D_n/D_n}\right) = \frac{P}{P_n T}$	=. <sup>121</sup>	0	<u>-</u>	<u>, 1, 2, 1</u>		<u></u>		-		
	2C Ma	<u>*</u>	$\frac{(H_{\rm H})}{(H_{\rm H})} = \frac{6P}{T^2} =$	1		+	+: 0a	+. 00	-/ cxf	* 00	- 0	+, 20	
•.	4	Rm <sup>2</sup> β 2 <sup>π</sup> α	$K_{n}\left(\frac{N_{\pi}}{M_{c}\cdot R_{m}^{2}/3}\right) \cdot \frac{M_{c}}{R_{m}^{2}/3}$	a <del>r</del> -					- 11 - 11	- '11	4.11	4.11	
	2 A Mc	Rm/3 0 07	$F.b\left(\frac{M_{H}}{M_{C}/R_{m}/3}\right) \cdot \frac{6M}{R_{m}/3}$	λ <u>ε</u> } Τ 2						ta.57	4.57	-4.57	$\frown$
	48 . H	Rm <sup>2</sup> / <sup>1</sup> Z.1	$K_{\rm II}\left(\frac{N_{\rm III}}{ML/R_{\rm III}^2/3}\right) + \frac{M_{\rm II}}{R_{\rm III}^2}$	L /37 -	07	07	+ 07	+.07	Ŵ	SIL.			
	28 pr <u>M</u> 28-1 ML	Rm/1 2. 1	$K_{b}\left(\frac{M_{b}}{M_{b}}\right) = \frac{6M}{R_{m}/3}$	L 172 =	4.66	4.66	+4.6	-4.66	THE SECTION OF SECTION				
	Add algebraical of X streests, A	lly for summit Fy ==	ien '	,	-12.8	10.20	-3.34	1.09	-12.75	10.15	3.39	1.22	
	Shear stress du to Tarsien, Mr	<b></b>	τψx <del>–</del> τxφ =	$\frac{M\tau}{2\pi r_0^2 T}$	+-13	+ .13	+.13	113	+.13	+ .13	+.13	+.13	1
	Shear stress du to load, Ve	/•	txó	- Ve 7 ro T	+.59	+.59	59	59	M		M	M	
	Shear stress du to load, VL	•	د گ∗ ۲	VL Trot					7.41	91	<b>+</b> . <1	+.4 I	1
	Add Algebraica of shear stress	illy for summat	lion		בר,	דר,	- 46	- 46	-28	- 28	.54	.59	
	COMBINED ST	RESS INTEN	SITY, S	·		· · · · · ·							
	1) Mher have	n ơ <sub>c</sub> , & ơ <sub>m</sub> . Hike signs	s % [2¢ + 0 <sub>#</sub> 1 \	VIIG - U.F + 4P	H. 64	12.27	7.39	6.09	17.52	15.44	4.48	2.76	
	2) When	, r <b>O</b>	S = lorgest of $a_0$ , $a_n$	•r 0 <sup>4</sup> 4 - 0 <sub>8</sub>	KST	KST	KSI	KST	KSI	KST	KSI	KSI	
	3) When have	unlike signs	$s = \sqrt{(\alpha_{cb} - \alpha_{\mu})^2}$	4;?									

 $N_L/(M_L \cdot R_m^2\beta)$  so determined by  $(C_L)$  from Table 8 (see para. 4.3).

4.3 Calculation of Stresses

4.3.1 STRESSES RESULTING FROM RADIAL LOAD, P. 4.3.1.1 Circumferential Stresses (a,):

4.2.2.5.2: When considering bending moment  $(M_i)$ :  $\beta = K_L \sqrt[3]{\beta_1 \beta_2}$  where  $K_L$  is given in Table 8.

Step 1. Using the applicable values of  $\beta$  and  $\gamma$ 

P=	1H=	0.10	COEF 1C-1	7220.99	I
MC=	COEFS 28=		U.28 COFES	121.02 8004.66	ס י ע
420000.00	<u></u>	0.06	20=	енме	0
ML= 260000.00	COEFS		0.20	-15871.66	l v
MT=	3H=	2.60	20-1=	13460.12	
250000.00	COEFS		0.20.	-2307.17 -15200.48	16
VC= 5500.00	4 <b>R</b> =	2.80	COEFS 3C=	12563.95	
WI =	COEFS	en de la companya de Esta de la companya de	37.00	-1411.00	JO H
3000.00	1 B =	0.06	COEFS 4C=		<b>7</b> 3
	0553		47.00	SHEARS	
T=	B-1=	0.06		125.05	7
1.75	orro	0.00	853.95	58.21	2
R0= 8.00	UEFS B=		9325.71 216.83	SUMS. 480.31	0 N
RM=		. <b>19:, 1 1</b>	12034.99 453.84	480.31 230.21	
420.90	COEFS 28-1=		4366.18	230.21 287.05	
KN=		0.11	SJMS	287.05 423.47	
1.00	COEFS 3B=		-14999.69 12384.10	423.47	LTR
KB=		9.00	-5359.65		121
1.00	COEFS 4B=		~22431.49		N
GAMMA= 240.51		2.40	2072.15		<b>o</b> , - 0
	COEFS				
			· · · · · · · · · · · · · · · · · · ·		
	ىدىمىمەرىما رەيەردىيە <del>ب</del> ىلى 14. 1	n an an State Stat			

• •	•		lablu 5—L	oniputation Sh	eet for	Local S	trosses	in Cylind	drical Sh	ielis L	<b>TR</b> 12	17	6 -	A-1
	: • • • •	<b>1</b> 0	6" DIÀ	NOSST	E	Pm ·	+ Q	•••			F M	- • · ·		· · · · <sup>·</sup>
	1. Appligi	d Loods"		1.	Geometi	ic Perame	ters	•	· 'o	Ve	Me	ج		,
•	Rod Cire .::: Lori Tor	ial laas, Moment, ig. Mamints, sidn Moment.	P	b.	ץ וו	$\frac{Rm}{T} = 1$	·· 0·	<u>616</u> 6		Du Du D	er er	-VL RO	UND CHMENT	ļ
	She She	or Lood, or Lood,	Ve - 5500 16. VL 3,000 16.	· ·			Rm		1	AU.	SX	8u	2	
••	-2. Geome	try	1.75	• .	· a) me b) be	mbrane lo nding lood	ed, Kn   , Kb   _		(AA)	⊷T ∱` ∖ AL	71	° <sup>8</sup> ∟ ((	})	
	V et Attr V,et	ochment rudius, " sel rodius, "	$r_{0} = -\frac{6.0}{420.2}$ in.	•	NOT E: accorde	Enter all ince with a	force valu sign conve	ves in Intion	~//~ 	TINDR	ICAL S	N HELL	• /	
	From	Pred entries	Compute al	and the volume of	····-	STRESS	ES - il lo	nd 15 0000	site that s	hown, rev	cise signs	shown	·	•
	Fig.	lor	Stress or	id enter result.		Au	AL	Bu	BL	Cu	CL	Du	DL	
• •	1 3°C	NO = 37	$K_{n} = \left(\frac{NO}{P^{-1}R_{m}}\right)$	P RmT		85	7.85	<del>.</del> .85	7.85	7.85	85	785		
•	۱c	<u>₩Ú</u> ₽ <b>Ξ.</b> Ζ8	$\frac{Kb}{S} \left(\frac{MO}{P}\right)$	6P T2		-9.33	+9.33	-9.33	+9.33	9.33	to.33	· 9. 33 ·	9.33	
•	3.4	H.() Z.C Me. Rm /	$K_{n}\left(\frac{NC}{Me\cdot Rm^{2}\beta}\right)$	)• <u>Mc</u> Rm <sup>•</sup> /\$T						72	77	4.zz	+.22	• •
<u>.</u> 1	1.4	<u>- NÚ</u> <u>He Rm/3</u> . =11.	$\frac{K_{b}\left(\frac{-M_{1,2}}{M_{c}/R_{m}/3}\right)}{\frac{M_{c}}{M_{c}}}$				<u>MK</u>			12.03	+	17.03	17.03	
:	38	HC	$K_{\rm fr}\left(\frac{\rm NC}{\rm ML2Rm^2/3}\right)$	$\left(\frac{ML}{R_m^2/3T}\right) = \frac{1}{2}$		15	1.45	445	t.15					7
	<sup>1</sup> j'18 of 18-1	ML Pm/1 - Ob	$Kb\left(\frac{M\odot}{MI\cdotRm/f}\right)$	- <u>6ML</u> Rm/ST2		-4.37	+4.37	tq.37	-4:37			MA CAR		
•	Add alge of the stre	braically for summains and a sea, and a				15.00	12.38	-5.76	1.56	722.93	26.29	2.07	-3.35	1
	40	$\frac{N_{s}}{P/R_{m}} = 47$	$R_n\left(\frac{N_n}{P/R_m}\right)$	<u>P</u> RmT		-1.08	- 1.08	-1.08	7.08	-1.09	-/.08	7.08	-1.08	
•	20	H+ P 2.20	$Kb\left(\frac{M_{R}}{P}\right)$	6P 1 T2		-6.66	+ 6.66	-6.66	+ 6.64	-6.4.6	+1.6	-6.66	H., 66	
•	4.4	$\frac{N_{\pi}}{M_{r} R_{m^{2}} \beta} \stackrel{Z \to B}{=}$	$K_{n}\left(\frac{N_{\pi}}{M_{c}/R_{m}^{2}/3}\right)$	)• <u>He</u> Rm²/3T =					11H	23	23	1 .23	+.23	
	2 .	<u></u>	$H_{b}\left(\frac{M_{a}}{M_{c}/R_{m}/3}\right)$	• <u>6Mc</u> Rm/j T2						-7.72	+7.72	+ 7000	-7.72	۰.
11	48	H Z 1 ML/Rm2/1	$= K_{\rm H} \left( \frac{N_{\rm H}}{M L^2  {\rm Rm}^2  {\rm f}^3} \right)$	• HL Rm2/37		12	12	+.1Z	+12			HIII III K		
	28 •/ 28-1	ME Rm/1 -11	$Kb\left(\frac{Ma}{ML^{2}Rm/l}\right)^{2}$	6ML Rm/iT <sup>2</sup> =	•	-3.00	$t_{8,\infty}$	+8.00	8.00			<i>M</i>		
,	Add alge of X stre	braically for summat sats, 0 x =	lien			-5.27	13.46	.38	-z.31	-15.20	12.56	z9	1.41	
	Shear sti to Torsi	on, MT	тфя = тя	$\phi = \frac{M\pi}{2\pi r_0^2 T}$		+-36	t.36	+.36	t.36	<del>1</del> .36	+.36	1.36	+.36	
	Shear sta to load,	Vc	7 x	ა <u>- ∀</u> ლ. ოი⊤		+,13	+.13	-,13	13					
: ·	Shear str to lood,	ess due VL		ό <u>VL</u> πιοΤ						٣.0٦	To ."	+.07	+. 07	
	Add Alge of sheer	braically for summa etresses, 7 🚽	tion			.48	. 48	. 23	:23	.29	·29	·42	.42	
	COMBIN	ED STRESS INTEN	SITY, S											
	. 1)	When 05 & 08 heve like signs	s = n'[2φ +	σ <sub>π</sub> ) √(···ċ, <sub>□</sub> · σ <sub>π</sub> )	12 + 472	16.08	13.6A	5.76	6.88	22.44	20.30	2.51	3.43	
	2)	When F - O	S - largest of	ng, a <sub>n</sub> <del>a</del> 1 ag - a	·- ]			~>1	~>+	K-51		KSL	KS1 :	
· .	3)	When 125 & 17 <sub>2</sub> have unlike slans	s V (114) -	- 1	•									
	<u> </u>		4	·		1	L	L		1	I		<u>.</u>	

 $N_L/(M_L/R_L^2\beta)$  so determined by  $(C_L)$  from Table 8 (see para. 4.3).

4.2.2.5.2: When considering bending moment  $(M_i)$ :  $\beta = K_L \sqrt[3]{\beta_1 \beta_2}$  where  $K_L$  is given in Table 8.

#### 4.3 Calculation of Stresses

4.3.1 STRESSES RESULTING FROM RADIAL LO P.

4.3.1.1 Circumferential Stresses (a,):

Step 1. Using the applicable values of  $\beta$  an

				· -	• •	· · · · · · · · · · · · · · · · · · ·	-		
P=	<u>.</u> .	CO 18	0.11		10-1-	0 V3	40.34 970.26 13.96		HP
MC= 650) MI =	30.00 :	COEFS 2A=	0.06	÷	C0EFS 2C=		820.99		186-
300( MT=	30.00	COEFS 3A=			COEFS	0.20	-2193.75 1799.26 -523.84	: .	0
	)0.00 <sub>}</sub>	COEFS	2.80		20-1=	0.20	185.20	5	00
· · · 50	, 90.00	48=	3.60		COEFS 3C=	35.00	-348.19 62.31	3	= LO
VL= 100	90.00	00EFS 18=	0.06		COEFS 4C=	45.00	HEARS	Ø	AMET
T=	1.75	COEFS 18-1=	0.06			142.55	101.05 10.11 20.21		やアノ
RM=	9.00	COEFS 2B≠	0.11			1645.71 31.38 1778.81 56.89	111.16 111.16 90.95	1 - - - -	OFALE
42 KN=	.0.70	COEFS 28-1=	0.11	-	онме	447.81	50.50 80.84 80.84 121.26		
КВ=	1.00	COEFS 3B=	11.00		-	2292.97 1894.08 1283.56		217 (	7-11-7
GAMMA=	240.51	COEFS 4B=	2.70	·	-	1112.24 3598.46 3250.60 21.92 28			0°
¥	0.02		. *	····	:				A-12

·. "

			Table 5—Compu	itation Sheet for	Local SI	rossesi	in Cylind	tical Sh	clis L	TR12	17	6	A-13
	: 	n An the I	O" DIA I	AOSSTE	₽.	m + 1	Q			F ML	· - •		· • •
<i>.</i>	1. Applied Radi Circ, Lang Tors Shea Shea	Loads" of Ipad, , Moment, g, Moments, , Moment, , Load, pr Load,	P $\frac{3000}{65000}$ lb. Mc $\frac{65000}{1000}$ n. lb. M1 $\frac{30000}{1000}$ n. lb. M1 $\frac{90000}{1000}$ n. lb. Vc $\frac{2000}{1000}$ lb.	3. Geometri 7 /l Stress C	c Paramet <u>Rm</u> - 3 (0.875) <del>r</del> A	ers 24,0.5 0 0.0	<u>518</u> 7		2 Du Du Au	M M	-VL ATTAC Bu	IND HMENT	
•	2. Geomet Ves Atta Ves	ry set thickness, ichment radius, set radius,	T = <u>1.75</u> in. 10 = <u>9.0</u> in. Rm <u>420.9</u> in.	oj men b) ben *NOTE: occordor	ding load, Enter all nce with s	Kb L Kb L larce valu ign conve	Rm <sup>2</sup> Rm <sup>2</sup>		LINDR	CU CL	HELL	リ	
<sup>74</sup> i [	From	Réad curves	Compute absolute	values of	STRESS	ES - il lo	ad is appo	site that s	hown, rev	erse signs	shown		
	3.6		$\frac{\text{stress ond enter}}{K_n \left(\frac{NO}{2}\right) \cdot \frac{P}{2}}$	· · · ·	<u>Au</u>		8v 		<u> </u>	- 14	- 14		
	10	MÚ = 70	$\frac{(P'Rm/Rm)}{Kb} \left(\frac{M(J)}{Rm}\right) \cdot \frac{\delta P}{Rm}$		- 1.1	-19 +	-14	+//6	-160	*		+, 4	
	3 .	H () 2.8	$\frac{1}{K_{n}}\left(\frac{N\dot{\Theta}}{M_{e}\cdot Rm^{2}\beta}\right)\cdot\frac{M}{Rm^{2}}$	ie βτ		1.65 M			03	- - -	1.65 +	t. 03	
.i	14	M.G11 Me Rm/3	$Kb\left(\frac{Mi}{Mc/Rm/I}\right) \cdot \frac{6N}{Rm/I}$	Ac (177					-1.78	+ 1.78	+1/18	1.78	
	3 B	NC: ML Rm:/1 = []	$K_{n}\left(\frac{NL^{2}}{ML}\frac{NL^{2}}{2Rm^{2}/3}\right) \cdot \frac{M}{Rm^{2}}$	<u>i</u> // - ?	ا ک <sup>ر</sup>	-``C	4,06	4.06					
	' '18 or 18-1	MU 106	$Kb\left(\frac{M(j)}{MI-Rm/I}\right) = \frac{6K}{Rm/I}$	4L	45	t. 97	t.as	7.15			11 May		
	Add alget of the street	ses, rd =	(en ,		-2.29	1.89	-1.28	1.11.	-3.60	3,25	.02	29	•
	40	$\frac{N_{\pm}}{P/R_{m}} = 45$	$K_n \left(\frac{N_B}{P/R_m}\right) \cdot \frac{P}{R_m T}$		18	-, 1E	- 18	- 18	- 18	15	18	Ţ IB	• •
•	2 C	M# = 120	$Kb\left(\frac{M_{H}}{P}\right) + \frac{6P}{T^{2}} =$	`	- 1.18	41.18	-1.18	+1.18	-1.18,	+1.18	-1.16	+1.18	: .
•	4.4	HT Bright B	$K_{n}\left(\frac{N_{z}}{M_{c},R_{m}^{2}/l}\right) \cdot \frac{M}{R_{m}^{2}}$	ne PAT					04	7:04	+ <u>`</u> 0∢	+.04	·
	2.4	M= -055 Mc. Rm/3 -	$\frac{1}{16}\left(\frac{M_{\rm H}}{M_{\rm C}/R_{\rm H}/3}\right) = \frac{6}{R_{\rm H}}$	Mc /} 72 -					97	4- 97	+.97	97	1
14	48	<u>Η</u> <u>Μί/θm²β</u>	$K_{\rm II}\left(\frac{N_{\rm II}}{MU'{\rm Rm}^2/{\rm I}}\right) \cdot \frac{K_{\rm II}}{{\rm Rm}^2}$	4L 2/37 "	<u></u>	01	+.01	+ . 01					
•	28 er 28-1	ME O 1	$K_{b}\left(\frac{M_{a}}{ML}R_{m}/l\right) \cdot \frac{6M}{R_{m}}$	ML	87	+.8Z	<b>t</b> . 87	<del>.</del> 82			<u>MH</u>		
	af X stre	bialcully for summą ssts, 17 ± =	llon		-2,19	1.80	-52	.18	-2.31	1.92	35	.06	
	Shear ste to Torsie	ess due on, My.	ribin = 1×5 =	<u></u> 2 <i>π</i> r <sup>2</sup> <sub>0</sub> T	+.10	+,10	+ .10	+.10	+.10	+.10	+10	+ 10	
* .	Shear str to lood,	ess due Vc	7×0 -	Υ <u>ε</u> πιο Τ	+ .01	+. 01	-01	-, 01					
	Shear stri to lood,	ess due VL	τ×ό «						-02	50.7	+ 02	4.02	
:	of shops	ibralcally for summa stresses, f =	tion		.11	. 11	.09	وه.	.08	.08	12	.12	
	COMBIN	Then OL & T		P		7						20	
:		have like signs	\$ 10 % [ 74 + 0 <sub>#</sub> +	$V(n_{Ck} - \sigma_{x} p \in 4P]$	KSF	I CSI	1.29 KSI	1.12 KSI	K21	KSI	.49 KSI	~>>   <si< td=""><td>I .</td></si<>	I .
•	2)	When I. · D	$\beta = 1 \text{ teroset of } (45, 4)_{\text{B}}$	$[a, a] = a_{\rm H}$									
	3)	When 115 & 17 heve unlike signs	$S = \sqrt{(\alpha_{cb}^2 - \alpha_{\mu})^2}$	1 477				<u>.</u>					·

 $N_t/(M_L/R_m^2\beta)$  so determined by  $(C_L)$  from Table 8 (see para. 4.3).

4.3 Calculation of Stresses 4.3.1 Stresses Resulting FROM RADIAL LO

4.2.2.5.2: When considering bending moment  $(M_i)$ :  $\beta = K_L \sqrt[3]{\beta_1 \beta_2}$  where  $K_L$  is given in Table 8.

- P, 4.3.1.1 Circumferential Stresses  $(\sigma_{\phi})$ :
  - Step 1. Using the applicable values of  $\beta$  an

		·								
· · · · · · · · · · · · · · · · ·	CDEFS					-	116 76			
°≕ 2000.00	14=	0.11		.COEFS 10-1=			587.76			
C= 55000.00	COEFS 2A=	а аб	·	COFES	0.28	·	615.74 48.87 1847.23			1 8
				20=	· . ·					U
L= 90000.00	COEFS 38=			oonno	0.15	SUM:	3 -2600 co			
IT=		4.00		COEFS 20-1=			2269.35			X
30000.00	COEFS 4A=	· .'		-	0.15		1191.59 -1327.36		D	_
/C= 2500.00		5.00		COEFS 3C=			-1355.81	- er.,	3	
/L=	COEFS 1R=				33.00		-53.21 -109:19		ດ	R
2500.00	10-	0.06		COEF(S) 4C=						
t p 	COEFS 18-1=				43.00	SHEF	IRS			7
r= 1.75		0.06				- - -	18.95 37.89		,	3
20 =	COEFS				89.60		37.89			0 1 1
12.00	28=	0.11		. 1	077.14 28.45 120 02	SUMS	56.84	· · ·		
RM= 420.90	COEFS 28-1=			1	174.55 007.58		56.84			
	1	0.11		•			-18.95 -18.95		LTR	
KN= 1.00	COEFS 3B=			SUMS -21	368 00		-18.95 56.84	ļ.	12	1
K8=	00-	15.00	ł	18	340.57	STRF	56.84 SS	:	5	G
1.00	COEFS 4R-		:		-4.61 174.51 844 BC	INTE	NSITIES 2613.81			ā
CAMMA= 240.51	4D-	4.20	:	21	277.00 107.96 -29 ии	;	2276.76	:	.L	
· · · · · · · · · · · · · · · · · · ·	COFFS			-	92.88		1502.35	i		
0.02 7		0.28				•	2108.30			J
		• •			-		116.14 158.46	• 1		

•••			lable 5 - Computation Sho	eul Ior Local S	trusses	in Cylinc	drical Sh	eli L T R	121	76	-	- 14
	24	4" DIF	A. NOZZLE A	m+Q	•	•			<i>f</i> ™	L	₩, •	
	1. Applied	l Loods"	2, 0	Geometric Parame	iers		' 'a	Vc.	¢ Mc		:	•
	Radi	lai leas,	P 2000 16	. <u>Bn</u> -	240.4	5		2		_v.	•	
	Cire Lon	, Moment, g, Moments,	Mc -90,000 in. 1b. ML -90,000 in. 1b.		•	0740				RO	UND.	
•	Tors She	sion Monent, at Lood.	N1 = <u>10,000</u> in 16. Vr - <u>2,500</u> lb.	/1 (0,075) -		<u></u> 247		Au	<b>~</b>	ATTA Bu	CHMENT	
	. She	er Lood,	VL 2,400 16.	Succes Conception	Internetion				$\supset$	+	2	$\mathbf{v}$
	2. Geomet	117	· • •	· o) membrane to	id, Ka		(AA)	⊢T /` Α,	71)	`B∟ Íí	<pre>()</pre>	
	Ves	sel thickness,	$\gamma = \frac{1 \cdot 12}{12} in$	NOTE: Enter all	, ND ·	ves in	N/J/		<sup>C</sup> u ċĻ	1		
	Ves	sel radius,	Rm 4209 in.	accordence with i	ign conve	ntion	<u>C</u>	LINDR	ICAL S	HELL		
· ſ	From	Read curves	Compute absolute values of	STRESS	ES - if ła	ad is oppo	sile that s	hown, rev	crse signs	shown	·j	i
ļ	Fig.	lor	stress and entar result +	Au	A.L	<u>8</u> 0	BL	Cu	CL	Du	DL	
· .	30	NO - 33	$K_{n} \left(\frac{HO}{P R_{m}}\right) \cdot \frac{P}{R_{m}T}$	09	09	20.	09	وه.+	- 09-	1.09	ده.	
. [	10	MÚ	Kb (MU) . 6P	·	u.		<u>,</u>				<u> </u>	
		p28	P / T2	1.10	1.10	1.10	1.10	<u> </u>	T 1.10	1.10	71.16	
•	3.4	He.' Rm /	$K_{n}\left(\frac{R_{0}}{M_{c}\cdot R_{m}^{2}/3}\right) \cdot \frac{R_{c}}{R_{m}^{2}/3T}$		MU			03	. ro.	+.03	4.02	
	1.	Mú	Kb () 6Mc						4	+		
		Me Rmfi 15W	\Mc/Rm/S/ Rm/ST?		///////////////////////////////////////	¥#####################################		1.13	71.13	1.13	1.13	
	38	ML Rm2/1 =15	Kn ( ML / Rm=/3) · Rm=/3 T	1.17	-:17	4.0	4.17					
	18 or	H¢ -	Kb ( )								STILL.	
		ML, Rm/3 -06	\MI Rm/5 / Rm/5 12	<u></u>	1.01	1.01	1.01	1111155				
	of \$ stie	sses, nd -	ien	-2.39	1.84	0	.17	-2.34	2.12	03	-09	
- [	4C	N= - 12	$K_n\left(\frac{N_n}{M_n}\right) \cdot \frac{P}{M_n} = V'$	-								
		42 42	<u>(P/Rm/ RmT</u> (Mr) 6P		•12	-12	16	12			1.12	
	2 C	F 1.15	$\frac{Kb}{P} \left( \frac{-p}{T^2} \right) + \frac{-p}{T^2}$	59	وي.+	59	+.59	7.59	4.59	59	4.59	
	44	N	$K_n\left(\frac{N_n}{1-N_n}\right) \cdot \frac{M_n}{N_n} =$		3911	ISTII.	HAN I	-		4		
-		M= .055	(Mc. Rm/)) Km/)) ( Mu ) 6Mc		4.11			.09	<u>.09</u>	1.04	7.04	
	· 2A	Mc. Rm/3 -	Pb (Me/Rm/3) * Rm/172		111 Martin Starten Sta		Mit Marka	62	7.62	+.62	62	
11	48	$\frac{N_{1}}{ML/R_{0}^{2}H}$	$K_{\rm H}\left(\frac{N_{\rm H}}{ML/R_{\rm H}^2/H}\right) \cdot \frac{ML}{R_{\rm H}^2/R_{\rm H}} =$	- ~	- ~							
	28 er	. Ma	( Ma ) 6ML		.03	1.05	7.05	2000				
	28-1	ML Rm/3 -11	Kb (ML'Rm/3) Rm/3T2	7.85	1.85	+1.85	785			MM .		
	Add algel of X ste	broicolly för summai sata, 17 m m	ien '	-7.60	,	1,19	- 22	-1 2/	1.00	- ~	L	
	Shear str	ess due			<u> </u>		1.22	1.26	1.03			
	te Torsie	en, MT	τώx = τ×ψ = 2πτ <sup>2</sup> T	1.02	+ .62	4.02	4.02	toz	4.0Z	+.02	H.02	
•	Shear str	vessidue : Vic	7x0 = 7+0T	+.04	+.04	04	04				IIII	
	Shear str	ess due	r∡d ∞ VL	3400	541111	KUI	SUM	<u> IIIII A</u>				1
	to load,	VL	<u> </u>					<u>04</u>	1.04	1.04	7.04	
	of shoor	oraicaliy for sumpà: stresses, 7 =	lien .	-06	.06	02	- 02	- 02	507	+06	.06	[
	COMBIN	ED STRESS INTEN	SITY, S			·		<u> </u>				1
	, I)	When of & o	s. K Jak a 1 Jund - 0	P + 4P 1	[	<u> </u>	<u> </u>		<u> </u>	[	[	1.
		have like signs		19-21	5.28	1.20	1.50	Z.39	Z.11	.12	.16	
	-	1 Mil		KSt	KSI	1<51	KSI	KSI	IS I	KSt	KST	ł
	2)	When 7 · U	$3 \simeq 1 \text{ orgest of } \theta_{ij}, \theta_{ij} \text{ or } \eta_{ij} = 0$	<b>*1</b>				1		· ·		1
	) )	When I'd L II	\$ 1100 - 11 18 1 ATR									
· I	L	neve unlike signs		l	L		<u> </u>	I	1	1	1	<b>j</b> –

 $N_t/(M_L/R_m^{i}\beta)$  so determined by  $(C_L)$  from Table 8 (see para. 4.3).

4.3 Calculation of Stresses 4.3.1 STRESSES RESULTING FROM RADIAL LOAD,

4.2.2.5.2: When considering bending moment  $(M_i)$ :  $\beta = K_L \sqrt[3]{\beta_1 \beta_2}$  where  $K_L$  is given in Table 8.

Ρ. **4.3.1.1** Circumferential Stresses  $(\sigma_{\phi})$ :

Step 1. Using the applicable values of  $\beta$  and  $\gamma$ 

(	•			X
P	- Cf • 16- 8.11			
MC= 90000.00	COEFS 2A=	ม 10 ย.18	806.06 -87.92 2537.61	96-1
ML= 170000.00	0.06 COEFS 3A=	COEFS 2C= 0.12	SUMS -2917.66	515
MT= 10000.00 VC=	5.10 COEFS 48=	COEFS 2C-1= 0.12	2333.41 -2271.60 -1156.84	
1000.00 VL=	6.30 ^OEFS 8=	COEFS 3C= 32.00	925.50 572.59 -569.33	
1200.00	0.06 COEFS	:FS = 42.00	3HEARS	
T= 1.75 RO=	18-1= 0.06 COEFS	ः वित्र वव	4.84 12.13 18.19	ETER
15.00 RM=	28= 0.10	352.65 47.48 1477.78	SUMS 16.17 16.17 -8.08	20
420.90 KN=	28-1= 0.10	1522.57	-8.08 -14.15 -14.15	
1.00 KB=	COEFS 38= 18.00	SUMS -2235.19 1515.25	22.23 22.23 Stress Tics	TR121
GAMMA= 240.51	COEFS 4B= 5.00	-896.83 -1921.36 1739.51		-11-78 -11-78
E 33	COFFS_	- ,	r r	
				A-16
	• • • •	· · · · ·		

•	ь •*		12014 5-	Computation	Sheet for	Local S	lrosses	in Cylini	drical St	iclis	LTRI	217	<b>.</b>	A-1
	а Ада	·*	30"	DIA	NOZ	SLE	P	m t	Q		PM	⊆ <b>⊥</b> .∥ L	0 ~	
	1. Applie	d Looas*			3. Geometi	ile Parama	ters		'.	,_V <sub>c</sub> .	Mo			
	Rad Circ Lon Tor She She	liel Ipad, c. Moment, ig. Moments, sign Mament, ar Load, ar Load,	$P = \frac{1000}{1000} \text{ lb.} \\ Me = \frac{90,000}{1000} \text{ in.} \\ MI = \frac{170,000}{1000} \text{ in.} \\ Ve = \frac{1000}{1500} \text{ lb.} \\ Ve = \frac{1500}{1500} \text{ lb.} \\ \text{Ib.} \end{cases}$	(b.  b.  b.	Y  } Stress (	<u>Rm</u> T (0.875) - Concentral	<u>240</u> .5  Rm.	312				-VL ATTA		
	2. Geome	try .	• 1.75 in		. a) ma b) ba	mbrane lo nding load	ad, Kn I, Kb —	<u>/_0</u> /_0 <b>R</b> m'	t(+);		71	` <sup>8</sup> L (	))	·
	Atte Ves	ochment radius, ssel radius,	ro - <u>15</u> in. Rm <u>4709</u> in.		*NOT É: accorde	Enter all ance with	force val sign convo	ues in ention				N HFLI	:	
	From	Read curves	Compute	absolute values	of	STRESS	iES - if la	ind is oppo	site that	chown, rev	crse signs	shown	1	
· '.	Fig.	lor Nu <sup>1</sup> i	stress a	enter result	•	Au	AL	<u>6</u> u	BL	Cu	CL	Du	DL	
	1 9c	P . Hm = 32	$K_n \left(\frac{1}{P \cdot R_m}\right)$	RmT		01	01	04	04	04	04	04	.01	
·	10	<u>₩0</u> = .18	$\begin{array}{c} Kb  \left(\frac{MG}{P}\right) \\ \vdots \\ \end{array}$	τ <sup>2</sup>		35	+.35	T.36	1.35	36	+.35	-,35	4.35	
	34	$\frac{N(\beta)}{Me_{1}^{2}Rin^{2}/\beta} = \frac{1}{2}$	$K_{n}\left(\frac{NO}{Me-Rm^{2}}\right)$	$\frac{M_c}{R_m}$ $\frac{M_c}{\beta T}$						05	05	+.03	+05	
1	14	Mc Am/1 = 11	$K_{b}\left(\frac{-\frac{M_{1,2}}{M_{c}/R_{m}}}{\frac{M_{c}}{R_{m}}}\right)$	$\left(\frac{6Mc}{Rm/1T^2}\right)$						7.10	+1.48	+1.18	-1.48	
:	38	NU 10	$K_{\rm H} \left( \frac{\rm NC}{\rm ML  2  Rm^{2}/3} \right)$	$\frac{ML}{Rm^2/3T} =$		37	-32	1.32	1.32	HU				
	18 or 18-1	MC	$Kb\left(\frac{M\odot}{M-Rm/3}\right)$	) - 6ML -		- 1.52	+1.52	+1.52	-1.52					
	Add olge ol Ø stie	broicolly for summa isses, rd =	lion		<del>.</del> .	-724	1.57	1.44	- 99	-1 97	1.7A	1.13	-117	
- 1	4C	N= -42	$K_n\left(\frac{N_n}{P/R_n}\right)$	• <u>P</u> =,	<u>`</u>	06	06	06	- 06	96	- 06	06	1.06	
	2 C	₩# ₽ ₽.12	$K_b\left(\frac{M_H}{P}\right)$	6P 1 T2	······	74	+ .74	24	4.24	74	+.74	74	4 24	
•.	4.4	N= 633 Mr Rm2β	$K_{\rm R} \left( \frac{N_{\rm H}}{M_{\rm C}, R_{\rm m}^2/r} \right)$	$\frac{1}{Rm^2/3T}$ -			1.	III.				+ 0.6	+ 04.	
7	2.4	Ma 106 Mc. Rm/3 -	Fb ( Ma	$-\frac{6Mc}{Rm/3T^2}$							1.81	4. 2.1	- p.1	•
11	48	HR 50	$K_{\rm II} \left( \frac{N_{\rm H}}{M L / R_{\rm H}^2} \right)^2$	) · ML	1		-09	+ 0.9	+.c.s	Ŵ				
	28 or 28-1	Ma L. ML Rm/3 - \(	Kb ( Ma - )	) • 6ML Rm/372 =		7 54	5.50	+2 5.4	7.61			<u>Hill</u>		
	Add algs of X at e	braicutiv for summe sats, (7 p. sc	tian			-292	762	7.72	7.77	- 11 L	.97	.27	- 67	
,	Shear str to Torsi	ess due on, Mr	r¢ x = T	$xs^{i} = \frac{M\tau}{2\pi r^{2}}$	т т	+ ^	4 0	+ 0	+ 0		+ 2	+ 1	+	
	Shear str te laad,	vesa due Ve	1	<del>م</del> ×دا <u>بر</u>	٣	+ .01	+ .01	- 01		X	S.	XIII.		
	Shear ste to lood,	ess due VL ·	r:	x 3 <u>VL</u>					Ì	- 107	- 07	1 07	+ 02	
·. :.	Add Alga ut shear	braically for summa stresses, 7 ==	tion			;01	. 01	-,01	- 01	- 07	- 07	107	.07	
	COMBIN	ED STRESS INTEN	ISITY, S			1	1	I						
	), I)	When Of & CR have like signs	S == Ys [745	• a <sub>z</sub> + √(a <sub>0</sub> )-	. U <sub>R</sub> F + 4P	2.92 KSI	Z 63 KS E	2-33 KSE	2.27 KS1	1.92 KSt	1.74 KSt	IJB KSI	1.12	
	2)	Whan I . O	ji S = largest of	asian n lag	5 - 0 <sub>n</sub>								~>1	
	3)	When 115 & 172 have unlike signs	$\mathbf{s} \in \sqrt{a_{\mathcal{S}}}$ =	·/_)2 . 472										
	•						· · · · · · · · · · · · · · · · · · ·					<b></b>	<b></b>	

 $N_L/(M_L/R_m^2\beta)$  so determined by  $(C_L)$  from Table 8 (see para. 4.3).

4.3 Calculation of Stresses

4.3.1 STRESSES RESULTING FROM RADIAL LO ·P.

4.3.1.1 Circumferential Stresses (a,):

Step 1. Using the applicable values of  $\beta$  an

8.

(		· · · ·	(			
	( COEFS	9.11	C 1 0.32	17 806 28 2586	.38 .06 : :51 .12	H6-2
MC= 20000.00	28=	9.06	COEFS 2C=			218
ML= 35000.00	COEFS 3A=		0.21 COFF®	SUMS -2982 2806	.60 .79	
MT= 5000.00	COEFS 48=	1.30	20-1= 0.21	2246 -2308 -1191 1637	.66 .44 .41	,0/
VC= 500.00	COFES	1.60	COEFS 3C= 42.00	455	), 47 ), 51 , - +	DI
VL= 500.00	18=	0.07	COEFS 4C=	SHEARS		CA M
	COEFS 1B-1=	0.07	50.00		3.19 3.19 3.19 3.19	ETER
R0=	COEFS 28=		49.89 470.20 14.12	SUMS	6: 38	Z
RM=	COEFS	E . I I	1477.78 96.94 		3.00 9.00	0221
an generalisen synaptical and synaptical and such a such	n	0.11	CIENC	3 	0.00 6.38	- M
KB= 1.75	COEFS 38=	5.10	-2145.20 1851.54 1105.00	SIRESS INTENSIO	6.38 <b>TRIZI</b>	7-7
1.50 GAMMA= 240.51	COEFS 4B=	1.50	-1010.92 -2012.00 1883.98 971.81		7 6	-78
0.01	CNEFS		-1043.35			
		andra and an and an	ال من المراجع المراجع المراجع المراجع المراجع مراجع المراجع ا			A-18
					· · · ·	

			Table 3-Compulation Siles	et for Local St	Fessus H	n Cylinai	icei soe	905 A T	e 1 2	1 7	e	
	·	10'	DIA. HOZZL	E Pm	+ Q ·	tF .		1	ML	17-0	D F	19
	<ol> <li>Applied Rodi Circ Uony Torr Shec</li> <li>Geomet Ves Atto</li> </ol>	Looos <sup>*</sup> ol lood, P Moment, M g. Moment, M ican Moment, M ir Lood, V ir Lood, V ir Lood, V ir sel thickness, T schment redius, 7	3. Go 500 lb. $z = \frac{20000}{2000}$ in. lb. $11 = \frac{5000}{100}$ in. lb. $12 = \frac{5000}{100}$ in. lb. $12 = \frac{500}{100}$ lb. $12 = \frac{500}{100}$ lb. 50 $1 = \frac{1.75}{100}$ in.	eametric Parametr Y <u>Rm</u> - A /i (0.875) <del>/</del> , tress Concentrati a) membrane laa b) bending laad, iOTE: Enter oll	ers 240.5 m on due to: d. Kn Kb List force volume	210 15 50 Rm			MAT I I I I I I I I I I I I I I I I I I I	- P -VL ATTAC Bu BL I (		$\widehat{}$
	Ves	sel radius, f	R. 4492 in. 0	ic <u>c</u> ardance with s	ign conver		<u>CY</u>	LINDRI	CAL SH	IELL		
	From Fig.	Read curves	Compute absolute values of stress and enter result.	STRESS	ES - if fon	d is oppos Bu	BL BL	Cu	CL	shown Di	DL	
	30	NO = AZ	$K_{n} = \left(\frac{N\dot{\phi}}{P \cdot R_{m}}\right) \cdot \frac{P}{R_{m}T}$	05	05	05	05	05	05	-,05	05	
·	۱c	mui =0.32	$Kb = \left(\frac{M_1S}{P}\right) \cdot \frac{GP}{T^2} - \frac{1}{T^2}$	47	+.47	47	+ .17	47	+.97	47	+.47	
	34	He Ring L3	$K_{n}\left(\frac{NC}{M_{c}-Rm^{2}/\beta}\right) = \frac{M_{c}}{Rm^{2}/\beta T}$		X			01	01	+.oi	+.01	
.1	1.4	Mi, , Mc Rm/i =-11	$K_{b}\left(\frac{M_{1}}{M_{c}/R_{m}/\beta}\right) \cdot \frac{\delta M_{c}}{R_{m}/\beta^{2}}$					- 1.97	4 197	+ 1.47	-1.97	
:	3 B	NG ML Rm=1/1 5.1	$K_{n}\left(\frac{NC^{2}}{ML^{2}/Rm^{2}/3}\right) = \frac{ML}{Rm^{2}/3T} = \frac{1}{2}$	- ,10	-,10	+.10	+.10					
·	18 or 18-1	ML Pm/1	$\frac{K_{b}\left(\frac{M_{i}}{M_{i}},\frac{M_{i}}{R_{m}/2}\right)}{M_{i}} = \frac{OML}{R_{m}/2T^{2}}$	- 1.53	+1.53	+1.53	-1.53		M			
	Add alge al () stie	brnically far summations and the second s	eh '	2.15	1.85	1.10	-1.01	2.01	1.88	.97	1.04	
-	40	N: 50	$K_{n} \left(\frac{N_{n}}{P/R_{m}}\right) = \frac{P}{R_{m}T} =$	06	-06	-,06	06	06	-`œ	06	06	
•	20	<u>₩</u> # <b>₽.2</b> ]	$K_{b}\left(\frac{M_{x}}{P}\right) \cdot \frac{\delta P}{T^{2}} = \frac{1}{T^{2}}$	31	+.31	31	+.31	31	+.31	31	+.31	
•	4.	<u>Nr 'Rm<sup>2</sup> /</u>	$K_{n}\left(\frac{N_{H}}{M_{C}, R_{m}^{2}/3}\right) = \frac{M_{C}}{R_{m}^{2}\sqrt{3}T} =$					oz	<u>02</u>	4.02	+.oz	$\sim$
	2 A	Mc Rm/3 .06	$\frac{Fb\left(\frac{ma}{Mc/Rm/l}\right) \cdot \frac{omc}{Rm/lT^2}}{\sqrt{Na}}$			<u>Milles</u>		81	+.81	4.81 ≫/////	- 81 SZ///	
••	48	ML / Fm <sup>2</sup> /1 -	$\frac{K_{\rm H}\left(\frac{1}{ML^2{\rm Rm}^2{\rm Rm}^$	03	03	<b>⁺</b> .ന⊴	+.03					
	28-1 Add olga	ML Rm/1 6.11	$\frac{K_{b}\left(\frac{1}{ML}R_{m}/l\right) \cdot R_{m}/lT^{2}}{R_{m}/lT^{2}} =$	- 2.57	+2.57	+2.57	2.57		<u>Mark</u>		<u>MMS</u>	
	of X 11.0	cs13, (7 x ==================================			7.81	2.25	-2.31	-1.19	1.04	.46	54	
	Shear st to Tarsi	iess due ion, Mit	$\frac{M_T}{r(b_R + r_R \psi)} = \frac{M_T}{2\pi r_0^2 T}$	+.02	+.02	+.02	+. 02	+_02	+.oz	+. oz	t <sub>oz</sub>	
	Shear st to lood,	vess due Ve	rxώ - <u>νε</u> πτο 1	+.02	+ 02	0Z	07 2011/1		<u>Milles</u>		<u>Marka</u>	
	Shear sti to lood,	VL ·						7,02	<u>, 05</u>	+. oz	+.0Z	
	of shear	stresses, 7 =		.09	-04.	0	D	0	0	.04	<u>, о</u> д	
	COMBIN	ED STRESS INTEN	SITY, S		,		r		1	1		Į
	1	When $\sigma_{ch}$ & $\sigma_{sr}$ have like signs	$\mathbf{S} = \mathbf{Y} \left[ \mathbf{v}_{\mathbf{y}} + \mathbf{\sigma}_{\mathbf{x}} + \sqrt{(\mathbf{\sigma}_{\mathbf{y}} - \mathbf{v}_{\mathbf{x}})} \right]$	Z.98	Z.81	2.25 rst	2.31 K57	Z.01	1.88 KSI	.97 KSI	1.05 KST	
	2	) Whan 7 · 0	S.⊒. lorgest of n,j, n, or n,j = n		P.34							
	(1	When V <sub>65</sub> & M <sub>2</sub> have unlike signs	$5 = \sqrt{(a_{xy}^2 - a_y^2)^2 + 47^2}$									]

 $N_t/(M_L/R_m^2\beta)$  so determined by  $(C_L)$  from Table 8 (see para. 4.3).

4.3 Calculation of Stresses

4.3.1 STRESSES RESULTING FROM RADIAL LOAD, P.

4.2.2.5.2: When considering bending moment  $(M_i)$ :  $\beta = K_L \sqrt[4]{\beta_1 \beta_1}$  where  $K_L$  is given in Table 8.

4.3.1.1 Circumferential Stresses (0,);

Step 1. Using the applicable values of  $\beta$  and  $\gamma$ 

			· · · ·	<b>`</b> .
			· · · · ·	· · · · · · · · · · · · · · · · · · ·
	· · · ·	•	190.07	E E
MC=	COEFS	the second	6857.14 118.79 6007.09	
170000.00	20- 0.07	20=	0771.00	81.
125000.00	COEFS 3A≠	0.18	SUMS -19515.80	
MT= 51000.00	2.50	COEFS 20-1=	15108.58 -5284.04	
VC=	COEFS 48=	Солто	1351.99 -19447.13	Pr N
19500.00	2.40	соень 30= ря аа	, 14897.36 -5352.71	+ 0
vL≖ 13500.00	СОСТО (В= 0.07	30.00 30EFS	1363.21	QHA
	COEFS	4C= 45,00	HEARS	+ 3 m
T= 1.75	1B-1= 0.07		128.84 591.15	
R0=	COEFS	1621.53 14099 59	409.26	
ь.00 рм-	20- 0.10	i· 9795.92	50M5 719.99 719.99	20
420.90	COEFS 2B-1=	452.54 4897.96	-462.31	2
KN=	0.10		-280.42 -280.42	LTR d
1.75	COEFS 3B=	SUMS -21871.62	538.10 538.10°	121
KB= 1.50	00550 00550	-11170.61 -2222 65		31-
GAMMA= 240.51	48= 2.10	-26515.02 22876.00		
	C	-6527.21		
.01	]			
			. · · ·	A-2
	 			0
		· · ·	· · · · · · · · · · · · · · · · · · ·	•

	12. 0	IN. NOZZLE	Fm T	2	T 1			M	L .	-
1. Appl	ed Loods"	10 ( co	metric Parame			°, 'o	Ve	Mr		
R	adial load,	$P = \frac{ Z_{1}, Z_{2}, Z_{2}, Z_{1} _{b}}{ Z_{2}, QQ_{1} _{b}}$	$\frac{Rm}{T} = 2$	230	2		2 ) Du K	>*~}	v	
Ĺ	ong. Moments,	ML - 125,000 in. 16.		. 0	012				-RO	
5	orsion Moment, hear Load,	$V_{c} = \frac{12}{12} \frac{12}{59} \frac{12}{69} \frac{12}{6} \frac{12}{6}$	(0.875) -	Rm			Au	<b>≿</b> -↓	Bu	
S	hear Load,	VL 3,509b.	ess Concentrat	ion due to		AAT.		$\sim$	+	$\mathcal{A}$
2. Geo	n et ry	o	) membrane la	od, Kn	$\frac{1}{40}$	(AA)	⊷T Ţ` Ai	ティ	`BL []	})
v	essel thickness,		) banding lood	, ND -4		N/J		CuĊĻ	1	11
	essel radius,	Rm 4209in. occ	cordance with s	sign conve	ntion		YLINDR	ICAL S	HELL	
Euro		Company and the second second	STRESS	ES - if lo			hown, rev	CIAE Signs	shawa	· · · · · · · · · ·
Fig.	Read curves for	stress and enter result.	Au	AL	Bu	BL	Cu	CL	Du	DL
10	-N.5 = 7.6	Kn (-NU)	-,	-	_		-			_
	P·Rn 25	\P Rm / RmT	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.6
· 10	mo P = .26	$\frac{1}{1} \operatorname{Kb} \left( \frac{m(r)}{P} \right) \cdot \frac{\mathrm{d} r}{\mathrm{T}^2} = \frac{1}{1}$	14.00	+19 90	-14 00	+10 90	-14.90	+,4.90	7/1 5	H, a (
1	NO 2.5	K- ( NO),K		SIII	1411	SUII.	1.20	1.1.20		
	Me. Rm /3.	Me Rm2/3/ Rm2/3T					.20	120	4,20	4.20
1.4	Mr. 5m/1	$K_{b}\left(\frac{-\frac{M(1)}{m_{c}}}{M_{c}}\right) \cdot \frac{-\frac{M(1)}{m_{c}}}{R_{m}}$		M	V He		000	toso	3 80	+ 9 81
	NO 8.0	M. ( NC) ML					Sein	1	SETTI	1
38	ML Rmili	ML Rm:/// Rm://17	<u>,45</u>	45	4.45	4.45	12 in			
1B -	1 0_07	$K_{b}\left(\frac{M_{i}}{M_{i}}\right) \cdot \frac{6ML}{R_{m}/S} - \frac{6ML}{R_{m}/S}$	130	taon	tion	-490				
Add al	ground for symmetry	ien		1.70		1.70		1 and the second		
01 \$ 0	1100000, "d =		21.87	17.72	71.17	8.83	26.52	22.88	-653	3.6
40		$K_n \left( \frac{N_a}{\dots} \right) + \frac{P}{\dots} = \cdots$			7 -0		-			
		/ P/Rm/ RmT / Mx \ 6P \	2.00	2.08	2.08	2.00	2.08	2.06	2.08	200
20	<u>₽</u> *.18	$K_{b}\left(\frac{1}{p}\right) \cdot \frac{1}{T^{2}}$	10.32	+/037	70.32	+~ 37	70.00	1/037	10.32	4,0.3
. 44	N. 2.9	Kn (		1.		C.I.I.				1
	Mr Rmr/1	(Mc. Rm²/s/ Rm²/st		(	44449	10 ing	19	- 19	<u> </u>	T. 19
2 *	Mc Rm/3 -	Fb (Mer Rm/1) Rm/172		Mist.		X MAL	-6.86	+6.86	\$6.86	-68
48	N. Z.1	Kn ( N = ) ML					SU I	S.M.	NUT THE	SQU.
	Mr	(ML/Rm <sup>2</sup> /{/ Rm <sup>2</sup> /{T	- 19	19	+.19	+.19	1.	44.444		1111
28-	1 ML Rm/1 .11	Kb (ML Rm/3) · Rm/3T2	7.00	+7.00	+7.00	7.00		1. Martin		
A dd ol	gebraiculty for summat	lon	-							
	******		12.52	12.11	728	1.35	13.42	N.90	5.35	1.56
10 To	stress due raion, Mit	$T(j_{x} - T_{x}) = \frac{M_{T}}{2\pi r_{1}^{2}T}$	+.13	+.12	+.13	+.13	+.13	4.13	+.13	1.12
Shear	stress due	Ve_					1	8211	SUM	ST IN
10 100	d, ve		- 59	1.59	59	- 59	11111	Millin.		
Shear to loo	d, VL -	. 1×5 - VL					41	- 11	4 41	40)
A 66 A	gebraicolly for summa	licn						<u>``</u>		
of she	or stresses, 7 =		.72	57.	1-46	149	.z8	1.2B	.59	.5<
COMB	INED STRESS INTEN	SITY, S	·····-		····		·	, <u> </u>		
	1) When of & on	5 - 3 25 + 0x + V(00 - 0x F+	TP	17 01		A 0,	7/	27 4	6-4	
	have like signs		10.531	11.71	re+	0.06	26.53	22.8	0.79	ه د ا
	2) When t = 10	S. Jama et al. a Int. a. I	LSE	<b>*2</b> *	-27	~ 51	164	KSI	KST	<b>I</b> < 5
1	ay wagain U					· ·				ł
1	•• ••• •			1	ł	1	1 .	1	1	1

 $N_L/(M_L/R_m^2\beta)$  so determined by  $(C_L)$  from Table 8 (see para. 4.3).

4.3 Calculation of Stresses

4.3.1 STRESSES RESULTING FROM RADIAL LOAD, P.

4.2.2.5.2: When considering bending moment  $(M_i)$ :  $\beta = K_L \sqrt[3]{\beta_1 \beta_1}$  where  $K_L$  is given in Table 8.

**4.3.1.1** Circumferential Stresses  $(\sigma_{\phi})$ ;

Step 1. Using the applicable values of  $\beta$  and  $\gamma$ 

(			•
- <u>-</u>	COEFS 1A= 0.10	······································	10831.49 211.79
MC= 430000.00	СОЕFS 28= .0.06	0.28 COEFS	12007.00
ML= 260000.00	COEFS 38=	20= 0.20	SUMS -24108.94 19888.73
MT= 250000.00	2.60 COEFS	2C-1= 0.20	328.64 -3701.68 -23130.28
VC= 5500.00	4A= 2.80	.COEFS 3C≍ 37.00	18516.36 -650.01 -2329.32
VL= 3000.00	:0EFS (B= 0.06	COEFS 4C=	
T= 1.75	COEFS 1B-1= 0.06	47.00	ненкъ 355.26 + 125.05 1 68.21 1
RO= 8.00	COEFS 28=	1494.42 13988.57 379.46	JUMS 480.31
RM= 420.90	COEFS	18052.48 794.22 6549.27	230.21 230.21 230.21
(N=	20-1- 0.11 COFFS	SUMS	287.05 423.47 423.47
(B=	3B= 9.00	-22826.48 18249.21 -8139.50	
GAMMA= 240.51 ~	COEFS 4B= > 2.40	6739.10 -33914.93 30167.17 2948.95 -5178.86	176
1570- 0 02	COFFS		5240,46
· ·	•• • • · ·		·.

		· · · ·	iaplu 5-Lo	inputation 5	hee <b>l lor</b> l	Locat St	rosses i	n Cýlind	rical Sh	elis I TI	2121	7 6	• • • • •	
•			16"	DIA.	MO	221	E	Pinti	Q+F	7	μ. ML		- A	-20
	1. Applied Radi Circ	Loods* ial lood,	р. <u>17,000</u> Ib. Mc. <u>430,000</u> Ib.	3.	Geometric Y	: Poramet <u>Rm</u> T	 2 <u>40</u> .5		'.  - L/	Vc 2 Du	Mc	-v,		
<b>.</b>	Lon Tars Shea Shea	g. Moments, sion Moment, or Load, or Load,	ML - <u>260,000</u> in. 1b M, <u>250,000</u> in. 1b Vc - <u>5,500</u> ib. VL <u>3,000</u> ib.	•	/ł ( <sup>-</sup> Stress Co	0.875)	on due to	<u>-166</u>	KATI				HMENT	$\frown$
	2. Geomet Ves	isel thickness,	T = <u>1.75</u> in.		- a) mem b) ban *NOTE:	ibrane loa ding load, Enter oll	d, Kn – Kb – force valu	So Rm		ÁL	Cu CL		リ	
	Ves	sel radius,	R. 120.9 in.		occordan	ce with s	ign conve	ntian	<u>C1</u>	LINDR	CAL SI	HELL	·····	
. 1	From Fig.	Read curves for	Compute ob stress and	solute values of Lenter result •	}	STRESS	ES = ifilo AL	nd is oppo Bu	BL	hawn, revr Cu	CL	shown Du .	DL	
	30	N.J. = 37	$K_{n} = \left(\frac{NC}{P \cdot R_{m}}\right)^{n}$	P RmT		-1.49	- 1.49	-1.49	-1.49	-1.49	- 1.49	- 1.49	- 1.41	
•	10	<u>₩ΰ</u> ₽ = .28	КЬ ( <u>н</u> ), <u>е</u>	5P . ' T?		-13.99	+13,99	-13.99	+13.99	-13.99	+13.99	-13.99	†1 <u>3.9</u> 9	
•	3.4	HO Z.6	$K_{n}\left(\frac{NO}{M_{c}-Rm^{2}/\beta}\right)$	<u>Mc</u> Rm <sup>2</sup> /{T						38	38	+ 38	+.38	
÷i	1.4	Mc Rm/1 . =.11	$\frac{K_{\rm b}\left(\frac{M_{\rm C}}{M_{\rm c}/R_{\rm m}/\beta}\right)}{\left(\frac{-M_{\rm c}}{M_{\rm c}}\right)}$	Rm/177			Mile			18.05	+18.05	+18.65	18.45	
:	38	ML Rm=/1 = 90	$\frac{K_{\rm m}\left(\frac{NC}{ML^2/R_{\rm m}^2/l}\right)}{(MC)^2}$	Rm 2/3 T	·	79	79	+.79	+.79					
· · ·	18 or 18-1	ML. Pm/I TOL	$Kb\left(\frac{m(\mathcal{F})}{ME(Rm/F)}\right)$	Rm/172		-6.55	+6.55	+6.55	76.55		<u>IMB</u>	<u>IMA</u>		•
	Add olge of Ø etro	broically far summot uses, でよ = 1	T			-27.83	16.25	- 6,13	6.A	-33.91	30,12	z.95	-518	
· -	40	P/Rm = 47	$\frac{K_n \left(\frac{N_n}{P/R_m}\right)}{\left(\frac{M_n}{P}\right)}$	RmT		-1.90	-71.90	-,1.90	-1.90	-1.90	<u>=1.90</u>	-1.90	-1.90	
ν.	2 C	<u>Hx</u> ₽ ₹,20	КЬ ( <u>-</u> ).	<u>7</u> 2		9.99	<b>+</b> 9.99	-0.09 Salara	+0.99	5.99	+ <u>5 99</u>	-9.56	+ <u>9.99</u>	t
<b>N</b>	4.	Mr 'Rm2 / 300	$\frac{Kn\left(\frac{n\pi}{Mc,Rm^{2}/3}\right)}{\left(\frac{M\pi}{Mc}\right)}$	$\frac{Mc}{Rm^2/3T} = 6Mr$				44444		<u>- 41</u>	41	+.41	1,41	
	2 Å	Mr. Rm/3	$\frac{Fb\left(\frac{1}{Mc}, Rm/S\right)}{N}$	Rm/177						70.83	10.83	t 10.85	. 10.83 	
11	48	ML / Pm2/3 -	Kn (MU Rm ? [])	• Rm2 /7	· ·	zl	21	+.21	+.21					
	281 Add alac	ML Rmji - 1	Kb (ML Rm/i)	Rm/172		2.33	12.33	tz.33	2.33					
×	of X stre Shear at	rests, 7 # #				-24.11	19.89	.33	-3.70	-23,13	18.52	65	-7.33	
	to Torsi Shear st	ian, Mt	1.0 x + 1 x	<sup>ψ</sup> = 2π · <sup>2</sup> T		+.36	+36	+,36	+.36	+.36	+ 36	* 36 S	+ 36 Killi	1
	to lood,	Vc	7,× 1			T .(3	T.13	T. 13	13 SUII					ł
	to lood, Add Ala	•braically for summa	, ion	π <sub>10</sub> Υ	-					07	.07	1.07	7.07	
	of shear COMBIN	STRESS INTEN	15ITY, 5			.48	₹₽,	.23	1.23	.29	.29	.42	.42	
	1)	) When $\sigma_{\zeta\zeta} \in \sigma_{\mu}$ have tike signs	s = ½ [>4 +	a <sub>n</sub> 1 √(03 -	U <sub>2</sub> F + 41 <sup>2</sup>	24.27 KSI	20.02 KS I	8.48 KSI	10.45 KSI	33.92 KSI	30.17 KSI	3.70 KSI	5.24- KSI	
	2	) When 7 - 0	S .a torgest of f	ig, a <sub>∎</sub> er ] αφ	- 0 <sub>8</sub>	ł							:	
	. 3)	When His & My have unlike signs	s <u>v</u> (0,g) -	17 12 1 478										

 $N_{I}/(M_{L}/R_{m}^{2}\beta)$  so determined by (C<sub>L</sub>) from Table 8 (see para. 4.3).

4.3 Calculation of Stresses

4.3.1 STRESSES RESULTING FROM RADIAL LOAD, P.

4.2.2.5.2: When considering bending moment  $(M_i)$ :  $\beta = K_L \sqrt[3]{\beta_1 \beta_1^2}$  where  $K_L$  is given in Table 8.

**4.3.1.1** Circumferential Stresses  $(\sigma_{\phi})$ :

Step 1. Using the applicable values of  $\beta$  and  $\gamma$ 

	(			(		<b>X</b>	
F		( 1				. റല്	
MC=		COEFS	.0.11	0.28	1334 24 : 1231	-11 .44 .49	6-91
HL=	5000.00	28=	0.06	COEFS 2C=	CHMC		218
MT=	30909.00	COEFS 38=	2.80	COEFS	-3339 2649 -928	.93 .57	
9 VC=	90000.00	COEFS 4A=		0.20	235	.47 .71	8
VL=	500.00	COEFS	3.60 -	CUEFS 3C= 35.001	-679 179	.30 .01	0
	1000.00	<u>3</u> = .	0.06	nnefs =	CUEODO	¢	IAN
Τ=	1.75	COEFS 18-1=	0.06	45.00	101 10 20	.05 TI .11	ETE
R0=	9.00	COEFS 2B=		249.47 2468.57	SUMS	. 16	
RM=	420.90	! COEFS	0.11	2668.22 99.56	111 90 90	.16 .95 .95	201
KN=	1 75		0.11	SUMS	80 80 121	.84 .84 .26	ш И И
KB=	1.50	38=	11.00	-3489.32 2791.27 -1946.76		.26 <b>TR12</b>	. 7
GAMM	A= 240.51	COEFS 4B=	2 70	1646.95 -5441.17 4832.42		9 41	7-7
		COEFS	2.10	5.09			0
· · · · · ·	•	• • • • • • • • • • • • • • • • • • •		- · · · ·			A-24
		· .					
							. `

		· · · · · ·	IB" DIA.	NOZ	52L	e . (	Pm + (	27F	LTR	21-21 Mi	7 6	- - A	-25
	<ol> <li>Applied Radi Circ. Lang Tors Shed Shed</li> <li>Geomet Ves Atta Ves</li> </ol>	Loads <sup>o</sup> at load, i Moment, i g. Moments, i ion Monent, i r Load, ar Load, ar Load, i y set thickness, set radius,	3. P $3000$ lb. Mc $4000$ in. lb. ML - $30000$ in. lb. ML - $30000$ in. lb. Vc - $500$ ib. VL $1000$ lb. T + $1.15$ in. T - $2.0$ in. Rm $420.9$ in.	Geometric y j; (0 Stress Cor o) memb b) bendi *NOTE: E accordance	Parametr <u>Rm</u> - 2 T - 2 J.875) - 7 R ncentration stone loo ing lood, inter all ' with si	ers 2 <u>40</u> 5 m on due to: d, Kn L Kb L force valu ign conve	<u>o</u> 187 <u>-15</u> <u>S</u> ORm			Mor MMT Cu CL SI	-VL ROL ATTAC BU 	IND HMENT	
1	From	Bood curren	Compute obsolute values of	I :	TRESSE	5 - il loc	nd is oppo-	site that s	hown, reve	use signs	shown		•
	Fig.	lor	stress and enter result		Au	AL	Bu	BL	Cυ	CL	Du	DL	
	30	NIS = 35	$K_{n} = \left(\frac{NC}{P R_{m}}\right) \cdot \frac{P}{R_{m}T}$		25	25	25	25	25	25	25	25	
· .	10	<u>м()</u> = ,28	$K_{b} = \left(\frac{M(5)}{P}\right) \cdot \frac{\delta P}{T^{2}}$		247	+2.47	-z.A7	+ 2:17	72.97	+ Z. 11	2.97	+2:37	
• •	3 A C	N.) 2.8 Me. Rin <sup>2</sup> /3	$\frac{K_{n}\left(\frac{NG}{M_{c}-Rm^{2}/\beta}\right)\cdot\frac{Mc}{Rm^{2}/\beta T}}{M_{c}^{2}}$						<u>-, 05</u>	<b>-</b> .05	+.05	4,05	
<u>, 1</u>	1.4	$\frac{M_{C}}{M_{c}-R_{m}/l} = -1$	$\frac{K_{b}\left(\frac{m_{t}}{M_{c}/R_{m}/f}\right) + \frac{Omc}{R_{m}/f T^{2}}}{f}$						2.67	+ 2.67	+2.67	2.67	
	. 3B	ML Rm=/3 = /1	$\frac{K_{\rm m}\left(\frac{1}{ML/Rm^2/\delta}\right) + \frac{1}{Rm^2/\delta T}}{(MS^2)} = \frac{1}{6}$		10	10	+ .10	<u>+10</u>					
•	1B-1	ML. P-1 0:06	Kb (		•.67	+.67	+.67	- 67			<u>Mark</u>		
	of \$ stie	sses, nd ÷			3.19	2.79	-1.95	1.65	-5.91	4.83	0.0	-,39	
-	40	P/Rm - 45	$K_{n} \left(\frac{N_{n}}{P/R_{m}}\right) \cdot \frac{P}{R_{m}T} = \cdots$		- 32	32	32	- <u>.32</u>	<del>-</del> , 32	32	.32	32	
•	20	<u>₩</u> # \$20	$K_{b}\left(\frac{m_{H}}{P}\right) \cdot \frac{D^{P}}{T^{2}} =$	-	- 1.76	+1.76	-1.76	+1.76	-1.76	41.76	1.76	41.76	
•	4.	$\frac{1}{M_r} \frac{3}{R_m^2 \beta} = \frac{3}{2}.6$	$\frac{K_{n}\left(\frac{H_{m}}{M_{c},R_{m}^{2}/3}\right) \cdot \frac{K_{c}}{R_{m}^{2}/3T}}{\sqrt{M_{c}}}$						<u>- , 07</u>	07	+. 07	+.07	
	2 A	Me Rm/3	$\frac{1}{100} \frac{1}{M_{c}/R_{m}/3} = \frac{1}{R_{m}/3} = \frac{1}{100}$			Mill			-1.33	+ 1.33	41.33	1.33	
• •	4B	N= 2.7 ML/Rm2/1	$K_{\rm In}\left(\frac{N_{\rm H}}{ML/Rm^2/l}\right) = \frac{ML}{Rm^2/lT}$		<b>-</b> .oz	oz	toż	+.02	X.,			No.	
	28 er 28-1	ML Rmji O.I	$K_{b}\left(\frac{M_{b}}{ML\cdot R_{m}}\right) \cdot \frac{OML}{R_{m}} =$		1.23	<b>†</b> 1.23	+1.23	7.23		<u>Marke</u>	MASS.		
	of X stre	sts, Π x ≌	****		-3.34	2.65	-,83	.Z <b>3</b>	-3.49	2.70	- 68	.18	
	Shear sti to Torsi	ess due on MT	$f(j) = \frac{MT}{2\pi r^2 T}$		t_10	+.10	+.10	t.10	+.10	+.10	+,10	+ 10	
	Shear sti to lood,	vess due Ve	rxd - Ve		<b>+</b> .01	+.01	01	701					
	Shear str to load,	ess due VL	rxύ ··· <u>VL</u> πτο Υ						oz	oz	+ .oz	toz	
	Add Alge of shear	rbraically for summa stresses, 7 =	ition		.11	•11	.09	وں.	.08	80.	.12	.12	
	Сомвін	ED STRESS INTEN	ISITY, S		<u> </u>		•			••••••••••••••••••••••••••••••••••••••			l
	1 1)	When O <sub>5</sub> 5 & O <sub>8</sub> have like signs	$\mathbf{s} = \mathbf{y}_{1} \begin{bmatrix} \mathbf{y}_{1} + \mathbf{a}_{1} + \sqrt{(\mathbf{a}_{2} - \mathbf{a})} \end{bmatrix}$	<b>1 1 1 4 7</b> <sup>2</sup>	3.55	z.85	1.95	1.65	5.49	4.84	,73	.67	
	21	When 7 · O	5 - lorgest of 0.5, 0. or 0.5 -		KSI	KSI	KSI	KS1	KSI	KSI	K>+	KSI	·
	(1	When 11.5 & 17. have unlike signs	$S = \sqrt{(\alpha_{0})^{2} - (\alpha_{\mu})^{2} + 4\tau^{2}}$	-									

 $N_1/(M_L/R_m^2\beta)$  so determined by  $(C_L)$  from Table 8 (see para. 4.3).

4.3 Calculation of Stresses

4.3.1 STRESSES RESULTING FROM RADIAL LOAD, P.

4.2.2.5.2: When considering bending moment  $(M_i)$ :  $\beta = K_L \sqrt[3]{\beta_1 \beta_1^2}$  where  $K_L$  is given in Table 8.

4.3.1.1 Circumferential Stresses (o+);

Step 1. Using the applicable values of  $\beta$  and  $\gamma$ 

Stresses in Shells

	COEFS		204.32 881.63	ב
P= 2000.00	1A= 0.11	COEFS 1C-1=	62.22 923.62 85.53	
MC= 55000.00	COEFS 28= 0.00	0.28 COEFS	2770.85	ច ប៊
ML= 90000.00	. COEFS	2C= 0.15	SUMS -3942.33	
MT= 30000.00	3A= 4.00	COEFS 20-1=	3362.62 1770.42 -2008.01	۲ ل
VC= / 2500.00	СОЕFS ( 4А= 5.00	COEFS	-2071.80 1538.70 -100.12	P
VL= 2500 00	COEFS	3U= 33.00	-184.08	
2000.00	18= 0.06		SHERRS	
T= 1.75	COEFS 1B-1= 0.06	40.00	18,95 37.89 37.89	א וד ג
RO= 12.00	COEFS 2B=	156.81 1645.71 49.78	SUMS	4 1
RM= 420.90	0.11 COEFS	1693.29 305.47 1511 27	56.84 -18.95 -18.95	, r
KN=	2B-1= 0.11	1011.07	-18.95 -18.95 56.84	TRI
1.75 VŘ=	COEFS 3B= 15 00	5005 -3619.36 2694.81	56.84 STRESS	17
1.50	COEFS	14.32 283.01 -3545.60	3952.04 3367.43	•
GAMMA= 240.51	48= 4.20	3132.42 -59.45 -154 61	1770.62 2291.32 3545.84	
0,02,			3132.65 <u>140.15</u> 228.06	1
	· · · ·	· · ·		6

• '			lable 5-Computation	on sheet for	Local SI	lusses	in Lylind	rical Sh	ells			A 71	1
	24"	DIA	I NOZZLE	Pm +	Q-	F	LTR	1217	6	K.ML			6
	1. Applied Looc Radial loo Circ, Mame Long, Mam Tarsian Ma Shear Lood Shear Lood 2. Geometry Vessel thi Atlachmen Vessel rac	io j, P nt, M ment, M i, V j, V chiness, T t readius, F lius, I	$\frac{2000}{56,000}$ lb. Ac. $\frac{56,000}{50,000}$ lb. At. $\frac{30,000}{50,000}$ lb. At. $\frac{30,000}{50,000}$ lb. At. $\frac{30,000}{50,000}$ lb. At. $\frac{100}{50,000}$ lb. At. $1$	3. Geometric 7 /S Stress Cr 0) mem b) ban *NOTE: accordan	Paramet <u>Rm</u> - S (0.875) - <u>r</u> poncentration phrane lood ding lood, Enter ell sce with s	ers <u>o</u> <u>O</u> , C im on due 10. id, Kn <u>I</u> id, Kn <u>I</u> force volution	SORm			Me Mr Mr Cu CL ICAL SI		IND HMENT	J
	From Reo	d curves	Compute absolute valu	esol	STRESS	ES - if lo	nd is oppo	site that s	hown, rev	erse signs	shown		
	3C N(	- = zz	$\frac{\text{stress ond enter resu}}{K_n \left(\frac{N\sqrt{5}}{2\pi^2}\right) \cdot \frac{P}{2\pi^2}}$		<u><u>Au</u> - 16</u>		- Bu	BL	<u>Cu</u>				
		=	$\frac{(P'Hm)}{Kb} \left(\frac{MO}{D}\right) \cdot \frac{6P}{T}$		.10	+	- 16	+	.16	+ -	<u>. 10</u>	<u>, 16</u>	
	3A <u>N(</u>	<u>4.0</u>	$\frac{\left(\frac{P}{P}\right)^{2}}{K_{n}\left(\frac{NC}{P-2B}\right) \cdot \frac{Mc}{P-2B}}$			1.65	1.65		7.65	7.65	+ ~ ~	+ 05	
-1	TA MC		$\frac{M_{\rm c}}{M_{\rm c}/R_{\rm m}/3} = \frac{6M_{\rm c}}{R_{\rm m}/3T^2}$						1.69	1,60	+1.69	-1.69	
	38 NU		$K_{n}\left(\frac{N\zeta^{2}}{ML / Rm^{2}/3}\right) \cdot \frac{ML}{Rm^{2}/3T}$	-	-31	31	+.31	+,31	<u>H</u>			T	
÷	18 or	-/i <b>-o</b> 6	$Kb\left(\frac{M\odot}{ML-Rm/3}\right) = \frac{6ML}{Rm/3T^2}$	÷ ·	-151	7.51	+1.51	-1.51				Sills.	
	Add algebroically of $\phi$ stresses, $\sigma$	y for summatio Ø =	an		3.62	2.62	.01	. z8	-3.55	3.13	-06	7.15	
•	$4C = \frac{N_{H}}{P/R}$	- 13	$K_{n}\left(\frac{N_{n}}{P/R_{m}}\right) \cdot \frac{P}{R_{m}T} = .$		zo.	zo	zo	20	zo	zo	-z0	20	
•	2C Hx P	<b>*</b> .15	$K_{b}\left(\frac{M_{H}}{P}\right) \cdot \frac{6P}{T^{2}} = $		<u>.88</u>	+,88	88	+.88	06	t.06	06	+.06	
	4A	Rm <sup>2</sup> / <sup>3</sup> 5.0	$K_{n}\left(\frac{N_{H}}{M_{C}/R_{m}^{2}/3}\right) \circ \frac{M_{C}}{R_{m}^{2}/3T}$	-					06	<u>~,06</u>	4 06	+.06	
	2A Mc. 1	am/3 0.055	$\frac{V.b\left(\frac{m\pi}{Me_{\ell},Rm/3}\right) \cdot \frac{DMe_{\ell}}{Rm/3T^{2}}}{(Me_{\ell},Rm/3)}$	÷		<u>Mille</u>			92	+.92	+.92	92	
• 7	4B HL/F	1m <sup>2</sup> β <sup>2</sup> <sup>4</sup> με ζ	$\frac{K_{1}\left(\frac{1}{MURm^{2}/l}\right) \circ \frac{ML}{Rm^{2}/lT}}{(MURm^{2}/l)}$	π	09	09	209	4.09				<u></u>	
	28 or 28-1 ML	Rm/1 -11	$K_{b}\left(\frac{m\pi}{ML^{2}R_{m}/l}\right) \circ \frac{GML^{2}}{R_{m}/l^{2}T^{2}}$	-	2-17	72.77	77.5	7.77					, í
• •	of X stressts, (7)	• ==	on		-3.99	3.36	1.77	72.01	72.07	1.59	-10	-18	
	Shear stress due to Tarsian, Mr		τψ≖ τ×ψ = 2π	<u>M T</u> 7 <sup>2</sup> T	<b>t</b> .oz	toz	+.02	+_02	+.oz	+.02	+ .02	t'oz	
	Shear stress due to lood, Vc		τχό - π	V <u>e</u> 70 <b>T</b>	+:04	+.04	7.04	09					·
	Shear stress due to lood, VL -		r x Ó 7	VL , , T					704	04	¥.04	4.0∢	
	Add Algebraical of shear stresse	ly for summati s, 7 =	ion	•	.06	.06	oz	OZ	1.07	02	.06	. 06	
	COMBINED STI	RESS INTENS	SITY, S					•		•			
	. 1) When have	σ <sub>ζ</sub> j & σ <sub>H</sub> like signs	s = ½ [2φ + σ <sub>x</sub> + √(σ)	$\dot{\sigma} = \sigma_{\pi} \dot{F} + 4 T^2$	3.95 Kst	3.38 KS I	1.77 KSI	2.29 KST	3.55 KST	3.13	·19	8 S.	
	2) When	r 0	S = lorgest of $(l_{ij}, d_{ij})$ or	114 - 11 <sub>8</sub>									
	3) When i have u	್ಪಷ್ಟಿಗ <sub>ಟ</sub> inlike signs	$(\mathbf{S} - \sqrt{(\theta_{ij}) - \theta_{ij})^2} + 4\tau$	7									

 $N_t/(M_L/R_m^2\beta)$  so determined by  $(C_L)$  from Table 8 (see para. 4.3). 4.2.2.5.2: When considering bending moment  $(M_1)$ :  $\beta = K_L \sqrt[3]{\beta_1 \beta_2}$  where  $K_L$  is given in Table

4.3 Calculation of Stresses

4.3.1 STRESSES RESULTING FROM RADIAL LOAD, Ρ.

**4.3.1.1** Circumferential Stresses  $(\sigma_{\phi})$ :

Step 1. Using the applicable values of  $\beta$  and  $\gamma$ 

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8.

		· .	(		(	
			· · · · · · · · · · · · · · · · · · ·			
F =					147.64	I
Mi= 90000.00	COEFS 2A=	·	0.18	1	209.10 153.87 806.41	P-ya
ML= 170000.00	COEFS	0.06	2C= . 0.12	SUMS	· · · · · ·	บี
MT= 10000.00	3A=	5.10	COEFS 2C-1=	-4	412.72 905.42 507.84	
VC= 1000.00	COEFS 48=	2 39	0.12 COEFS	-3 -1	399.68 764.17 359.33	
VL= 1500.00	°OEFS	0.00	3C≕ 32.00	-	859.29	P3 t
	D-	0.06	COEFS 4C= 42.00	· · · · · · · · · · · · · · · · · · ·		Q +
T= 1.75	0EFS B-1=	0.06	12:00	HEHR	4.04 12.13	
RO= 15.00	:0EFS :B=		76.03 528.98	SUMS	18.19	۲ ·
RM≂ 420.90	COEFS 28-1-	0.10	2216.68 553.92 2283.35		16.17 16.17 -8.08 -8.08	
KN= 1.75	COEFS	0.10	SUMS		-14.15 -14.15 22.23	LTRI
KB= 1.50	3B=) 1	8.00	-3442.77 2182.89 2232.76	STRES	22.23 S'ITATS'	217
GAMMA= 240.51	COEFS 4B=	5.00	-1276.98 -2904.77 2586.54		4412.99 9905.57 3507.89	<b>0</b> 1 1 1
3	COEFS	· .	· · · · · · · · · · · · · · · · · · ·		3399:71 2984399 2586.70	
	••••••••••••••••••••••••••••••••••••••		······································		1695,35 1581,23	

•		tania a southernitati	Cector Locpi 3	11.6226.5	cymue	arical an	(ens		i na d		
		30" DIA.	NOZZI	3.	Pmt	atF	: 11	R12]	L7 6		A-2
* ·	•	•	2:					TM	•		
	1. Applied Loods*	2	Geometriz Porame	iers ·		· · · ·	Ve	L Mr	<b>.</b>	· · ·	
	Radial load, Circ, Moment,	P <u>1000</u> lb. Me <u>99,000</u> in. lb.	γ <u>- Hm</u> -	2405		-  + <u></u>		»vY	VL	·	
う	Long. Momant	$ML = \frac{176000}{10.000} in . 16.$	· · · · · · · · · · · · · · · · · · ·		2312		DL		ATTA	UND .Hm <b>ent</b>	
	Shear Lood,	Vc - 1600 lb.	15 30.0131 -	Ran [		1-	Au	<u>}:</u> *	Bu	<u> </u>	
1.4 · gramma -	Shear Load,	VL 1.4	Stress Concentrat	ion due; h	15 –	你去了	╤╤╱	江大	;ŕ;	$\eta$	
•	2. Geometry Vacant shipky		b) beiteling lood	, Kb "L	50 Rm	RTH	ÁL	cu l		<u>)</u> –	
	Attachment ro	dius, 'o - 15 in.	•NOT E: Enter ell	force val	es in					· /	
	Vessel radius	, R	accordence with s	lign convi		<u>C</u>	LINDR	ICAL S	HELL		_
	From Read of	Compute absolute values of	STRESS	E5 - if la	nd is oppo	site that s	hawn, rev	erse signs	shown		l
	N ()	(HO) P									
	3C PrRm	= 3Z Rn (P Rm) RmT	.08	.08	08	08	08	08	oß	.08	
•		= $18$ Kb $\left(\frac{MO}{P}\right) \cdot \frac{6P}{Tr}$	53	+.53	- 53	+ 53	- 53	+ 53	- 43	+ 53	İ
	N.C.	5.1 . ( NO) MC		<u>XIIII</u>	HUI	SIIIII					1
· ·	JA Me. Rm?/	$\frac{1}{3} = \frac{R_{\rm III}}{M_{\rm E} \cdot R_{\rm III}^2/1} \frac{R_{\rm III}^2/3T}{R_{\rm IIII}^2/3T}$					08	08	+.08	+.08	1
, i	1A	$= \left  \left  \frac{K_{b} \left( \frac{M_{c}}{M_{c} \times R_{m} / \beta} \right) \cdot \frac{6M_{c}}{R_{m} / (17)} \right  \right $		in the		IN U	777	+	+= 72	7.72	ľ
:	Nú	18 4 ( NC) ML -				1111111	Serii i			, Th	
	ML Rm*/	3 (ML / Rm?/) Rm?/) T	<u> </u>	.55	t.55	<u>+.55</u>	illin,				
•	18 or 18-1	$\begin{array}{c c} \mathbf{T} \mathbf{B} \\ \mathbf{T} \mathbf{T} \\ \mathbf{T} $	778	+2.28	+2.78	7.28	11 M		11 May		1
	Add algebraically for							annan	1		1
	of P stresses, rd =		3.99	Z.18	2.23	-1.27	-2.90	2.59	1.69	-1.68	Į
-	$4C = \frac{N_{\rm H}}{P/R_{\rm H}}$	$= 4Z \left[ K_n \left( \frac{N_n}{P/R_m} \right) \cdot \frac{P}{R_m T} \right] = 2$	10	10	10	10	<i>۳</i> .۱0	10	10	10	
	Ma H	$Kb\left(\frac{Mx}{m}\right) \cdot \frac{6P}{m} = 1$		1							1
			.35	<b>7.35</b>	35	<b>T</b> .35	-,35	T.35	.35	1.35	ł
$\sim$	. 4A	$\overline{R} \stackrel{\mathbf{G}}{=} \sum_{k=1}^{N} \left[ K_{n} \left( \frac{R_{n}}{M_{e}/R_{m}^{2}/\tilde{f}} \right) \cdot \frac{M_{e}}{R_{m}^{2}/\tilde{f}} \right] = 0$			18110	MA AND AND AND AND AND AND AND AND AND AN	10	10	+.10	+.10	
	24	$-26$ $V_b\left(\frac{M_E}{1-2\pi/2}\right) \cdot \frac{6M_E}{\pi/2}$						+ 1			
	Nu Nu	Me/ Rm/3 / Rm/312						2000	501111	1:21	
	48 ML/Rm2	$\frac{1}{3} = \frac{1}{100} \frac{1}$	15	15	H.15	+. IS	MH -	XIII U	(inpl)	1. Marke	
	28 of <u>Ma</u> 28 ) <u>MI</u> 8-1			4-01	+- 01		HU.		KU)		1
	Add algebraiculty fe	summotion	3.01	3.01	.3.0	201					4.
	of X stressts, it w =		-1.11	3.91	3.51	- 370	-1.76	1.36	.86	85	
	Shear stress due - to Torsion, Mr	$r\phi_{\pm} = r \pm \phi = \frac{M_T}{2\pi r^2 T}$	+0	+0	+ 0	+ 0	+0	40	+ 0	+ 6.	
	Shear stress due.						5.C.()	×1111	SIII)	ST.	
	to lood, Ve	7 x C) 7 t o T	T.0	+.01	01	01	IM S	<u>IIIIIn</u>			1
	Shear stress due to lood, VL -	7 x 3 VL					- 02	- 07.	+.02	7.07	
	Add Algebraically le	r summation									1
	of shear stresses, t	e	1.01	.01	01	10	<u>- 02</u>	-, oz	-02	.02	
	COMBINED STRES	INTENSITY, S		·	I	r	r		r	r · <b></b> · · <b>-</b> ·	{
	1) When Ogy have like	$\frac{\delta}{m} = \frac{\sigma_{\mu}}{s} + \frac{s}{s} + $	19.41	3.91	3.51	3.40	2.90	2.59	1.70	1.6.0	
·			KSI	KSA	KSI	KS1	KKT	KST	KST	KST	<b>.</b>
	2) When 7	0 S - lorgest of AG, I's or AG -	0.								
	3) When 17.		• 1	<b>i</b> :'						<b>i</b> .	1
	1		J	1 D	1	1	Ι.	1 <i>.</i>	i i	1	1

 $N_{L}/(M_{L}/R_{m}^{2}\beta)$  so determined by  $(C_{L})$  from Table . 8 (see para. 4.3).

4.3 Calculation of Stresses

4.3.1 STRESSES RESULTING FROM RADIAL LOAD, P.

4.2.2.5.2: When considering bending moment  $(M_i)$ :  $\beta = K_L \sqrt[3]{\beta_1 \beta_2}$  where  $K_L$  is given in Table 8.

**4.3.1.1** Circumferential Stresses  $(\sigma_{\phi})$ : Step 1. Using the applicable values of  $\beta$  and  $\gamma$ 

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### APPENDIX B

LTR 1217-6

# STRESS IN THE CONTAINMENT VESSEL AND NOZZLES DUE TO TEMPERATURE GRADIENTS

THERMAL STRESS IN THE NOZZLES AND IN THE PIPE WELDS AT THE AT THE PENATRATIONS

SIX NOZZLES HAD LINES PENETRATING THEM WITH TEMPERATURES HIGH ENOUGH TO LEAD TO SIGNIFICANT THERMAL STRESSES.

## 1.0) (ONE SHAPED NOZZLES

NORRES S- BE AND S- SE ARE BOTH LONE SHAPED NORRES WITH SIMILAR DIMMENSIONS. AND BOTH OPERATING AT HIGH TEMPERTURES (S-BED SBOFF AND S-SE OD 407° F). JOHN CANDERS PERFORMED A FINITE ELEMENT ANALYSIS ON NORRES S-BE AND ARKIVED AT A MAXIMUM STRESS OF 34,251 WHICH IS MUCH LESS THAN THE ALLOWABLE 52,500 THE TWO NORRES HAVE SIMILAR DIMMENSIONS, NORRES S-BE DPERATES AT A HIGHER TEMPERATURE THAN NORRES S-SE AND THE MECHANICAL LOADS ON S-BE ARE AIGHER THANS-SE, STRESSESIN NORRES S-SE WILL ALSO BE LESS THAN THE ALLOWABLE.

2.0) PIPE WELDS AT THE PENETRATION

2.1) THERMAL STRESSES

INFORMATION ON PAGE B-10 THROUGH B-13 WAS PROVIDED TO THE THERMAL ANALYSIS BRANCH. THEY DETERMINED THE TEMPERATURE GRADIENTS AND DOCUMENTED IT IN THE FOLLOWING LETTER.

B-1



B-2 LTR 1217-6

### INTEROFFICE CORRESPONDENCE

August 3, 1978

R. J. Beers

from

date

to

W. C. Townsend

subject

CONTAINMENT PENETRATION - TEMPERATURE PROFILE AT WELD - WCT-21-78

Preliminary analyses of the temperature distribution of the containment penetration nozzle end plates and of the lines penetrating and welded to the end plates were performed. Results of these analyses indicated that the slope of the temperature profile at the weld is small and can be used in your thermal stress analyses. Should the calculated stresses be high, we will perform detailed computer solution of the end plates and weld areas.

The preliminary analyses considered the end plate as a fin attached to the penetrating pipe wall. Parameters and assumptions used in the analyses are given below.

- Thermal conductivity of the stainless steel end plate and pipe wall: 9.75 Btu/hr-ft-°F
- Assumed natural convection film coefficient acting on the end plate: 5.0 Btu/hr-ft<sup>2</sup>-°F
- Assumed containment temperature: 70°F
- The outside diameter of the end plate was assumed large in comparison with the inside diameter of the penetrating pipe
- Complete penetration welds at the outside pipe wall-end plate interface (penetrations) were assumed.

The slope of the temperature profile at the penetration weld is given as

$$\frac{dT}{dr} = B (T_p - 70) \frac{\sinh B (r_2 - r_3)}{\cosh Br_3}$$

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where

## $B = (2h/kt)^{1/2}$

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h: outside film coefficient, Btu/hr-ft<sup>2</sup>-°F

K: thermal conductivity, Btu/hr-ft<sup>2</sup>-°F

t: end plate thickness, ft

T<sub>n</sub>: temperature of fluid contained in pipe, °F

r<sub>2</sub>: outside radius of pipe, ft

r<sub>3</sub>: outside radius of end plate, ft

 $\frac{dT}{dr}$ : sl

slope of temperature profile at weld,  $^{\circ}F/ft$ 

Results from the calculation are summarized below in Table I

<u>Nozzle</u>	Line Dia. Inches	Max. Fluid Temp., °F	dT/dr at Weld, °F/in
S-20A	1/2	· 220	-10.20
S-20B	1/2	220	-10.20
S-11C	4	250	-7.84
S-5C	1/2	100	-1.97
S-1A	2	250	-9.85

#### TABLE I

jj

cc: J. L. Liebenthal N. E. Pace *MEP/Nzw* E. D. Uldrich W. C. Townsend File Central File TAB File 3.8

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FROM EQ(2) WERE DETERMINED STRESS THERMAL 7.1P-290) AND (3) TAKEN FROM REFERENCE dT = K °F dR TH R = RADIUS OF POINT OF STRESS Q = INSIDE RADIUS dT = KdR 6 = OUTSIVE RADIUS THKR K = DOFATH (i) $T_{ik} = \frac{\alpha E}{R^2} \int \frac{R^2 - a^2}{b^2 - a^2} \left( T R dR - \left( T R dR \right) \right)$ (Z)SUBSTITUTING EQ (1) INTO (2)  $T_{RR} = \frac{KE}{R^2} \left[ \frac{R^2 - a^2}{b^2 - a^2} \right]_a^b KR^2 dR - \left( \frac{R}{KR^2} dR \right)$  $\nabla_{\mathbf{R}\mathbf{K}} = \frac{\alpha E}{\mathbf{R}^2} \left[ \frac{\mathbf{R}^2 - \mathbf{a}^2}{\mathbf{b}^2 - \mathbf{a}^2} \left| \frac{\mathbf{R}^3}{\mathbf{a}} \right|_{\mathbf{a}}^{\mathbf{b}} - \mathbf{K} \left( \frac{\mathbf{R}^3}{\mathbf{3}} \right) \right|_{\mathbf{a}}^{\mathbf{k}}$  $(\mathbf{I}) \quad \nabla_{\mathbf{R}\mathbf{R}} = \underbrace{\propto \mathbf{E}}_{\mathbf{R}^{2}} \left[ \frac{\mathbf{R}^{2} - \alpha^{2}}{\mathbf{b}^{2} - \alpha^{2}} \left( \mathbf{K} \right) \left[ \frac{\mathbf{b}^{3} + \alpha^{3}}{3} \right] - \mathbf{K} \left[ \frac{\mathbf{R}^{3} - \alpha^{3}}{3} \right] \right]$ (3)  $T_{\Theta\Theta} = \frac{\alpha E}{R^2} \left[ \frac{R^2 + a^2}{b^2 - a^2} \int_{a}^{b} T_R dR + \int_{a}^{T} T_R dR - T_R^2 \right]$ SUBSTETUTENG EQ() INTO (3)  $T_{00} = \frac{\alpha E}{R^2} \left( \frac{R^2 + \alpha^2}{b^2 - \alpha^2} \left( \frac{\kappa R^2 dR}{\kappa} + \int_{\alpha}^{\alpha} K R^2 dR - K R^3 \right) \right)$  $T_{ab} = \frac{\alpha E}{R^2} \left[ \frac{R^2 + a^2}{b^2 - a^2} \left( K \right) \left( \frac{R^3}{3} \right) \Big|_a^b + K \left( \frac{R^3}{3} \right) \Big|_a^b - K R^3 \right]$  $V_{ee} = \frac{kE}{R^2} \left[ \frac{R^2 + a^2}{b^2 - a^2} (k) \left[ \frac{b^3 - a^3}{3} \right] + k \left[ \frac{R^3 - a^3}{3} \right] - k R^3 \right] + k \left[ \frac{R^3 - a^3}{3} \right] - k R^3 \right] + k \left[ \frac{R^3 - a^3}{3} \right] - k R^3 \left[$ (III)

B-3



R(IN)

6

RAN

B-~

LVR1217 6 7-21-78

REVIEWING THE THERMAL STRESSES AND THE SIZE OF PIPE THAT CAUSES THESE STRESSES, THE WELD FOR PIPE 2"-LS-120-AB PENETRATING NOZZLE S-IA REQUIRES A COMPLETE ANALYSIS.



WELD ELEMENT S-IA (2"-LS-120 AB)

2.2 RADIAL STRESSES

THEKMAL

$$\nabla_{R} = -6000 \, \text{psi} \, (\text{see Page B-A})$$

FROM MOMENT IN PIPE

BASED ON INFORMATION ON PAGE 369, CASE 21 OF REFERENCE 8.



$$a r = b$$

MAX 
$$\nabla r = \frac{BM}{a x^2}$$
  
 $\frac{b}{a} = \frac{1.2}{14.3} = .08 \Rightarrow B = 10.2$   
 $M = MOMENT ON 2u LINE THKEN FROM
KEFERENCE Z.$ 

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DW + 55E - HIGHEST LOAD $<math>M_{y} = 5340 \text{ in} - 16$   $M_{z} = 3202 \text{ in} - 16$   $M = (5340^{2} + 3202^{2})^{\frac{1}{2}} = 6230 \text{ in} - 16$  $\nabla_{r} = \frac{10.2 (6230)}{14.3 (2)^{2}}$ 

$$\nabla r = \pm 1/10 PSI$$

#### FROM AZIAL LOAD IN PIPE

BASED ON INFORMATION ON PAGE 336, LASE 1-9 OF REFERENCE 8

$$M_{rb} = \frac{Wa}{Cs} L_{b}$$

$$W = \underline{P}_{Perimeter}$$

P = ATTAL LOAD ON 2" LINE TAKEN FROM REFERENCE 2. DW+SSE GOVERN

- $\rho = 123 \text{ lb}$   $\omega = \frac{123}{277(1.2)}$

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 $M_{rb} = 16.3(14.3)(.083)$ 

$$Mrb = 38 In-16 (VEry LOW)$$

 $\therefore$   $T_r \equiv 0$ 

TOTAL RADIAL STRESS: Tr = -6000-1110 +0

$$\overline{\nabla_r} = -7110 \text{ psi}$$

23 HOOP STRESS

THERMAL

### Va = -19,000 PSI

STRESSES FROM OTHER LONDING IS NEGRIGIBLE

NEGLIGICLE VT = 0

2.5) SHEAR STRESS

NEGLIGIBLE T=0

SINCE SHEAR IS NEGLIGIBLE, THE RADIAL, HOOP AND TANGENTIAL STRESSES ARE THE PRINCIPLE STRESSES.

$$S_{1-2} = \nabla_{r} - \nabla_{\theta} = -7110 - (-14,000)$$

$$S_{1-2} = 6890 \text{ psi}$$

$$S_{2-3} = \nabla_{\theta} - \nabla_{T} = -14,000 - 0$$

$$\frac{S_{2-3} = 14,000 \text{ psi}}{S_{1-3} = \nabla_{r} - \nabla_{T}} = -7110 - 0$$

$$S_{1-3} = \nabla_{r} - \nabla_{T} = -7110 - 0$$

$$S_{1-3} = -7110 \text{ psi}$$

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## 2.7) PRIMARY PLUS SECONDARY STRESS INTENSITIES

SINCE THIS WORK IS A MODIFICATION OF WORK THAT USED THE 1965 EDITION OF THE ASME BOILER AND PRESSURE VESSEL CODE [1] THE 1965 EDITION WILL BE USED IN THIS REPORT.

Pm + Q = PRIMARY + SECONDARY STRESS

Pm+Q = 19,000 psi (MAX STRESS INTENSITY) (SECTION 2.6)

THE FLANGES THAT THE PIPES ARE WELDED TO ARE COMPOSED OF SA-350, GRADE LFI CARBON STEEL AT A DESIGN TEMPERATURE OF 260° F. (6)

> Sm = DESIGN STRESS INTENSITY Sm = 17,950 psi @ 260°F (REFI)

- Pm+Q < 35m (REFI)
- Pm+q = 14,000 psr & 35m = 53,850 psr

THERE FORE THE REQUIREMENTS FOR PRIMARY + SECONDARY STRESS ARE SATISFIED

2.8) PRIMARY PLUS SECONDARY STRESS INTENSITIES (PEAK)

PM + Q + F = PRIMARY + SECONDARY + PEAK STRESS

FOR THIS WELD AREA, THE STRESS CONLETKATION FACTOR IS 3.0 [9]

Pm + Q + F = 3.0(14,000)

Pm + Q+F = 42,000 PSI

THE MAXIMUM STRESS WILL FLUCTUATE RETWEEN 0.0 PSI AND 42,000

THERE FORE SH = 42,000 - 0

## SA = 21,000 PSI

ENTERING SA ON THE FATIGUE CURVE FOR CARBON STEEL (SEE REF |, PAGE 1)

THE MAXIMUM # OF CYLLES = 100,000 CYCLES

FROM LOFT SPECIFICATION 5-1,67 THE MAXIMUM NUMBER OF FATIGUE CYCLES ON ANY NOZZLE IS 10,000. SINCE THIS IS LESS THAN 100,000, THE FATIGUE CRITERION ARE SATISFIED.



B-M TR1917 6 NOZZLE 5-20B NOZZLE SIZE - 10" NOZZLE THICKNESS - 0.693" PLATE THICKNESS - 0.75 " 1'-10" 6'-3" NOZZLE <PLATE OPEN INSIDE OUTSTOE FLOW MAX. MTH OPERATING TEMP RATE LINES PENETRATING TEMP TEMP DESCRIPTION 1) 1/2 "- BS-52-VC 70° BLOWDOWN 220° F 220°.F. 1.1% 2) 1/2"= B5 - 53 - UC SUPPRESSION D) 1/2"-B5-54-VD SYSTEM 1,2,3) PROTECT ENGINEER NANCY SMITH EXT-6-6319 WELDON MAKELA EXT-6-6728 <u>dr</u>) = - 1.01999 \$/14.[3] st weld

LTR1217 6 B-12 NOZZLE S-11C NOZZLE SIZE - 12" NOZZLE THICKNESS - D.406" PLATE THICKNESS - 1.25" 7'-0" 4'-8" NOZZLE <PLATE OPEN OUTSEDE INSIDE MAX. OPERATING MTH FLOW TEMP TEMP TEMP LINES PENETRATING RATE DESCRIPTION SUMP SAMPLING N1"-555-3-E 100°F. 1 gpm 100°F 70°F SYSTEM MAN 70°F 250°F 2)4"- BS -285- AB BLOW DOWN 250°F 7:00010/ SUPPRESSION SUSTEM 1) PROJECT ENGINEER - BUD WHITE ENT-6-6215 PROJECT ENGINEER - NANCY SMITH EXT - 6 - 6319

2) PROJECT ENGINEER - NANCY SMITH EXI- 6-6228 WELDON MAKELA EXT- 6-6228

- - 7.8416 F/1. [3] dr) aneid

B LTR1217 6 NOZZLE S-IA NOZZLE SIZE - 30" \$ NOZZLE THICKNESS - 0.50" PLATE THICKNESS - 2.00" 5'-9" 4'-3" -----// NOZZLE <PLATE OPEN INSIDE OUTSIDE MAX. - 144 - I FLOW OPERATING MTH RATE LINES PENETRATING TEMP TEMP TEMP DESCRIPTION P - 0 LOW PRESSURE .250 250°F 70°F 500 16/5 L DZ"-LS-120-AB 1: ps3 x STEAM SUSTEM 70° F N.A. 100°F 2)3"-PR-94-E PRESSURE REDUCTION 100° F SPRAY SUSTEM 3)1"-PLL -77-AB PRIMARY LOMPONENT 80° F 80°F 70°F 10 gpm LOULTHU SYSTEM 70°F A)1" - PCC - 78 - AB 80 F 80° F 11 F 1 1.1. 11 BUD WHITE - EXT - 6-6215 1,2) PROJECT ENGINEER -GERRY TANGUAY EXT - 6-6293 PROSECT ENGENEER -3,4) - 9.8549 F/1N. [3]