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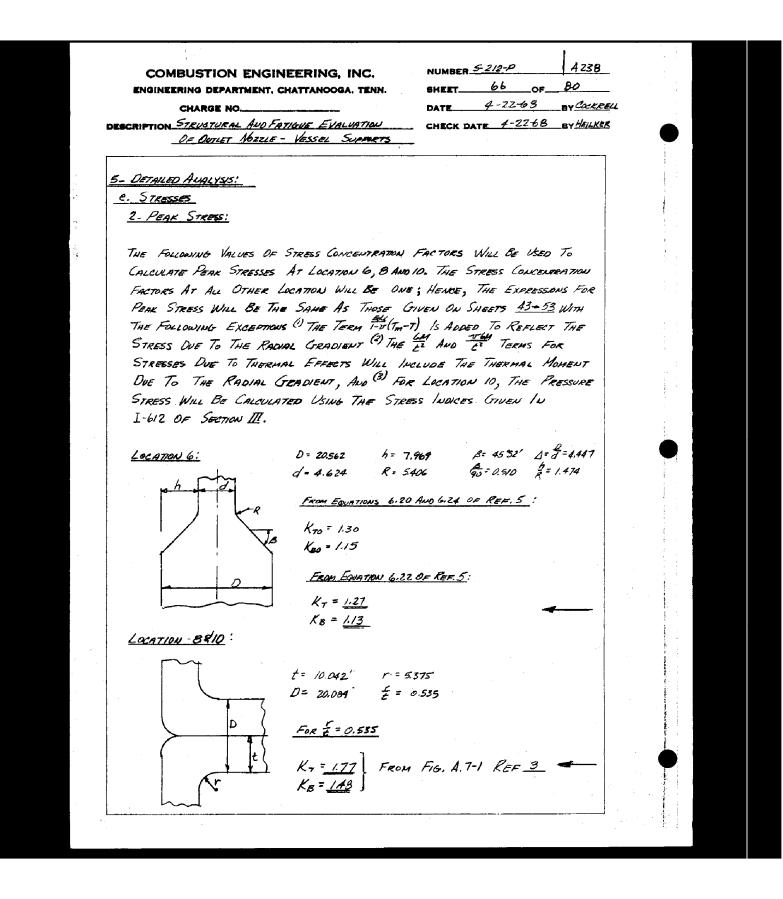
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ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. BHERT CHARGE NO DATE	4-22-68 BY Cackers
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CONSIDER CRITERION 5. b.4.	
Safe END	
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5 11.35 2.27 18.69 11.05 -10.37 0.97 11.86 -3.84	5 7.64 21.19 5 15.70 14.36
2 1 0 13.24 238 20.48 11.15	0 9.33 20,48 11.15 0 17.55 11.84 -5.71
144x = 07-03 = 24.19.451 < 1.2(1.51m) = 30.06 KSI	1- va18007
SHALL END DE NOZZLE	
LOCATION PRESSURE STREES STATES LE 70 PANULAR STREESS	55 577ESS /WTEUSITY
6 12.16 -25 12.33 247 20.24 11.41 -25 -11.27 1.05 12.23 -4.18 0 14.22 2.58 22.05 11.49	8.83 22.74 8.83 22.74 7.14.73 1056 22.05
1 < 1/2 (1/2 2m)= 48.	Lacamon
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ENGINEERING DEPARTMENT, CHATTANOGA, TENN. CHARGE NO CHARGE NO DATE <u>422-65</u> BY (2012) DATE <u>422-65</u> BY (2012) DEECRIPTION STRUCTURED AND LATE ALL SCORES BY (2012) DECRIPTION STRUCTURE NOTICE STRUCTURED: CHECK DATE <u>422-65</u> BY (2012) S. DETAILED AND LYSE: <u>6. STRESSES:</u> <u>1. COMMINED STRESSES - CHECK STRETED:</u> CONSIDER THE COMBINED FORCES OF THE PRO! THE MAXIMUM AND MINIMUM VERTICAL FORCE OF THE QUILET NOTLE PROS WAS FOUND TO BE, UMAX = <u>12373</u> HIPS NOTE HERE THAT THESE FRACES WERE DETERMINED VOINT <u>1149</u> FIPS NOTE HERE THAT THESE FRACES WERE DETERMINED VOINT <u>1149</u> FIPS NOTE HERE THAT THESE FRACES WERE DETERMINED VOINT <u>1149</u> FIPS NOTE HERE THAT THESE FRACES WERE DETERMINED VOINT <u>1149</u> FIPS NOTE HERE THAT THESE FRACES WERE DETERMINED VOINT <u>1149</u> FIPS NOTE HERE THAT THESE FRACES WERE DETERMINED VOINT <u>1149</u> FIPS NOTE HERE THAT THESE FRACES WERE DETERMINED VOINT <u>1149</u> FIPS NOTE HERE THAT THESE FRACES WERE DETERMINED VOINT <u>1149</u> FIPS NOTE HERE THAT THESE FRACES WERE DETERMINED VOINT <u>1149</u> FIPS NOTE HERE THAT THESE FRACES WERE DETERMINED VOINT <u>1149</u> FIPS NOTE HERE THAT THESE FRACES WERE DETERMINED VOINT <u>1149</u> FIPS NOTE HERE THE SUMPLET STRUCTURE CHARE THE VESSEL WILL NOT LIFT OFF THE SUMPLET STRUCTURE CHARE THE VESSEL WILL NOT LIFT OFF THE SUMPLET NOTICE FROM WAS FOUND TO EE, THE MAXIMUM HORIZOUTAL FORCE ON THE ATLEST NOTICE FROM WAS FOUND TO EE, THE ABOVE MAXIMUM FORCES PRODUCE BEAKING STREEDES ON THE PHO EQUIL TO, UMAX = <u>2010</u> FIDE STRESS PROVE BEAKING STREEDES ON THE PHO EQUIL TO, UMAX = <u>2010</u> FIDE STRESS ON THE BOTTON OF THE PAD & S 3.46 KSI WHEN CONSIDERING DEAD WEIGHT AND THERMAN LOWERD FOR REACTANS ON THE BOTTON OF THE PAD & S 3.46 KSI WHEN CONSIDERING DEAD WEIGHT AND THERMAN LOWERD FOR REACTANS ON THE SUPPORT ON THE PAD & S 3.46 KSI WHEN CONSIDERING DEAD WEIGHT AND THERMAN LOWERD FOR REACTANS ON THE SUPPORT AND THERMAN LOWERD FOR REACTANS ON THE SUPPORT ON THE PAD & S 3.46 KSI WHEN CONSIDERING DEAD WEIGHT AND THERMAN LOWERD FOR REACTANS ON THE SUPPORT AND	CHARGE NO DATE <u>4-22-63</u> BY COMPLET NO. <u>STRUKTURAL AND FATIONE FUNDATION</u> DE OUTLET NOZZIE - VESSEL SUMMETS CHECK DATE <u>4-22-63</u> BY COMPLET <u>DE OUTLET NOZZIE - VESSEL SUMMETS</u> CHECK DATE <u>4-22-63</u> BY COMPLET <u>DE OUTLET NOZZIE - VESSEL SUMMETS</u> CHECK DATE <u>4-22-63</u> BY COMPLET <u>DE OUTLET NOZZIE - VESSEL SUMMETS</u> CHECK DATE <u>4-22-63</u> BY COMPLET <u>DE OUTLET NOZZIE - VESSEL SUMMETS</u> <u>CHECK DATE <u>4-22-63</u> BY COMPLET <u>DE OUTLET NOZZIE - VESSEL SUMMETS</u> <u>CHECK DATE <u>4-22-63</u> BY COMPLET <u>DE OUTLET NOZZIE - VESSEL SUMMETS</u> <u>CHECK DATE <u>4-22-63</u> BY COMPLET <u>CHECK DATES</u> <u>CHECK DATE <u>4-22-63</u> BY COMPLET <u>COMPLET THE COMPLEX FORCE ON THE CONCE</u> BEARING <u>CONSTRUCT</u> <u>COMPLET ADD</u> <u>JESTESES COMPLET <u>COMPLET ADD</u> <u>CAMPA</u> <u>CHECK DATE <u>4-22-63</u> CM <u>CHECK DATE <u>4-22-63</u> BY COMPLET <u>4-22-63</u> CM <u>COMPLET 14-20-600</u> <u>COMPLET ADD</u> <u>COMPLET ADD</u> <u>COMPLET ADD</u> <u>CAMPA</u> <u>CHECK DATE ADD</u> <u>COMPLET ADD</u> <u>COMP</u></u></u></u></u></u></u></u></u></u></u></u></u></u></u></u></u></u></u></u></u></u></u></u></u>	A 237 80		NUMBER <u>5-2/2</u> Sheet <u>65</u>	-	
DESCRIPTION STRUCTURED AND FATURE FIGURITION DE QUILET NORLE - VESSEL SUPPARTS C. DETAULCO ANDURSE: C. STRESSES: L. COMMINED STRESSES - CHEQUIGENTIATED: CONSIDER THE CONSUME FORCES OF THE POD' THE MAXIMUM AND MULTIMUM VERTICAL FORCE ON THE QUILET NOTLE PADE WAS FOUND TO BE; UMAN = 12373 LIPS NOTE HERE THAT THESE FREES WHEE DETERMILED USING THE DESIGN SERVICE PARE LAND, THE MULLET NOTLE FADE WAS FOUND TO BE; UMAN = 114.9 MID NUMBER THAT THESE FREES WHEE DETERMILED USING THE DESIGN SERVICE PARE LAND, THE MULLET NOTE THAT SILVES THE MULTIMUM VERTICAL FORCE ON THE DESIGN SERVICE THE MAXIMUM AND MULTIMUM VERTICAL FORCE ON THE DESIGNE FREEMAL USING THE DESIGN SERVICE PARE LAND, THEEMAL USING THE DESIGN SERVICE PARE LAND, THEEMAL USING THE DESIGN SERVICE FREE LAND, THEEMAL USING THE DESIGN SERVICE FREE LAND, THEEMAL USING THE DESIGN SERVICE FREE LAND, THEEMAL VESSEL WILL NOT LIFT OFF THE SUPPORT STRUCTURE CHOORE THE DEIGN CONDITIONS THE MAXIMUM HORIZONTAL FORCE ON THE DETLET NOTLE PROS WAS FOUND TO BE; THE MAXIMUM HORIZONTAL FORCE ON THE DETLET NOTLE PROS WAS FOUND TO BE; THE ABOVE MAXIMUM FORCES PROVES BEARING STRESSES ON THE ABOVE MAXIMUM FORCES PROVES BEARING STRESSES ON THE PHD EQUIL TO; DETLE THAT THE BEARING STRESS ON THE BOTTOM OF THE PHD EQUIL TO; NOTE THAT THE BEARING STRESS ON THE BOTTOM OF THE PHD IS 3.6 KSI WHEN CONSIDERING DEED WEINT AND THERMAL NOUSED PARE RECTAINS OLLY. TWO COMPLETES WITH A DESIZED BEARING STRESS OF 5.0 KSI. THE STRESS WITH A DESIZED BEARING STRESS OF 5.0 KSI. THE STRESS WITH A DESIZED BEARING STRESS OF 5.0 KSI. THE STRESS	DESCRIPTION STRUCTURAL AND FAILOUE EVALUATION CHECK DATE $4.22.68$ By the DE OUTLET NOIZLE - VESSEL SUPPORTS 5. DETAILED ANALYSS: E-STRESSES: 1- CONDINED STRESSES - CHECONCENTENTED: (CONSIDER THE CONSINED FORCES ON THE PAD: THE MAXIMUM AND MINIMUM VERTICAL FORCE ON THE OUTLET NOZZLE PADS WAS FOUND TO BE, $\overline{V}_{MAX} = 12373$ kips $\overline{V}_{MAX} = 114.9$ kips $\overline{V}_{MAX} = 0$ kips $\overline{V}_{MAX} = 114.9$ kips $\overline{V}_{MAX} = 0$ kips \overline{V}_{MA	MANER				
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THE MAXIMUM AND MINIMUM VERTICAL FORCE ON THE QUILET NOZILE PROS WAS FOUND TO BE; $\overline{U_{MMX}} = 12373$ MASS FOUND TO BE; $\overline{U_{MMX}} = 12373$ MASS FOUND TO BE; $\overline{U_{MMX}} = 114.9$ MASS FOUND TO BEST THE FORCES WHERE DETERMINED $\overline{U_{MMX}} = 114.9$ MASS MASS FOUND ARE LOADS AND THE DESIGN CALLS, THEEMOL $\overline{U_{MMX}} = 114.9$ MASS MASS FOUND ARE LOADS AND THE SETSARE SAME FORCES $\overline{U_{MMX}} = 114.9$ MASS MASS FOUND ARE LOADS AND THE SETSARE SAME FORCES $\overline{U_{MMX}} = 114.9$ MASS MASS FOUND ARE PARE LOADS AND THE SETSARE SAME FORCES $\overline{U_{MMX}} = 114.9$ MASS MASS FOUND ARE FOR THE DESIGN CONDITIONS NOTE THAT SINCE THE MINIMUM VALUE OF \overline{U} is DOSITIVE, THE VESSEL WILL NOT LIFT OFF THE SUMPORT STRUCTURE CHOOSE THE DETIGN CONDITIONS THE MAXIMUM HORIZOUTAL FORCE ON THE QUILET HOZZLE PROS WASS FOUND TO BE, $\overline{H_{MX}} = \frac{821.0}{4}$ MAXIMUM FORCES PRODUCE BEARING STRESSES ON THE ABOVE MAXIMUM FORCES PRODUCE BEARING STRESSES ON THE PHD EQUIL TO, $\overline{U_{REF}} = \frac{\overline{U_{RMX}}}{A} = \frac{1237.3}{10+32} = \frac{56}{2.510}$ $S_{EEG} = \frac{\overline{U_{RMX}}}{A} = \frac{821.0}{2.510} = \frac{32.8}{2.8} MST$ MOTE THAT THE BEARING STRESS ON THE BOTTOM OF THE POD IS 3.6 KS1 WHEN CONSIDERING DEAD WEIGHT AND THERMAL INDUCED PIPE REACTIONS ONLY. THIS COMMENSES WITH A DESIRED BEARING STRESS OF 5.0 KS1. THIS STRESS WITH A DESIRED BEARING STRESS OF 5.0 KS1. THIS STRESS	THE MAXIMUM AND MINIMUM VERTICAL FORCE ON THE QUILET NOIZLE PADS WAS FOUND TO BE, $V_{MAX} = 12373$ MIPS $V_{MAX} = 12373$				- UNCONCENTRATED;	1- COMBINED STRESSES
NOTILE PADS WAS FOUND TO BE, $\overline{V}_{MAX} = \frac{12373}{2} \frac{\mu}{105}$ NOTE HERE THAT THESE FORCES WERE DETERMINED $\overline{V}_{MAX} = \frac{12473}{12} \frac{\mu}{105}$ NOTE THE SERVICE THE THAT THESE FORCES WERE DETERMINED $\overline{V}_{MAX} = \frac{114.9}{114.9} \frac{\kappa}{115}$ NOTE THAT SINCE THE MINIMUM VALUE OF \overline{V} is POSITIVE, THE VESSEL WILL NOT LIFT OFF THE SUMPORT STRUCTURE CHOSE THE DEIGN CONDITIONS THE MAXIMUM HORIZONTAL FORCE ON THE OPTLET NOTILE PROS WAS FOUND TO BE, $\overline{H}_{MAX} = \frac{621.0}{A} \frac{\kappa}{10} \frac{\kappa}{212} = \frac{5.6}{10} \frac{\kappa}{51}$ $\overline{V}_{RES} = \frac{1237.3}{A} = \frac{528}{10} \frac{\kappa}{51}$ $\overline{V}_{RES} = \frac{1403}{A} = \frac{627.3}{2.5\times10} = \frac{32.8}{32.8} \frac{\kappa}{51}$ NOTE THAT THE BEARING STRESS ON THE BOTTOM OF THE PRO IS 3.6 KS1 WHEN CONSIDERING DEAD WEIGHT AUD THERMAL INDUCED PIPE REPORTING DILY. THIS COMPARES WITH A DESIDED BEARING STRESS OF 5.0 KS1. THIS STRESS WITH A DESIDED BEARING STRESS OF 5.0 KS1. THIS STRESS	NOZZLE PADS WAS FOUND TO BE, $\overline{V}_{MAX} = \underline{12373}_{KIPS}$ NOTE HERE THAT THESE FORCES WERE DETERMINED $\overline{V}_{MAX} = \underline{12373}_{KIPS}$ NOTE HERE THAT THESE FORCES WERE DETERMINED V_{SNWG} THE DESIGN SEISHIC PIPE LAADS, THEEMAL $\overline{V}_{MAX} = \underline{114.9}_{KIPS}$ NOTE THE DESIGN SEISHIC PIPE LAADS, THEEMAL $\overline{V}_{MAX} = \underline{114.9}_{KIPS}$ NOTE THE DESIGN SAVE FACTORS $GIVEN IN REF 980. NOTE THAT SINCE THE MINIMUM VALUE OF \overline{V} is POSITIVE, THEVESSEL WILL NOT LIFT OFF THE SUPPORT STRUCTURE CHOER THEDEIGN CONDITIONSTHE MAXIMUM HORIZOWTAL FORCE ON THE OUTLET NOZZLE PROSWAS FOUND TO BE,\overline{H}_{MAX} = \underline{821.0}_{KIPS} SEE NOTE ABOVE FOR \overline{V}_{MAX} \neq \overline{V}_{MM}.THE ABOVE MAXIMUM FORCES PRODUCE BEARING STRESSES ON$			Pap!	IED FORCES ON THE	CONSIDER THE COMES
$V_{HIN} = 114.9 \text{ KIPS} \qquad V_{VAVED} Pre LOADS SEISMIC Prof. LAALS, THEEMAL V_{HIN} = 114.9 \text{ KIPS} \qquad V_{VAVED} Pre LOADS AND THE SEISMIC SHARE FAITURES GIVEN IN REF. 940. NOTE THAT SINCE THE MINIMUM VALUE OF VIS POSITIVE, THE VESSEL WILL NOT LIFT OFF THE SUPPORT STRUCTURE CHORE THE DEIGN CONDITIONS THE MAXIMUM HORIZOWTAL FORCE ON THE OUTLET NOZILE PROS WAS FOUND TO BE, \overline{H}_{MAX} = \underline{S21.0 \text{ KIPS}} See NOTE ABOVE FOR \overline{V}_{MAX} \neq \overline{V}_{MAX},THE ABOVE MAXIMUM FORCES PRODUCE BEARING STRESSES ONTHE PHD EQUAL TO,\overline{U}_{REF} = \frac{\overline{U}_{MAX}}{A} = \frac{1257.3}{10^{+21}} = \underline{516 \text{ Ks}}V_{OTE} THAT THE BEARING STRESS ON THE BOTTOM OF THE PAD IS 3.6 KSI WHEN CONSIDERING DEAD WEIGHT AND THERMAL INDUCED PIPE REACTIONS ONLY. THIS COMMERS WITH A DESIRED BEARING STRESS OF 5.0 KSI. THIS STRESS$	USING THE DESIGN SEISHIC PIPE LOADS, THERMAL USING THE DESIGN SEISHIC PIPE LOADS, THERMAL UNIT IN THE SINCE THE MINIMUM VALUE OF VIS POSITIVE, THE VESSEL WILL NOT LIFT OFF THE SUPPORT STRUCTURE CAUGER THE DEIGN CONDITIONS THE MAXIMUM HORIZONTAL FORCE ON THE OTLET NOZZLE PROS WAS FOUND TO BE, THE ABOVE MAXIMUM FORCES PRODUCE BEARING STRESSES ON	-7	E QUILET	RCE ON THE	_	
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DEIGN CONDITIONS THE MAXIMUM HORIZOWTAL FORCE ON THE OUTLET NOZZLE PROS WAS FOUND TO BE, $\overline{H}_{MAX} = \underline{B21.0} \underline{KIPS}$ See NOTE ABOVE FOR $\overline{V}_{MAX} \neq \overline{V}_{MAX}$, $\overline{H}_{MAX} = \underline{B21.0} \underline{KIPS}$ See NOTE ABOVE FOR $\overline{V}_{MAX} \neq \overline{V}_{MAX}$, $THE ABOVE MAXIMUM FORCES PROJECE BEARING STRESSES ON THE PHD EQUIL TO, \overline{U}_{RES} = \frac{\overline{V}_{MAX}}{A} = \frac{1237.3}{10^{-22}} = \underline{56} \underline{KS1}\overline{U}_{RES} = \frac{\overline{V}_{MAX}}{A} = \frac{\underline{B21.0}}{2.5 \times 10} = \underline{32.8} \underline{KS1}V_{ST} = \overline{H}_{MAT} = \underline{B21.0} = \underline{32.8} \underline{KS1}NOTE THAT THE BEARING STRESS ON THE BOTTOM OF THE PAD IS 3.6 KS1 WHEN CONSIDERING DEAD WEIGHT AND THERMAL INDUED PIPE REACTIONS ONLY. THIS COMMARDS WITH A DESIRED BEARING STRESS OF 5.0 KS1. TAS STRESS$	DEIGN CONDITIONS THE MAXIMUM HORIZONTAL FORCE ON THE OUTLET NOZZLE PROS WAS FOUND TO BE, FLMAX = <u>B21.0 KIPS</u> See NOTE ABOVE FOR VMAX & VMM. THE ABOVE MAXIMUM FORCES PRODUCE BEARING STRESSES ON	1			E MINIMUM VALUE OF	
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THE ABOVE MAXIMUM FORCES PRODUCE BEARING STRESSES ON THE PHD EQUIL TO, $D_{BEG} = \frac{\overline{M_{MAX}}}{A} = \frac{1237.3}{10 \cdot 22} = \underline{5.6 \ \underline{k}_{51}}{4}$ $S_{BEG} = \frac{\overline{M_{MAX}}}{A} = \frac{\underline{B21.0}}{2.5 \times 10} = \underline{32.8 \ \underline{k}_{51}}$ $L S_{y} = 44.5 \ \underline{k}_{51} \ \underline{0} = 400^{\circ}F$ $NOTE THAT THE BEARING STRESS ON THE BOTTOM OF THE PAD IS 3.6 \ \underline{k}_{51}$ WHEN CONSIDERING DEAD WEIGHT AND THERMAL INDUCED PIPE REACTIONS ONLY. THIS COMMENTES WITH A DESIRED BEARING STRESS OF 5.0 \ \underline{k}_{51}. This STRESS	THE ABOVE MAXIMUM FORCES PRODUCE BEARING STRESSES ON	Phos	Vozzie Prz	OUTLET A		
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UTH A DESIRED BEARING STRESS OF 5.0 KSI. (2) 400°F		On	RESSES ON	BEARING ST		
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PAO IS 3.6 KSI WHEN CONSIDERING DEAD WEIGHT AND THERMAL INDUCED PIPE REACTIONS ONLY. THIS COMMAKES WITH A DESIRED BEARING STRESS OF 5.0 KSI. THIS STRESS	$\sigma_{BRG} = \frac{H_{MBX}}{A} = \frac{B21.0}{2.5 \times 10} = \frac{32.8 \ ksl}{32.8 \ ksl}$				<u>0</u> 10 = <u>32.8 (</u> 51)	$\sigma_{BR6} = \frac{H_{MBX}}{A} = \frac{BZ_1}{2.5}$
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Engineering department, chattanooga, tenn.	SHEET	67 0	_ 80
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			68 BY HEILKEN
DESCRIPTION STRUCTURAL AND FATHERE E VALUATION	CHECK DATE	7-22	BAILTER
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5. DETAILED ANALYSIS:			
<u>e. Stresses:</u>			
2. PEAK STRESS:			
C. / ERS U/KESS.			
THE FOLLOWING EXPRESSIONS FOR STRESS WILL B	Re lleen	To Carry	ATE
PEAK STRESSES AT LOCATION 6, 8 AND 10.			
			2
LOCATION 6:			
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PRESSURE STRESS!			
$\delta_{x} = -\frac{bM_{z}}{\epsilon_{zA}^{z}} K_{B} + \frac{b^{3}D}{2R_{a} t_{zA}} K_{T} = -\frac{0.8568M_{2}}{2R_{a} t_{zA}} + \frac{2.9897P}{2R_{a} t_{zA}}$			
$D_{0} = -\frac{T_{0}M_{0}}{L_{20}^{2}}K_{0} + \frac{EW_{22}}{R_{2}} + \frac{bP}{L_{20}} = -\frac{0.2570M_{2} + 0.0630EW_{2}}{L_{20}}$	z + 5.1546F	2	
* 7			
5,= 0			
THERMAL STRESS:			
$G(M_2 + M_{2T})$ EL: ()			
$\sigma_{Y} = -\frac{6(M_{3} + M_{2T})}{\epsilon_{IA}} K_{B} + \frac{E d_{i}}{(1 - \nu)} (T_{m} - T) K_{T} = -0.856B(r)$	$M_2 + M_{2T} +$	1.8143 EA	((Tm-T)
$\sigma_{\phi} = -\frac{v_{\phi}(M_{2}+M_{er})}{E_{2A}^{2}}K_{B} + \frac{EW_{2}}{R_{2}} + \frac{EK_{1}}{(1-v)}(T_{m}-T) = -0.2570(1-1)$			
		.0630EW22	
	$6(T_m-T)$		
THERMAL LOUGED PIPE REACTIONS:			
Ox = - Fx KT + Ma KE = -0.00446 Fx + 0.00053 M. Po			
$U_{X} = A K_{T} T L K_{E} = -0.00446 F_{X} + 0.00053 M_{E} F_{0}$ $= -0.00446 F_{X} = -0.00053 M_{E}$	NNT A P		
$= -0.00446F_{x} - 0.00033M_{z}$ $= -0.00446F_{x} + 0.00053M_{y}$	0		
= - 0.00446 Fx + 0.00053 My = - 0.00446 Fx - 0.00053 My	D		
The second se	<i>U</i>		
Tre Ib' KB + Me KB = 0.00789 FE + 0.00027 MK	POULTA		
$1_{X_0} = 10^{-6} - 21^{-8} = 0.00787 F_2 - 0.00027 M_x$			
$= 0.00789 F_{y} + 0.00027 M_{x}$	B C		
= 0.00789Fy - 0.00027Mx	δ		
0.000714 - 0.00021P1x	0		

COMBUSTION ENGINEERING, INC. Engineering department, chattanooga, tenn. charge no	NUMBER <u>5-2/2-P</u> SHEET <u>69</u> OF DATE <u>4-22-69</u> CHECK DATE <u>4-22-68</u>	BY COCKEELL	
5- DETAILED ANALYSIS:			
e-Stresses!			
2-PEAK STRESSES;			
SEISMIC PIPE REACTIONS:			
THE FORMULAS FOR CALCULATING THE STRE			
PIPE REACTIONS ARE THE SAME AS FOR	THE THERMAL MAKED I	Cene news,	
LOCATION B:			
		· · · · · · · · · · · · · · · · · · ·	
PRESSURE STRESS;			
$\sigma_{\rm X} = -\frac{6M_{\rm H}}{E_{\rm AA}^2} \frac{R_{\rm A}}{R_{\rm AA}} \frac{K_{\rm B}}{K_{\rm B}} + \frac{b^2 P}{2R_{\rm AA}} \frac{K_{\rm T}}{K_{\rm T}} = -\frac{0.09428}{0.09428} \frac{M_{\rm A}}{M_{\rm A}} + \frac{1}{2}$	1.0697910		
$D_{\theta} = -\frac{\nabla bM_{\theta}}{E_{AB}}\frac{R_{\theta}}{R_{AB}}k_{B} + \frac{EWk_{B}}{R_{AB}} + \frac{bP}{E_{AB}} = -0.02827M_{0}$			
	······		
$\sigma_{r} = 0$			
THERMAL STRESS:			5
$\mathcal{O}_{X} = -\frac{6(M_{4} + M_{4} \tau)}{E_{4,0}^{2}} \frac{R_{4}}{R_{4,0}} K_{B} + \frac{55(i}{(1-v)} (T_{40} - \tau)K_{7} = -0.094$	28(Ma + Mat) + 2.52857	<u>K</u> _T	
$\mathcal{T}_{\phi} = -\frac{\nabla G(M_{4} + M_{47})}{L_{AA}^{2}} \frac{R_{4}}{R_{4A}} K_{B} + \frac{EM_{44}}{R_{4A}} + \frac{EK_{1}}{(1-v)} (T_{m} - 7) = -C_{1}$	0,02327 (Mat Max) + 0.04	13EW44	
	+ 1.42357 (Tm-T)		
THERMAL INDIDED PIPE REACTIONS:			. 1 1
Ox= - Fx Ky ± Mc KB = -0.00145 Fx + 0.0001	15M2		•
= -0,00145 Fx - 0.0001	5 Mz		
= -0.00145 Fx + 0.0001	5 My		
= -0.00145 Fx - 0,0001	5My		
Txo = ID' KB ± AIC KB = 0.00231 FZ + 0.0000;	TIMX		
= 0.00231 Fz - 0.00007.	IMX		
= 0.00231 Fy + 0.00007			:
= 0.00231 Fy - 0.00007			

NUMBER 5-212-P A 241 COMBUSTION ENGINEERING, INC. ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. 80 SHEET..... 69 4-22-68 CHARGE NO. BY COCKRELL DESCRIPTION STRUCTURAL AND FATIGUE EVALUATION CHECK DATE 4-22 68 BY HEILKER OF OUTLET NOTTLE - VESSEL SUPPORT <u>5- OETAILED ANALYSIS:</u> E-STRESSES! 2. PEAK STRESSES: THE EQUATIONS FOR STRESS DUE TO SEISMIC PIDE REACTIONS, STATIC LOADING THROUGH SUPPORTS, EARTHQUAKE LOADING THROUGH SUPPORTS, AND THERMAL EXPANSION & CONTRACTION ARE THE SAME AS FOR THE THERMAL MORES PIDE REACTIONS. THE VALUES OF FX, Fy, FZ, MX, MU, AND MZ ARE THE SAME AS THOSE LISTED ON SHEETS 47 \$48 LOCATION 10: PRESSURE STRESS: POINTS A & B POINTS C. D LONGITUDINAL PLANE CIRCUMFERENTER PLANE $\sigma_{x} = \frac{1}{4} \left(\frac{bP}{4} + \frac{P}{2} \right) = 8.4477P$ 17.7402 P $\sigma_{\phi} = \dot{l}_{\phi} \left(\frac{bP}{t} + \frac{P}{2} \right) = 10,1373 P$ = 21.9641P 0-=0 THERMAL STRESS: POINTS A & B (LONGITUDINAL PLANE): $\sigma_{x} = -\frac{6}{E_{z}^{2}}(M_{4} + M_{5T})K_{B} - \frac{H_{4}}{E_{5}}K_{T} + \frac{E_{4}}{(1-v)}(T_{m} - T)K_{T} = -\frac{0.01604(M_{z} + M_{5T})}{-0.16465}K_{4}$ + 2.5286 EX; (Tm-T) $\sigma_{\theta} = -\frac{TL}{L_{z}^{2}} (M_{4} + M_{57}) K_{8} + \frac{EW_{s}}{R_{5}SW_{\theta}} + \frac{Ed_{z}}{(1-v)} (T_{m} - T) = -0.02305 (M_{4} + M_{57}) + 0.0501 EW_{s+}$ + 1.42857 Edi (Tm-T) POINTS CED (CIRCUMFERENTIAL PLANE): $\sigma_{\chi} = -\frac{\pi 6}{c_{\pi}^{2}} \left(M_{4} + M_{57} \right) k_{5}^{+} \frac{EM_{52}}{k_{5}} + \frac{EM_{51}}{(1-v)} \left(T_{m} - T \right) = -0.02305 \left(M_{4} + M_{57} \right) + 0.050 \left(EW_{54} - W_{54} \right) + 0.050 \left$ + 1.42857 EX: (Tm -T) σ= - 6/25 (M4+M3T)KB - Hecos & + (1-V)(Tm-T)KT = -0.07684 (M4+M5T)-0.16288 He + 2.5286 Ed; (Tm-T)

ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. CHARGE NO.	SHEET 70 OF	BY COCKRELL	
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DETAILED AUALYSIS:		· .	
2- STRESSES:			t e
2. PEAK STRESSES:			
THERMAL INDUCED PIPE REACTIONS!			
$\sigma_{x} = -\left(\frac{N_{k}}{F_{h}/R_{m}}\right)\frac{F_{x}}{R_{m}T}K_{T} \pm \left(\frac{M_{x}}{F_{x}}\right)\frac{be\bar{F}_{x}}{T^{2}}K_{B} \pm \left(\frac{N_{x}}{\bar{M}/R_{m}^{2}\beta}\right)\frac{F_{1}}{R_{m}^{2}\beta}T^{K}_{T} \pm$	(<u>Mn</u>) <u>GA</u> (<u>A</u> /Rm/B) Rm/B T ^a KB		
= - 0.00 B32 Fx + 0.00027 Mz POWT A			
= - 0.00832F, - 0.00027 Mz B		•	
=-0.00932Fx + 0.00023My C			
= -0.00832Fx - 0.00023My D			
$\mathcal{O}_{\Theta} = -\left(\frac{M_{\Theta}}{\tilde{F}_{x}/R_{m}}\right)\frac{\tilde{F}_{x}}{R_{m}T}K_{T} \pm \left(\frac{M_{\Theta}}{\tilde{F}_{x}}\right)\frac{G\tilde{F}_{x}}{T^{2}}K_{B} \pm \left(\frac{M_{\Theta}}{\tilde{M}_{x}/R_{m}^{2}}\right)\frac{\tilde{L}_{x}}{R_{m}^{2}}\tilde{S}^{T}K_{T} \pm$	$\left(\frac{M_{X}}{\overline{M}/R_{m}\beta}\right)\frac{G\overline{M}}{R_{m}\beta T^{2}}K_{R}$		
=-0.01054 Fx + 0.00023 Mz POINT A			
=-0.01054Fx - 0.00023 Mz B			
=-0.01054Fx + 0.000 36 My C			
=-0.01054 Fx - 0.00036 Mg D			
F D			
$T_{xo} = \pm \frac{E}{\pi r_0 T} K_{\rm g} + \frac{M_{\rm A}}{2\pi R_0 T} K_{\rm g} = 0.00162 F_{\rm m} + 0.00003.$			
= -0.00/02 Fz + 0.00003			
= 0.00162 Fy + 0.00003			
= -0.00162 Fy + 0.000031	M _z D		
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Note Here Tunt Peak Stresses Where Calculated At The Ten Locations As Shown ON Sheet 14 For the Four Orientations A, B, C And D. The Following These Gries The Overall Usage Factors For Each Location And Each Orientation. Stresses And Stress Intensities Preducing These Usage Forces Will Not Be Presented For All Locations And Orientations Only Stresses And Stress Intensities At The Location And Orientations (Usage Will Be Presented - This Was Location 9A . $\frac{1}{1}$ A advocat B accord C accord B accord B accord B accord B accord C ac										
LOCATIONS AS SHOWN ON SHEET 14 FOR THE FOUR ORIGUTATIONS A, B, C AND D. THE FOLLOWING TABLE GIVES THE OVERAL USAGE FACTORS FOR EACH LOCATION AND EACH ORIGUTATION STRESSES AND STRESS INTENSITIES PRODUCING THESE USAGE FACTORS WILL NOT BE PRESENTED FOR ALL LOCATIONS AND ORIGUTATIONS. ONLY STRESSES AND STRESS INTENSITIES AT THE LOCATION AND ORIGUTATION WHICH PRODUCE THE HIGHEST OVERALL USAGE FACTOR WILL BE PRESENTED. THIS WAS LOCATION 9A. AUD ORIGUTATION WHICH PRODUCE THE HIGHEST OVERALL USAGE FACTOR WILL BE PRESENTED. THIS WAS LOCATION 9A. $AUD ORIGUTATION WHICH PRODUCE THE MIGHEST OVERALL USAGE FACTOR WILL BE PRESENTED. THIS WAS LOCATION 9A. AUD ORIGUTATION WHICH PRODUCE THE MIGHEST OVERALL USAGE FACTOR AUD ORIGUTATION WHICH PRODUCE THE MIGHEST OVERALL USAGE FACTOR AUD ORIGUTATION WHICH PRODUCE THE MIGHEST OVERALL USAGE FACTOR AUD ORIGUTATION WHICH PRODUCE THE MIGHEST OVERALL USAGE FACTOR AUD ORIGUTATION WHICH PRODUCE THE MIGHEST OVERALL USAGE FACTOR AUD ORIGUTATION WHICH PRODUCE THE MIGHEST OVERALL USAGE FACTOR AUD ORIGUTATION WHICH PRODUCE THE MIGHEST OVERALL USAGE FACTOR AUD ORIGUTATION WHICH PRODUCE THE MIGHEST OVERALL USAGE FACTOR AUD ORIGUTATION OVER THE ORIGITAL THE MIGHEST OVERALL USAGE FACTOR AUD ORIGUTATION OVER THE ORIGITAL THE MIGHEST OVERALL USAGE FACTOR AUD ORIGITATION OVER THE ORIGITAL THE MIGHEST OVERALL USAGE FACTOR AUD ORIGITATION OVER THE ORIGITAL THE MIGHEST OVER THE OVER THE ORIGITAL THE O$	2- PEAK ST	eesses								
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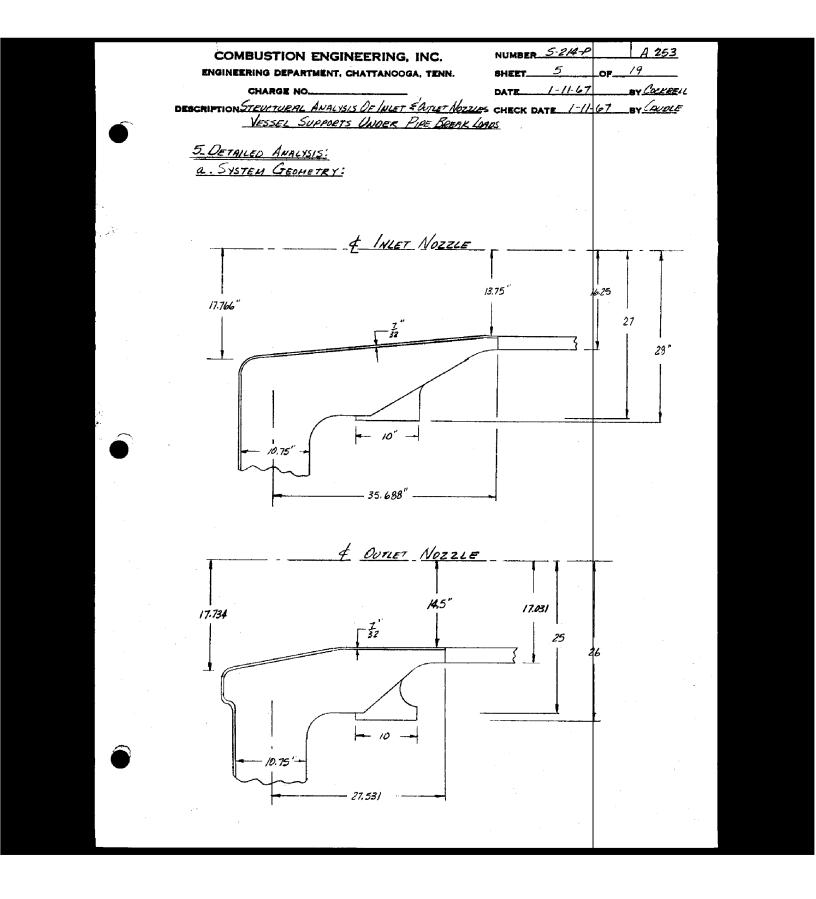
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	1	TOTAL STREES	5	57.90	56.11	82.38	16.72	64.85	23.06	60.08	51.15	71.60	80.50	65.32	42.60		40.28	- 20								
	OCATION									60			62	65		43.01	\$	75.18								
) OCH		6	-10.91	-4.90	-3.66	-17.29	-5.57	14.60	-/2,36	-15.71	1.96	7.5/	- 18.26	-20.07	-5.04	24.96	48.71								
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<u>5. DETAILEO ANALYSIS:</u> <u>F- FATIGUE EVALUATION:</u> 71/30/851 @ Function 5:6.	- K - K - K	5 20 30 - 30 - 5	* Fron File. N-415 (A)	REFERENCE 1	ť			•			
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	р Р	200 20 Sunx	36.04	33.58	72.43	7243	72.43		-	 A state of the second se	
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NUMBER 5-214-P A 254 COMBUSTION ENGINEERING, IN \dot{q} . 6 19 OF. ENGINEERING DEPARTMENT, CHATTANOOGA, SHEET 1-11.67 BY COCKRELL CHARGE NO. DATE DESCRIPTION STEUCTURAL ANDLYSIS OF WLET & OUTLET NOZZLES 1-11-61 BY CAUDLE CHECK DATE____ VESSEL SUPPORTS UNDER PIPE BREAK LOADS DETAILED ANALYSIS: 65YSTEM LOADS: 1-LOADING ON NOZZLES! MyD Fyp MZP F, " Мур POSITIVE DIRECTION A SHOWN X = 40.188" (INLET NOZZLE) 32.031" (OUTLET NOZZLE) ASE NOZZLE Mxp Fxp Myp Mzp Fyp Fzr 1 INLET 1185 0 601 0 0 0 2 OUTLET 1470 0 0 Ø 0 0 3 0 INCET 1330 0 0 0 U OUTLET 4 945 - 461 0 0 0 88500 5 INLET 0 253 253 72800 Ð 0 Note THAT UNITS ON FORCES AND MOMENTS ARE KIPS AND KIP-INS.

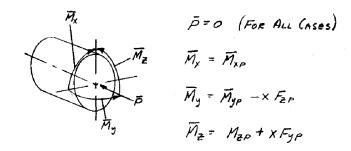
COMBUSTION ENCINEERING, INC. NUMBER 5.244-D 4.255 BERNELING DEARTHER, PAILTHUR, PAILER HELL, MUMBER 5.244-D 4.255 ENCINEERING DEARTHER, PAILTHUR AND ALL HELL AND ALL HELL AND ALL COMBER NO. LEARNEL ALLERE ALL HELE HELL HELL HELL AND ALL HELL AND ALL HELL ALL HELE ALL HELL ALL H	4 255	BY LOULE		$\boxed{2}$.01	- 14E AS 3805	14 & HLOWAOLE 54 = d5,25 KS1		A+D	1329	322	6//	Vesser	Sm 41	BE LESS		073
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COMBUSTION ENGINEERING	INC.	NUMBER.	5-214-P	A 256
ENGINEERING DEPARTMENT, CHATTANOOL)	SHEET	<u> </u>	
CHARGE NO.		DATE	1-11-67	BY COCKRELL
DESCRIPTION STRUCTURAL ANALYSIS OF INLE	T FOURET NOZZIE	SCHECK DA	TE 1-11-67	BY LAUDLE

<u>5 DETRILED ANALYSIS:</u> <u>d- Forces On Vessel Wall;</u>

WESTINGHOUSE PAR NO. 32 STATES THAT THE AXIAL LOAD (FXP AS SMOON ON THE SHEET (D) "SHOULD NOT BE CONSIDERED AS ACTING ON THE NOTZLES BUT MUST BE REACTED BY THE NOTZLE SUPPORTS". SINCE THERE ARE NO OTHER FORMES ACTING FOR CASES NO. 24'3, THESE CASES WILL BE DISREGARDED; AND, THE AXIAL LOAD FXP WILL BE DISREGARDED FOR ALL CASES WHEN CONSIDERING THE NOTZLES.



VESSEL SUPPORTS UNDER PIRE BREAK LOADS

CASE	NOZZLE	Ē	Mх	My	Mz
1	INLET	0	0	-24-274	0
4	DUTLET	0	0	0	-103266
5	INLET	0	253	-82968	0

THE METHOD OF DETERMINING THE FORCES EXERTED IN THE LONGITUDINAL AND CLECUMFERENTIAL DIRECTIONS OF THE VESSEL DUE TO THE APPLIED EXTERNAL LOADS IS AS OUTLINED IN REFERENCE 20

$$\mathcal{B} = \frac{0.875Y^{\circ}}{\alpha} = 0.260 \quad (\text{INLET NOZZLE}) \quad \frac{For}{Y_{o}} = 27" \quad (\text{INLET NOZZLE RAUNS}) \\ 0.240 \quad (0UTLET NOZZLE) \quad Y_{o} = 27" \quad (\text{INLET NOZZLE RAUNS}) \\ 25" \quad (0UTLET NOZZLE , KACHS) \\ \alpha = 91.031" \quad (\text{Vessel Rauns}) \\ \chi = \frac{\alpha}{t} = 9.468 \quad t = 10.75" \quad (\text{Vessel Wall THATENES})$$

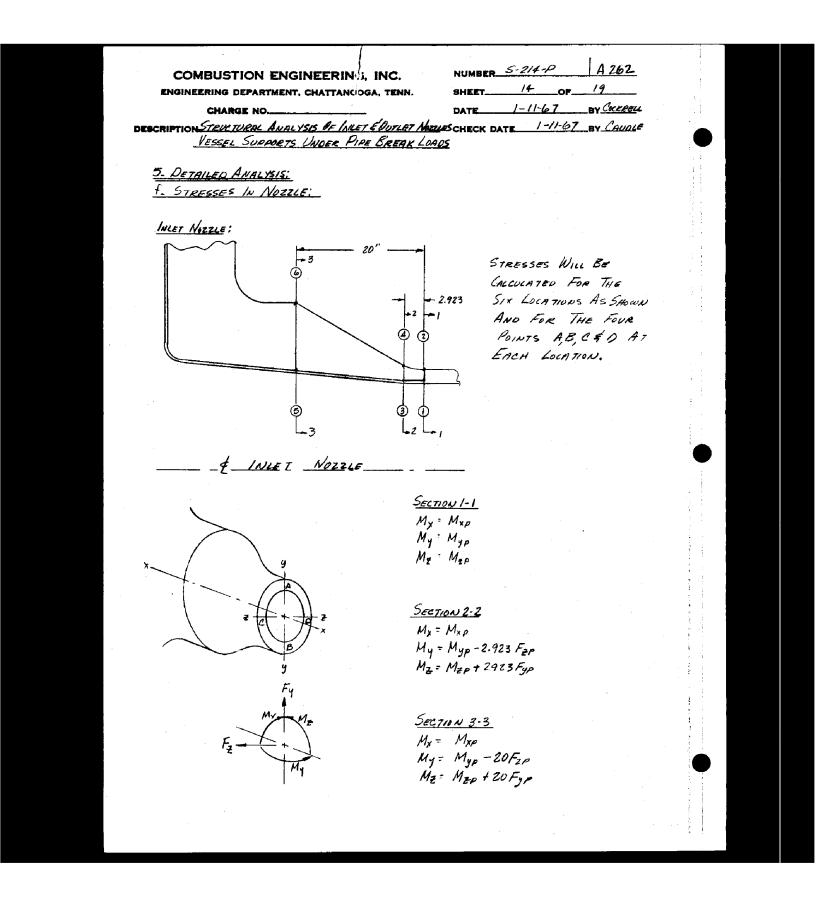
COMBUSTION ENGINEERING, INC. NUMBER 5-2/4-2	A 257	
ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. SHEET	OF	
CHARGE NO DATE 1-11-6.7	BY COCKRELL	
DESCRIPTION STEWITURAL AUGUSTS OF WLET SOUTLET NOZZLES CHECK DATE 1-11-	67 BY CAULUE	
VESSEL SUPPORTS UNDER PIPE BREAK LOADS		
5. DETAILED ANALYSIS!		
d- FORCES ON VESSEL WALL:		
FOR EXTERNAL LONGITUDINAL MOMENT MZ:		
INLET NOZZLE: OUTLET NOZZLE:		
$\frac{N_{d}}{\overline{M}_{2}/a_{1}^{2}a} = 0.95; N_{d} = \frac{0.95}{(91.03)} \frac{M_{\pi}}{(24-3)} = 0.00044 \overline{M}_{\pi} = \frac{N_{d}}{\overline{M}_{2}/a_{1}^{2}a} = 0.92; N_{d} = \frac{0.92}{(91.03)}$	Ma = 0.00046 Hz	
No. 000 M N	7.	
$\frac{N_{\star}}{\overline{M_{\Xi}}/a_{JS}^{*}} = 0.22 ; N_{Y} = \frac{0.22}{(91.031)^{1}(.240)} = 0.00010 \widetilde{M_{\Xi}} = \frac{N_{\chi}}{\overline{M_{\Xi}/4_{JS}^{*}}} = 0.20 ; N_{\chi} = \frac{0.20}{(91.031)^{2}}$	(240) = 0.00010 MZ	
$\frac{M_{0}}{M_{2}/a/b} = 0.041; M_{0} = \frac{0.041M_{2}}{191.031} = 0.00173M_{2} \frac{M_{0}}{M_{2}/a/b} = 0.043; M_{0} = \frac{0.043}{(91.031)}$	Ma I A PO 107 II	
	· · ·	
$\frac{M_{X}}{M_{Z}/a, \beta} = 0.063; M_{X} = \frac{0.063}{(91.031)} \frac{M_{Z}}{(240)} = 0.00266 M_{Z} \left[\frac{M_{X}}{M_{Z}/a, \beta} = 0.069; M_{X} = \frac{0.069}{(91.031)} \right]$	(1+)= 0.00316 M =	
	2 (TT)	
CASE NOZZLE MZ NA NX MA MX		
1 INLET 0 0 0 0 0		
4 OUTLET - 103266 -47.502 - 10.327 - 203.434 - 326.321		
5 INLET 0 0 0 0 0		
FOR EXTERNAL CIRCUMFERENTIAL MOMENT My!		
INLET NOTIE: DUTLET NOTILE		
	<i>M</i> .	
$\frac{N_b}{M_y a^2 s} = 0.33; N_\phi = \frac{0.33 \overline{M_y}}{(91.031)^2 (.200)} = 0.00015 \overline{M_y} \frac{N_\phi}{\overline{m_y} a^2 \beta} = 0.30; N_\phi = \frac{0.30}{(91.031)^2}$	(240) = 0.00015 My	
$\frac{N_x}{M_y/a_{1,8}^2} = 0.52; N_x = \frac{0.52M_y}{(91.03)^2(.260)} = 0.00024M_y \frac{N_x}{M_y/a_{1,8}^2} = 0.50; N_x = \frac{0.50}{(91.03)^2}$		
$\frac{M_{d}}{M_{y}/a_{\beta}} = 0.092; M_{b} = \frac{0.092M_{y}}{(91.051)} = 0.00389M_{y} \frac{M_{d}}{M_{y}/a_{\beta}} = 0.094; M_{b} = \frac{0.094}{(91.031)}$	My 1.240)= 0.00430My	
$\frac{M_{x}}{M_{y}/a_{\beta}} = 0.053; M_{x} = \frac{0.053M_{y}}{[91.031]} = 0.00224M_{y} \frac{M_{x}}{M_{y}/a_{\beta}} = 0.055; M_{x} = \frac{0.055}{[91.031]}$	(.240) = 0.00252AJy	
CASE NOZILE I Al. 11 11.		
LASE NOZILE My No Nx Mo Mx		
1 INLET -24274 - 3.641 - 5.826 -94.426 - 54.374		
4 OUTLET 0 0 0 0 0		
5 INLET -82968 - 12.445 - 19.912 - 322.746 -185.848		

NUMBER 5-2/4-P A 258 COMBUSTION ENGINEERING, INC. 10 19 ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. SHEET. 1-11-67 BY COLKEELL CHARGE NO. DATE DESCRIPTION STEVETURAL ANALYSIS OF INLET FOUTLET NOZUES CHECK DATE 1-11-67 BY (AUNLE VESSEL SUPPORTS UNDER PIPE BREAK LOADS <u> 5 DETRILED ANALYSIS:</u> E-STRESSES IN VESSEL WALL: a = 91.031" t = 10.75" r = 27" (INLET NOZZLE) 25" (OUTLET NOZZIE) 1 = 0.09302 M., Car C. Dr. 200 6 .05191 Bi B. SIGN LONVENTION FOR STRESSES TYPE OF LOCATION EXTERNAL LOAD STRESS \overline{M}_{z} Mу Ao & Ac MEMBRANE ___ Bo & Bi + No E & No C. E Ci + Do E Di -A; + BENDING A. ----Bi ----<u>6M</u>x t² 8. + Ci -C. + Di + D. _ BENDING Ai + Α. --------Bċ .6Md t2 в. + Ci C. + Di + D, ----

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	CHARGE NO.				1-11-6		COCKRELL
DESCRIPTI	ON STRUCTURAL AN	ALYSIS OF INLETED	mer Norues	HECK DA	TE/-//	-67 BY	CAUCLE
a i i Li a	VESSEL SUPPORT	s UNDER PIPE BRED	ak Loaos				
5 De	TAILED ANALYSIS;						
	RESSES IN VESSER	Mari					
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	POINT SURFACE				TOTAL		
		$\frac{N_x}{t}$ $\frac{6M_x}{t^2}$	<u>Nx</u> t	$\frac{6M_{\star}}{t^2}$			
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	A OUT					1	
	14			-	<u>├─── </u>		
	B OUT		+	•			
	C IN		- 0.54 -	+ 2.82	2.28]	
	OUT		- 0.54 -	- 2.82	-3.36		
	DM			- 2.82	- 2.28	-	
	OUT	1 1	+ 0,54 -	+ 2.82	3.36	}	
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		Do KSI					
	POINT SURFACE	DUE TO M.	Due To	My			
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	- OUT						
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	C IN			+ 4.90	4.56		
	OUT			- 4.90	-5,24		
	0 IN DOT			- 4.90	-4.56		
			- 0.34 -	L 4,90	5.24		

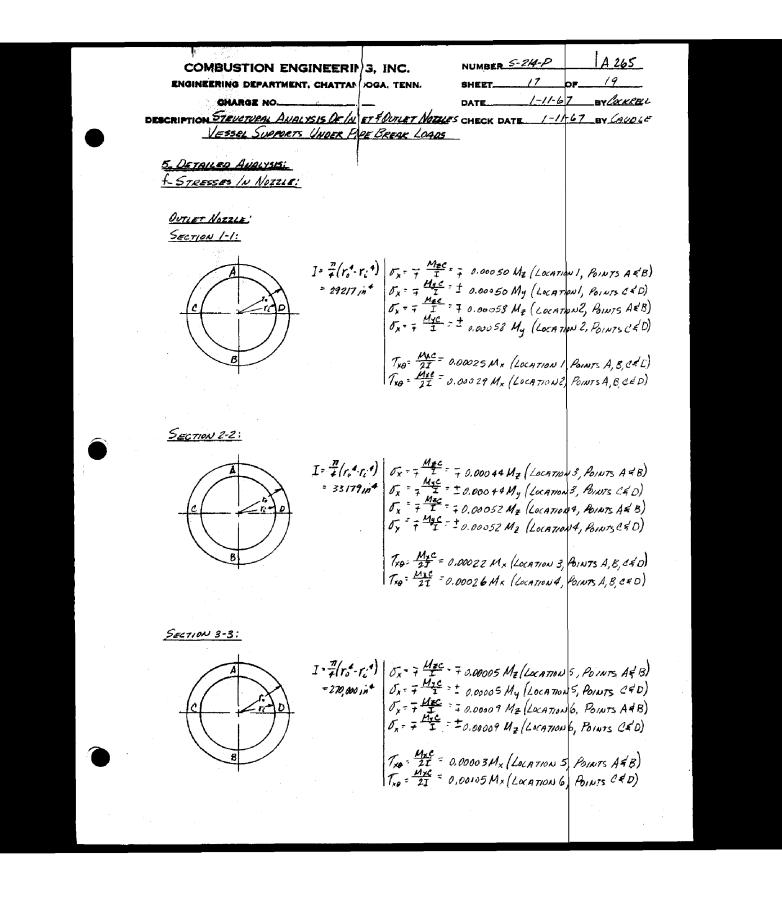
NUMBER 5-214-P A 260 COMBUSTION ENGINEERING, INC. SHEET /Z OF 19 ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. 1-11-67 BYLCCKREI CHARGE NO. DATE DESCRIPTION STRUCTURAL ANALYSIS OF INLET ÉDUTLET NOTLES CHECK DATE 1-11-67 BY (AUDLE VESSEL SUPPORTS UNDER PIPE BREAK LOADS 5. DETRILED ANALYSIS! C- STRESSES IN VESSEL WALL: CASE No. 4 \overline{M}_{4} OUTLET NOZZLE $\sigma_{\mathbf{x}}$ KSI DUE To My DUE TO My BINT SURFACE TOTAL $\frac{N_x}{t}$ <u>6Mx</u> t² <u>N.</u> t <u>6Mx</u> 22 - 16.94 Įv. + 0.96 0 0 -15.98 A OUT + 0.96 + 16.94 17.90 IN - 0.96 + 16.94 15.98 В OUT - 1.96 - 16.94 - 17.90 IN 0 0 O C 001 N D 007 Jo KSI DUE TO MZ DUE TO My SURFACE POINT TOTAL <u>Na</u> t 6Mb t2 <u>6 Md</u> t2 Nø t IN + 4.42 - 10.56 0 0 -6.14 A OUT + 4.42 + 10.56 14.98 ΙN - 4.42 + 10.56 $SI_{max} = 5_x - 5_y$ 6.14 В - 4.42 Out _ = 17.9 45! 10.56 - 14.98 IN 0 D 0 С Оυт Ŵ D Ουτ

	NGINEERING DEPARTN CHARGE NO		D	ATE	1-11-67	
DESCR	IPTION <u>STEVETUERLA</u> V <u>ESSEL</u> SURPO	NALYSIS OF INLET & OUT ETS UNDER PIPE BR	<u>iet Nozele</u> s ci <u>ear Loads</u>	HECK DA	T <u>e /-//</u>	67 BY (AUDLE
5	DETAILED ANALYSIS					
e.	STRESSES IN VESS	EL WALL :				
	•					
			A	و	· -	
	CASE No. 5		× f	$\sum_{i=1}^{n}$	₩.	My
	INLET NOZZL	E	e	14	Ĵ_₹	
			B	J		Y
		5		5		
:			KSI -	-	1. J.	1
	POINT SURFACE	DUE TO MZ	OUE To	My	TOTAL	
, when		$\frac{N_{v}}{t} = \frac{6M_{x}}{t^{2}}$	<u>Nx</u> t	6M, t2	· •	
					<u></u>	
	A W OUT	0 0	0	0	0	
	B IN					
	B DUT		V	4	-	
	C 1N		1 1	9.65	7.80	
	DUT D IN	-			- 11.50	
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		DUE TO MZ	Due To	My		
	POINT SURFACE				TOTAL	
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	B IN Dur	╫──╆──┼──┼	+			S.I. MAX = 5 - 5r
	a IN		- 1.16 +	, 16.15	15.59	= 17.91KS1
	C DUT				-17.91	
	DIN			16.75	- 15,59	
	DUT		+ 1.16 +	16.75	17.91	
		•				



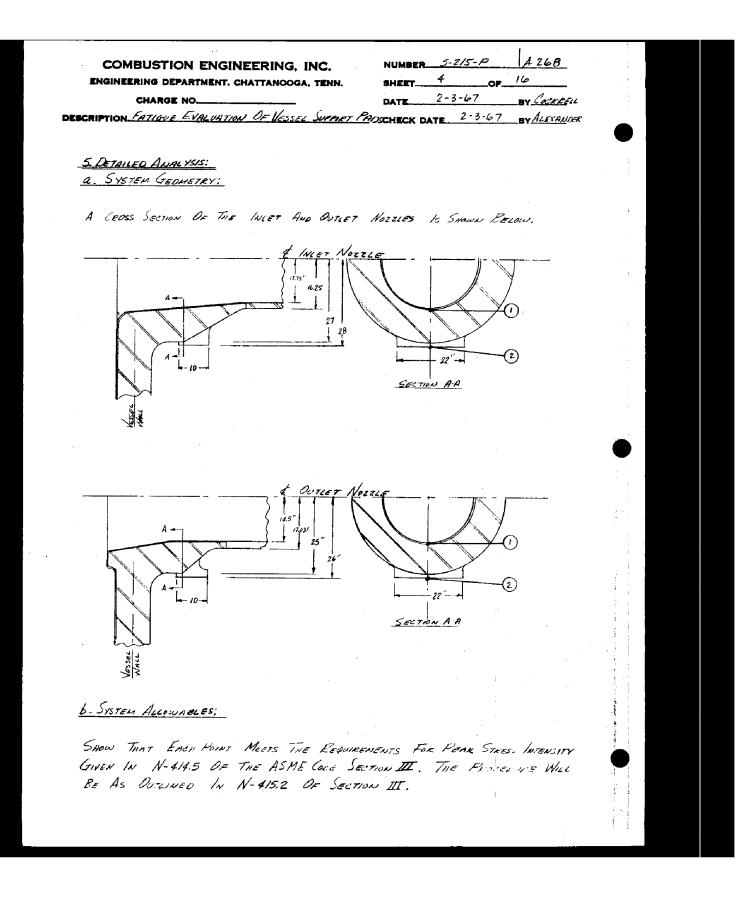
NUMBER 5-24-P A 263 COMBUSTION ENGINEEN ING, INC. ENGINEERING DEPARTMENT, CHATI NOOGA, TENN. SHEET 1-11-67 BY COCKLELL CHARGE NO. DATE DESCRIPTION STEULTURAL ANALYSIS OF YNLET & OUTLET NOTLES CHECK DATE 1-11-67 BY CANOLE VESSEL SUPPORT UNDER PIPE BREAK LOADS 5- DETAILED ANALYSIS ! f-STRESSES IN NOZZLE: INLET NOZZLE; SECTION 1-1
$$\begin{split} \mathbf{I} &= \frac{\pi}{4} \left(r_{i}^{a} \cdot r_{i}^{a} \right) \\ &= 24861 \text{ in}^{4} \end{split} \\ \begin{aligned} \nabla_{\mathbf{x}} &= \frac{\pi}{4} \left(\frac{M_{\mathbf{x}} c}{\Sigma} \right) \\ &= \frac{\pi}{4} \left(r_{i}^{a} \cdot r_{i}^{a} \cdot r_{i}^{a} \right) \\ &= \frac{\pi}{4} \left(r_{i}^{a} \cdot r_{i}^{a} \cdot r_{i}^{a} \cdot r_{i}^{a} \right) \\ &= \frac{\pi}{4} \left(r_{i}^{a} \cdot r_{i}^{a} \cdot r_{i}^{a} \right) \\ &= \frac{\pi}{4} \left(r_{i}^{a} \cdot r_{i}$$
 $\begin{aligned}
& T_{XO} = \frac{M_{X}e}{2I} = 0.0002B M_{X} \left(L_{0CATTON} I, B_{MTS}A, B, ctD \right) \\
& T_{XO} = \frac{M_{XC}}{2I} = 0.00033 M_{X} \left(L_{0CATTON} 2, H_{11MTS}A, B, ctD \right)
\end{aligned}$ SECTION 2-2
$$\begin{split} \mathbf{I} &= \frac{\pi}{4} \left(r_{0}^{4} - r_{c}^{*4} \right) \\ &= 26562 \, in^{4} \end{split} \\ \begin{array}{l} \sigma_{\mathbf{x}} &= \frac{M_{\mathbf{z}\mathcal{C}}}{2} = \frac{7}{4} \, 0.00053 \, M_{\mathbf{z}} \, \left(\textit{Location 3, Points A \neq B} \right) \\ \sigma_{\mathbf{x}} &= \frac{M_{\mathbf{z}\mathcal{C}}}{1} = \frac{1}{2} \, 0.00053 \, M_{\mathbf{z}} \, \left(\textit{Location 3, Points C \neq D} \right) \\ \sigma_{\mathbf{x}} &= \frac{M_{\mathbf{z}\mathcal{C}}}{1} = \frac{7}{4} \, 0.00062 \, M_{\mathbf{z}} \, \left(\textit{Location 4, Points A \neq B} \right) \\ \sigma_{\mathbf{x}} &= \frac{M_{\mathbf{z}\mathcal{C}}}{1} = \frac{7}{4} \, 0.00062 \, M_{\mathbf{z}} \, \left(\textit{Location 4, Points A \neq B} \right) \\ \end{array}$$
 $T_{XO} = \frac{M_{XC}}{2I} = 0.00027 M_X (Lacation 3, POINTS A, B, C+D)$ $T_{XO} = \frac{M_{XC}}{2I} = 0.00031 M_X (Lacation 4, POINTS A, B, C+D)$ SECTION 3-3 $I = \frac{\pi}{4} \left(r_0^{4} r_i^{4} \right) \begin{vmatrix} \sigma_{x} = \frac{M_{zc}}{L} & \mp 0.00005 M_{z} \left(LocATION 5, POINTS A \# B \right) \\ \sigma_{x} = \frac{M_{yc}}{L} = \frac{1}{2} 0.00005 M_{y} \left(LocATION 5, POINTS A \# B \right) \\ \sigma_{x} = \frac{M_{yc}}{L} = \frac{1}{2} 0.00005 M_{y} \left(LocATION 5, POINTS A \# B \right) \\ \sigma_{x} = \frac{M_{yc}}{L} = \frac{1}{2} 0.00005 M_{y} \left(LocATION 5, POINTS A \# B \right) \\ \sigma_{x} = \frac{1}{2} \left(r_{0}^{4} r_{1}^{4} r_{1}^{4} \right) \\ \sigma_{x} = \frac{1}{2} \left(r_{0}^{4} r_{1}^{4} r_{1}^{4}$ $\frac{1}{2} \frac{1}{10} \frac$ $T_{X0} = \frac{M_{AC}}{2I} = 0.0000 3 M_{X} (Location 5, Points A, B, C = D)$ $T_{X0} = \frac{M_{XC}}{2I} = 0.00004 M_{X} (Location 6, Points A, B, C = D)$

NUMBER 5-214-P A 264 COMBUSTION ENGINEERING, INC. ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. 16 SHEET. 1-11-67 BY COCKERL CHARGE NO. DATE DESCRIPTION STRUCTURAL A NALYSIS OF WHET & OUTLET NOTLES CHECK DATE 1-11-67 BY CAUDLE VESSEL SUPPORTS UNDER PIPE BREAK LOADS 5. DETAILED ANALYSIS : f- STRESSES IN NOZZLE: OUTLET NOZZLE 12 == STRESSES WILL BE CALCULATEL FOR THE SIX LOCATIONS AS SHOWN AND FOR THE FOUR (4) POINTS A, B, C &D AT EACH LOCATION QUILET NOZILE SECTION 1-1 Mx = Mxp My + Myp Mz + Mzo SECTION 2-2 My = Myp My = Myp - 4.063 Fap M2 = MZD + 4.063 Fyp SECTION 3-3 My = Myp My = Myp - 12.281 Fyp Mz = Mzp + 12.281 Fyp



ENG		RING CHA	i de Rgi	PAR	TMI	ENT.	СН/	\TT/	4NO	DGA	., т і	ENN			SH DA	NUMBER 5-214-P A 266 SHEET 18 OF 19 DATE 1-11-67 BY COLFECT CHECK DATE 1-11-67 BY (AUDLE													
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/we	M#	٥			<u>+</u>				+				_+			_7	<u>+</u>			-		-			+				
N	H,	- 72920								-73540								-77860											
CASE	M,	+253															- 											- - -	
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NUMBER 5-214-P A 267 COMBUSTION ENGINEERING, INC. ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. 19 SHEET. 19 1-11-67 CHARGE NO ... BY COCKRELL DATE DESCRIPTION STELETURAL ANALYSIS DE INLETE OUTLET NOZZLEEHECK DATE 1-11-67 BY CAUDLE VESSEL SUPPRETS UNDER PIPE BREAK LOADS 5- DETAILED ANALYSIS: f- STRESSES IN NOZZLE: FROM THE TABLE ON SHEET-18, THE HIGHEST STRESS /s , 07 = 51.3 KSI < 1.27 Sy = 54.1 KSI @ 550°F 9- STRESSES ON SUPPORT PAD: THE MAXIMUM SURFACE TEMPERATURE OF THE SUPPORT PAUS IS TAKEN AS 300°F; HEARE, THE FOLLOWING BEARING STRESSES WILL BE COMPAIRED TO THE YIELD STRENGTH AT THE 300%F. MAXIMUM BEARING STRESS ON SIDE OF PAD: TERS. - ABRE ABEG = 10+25 = 25 in 2 THAN = 1109 KAS = 1109 25 = 44.4 KS1 < Sy = 45.25 @ 300 OF MAXIMUM BEARING STRESS ON FRONT OF PAD: OBEL = RMAX AREL Aset = 22×2.5 = 55/12 RMAX = 322 KIPS = 382 = 5,9 KS1 < Sy = 45,25 @ 3000F MAXIMUM BEARING STRESS ON BOTTOM OF PAD: Bes = PMAX ABRY Acre = 22×10= 220 in2 PMAX = 1459 EVPS $= \frac{1459}{220} = 6.6 \text{ Ks1 } < Sy = 45.5 @ 30097$



	2-3-67
Q	DESCRIPTION FATION & LANDAN OF VESSEL SUMMER PARS CHECK DATE 2-3-67 BY ALEVANCER
)	5- CETAILED ANALYSIS: C SYSTEM LODGE
	THE VESSER SUPPORT PAC AT SETTION A.A. A. SHOWN ON SHEET-4 WILL BE INVESTIGATED FOR THE FOLLOWING LOADS!
, <i>(</i>),	e Fressukt And Therman Transleuts As Given In Perso Vessel Is Supration By Four Nozzles (Two Inte And Tennemickie Gradient Theo Inc Mozzles Unice And
	FOR THE HEATUR AND CARDOWN TEALSENTS AND STARDEDTE CANTANT WILL BE AS FOLLOWS TO THE MARTIN CONDING AND THE MARTIE CONCET MARTIE
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	For ALL TEANSIENTS OTHER THAN THE HEATUR AND COSLOBARD TEANSIENT, THE INSTRE SUPPORE OF THE NUZZLE (POINT -1 AS SHOWN)N SWEET-4) WILL BE AT A TENDERMORE EQUAL TO THE REAMINE COMMIT TEADERATIONE NAME THE OFFICE SUPERCE (MAN-2 - AM
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NUMBER 5.2/5-P SHEET 5 OF 16 DATE BY Corerect		Lausier De Thermar And Seismic Pipe Reactions, Enernique Lenanus. The Following Frages arrows And Lansmic Theoson The Support 2000 Ar The Points In Consideration.	DUTLET NOZZLE GARTINE C SEGANC STATE GARTINE PAGE ULENT JANULT S REACTURE	+ 122 0 + 900 0 + 9387 - 1796	EC LOADS TO THE FOLLOWS	
COMBUSTION ENGINEERING, INC. ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. CHARGE NO.	s. Detauer Annevses: C. Systen Lones	2. EXTERMIL LOODS THE EXTERUIL LOADS CONSIST OF THERMAL AND SEISMIC PLAS REACTIN STATIC WENGHT AND ENETHQUARE LONGING. THE FOLIOWING FRANCE SHOUS THE PLATE REACTORS AND LONGING THEODON THE SUPPORT WHICH PRODUCE STREEDES AT THE POURS IN CONSIGERATION.	FREE NALE NOZZLE CARENAGIANE THERMAN FREE NALE SEISANE STATIC CARENAGIANE THERMAN PLARE AND SPEE NEEDAS FREE NILLOSAN PARE	± 52,9 0 0 ∓ 67,0 0 0 ± 1/250 -15/5 ± 341 0 566,1 ∓ 126.4	THE AENVE LOADS ARE THE RESOLVED LEDSS SECTION IN CONSIDERATION AS F	$F_{X} = F_{XP}$ $F_{Y} = F_{YP}$ $M_{3} = M_{aP} - X, F_{YP} - X_{2} V$

	COMBUSTION ENGINEERING, INC. Engineering department, chattanooga, ten		NUMBER <u>5-2/5-</u> Heet <u>7</u>	₽ OF	A 271 16
	CHARGE NO.	D	ATE 2-3-	67	BY CANKELL
•	ESCRIPTION FATIQUE EVALUATION OF VESSEL SUPPORT	<i>et Paps</i> c	HECK DATE	2-3-67	BY ALEXAMOER
•	<u>5- DETAILED AVALYSIS;</u> d- Stresses;				
	THE FOLLOWING EXPRESSIONS WILL BE THE TWO POINTS / AND & AS INDI				es At
	INLET NOZZLE;	OUTLET N	OZZLE:		
	<u>Рансьиен Streesses:</u> <i>О</i> у = - <u>t² + <u>6</u>¹/₂ = <u>3.267/17</u> Ромт-1 -<u>2.14795</u>Р Ромт-2</u>	$\frac{P_{RESSURE}}{\sigma_{\chi}} = \frac{+}{2} \frac{M}{t^2}$	+ bP 2Rt = 2.917	<u>72 P</u> P 98 P P	
		≍ <u>3</u> .	6H + EA + - 20524P Po, 17942P Po,	~ / } #	
	$\frac{T_{HEKMAL} S_{TKESSES:}}{\sigma_{X} = \frac{6M}{L^{*}} + \frac{\varepsilon_{el}(T_{W}-7)}{(1-v^{*})}$ $= \frac{\pm 0.05254M + 1.42857Eck(T_{en}-7)}{2}$		57 <u>RE5585;</u> M ^Z + <u>Fd (1m</u> -7) (1-25) 15950M + 1,42857	5 of (Tim-	7)
	$\mathcal{D}_{0} = \pm \frac{\mathcal{T}_{0} \mathcal{D}_{M}}{\mathcal{L}^{2}} + \frac{\mathcal{E}_{0}}{\mathcal{R}}_{roacco} + \frac{\mathcal{E}_{0}(T_{m}-T)}{(1-\mathcal{T})} = \pm \frac{2}{\mathcal{O}_{0}} \frac{\mathcal{O}_{0}(57\mathcal{L}_{0}M+\mathcal{O}_{0}\mathcal{O}_{0}\mathcal{L}_{0})}{\mathcal{D}_{0}(1-\mathcal{L}_{0})}$ $where E^{2}$		1 + <u>EA</u> mareo + R 1785 M + 0.05005.	1 - 1	
	M= M, + M, M, Is The RECUNDANT MOMENT DETERMINED M, Is THE THERMOL MOMENT AT THE CE.				Тени:61-7
	<u>SUPPORT LOAD STRESSES:</u> $\sigma_{\rm X} = - rac{E_{AP}}{A} + rac{M_Z C}{T}$	SUPPORT L $\sigma_{\rm X} = - \frac{E_{\rm X}}{A}$	COMO STRESSES;		
	$= -0.00069 F_{XP} - 0.00005 \overline{M_2} P_{DWT} $ = -0.00069 F_{XP} - 0.00007 \overline{M_2} P_{DWT} 2 WHERE	= - <u>0.00</u> Where	0 73 F _{XP} - 0,000 0 78 F _{XP} - 0.0000	9 Mz	Park 7 2
	$ \overline{M}_{Z} = M_{ZP} - \chi_{1}(F_{YP}) - \chi_{2}V $ $ \mathcal{O}_{T} = \frac{V}{A_{PRC}} = -0.00455V (POINT 2) $		$\frac{V}{A} = -\frac{0.00455}{0.00455}$		

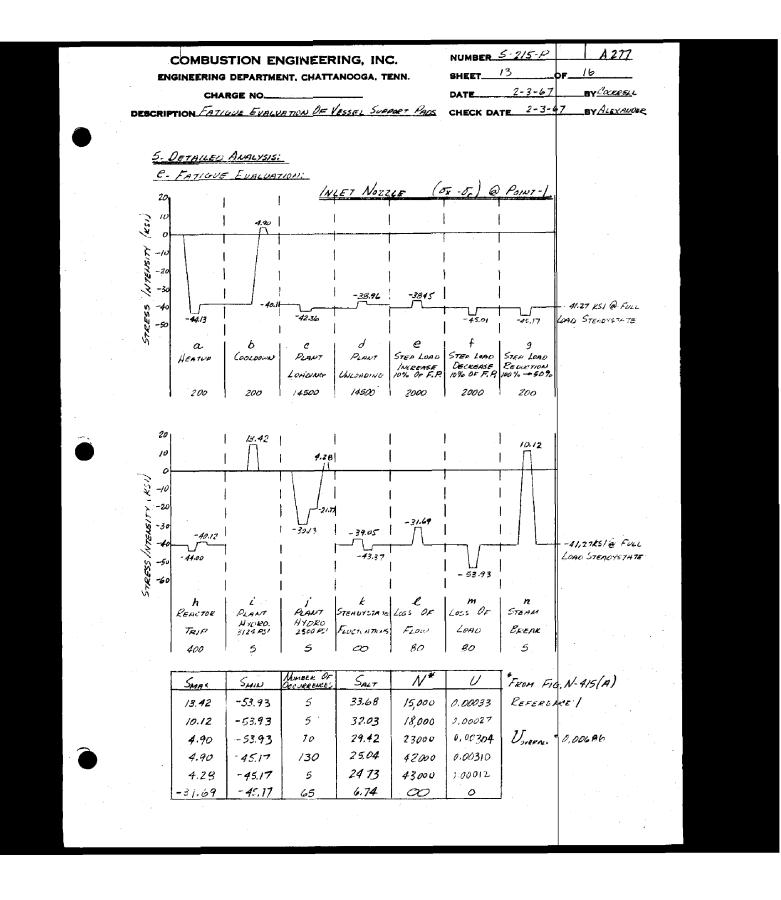
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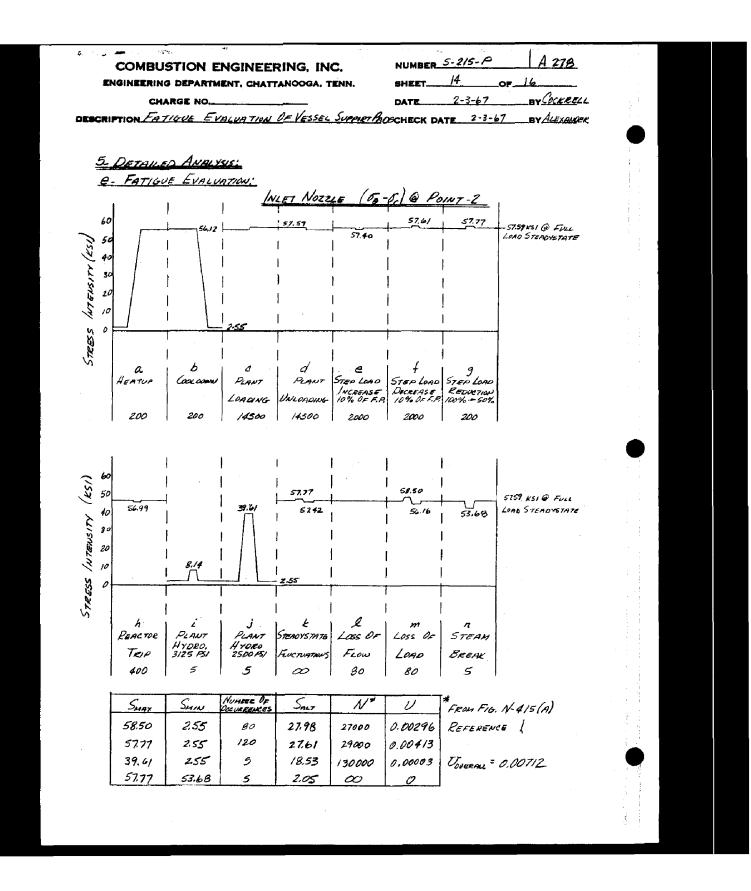
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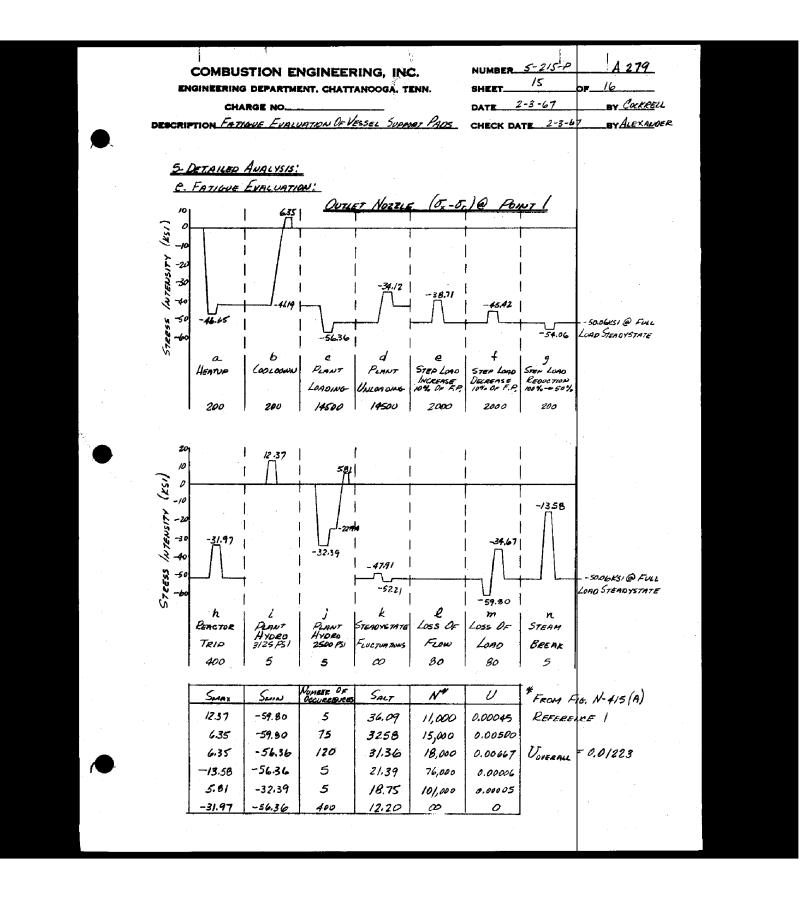
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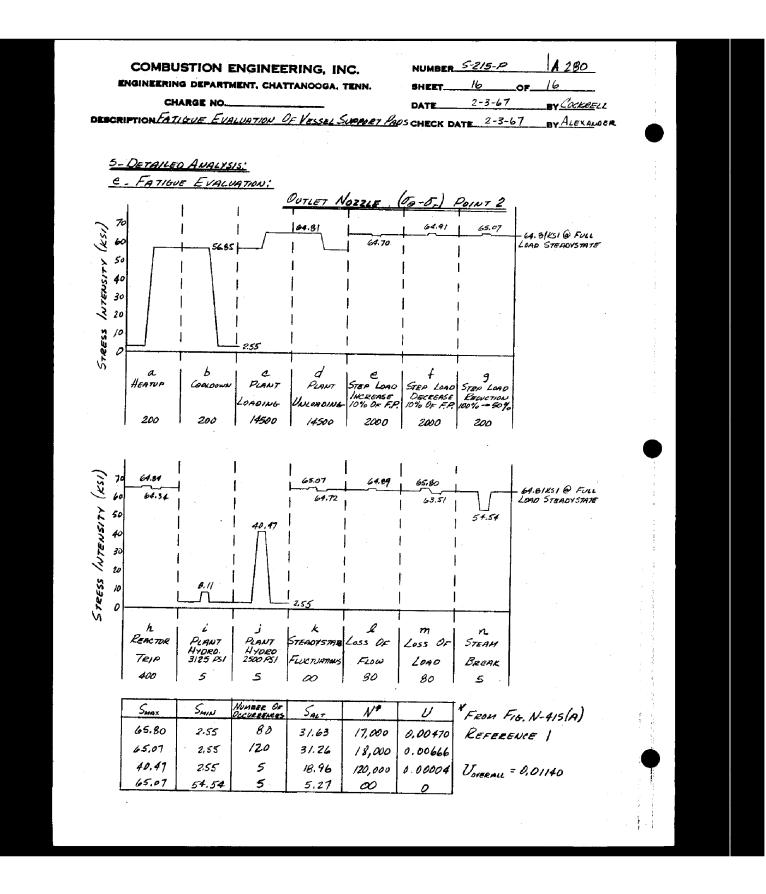
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Tousiner Parsiner Same			YTIZH	G-07		5.24			- 52.84	1742-	-44.79	-52.90	- 42.90	- 30.90	3.15	-30,17	-21.17	5.24	-46.75	-51.10	- 49,93				10.2/-		
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$			2		- 46.65	6.35	-56.36	-20.6	11.10	-28 71	-45.42	-54.06	-44.93	-31.97	12.37		-22.94	18.5	1627-	-52.21	-50.06	-5 7.80	-57.50		_		
Tenson Deriver Deriver <thderiver< th=""> <thderiver< th=""> <thd< td=""><td></td><td></td><td>576</td><td>02-00</td><td></td><td>111</td><td></td><td>_</td><td></td><td></td><td>-</td><td></td><td><u> </u></td><td></td><td></td><td></td><td></td><td>0.57</td><td></td><td>111-</td><td></td><td></td><td>000-</td><td>-1.27</td><td></td><td></td><td></td></thd<></thderiver<></thderiver<>			576	02-00		111		_			-		<u> </u>					0.57		111-			000-	-1.27			
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Tansant Ditter Auter Autor σ_{12} </td <td></td> <td>/</td> <td>1 1</td> <td>6</td> <td></td> <td></td> <td></td> <td>0,10-</td> <td></td> <td></td> <td>-46.55</td> <td>-55,25</td> <td>-45.12</td> <td></td> <td></td> <td>-31.42</td> <td></td> <td></td> <td>1</td> <td><u>_</u>+</td> <td></td> <td>-61.25</td> <td>14.20</td> <td></td> <td>-</td> <td></td> <td></td>		/	1 1	6				0,10-			-46.55	-55,25	-45.12			-31.42			1	<u>_</u> +		-61.25	14.20		-		
Tennsmer Durre Durre Nazzle Tennsmer 05 05 05 05 05 U 4211425 659 72 -2.25 -53.53 -64.77 -1.42 U 4211425 6.59 721 -2.25 -53.59 -64.77 -1.42 Extrates 6.59 7.21 -2.25 -53.78 -64.77 -1.42 Extrates 6.59 7.21 -2.25 -53.78 -64.77 -1.42 Extrates 6.59 7.21 -2.25 -63.78 -64.77 -1.42 Extrates 6.59 7.21 -2.25 -63.79 -64.77 -1.42 Extrates 6.59 7.21 -2.25 -63.79 -64.77 -1.42 Extrates 6.59 7.21 -2.25 -57.49 -53.79 -64.57 Extrates 6.59 7.21 -2.25 -57.84 -57.84 -64.77 -1.42 Passtes 6.50 7.21	Ð	-2710		R	-48.91	6.0	-58.64	26.3	- 4344	- 40.85	- 47.68		- 4/0.25	- 33.91	9.24	- 33.64	- 25.44	5.49	- 50.26	- 54.36	-52.31	-62.56	2/1/2-	61.00	011L		
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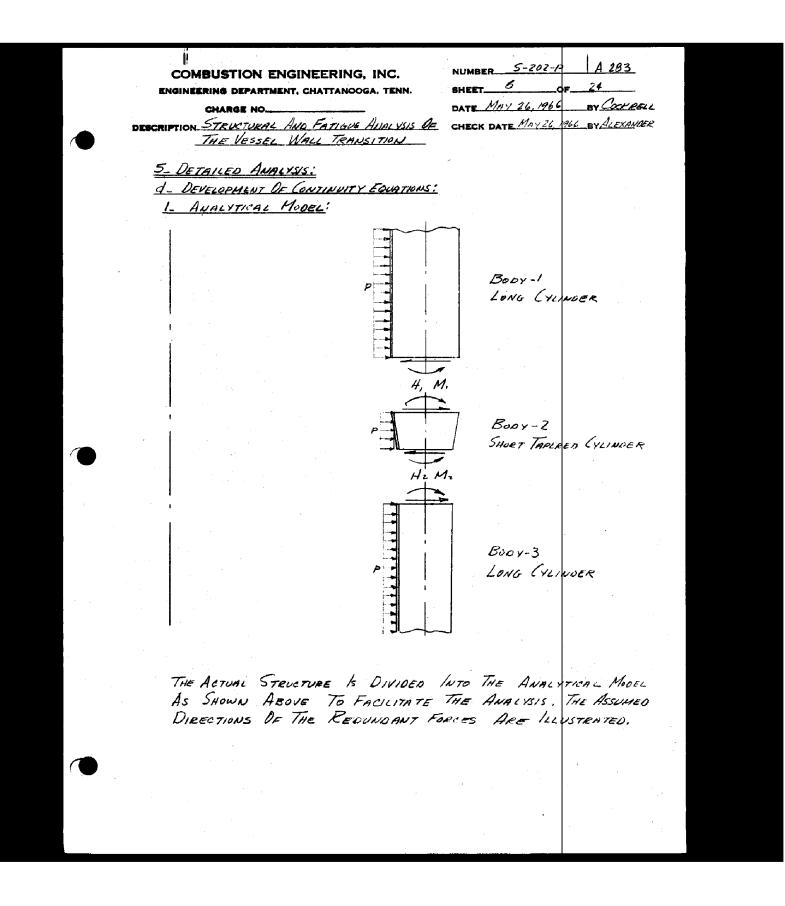


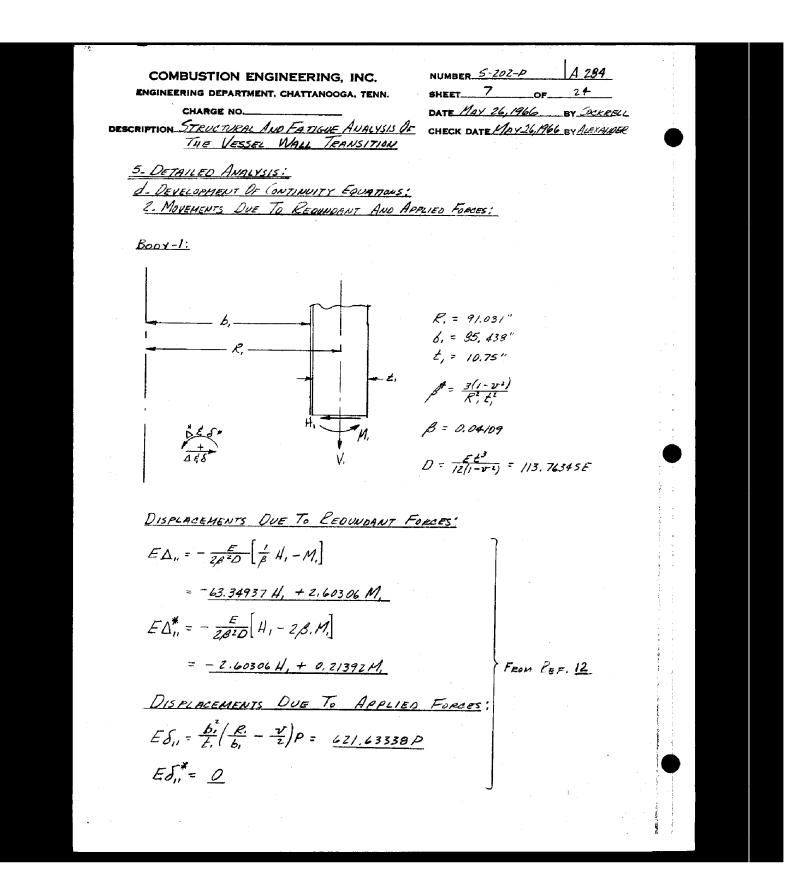


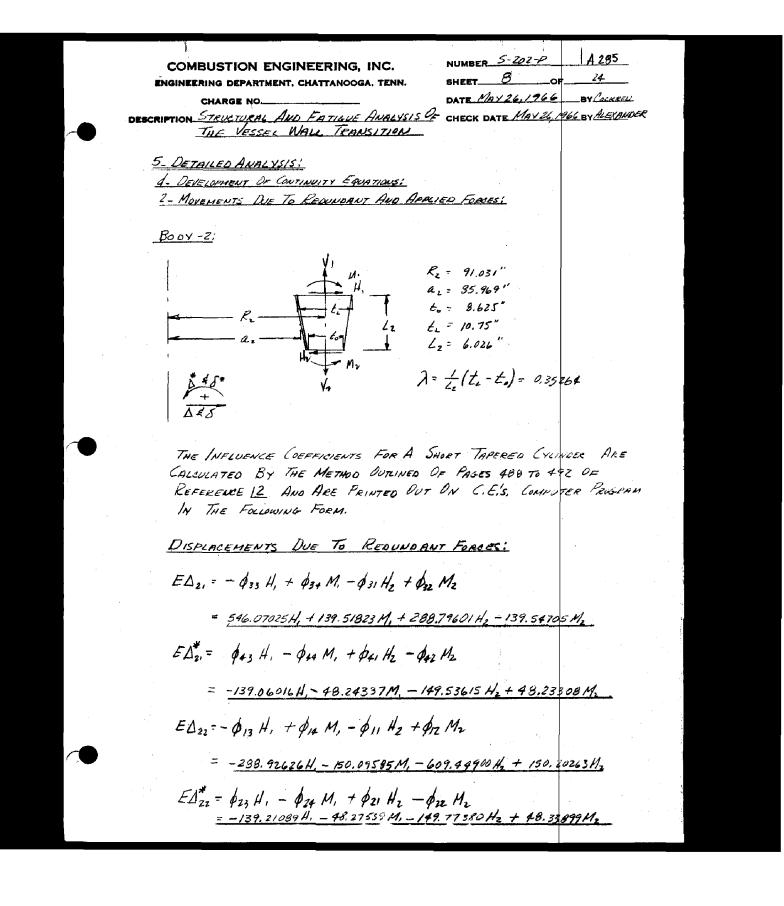


COMBUSTION ENGINEERING, INC.	NUMBER 5-202-P	A 231
ENGINEERING DEPARTMENT, CHATTANOOGA, TENN.		F
CHARGE NO	DATE MAY 26, 19.	
DESCRIPTION STRUCTURAL AND FATIOUE ANALYSIS DE THE VESSEL WALL TRANSITION	CHECK DATE MAY 26,0	<u>946 evAlexanier</u>
5- DETAILED ANALYSIS: u. System Geometry;		
A CEOSS SECTION OF THE VESSEL WALL	TEANSITION IS SA	IOWN BELOW.
91,031"	- 10.75	·
3	6.026"	
	4	
86.5	8.625"	
\$6.719	0.625	
MATERIAL	\sim	
5A-30Z-B		
b. SYSTEM LOADS:		
THE VESSEL SHELL JUNCTURE (TERNITH BE INVESTIGATED FOR DESIGN CONDIT. THE EFFECTS OF THE FOLLOWING TR INVESTIGATED.	TON'S (INTERNAL PA ANSIENT CONDITI	RESS OF 2.5451), ONS WILL BE
· · · · · · · · · · · · · · · · · · ·		ER OF
TRANSIENT	Decu	RRENCES
a_ PLANT HEATUP AT 100% PER HOUR		200
6_ PLANT (OOLDONNI AT 100 of PER HOUR		200
C_ PLANT LOADING AT 5% OF FULL POWER PER	MIN. I	4,500
- RANT UNLOADING AT 5% OF FULL POWER PER		4,500
C_ STEP LOAD INCREASE OF 10% OF FULL POWE		2,000
BUT NOT TO EXCEED FULL POWER		

ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. CHARGE NO	SHEET 5 OF 24 DATE MAY26, 1965 BY COCKEELL
THE VESSEL WALL TRANSITION	CHECK DATE MAY 24,1966 BY ALE GALOER
<u>5- DETAILED ANALYSIS:</u> C_SYSTEM LOADS;	
	NUMBER OF
TRANSIENT	OCCURRENCES
F. STEP LOAD DECREASE OF 10% OF FULL POWE	R 2000
FROM 10040 POWER	
9- STEP LOAD RELICTION FROM 100% To 50% FULL	POWER 200
h - REALTOR TRIP FROM FULL POWER	400
L_ PLANT HYDROSTATIC TEST OF 3125 PSIA AT.	Roser Temp. 5
j_ PLANT HYDR & TATIC TEST OF 2500 PSIA AT	100 % PERHOUR. To 400% 5
K- STEADY STATE FLUCTUATIONS OF 16°F AND 1.	100 psi Par Min. 00
L- Loss OF FLOW, ONE PUMP	80
M- Loss OF LOAD	30
N- STEAM BREAK	5
THE FOLLOWING ALLOWABLE STRESSES NUCLEAR CODE SECTION III, REFERENCE I THE ANALYSIS. 1. THE AVERAGE PRIMARY STRESS INTER SHALL NOT EXCEED Sm AT DESIGN PRESSURE (2.5 KS.). 2. THE LOCAL PRIMARY STRESS ALONE O SHALL NOT EXCEED 1.5 Sm AT DESIGN PRESSURE (2.5 KSI). 3. THE PRIMARY BENDING STRESS ALONE ABOVE SHALL NOT EXCEED 1.5 Sm AT D DESIGN PRESSURE (2.5 KSI). 4. THE RANGE OF PRIMARY PLUS S FROM MECHANICAL OR THERMAL LOADS - METAL TEMPERATURE AND OPERATION 5. SHOW THAT EACH POINT MEETS T STRESS INTENSITY CTIVEN IN N-414. SECTION III. THE PROCEDURE WILL OF SECTION III.	AND ARE RELEVANT FOR USITY ACRES A SOLID SECTION TEMP. (650°F) AND DESIGN DR COMBINED WITH 1- ARIVE SAN TEMP. (650°F) AND DESIGN OR COMBINED WITH 1- AND 2- DESIGN TEMP (650°F) AND CECONDARY STRESS RESULTING SHALL NOT EXCEED 30 AT ASTMC SHALL NOT EXCEED 30 AT ASTMC OF PRESSURE. THE REQUIREMENTS FOR PENK. 5 DF THE A.S.M.E COLE







NUMBER 5-202-P A286 COMBUSTION ENGINEERING, INC. 9 ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. DATE MAY 26. 1966 BY CAREEL CHARGE NO. DESCRIPTION STRUCTURAL AND FATIGUE ANALYSIS OF CHECK DATE MAY 26, 1966 BY ALEXANDER THE VESSEL WALL TRANSITION 5. DETAILED ANALYSIS! d. DEVELOPMENT OF CONTINUITY EQUATIONS: 2. MOVEMENTS DUE TO REDUNDANT AND APPLIED FORCES: BODY 2 (CONTO): DISPLACEMENTS DUE TO APPLIED FORCES: $E \delta_{21} = \alpha_{2}^{2} \left(\frac{R_{1}}{\alpha_{1}} - \frac{\nu}{2} \right) \left[\left(\phi_{32} + \phi_{34} \right) \frac{-\lambda^{2}}{6(1 - \nu^{2})} + \frac{1}{F_{1}} \right] F = 629, 27110F$ $E \delta_{21}^{\#} = -a_{2}^{2} \left(\frac{R_{2}}{a_{2}} - \frac{v}{2} \right) \left[\left(\phi_{12} + \phi_{14} \right) \frac{-\lambda^{2}}{b(1-v^{2})} - \frac{\lambda}{A^{2}} \right] P = 22.03255P$ $E\delta_{22} = a_{2}^{2} \left(\frac{R_{2}}{a_{1}} - \frac{v}{z}\right) \left[\left(\phi_{12} + \phi_{14}\right) \frac{-\lambda^{2}}{b_{1}(1-v^{2})} + \frac{1}{F_{2}} \right] P = \frac{762.47399P}{162.47399P}$ $E \int_{22}^{4} = -\alpha_{2}^{2} \left(\frac{R_{1}}{\alpha_{1}} - \frac{\nu}{\epsilon}\right) \left[\left(\phi_{22} + \phi_{23} \right) \frac{-\lambda^{2}}{6(1-\nu^{2})} - \frac{\lambda}{\ell^{2}} \right] P = \frac{22.09972P}{22.09972P}$ BODY -3: R3 = 91.031" b3 = 86.5 * t3 = 8.625" M $\beta^{4} = \frac{3(1-y^{2})}{R_{s}^{2}t_{s}^{2}}$ $\beta = 0.04587$ $D=\frac{Et^2}{(2(1-y^2))}$ DISPLACEMENTS DUE TO REDUNDANT FORCES $E \Delta_{32} = \frac{E}{2\beta^2 D} \left[\frac{i}{\beta} H_2 + M_2 \right] = 88.14883 H_2 + 4.04373 M_2$ $E\Delta_{32} = -\frac{E}{2B'D} \left[H_2 + 2B M_2 \right] = -4.04373 H_2 - 0.37100 M_1$ FROM REF. 12 DISPLACEMENTS DUE TO APPLIED FORCES! $E \delta_{12} = \frac{b_1^2}{\xi_3} \left(\frac{R_1}{b_2} - \frac{v}{2} \right) P = \frac{782}{182} \cdot 82249P$ E S32 = 0

	COMBUSTION ENGINEERING, NC. NUMBER 5-202-7 1 4 287
	ENGINEERING DEPARTMENT, CHATTANOOGA. TENN. SHEET 10 of 24
	CHARGE NO DATE MAY 26,1966 BY COCKPELL
_	DESCRIPTION STRUCTURAL AND FATIGUE ANNINSIS OF CHECK DATE MAY 20, 1966 BY ALEXANDER
	THE VESSER WALL TEANSITION
	5- DETAILED ANALYSIS:
	<u>J- DEVELOPMENT OF CONTINUITY EQUATIONS:</u>
	3- CONTINUITY MATRIX AND LOADING VECTORS:
	The A The Market The Area Market
	FROM CONTINUITY AT EACH CUT, WE WRITE THE CONTINUITY MATRIX
	IN THE FOLLOWING FORM,
·	
	$E\Delta_{ii} - E\Delta_{z_i} = E\delta_{z_i} - E\delta_{ii}$
	$E\Delta_{i,i}^{*} - E\Delta_{z_i}^{*} = E\delta_{z_i}^{*} - E\delta_{n}^{*}$
	$E\Delta_{22} - E\Delta_{32} = E\delta_{32} - E\delta_{22}$
	$E \Delta_{22}^{*} - E \Delta_{32}^{*} = E \delta_{32}^{*} - E \delta_{32}^{*}$
	IN MATRIX FORM WE HAVE,
	-609.41962 -136.91517 -288.79601 139.54705 H. 7.63772
-	-609.41962 -136.91517 -288.79601 139.54705 H. 7.63772
	12/ 15710 10 15770 110 57110 10 000 114 20 0700
	136.45710 48,45729 149.53615 -48.23308 M, 22.03255
	$-288,92626$ -150.09585 -697.59783 146.15890 H_1 20.34850
	-139,21089 -48,27539 -145,73007 48,70999 M22.09972
1	-139,21089 -48,27539 -145,73007 48,70999 M2 -22.09972
	4. REDUNDANT LOAD VALUES:
	T- NEOUNDAUT LOHD VALUES.
	SOLVING THE ABOVE MATRIX, WE GET THE FOLLOWING VALUES
	FOR THE REDUNDANT FORCES,
	IVA THE REDURNIAL IDAGS;
	$H_{1} = -0.81732P$
	$M_1 = 5.22711P$
	$H_2 = -0.84249P$
	$M_2 = -0.12963P$
1	

NUMBER 5-202-P A 288 COMBUSTION ENGINE IRING, INC. SHEET // OF 24 ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. DATE MAY 26, 1966 BY COCKEELL CHARGE NO. DESCRIPTION STRUCTURAL AND FATILOUE ANALYSIS OF CHECK DATE MAY 26, 1966 BY ALEXANDER THE VESSEL WALL TRANSITION 5- DETAILED ANALYSIS: e STRESSES: THE FOLLOWING EXPRESSIONS WILL BE USED TO CALCULATE STRESSES AT THE FOUR LOCATIONS AS SHOWN ON SHEET 4 LOCATION 1: $\overline{U_{r}} = \frac{\underline{b}M_{r}}{\mu^{2}} + \frac{\underline{b}_{r}^{2}P}{2R_{r}t} + \frac{\underline{b}_{r}^{2}(T_{m}-T)}{1-v} = 0.05192 M_{r} + 3.72970 P + 0.30714 (T_{m}-T)$ $\Gamma_{A} = \frac{T_{b}M_{c}}{A^{2}} + \frac{E\Delta_{c}}{R_{c}} + \frac{b_{c}P}{t_{c}} + \frac{Ed(T_{m}-T)}{I-V} = \frac{0.01558M_{c}+0.01099E\Delta_{c}}{0.01558M_{c}+0.01099E\Delta_{c}} + 7.94772P + 0.30714(T_{m}-T)$ LOCATION 2: $\overline{U_{x}} = \frac{-4M}{t^{2}} + \frac{b_{i}^{2}P}{2Rt_{i}} + \frac{5d(Tm-T)}{1-t^{2}} = -0.05/92M_{i} + 3.72970P + 0.30714(Tm-T)$ $T_{A} = \frac{-v_{b}M_{i}}{t^{2}} + \frac{E_{A,i}}{E_{i}} + \frac{b_{i}P}{t_{i}} + \frac{E_{a}(T_{m}-T)}{t_{i}} = -0.0155 BM_{i} + 0.01099 EA_{i} + 7.94772 P + 0.30714(T_{m}-T)$ LOCATION 3: $U_{x} = \frac{6M_{2}}{2!} + \frac{b_{x}^{2}P}{2R_{x}t_{y}} + \frac{Ed(I_{m}-T)}{1-V} = \frac{0.08066M_{2} + 4.76490P + 0.30714(T_{m}-T)}{1-V}$ $\mathbb{V}_{\theta} = \frac{-\sqrt{6}M_{L}}{E_{1}^{2}} + \frac{E\Delta_{II}}{R_{3}} + \frac{b_{2}P}{t_{3}} + \frac{Ed(T_{III}-T)}{I-V^{2}} = 0.02420 \ M_{Z} + 0.01099 E\Delta_{32} + 10.02899P + 0.30714(T_{III}-T)$ LOCATION 4: $\overline{U_x} = -\frac{bM_2}{2!} + \frac{b_1^{1/p}}{2R_2 t_1} + \frac{Ed(T_m-T)}{1-v} = -0.08066 M_2 + 4.76490P + 0.30714 (T_m-T)$ $\overline{V_{a}} = -\frac{T L H_{2}}{R_{2}} + \frac{E \Delta_{22}}{R_{3}} + \frac{b_{3} P}{L_{3}} + \frac{E \Delta [T_{m} - T]}{L_{2}} = -0.02 + 20 M_{3} + 0.01099 E \Delta_{23} + 10.02399 P + 0.30714 (T_{m} - T)$ NOTE THAT THERMAL STRESS WILL BE CONSERVATIVELY TREATED HS A SKIN TYPE STRESS. Ed = 0.215 FOR SABOLB MATERIAL AT 550°F

	IEERING CHA	STION DEPAR ARGE NO <i>WE TURAL</i>	атмент. 	снати <i>Fatia</i>	FAN 00	ба, тен - <i>Аласу</i> з	nn. 7 <u>5 Of</u>	SHI DA	EET		OF	24 	289 (<u>ccxao</u> cc <u>Acexn2</u> 05	e
And a statement of the	TAILE	<u>o Anal</u> ses:	<u>YS/S :</u>											
LOCATION	м	+ 64	PR Zt	Vx :	+ <u>v64</u> t	EΔ	<u>EA</u> R	PR t	Γ _σ	Tr	5722 Tx-To	55 /NT. Tx-Tr	FUSITY TO-TT	
1	13.068	0.68	9.32	10.00	0.20	163.46	1.80	19.87	21.87	-2.5				
2	13.068	-0.68	9.32	8.64	-0.20	163.46	1.80	19.87	21.47	0	-12.83	3.64	21.47	
3	-0,324	-0.03	11.91	11.88	-0.01	-18(.97	-2.05	25.07	23.01	-2.5	-11.13	14.38	25.51	_
4	-0.324	0.03	11.91	11,94	0.01	- 186.97	-2.05	25.07	23.03	0	-11.09	11.94	23,03	
5,I. _m <u>Crite</u> 5,I. =	14 = To even 5 To =	$-\overline{V_{r}} = -\overline{V_{r}} = -\overline{V_{r}} = -\overline{V_{r}}$ $\underline{E} = -\overline{V_{r}} = -\overline{V_{r}}$	<u>P</u> <u>2</u> - 1 <u>Local</u> 2.05	(<u>-P</u>): < 40 J	= 25.4 n <u>gra</u> e ks, (07 + 1.2 <u>ve Stre</u>	:5 = ; (:5:	<u>26.3 к</u> Ә Loca ;	<u>s</u> , <		451			
5.1., <u>Ceite</u>	мах = ; стол 5.	<u>24.3 k</u> <u>C.4 -</u> To - Tr)	s' < Rang	40 ks	51 ST 574	255	LUTER	<u> 5179 :</u>		ici Q		(a.). 3		
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EN	GINEER	NG DE	PARTM	ENT, CH	ATTANC	DOGA, T	ENN.		EET	13	OF_		
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R 11	TION			AUD EL W				<u> </u>	ECK DA	TE ///	1 26,191	66 BYA	<u>ex All</u> o ck
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5_	DETAL	LED A	NIL YSIS	<u>.</u>									
C	_ STR	esses :											
	THE F	occowi	No T	98LES	Give	THE	Como	NED	Presse	RE A	1ND 7.	HERMA	2
-	TRESS	es (Ne	GLECTI	NO 57	CE35	Conce	UTRAT	NO FR	e roes.).			
-			<u>_</u>	7	4	0 (19710	w -1	.				•	
TRA	USIEN 7	Intermel Prossme		THERMOL STRESS		SURE ST	TRESS	l	L STR	255	5 TEE	S INTER	ידווצי
		KS1A	°F	Fx = 60	Γ _κ	5.	G.	6.	5	Cr.	5x-50	Ox-Or	G-Fr
7.64	DY STATE	2.250	0	0	9.00	19.68	-2,25	9.00	19.68	-2.25	-10,68	11.25	21.93
a.	4.47hrs	2.250	-65	-19.96	9,00	19.68	-2.25	-10.96	-0.28	=2.25	-10.68	-8.71	1.97
6	4.AThrs	0.315	65	19.96	1.26	2.76	-0.32	21.22	22.72	-0.32	-1.50	21,54	23.04
C	20 min	2.250	-7.8	-2.40	9.00	19.68	-2.25	6.60	17.28	-2.25	-10,6B	8.85	19.53
d	20 min	2.250	7.8	2.40	9.00	19.68	-2.25	11.40	22.03	-2.25	-10.63	13.65	2433
2	100 SEC	2.140	11.Z.	3.44	3.56	18.72	-2.14	12.00	22.16	-2.14	-10.16	14.14	24.30
_	225 Sec	2 275	1.7	0.52	9.10	19.90	-2,28	9.62	20.42	-2.28	-10.80	11.90	22.70
	40 sec	2.320	-9.3	-2.86	9.23	20.29	-2.32	6.42	17,43	-2.32	-11,01	8,74	19.75
f.	100 sec	2.260	-13.3	-4.08	9.04	19.77	-2.26	4.96	15.69	-2,26	-10.73	7.ZZ	17.95
	260 sec	2.140	-1.3	-0.40	3.56	18.72	-2.14	8.16	18.32	-2.14	-10.16	10.30	20:46
	2 min	2.370	-12,0	-3,69	9.48	20.73	-2.37	5.79	17.04	-2.37	-11.25	8.16	19.41
9	3.2 min	2.350	-15.0	-4.61	9.40	20.53	-2.35	4.79	15,92	-2.35	-11.13	7.14	18.27
_	10.4 min	2.150	0	0	8.60	18.81	-2.15	8.60	18,81	-2.15	-10,21	10.75	20,96
6	10 sec	2.220	-9,5	-2.92	8.8B	19.42	- 2.ZZ	5.96	16.50	-2.22	-10.54	8.13	18,72
_	655ec	1.910	8.5	2.61	7.64	16.71	-1.91	10.25	19.3Z	-1.91	-9.07	12.16	21,23
i	2201001	3.125	0	0	12.50	27.34	-3.13	12.50	27.34	-3./3	-14.34	15.63	30,43
	3.5hrs	1.250	-64	-19.66	5.00	10.94	-1.25	-14.66	-8.72	-1.25	-5.94	13.41	-7.47
J	5.5 600±00#W	2.500	0	0	10.00	21.87	-2.50	10.00	21.87	-2,50	-11.87	12.50	24.37
	3.5 hrs	0.315	64	19.66	1.26	2.76	-0.32	20.92	22.42	-0.32	-1.50	21.24	22.74
K.	\sim	2350	6.0	1.84	9,40	20.53	-2.35	11.24	22.37	-2,35	-11,13	13.59	24.72
	~	2.150	-6.0	-1.84	8.60	18.81	-2.15	6.76	16.97	-2.15	-10,21	8.91	19.12
l	12.xc	2.250	33.3	10.Z3	9.00	19.68	-2.25	19.23	29.91	-2,25	-10.68	21.48	32.16
	10sec	2.760	-30,2	-9.28	11.04	24.14	- 2.76	1.76	14,86	-2,76	-13,10	4.52	17.62
m	28 sec	2.120	-41.Z	-12.65	8,48	18.55	-2.1Z	-4.17	5.90	-2.12	-10.07	-2.05	8.02
	1605ec	1.440	4.8	1.47	5.76	12.60	-1,44	7.23	14.07	-1.44	-6.84	8,67	15.51
n	33 <i>5e</i> C	0.300	117	35,9 4	1.20	2.62	-0.30	37.14	38.56	-0.30	-1.42	37.44	39.86
	54 Sec	0.700	197	60.51	2.80	6.12	-0.70	63.31	66.63	-0.70	- 3.32	64.01	67.33

5.1 max = (10-10) = 37.9 ks1 < 35m= 80.1 ks1 (eretion 5-C-4

DATE May 22, 4, 16.6 Sylowers DEBCRIPTION STRUCTURAL MALE TRANSITION DETRIFUTION STRUCTURAL DATE May 22, 1964 Sylowers S. DETRIFUT AND STRUCTURAL CONTROL 10.111 S. DETRIFUT AND STRUCTURAL Control -2 Control -2 Tower Struct Annu Structure Structure Annu Structure Structure Annu Structure Control -2 Control -2 Tower Structure Structure Structure Structure Annu Structure Control -2 Control -2 Tower Structure Structure Structure Structure Annu Structure Structure Annu Structure Control -2 Control -2 <th colsp<="" th=""><th>DES</th><th>CRI</th><th></th><th></th><th></th><th></th><th></th><th></th><th>•</th><th></th><th>-</th><th>HEET</th><th>ay 21.</th><th>1960</th><th></th><th></th><th></th><th></th></th>	<th>DES</th> <th>CRI</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>•</th> <th></th> <th>-</th> <th>HEET</th> <th>ay 21.</th> <th>1960</th> <th></th> <th></th> <th></th> <th></th>	DES	CRI							•		-	HEET	ay 21.	1960				
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$ \begin{array}{c} \underbrace{5. \text{ Determs from sets}}{\text{Seconds}} \\ \hline \text{Seconds} \\ \hline \text{C} = $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $			PHON_								<u> </u>	IECK DA	ΥΕ<u>/ //</u>	: 00,1	700	BYAL	<u> </u>	ς.	
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Asin $q = f_1 - G_0$ G_0 f_0			•	INTERMAL	4			1			7070	y 5-0		5-		luter		T	
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$\begin{array}{c c c c c c c c c c c c c c c c c c c $		d	20 min	2.250				7.78	19.32		7.78	19.32		-//.	4	7.78	·		
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$		0	100 sec	2.140				7.40	18.37		7.40	18.37				7.40			
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$			225 50	2.275				7.87	19.53		7.87	19.53		-11.6	6	7.87	19.53		
10562 2.160 7.40 1837 7.40 18.37 7.40 18.37 24052 2.140 7.40 1837 7.40 18.37 -10.47 7.40 18.37 2501 2.370 8.20 20.35 8.20 20.35 -12.55 9.20 20.35 9 $32 min$ 2.350 8.13 20.17 9.13 20.17 -12.04 8.13 20.17 $10.4 min$ 2.150 7.44 18.46 7.44 18.46 -11.02 7.44 18.46 h 10.52 2.220 7.66 19.06 7.68 19.06 -11.38 7.66 19.06 $655xt$ 1.910 6.61 14.40 6.61 16.40 -9.79 6.61 16.40 c $220min$ 3.125 V 10.81 26.83 -16.42 10.81 24.83 $3.54rs$ 1.25° 33 10.14 4.32 10.73 14.44 20.97 -6.41 14.46 20.97 j 5.5 2.500 O 0.865 21.46 8.65 21.46 -12.87 8.65 21.46 s s 2.500 O 0.815 20.77 -9.05 -7.44 -1.61 -9.05 -7.44 s s 5.50° O 0 8.13 20.17 -1.64° 18.45 21.46 s s 2.500 O 0 8.65 21.46 8.65 21.46			40 sec	2.320				8.02	19.92		8.0Z	19.92		-11,9	0	8.02	19.92	1	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		f	100 sec.	2.260				7.82	19.40		7.82	19.40		-11.5	в	7.82	19.40		
9 $32 \min 2.350$ $9 32 \min 2.350$ $10.4 \min 2.150$ $10.4 \min 2.150$ 1.15 $10.4 \min 2.150$ 1.15 $10.4 \min 2.150$ 1.14 18.46 1.18.46 1.14 18.46 1.14 18.46 1.14 18.46 1.14 18.46 1.14 18.46 1.14 10.322 2.220 1.14 1.14 1.14 1.14			260500	2.140				7.40	18.37		7.40	18.37		-10.9	7	7.40	18.37		
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$				2.370				8.20	20.35		8.20	20,35		-12.1	5	9.70	20.35		
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	•	9	3.2 min	2.350				8.13	20.17	ŀ	8.13	20.17		-12.0	4	8.13	20.17		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $			10.4 min	2.150	_							1	┞──┼──	1					
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GR	IPTION_	<u>аткист</u> Тне	Jess		FATION ALL T			<u> </u>	HECK D	ate. <u><i>Mi</i></u>	17 20, 19	6 6 BYA	<u>LEXAN</u> 00	× _
			<u></u>	<u> </u>	<u>H6C /</u>	<u>cansi</u>	1100							
<u>5</u> .	DETAL	LED A	NALYSI	<u>.</u> .										
0	2_ STR	esses :												
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	· · · · · · · · · · · · · · · · · · ·					LOCATI	n - 3							
Te.	ANGIENT	INTERNAL PRECEME	(Tm-T)	THERMAL STRESS	PRES	SURE S	TRESS	7074	2 STR	255	STEE	ss INTE	NSITY	7
		KSIA.	0F	Fx=60	(Tx	50	6.	6.	6	- Fr	Fx-To	Jx-Or		1
571	EADY STATE	2,250	. 0	0	10.70	20.71	-2.25	10,70	20.71	-2.25	- 10.01	12.95	22.96	1
a	4.47hrs	2.250	-43	-13.ZI	10.70	20,71	-2.25	-251	7.50	=2.25	-10.01		9.75	t
b	4.4Thrs	0.315	43	13.21	1.50	2.90	-0.3Z	14.71	16.11	-0.32	-1.40	15.03	16.43	1
Č	20 min	2.250	-7.8	-2,40	10.70	20.71	- 2.25	8.30	18.31	-2.25	-10.01	10.55	20,56	+
d	20 min	2.250	7.8	2,40	10.70	20.71	-2.25	13.10	23,11	-2,25	-10.01	15.35	25.36	
e	100 sec.	2.140	11.2	3.44	10.17	19.70	-2.14	13.61	23.14	-2.14	-9.53	15.75	25,29	
	225 SPC	2.275	1.7	0.52	10,82	20.94	-2.29	11.34	21.46		-10.12	13.62	23,72	
	40 sec	2.320	- 9.3	-2.86	11.03	21.35	-2.32	8.17	18.49	-2.32	-10.32	1	20.81	1 -
f	100 sec	2.260	~ /3,3	-4.03	10.75	20.80	-2.26	6.67	16.72	-2.26	-10.05	8.93	18.98	
	260 500	2.140	- /,3	-0.40	10.17	19.70	-2.14	9.77	19.30	-2.14	-9.53	11.91	21.44	
	2 min	2.370	12,0	-3.69	/ 1, 27	21.81	-2.37	7.58	18.12	-2.37	-10.54	9.95	20.49	
9	3.2 min	2.350	- 15.0	-441	11.17	21.63	-2.35	6.56	17.02	-2.35	-10,46	8.91	19.37	
_	10.4 min	2.150	0	0	10.2Z	19.79	-2.15	10.22	19.79	-2.15	-9.57	12.37	21.94	
h	10 sec	2.220	-9.5	-2.92	10.55	20.43	-2.22	7.63	17.51	-2.22		9.85	19.73	
<i>n</i>	655m	1.910	8.5	2.61	9.08	17.59	-1.91	11.69	20,19	-1.91	-3.50	13.60	22.10	• •
ć		3./25	0	0	14.86	28.76	-3.13	14.86	28.76	- 3./3	-13,90		31,89	
,	3.5hrs	1.250	-43	-13.21	5.94	11.50	-1.25	-7.27	-1.71	-1.25	-5.56	-6.02		
j	5.5	2.500	0	0	11.89	23.01	-2.50	11.89	23.01	-2.50	-11.12	14.39	25.51	
	3.5 hrs	0.315	43	13.21	1.50	2.90	-0.32			-0.32			16.43	
	\sim	2350	6.0	1.84	11.17	21.63	-2.35	13.01	23.47	-2.35	-10.46	15.36	25.82	
Ł	~	2.150	-6.0	-1.84	10.2Z	19.79		8.3B	17.95	- 2.15	- 9.57	10.53	20.10	
l	12.xc	2.250	33,3	10.23	10,70	20.71	-2,25	20.93	30.94	-2.25	-10.01	23.18	33,19	
	losec	2.760	-30.Z	-9.28	13.12	25.40	-2.76	3.94	16.12	-2.76	-12.28		18.18	
m	28 sec	2.120	-4/.2	-12.65	10.08	19.51	-2.12	-2.57	6,86	-2.12	-9.43		3.98	
	1605ec	1.440	4.8	1.47	6.85	13,25	-1.44	.8.32		-1.44	-6.40	9.76	16.16	
n	33 sec	0.300	117	35.94	1.43	2.76	-0.30	37.37	38.70	-0.30	-1.33	37.67	39.00	
''		0.700	197	60.51	1	6.44		63.84		-0.70	-3.11	1	1	

S.I. Max = (10-5r) = 32.4 KSI 235m = 80.1 KSI CRITERION 5-C-4

4		NGINEE	BUSTI							IUMBER_	16	5-20	ÓF.		293
	•		CHARG				•		-	ATE M	AY 26	,190	56	вү/4	<u>xreeu</u>
DES	ic n	PTION_	STRUCT	VRAL	AUD	Евпон	<u>e Anal</u>	1515 .0	E c	HECK DA	TE M	<u>9726</u>	19	66 BYA	<u>LEXAN</u> O
			THE	Vess	CL K	ALL 7	RANSE	TION				-			
	<u>5</u>	- DETA	UED A	NALYSI	51										
		:_ STR													
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	f"		14		17.		LOCATIO	N-4	- 1		1				
	Te,	WALEN T	INTERMOL PROSEME	(Ton-T)	THERMAN STRESS	PRES	SURE ST	reess	707	a Ste	ess	5,	Z.E.	es Inter	USITY
			KSIA	°F	Fx-60	<i>•</i>	50	6.	<u> </u>	Го	fr.	6x-	To	Ox-Or	To-61
		MOY STATE	2.250	0	0	10.74	20.72	0	10.74	20,72	0	-9.	78	10.74	20.72
•	a 4	7		22	6.76	10.74	20,72	<u> </u>	17.50	27.46		-9.9	8	17.50	27.48
	6		0.3/5	-22	-6.76	1.50	2.90		-5.26	-3.86		-1.4	6	-5.26	-3.86
•	C d	20 min 20 min	2.250	0	0	10.74	20.72		10.74	20.72		-9.9	-	10.74	20.72
	4		2.250		-	10.74	20.72		10.74	20.72		-9.	-	10.74	20.72
	e	100 SEC 225 SEC	2./40 2.275			10.22	19.71		10.22	19.71		-9.		10.22	19.71
		40 500	2.320			10.88	20,95 21.37		10.88	20A5		-10.		10.88	20.15
.	f	100 sec	2.260			10.79	20,82		10.79	21.37 20.82		-10.2	1	11.08	21.37
	· .	260,80	2.140			10.22	19.71		10.22	19.7)		-10.9 -9.4	1	10,79	20.82
[2 min	2.370			11.32	21.83		11.32	21.83		-10,	-	10.22 11.32	19.71 21.83
	9	3.2 min	2.350			11.22	21.64		11.22	21.64		-10.	. 1	11.22	21.64
ļ	_	10.4 min	2.150			10.27	19.80		10.27	19.80		-9.5		10.27	19,80
· (L.	10 sec	2.220			10.60	20,45		10.60	20,45		-9.8		10.60	20.45
ŀ		655m	1.910			<i>9.1</i> Z	17.59		9.12	17.59		-3.9	1	9.72	17.59
.	i	220inm HEATUR	3./25	V	¥	14,9Z	28.78		14,92	28,78		-B,8	-+	14.92	28.78
	,	3.5 hrs	1.250	22	6.76	5.97	11.51		12,73	18.27		-5.5	-	12.73	18.27
<u> </u>	J	S.S.	2.500	. 0	0	11.94	23.02		11.94	23.02		-11.0	8	11.94	23.02
: -		3.5 hrs			-6.76		2.90		-5.26	-3.86		-1.4	0	5.26	-3,86
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ŀ	-	12.500	2.250	╤┼╼╌┤		10.74	20.72		10,74	20.72		-9.9		10.74	20,72
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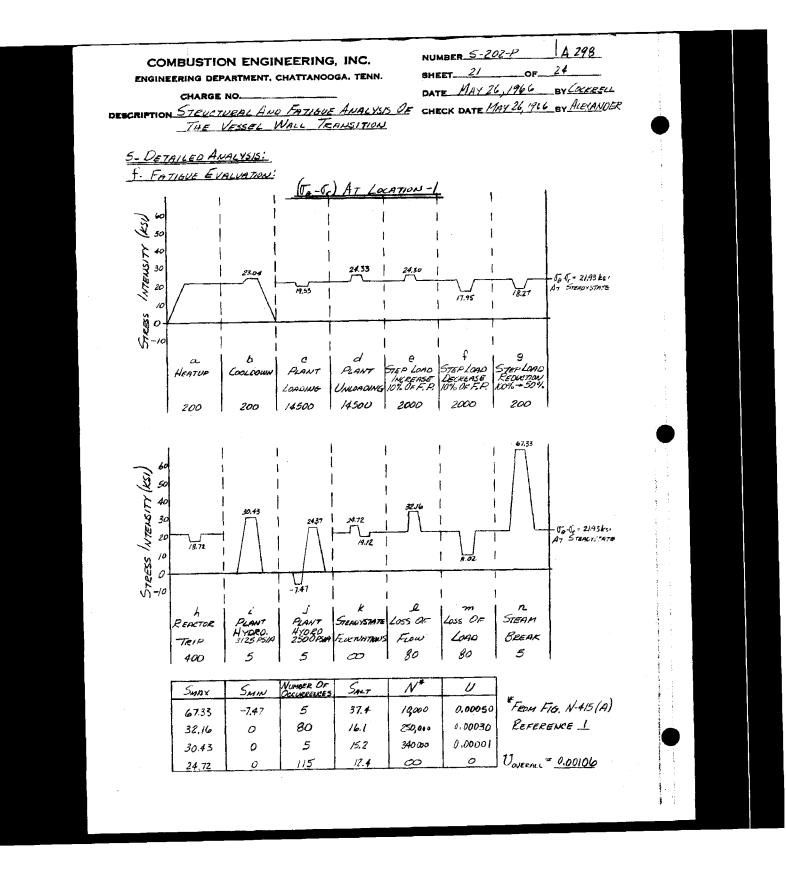
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$\begin{aligned} k_{7} &= 1.85 \\ k_{8} &= 1.53 \end{aligned} \qquad $		•	$\frac{r}{h} = 1.831$			
$K_{g} = 1.53$ $K_{f}' = 1 + 0.4 (K_{T} - 1) = 1.34$ $K_{g}' = 1 + 0.4 (K_{B} - 1) = 1.21$ $\frac{Location 3}{(T_{X} = \frac{6M_{2}}{L_{3}}} K_{5}' + \frac{b_{3}P}{2K_{3}L_{3}} K_{7}' + \frac{Ed(T_{m} - T)}{1 - v} K_{7}' = \frac{6.37232P + 0.41157(T_{m} - T)}{9.20326P + 0.30714(T_{m} - T)}$ $\overline{U_{g}} = \frac{v_{b}M_{2}}{L_{3}} K_{g}' + \frac{EA_{2}}{R_{3}} + \frac{b_{3}P}{L_{3}} + \frac{Ed(T_{m} - T)}{1 - v} = \frac{9.20326P + 0.30714(T_{m} - T)}{1 - v}$ $\frac{Lacation 4}{(T_{X} = -\frac{6M_{1}}{L_{3}}} K_{g}' + \frac{b_{3}^{2}P}{2R_{3}L_{3}} K_{7}' + \frac{Ed(T_{m} - T)}{1 - v} K_{7}' = \frac{6.397L_{2}P + 0.41157(T_{m} - T)}{1 - v}$	FROM FIGURE A.7-1 OF REF.3	FROM FIGURE A.T	7-2 OF REF. 3			
$K'_{7} = 1 + 0.4 (K_{7} - 1) = 1.34$ $K'_{8} = 1 + 0.4 (K_{7} - 1) = 1.21$ $K'_{8} = 1 + 0.4 (K_{7} - 1) = 1.21$ $T_{X} = \frac{6M_{1}}{C_{3}}K'_{8} + \frac{b_{1}^{2}P}{2R_{3}t_{3}}K'_{7} + \frac{Ed(T_{m} - T)}{1 - V}K'_{7} = 6.37232P + 0.41157(T_{m} - T)$ $T_{B} = \frac{\pi 6M_{1}}{C_{3}}K'_{8} + \frac{EA_{1}}{R_{3}} + \frac{b_{3}P}{t_{3}} + \frac{Ed(T_{m} - T)}{1 - V} = 9.20326P + 0.30714(T_{m} - T)$ $\frac{Lach Tion 4}{T_{X}} = -\frac{6M_{1}}{C_{3}}K'_{8} + \frac{b_{3}^{2}P}{2R_{3}t_{3}}K'_{7} + \frac{Ed(T_{m} - T)}{1 - V}K'_{7} = 6.39762P + 0.41157(T_{m} - T)$	K7 = 1.85	$\frac{\left \frac{k'-l}{k_{0}-l}\right = 0.4$				
$\begin{aligned} & K'_{g} = 1 + 0.4 (K_{B} - 1) = 1.21 \\ \hline & U_{X} = \frac{6M_{2}}{L_{3}}K'_{g} + \frac{b_{3}^{2}P}{2R_{3}t_{s}}K'_{T} + \frac{Ed(T_{m} - T)}{1 - \nu}K'_{T} = -\frac{6.37232P + 0.41157(T_{m} - T)}{1 - \nu} \\ & \overline{U_{g}} = \frac{\pi 6M_{2}}{t_{3}}K'_{g} + \frac{EA_{2}}{R_{3}} + \frac{b_{3}P}{t_{3}} + \frac{Ed(T_{m} - T)}{1 - \nu} = -\frac{9.20326P + 0.30714(T_{m} - T)}{1 - \nu} \\ & \frac{LacATION4}{U_{X}} + \frac{b_{3}^{2}P}{2R_{3}t_{3}}K'_{T} + \frac{Ed(T_{m} - T)}{1 - \nu}K'_{T} = -\frac{6.397162P + 0.41157(T_{m} - T)}{0.41157(T_{m} - T)} \end{aligned}$	K _e = 1.53		1			
$\frac{L_{0CATION} 3}{\sigma_{\chi}} = \frac{6M_{2}}{c_{3}^{2}} K_{B}' + \frac{b_{3}P}{2R_{3}t_{3}} K_{T}' + \frac{Ed(T_{m}-T)}{1-\nu} K_{T}' = -\frac{6.37232P + 0.41157(T_{m}-T)}{1-\nu}$ $\overline{\sigma} = \frac{\pi 6M_{2}}{t_{3}^{2}} K_{B}' + \frac{E\Delta_{2}}{R_{3}} + \frac{b_{3}P}{t_{3}} + \frac{Ed(T_{m}-T)}{1-\nu} = -\frac{9.20326P + 0.30714(T_{m}-T)}{1-\nu}$ $\frac{L_{0CATION} 4}{\sigma_{\chi}} = -\frac{6M_{2}}{c_{3}^{2}} K_{B}' + \frac{b_{3}^{2}P}{2R_{3}t_{3}} K_{T}' + \frac{Ed(T_{m}-T)}{1-\nu} K_{T}' = -\frac{6.397L_{2}P}{0.41157(T_{m}-T)}$		$K_{7} = 1 + 0.4 K_{7} -$	-// = 1.34			
$ \begin{aligned} & \int_{\Theta} = \frac{\pi b M_{e}}{t_{3}^{*}} K_{e}^{\prime} + \frac{E A_{s^{2}}}{R_{3}} + \frac{b_{s} P}{t_{s}} + \frac{E d (T_{m} - T)}{1 - v} = \frac{9.20326 P + 0.30714 (T_{m} - T)}{0.30714 (T_{m} - T)} \\ & \frac{Lac n T 100.4}{T_{X}} = -\frac{6 M_{1}}{t_{3}^{*}} K_{B}^{\prime} + \frac{b_{3}^{2} P}{2R_{3} t_{3}^{*}} K_{T}^{\prime} + \frac{E d (T_{m} - T)}{1 - v} K_{T}^{\prime} = \frac{6.39762 P + 0.41157 (T_{m} - T)}{0.41157 (T_{m} - T)} \end{aligned} $			-1) = 1.21	•		
$\frac{L_{acnT10ks}4}{T_{\chi}=-\frac{6M_{1}}{L_{3}^{2}}K_{B}^{\prime}+\frac{b_{3}^{2}\rho}{2R_{3}L_{3}}K_{T}^{\prime}+\frac{Ed(T_{m}-T)}{1-Y}K_{T}^{\prime}=6.397L_{2}P+0.41157(T_{m}-T)$	$\frac{L_{0CA}T_{IIA}S}{\sigma_{X}} = \frac{\frac{4M_{3}}{2}}{\ell_{3}^{2}}K_{8}' + \frac{b_{3}^{2}P}{2R_{3}t_{3}}K_{7}' + \frac{Ed(T_{IA}-T)}{r}K_{7}' =$	6.37232P+	0.41157 (Tm-T	2		
	$\int_{\Theta} = \frac{r_{b}M_{e}}{t_{s}}K_{e}' + \frac{E\Delta_{e}}{R_{s}} + \frac{b_{s}P}{t_{s}} + \frac{Ed(T_{m}-T_{e})}{1-r}$	9,20326P+	0.30714 (Tm-T	2		
	$\frac{L_{acm Tion 4}}{T_{x} = -\frac{6M_{I}}{Z_{x}}K_{b}^{\prime} + \frac{b_{s}^{2}\rho}{2R_{s}t_{s}}K_{\tau}^{\prime} + \frac{Ed(T_{m}-T)}{I-V}K_{\tau}^{\prime} =$	6.39762P +	0.41157 (Tm-T)		
	$\int_{\Theta}^{-} = -\frac{\nu_{6}M_{z}}{\varepsilon_{5}}\kappa_{6}' + \frac{\varepsilon\Delta_{xz}}{\kappa_{3}} + \frac{b_{5}\rho}{\varepsilon_{3}} + \frac{\varepsilon_{4}(\tau_{m}-\tau)}{\tau_{-\nu}}$	= 9.21086P +	0.30714 Tm-T	2		
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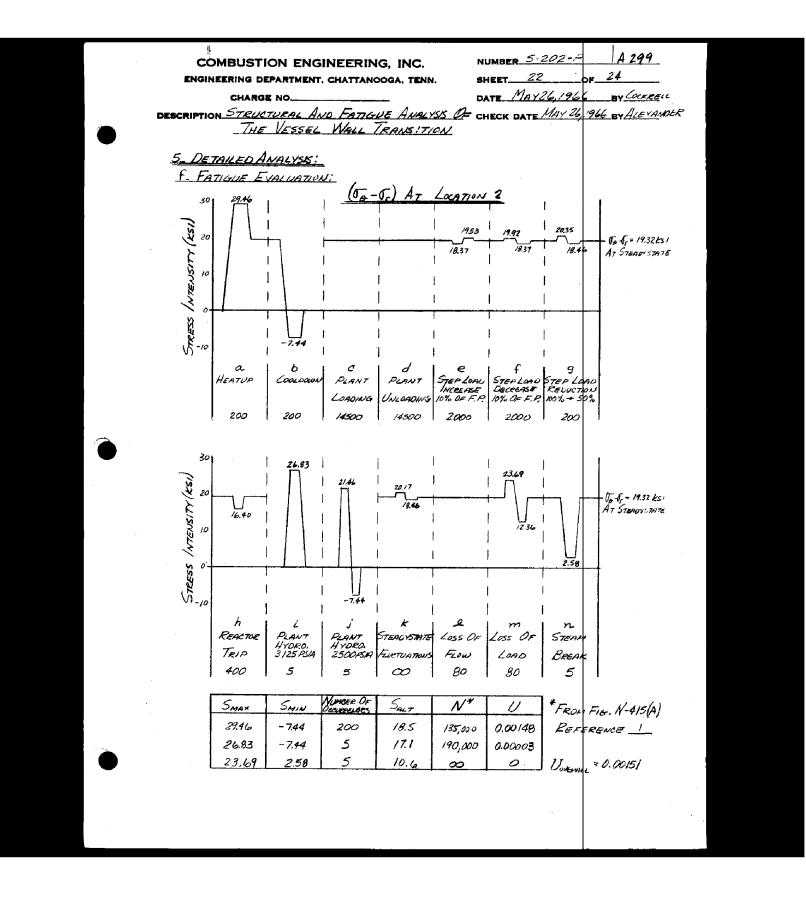
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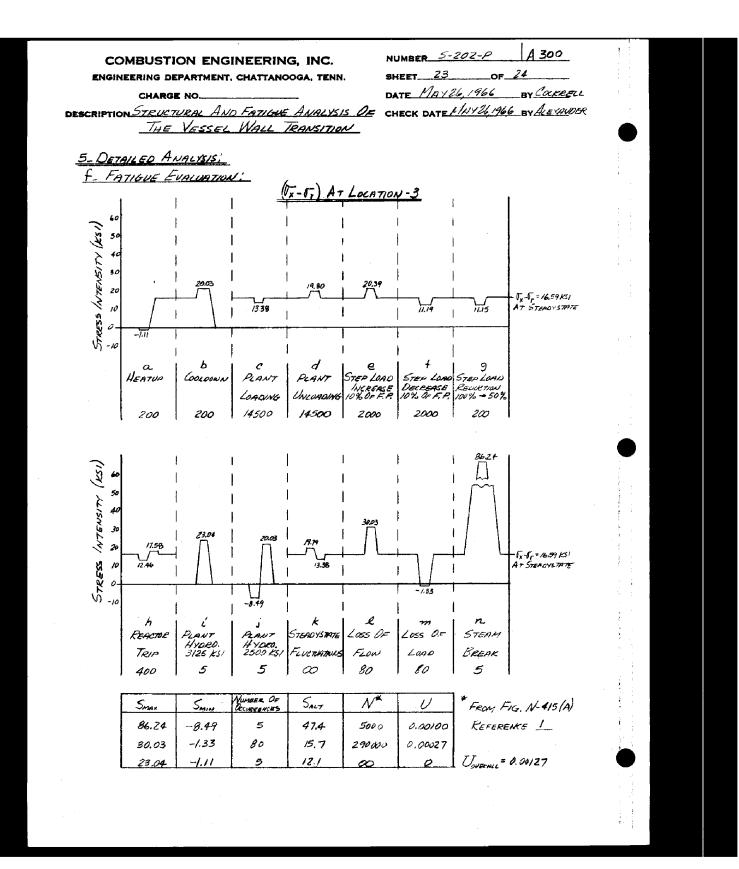
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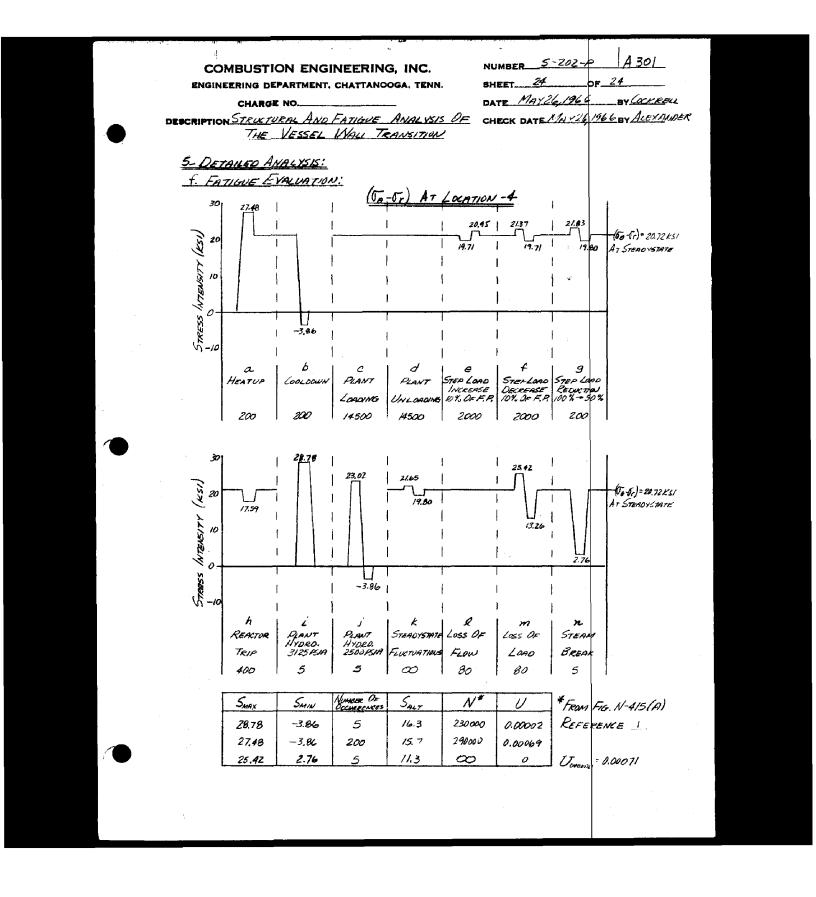
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d	20 min					14.39	20.72		14.39	1		-4		i	
e	100 sec	2.140				13.69	19.71		13.69	19.71		-			
E	225 Sec	2.275				14.55	20,95		14.55	20.95					
	40 sec	2.320				14.84	21.37		14.81	21.37		-		-	
F	100 sec	2.260				14.46	20.82		14.46	20.82					
	240sec	2.140				13.69	19.71		13.69	19.71					
	2 min	2.370				15.16	21.83		15.16	21.83					
9	3.Zmin	2.350				15.03	21.65		15.03	21.65		ļ			
-	10.4 min	2.150		ļ		13.75	19.80		13.75	19.80					
4	10 sec	2.220				14.20	20,15		14.20	20.45					
<u> </u>	65 sec					12.22	17.59		12.22						
2	220min	3.125	V	1	V	19.99	28.78		19.99	1		+			
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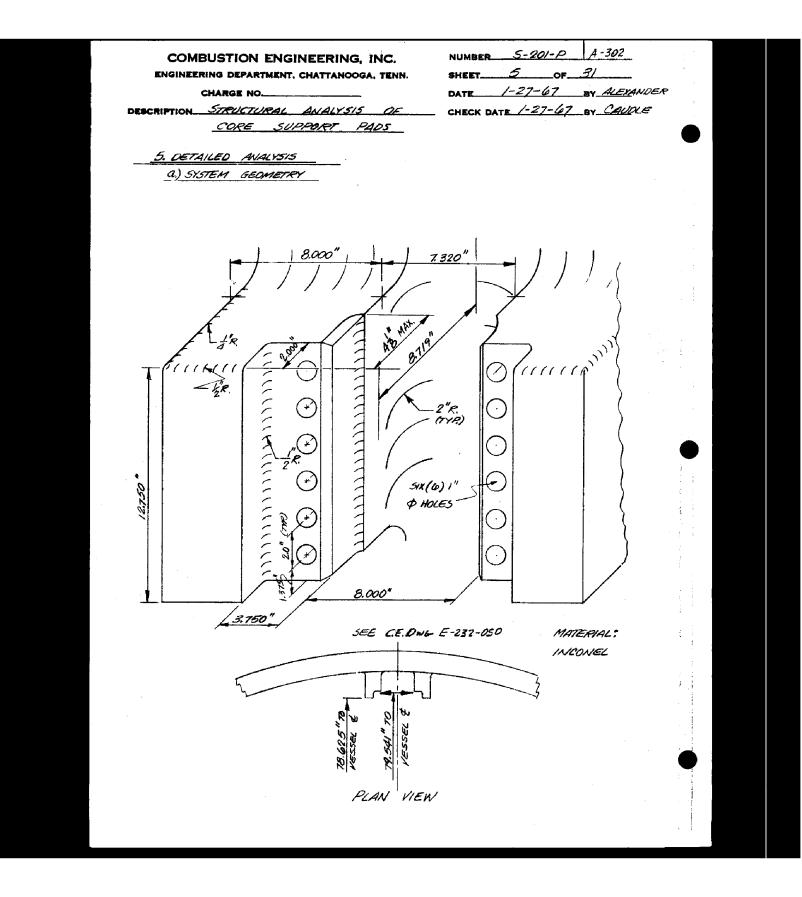
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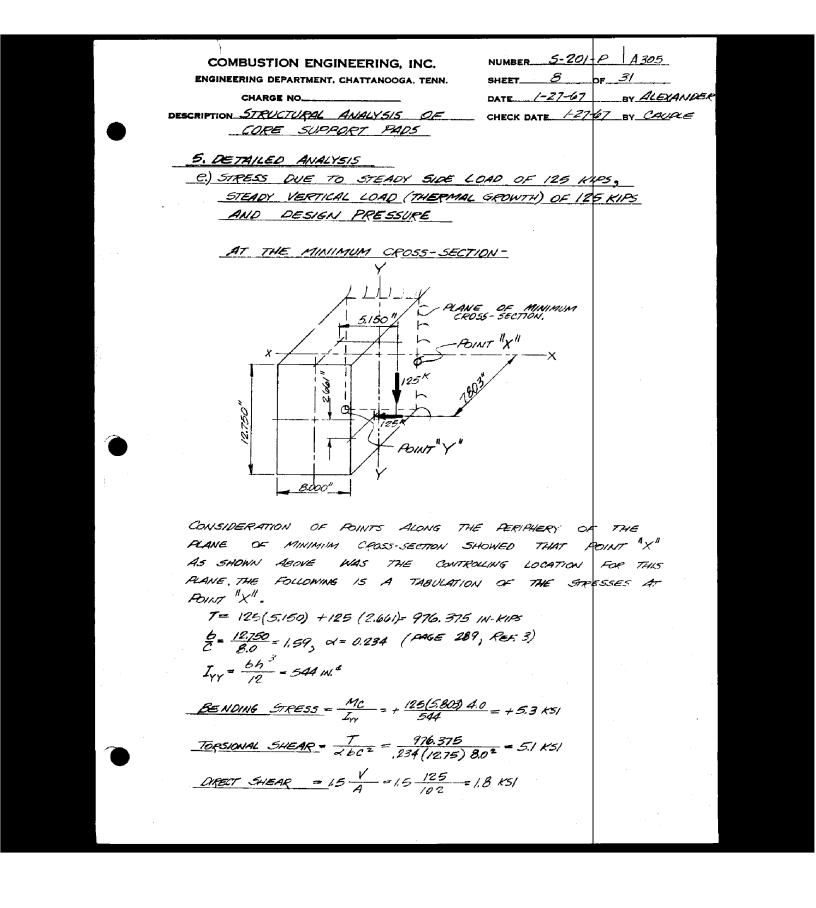




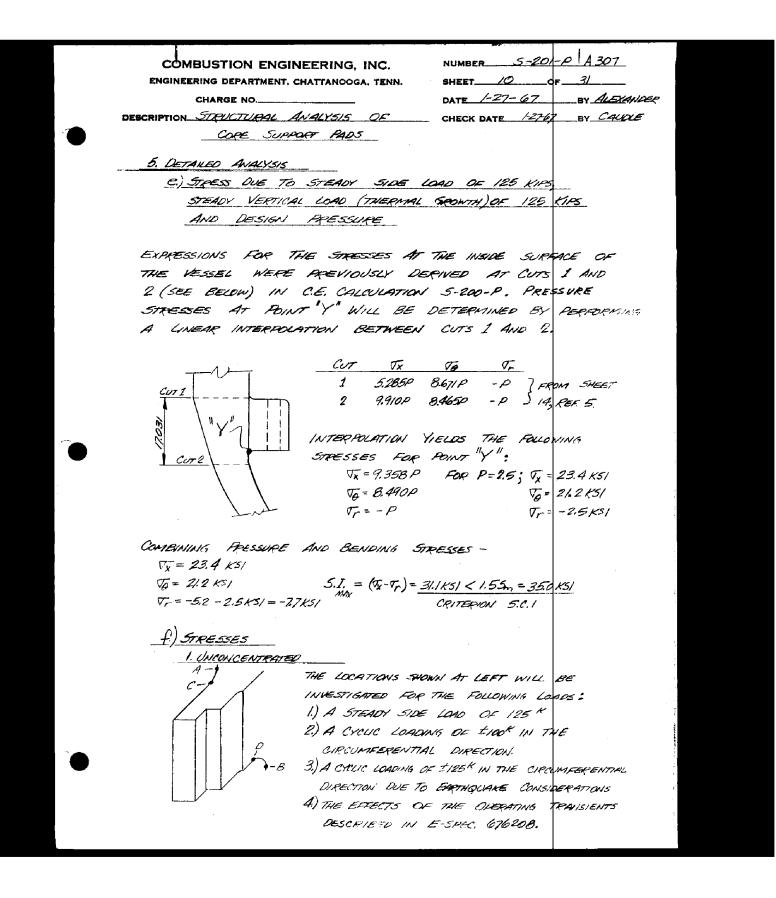


	COMBUSTION ENGINEERING INC NUMBER 5-201-P 4 303
	1-27-62
	CHARGE NO DATE 1-27-67 BY ALEXANDER
-	DESCRIPTION STRUCTURAL ANALYSIS OF CHECK DATE 1-27-67 BY CAUDLE CORE SUPPORT PADS
	LUKE SUFFURI MUS
1	5. DETAILED AMALYSIS
	b) SYSTEM LOADS
	THE SYSTEM SHOWN ON SHEET SWILL BE ANALYZED FOR THE
	FOLLOWING LOADINGS:
	1. A MOMENTARY VERTICAL LOAD OF 250 KIPS DURING INSERTION
2	OF THE CORE.
	2. A NON-CY C LIC STEADY LOADING OF 125 KIPS IN THE CIRCUMFERENTIAL DIRECTION.
	3. A VERTICAL THERMAL GROWTH FRICTION LOAD OF 125 KIPS
	BETWEEN THE KEY ON THE CORE BARREL AND THE PAD AT
	ONE VERTICAL INTERFACE ONLY.
	4. A CYCLIC LOADING OF PLUS/MINUS 100 KIPS ACTING IN THE
	CIRCUMFERENTIAL DIRECTION FOR AN INFINITE NUMBER OF
	CYCLES.
	5. AN ADDITIONAL CYCLIC LOAD OF 125 KIPS IN THE CIRCUM-
	FERENTIAL DIRECTION DUE TO EARTHQUAKE CONSIDERATIONS.
	6. THE OPERATING TRANSIENTS DESCRIBED IN E-SPEC. * 676208.
	C) SYSTEM ALLOWABLES
	1. SHOW THAT THE STRESS INTENSITY DERIVED FROM PRIMARY
	MEMBRANE (GENERAL OR LOCAL) PLUS PRIMARY BENDING
	STRESSES PRODUCED BY DESIGN PRESSURE AND OTHER MECHANICAL LOADS IS LESS THAN 455m.
	2. SHOW THAT THE RANGE OF STRESS INTENSITY AT EACH POINT DUE
	TO THE COMBINATION OF MECHANICAL LOADING PLUS THERMAL
	EFFECTS (NEGLECTING STRESS CONCENTRATIONS) 15 LESS THAN 35m.
	3. SHOW THAT EACH POINT MEETS THE REQUIREMENTS FOR
	PEAK STRESS INTENSITIES GIVEN IN N-414.5 OF THE
	A.S.M.E. CODE. THE PROCEDURE WILL BE THAT DESCRIBED
	IN N-415.2 AND N-414.2 OF SECTION I.
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NUMBER 5-201-P A 304 COMBUSTION ENGINEERING, INC. ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. SHEET 7 OF 31 DATE 1-27-67 BY ALEXANDER CHARGE NO CHECK DATE 1-27-67 BY CALDLE DESCRIPTION STRUCTURAL ANALYSIS OF COPE SUPPORT PADS 5. DETAILED ANALYSIS d.) STRESS DURING INSERTION OF CORE CONSIDER LOADING I SHOWN ON SHEET 6. DURING INSTALLATION OF THE CORE, IF ALIGNMENT FAILS TO BE SMOOTH, A VERTICAL LOAD OF 250 KIPS OF MOMENTARY DURATION WILL BE TRANSMITTED TO ONE LUG AS SHOWN BELOW. STRESSES WERE CONSIDERED AT THE JUNCTURE OF THE LUG TO THE VESSEL WALL AND AT THE PLANE OF MINIMUM CROSS-SECTION. IT WAS DETERMINED THAT THE CONTROLLING LOCATION WAS THE PLANE OF MINIMUM CROSS-SECTION. FOR THE MINIMUM CROSS-SECTION: $I_{xx} = \frac{6h^3}{12} = \frac{8(1275)^3}{12} = 1381.781 \text{ m.}^4$ 250 K AND , FROM AS. 289 , REF. 3 -PLANE OF CROSS-SECTION $\frac{b}{c} = \frac{12.75}{8.0} = 1.59; \alpha = 0.234$ 5.150 BENDING STRESS SHORT SIDE LONG SIDE <u>5.803(250) 6.375</u>=6.7K51 $\mathbf{\nabla} = \frac{M_C}{I_{Y-Y}}$ 0 1381.781 TORSION Tr= T <u>.250(5:15)</u> = 4.21×51 250(5.15) 234(12,75) 82 = 6.7 KSI DIRECT SHEAP $T_s = 1.5 \frac{V}{A}$ 15 - 250 102.0 = 37KSI 0 CONSIDER MID-POWT OF SHORT SIDE CONSIDER MID-POINT OF LONG SIDE $\tau_{,=} = \frac{\nabla}{2} + \sqrt{\frac{\nabla^2}{2} + \gamma^2} = 8.7 \text{KSI}$ T=0 J= 2- V=+T2 = -2.0 KSI T= 6.7+3.7 = 10.4 KSI < 0.85 = 18.6KSI V,-V2 = 8.7-(-2.0) = 10.7 KS1 21.55m = 35.0 KSI



NUMBER 5-201-P A 306 COMBUSTION ENGINEERING, INC. SHEET____9___OF___3/____ ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. DATE 1-27-67 BY ALEXANDER CHARGE NO DESCRIPTION STRUCTURAL ANALYSIS OF CORE CHECK DATE 1-27-67 BY CAUGE SUPPORT PADS 5. DETAILED ANALYSIS C.) STRESS DUE TO STEADY SIDE LOAD OF 125 KIPS, STEADY VERTICAL LOAD (THERMAL GROWTH) OF 125 KIPS AND DESIGN PRESSURE THE DESIGN PRESSURE IS 2.5 KSI WHICH GIVES - $\nabla_{x} = \nabla_{\theta} = \nabla_{r} = -2.5 \text{ KSI}$ CONSIDER A STRESS BLOCK AT POINT "X" Vx=-2.5 $\nabla_{i} = \frac{\nabla_{i} + \nabla_{x}}{2} + \sqrt{\left(\frac{\nabla_{r} - \nabla_{x}}{2}\right)^{2} + \gamma^{-2}} = 7.5 \text{KSI}$ Vo=-2.5 $\sqrt{\frac{\nabla r}{2}} = \frac{\sqrt{\tau} + \sigma_x}{2} - \sqrt{\left(\frac{\nabla r}{2} - \sigma_x\right)^2 + \gamma^2} = -7.2 \text{ KSI}$ T= 5.1+1.8-6.9K51 , V_= +5.3-2.5= 2,8K5/ V3= -2,5 KS1 $S.I. = (V_1 - V_2) = 7.5 - (-7.2) = 14.7 \text{ KSI } < 1.5 \text{ Sm} = 35.0$ CRITERION S.C. 1 AT THE VESSEL WALL -CONSIDERATION OF POINTS AT THE JUNCTURE OF THE PAD TO THE VESSEL WALL SHOWS THAT THE CONTROLLING LOCATION 15 POINT "Y" (SEE SHEET 8). IY-Y'= bh3 WHERE ; b= 12.750 + 2(.76) 2 = 15.75 h= . 8.000+2(.75)2=11.0 $=\frac{15.75(11)^3}{12}=1746,938 \text{ m.}^4$ $I_{xx'} = \frac{11.0(15.75)^3}{12} = 3581.402 \text{ IN.}^4$ T= 976375 IN-KIPS BENDING STRESS =- MC - MC - 125(7.803)7.875 - 125(7.803)55 - 5.2KSI TORSION AND DIRECT SHEAR=0



NUMBER 5-201-P A 308 COMBUSTION ENGINEERING, INC. SHEET_____OF_____ ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. DATE 1-27-67 BY ALEXANDER CHARGE NO ... DESCRIPTION STRUCTURAL ANALYSIS OF CHECK DATE 1-27-67 BY CAUDLE CORE SUPPORT PADS 5. DETAILED ANALYSIS <u>f.) STRESSES</u> I. UNCONCENTRATED THERMAL STRESSES - * POINTS "A" # "B"- $\nabla_{\mathbf{x}} = \nabla_{\mathbf{\theta}} = \frac{Ed(T_{\mathbf{h}_{T}} - T)}{1 - 2}$ WHERE; EX= YOUNG'S MODULUS X COEFFICIENT OF THERMAL EXPANSION. TAKEN POINTS CED-AS 0.214 FOR POINTS A & PR AND 0.254 FOR POINTS $\nabla x = \nabla_r = \frac{E \alpha (T_{m} - T)}{1 - \alpha}$ "c" & "0." TM = MEAN TEMPERATURE AT PRESSURE STRESSES-STEADY STATE, POINT A -T = INSTANTANEOUS REACTOR Vx = 5,285 P FROM P6,10 INLET COOLANT TEMPERATIONE V0=8.671 P OURING TRANSIENT. Tr= - P V= POISSON'S RATIO, TAKEN POINT "B"-AS 0.3. $\nabla_{\rm X} = 9.358P$ FROM RG. 10 Vg = 8.490 P Vr=-P POINTS "CED" $\nabla x = \nabla p = \nabla r = -P$ STRESSES DUE TO APRIED LOADS -COMBINING THE CYCLIC AND STEADY LOADS AS GIVEN ON PAGE 10 YIELDS THE FOLLOWING APPLIED LOADING: 125 K STEADY YCLIC NOTE - ALL THERMAL STRESSES CONSERVATIVELY TREATED AS SKIN TYPE STRESSES.

NUMBER 5-201 P A 309 COMBUSTION ENGINEERING, INC. SHEET_______ OF____3/ ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. DATE 1-27-67 BY ALEXANIER CHARGE NO.____ - CHECK DATE 1-27-67 BY CAURE DESCRIPTION STRUCTURAL ANALYSIS OF CORE SUPPORT PADS 5. DETAILED ANALYSIS _f.) STRESSES I. UNCONCENTRATED STRESSES DUE TO APPLIED LOADS-POINT "A" - (VESSEL WALL) $\nabla_{r} = -\frac{M_{C}}{I_{Y-Y'}} = \frac{-\binom{350}{(125)}7.803(5.5)}{1746.938} = -\frac{8.6}{-3.1} \frac{1}{181}$ POINT "B" - (VESSEL WALL) Fr= +8.6 K51 POINT "C"- $\nabla_r = -\frac{M_c}{I_{Y,Y}} = \frac{\binom{350}{125}}{5.803} \frac{5.803}{(4)} = \frac{-14.9}{-5.3} \frac{18.9}{851}$ POINT D-Vr = +14.9K51 Vr = +5.3K51 SHEAR STRESSES NEGLECTED. NOTE: THE FOLLOWING TABLES SUMMARIZE THE STRESSES AND STRESS INTENSITIES FOR THE FOUR LOCATIONS AS SHOWN ON SHEET 10. COMPARISON WITH 35 ALLOWABLES (CRITERION 5-C-2) IS GIVEN AT THE END OF EACH TABLE. FOR THE 35 CONSIDERATION, THE FOLLOWING TRANSIENTS ARE NOT CONSIDERED: 1 - "LOSS OF FLOW" 2- "STEAM BREAK" 3 - "LOSS OF LOAD"

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		INTENSITIES	5-5-6	19.8	14.3	18.8	13.3	22.2	16.7	19.6	14.1	23.2	17.7	28.2		1.2	5.7	23.7	18.2			4	14.9	6.8	1.3	33		~					
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		CORD	ъ	-8.6	-3.1	-0,6	-2-	9.6	-3.1	-8.6	-3./	-8.6		-8.6	-3.1	13.6	-3./	-0.6	-3.1	цб. 6.6	-3.1	2.6-	-3,1	90	-3,1	-8.6	1:2-	-2.6	-3/				
;		53553245	ц	-2.4	-2.4	-2.4	-2.4	-22	-2.2	-22	-2.2	1.9	4.9	-3./	-3./	-25		-0 B	-0.3	-2.4	-24	-2.2	-2:2	-2.8	8:2-	-2.1	-2.1	4%-	47				
			С6	20.6	206	204	20.4	18.6	18.6	/9.2	19.2	0:0/	16.6	1:12	1.12	21.7	21.7	2.8	2.8	20.4	204	186	18.6	239	23.9	184	18.4	12.5	12,5				
		PRESSURE	5	12.5	12.5	124	124	11.4	11.4	1.17	1.7	10/	101	16,5	16.5	132	/3.2	1.7	1.7	12.4	12.4	11.4	11.4	146	9:41	11.2	11.2	7.6	92				
	•	THERM.	τ _x = 1°0	-3.7		- F	-4.6	0	0	-2.9	-2:9	2.6	2.6	0	0	-/3./	-13.1	13.1	13.1	1.8	<i>8</i> ′	-/0	-, 8,	-92	26-	-12.6	-12.6	1.5	15				
		1 8	8	-/2.0	- 12.0	-15.0	-15.0	0	0	-9.5	6 N	8.5	8.5	0	0	-43	-43	43	43	6.0	6.0	-6.0	-6.0	-302	2:08-	-4/2	21/10-	A. 8	4.8				
		5574	(ist)	2.37	2.37		2.35		2.15	2:22	222	16:1		3./3	3,13	2.50	2.50	0.32	0.32	2.35	2.35	2.15	2.15	2.76	2.76	21.2	2.12	1,44	1.94				
			TIME	2MIN	ZMIN	3.2 MIN.	32 MIN	104 MIN	INTA MIN.	10 SEC.	NOSEC.	6558	66550	220MIN	220MIN	{	•	{		}		2		DSEC.	10 SEC.	28 Sec.	28.5EC	160560	160525				
			TRANSIENT	STEP LOAD	REDUCTION	Ron 100%	205 02	Fut	POWER	REACTOR	MAXY didl	FULL	POWER	PLANT HYDRO	AT 3125 PSIA	PLANT	HYDRO	AT	2500 PSIA	SEADY STATE	FLUCTUATIONS	OF PRESS.	AND TEMP.		2025	20	a Har					:	

ENGIN				DN E					-					SHE	ЕТ		5		_07	_3;					•	-
	•	CHA	RGE	NO										DAT		1-	27	<u>-67</u>	, 7-6;			<u>EX</u> 2 <u>au</u>		DER -	<u>.</u> د	
SCRIPTIC)N	<u>5</u> 0	O.F.	<u>////</u> F	1.R. 51	46. UPP	_A. DR		Y SI Pa	4D3	<u> </u>	<u> </u>	- '	CHE	CK I	DATI	E	-2	-0/	B'	f	, 14.0	uc	-		D
								<u> </u>				- '														•
<u>5. 0</u> <u></u> <u></u>	<u>E7</u>] <u>5</u> 7	412. RE 3	ED SE	<u> </u>	NA UI	LYS VCD		NT	21	ΈD							5									
8	217165	6.5	18.3	500	2.2	2 0	100	15.9	15.2	20.7	1:21	206	13.60	1.6.1	10.6	1.0)	BB	143	1.3	23.0	28.5	58.2	63.7			
1.0C 471/0N	<i>twrens</i>	5-7-0	20.3	1.1	4.6	7. v v v		17.9	172	227	16.9	22.4	15.5	21.0	12.6	ġ,	10.7	16.2	1.81	250	36.5	6.85	644		-	
	STRESS -	5-00 1	2,0	000	2 4	0 a		0 c i i			87			6.		50	6.		<i>6</i> , <i>6</i>			0.7	07			•
5 117		5	0.0	ю <i>а</i>	1	w a	1) 90		0.8			6.3	0.8				$\overline{\varphi}$, 0 0 0	+	00	0	2.4.			:
INTENSITIES	STRESSES	6	9.1 0			5.0	-	1.9	<u> </u>		21.6		19.91		6.9/		~		0.0	_	293		1.00			•
TENS					_	<u> </u>	1_	197 18	10					21.8 15	18.9 16	18.9 1	1201		1) 19:00		31.3 2		Ø			
Ň.	55 70741	5	21.1	000)ø 1	+							1				· · ·					66.			
STRESS	ES 572E55	Ъ	3 3.1			00 n						_	8.6	m	3 36				00 m		3 3.1					D
-	STRESSES	Ŀ	-2,	1 1 1 1	C17-	0,0	5 6	-2.3	-2.5	-2.3		-2.1	-23						010	i și		9	-0.7			•
and	1	Ъ	16/	1.61	77	11	i 9	0	1.61	161	18,	18.2	19.4	19.4	161	19.7	192	19.2	182 182	ĝ Ó	1.61	5.9	50			÷
ES	PRESSURE	Ŗ	21.1	7:1	7.	10 N N N	200	1	21	21.1	20.0	20.0	213	21.3	21.7	21.7	21.1	21.1	0.02	21.1	21.1	6.6	6.6			
STRESSES	STRE SN	t,= C6	0	-/3./	-15.1	131	12	42-	24	2.4	34	34	0.5	0.5	-2.8	-2.8	-4/	4	-04	100	10.2	602	60.2			
		N.	0	64.	\$	43	1 4	0.2	28	2.8	211	11.2	1.7	1.7	<i>bi</i> w	-9.3	-13.3	-13.3		33.3	33.3	197	197			
02	PRESS .	(15×1)	2.25	2.25	62'2		0 2	2.25 -7.8	522		2.14	2.4	2.28	2.26	2:32	2'32 -		2.26	2.14	2,25	2.25	0.70	020			
4RY		11112	2	4.47 HRS.		4.47 HPS		NILLOX	20 MIN 2.25		100 SEC.	100 560.	225 250	2255B	40 SET.	40 Sec.	100 SEC, 2, 24	IDO SER.	260 SEC	200 200	12244	Ed 500 0170	5.55			÷
SUMMARY			44											ER 2		<u> </u>	-			-						
Ŋ		TRANSIENT	STEADY STATE	HEAT-UP		NMOC 100)		LOPONG	PLANT	UNIDADING	STEP LOAD	INCREASE	10% OF	GULL POWER	STEP	0007	DECREASE	10 % OF	FULL	LOSS OF	FLOW	STEAN	BKEAK			

DESCR	IPTIC		57	R		UR						5/5	OF	-			HEG			27- E			6 7				ZAI LA	VDE. E
	_				2						14	45	·												/=	,		
		577 577						515 NCL		EN	177	PATE	0		-													
SHLISHEAN	6-5-	10.2	15.7	9.2	147	11.9	17.4	6.5	15.0	121	176	211	0.07	c i	2.5	5.1	13.0	15.6	21.1	101	15,6	84	13.9	-/./-	4.4	6.5	12.0	
	12-0-	12.3	17.8	11.2	16.7	13.7	19.2	11.5	021	13.8	19.3	23.8	C17	+ (1	9.7	0.7	13.3	17.6	23.1	11.9	17.4	108	/á 3	~	6.2	7.8		
STRESS	2-5	2.1	2./	2.0	2.0	<u>,0</u>	ġ,	2.0	2.0	1.7	1.7	110	2 1	1	2.2	<i>m</i>	n N	2.0		6.	-	24	2,4	ó	ó	2.3	ŝ	-
ies .	5	6.2	0.7	6.2	0.7	4.0	0.9	<i>b</i> .0	0.9	6.7	1.2	200	5 ,	ì		6.3		6.0	0.7	6.4	29	8	0,3	6.9	1.0	22	Ń	
STRESSES	Pø	16.4	16.4	15.4	15.4	183	183	159	159	18.8			I	3 .	à	15.0	15.8	2.8	2.8	1/45	16.5	142	122	5.4	54	13.7		
<i>דמדא</i> ג	Ъ	18.5	18.5		17.4	20.1	20.1	621	17.9	20.5	20.5	29.3	C:X7	, č 1	6.9	10.1	1.001	m'	238	6.9	18.3	16.6	16.6	72	7.2	15.0	15.0	
1040	Ъ.	<i>w</i> <i>w</i>	<u>.</u> 1.	ω		αń.		9. 19	<i></i>	0. 0	3.1	8.6	ni a	_	n; '	,9 ()		ø,		8.6	_ _	36	3.1	<i>G</i> 9	3.7	8.6	in	
STRESSES	Ь	-2.4	1.				-2.2	-2.2	-2.2	67	-/-9	1.2	-96	1 (-1.5	ġ.	-0.3	-2.4	-2.4	-2.2	127-	-28	-2.8	-2.1	-2.1	-/.4	4./-	
	5					103	<i>(</i> 6 .3	18.8			16.2	26.6	010	10	712	27			20.0	/8,3	183	23.4		ó	Ô.	12.2	2	
PRESSURE	ß	22.2	22		22.0	20.1	20/	20.8	20.8	17.9	129	6.62 8.92 8.92	<u> </u>	16		5	m			8		258	25.8	19.8	õ.	13.5	13.5	
THERM.		L'i		-46	-46	0	0	-2.9	-2.9	26	2.6	00	- 12		1:51-	3.	13.1	00	Ś	6/-	-/0	-92	-92	-/2.6	-12.6	51	1.5	
· · · · 1	(1-14).	-/2.0	- 12.0	-15.0	7	0	0	-9.5	2.6-	8.5	8.5	00	Ý	; ;	2 2 2	4 M	43	6.0	6.0	-6.0	-6.0	-30.1	-30.2	-412	-41.2	4.8	4.8	
Bates	(KSV)		2.37	2:35	2.35		2.15	2,22	2.22	161	161	3.13			2.50	0.32	0,32	2:35	2.35	2.15	2.15	2.76	2.76	21/2	2.12	1.44		
	TIME	2MIN.	2MIN	3.2 MIN.	32 MIN	VIW DO	VOA MIN.	10 SEC.	IDSEC.	6558	65 SEC.			{	•	{		}	- 14-	{		DSEC.	10 500.	28560	28.SEC	100500	160517	
	TRANSIENT	STEP LOAD	REDUCTION	5001 100%	70 50%	Ful	POWER	REACTOR	MAX didi	PULL	POWER	RANT HYDRO DT 2125 DCIA	BANT		HYDRO	47	2500 PSIA	STEADY STATE	ELUCTUATTOMS	- Q	AND TEMP.	÷	4055	20	0407		-	

		EER	UNG	DE	PAR	ENG				•					SHE			7.		o	F	31					•	
				RGE						-		-			DAT				<u>-6</u> 1-7	Z	7		<u>ALE</u> LA		VDER V -	-	•	
DESCR	IPTIO			RUC UCE		RAL. SUPI			<u> </u>			2		-	CHE	CK	DAT	E	2	<u> </u>	<i></i>	-8Y.	-1					
		-	<u> </u>	<u>17</u> 2		<u> 2000</u>	UK	<u> </u>	[74	2																		
					_	ALYS.				_																		
		<u>577</u>	PE	5 <u>5</u> 6			1	22/0	ENT	-				-1					N			- <u></u>	0 0	1		:		
:	INTENSITIES	6-9	5.3	30.5	20.9	-0.7		ġ	12.1	2.5	10.8			47	18.3	8.7	19.7	101	15.4	00	00 01 10	-6.0	-50.0	9			1	
2 2		<u>त</u> ्र - फ	5.3	19.9	89	4.4 4.4			14.9	5	641	5	149 1	53	149	5	14.9	5.3	14.9	5.3	14.4	5.5	4. r 2 2	n N				
LOCATION	STRESS	<u>қ</u> - <i>П</i> ө	0	-/5.6	- 15.6	15.0	-28	-2.8	2.8	2.8	4./	4	90	0.0	-3.4	-34	-4.8	Å-	-0.5	6.0	/2./	/2./	7.5	1.11			÷	
AT 20	SES	ь. С	9%-	32.9	23.2	0.4	20.0	-10.4	-14.4	4.8	-/2.9	1, 13 10	-/6.6	-7.0	20.6	0://-	-22.0	-/2.4	5%1-	-2.9	-5.1	45	55.9	0.00			•	
	577855555	٦	-2.3	-2.3	-2.3	e.0-	-23	ŝ	-5.3		-2.1	.		-23	-23 -			-2.3		\uparrow	an i	+	2.0-	2/				
INTENSITIES	70741	2	-2,3 -	- 12.9 -)5.3 5.3	<u> </u>		- 50	0.5	2.0	2.0		-1.7	~					÷	80. 100	<u>_</u>	8.0% 8.0%	0				
1			5.3 -		5.3 1							5.3				5.3							<i>o</i> 10	-		1		
STRESS	5 2040 55 578ESS	5. T	1	-/4.9	+ 1 	4-1	-/4		-149	-5.3	6%/-			-53	6:5/-	,		-5:3		+							1	
4110 S	APESS.	VX=66=9~	-2.3	-2:3	-2.3	00 10 10 10 10 10 10 10 10 10 10 10 10 1	-23	-2.3	-23	- 23	-2.1	-2.1	2.3	-2.3	-2- 19-	-2:3	-2.3	-2.3	-2.1	-2-	- 2:3	-2.3	10-10	10-				
· 1	THERM. STRESS	<u> 7</u> , <i>1</i> ,	0	-15.6	-15.6	15.6	-28	-28	2.8	20	4	4	00	0.6	-34	-3.4	-4.8	-48	-0.5	-0.5	12.1	/2.1	2.0	G.12			•	
STRESSES	1	(1-11)	0	-43	-43	F 4	-78	-7.8	2.8	2.8	11.2	11.2	1.7	1.7	-93	-93	-13.3	-13.3	-1.3	-/.3	33, 3	33.3	161	161				
6		14655	2.25	2.25	2.25	0.32	200	2.25	2.25	2.25	2.14	2.14	2.28	2.28	2:32	2.32	2.26	2.26	2.14	2.14	2.25	2.25	0.70	0.70				
VARY	TIME		2	Admo			_	IN WIN OT	20 MIN		100 SEC.	OO SEC.	125 SE.	225SEC	40 SEC.	40 SEC.	10055	100 550.	26052.	26035,	18 SEC.		54 SEC					
SUMMARY		TRANSIENT	STEADY STATE		10-10-11-	כססר- הסמוא לקלואוצי	D' A' L			UNLOADING	STEP 1040 100 SEC.	INCREASE 100 SEC.	10 20 202	FULL POWER	STEP	1040	DECREASE	10% OF	FULL	POWER	20 2207	FLOW	Į.	BREAK		(

CORE CORE	ANALYSIS -1. UNCONCENTRATED			ن ب
тениятез - С. Т Г. 4.9 19.3 5.3 9.7 4.9 20.3 7.3 10.7				
1 4 4 6 8		20.9 20.9 -0.7 -0.7 -0.3	3.1 17.1 25.9	16.3 20.0 13.1 15.1
	14 9 4 9 4 9 4 9 4 9 4 9 4 9 4 9 4 9 4 9	149 189 189 189 189 189		53
-5.4 -5.4 -5.4	00 4 4 m m 00	-15.6 -15.6 15.6 2.2	-222-1:0	-140 -149 -149 7.1 7.1
	-7.7 -7.5 -7.5 -10.9 -41 -8.6 -8.4 -8.6	044074		-19.1 -31.9 -5:03 -5:0
57865565 57865565 -2.4 -21. -2.4 -22. -2.4 -13.			-2.2	-20 -21 -1.4 -1.4
7074L 6.8 -7,8 -7,8 -7,8	222 56 1.2 1.2 1.2 1.2 1.2 1.2	-181 -181 153 153 -0.2	-44 -44 -73.8	-13.8 -17.0 03 03
-5.3 -149 -5.3 -5.3 -5.3 -5.3	-149 -149 -149 -149 -149 -149 -53 -53	-149 8-2- 8-2- 8-2- 8-2- 8-2- 8-2- 8-2- 8-2	1.2- 1.2- 1.2- 1.4- 1.4- 1.4- 1.4- 1.4- 1.4- 1.4- 1.4	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1
реть 57725 577755 577655 -2.4 -2.4 -2.4 -2.4	-2.2 -2.2 -2.2 -1.9 -1.9 -1.9	2.2 2.5	-2.2 -2.2 -2.2	-20 -21 -22 -22 -22 -22 -22 -22 -22 -22 -22
-5.4 -5.4 -5.4 -5.4	00 4.4.4.00	-15.6 -15.6 15.6 15.6	-2:2 -2:2 -//.0	-11.0 -149 -149 -121
(Tm-T) -12.0 -12.0 -15.0 -15.0	8:5 25 8:5 8:5 00	& & & & & & & & & & & & & & & & & & &	-6.0 -6.0 -30.2	-30.2 -41.2 -41.2 -41.2 -41.2 -41.2 -41.2 -41.2
PRESS. 2.37 2.35 2.35 2.35		2.50 2.50 0.32 0.32 2.35 2.35	2.15 2.15 2.16 2.76	2.18 2.12 1.44 1.44
71115 2 19111 2 19111 32 1911	104 Min 104 Min 105 EC 65 EC 65 EC 120 Min	155	D SEC.	10 SEC. 28 SEC. 10 SEC. 160 SEC.
TRANSIENT TIME STEP LOAD 2 MIN REDUCTION 2 MIN FROM 1006, 32 MIN	29 V	PLANT HYDRO AT 2500 FSM STEAD STATE CUMMUTION	de PEEss. de PEEss. devo TEMP.	1055 05 1040

	COM	BU	STIO	N ENG	SINEE		INC	•		NI	ливе	2R	5	-20	/-/	2	A	316				:
E	NGINEI	RING	3 DEPA	RTMEN	T. CHATT	FANOOG/	A. TE	NN.		Sł	IEET.		19		<)f	31		_			
								~-			TE		-27	<u>7(1</u>	2 <u>7</u> .	10		<u>ALEX</u> CAL	_			
ESCR	IPTION_		APE		<u>_AUA</u> PORT	PADS		20		_ Cł	IECK	DAI	· E	<u> </u>		¢7	BY.	- All	DCE			
_																						
	05TA +) 5:		D A. SSES	NALYS	UNCOM	CENTRO	AT EL	,														
	INTENSITIES	R.	ь n	0 40	7 ~ 5	1			100	101	61-	-, 21/	-0.5	1 1 1 1 1	,4 ,4 a)	023-	-174	- 764		:	•	-
<u>v</u>		-53	-149	64.4	1 7 6	-14.9 -5:3	67/-	·····	01	-149	- 5.3	6:5/-	-6,3		-53	1+1-	5	1.4.1- N.10-				
LOCATION	577555	0	-15.6	120	-2.0	2.8 2.8	41	4	9.6	0.0	4.6-	-4,8	84-	, v .	-0,5	12.1	/2./	2% 2%				-
AT 10	5			30.2	9.9 8.8 8.9	15.4 5.8	16.9	7.3	13.2	3.0	+	7.8	8.1-	123		171	151	7.07 1.9.				
1	57.78E.SSE	-23	-2:3		S N N	-2.3	-2.1	-21	1	v v v	-2.3	-2.3	N i i N	-2.1	-2./	-2.3	-2.3	-0.7				:
INTENSITIES	70741	-2,3		15.3	-5.1	0.5 0.5				-61	-27	12-	1.2-	-2.6	-2.6	90. 100	96	70.8				
STRESS 1	LOAD SRESS	5.3	149	14.9		149 53	149	Я. У. Ю. У.	14.9	5.3 149	5.3	149	53	14.9	n Vi	144	85	5.3 5.3				
-	225555 5776555 10-10-10-	-23		0.0	2 0 0 0 0 0 0 0 0 0	1 2 2	-2.1	01		- 2.3	10 10 10	-1:3	- 2:3	-2.1	-2./	12.3	-2:3	10-				
ES AND	THERM. STREESS	1	-15.6	156	- 2.8	2.8 2.8	4.1	4)	0.6	0.0	-3.4	07-	8:5-	-0.5	-05	12.1	121	2.5	-		•	
STRESSES	(2-m)	0	-43	\$ \$ \$	et	8% 8%	11.2	11.2	1.7	- 93	56-	-13.3	-13.3	-1.3	-/.3	33,3	33.3	197				
6	PRESS	2.25	2.25	0.32	2.25	2.25 2.25	2.14	2.14	2.28	2.28	2.32	2.26	2.26	2.14	2.14	2.25	2.25	0.70 0.70				1
SUMMARY	TIME	{	447HRS.	447 HRS.	20 MIN	20 MIN.	100 SEC.	100 SEC.	125 S.E.	40.5EC	40 SEC.	100 Sec.	100 500.	260.SEC.	26055	12. SEC.		54 SEC.				
SUM	TRANSIENT	STEADY STATE	HEAT - UP	COOL-DOWN 447HES.	PLANT	16	57EP 2040 100 SEC.	5	10 4 02	בודבם	1040	SE	10% OF	FULL	POWER	20 S207	FLOW	STEAM BREAK				
					,			•											-			

		1				RING	3 DI	EPAI	RTM						, IN 01.					SHI	,		<u>5</u> - 20	-20	/-/	2' OF_	31	13		_	
								E NO				1.	AL		-	_				DAT		<u>s (</u>	- 2	<u>[-</u>	27	-67				<u>AN</u> 100	DER C
		DEI	GRI	PTIC)N		COR	1 <u>C</u> 1 7 ह		741. 571.	PP			_	13 14 D.		E_		-	CHI	ECK	DA1	·	<u> </u>		-67	B1				-
					· ·			<u> </u>	`	<u>, </u>	- /	27	£										:					ź.			
	-		5	D F	<u>57</u>		LE] 555		<u>A/</u>		LY E		VCE	N7	RA	TEL	0														
			CITIES	79-62	-105	-0.9	-9.5	0.	6.71-	-5.3	-11.5	6%-		-8.4	0	3	6.7	-15.3	-305	-20.9	121-	52-	- 12.7	-3.1	-39	5.7	0	9.6	-16.6	-7.0	
			INTENSITIES	5-9-	- 14.9	-53	-/49	-5.3	-/49	-5.3	6:0/-	-53	-14.9	-53	671-	-53	67/-	65-	6:4/-	-53	67/-	5.3	-149	5.3	-149	- S. S.	-149	-53	-14.7	-53	
			STREES	G - 75	カガー	-4,4	-5,4	-54	0	0	-3.4	-3.4	3.1	3.1	0	0	-156	-15.6	15.6	15.6	2.2	2.2	-2.2	-2.2	-11.0	0%-	-/49	-14.9	1.7		
			5565 .	4	8.1	1/12	12	-2.5	12.7	3./	6.3	-0.3	1.01	6.5	11.8	2.2	-3.2	-/2.8	302	20.6	14.7	5.1	10.5	00	1.1	-0.5	-2.1	-1/.7	15.2		
			STRESSES	00	-2.4	-2.4	-2.4	-2.4	-2.2	-2.2	-2.2	-2.2	6%	-/9	-3.1	-3.1	-2.5	-25	è.	-0.3	72-	-2.4	-22	-2.2	-28	-2:8	-2.1	-21	-/-4	-1.4	
•			TOTAL	<u>1</u>	-6.8	6.9	-78	-7.8	-2.2	-22	-56	-5.6	1.2	1.2	-3.1	-3./	-/8/-	-/8/-	15.3	153	-02	-0.2	44-	-94	-/3.8	-13.8	021-	-17.0	0,3	0.3	
			1040	L'L	14.9	53	14.9	5.3	149	53	14.9	50	149	53	671	53	14.9	53	14.9	53	149	53	14.9	133	149	<i>ж</i>	14.9	5.3	14.9	5	
			STERES		-2.4	-24	-2.4	-24	-22	-2,2	-2.2	-2.2	-1.9	-/.9	1.2-	-3.1	-2.5	-2.5	0' W 0	-0.3	-2.4	-2.4	-22	-2.2	-2.8	-28	-2.1	-2.1	4.1-	4	
	-		STREEM	Tx=0-	-4.4	-4.4	24	-5.4	0	0	-3.4	-3.4	3./	3.1	0	0	-/5.6	-15.6	15.6	15.6	2.2	2.2	- 2.2	-2:2	-110	-11.0	67/-	-14.9	1.7	1.7	
			ł	((m -1)	-12.0	-12.0	0:5/-	-15.0	0	0	-95	-95	8.8	8.5	0	0	-43	Ą	Ð	43	6.0	6.0	-6.0	-6.0	-302	-30.2	-41.2	-41.2	40	4.8	
				1420S	2.37	2.37		2.35	2.15	2.15	2.22	2.22	1.91	1.91		3.13	2.50	2.50	0.32	0.32	2.35	2.35	2.15	2.16	2.76	2.76	2.12	212			
		. *		11115	2 MIN	2 MIN	32 MM	3,2 MM.	NH ĐƠI	10.4 MIN.	10.55	1050	65 SEC.	6550		220 MIN.		2	2	_		2	(10.SEC.	10 550.	28 SEC.	28 SEC.	160 SEC.	160 SEC.	
•				IKANSIENT	STEP LOAD	REDUCTION	N9	70 50%	FULL	REWER	REACTOR	TRIP	EL.	RWER	PRANT HIDRO	AT 3125 PSIA	PLANT	NORO	47	2500 PS1A.	STEADY STATE	FLUCTOATIONS	OF PRESS.	AND TEMP.		1055	OF.	0407			
	•		5, .	I. M	1×. £	39 N.	se '	= 0	5-0	F	= 4	10.2	8 K.	\$/	<u> </u>	3 <i>5</i> n	n -	6	9.9	KS,	,		С.	E17	'e e	104	5	-2.	2		

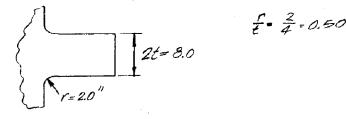
COMBUSTION ENGINEERING, INC. ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. CHARGE NO. DESCRIPTION STRUCTURAL ANALYSIS OF CHECK DATE 1-27-67 BY CAUDLE CORE SUPPORT PADS

5. DETAILED ANALYSIS f.) STRESSES

NUMBER 5-201-0 A 318 SHEET 21 OF 31 DATE 1-27-67 BY ALEXANINGA

2. CONCENTRATED IN ORDER TO PERFORM THE FATIGUE EVALUATION, PEAK STRESSES MUST BE KNOWN AT POINTS "A", "B", "C" AND "D" (SEE PAGE 11). THE STRESS EXPRESSIONS GIVEN ON SHEETS 12 & 13 WILL BE MODIFIED TO ACCOUNT FOR STRESS CONCENTRATIONS. STRESS CONCENTRATION FACTORS FOR BENDING AND TENSION WILL BE DETERMINED BY THE METHOD

PRESENTED IN REF. 2.



FROM FIG. A.T-1 OF REF. 6

KT = STRESS CONC. FACTOR FOR TENSILE STRESSES = 1.80 11 KR= " 11 BENDING 1 = 1.50

APPLYING THE APPROPRIATE S.C.F. TO THE STRESS EXPRESSIONS PREVIOUSLY DERIVED YIELDS:

FOR THERMAL STRESSES -POINTS "A" AND "B"

 $T_x = C_0 = K_r \frac{E_{cd}}{1-T_c} (T_{ay}, T) = 0.5502B (T_{ay}, T)$

BY ALEXANDER CHECK DATE 1-27-67 BY PANULE NOTE: DUE TO THE SYMMETRY NUMBER 5-20-0 2319 FOLLOWING ONLY POINT C APLE BE ñ OF PANTS C AND D THREES AND ENTRUE DATE /-27-67 GIVEN IN THE 22 FOR STRESSES DUE TO APPLIED LOAUS-POINT "A" CURVES. SHEET $\overline{V}_{r} = -k_{B} \frac{M_{C}}{L_{W'}} = k_{B} \left(-\frac{R_{b} K_{SI}}{-3.1 K_{SI}} - \frac{12.9 K_{SI}}{-4.7 K_{SI}} \right) = -\frac{4.7 K_{SI}}{-3.1 K_{SI}}$ POINT D" Tr = KR(14.9) = 22.4 KC1 Tr = (r = Kr 1 - 1 = 0.05313 (Tm-1) DESCRIPTION STRUCTURAL ANHLYSKS OF $T_{r} = -k_{R} \frac{M_{L}}{2W} = k_{R} \left(-5.3 \right)^{2} - 22.4 \text{ KSI}$ ENGINEERING DEPARTMENT, CHAITANOOGA, TENN. COMBUSTION ENGINEERING, INC. COPE SUPPORT PADS FOR PRESSURE STRESSES -POINT "A" 0- KR (3.1 KSI) = 12.9 KSI The The The - Ky P = -1.80 P $\nabla_{x} = K_{T} S 285 P = 9513 P$ G= 4- 8.671 P= 15.608 P 0x= K, 9358 P = 14 844 P 0= K_B491 H= 15.282P 2. CONCENTRATED 5. DETAILED ANDLYSIS Points "C" An "D" POINTS "C" AND "O" 5= -K+ P= -1,80 P Tr=-KTP=-1,800 E) STRESSES CHARGE NO. POINT "A" POINT C" PANT "8"

IPEC00069821

INCEP					NT.	CH/	TTA	NO	OGA	. T i	NN.			8HI		م ۲	<u> </u>	7 -	0 /~~		-5/	1, -	-
		RGE				,	AN.			_	_) (DAT			- <u>-</u>	<u>/-0</u> /-7	<u>e / .</u> 	7.	_BY		-
'ION		TRI OF					<u>an</u> 187		P _A		84 T	<u> </u>		GH	ECK	DAT	.	 ,	<u></u>	<i></i>	_01		
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í			_	~	64	0	CEA m				H	01		100	2	0	0	8	10	<u>_</u>		2	m
1217165	5	43.	28.4	20.	42.	15	47.8	39.6	56.4	48.2	5/24	48.2		453	48.2			5.2.8	42.5	-	70.4	133	125
S INTEN	5	30.2	14.7	6.5	40.2	32.0	34.1	25.7	42.7	24.5	43.4	35.2	39.6		34.1	25.7		250	i?	20.3	20.7 2. 4.1	129.	/2/
STRESS	5-2	-13.7	-/3.7	-/3.7	-2.0	-2.0	-/3.7	-13.7	-13.7	-13.7	-/3.0	-/3.0		-13.9	12/-	- /4/-	-/3.8	-13.8	-13.0	-13.0	13.7	-4.0	
ES.	Ŀ	<i>в.</i> 9.	-17.0	-3.8	-13.5	-5.3	02/-	-8.8	0%-	$\mathcal{G}^{*}_{\mathcal{O}}$	-,6.8	- 8,6	-17.0	$\dot{\phi}$	121-	-3.4	021-	-88	-,6.8	-3.6	027-	277	
STRESSES	5	35.1	11.4	1.4	287	28.7	30.8	30.8	39.4	39,4	39.6	39.6	30.5	305	31.1	31.1	280	28.0	32.7	327	53.4		~ `
- 74101	u u	4	12.3	- 2.3	24.7	26.7	121	121	25.7	257	26.6	246	22.6	22.6	17.0	021	142	142	6	19.7	39.7	121	1151
LOAD	5	123-	-12.9	-47	-12.9	-4.7	-129	41	-/29	-4.7	-12.9	-+.7	-12.4	-47	-12.7	17	-/27	14-	-12.7	2.4	-12.4	1 2	47
STREES	r.	-41	-4./		0.0-		~~~~	-41	-4/	-41	-3.9			_		-42	<u>`</u>	4		55-	14-	m	m
	ц Ц	35.1	35.1	_	5.0		35.1	351	35.1	35.1	33.4	33,4	35.6	356	36.2	36.2	35.3	35.3		33.4	35.1	+	0
PRESSURE	<u>ت</u>	21.4	2,4		3.0		21.4	214	21.4	21.4	204	20.4	21.7	217	22./	122	512	21,5	4.	20.4	2/4		N
THERM STRESS	σ _x = σ ₆	0	-237	-23.7	23.7	23.7	-43	-43		43		62	_	0.0	-2.1	1.5-	-73	-7.3	-07	67	mn	080	
	72-20	0	64 10	43 -	43	43	80 N-	_		2.8	11.2	11.2	1.7	17	63	-9.3	-/3.3	-13.3		1.3		2.20	<u>````</u>
ances		2.25	2.25 -	2,25 -				2.25	522	2.25	2.14	2.4	2.28	2.26	2:32	2:32			******	2.14 -		0.70	
_	2011	{	4.47 2		4.47	HES.	20 MIN		20 MIN 2.25				225 500 2.28		& SET.	40 5.00	100 SEC, 2.24	10050. 2,24	260 Ser.	260 SEC.	12560, 2.25		SX SKC
	TRANSIENT 1	STEADY STATE		HEA/-UP		COOLDOWN ,	PLANT 2	\$	PLANT	ş	57EP LOAD 140 SEC.	INCREASE N		ŝ	STEP	1007	DECREASE	10 % 05	FULL	POWER	ų	STEAM	

	,				cc	OME	30	STI		ίE	NG	ini	EEI	RIN	۱G,	, IN	10.	,			NUN	IBEF	٤		5-2	201	- P		43	<u>z/</u>	-	
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		E	FF	CRU	PTIC			RG TRZ		0 TUR	AL		AN	AL	YS	5/5	4	0F			DAT	е СК і		<u> </u>	/-:						-	
		-						<u>lor</u>				PO	<u>87</u>		A	25				- 1											•	
				5.	De	577	41 L	€D		4N 4	1LY	515																				
		-	بر ہے ۔۔۔۔ ا			577	7E	عى	95				NC	EA	77	-472	D							_								
				INTENS/TIES	6-7-	9:25	29.4	45.5	Ę.	50.4	42.2	10 1 1 1 1 1	33.1	50.E	72.6	1.22	57.2	32.7	24.5	12.2	340	57.1	£.8.7	12+	$\tilde{s}\tilde{s}.$	474	30.2	27.1	6.3	4.6	5.2.4	
				- 1	5-5	32.1	22.9	31.2		37.3	29.1	328	24:00	39.2		2.34	40.1	17.	Ø	40.2	32.0	£.0.	34.6	0.7	25.0	27.6	144	742		21.5	230	
		•		SYRESS	5-5-	-45	-145	-143	<u>1</u> 4:	• •	-13,1			071-	-11.6		1.6/-	-15.2	-15,2	-2.0	-2.0		· ·	- ·	-13/	-//0.0	-//6.8	-12.9	1/2		0,8-	
				CES	Ľ	221-	1-20	121-1	-3.9		-56	-16.9	1-9.7	-/6.3	1-31		-10.3	-+::/-	- 22	-13.5		<u> </u>	_	Ì	- 20	-179	1.1-	-16.7	30	1		
				STRESSES	ଷ	304	20.4		28.4		33.6	294				489	and the second second	15.3	15,3		287		40.0	303	30.3	26.5	26.5	10.4	10.4	25.1	251	
				C TOTAL	5	Ń	_	Ą	14	Å	20.5	<u>159</u>	15.9	22.9		29.8		6			26.7		257	1.	22/	37.	9.7	13.0	-2.5	/6.3	16.3	
D			<u> </u>	Sizers	ц,	-12.9	-4.7	-12.9	-47	-12.9	-47	-12.7	-47	-12.7	-4.7		4	-124	-47	- 12.7	-47	12.4	1.4.1	-12.9	(-) '7'	-/2.9	14-	000	-*-	1.53	54-	
				STRESSES	ป	-43	4.3	-42	74-		-3.9	-40	-40	13.4	-3.4	•	-5.6		40	90-	90-	-42	-42	17		-5.0	-5.0	-38	- 38	1	-2.6	
					Ь	37.0	37.0	36.7	36.7	33.6	33.6	346	34.6		298	48.9	46.	39.0	_	5,0	5,0		36.7	Ŵ.	33.6	43.1	43./	33./	33./	22.5	22.5	
<i>.</i> .		• •		S PRESSURE	ß	225	225			20.5	205	21.1	21.1	18.2	182	29.8	29.8				30	22.4	22.4	20:5	20.5	26.3	26.3	202	202	13.7	13.7	
•		•	11000	<u> </u>	02 = C0	-6.6	-0.6	φ	· · · ·	0	0	25.7		47	47	0	0	-23.7	-237	23.7	23.7	3	W.	<u>5</u> .	ŝ	-16.6	-/(0:0	-22.7	-22.7	2.6	2.6	
				5 12 - 7)		-/2.0	- 12.0	-15.0	-15.0		0	-9.5	91	6.5	8.5		-+	43	<u> </u>			6.0		•	-6.0	-302	-30.2	2110-	2.10-	Ą.		
				_	(151)	2.37	(2.37	N 235		V 2.15	4 2.15	2:22	222	16:1	16.	220MIN 3.13	<u>v</u> 3./3	2.50	2.50	0.32	0.32	2.35	2.35	2.15	2.15	2.76	2.76	2/2	2.72	1.44		
•				There	21111	2MIN.		3.2 MIN.	32 111	NIW 4:01	104 min.	10 SE.	IDSEC.		65 SEC.		ZZOMIN	}		2		<u>ر</u>	- फ्र-	2		DSEC.	1050	2BSec.	28.SEC	100 SEC.	16050	
				TRANSIENT		STEP LOAD	REDUCTION	5001 Mar	70 50%	EKL	POWER	REACTOR	TRIP ROM	FULL	POWER	PLANT HYDRO	AT 3125 PSIA	RANT	HTORO	47	2500 PSIA	STEADY STATE	FLUETUATIONS	OF PRESS.	AND TEMP.	-	2025	ZO	a Hat			
				•				•••		ал. -									:													-

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TRC	RIPTI	ON	CHA	_			e Al		ANA	114	5/	٢	C	- مرد		DAT	ГЕ ЕСК		<u> </u>	-6 [-2	/ ?7:e	67				4742 V.ET)EK	•		_
				OK					PR7			DS	5	•	-															
	5. L	7=7	ALL	ED		AN	'AL)	151	<u>د</u>																					
 	-7	15	TRE.	55E	5	- 4	?. C		CEN	_	76	50				···= -p	-													
	00	517165	5	33.3	6.1	10.1	16.3	245	0.19	24.0	24.4	38.1	29.9	38.1	26.9	35.1	21.7	29.9	13.4	26.6	23.0	31.2	¢.4	52.1	107.5	1151				
	LOCATION	INTEN	5	57.3	54	13.20	168	25.0	24.8	33.0	1.50	41.6	33.2	4.4		53.7	25.3	33.5	22.0	202	26.3			52.6	08.6	6.9			i i i	
	27	STRESS 1			Ś	S		S	5 I W		n N	N		10 10 10		3.6 2	51 30 19			3.6	m m		n N		2	11/1			1	
	X	25	2-5	in 19	a) M		<u>a</u> 0.	0			ni O					-1		36					<i>w</i>	(n)	~	~			i	
	ies	SES	6	8	aj	Ø	ź,	4.	8.0			00	1.0	0.0	θ.	9.6	3.7	0. 10	o) a)	0. 0	Ň	Ö	щ	_	11:6	34				
	VSIT	STRESSES	Po	344	10.7	10.7	28.6	28.6	301		200-	30.7	30.9	389	35.7	35.7	30.4	304	272	272	32.0	32.0	527	52.7	1.6/1	1.61			ł	
	INTENSITIES	70141	2	37.9	142	142	29.1	1.62	33.6	25.6	7.74	42.2		42.2	39.3	393	34.0	34.0	30.8	30.8	35.3	35.3	2.5	295	120.2	20.2				
		07967			12.9			+	12.9			47	129 4	47 4	12.9	17	12.7	4.7		47	•	4.7	<u>(5</u> .7		S.	$\frac{1}{2}$				
	STRESS			/ 4		_		-+		+	<u> </u>				<u> </u>	$\overline{}$					<u> </u>	0			<u>N</u>					
		STRESSES	6	<u>'</u>	1-4-1	1-41	- 00	-0.6			I.	4-1	-3.9		14	4	1			1	1	-		4	7	7			i	
	AND	1.	1.0	34,4	34.4	344	49	49	344	34.4	344	344	32.7	32.7	348	348	35.5	35,6	345	34.5	32.7	32.7	344	24.4	10.7	10.7				
	ES	PRESSURE	R	379	37.9	379	5.4	54	379	21.4	5.4	37.9	36.0	36.0	38.4	384	39.1	39.1	38.1	38.1	36.0	36.0	37.9	37.9	<i>Q:1</i>	1.18				
	STRESSES	MERN	6	0	23.7	-23.7	23.7	23.7	m N	-+-	n F	43	6.2	6.2	0.0	6.0	15	1:5-		-73	27	0.7	б м	23	08.4	08.4				
•	×LS		2	-			÷	-		·		7.8	2	2					m	m		+	~ ~			22 1/2				
	50	-	(KSI) (th - 1	5	1		0.32 43	0.32 43	5 - 7 00						8 1.7			2 -9.3	6 -13.		4 -1.3	4 -1.3		5 33.	-	6/0			i i	
				2,25	2.25					2.25	212	2.25	2.14	2.4	c 2.28	2.26	2:32	2.32	22	2,24	c. 2.14	2.14	2.25	226	00	0.70				
÷	SUMMARY		TIME	ľ	4.47	#R5.	4.47	HRS.	20 MIN.		52.7 WIN 02		100 SEC.	100 500.	275 560	2255E	40 SEC.	40 SEC.	100 SEC, 2,24	10050	260 SEC	260 SEC.	12550.		54560, 0.70					
	VLVID			TATE	ç	۱. ۱			1	8	5	5110							95E	ų					•				-	
	5		TRANSIENT	STEADY STATE		NCH/- (N-	COOL DOWN		PLANT	1040	PLANT	UNICADINIS	STEP LOAD	INCREASE	10% 05	GUL POWER	STEP	0007	DECREASE	10 % 02	FULL	POWER	20 SS02	FLOW	STEAN	BREAK				
			2	Ŗ	1	Ĕ	8		<i>d</i> , ,	Ĵ.	*	\$	6	1	ó	Ì			\$	6		٩	3		<i>ب</i> ر 	<i>B</i>				

		C	OMI	30:	STI	ON	El	٩G	INE	EF	RIN	G,	IN	IC.			 -	NUM	IBEF	<u>م</u>	<u> </u>	-20	2/-	P		3:	<u>73</u>		
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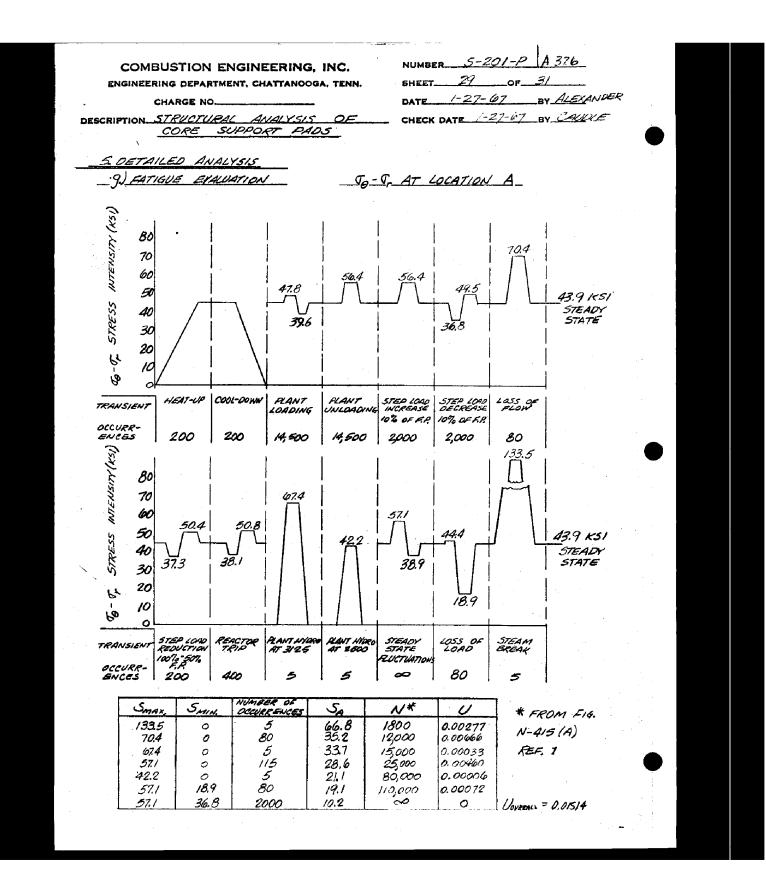
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	COMBUSTION	Engineering department. Chattanooga. Tenn	v	1		DETAILL	305	55.4	82-	5'78-	80-	1.21-	t'32 -	27-	82-	0.21-	15.2	NIWZ	0407 d315	
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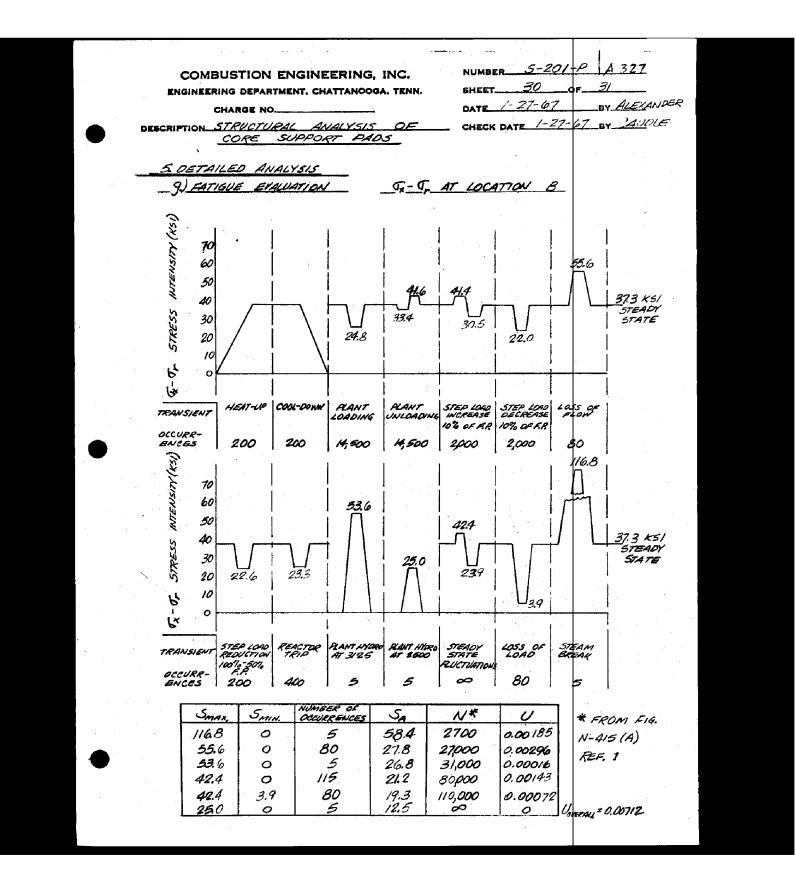
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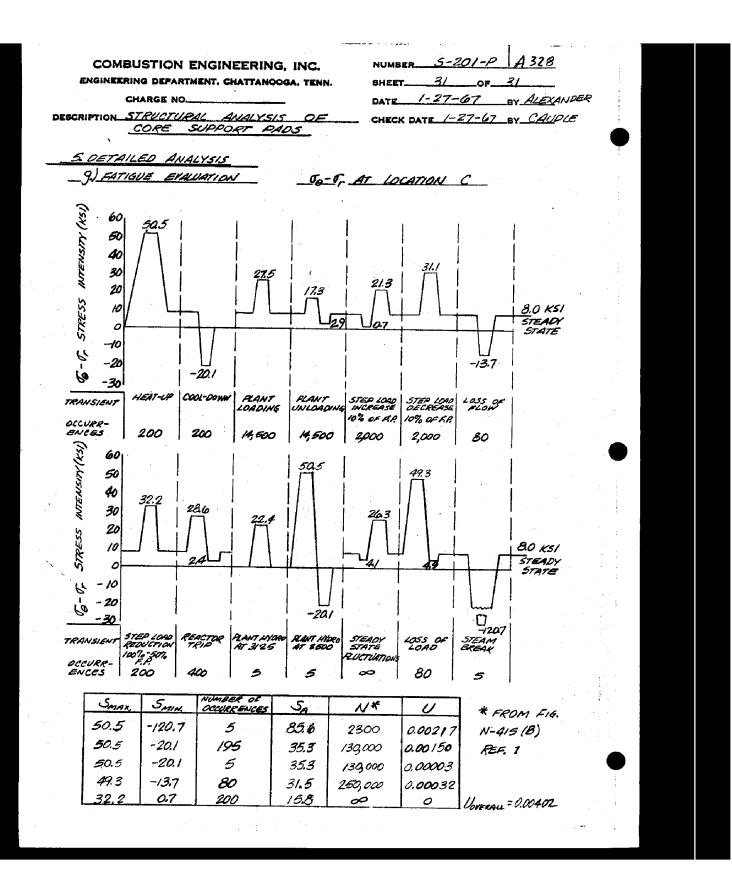
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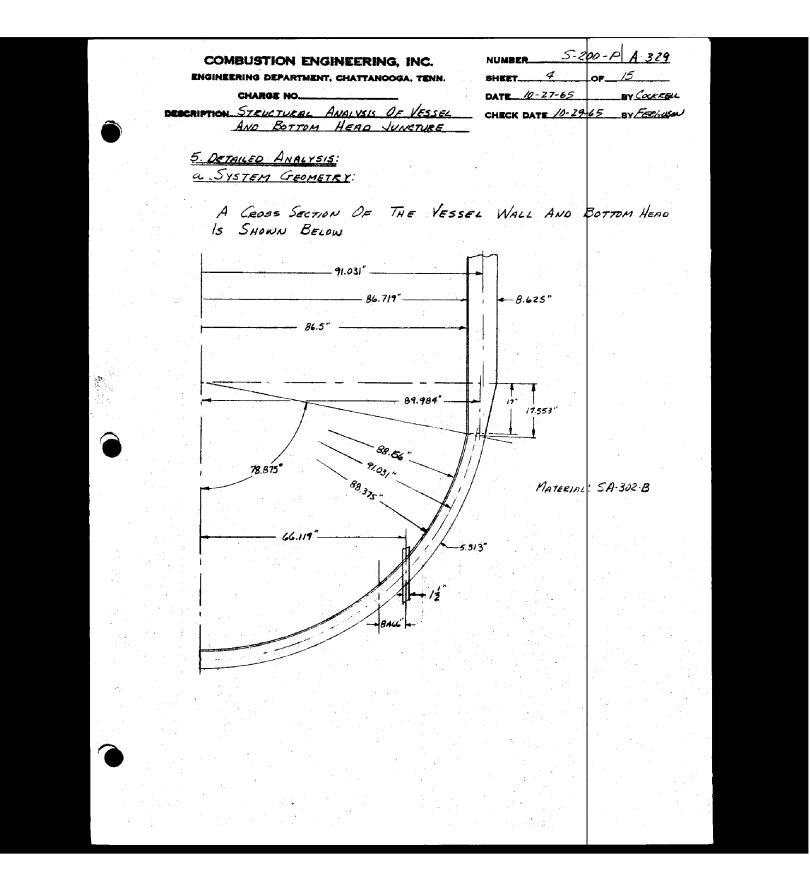
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COMBUSTION ENGINEERING, INC.	NUMBER 5-200-P A 330
ENGINEERING DEPARTMENT, CHATTANOOGA, TENN.	SHEET
CHARGE NO.	DATE 10-27-65 BY CONKRELL
DESCRIPTION STRUCTURAL ANALYSIS OF VESSEL AND BOTTOM HEAD JUNCTURE	CHECK DATE 10-29-65 BY FRESHOW
AND BOTTOM HEAD JUNCTURE	

5- DETAILED ANALYSIS: <u>b- SYSTEM LOADS:</u>

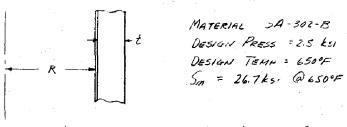
THE VESSEL SHELL HAN BOTTOM HEAD SHOWN ON THE PREVIOUS SHEET ARE INVESTIGATED FOR INTERNAL PRESSURE OF 2.5 KSI (DESIGN PRESSURE) AT DESIGN TEMPERATURE OF 650°F

C- SYSTEM ALLOWABLES:

THE FOLLOWING ALLOWABLE STRESSES ARE BASED ON THE A.S.M.E. SECTION III NUCLEAR LODE, REFERENCE 1 AND ARE RELEVANT FOR THIS ANALYSIS. 1- THE AVERAGE PRIMARY STRESS INTENSITY AUGUSS A SOLID SECTION SHALL NOT EXCEED Son AT 6527F. 2- THE LOCAL PRIMARY STRESS COMBINED WITH 1. ABOVE SHALL NOT EXCEED 1.5 Son AT 650 % 3- THE RANGE OF PRIMARY RUS SECONDARY STRESS RESULTING FRAM MECHANICAL DE THERMAL LOADS SHALL NOT EXCEED 35m AT HETHLE METHL TEMPERATURE.

d. Design SizING:

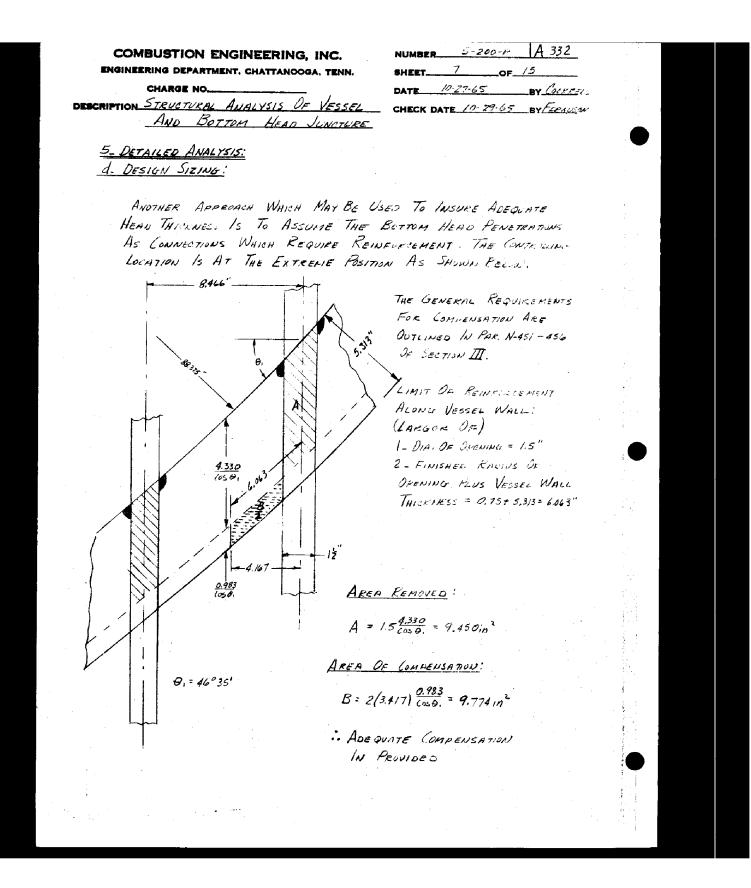
CONSIDER THE SIZING OF THE VESSEL WALL:

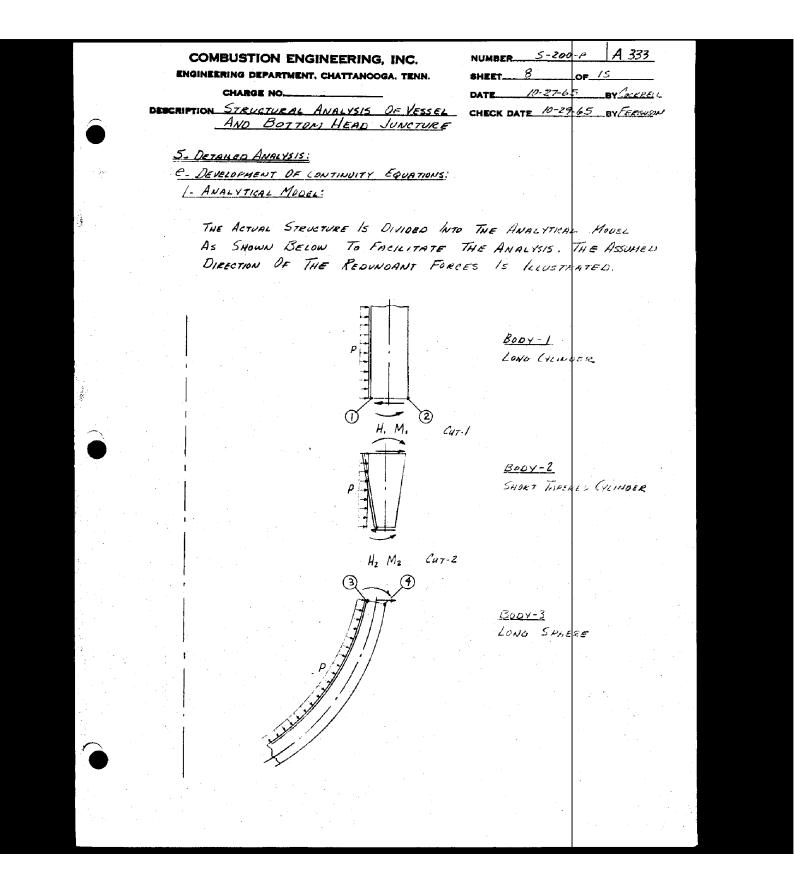


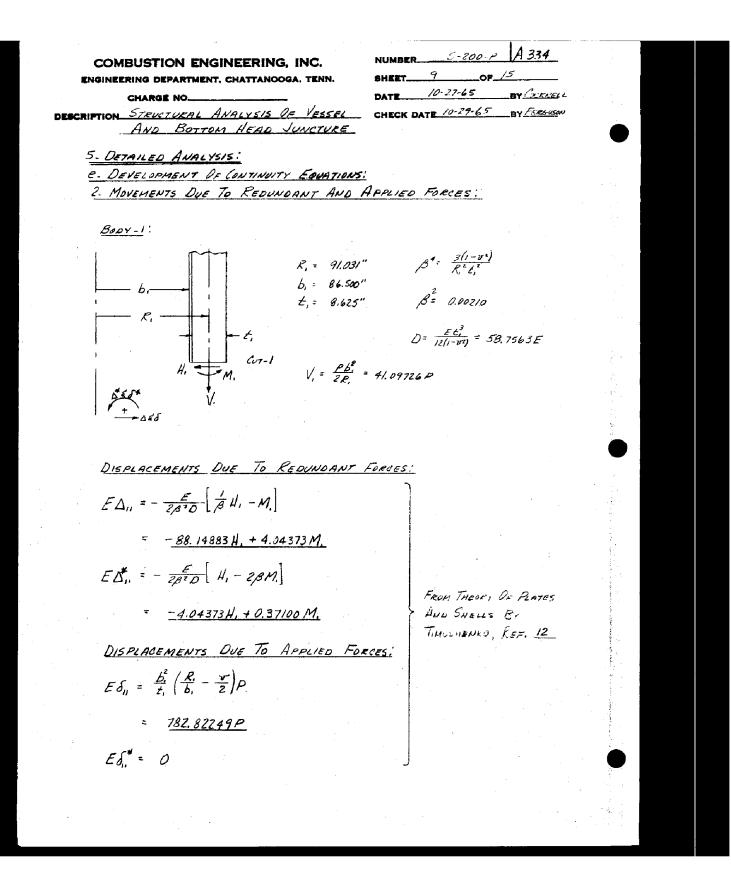
FROM N-431 OF SECTION IT NUCLEAR CODE

 $t = \frac{PR}{5_m - 0.5P} = \frac{2.5(36.5)}{26.7 - 1.25} = 3.497" \qquad \therefore THE 8.625" THICK PARTS is ACE OTHER THE STATES IS$

NUMBER 5-200-A A 331 COMBUSTION ENGINEERING, INC. OF_15 ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. SHEET 6 DATE 10-27-65 BY COCKRELL CHARGE NO. DESCRIPTION STRUCTURAL ANALYSIS OF VESSEL CHECK DATE 10-29 65 BY FERLUSON AND BOTTOM HEAD JUNCTURE 5- DETAILED ANALYSIS: d- DESIGN SIZING: CONSIDER THE BOTTOM HEAD; 88. 15₆ , 5.313 RFORATED AREA 66. 869 MATERIAL SA-302-B DESIGN PRESS. 2.5 KSI DESIGN TELLP. 650°F CONSIDER THE REQUIRED THICKNESS IN THE UN-PERFORMTED AREA: REFERENCE PARAGRAPH N-431, SECTION III NUCLEAR CODE, WHERE trea's = PR = 2.5(11.156) 2/26.17-2.5 TRADO = SHELL THREAPESS (EXCLUDING (LAD) P = DESIGN PRESSURE = 4.330" (USE 5 To MIN TO R = INSIDE PROIDS DE HEAD ALLOW FOR PENETRATIONS) Sm = ALLOWABLE STRESS AT 650°F CONSIDER THE REQUIRED THICKNESS IN THE PERFURATED AREA: THE REQUIRED THICKNESS MAY BE CONSERVATIVELY ESTIMATED BY ASSUMING THE LIGAMENT EFFICIENCY To BE (L.E. = 6.406 = 0.823). THIS /NSURES SATISFACTION OF THE PRIMARY STRESS , Sm , REQUIREMENT IN THE PERFORATED REGION L.E. = 0.823 $\frac{t}{PREQ^{2}O[PERFORMATED]} = \frac{t}{L.E.} = \frac{4.330}{0.823} = 5.261'' \angle 5.313'' \qquad :. CRITERIOLI 5.C.1$ $\frac{D_{RIMARY[OBRIZATED]}}{\frac{1}{2}E[L.E.]} = \frac{PR}{2E[L.E.]} + \frac{r}{2} = 26.5 \text{ KSI } < S_{RI} = 26.7 \text{ KSI} \ IS SATISFIED$







	COMBUSTION ENGINEERING, INC.	NUMBER 5-200-1	-2- A 335	
	Engineering department. Chattanooga, tenn.	BHEET /0	-0F <u>/5</u>	
	CHARGE NO. CHARGE NO. DERCHIPTION STRUCTURE VESSEL	DATE // 27-65 CHECK DATE //-29-65	5 BY CARRELL 65 BY FERENSAN	
	5. DETAILED ANALYSIS: C. DEVELOPMENT DE CONTINUITY ÉQUATIONS: 2. MOVEMENTS DUE TO REDUNDANT AND A	1005: 440 Appeleo Toures:		· · · · · · · · · · · · · · · · · · ·
	Booy- 2 :			
an a	R. R.	89,984 " V = 1 86,500 " V2 = 1	V = 41.09726P V = 41.88383P	
	to the total to the total tota	5.313" Hp = 8.625" = 17623"	Hp = V'c 1050 = 3.23624P	
			λ= <u>/</u> ({t ₂ - t ₄)= 0,19463	-
	N1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		24= 7+2+ = 003748	
	THE INFLUENCE COEFFICIENTS FOR A SHOET TAPERED (YLINDER ARE CALCULATED BY THE METHID UNLINED ON PAGES 498 TO 492 0	A SHORT TAPERED (YLIND) OUTLINED ON PAGES 498	7 ER 4RE 70 492 05	
		ON C.E. COMPU	TER PROGRAM	
	DISPLACEMENTS DUE TO REDUNDANT FORMES!			
	$E\Delta_{21} = -\phi_{32} H_1 \frac{E_3}{R_2} + \phi_{31} H_1 \frac{E_4}{R_3} - \phi_{31} H_2 \frac{E_6}{R_2} + \phi_{32} M_2 \frac{E_6}{R_1}$ $= 240.74307 H_1 + 21.75745 M_1 + 132.07532 H_2 - 20.68908 M_3$	+ 432 M2 R. : H2 - 20. 6 8908 M	- ni	1
	Ele = des H, E de M. E. + de H. E dez M. E. = - 21.79896 H, -2.79456 M, - 24.31443 H, + 2.52823 M.	- 4.2 M2 Re 12 + 2.52863 M2		
	ED22 = -\$\phi_13 H_1 \frac{R_2}{R_2} + \$\phi_14 M_1 \frac{R_2}{R_2} - \$\phi_11 H_2 \frac{R_2}{R_1} + \$\phi_1_2 M_1 \frac{R_2}{R_1}\$ = -134.67524 H_1 - 24.74584 M_1 - 300. 85321 H_2 + 25.38380 M_2\$	+ 412 M2 Eo 142 + 25.38380M2		
(●	$E\Delta_{x1}^{*} = \phi_{23} H_{1} \frac{R_{1}}{R_{2}} - \phi_{24} M_{1} \frac{R_{2}}{R_{2}} + \phi_{21} H_{2} \frac{R_{0}}{R_{2}} - \phi_{21} M_{1} \frac{R_{1}}{R_{1}}$ $= -21.14812 H_{1} - 2.57940 M_{1} - 25.44608 H_{2} + 2.94507 M_{1}$	- 421 Mr 20 42 + 2. 94507 Mz		

11. SHEET // DATE DATE DATE p_{1} (EL CHECK DATE p_{2} (EL FORCES : $-\phi_{34} V, C, \frac{E_{1}}{E_{2}} + \phi_{32} V_{2}$ $+\phi_{14} V, C, \frac{E_{1}}{E_{2}} - \phi_{31} V_{2} C$	COMBLISTION ENGINEEDING INC		NUMRER S.	5-200-P A 336	2	
$\begin{array}{l} \hline \begin{array}{l} \hline 5. & Armites Armi$		201. TENN. 	SHEET /// DATE ////27 CHECK DATE ////	-65 BY (24 -65 BY (24	7737	
$\begin{aligned} \hline \mathcal{L}_{0,0} = c_{1}\left(\frac{d_{1}}{d_{1}} - \frac{d_{1}}{d_{1}}\left(\mathbf{h}_{1} + \mathbf{h}_{1}\right)\frac{d_{1}}{d_{1}}\frac{d_{2}}{d_{1}}\right) + \frac{d_{1}}{d_{1}}\left[\mathbf{h}_{1} - \frac{d_{1}}{d_{1}}\left(\mathbf{h}_{1} + \mathbf{h}_{1}\right)\frac{d_{1}}{d_{1}}\frac{d_{2}}{d_{1}}\right) + \frac{d_{1}}{d_{1}}\left[\mathbf{h}_{1} - \frac{d_{1}}{d_{1}}\left(\mathbf{h}_{1} + \frac{d_{1}}{d_{1}}\right)\frac{d_{1}}{d_{1}}\frac{d_{2}}{d_{1}}\right] \\ = \frac{d_{1}\left[\frac{d_{1}}{d_{1}} - \frac{d_{1}\left[\frac{d_{1}}{d_{1}} - \frac{d_{1}\left[\frac{d_{1}}{d_{1}}\right]}{d_{1}}\right] - \frac{d_{1}}{d_{1}}\left[\mathbf{h}_{1} + \frac{d_{1}\left[\frac{d_{1}}{d_{1}}\right]}{d_{1}}\right] \\ = \frac{d_{1}\left[\frac{d_{1}}{d_{1}} - \frac{d_{1}\left[\frac{d_{1}}{d_{1}}\right]}{d_{1}}\frac{d_{1}\left[\frac{d_{1}}{d_{1}}\right]} - \frac{d_{1}\left[\frac{d_{1}}{d_{1}} + \frac{d_{1}\left[\frac{d_{1}}{d_{1}}\right]}{d_{1}}\frac{d_{1}\left[\frac{d_{1}}{d_{1}}\right]} \\ = \frac{d_{1}\left[\frac{d_{1}}{d_{1}} - \frac{d_{1}\left[\frac{d_{1}}{d_{1}}\right]}{d_{1}}\frac{d_{1}\left[\frac{d_{1}}{d_{1}}\right]} - \frac{d_{1}\left[\frac{d_{1}}{d_{1}}\frac{d_{1}}{d_{1}}\right]}{d_{1}\left[\frac{d_{1}}{d_{1}}\right]} \\ = \frac{d_{1}\left[\frac{d_{1}}{d_{1}} - \frac{d_{1}\left[\frac{d_{1}}{d_{1}}\frac{d_{1}}{d_{1}}\right]}{d_{1}\left[\frac{d_{1}}{d_{1}}\right]} - \frac{d_{1}\left[\frac{d_{1}}{d_{1}}d_{1$	 5. DETAILED AMALYSIS: C. DEVELOPMENT DE CONTINUTY E 2. MOVEMENTS DUE TO REDUM	EQUATIONS: VO ANT AND H	אסטובים לסבכבי.			
Dispensioneners Que To Americo Faces: $\begin{aligned} \mathcal{E}_{4b} = a_{1}^{2} \left(\frac{2}{6}_{0}^{2} - \frac{2}{7} \left[\left(h_{11} + h_{11} \right) \frac{1}{61^{2} - h_{11}} + \frac{1}{6} \right] e - \frac{1}{6} a_{11} \left(\frac{2}{6} + \frac{2}{6} \right) \left(h_{11} + h_{11} \right) \frac{1}{61^{2} - h_{11}} + \frac{1}{6} \right) e - \frac{1}{6} a_{11} \left(\frac{2}{6} + \frac{2}{6} \right) \left(h_{11} + h_{11} \right) \frac{1}{61^{2} - h_{11}} + \frac{2}{6} \right) e - \frac{1}{6} a_{11} \left(\frac{2}{6} + \frac{2}{6} \right) \left(h_{11} + h_{11} \right) \frac{1}{61^{2} - h_{11}} + \frac{2}{6} \right) e - \frac{1}{6} a_{11} \left(\frac{2}{6} + \frac{2}{6} \right) \left(h_{11} + h_{11} \right) \frac{1}{61^{2} - h_{11}} + \frac{2}{6} \right) e - \frac{1}{6} a_{11} \left(\frac{2}{6} + \frac{2}{6} + \frac{1}{6} a_{11} + \frac{2}{6} \right) e - \frac{1}{6} a_{11} \left(\frac{2}{6} + \frac{2}{6} + \frac{1}{6} a_{11} + \frac{2}{6} \right) e - \frac{1}{6} a_{11} \left(\frac{2}{6} + \frac{2}{6} + \frac{1}{6} a_{11} + \frac{2}{6} \right) e - \frac{1}{6} a_{11} \left(\frac{2}{6} + \frac{2}{6} + \frac{1}{6} a_{11} + \frac{2}{6} \right) e - \frac{1}{6} a_{11} \left(\frac{2}{6} + \frac{2}{6} + \frac{1}{6} a_{11} + \frac{2}{6} \right) e - \frac{1}{6} a_{11} \left(\frac{2}{6} + \frac{2}{6} + \frac{1}{6} a_{11} + \frac{2}{6} \right) e - \frac{1}{6} a_{11} \left(\frac{2}{6} + \frac{2}{6} + \frac{1}{6} a_{11} + \frac{2}{6} \right) e - \frac{1}{6} \left(\frac{2}{6} - \frac{2}{6} - \frac{1}{6} a_{11} + \frac{1}{6} \right) e - \frac{1}{6} \left(\frac{2}{6} - \frac{2}{6} + \frac{1}{6} a_{11} + \frac{1}{6} \right) e - \frac{1}{6} \left(\frac{2}{6} - \frac{2}{6} + \frac{1}{6} a_{11} + \frac{1}{6} \right) e - \frac{1}{6} \left(\frac{2}{6} - \frac{1}{6} a_{11} + \frac{1}{6} \right) e - \frac{1}{6} \left(\frac{2}{6} - \frac{1}{6} a_{11} + \frac{1}{6} \right) e - \frac{1}{6} \left(\frac{2}{6} - \frac{1}{6} a_{11} + \frac{1}{6} \right) e - \frac{1}{6} \left(\frac{2}{6} - \frac{1}{6} a_{11} + \frac{1}{6} \right) e - \frac{1}{6} \left(\frac{2}{6} - \frac{1}{6} - \frac{1}{6} a_{11} + \frac{1}{6} \right) e - \frac{1}{6} \left(\frac{1}{6} - \frac{1}{6} + \frac{1}{6} a_{11} + \frac{1}{6} \right) e - \frac{1}{6} \left(\frac{1}{6} - \frac{1}{6} + \frac{1}{6} a_{11} + \frac{1}{6} \right) e - \frac{1}{6} \left(\frac{1}{6} - \frac{1}{6} + \frac{1}{6} a_{11} + \frac{1}{6} \right) e - \frac{1}{6} \left(\frac{1}{6} - \frac{1}{6} + \frac{1}{6} + \frac{1}{6} \right) e - \frac{1}{6} \left(\frac{1}{6} - \frac{1}{6} + \frac{1}{6} + \frac{1}{6} \right) e - \frac{1}{6} \left(\frac{1}{6} - \frac{1}{6} + \frac{1}{6} \right) e - \frac{1}{6} \left(\frac{1}{6} - \frac{1}{6} + \frac{1}{6} \right) e - \frac{1}{6} \left(\frac{1}{6} - \frac{1}{6} + \frac{1}{6} \right) e - \frac{1}{6} \left(\frac{1}{6} - \frac{1}{6} + \frac{1}{6} \right) e - \frac{1}{6} \left(\frac{1}{6} - \frac{1}{6} + \frac{1}{6} \right) e - 1$	800× -2		·			
$\begin{split} \mathcal{E}_{k_{1}} &= \alpha_{1}^{2} \left[\left\{ \frac{1}{k_{1}} - \frac{1}{2} \right\} \left\{ h_{1} + \varphi_{1} \right\} \left[\frac{1}{2^{2}} - y_{1} + \frac{1}{2} \right] P - \varphi_{1} \sqrt{e} \left\{ \frac{1}{k_{1}} + \varphi_{1} \right\} \left \frac{1}{k_{2}} - \frac{1}{2} \right\} \\ &= \frac{2261 - 24 (k_{1}^{2} - \frac{1}{2} \left\{ h_{1} + \varphi_{1} \right\} \left[\frac{1}{2^{2}} \right] P + \frac{1}{2} + \frac{1}{2} \right] P + \frac{1}{2} + \frac{1}{$	DIS PLACEMENTS DUE TO	APPLIED FOR	, 520			
$E d_{n}^{*} = -d_{n}^{*} \left[\frac{2}{4} - \frac{2}{4} \left[h_{n} + h_{n} \right] \left[\frac{1}{11 - \frac{3}{2}} \right] - \frac{3}{4} \right] P + h_{n} \left[k_{n}^{*} - h_{n} \right] \left[k_{n}^{*} + \frac{3}{4} \right] H_{n} + \frac{2}{k_{n}^{*}} \right] $ $= \frac{(k - 77102)}{4k_{n}^{*} + \frac{3}{4} \left[\left(h_{n} + h_{n} \right) \right] \left[\frac{1}{11 - \frac{3}{2}} \right] - \frac{3}{4} \left[\left(h_{n} + h_{n} \right) \left[\frac{1}{11 - \frac{3}{2}} \right] \right] + \frac{1}{4} \left[k_{n}^{*} + h_{n} \left[k_{n}^{*} + \frac{3}{4} \right] + \frac{1}{4} \left[k_{n}^{*} + \frac{3}{4} \left[k_{n}^{*} + \frac{3}{4} \right] + \frac{1}{4} \left[k_{n}^{*} + \frac{3}{4} \right] + \frac{1}{4} \left[k_{n}^{*} + \frac{3}{4} \left[k_{n}^{*} + \frac{3}{4} \right] + \frac{1}{4} \left[k_{n}^{*} + \frac{1}{4} \left[k_{n}^{*} + \frac{1}{4} \left[k_{n}^{*} + \frac{1}{4} \right] + \frac{1}{4} \left[k_{n}^{*} + \frac{1}{$	$\mathcal{E} J_{\mathbf{Z}_{1}} = \alpha_{\mathbf{z}}^{2} \left(\frac{\beta_{\mathbf{z}}}{\widehat{\alpha}_{\mathbf{z}}} - \frac{\nu}{-\widehat{z}} \right) \left[\phi_{\mathbf{z}_{1}} + \phi_{\mathbf{z}_{1}} \right] \frac{-\gamma_{\mathbf{z}}}{6(i-\nu^{2})}$	$+\frac{j}{\xi_{k}}\right]P-\phi_{34}V_{j}$	e, <u>E</u> , + \$32 V, e2	R2 - \$31 H0	Ŷ	· .
$\mathcal{E}_{a}^{a} = -a_{1}^{2} \left(\frac{e_{1}}{2} - \frac{2}{2} \int_{0}^{a_{1}} h_{a_{1}} h_{a_{1}} \left[\frac{1}{1^{1-2} m^{2}} \right] - \frac{1}{2^{2}} \int_{0}^{a_{1}} h_{a_{1}} h_{a_{1}} \left[\frac{1}{1^{2} m^{2}} \right] + \frac{1}{2^{2}} \int_{0}^{a_{1}} h_{a_{1}} h_{a_{1}} \left[\frac{1}{1^{2} m^{2}} \right] + \frac{1}{2^{2}} \int_{0}^{a_{1}} h_{a_{1}} h_{a_{1}} \left[\frac{1}{1^{2} m^{2}} \right] + \frac{1}{2^{2}} \int_{0}^{a_{1}} h_{a_{1}} h_{a_{1}} \left[\frac{1}{1^{2} m^{2}} \right] + \frac{1}{2^{2}} \int_{0}^{a_{1}} h_{a_{1}} h_{a_{1}} \left[\frac{1}{1^{2} m^{2}} \right] + \frac{1}{2^{2}} \int_{0}^{a_{1}} h_{a_{1}} h_{a_{1}} \left[\frac{1}{1^{2} m^{2}} \right] + \frac{1}{2^{2}} \int_{0}^{a_{1}} h_{a_{1}} h_{a_{1}} \left[\frac{1}{1^{2} m^{2}} \right] + \frac{1}{2^{2}} \int_{0}^{a_{1}} h_{a_{1}} h_{a_{1}} \left[\frac{1}{1^{2} m^{2}} \right] + \frac{1}{2^{2}} \int_{0}^{a_{1}} h_{a_{1}} h_{a_{1}} h_{a_{1}} \left[\frac{1}{1^{2} m^{2}} \right] + \frac{1}{2^{2}} \int_{0}^{a_{1}} h_{a_{1}} h_{a_{1}} h_{a_{1}} h_{a_{1}} \left[\frac{1}{1^{2} m^{2}} \right] + \frac{1}{2^{2}} \int_{0}^{a_{1}} h_{a_{1}} h_{a_$	= 320.56k3P					
$E_{0} = \frac{(k.37102)}{2[(n_{1}, k_{1})] \frac{1}{n_{1}^{2}} - \frac{1}{2}[(n_{1}, k_{1})] \frac{1}{n_{1}^{2}} - \frac{1}{2}](n_{1}, k_{1})] \frac{1}{n_{1}^{2}} - \frac{1}{2}[(n_{1}, k_{1})] \frac{1}{n_{1}^{2}} - \frac{1}{2}](n_{1}, k_{2})] \frac{1}{n_{1}^{2}} - \frac{1}{2}[(n_{1}, k_{2})] k_{2})] \frac{1}{n_{1}^{2}} - \frac{1}{n_{1}^{2}} \frac{1}{n_{1}^{2}}$	 $\mathcal{E} \delta_{z_1}^{*} = -\alpha_z^2 \left(\frac{R_z}{\alpha_z} - \frac{w}{2} \right) \left(\theta_{a_z} + \phi_{a_y} \right) \frac{-\lambda^2}{2(1-\nu^2)} $	- 21 P + 444 V	e. E du V2 er	Per + du Ho K	0° 014	
	= /6.37/POP					-
$EG''_{n} = -a_{1}^{2} \left[\left(h_{11} + h_{11} \right) \left(\frac{\lambda^{2}}{1 - \nu^{2}} \right) - \frac{\lambda}{1 - \nu^{2}} \right] P + \phi_{11} V_{12} - \frac{\lambda}{2 - \mu_{11}} V_{12} - \frac{\lambda}{2 - \mu_{12}} V_{12} - \frac{\lambda}{2$		+ + + + + + + + + + + + + + + + + + +	2. R2 + Mr. V2 C2 R	$\sum_{i=1}^{n} - \phi_{ii} H_{p} \frac{\mathcal{E}_{i}}{\mathcal{E}_{i}}$		
$Ed_{n}^{2} = -a_{1}^{2} \left[\vec{k}_{n} + \psi_{n} d_{n} \frac{1}{n^{2}} - \vec{k}_{n} + \phi_{n} \left(k_{n} - \vec{k}_{n} - \vec{k}_$						+ 2 2 4 - 2
	$\mathcal{E}\mathcal{J}_{22}^{\mathcal{A}} = -\alpha_{2}^{2} \left(\frac{R_{2}}{\tilde{\alpha}_{1}} - \frac{\nu}{2} \right) \left(\left(\psi_{12} + \psi_{14} \right) \frac{-\tilde{\lambda}^{2}}{6(1 - \nu^{2})} - \frac{1}{2} \right)$	$-\frac{\lambda}{\xi_{s}^{n}}P + \phi_{z\ell}V$	2 <u>k</u> - 41 1, e2 k	$\sum_{i}^{n} + \phi_{2i} H_{p} \frac{R}{R_{2}}$	A	2.0
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		NIMER 5-200-1	5-200-1 A 337
	CUMBOUTION ENGINEERING, INC. Engineering department, chattanooga, tenn.	12	/5
	CHARGE NO	10-27-6	BYCOLKEEL
	DEACRIFTION STAULTURAL ANALYSIS OF VESSEL AND BOTTOM HEAD JUNETURE	- CHECK DATE /0-29-65	
	5- Οςταμείο Αναιγςις: C- Οενειορμεντ Ος (οντικυιτγ Εдияπους: 2. Μονεμεντς Due To Requireant Aud Applied	ies Forces :	
	Bapr-3.		
		R3 = 91.031 23 = 89.156	
2 2	a,	42	
		V2 = ZR3 P = 42.69592 P B ⁴ = 3(1-V2) (E) ² B ⁴ = 5, 32066	
		$K_{1} = 1 - \frac{(1-2v)}{2R} dtn = 2 = 39261$ $k_{2} = 1 - \frac{(1+2v)}{2R} dtn = 2,397261$	192 192
	DISPLACEMENTS DUE TO REQUIRANT FORCES.		
	$\mathcal{E}\Delta_{3z} = \frac{2\beta^{2}sin\beta}{c_{3}} \left[\frac{\kappa_{3}sin\beta}{2\beta} \left(\frac{1}{\kappa_{1}} + \kappa_{2} \right) H_{z} + \frac{1}{\kappa_{1}} M_{1} \right]$		-
	= 173.59527 H2 + 10.53420 M2		
·	$\mathcal{E}\Delta_{32}^{\#} = -\frac{2\beta^{4}s_{5}n}{\epsilon_{5}} \partial \left[\frac{1}{K}, H_{2} + \frac{2\beta}{R_{5}m\partial} \left(\frac{1}{K} \right) M_{2} \right]$	FROM THEORY ON	From THEORY OF PLATES
	= -1053420H2 - 125498 M2	HND WIEKS	TIMOSHENKO, CEF. 12
	DISPLACEMENTS DUE To APPLIED FORCES	ELES	
	$\mathcal{E} \delta_{32} = \frac{(i-2r)a_{32}^2}{2t_3} e_{10} \theta = \frac{502.335590}{202.335590}$		
	E 032 = 0		

Composition Enfoncements, inc.		A 338
ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. SHEET	/30	
		BY COCKRELL
DESCRIPTION STRUCTURAL ANALYSIS OF VESSEL CHECK DATE	19-29-6	5 BY FERGUSON

5- DETAILED ANALYSIS:

e- DEVELOPMENT DE CONTINUITY EQUATIONS: 3. CONTINUITY MATRIX AND LOADING VECTORS:

ONLY A PRESSURE SOLUTION IS REQUIRED FOR THIS ANDLYSIS. THE REDUNDANT LOADS ARE DETERMINED BY REQUIRING RADIAL AND ROTATIONAL CONTINUITY. THE COLUMN VECTORS ARE WRITTEN IN TERMS OF P. THE MATRIX WILL BE ARRANGED AS FOLLOWS

$$\begin{split} E \Delta_{i_1} &= E \Delta_{2i} = E \delta_{2i} - E \delta_{i_1} \\ E \Delta_{i_1}^{\#} &= E \Delta_{2i}^{\#} = E \delta_{2i}^{\#} - E \delta_{i_1}^{\#} \\ E \Delta_{22} - E \Delta_{32}^{\#} = E \delta_{31}^{\#} - E \delta_{22}^{\#} \\ E \Delta_{22}^{\#} - E \Delta_{31}^{\#} = E \delta_{31}^{\#} - E \delta_{22}^{\#} \end{split}$$

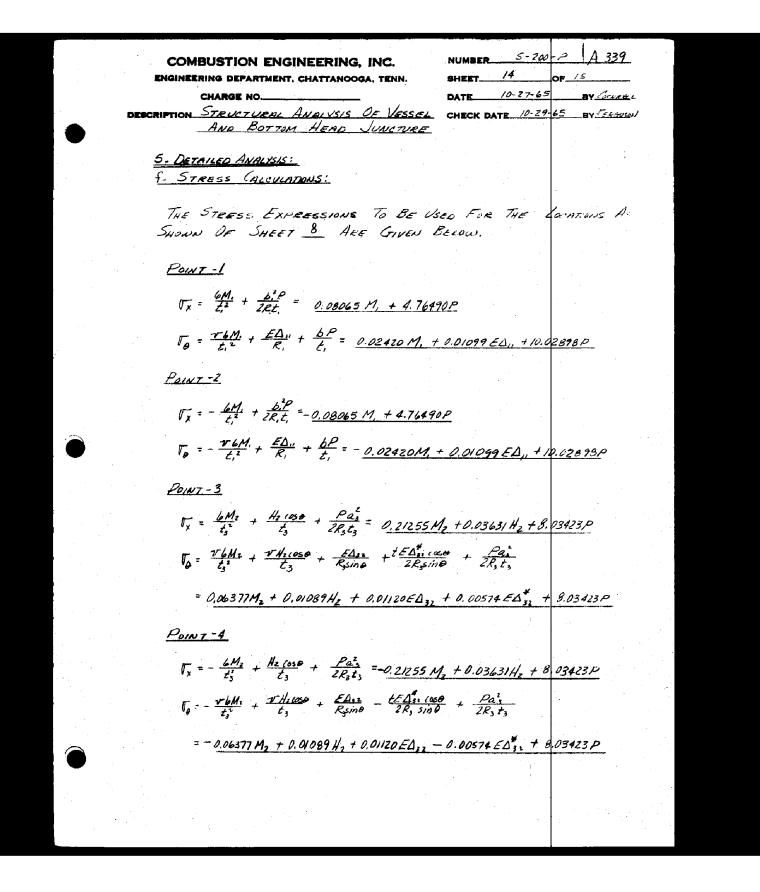
THE CONTINUITY REQUIREMENTS ARE EXPRESSED BELOW IN MARKY FORM.

-328.89140	-/7.7/372	-132.07532	20.63908	Γ <i>Η</i> ,		- 462.26086	
17. 755 2 3	3,16556	24,31413	-7.52823	M,		16.37180	
- 134. 67524	-24,74568	-474,44348	14.34960	H,	-	5.01416	
-21. 14812	-2.57940	-14.91138	4.20005	M,		- 9.56919	

INVERTING THE ABOVE MATRIX AND MULTIMITIME TIMES THE COLUMN VECTORS THELDS THE FOLLOWING RECOVANDS RESOLDED THE FROM PRESSURE, DESIGN PRESSURE IS 2.5 K21.

4 REDUNDANT LOAD VALUES:

H, = 1.85888P M, = 6.44620 P H₂ = -0.59500 P M₂ = 8.92778 P



NUMBER 5-200-P A 340 COMBUSTION ENGINEERING, INC. ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. 15 ... OF 15 SHEET__ 0-27-65 BY COURFELL CHARGE NO. DATE DESCRIPTION STRUCTURAL ANALYSIS OF VESSEL CHECK DATE 10-29-65 BY FERGUSON AND BOTTOM HEAD JUNCTURE 5- DETAILED ANALYSIS: F- STRESSES: 5x + 16H STRESS INTENSITY <u>PR</u> 2t. <u>-V(m0)</u> L <u>EA</u> R +<u>t</u>tt 7R + 61/7 (<u>050 H</u> Bw7 ΕÅ Sr. EΔ 0p 5x-00 5x-5. Do-Dr 1.30 15,7 1 11.91 13.21 0.39 21.67 -25 -85 24.2 344 48 -3.79 25.07 2 -/.30 11.91 10.61 -0.39 -344.48 -3.79 25.07 20.89 0 -10.3 10.6 20.9 3 4.74 -0.05 20.09 24.78 1.42 -0.02 -23.105 -0.26 -12.341 -0.07 20.09 21.16 3,6 27.3 -25 23.7 4 4.74 -0.05 20.09 15.30 -1.42 -0.02 -23.105 -0.26 -12.341 0.07 20.09 18.46 18.5 0 -3.2 15.3 THE VALUES OF THE H'S & M'S ARE TAKEN FROM SHEET 13. THE MOVEMENT EQUATIONS ARE GIVEN ON SHEETS 9512. CRITERION 5-C-1 PRIMARY GENERAL MEMBRANE: S.I. MEX = Do - Dr = PR + P2 = 23.9KSI < Sm = 26.7KSI FOR LOCATIONS 122 CRITERION 5-C-2 LOCAL MEMERANE STRESS: FOR CUT 1: 00 = EA = -3.8 KS/ OR COMBINED WITH CTENERAL MEMORANE, SJ.MAX = E + E + Z = 20,1 KS1 41.55m = 40 KS1 FOR LOCATIONS1 \$2 <u>FOR CUT 2'</u> $\overline{D_{0}} = \frac{\pi \log \theta H}{H} + \frac{EA}{R} = -0.3 \text{ KSI}$ OR COMBINED WITH CTENERAL MEMBRANE 5. Junx = 2+ + VOID + EA + P = 21.1 KS1 < 1.55m = 4.0K31 FOR LOLATIONS 344 CRITERION 5-C-3 RANGE OF STRESS INTENSITY: 5. I. inax = Ox - OF = 64 + 1056H + PR + P= 24.6 KSI < 35 = 30 KSI FOR LOCATION 3

CHARGE NO DATE 9-8-66 BY ALEXANDER DESCRIPTION <u>FATIGUE EVALUATION</u> OF CHECK DATE 9-8-66 BY CAUDLE <u>BOTTOM HEAD - TO - VESSEL</u> JUNCTURE <u>5. DETAILED ANALYSIS</u> <u>a) SYSTEM GEOMETRY</u> <u>86.719"R</u>	COMBUSTION ENGINEERING, INC.		R <u> </u>		2 <u>A 34</u> [16	***
DECRIPTION FAITIGLE EVENTION OF CHECK DATE 9.8 40 BY CAUDIE BOTTOM NEAD -TO - VESSEL JUNCTURE 3. DETAILED AMALYSIS a) SISTEM GEOMETRY BE 719 ⁴ /2 BE 719 ⁴ /2	ENGINEERING DEPARTMENT, CHATTANOOGA, TENN.	SHEET.				-
BOTTOM HEAD - TO - VESSEL AMAGNIK S. DETAILLED ANALYSIS a) SISTEM GEOMETRY BE 719 "R BE 719 "R BE 719 "R BE 719 "R BE 719 "R BE 719 "R BE 719 "R			,			
S. DETAILED AMAXISS a) SYSTEM GEOMETRY b) SYSTEM GEOMETRY b) SYSTEM LOADS THE BOITOM HEAD TO SHELL JUNCTURE WILL BE MINLYZED UNDER THE TRANSIENT CONDITIONS AS GIVEN N REFERENCE 9. c) SYSTEM ALLOWAGES 1. THE RANGE OF DEMMARY RUSS SECONDARY STRESS RESULTING FROM MECHANICAL OR THERMAL LOADS SHALL NOT EXCEED 35, AT ACTUAL METAL TEMPERTURE AND OPERATING PRESSURE. 2. SHOW THAT EACH POINT MEETS THE REQUIREMENTS FOR PEAK STRESS INTENSITIES GIVEN IN M-414,5 OF THE AS M.E. CODE, SECTION III. THE PROCEDURE WILL BE			UATE		BY <i>SV</i>	
a) STSTEM GEOMETRY BATTO "R BATTO	DUITON HEAD TO RESSEL CONC.					
BETTOM HEAD TO SHELL JUNCTURE WILL BE PURKTZED UNDER THE TRANSIENT CONDITIONS AS GIVEN IN REFERENCE 9. C) SYSTEM LOADS 1. THE RANGE OF PRIMARY RUS SECONDARY STRESS RESULTING FROM MECHANICAL OR THERMALL LOADS SHALL NOT EXCEED 3.5., AT ACTUAL METAL TEMPERATURE AND OPERATING PRESSURE. 2. SHOW THAT EACH POINT MEETS THE REQUIREMENTS FOR PEAK STRESS INTENSITIES GIVEN IN A 414.5 CT THE A.S.M.E. CODE, SECTION III. THE PROCEDURE WILL GE	5. DETAILED ANALYSIS					
 b) SYSTEM LOADS b) SYSTEM LOADS THE BOTTOM HEAD TO SHELL JUNCTURE WILL BE ANALYZED UNDER THE TRANSIENT CONDITIONS AS GIVEN IN REFERENCE 9. c) SYSTEM ALLOWARLES 1. THE RANGE OF PRIMARY RUS SECONDARY STRESS RESULTING FROM MECHANICAL OR THERMAL LOADS SHALL NOT EXCED 3.5., AT ACTUAL METAL TEMPERATURE AND OPERATING PRESSURE. 2. SHOW THAT EACH POINT MEETS THE REQUIREMENTS FOR PEAK STRESS INTENSITIES GIVEN IN A 414,5 OF THE A.S.M.E. CODE, SECTION III. THE PROCEDURE WILL BE 	a) SYSTEM GEOMETRY			. .+.		
b) SYSTEM 10405 THE BOTTOM HEAD TO SHELL JUNCTURE WILL BE ANALYZED UNDER THE TRANSIENT CONDITIONS AS GIVEN REFERENCE 9, c) SYSTEM ALLOWAGLES 1. THE RANGE OF PRIMARY PLUS SECONDARY STRESS RESULTING FROM MECHANICAL OR THERMAL LOADS SHALL NOT EXCEED 35, AT ACTUAL METAL TEMPERATURE AND OPERTING PRESSURE. 2. SHOW THAT EACH POINT MEETS THE REQUIREMENTS FOR PEAK STRESS INTENSITIES GIVEN IN A-414,5 BT THE ASME. CODE, SECTION III. THE PROCEDURE WILL BE	$\pi - \gamma - \gamma$					
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NUMBER 5-203-0 A 342 COMBUSTION ENGINEERING, INC. SHEET 5 OF 16 ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. DATE 9-8-66 BY ALEXANDER CHARGE NO ... DESCRIPTION FATIGUE EVALUATION OF BOTTOM CHECK DATE 9-8-66 BY CAUDLE HEAD-TO-VESSEL JUNCTURE 5. DETAILED ANALYSIS d.) UNCONCENTRATED STRESSES INTERACTION ANALYSIS WAS MADE FOR THE BOTTOM AN HEAD TO SHELL AND REPORTED IN ANALYSIS NO. 5-200-P. THE FOLLOWING EXPRESSIONS FOR STRESS DUE TO PRESSURE WERE TAKEN FROM THAT ANALYSIS. TO THESE EXPRESSIONS HAS BEEN ADDED A TERM FOR THE THERMAL STRESSES WHICH WILL BE CONSERVATIVELY TREATED AS SKIN STRESSES. LOCATION 1 $V_{X} = \frac{6M_{1}}{t^{2}} + \frac{6}{2R_{1}}^{2P} + \frac{E\alpha(T_{m}-T)}{(1-\nu)} = 0.08065 M_{1} + 4.76490P + 0.30571(T_{m}-T)$ $\nabla_{\theta} = \frac{V_{0M_{i}}}{L^{2}} + \frac{EA_{i}}{R_{i}} + \frac{b_{i}P}{t} + \frac{E\alpha(T_{m}-T)}{(1-v)} = 0.02420 \text{ M}, +0.01099Eb_{ii} + 10.02898P + 0.30571(T_{m}-T)$ LOCATION 2 $\nabla_{\mathbf{x}} = -\frac{6M_{1}}{t^{2}} + \frac{6^{2}P}{2R.t} + \frac{E\alpha(T_{m}-T)}{(1-\nu)} = -0.08065M_{1} + 4.76490P + 0.30571(T_{m}-T)$ $T_{\theta} = -\frac{\sqrt{b}(m_{i} + \frac{E\Delta_{i}}{L} + \frac{b_{i}P}{L} + \frac{E\alpha(T_{m}-T)}{(I-\nu)} = -0.02420M, \pm 0.01099E\Delta_{i} + 10.02898P \pm 0.30511(T_{m}-T)$ LOCATION 3 $\nabla_{\mathbf{X}} = \frac{6M_{e}}{t_{2}^{2}} + \frac{H_{2}(36\theta}{t_{2}} + \frac{Pa_{3}^{2}}{2R_{3}t_{3}} + \frac{E\alpha(T_{m}-T)}{(I-v)} = 0.21255M_{2} + 0.03631H_{2} + 8.03423P + 0.30571(T_{m}-T)$ $\sigma_{\theta} = \frac{v l_{\theta} M_{\theta}}{t_{3}^{2}} + \frac{v H_{g} c_{0s\theta}}{t_{3}} + \frac{E \Delta_{g2}}{R_{3}} + \frac{t_{4} E \Delta_{g2}^{*} c_{0s\theta}}{2 R_{3} S_{IN} \theta} + \frac{P a_{g}^{2}}{2 R_{s} t_{s}} + \frac{E \alpha (T_{M} - T)}{(I - V)}$ $= 0.06377 M_2 + 0.01089 H_2 + 0.01120 E \Delta_{32} + 0.00574 E \Delta_{32} + 0.03423P + 0.30571 (T_m-T)$ LOCATION 4 $\nabla_{\rm X} = -\frac{6M_Z}{t_1^2} + \frac{H_2 \cos\theta}{t_2} + \frac{P \alpha_{\rm Y}^2}{2R_z t_3} + \frac{Ed(T_m - T)}{(I - V)} = -0.21255M_g + 0.03631 \, H_2 + 8.03423 \, P + 0.30511(T_m - T)$ =-0.06377 M2+0.01089 H2+0.01120 ED32-0.00574 ED32+8.03423 P+0.30571(Tm-T)

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	1001		16:4:215	HEAT-UP	- 7001	10407 104	horno ALA	STEP	1777	57510	10%	FULL	127	STEP	FK01	1:02	REC.	FULL .	10001	121	260	SYER	1002	70	0	207	STIM					
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			_			_																5-20	12	0			-		
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						RGI										•••			ATE		9-8	3-6			_BY.	<u>_</u> ,	1.53	41.12	2.04
	DESC								E.:/ 70-						= VC				HE	скі	DATE	2-2	3-4	10	BY.		AU	PL	<u>e</u> .
											<u> ~~ </u>	<u> </u>	<u>_</u> _		V C	10						÷							
1. J. 1. 1	`	<u>5.</u>							YSI. Tel		577	25	SE	5								,							
•			50	M	MA	RY	0	<u>e</u>	57 R	£5.	<u>ses</u>	A	NP.	5	RE	23	1	TEL	V5 /	716	S AT	- 40	CA	714	DN	3	, 		
			9. 9.	21.3	15.8		18.9	23.7	23.6	22.1	161	17.3	19.8	31.5	18.8	17.7	204	18.1	207	29.6	23.7	1.42	18.6	17.0	24	15.1	6.8		
		. 1	0x-0-	24.6	161	60	222	27.0	26.7	25.4	22.5	20.6	2.9	34.8	0		23.5	21.3	234	~	0.20	10	21.7	0	0.5	22	67.8		
		STREESS	9 9	N	m	9	m	m		3.3		33				3.4					0.2 260 0.50	<u> </u>	+				0		
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		53	Ь- 	~	5-2.	2 -0.3	1			8-2.3		0 -23		2 - 23			2-22			10	2.4.0 2.4.0 2.2.0		┼─╀		17	4.1-	1-0.		
			۶ġ	190	13.	8.2				19.8		15.0	- 1	5 29.2			18.2	_	18.8		220		9	14.2	5	13.7	(0C)		
		1/1/01	R	22.3	/6.8	87	19.9	24.7	24.6	23.1	20.2	18.3	20.5	32.5	19.8		21.3		21.5	31.0	0.40 0.40 0.40	1:52	567	18.2	8.4	15.0	11/0		
		STRESS		-2,3	-2.3	-0.3	-2;3	-2.3	-2.1	-2.3	-2.3	2.3	-2.1	-2.3	-2.4	-2.4	-2.2	- 2.2	6.1-	-31	-00 200	-2:4	1.7-	69 90	1:2-	4.1-	-0.7		
		. 1	de de	19.0	0.61	2.7	19.0	19.0	181	(0.3	19.6	1.61	1.81	19.0	1.02	19.9	10.2	./8.8	16.2	26.5	20.00	19.9	1.01	23.4	17.9		5.9		
		PRESSUCE	Ъ	22.3	22.3	3.2	22.3	22.3	212	22.6	23.0	22.4	21.2	22.3	23.5	23.3	21.3				2.4 24.8 3.2	23.3	┿╋			43	6.9		
	· · L :	553	²	0	5.5	5.5	-2.4		3.4				0.4	10.2			0				5.5 1				-12.6	<i>is</i>	60.2		
	Г	ブ	ы Ц	0	100		- 7.8 -	-+	01				-+			0	0	-95-	-+				Ň.			4.8	0.191		
	-	92635. (Tm.	_	_	•		<u> </u>					-	÷							. 1	50 - 18 32 - 18 32 - 18				<u> </u>				
		30						in. 2.25	ec. 2.1		ec. 2.32	_		_	7. 2.37			20. 2.22		- 1	7. 1.25 	2:35	11		-	1.12	e. 0.10		
	1111		TEANS.		4.4760	4.471hrs.	20 min.			225 Sec.	40 Sec.	100 Sec.	Eled Sec.		2 min.	3.2 min.	104 min		60 500	220 min.	, HEAT 5.5 Cool	<u>ک</u>	***	10 5:0	25.52	160500	56.00		
		TRANSIENT		STEADY STATE	HEAT-UP	11M00-7007	LORDING	PLANT	2124 CARD	ULL POWER	STEP LORD DECREASE	10% OF	EUL POWER	FLOW	STEP LOAD REDUCTION	1001 100%	FULL POWER	REACTOR TRIP FRENT	FULL FORCE	レレルレ はいよう	PLANT HINN HEAT. 21.00 21.00 P.V.4 COOL	Steller Stell		1055	6	COND	STUARI Propri		
	L			2	<u> </u>	1	1	<u>)</u>	.,	<u> </u>	-,		<u> </u>	<u>_</u>	~~~~	<u>u K</u>	<u>«</u>]	11	<u>×</u> ľ	<u> </u>		<u>ડ ર</u>	<u></u>	÷			<u>``</u>		
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1117-11511	いち	16.6	19.0	0	16.6	16.6	15.8	16.8	121	16.7	15.8	16.6	17.5	17.4	15.9	16.4	14.	23.	185	0/14	18.	20.4	15.7	10.6	52	1			• • •		
	Q-9-	13.8	16.2	-0.4	13.8	13.8	13.1	13.9	14.2	13.8	13.1	13.8	145	144	13.1	13.6	11.7	16/	10.0	14:4	13.1	16.9	13.0	88	43						
STRESS	12-20 12-20	-2.8	-2.8	-0.4	-2.8	-2.8	-2.7	-2.9	-2.9	-2.9	12-	-2.8	-3.0	-3.0	-2.8	-2.8	-2.4	-4.0	-1.6	-3.0	-2.8	-3.5	-2.7	8.1-	-0.9						
SES	5	0					<u>.</u>				_									1				\neg	-				•		
STRESSES	2	16.6	19.0	0	6.6	16.6	15.8	/b.8	121	1te.7	15.8	10.6	17.5	17.4	15.9	16.4	14.1	23.1	11.6	17.4	15.9	20:4	15.7	0.0	5,2						
1074L	৬	13.8	10.2	0.4	13.8 1	13.8		13:9	14.2	13.8	13.1	13.8	14.5	14.4	13.1	13.6	14.7		10:0	·					43	• [: 1		
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STRESS	6											-				-			10		_			_							
÷.	Ъ	10.6	16.6	2.4	10.6	16.0	15.8	16.8	1:21		15.8	16.6		_	15.9	+.0%.	/4/	_	10.5	1	15.9	20.4	15.7		52	÷					
PRESSURE	Ŗ	13.8	13.8	2.0	13.8	13.8	13.1	13.9	14.2	13.8	13.1	13.8	14.5	14.4	13.1	13.6	11.7	19.1	76	14,4	13.1	16.9	13.0	0.0	43						
THERME		0	2.4	-2.4	6													-	4.0%	+; 7 -					-						
(Z 7)	1. 1.	0	<i>8</i> 0	0	0						_						_	-	a) 0'a	0											
2522°		2.25	2.25	0.32	2.25	2.25	2.14	2.28	ee. 2.32	2.20	2.14	2.25	2.37	2.35	2.15	2.22	1.91	3.13	1.25 2. 5 0	2.35	2.15	2.76	2.12	1.40	0.70			÷			
7111E	DING DOC	2	4.47hr	4.47 H.C.	20 min.	20 min.		225 sec.	4) Sec.	100 Sec.	~	12 500.	2 min.	3.2 min.	104 min.	sec.	65 522.	20 min.	HE47. 5.5.	, (cr.	2		25.500	160.Sec	54.500						
	1184,45151/17	STERN' STATE	HEAT-UP	11,400-2000	LOCUNG	PLENT UNCORDING	STZP LOAD	TUS OF OF	STEP LOND		FULL POWER	I					RALL FORGE	121.17 112:00	12/11/11/20	SI 1.00 STATE	SUDIENTIONS			10207	STERAL BROKK		•				
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		R4	WG	E	01	۴.	577	PE S	، ئ ن/مە	/N7	TEN	151	TY	C	200	UR			T 20 <u>ITER</u>						vD						

NUMBER 5-203-0 A 347 COMBUSTION ENGINEERING, INC. 10 OF 16 ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. SHEET____ BY ALEXANDER 9-8-66 CHARGE NO ... DATE CHECK DATE 9-8-66 BY CAUDLE DESCRIPTION_FATIGUE EVALUATION OF BOTTOM HEAD-TO-VESSEL JUNCTURE 5. DETAILED ANALYSIS <u>e.) PEAK STRESSES</u> IN ORDER TO DERFORM THE FATIGUE EVALUATION, PEAK STRESSES MUST BE KNOWN AT THE FOUR LOCATIONS AS SHOWN BELOW. THE STRESS EXPRESSIONS GIVEN ON SHEET 5 WILL BE MODIFIED TO ACCOUNT FOR STRESS CONCENTRATIONS, WITH THE PEAK STRESSES, A FATTGUE EVALUATION WILL BE MADE BY THE CUMULATIVE METHOD WHEREIN SUPERPOSITION OF ALL CYCLES IS TAKEN INTO CONSIDERATION . 27-17.18 + 1 BY INSPECTION, WE SEE THAT THE STRESS CONCENTRATION FACTOR AT LOCATIONS 1. 3.280" 2 AND 4 EQUALS 1.0. AT LOCATION 3. STRESS CONCENTRATION FACTORS FOR BENDING AND TENSION WILL BE DETER-1.1250 MINED BY THE METHOD PRESENTED IN REFERENCE 6. h~ 17.0 5IN 11.125°= 3.280" r:2 T= 8.593" E = 0.376 t= 5,313" = 0.610 Fo⁼ 0.876 B=78.875° FROM FIGURE A.T-1 OF REF. 6: Ky=2.0 , Kg=1.65 FROM FIGURE A.T-2 OF REF. 6; $K'_{T} = 1 + 0.31 (K_{T} - 1) = 1 + 0.31 (2 - 1) = 1.31$ = 0.31 K' = 1+0.31 (K8-1) = 1+0.31 (1.65-1)= 1.20 EXPRESSIONS FOR LOCATION 3 $\sigma_{x} = \frac{bM_{s}}{t_{3}^{2}} \kappa_{s}^{\prime} + \frac{H_{2} \cos \theta}{t_{3}} \kappa_{r}^{\prime} + \frac{Pa_{s}^{2}}{2R_{s} t_{3}} \kappa_{r}^{\prime} + \frac{E\alpha(T_{m}-T)}{(I-\nu)} \kappa_{r}^{\prime} = \frac{12.77366}{P+0.40048(T_{m}-T)}$ $\overline{V_{\theta}} = \frac{1/6M_{t}}{t_{3}^{2}}K_{\theta}^{\prime} + \frac{1/4_{2}C_{0S}\theta}{t_{3}} + \frac{EA_{st}}{R_{3}} + \frac{L_{3}EA_{s2}}{2R_{3}}C_{0S}\theta}{2R_{3}} + \frac{Ba_{3}^{2}}{2R_{3}t_{3}} + \frac{E\alpha(T_{h}-T)}{(1-2)} = \frac{0.57704F}{0.57704F} + \frac{0.30571(T_{h}-T)}{(T_{h}-T)} = \frac{0.57704F}{0.30571(T_{h}-T)} + \frac{1}{2}C_{s1}^{2}$

COMBUSTION E	ENGINEERING,	INC.
ENGINEERING DEPARTM	MENT, CHATTANOOG	A. TENN.

NUMBER <u>5-203-P</u> A 348 SHEET <u>II</u> OF <u>IQ</u> DATE <u>9-8-66</u> BY <u>ALEXANDER</u> CHECK DATE <u>9-8-66</u> BY <u>CAUDLE</u>

DESCRIPTION FATTGUE EVALUATION OF BOTTOM HEAD - TO - VESSEL JUNCTURE

5. DETAILED ANALYSIS

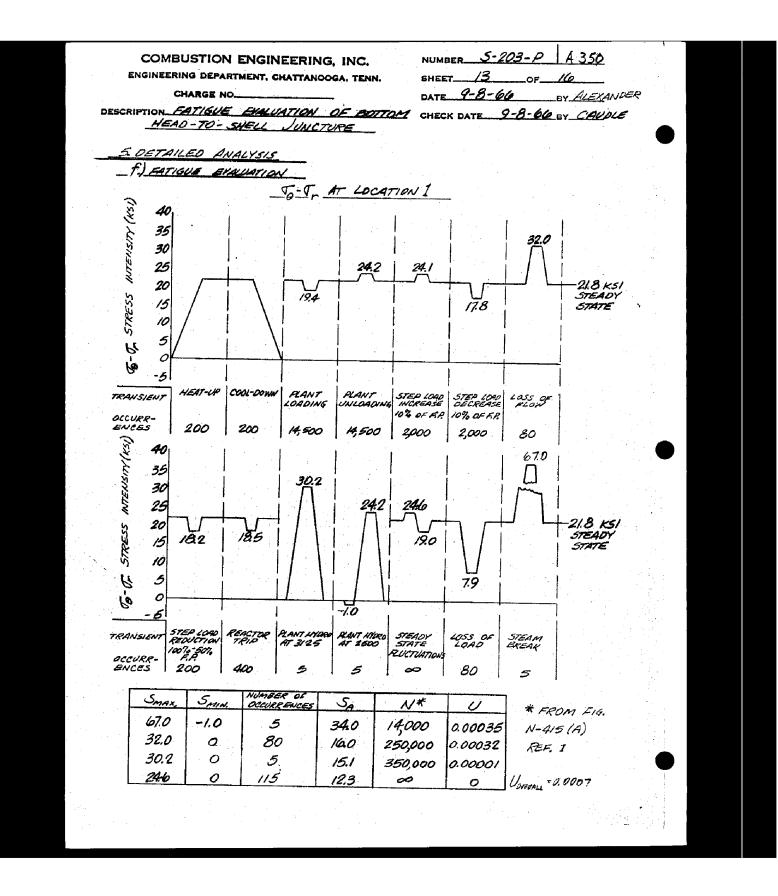
e) DEAK STRESSES

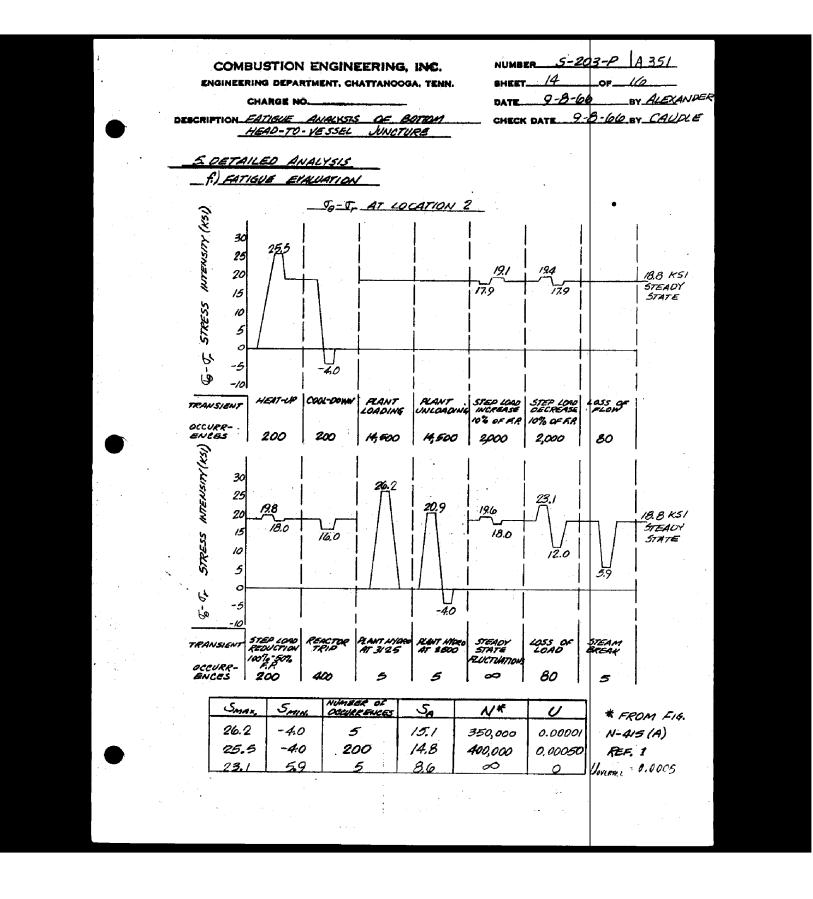
CHARGE NO.

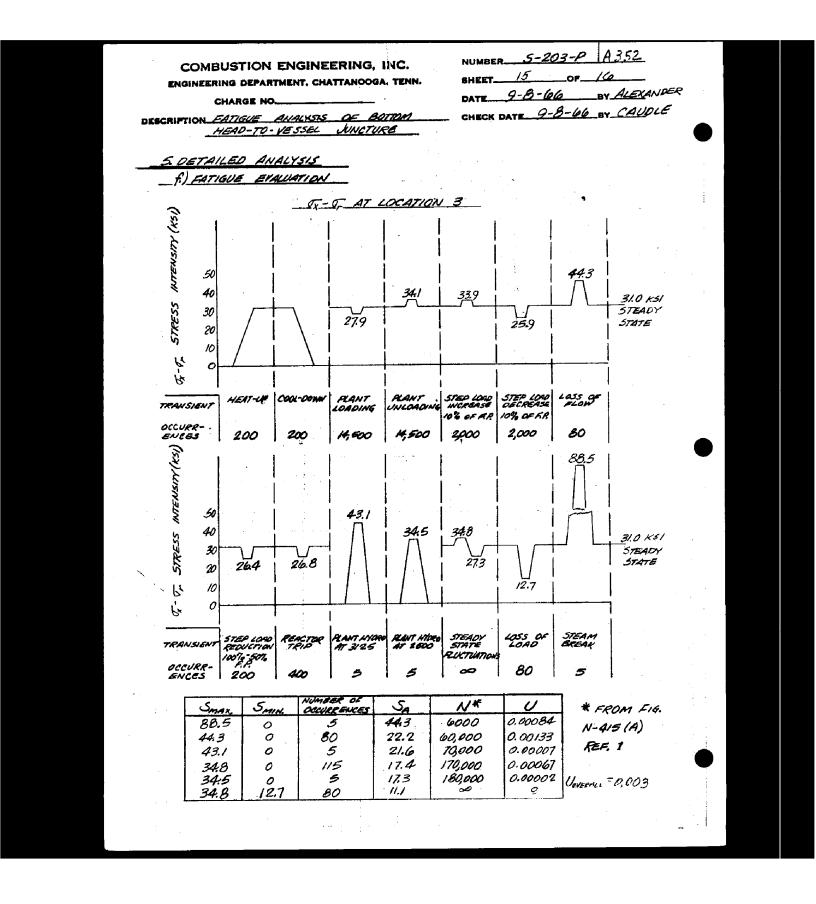
WITH THE EXPRESSIONS FOR STRESSES AS GIVEN ON SHEET 10 NE GET THE FOLLOWING VALUES FOR PEAK STRESSES.

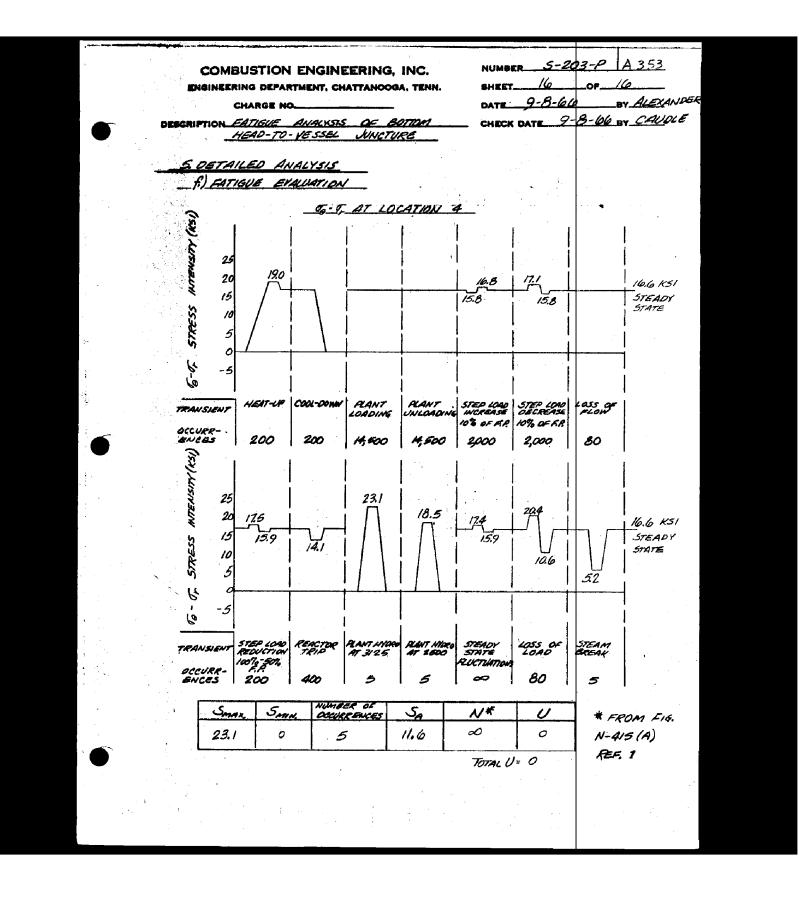
	T	APESS.		THER		DPES	5. STR.	<u>e 5565</u>	PEAK	577	SSE5
TRANSIENT	TIME	(KSI)	Tm-T (9=)	JTRE Tr	sses_	<u> </u>	1	Tr		· · · · ·	r
					<i>√</i> ∂	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	To	<u> </u>	<u> </u>	6	Tr
STEADY STATE		2.25	0	0	0	28.7	19.3	-2.3	28.7	19.3	-2.3
HEAT-UP	4,47 HRS.	2.25	-18	-7.2	-5.5	28.7	19.3	-2.3	21.5	13.8	-2.3
COOL-DOWN PLANT	4.47 HRS	0.32	18	7.2	5.5	4.1	2.7	-0.3	11.3	8.2	-23
LOADING	20 MIN	2.25	-7.8	-3.1	-2.4	28.7	19.3	-2.3	25.6	16.9	-2.3
UNLOADING	20 MIN.	2.25	7.8	3.1	2.4	28.7	19.3	-23	31.8	21.7	-2.3
STEP LOAD INCREASE	100 SEC.	2.14	11.2	4.5	3.4	27.3	18.4	-2.1	31.8	21.8	-2.1
10% OF FULL POWER	225.SEC.	2.28	1.7	0.7	0.5	29.1	19.6	-2.3	29.8	20.1	-2.3
STEP LOAD	405EC,	2.32	-23	-3.7	-2.8	29.6	19.9	-2,3	25.9	17.1	- 2,3
DECREASE 10% OF	100 500.	2.26	-13.3	-5.3	-4.1	28.9	19.4	-2,3	23.6	15.3	-2.3
FULL POWER	2605EC.	2.14	-1.3	-0.5	- 0.4	27.3	18.4	-2.1	26.8	18.0	- 2.1
LOSS OF FLOW	125EC,	2.25	33.3	13.3	10.2	28.7	19.3	-2,3	42.0	29.5	-2.3
STEP LOAD REDUCTION	2 MIN.	2.37	-12.0	-4.8	-3.7	30.3	20.3	-2.4	25.5	16.6	- 2.4
FROM 100%	3.2 MIN	2.35	-15.0	-6.0	-4.6	30.0	20.2	-2.4	24.0	15.6	-2.4
TO 50% EULL POWER	10.4 MM	2.15	0	0	0	27.5	18.4	-2.2	27.5	18A	-2.2
REACTOR TRIP FROM	10 SEC.	2.22	-9.5	-3.8	-2.9	284	19.0	-2.2	24.6	16.1	-2.2
FULL POWER	65 SEC.	1.91	8.5	3,4	2.6	24.4	16.4	-1.9	27.8	19.0	-1.9
PLANT NYDRO AT 3125 PSIA	220 MIN	3.13	0	0	0	40.0	Z6.B	-3,1	40.0	26.8	-3.1
PLANT	HEAT.	1.25	-18	-7.2	-5.5	16.0	10.7	-1.3	8.8	5.2	-1.3
HYDRO	5.5.	2.50	0	0	0	32.0	21.4	-2.5	32.0	21.4	-2.5
AT 2500 PSIA	COOL.	0.32	18	7.2	6.5	4.1	2.7	-0.3	11.3	8.2	-0.3
STEADY STATE	i	2.35	6.0	2.4	1.8	30.0	20.2	-2.4	32.4	22.0	-2.4
FLUCTUATIONS		2.15	-6.0	-2.4	-1.8	27.5	18.4	-2,2	25.1	16.6	-22
Loss	10 SEC.	2.76	-30,2	-12.1	-9.2	35.3	23.7	-2.8	23.2	14.5	-2.8
OF	28 SEC.	2.12	-41.2	-16.5	-12.6	27.1	18.2	-2.1	10.6	5.6	-2.1
LOAD	140 SEÇ.	1.44	4.8	1.9	1.5	18,4	12.4	-1.4	20.3	13.9	-1.4
STEAM BREAK	54 SEC.	0.70	197.0	78.9	60.2	8.9	6.0	-0.7	87.8	66.2	-0.7

	OMBUS	•			-		· ·	NUMBER	<u></u>	<i>203</i> c	р <u> </u>	349	
		RGE NO.	1 . T					DATE	9-8			ALEXAN	DER
DESCRIPTI	·		EVALUA	TION	OF BA	TTOM		CHECK I			66 BY		
			VESSE		INCTU								
·			an a										
	TAILEU												
	PEAK .	STRES	SES_	-	-								•
· .										1.12	. 4		
		P	EAK S	TRES	5 11.17	ENSIT	1.55						
_	10	CATIO			CATION			CATION	1 3		ATION	i d	Te e
TRANSIE	VT -T		· · · · · · · · · · · · · · · · · · ·	Vx-V0	Ux-0-	To-Tr	Vx-V0	VX-Vr	5-5-	Ux-00	VX-Or	10-57	
STEAD	-74	14.2	21.8	-9.2	9.6	18.8	9.4	31.0	21.6	-2.8	13.8	16.6	1
STATE HEAT-D		1.1	8.7	-9.2	16.3.	25.5	7.7	23.8		-2.8	15.0	19.0	
an-Dor		15,1	16.2	-1.3	-5,3	-4.0	31	11.6	16.1 8.5	-0.4	-0.4	0	
PLANT		11.8	19.4	-9.2	9.6	18.8	8.7	27.9	19.2	-2.8	13.8	16.6	
PLAN		10.6	24.2	-9.2	9.6	18.8	10.1	34:1	24.0	-2.8	13.8	16.6	
UNLOAD. STEP LOA	0		24.1		 			1					
INCREAS 10% 0	r	16.8	22.6	- 8.8 - 9.4	9.1 9.7	17.9	10.0 9.7	33.9	23.9	-2.7	13.1	15.8	
STEP LO				1		19.1	1	32.1	22.4	-2.9	13.9	16.8	
DECREA	5	11.8	19.6	-9.6	9.8	19.4	8.8	28.2	19.4	-2.9	14.2	17.1	
10% 0	F	10.1	17.8	-9.3 -8.8	9.6	18.9	8.3	25.9	17.6	-2.9	13.8	16.7	
FULL POW		13.0	20.3 32.0	-9.2	9.1 9.6	17.9	88	28.9 44.3	20.1	-2.7 -2.8	13.1	15.8	
FLOW STEP LOA	0	<u> </u>			· · ·	18.8			31.8		13.8	16.6	
REDUCTIO	_	11.2	19.2	-9.7	10.1	19.8	8.9	27.9	19.0	-3.0	14.5	17.5	
70 507		10.2	18.2	-9.6 -8.9	10.0	19.6	8.4	26.4	18.0	-3.0	14.4	17.4	1. T
FIAL POME REACTO						18.0		29.7	20.6	-2.8	13.1	15.9	
TRIP FRO	4	11.0	18.5	-9.2	9.4	186	8.5 8.8	26.8	18.3	-2.8	13.6	16.4	
PLANT NYL		19.6	30.2		8.1	16.0	13.2	29.7	20.9		167	14.1	
<u>AT 3/25</u>		<u> </u>		-12.9	13.3	26.2		43.1	29.9	-4.0	19.1	23.1	
PLANT HK		-5.2	-1.0	-5.1	12.0	17.1	3.6	10,1	6.5	-1.6	10.0	11.6	÷
AT	-8.5	15.7	24.2	-10.3	10.6	20.9	10.6	34:5	23.9	-3.2	15.3	18.5	
2500 PSI	9 -1.1	15.1	1	-1.3	-5.3	-4.0	3.1	11.6	8.5	-0.4	-0.4	0	
STATE		16.6	24.6	-9.6	10.0	19.6	10.4	34,8	24.4	-3.0	14.4	17.4	
SUCTURE		11.8	19.0	-8.9	9.1	18.0	8.5	27,3	18.8	- 7.8	13.1	15.9	
2055	-9.3	8.2	17.5	-11.4	11.7	23.1	8.7	26.0	17.3	-3.5	16.9	20.4	
OF	-7.2	0.7	7.9	-8.7	9.0	17.7	5.0	12.7	7.7	-2.7	13.0	15.7	
<u>LOAD</u> STEAM BREAK	-4.9	10.5	15.4	-5,9	6.1	12.0	6.4	21.7	15.3	-1.8	8.8	10.6	
BREAK	-2.4	1 04.0	67.0	-2.9	3.0	5,9	21.6	88.5	60.9	-0.9	4.3	5.2	









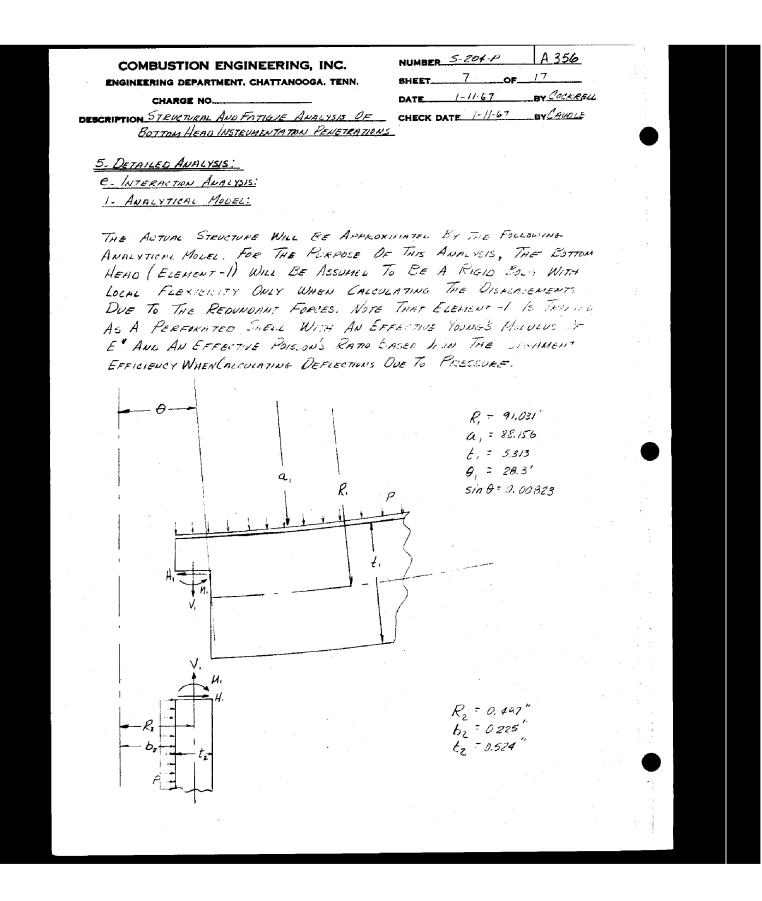
DESCRIPTION STEURINE AND FATLONE AND VISIS OF CHECK DATE 1-11-67 EV GUIDE BOTTOM HEDD INSTRUMENTATION PENETENTIONS S. DETAILED AND VSIS: Q. SYSTEM GEOMETRY: bur 88.156' MATERIAL: BOTTOM HEDD SA-3028 INGT. TURE INNOMEL INCOMEL U.G. DE HEDD FEWETENTION: 1.500 -0.000 INCHES DUTSINE DIA. OF INST. TURE: 1.499 +0.000 INCHES REF. DWG. E-252-056	COMBUSTION ENGINEERING, INC. ENGINEERING DEPARTMENT, CHATTANOOGA, TEN CHARGE NO.	NN. SHEET <u>5</u> OF 17 DATE 1-11-67 BY COCKRE
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		
$ \begin{array}{c} \begin{array}{c} \begin{array}{c} \begin{array}{c} \begin{array}{c} \begin{array}{c} \begin{array}{c} \begin{array}{c}$	<u>5. DETAILED ANALYSIS:</u>	
bh $\cdot 88.156''$ $BOTTOM HEND _ SA-3028$ $IWGT. TURE _ INCOMEL$ $R_{H} = 91.031''$ $t_{H} = 5.373''$ $t_{H} = 5.373''$ I.500 - 0.000 INCHES DIA. OF HEND PENETRATION: 1.500 - 0.000 INCHES DUTSIDE DIA. DF INST. TURE: 1.499 + 0.000 IWCHES	Q- SYSTEM GEOMETRY:	
$ \begin{array}{c} Bottion HEAD _ SA-302B \\ ING. UE L \\ INGT. TUBE _ NKO.UEL \\ INGT. TUBE _ NKO.UEL \\ INGT. TUBE _ NKO.UEL \\ Ingt. OF HEAD PENETRATION: \\ I.500 -0.000 NCHES \\ OUTSIDE DIA. OF INST. TUBE: \\ I.499 + 0.000 NCHES INCHES $		MATERIAL:
$ \begin{array}{c} R_{\mu}:91.031" \\ T_{\mu}=5.393" \\ \hline T_{\mu}=5.393" \\ \hline$	Бн • 68.156	
$\frac{DIA. OF HEAU PENETRATION:}{1.500 - 0.000 INCHES}$ $\frac{DIA. OF HEAU PENETRATION:}{1.500 - 0.000 INCHES}$ $\frac{DIA. OF HEAU PENETRATION:}{1.500 - 0.000 INCHES}$		INGT. TUBE INCONEL
OUTSINE DIA. OF INST. TUBE: 1.499 +0.000 1.499 -0.001 INCHES		
1.499 +0.000 INCHES		
		OUTSIDE DIA. OF INST. IDBE.
REF. DWG. E-232-056		1.499 +0.000 INCHES
		REF. DWG. E-232-056

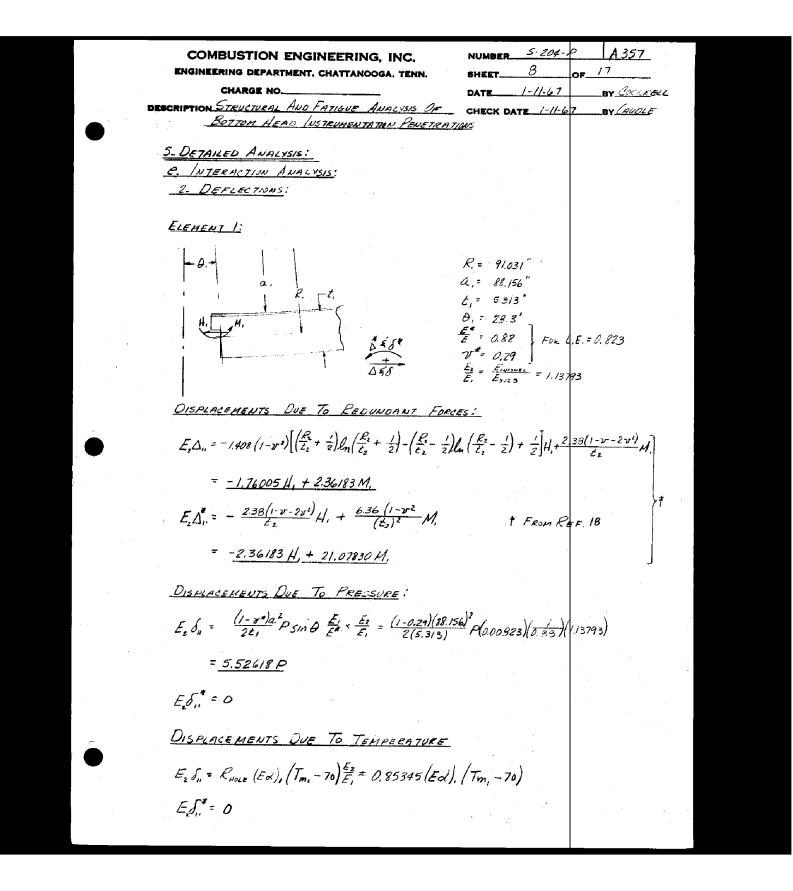
6. SYSTEM LOADS:

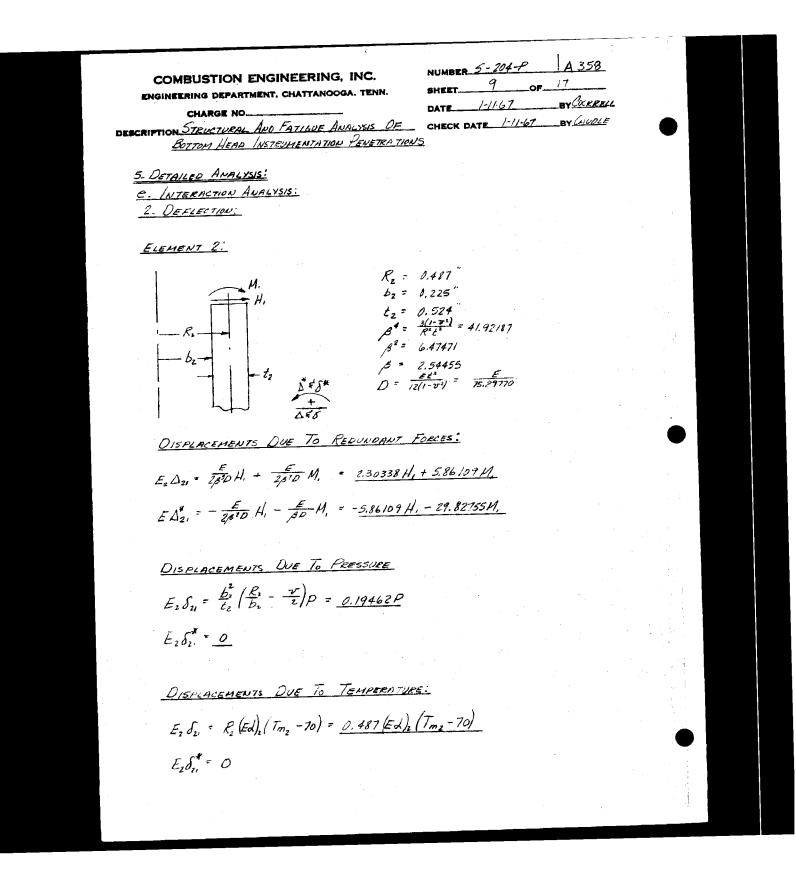
THE BOTTOM HEAD INSTRUMENTATION PENETRATION AS SHOWN ALOVE WILL BE INVESTIGATED FOR THE FOLLOWING LOADS IN THIS ANALYSIS, 1- DESIGN PRESSURE OF 2.5 KSI AT DESIGN TEMPERATURE OF 650°F

2. THE THERMAL AND PRESSURE TRANSIENTS AS GIVEN IN REF. 9

	COMBUSTION ENGINEERING, INC. NUMBER 2227 17022 ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. SHEET 6 0F 17
	CHARGE NO DATE 1-11-67 BY (ARRELL
	DESCRIPTION STRUCTURAL AND FATIGUE ANALYSIS OF CHECK DATE 1-11-67 BY LAVOLE BOTTOM HEAD INSTRUMENTATION PENETRATIONS
	5- DETAILED ANALYSIS:
	C. System AllowAbles!
	THE FOLLOWING ALLOWABLE STRESSES ARE BASED ON THE ASME NUCLEAR LODE SECTION II, REFERENCE - 1 AND ARE RELEVANT FOR THIS ANALYSIS.
	I- THE AVERAGE PRIMARY STRESS INTENSITY ACROSS A SOLID SECTION SHALL NOT EXCEED Son AT DESIGN TEMP. (650%) AND DESIGN PRESSURE (2.5 KSI).
	2. THE RANGE OF PRIMARY PLUS SECONDARY STRESS INTENSITY
	RESULTING FROM MECHANICAL AND THERMAL LOADS SMALL NOT
	EXCEED 35m AT ACTUAL METAL TEMP, AND OPERATING PRESSURE.
	3. SHOW THAT EACH POINT MEETS THE REQUIREMENTS FOR
	PEAK STRESS INTENSITY GIVEN IN N-414.5 OF THE ASME CODE
	SECTION III, THE PROCEDURE WILL BE AS OUTLINED IN N-415,2
	OF SECTION III.
• 5 ¥	
	d. Design SizING:
- 24 T	
· •.	LONGIDER THE THICKNESS OF THE INST. TUBE
	DESIGN PRESSURE = 2.5 KSI
	- t - DESIGN TEMPERATURE = 650 °F
	R- MATERIAL:
	INCOMEL TUDE, Sm = 22.3KSI (FROM REF. 4)
	R = 0.225 in
	$z_{ncT} = 0.524$ in
	FROM N-431 OF SECTION TIL ASME NUCLEAR CODE:
	tread = PR = 2.5(0.225) = 0.026 in < 0.524 in ACTUAL TARKARES; HERE,
-	CRITERION 5-C-1 A SATISFIEL.
	CKITERION D-C-1 19 SATISFIED.







NUMBER 5-204-P <u>A 359</u> COMBUSTION ENGINEERING, INC. ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. .OF_17 10 1-11.67 CHARGE NO. BY COCKRELL DESCRIPTION STRUCTURAL AND FATIGUE ANALYSIS OF CHECK DATE 1-11.67 BY (PUOLE BOTTOM HEAD INSTRUMENTATION PENETRATIONS 5- DETAILED ANALYSIS: C- INTERACTION ANALYSIS: 3. CONTINUITY MATRIX AND LOADING VECTORS FROM CONTINUITY WE HAVE, E2 A1 - E2 A2, = E2 J2, -E2 J1, = - 5.35156 P- [0.85345(Ed), (Tm, -70) - 0.487/Ed)2(Tm-70) $E_2 \Delta_{ii}^* - E_2 \Delta_{2i} = E_2 \delta_{2i}^* - E_2 \delta_{ii}^* = 0$ LET, We + WT = -5.33156 P - [0.85345(Ed), (Tm-70) - 0.487(Ed), (Tm2-70)] IN MATRIX FORM WE HAVE. $\begin{bmatrix} -4.06343 & -3.49926 \\ 3.44926 & 50.90585 \end{bmatrix} \begin{bmatrix} H_{1} \\ M_{2} \end{bmatrix} = \begin{bmatrix} I \\ 0 \end{bmatrix} W_{p} + \begin{bmatrix} I \\ 0 \end{bmatrix} W_{T}$ 1 4. REDUNCANT LOAD VALVES SOLVING THE ABOVE MATRIX, WE GET THE FOLLOWING VALUES FOR THE REDUNDANT FORCES, H, = - 0.26158 (wp + w7) M,= 0.01798 (Wp+WT)

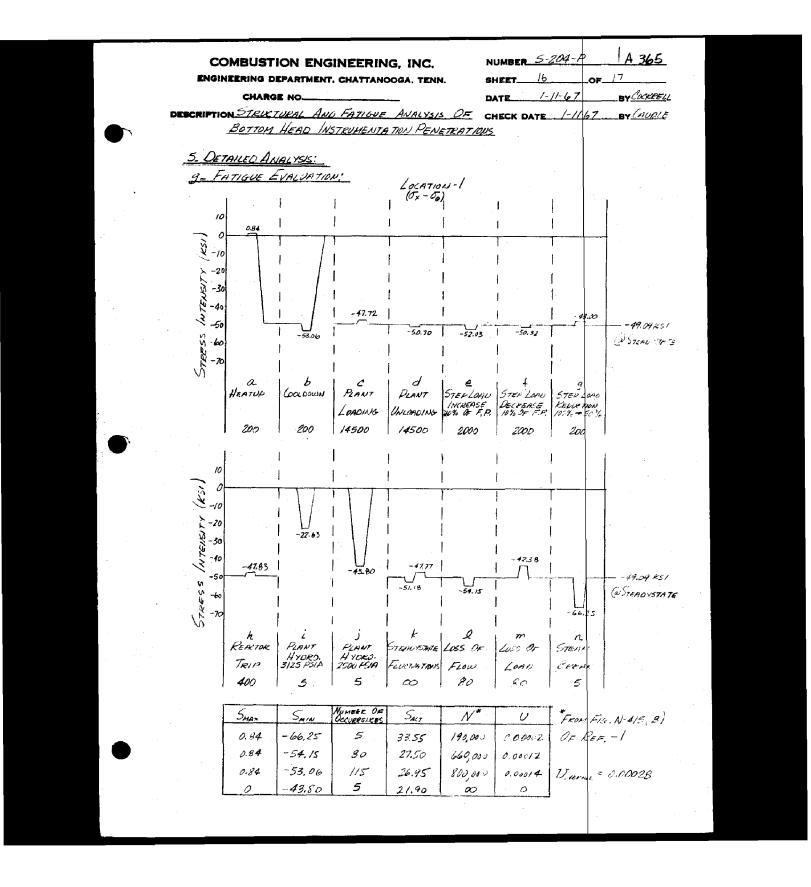
A 360 NUMBER 5-204-P COMBUSTION ENGINEERING, INC. 11 OF 17 SHEET ENGINEERING DEPARTMENT, CHATTANOOGA, TENN. 1-11.67 BY COCKPERE DATE CHARGE NO. CHECK DATE 1-11-67 BY AUOLE DESCRIPTION STRUCTURAL AND FATLANE ANALYSIS OF BOTTOM HEAD INSTRUMENTATION PENETRATIONS 5- DETAILED ANALYSIS: f. STRESSES : TYPICAL DEFLECTION SHAPE DUE TO PRESSURE OR THERMAL CONDITIONS IN WHICH THE TUBE IS COOLER THAN THE VESSEL LOWER HEAD. STRESSES WILL BE CALCULATED AT THE TWO LOCATIONS AS SHOWN. A STRESS CONCENTRATION FACTOR OF FOUR (4) WILL BE USED AT LOCHTION-2 FOR THE FATIGUE EVALUATION AS CTIVEN IN N-462.4 (d)(3) OF ASME LODE, SECTION III. LOCATION-1 $\sigma_{\rm X} = \frac{6M_{\rm H}}{t^2} + \frac{b_{\rm H}^2 P}{2R_{\rm H}} = \frac{6(0.01798)(w_{\rm P} + w_{\rm T})}{(0.524)^2} + \frac{(a225)^2 P}{2(0.417)(0.524)}$ = 0.39290 (W0+W7) + 0.09919P ED2, = 2.30338 H, + 5.86109 M, = -0.49713 (Wp +W4) $\sigma_{\theta} = \frac{v_{\theta}M_{1}}{t_{2}^{2}} + \frac{E\Delta_{e'}}{R_{2}} + \frac{b_{1}P}{t_{2}} = \frac{0.3/6)(0.01798(w_{P}+w_{T})}{(0.524)^{2}} + \frac{(-0.49715(w_{P}+w_{T}))}{(0.487)} + \frac{0.225P}{0.524}$ = 0.11787 (Wo + WT) - 1.02080 (WO + WT) + 0.429380 LOCATION -2 $\sigma_{\rm X} = -\frac{6\,M.}{t^2} + \frac{6^{2}P}{2R.t_{\rm Y}} = -0.39290\,\left(w_0 + w_{\rm T}\right) + 0.09919\,P$ $\sigma_{x} = -\frac{v \epsilon M}{r_{x}^{6}} + \frac{E \Delta_{x}}{R_{2}} + \frac{b_{x} P}{t_{z}} = -0.11787(w_{p} + w_{T}) - 1.02080(w_{p} + w_{T}) + 0.429387P$

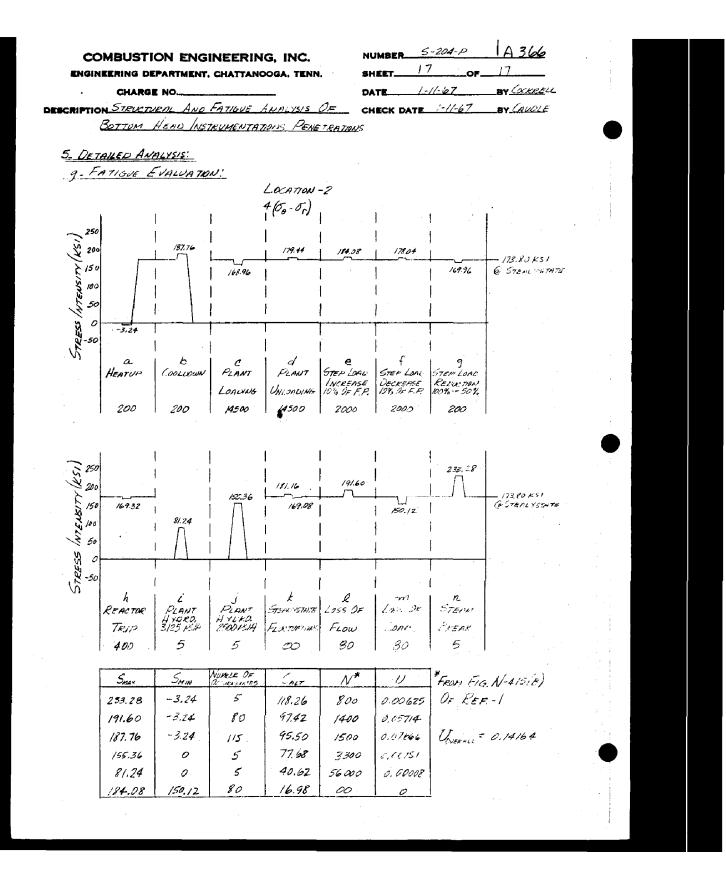
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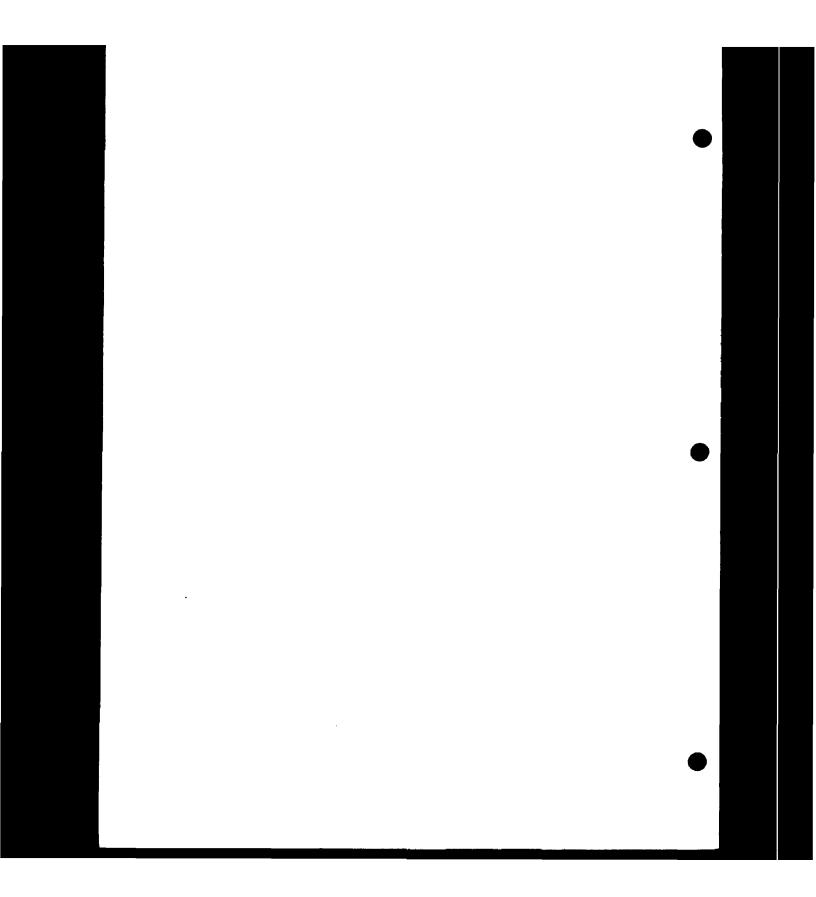
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	NOMENCLATURE	URE	
	۳ ۲۸	Poisson's ratio - taken to be 0.3	
	ا اینا ر	Elastic modulus (lbs/in ²)	
	ו צ י	Coefficient of thermal expansion $(in/in/^{O}F)$	
	Ш Оч	Pressure (lbs/in ²)	
	H 33	Resultant axial force at any transverse cross- section (1bs)	
	# 	Temperature (^O F or as specified)	
	" ^	Axial component of unit edge force (lbs/in)	·
	ш ж	Radial component (perpendicular to X-axis) of unit edge force (lbs/in)	
,B:	= W	Unit bending moment (in-lbs/in)	
	<i>۵۶۵</i> -	Components of deflection normal to the X-axis; radial deflection; (positive outward) where results from the action of redundant forces an results from all other causes(in)	s; and
	۳ ۲, <i>خ</i> 5	Components of rotation(positive if radial deflections of successive adjacent points toward the positive X direction are increasing) where results from the action of redundant forces and * results from all other causes (radians)	ward re * and
	I ×	Axis of revolution	
	# ~	A radial distance measured normal to the axis revolution (in)	of
	ت #	Shell thickness as measured normal to the mid- surface (in)	8.
	1	Normal stress; the subscripts x, and r denote meridional, circumferential, and radial (or lateral) stresses, respectively (lbs/in ²)	te ateral)
	11 (2)	Strain - Elongation per unit length (in/in)	
)			



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B.1.0 INTRODUCTION

This appendix presents a summary of the thermal analysis of the Indian Point, Plant #2 Pressurized Water Reactor Vessel. The assumptions made, method of analysis and results of the investigations are presented. Temperature distributions obtained from two-dimensional heat flow analyses are presented on cross sections of the components considered. Results of the one-dimensional heat flow analyses are presented in the form of graphs. The times for which distributions are presented were selected to present the total effects of the transients.

B.2.0 NOMENCLATURE

- Actual thickness of clad material, ft а A' - Cross section area, ft² - Dimension, ft ъ Cj - - Thermal capacitance of node j, BTU/7F - Specific heat, BTU/1b-°F сp - Actual thickness of base metal, ft C đ - Equivalent thickness of clad material, ft - Modulus of elasticity, psi Έ - Acceleration of gravity, ft/sec² ø - Heat transfer coefficient, $BTU/hr-ft^{2-O}F$ h - Thermal conductivity, BTU/hr-ft-^oF k - Length along a heat flow path, ft Ъ - Slope of temperature vs time curve, °F/hr m NFO - Fourier modulus, dimensionless - Slope of temperature vs time curve at x=0, $^{O}F/hr$ p. - Rate of heat flow, BTU/hr q - Heat generation of the node j, BTU/hr q''' - Rate of heat generation per unit volume, BTU/hr-ft3 qo" - Rate of heat generation per unit volume at the surface, BTU/hr-ft³ - Dimension, ft r R - Thermal resistance, hr-^oF/BTU - Temperature, ^OF Т $\mathbf{T}_{\mathbf{O}}$ - Uniform initial temperature, ^OF - Temperature at x=b, ^OF T1 - Temperature difference, ^OF ΔT - Slope of temperature vs time curve at x=b, $^{\circ}F/Hr$ u v - Volume, ft³ X - Dimension, ft - Thermal diffusivity, ft2/hr α αľ - Coefficient of thermal expansion, $ft/ft-^{O}F$

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B-3 β - Linear absorption coefficient for heat generation, 1/ft e - Emissivity for radiation, ft^2/hr - T-To, Temperature change, ^OF θ μ - Absolute viscosity, lb/ft-hr - Poisson's ratio, dimensionless ν $=\frac{x}{b}$, distance ratio, dimensionless ξ - Density, lb/ft³ ρ - Thermal stress, psi σ - Time, hr τ - Time difference, hr Δτ $=\frac{\alpha\tau}{b^2}$, temperature ratio, dimensionless φ - Natural convection property function, 1/ft³ oF B.3.0 GENERAL SOLUTIONS Various procedures were used to determine the thermal information presented in this appendix. The following paragraphs describe the techniques used and the conditions under which each would be applicable. B.3.1 Transient and steady state temperature distributions determined by use of a finite difference method programmed for solution on a digital computer. A code has been written which makes use of the general heat balance equations derived by Hellman, Habetler, and Babrov (1). Through the use of this code, temperature distributions can be obtained in bodies having irregular geometries and composed of different materials. The object being investigated is divided into a system of blocks or nodes. The thermal capacitance of each node and the thermal resistance between nodes is calculated using the physical properties of the material. The thermal capacitance of node j is: $c_{j} = \rho c_{p} v_{j}$ The thermal resistance between homogeneous nodes j and i 1s: $j^{R_{1}} = \frac{jL_{1}}{k_{1}A_{1}}$

B-4

where jL_1 is the length of the heat flow path between nodes j and i, jA_1 is the area normal to jL_1 and common to both nodes. k is the thermal conductivity of the material.

The thermal resistance between non-homogeneous nodes j and i in series is:

$$j^{R_{1}} = \frac{j^{(L_{1})}_{i}}{k_{1}} + \frac{j^{(L_{2})}_{i}}{k_{2}} + \dots + \frac{j^{(L_{n})}_{i}}{k_{n}} + \frac{j^{(L_{n})}_{i}}{k_{n}}$$

The thermal resistance for a film is:

$$\mathbf{j}^{\mathrm{R}_{1}} = \frac{1}{\mathbf{h}_{\mathbf{j}}^{\mathrm{A}_{1}}}$$

The equation for the change in temperature of a particular node in the time $\Delta\tau$ is:

$$\Delta T = \frac{\Delta \tau}{C_j} \left[q(\text{conducted}) + q(\text{generated}) \right]$$

The rate at which heat is conducted into the node is:

$$q = \sum_{i=1}^{n} \frac{T_i - T_j}{j^R_i}$$

where i represents each bordering node and ${}_{j}R_{j}$ is the thermal resistance between the i node and the node under consideration.

Thus, the equation for the change in temperature of a particular node becomes:

$$\Delta \mathbf{T}_{\mathbf{j}} = \frac{\Delta \tau}{C_{\mathbf{j}}} \begin{bmatrix} \mathbf{n} & \frac{\mathbf{T}_{\mathbf{j}} - \mathbf{T}_{\mathbf{j}}}{\Sigma} \\ \mathbf{i} = \mathbf{l} & \mathbf{j}^{\mathbf{R}} \mathbf{i} \end{bmatrix}$$

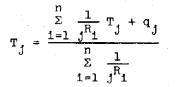
The temperature of each node is calculated at successive time intervals through the use of the finite difference equation:

$$T_{(\tau + \Delta \tau)} = T_{\tau} + \Delta T$$

B-5

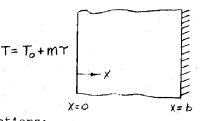
where ΔT is obtained from the previous equation and evaluated at time τ .

For a steady state problem, the term in brackets must be equal to zero; hence,



This expression is equivalent to performing a heat balance about node j.

B.3.2 Transient solution for a finite slab in which one boundary has a linear temperature change, while the other boundary is insulated. Initially the slab is isothermal.



Assumptions:

- 1. One-dimensional heat flow.
- 2. Thermal properties of the material do not vary with temperature and may be evaluated at the average temperature over the range covered.
- 3. Infinite heat transfer coefficient at x=0.

Mathematical statement of the problem:

$$\frac{\partial^2 T}{\partial x^2} - \frac{1}{\alpha} \frac{\partial T}{\partial \tau} = 0 \quad \text{for} \quad 0 < x < b \ , \ \tau > 0$$

Boundary conditions:

 $T = T_0$ at $\tau = 0$ for 0 < x < b

в-б

 $\frac{dT}{dx} = 0 \text{ at } x=b \text{ for } \tau>0$ $T = T_0 + m\tau \text{ at } x=0 \text{ for } \tau>0$ The solution is:

 $T = T_0 + \phi m \tau$

where,

$$\varphi = \frac{1}{N_{FO}} \left[N_{FO} - \xi \left(1 - \frac{\xi}{2}\right) + \frac{2}{\pi^3} \sum_{n=0}^{\infty} \frac{-\left(n + \frac{1}{2}\right)^2 \pi^2 N_{FO}}{\left(n + \frac{1}{2}\right)^3} \sin\left(n + \frac{1}{2}\right) \pi \xi \right]$$

$$T_{mean} = \frac{1}{b} \int_{0}^{b} T dx$$

$$T_{mean} = \frac{1}{b} \int_{0}^{b} (T_{0} + \phi m \tau) dx$$

$$T_{mean} = T_{o} + \frac{m\tau}{b} \int_{o}^{b} \varphi dx = T_{o} + \varphi_{mean} m\tau$$

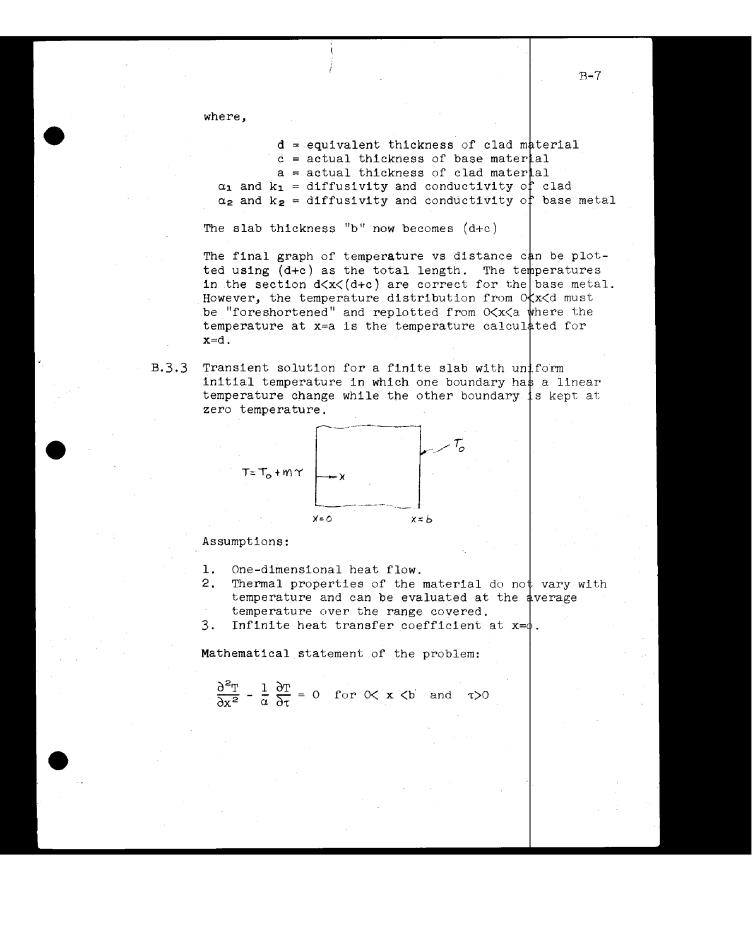
where,

$$\varphi_{\text{mean}} = \frac{1}{N_{\text{Fo}}} \left[N_{\text{Fo}} - \frac{5}{6} + \frac{2}{\pi^4} \sum_{n=0}^{\infty} \frac{e^{-(n+\frac{1}{2})^2 \pi^2} N_{\text{Fo}}}{(n+\frac{1}{2})^4} \right]$$

This solution only considers slabs of one material. To include clad on the base metal, an equivalent thickness must be added to be base metal thickness.

The equation for the equivalent thickness of clad is:

$$d = -c + \sqrt{c^2 + \frac{a^2 \alpha_2}{\alpha_1} + \frac{2k_2ac}{k_1}}$$



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Boundary conditions:

 $T = T_0$ at $\tau=0$ for 0 < x < b

 $\theta = 0$ at x=b

 $T = T_0 + m\tau$ at x=0 for $\tau > 0$

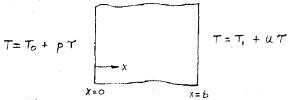
The solution is:

 $T = T_{O} + \phi m \tau$

where,

$$\varphi = \frac{\theta}{m\tau} = \frac{1}{N_{FO}} \left\{ \frac{(1-\xi)[6N_{FO} - \xi(2-\xi)]}{6} + \frac{2}{\pi^3} \sum_{n=1}^{\infty} \frac{e^{-n^2\pi^2 N_{FO}}}{n^3} \sin n\pi\xi \right\}$$
$$T_{mean} = \frac{1}{b} \int_{0}^{b} (T + \varphi n\tau) dx$$

B.3.4 Transient solution for a finite slab with non-uniform initial temperature which undergoes a linear temperature change on each surface.



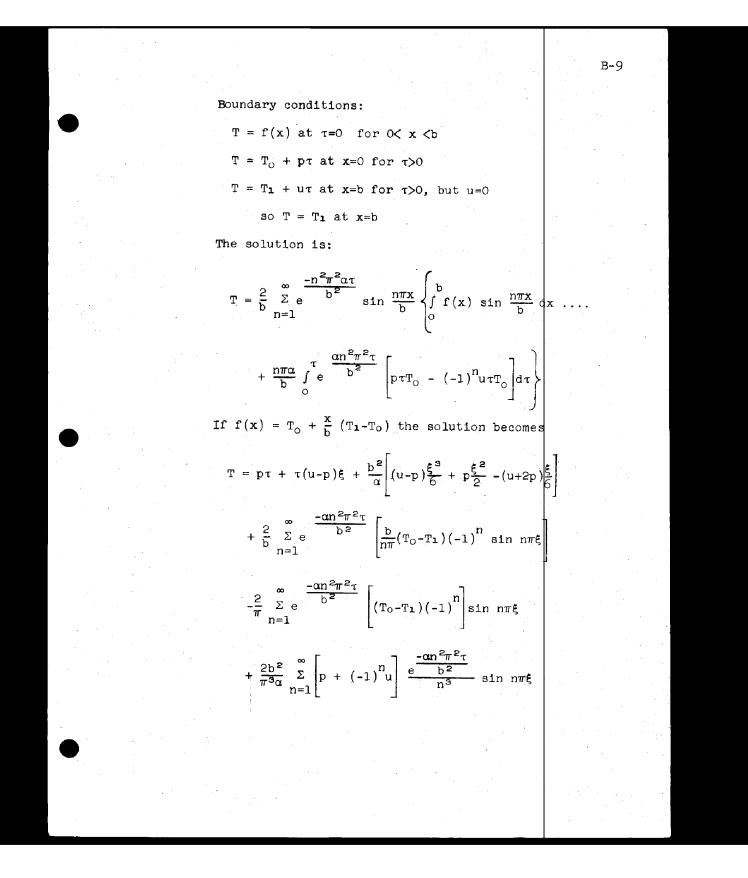
Assumptions:

- 1. One-dimensional heat flow
- 2. Thermal properties of the material do not vary with temperature and can be evaluated at the average temperature over the range covered.
- 3. Infinite heat transfer coefficient at x=0.
- 4. u=0 forcing the surface at x=b to remain at T1.

Mathematical statement of the problem:

$$\frac{\partial^2 T}{\partial x^2} - \frac{1}{\alpha} \frac{\partial T}{\partial \tau} = 0 \quad \text{for} \quad 0 < x < b \quad \text{and} \quad \tau > 0$$

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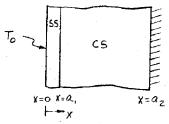


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The equation for the mean temperature is:

$$T_{mean} = \frac{1}{b} \int_{0}^{b} T dx$$

B.3.5 Nonlinear gradient at steady state resulting from heat generation due to gamma ray capture in a two material finite slab with one surface at a fixed temperature and the other surface perfectly insulated.



Assumptions:

- 1. One-dimensional heat flow.
- 2. Thermal properties of the materials do not vary with temperature and can be evaluated at the mean temperature of the body in question.
- 3. No contact resistance at the junction of the two materials.
- 4. Heat generation of the form $q^{\prime\prime\prime} = q_0^{\prime\prime\prime} e^{-\beta x}$.

Mathematical statement of the problem:

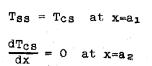
$$-k_{ss} \frac{d^2 T_{ss}}{dx^2} = q_0 \cdots e^{-\beta x} \text{ for } 0 < x < a_1$$
$$-k_{cs} \frac{d^2 T_{cs}}{dx^2} = q_0 \cdots e^{-\beta x} \text{ for } a_1 < x < a_2$$

Boundary conditions:

$$T_{ss} = T_0$$
 at x=0

$$-k_{ss} \frac{dT_{ss}}{dx} = -k_{cs} \frac{dT_{cs}}{dx}$$
at x=a_s

B-11



The solution is:

$$T_{SS} = \frac{q_{0}'''}{\beta k_{SS}} \left[\frac{1}{\beta} - \frac{e^{-\beta x}}{\beta} - xe^{-\beta a_{2}} \right] + T_{0}$$

$$T_{CS} = \frac{q_{0}'''}{\beta k_{CS}} \left[a_{1}e^{-\beta a_{2}} + \frac{e^{-\beta a_{1}}}{\beta} - \frac{e^{-\beta x}}{\beta} - xe^{-\beta a_{2}} \right]$$

$$+ \frac{q_{0}'''}{\beta k_{SS}} \left[\frac{1}{\beta} - \frac{e^{-\beta a_{1}}}{\beta} - a_{1}e^{-\beta a_{2}} \right] + T_{0}$$

Tangential thermal stresses at $x=a_1$ and $x=a_2$ due to this temperature distribution in a thin walled cylinder with ends free to expand axially but restrained from bending are:

$$\sigma_{1} = \left(\frac{\Xi\alpha'}{1-\nu}\right) \left(\frac{q_{0}}{k_{CS}\beta}\right) \left\{ e^{-\beta a_{1}} \left[\frac{1}{\beta} - \frac{1}{\beta^{2}(a_{2}-a_{1})}\right] + e^{-\beta a_{2}} \left[\frac{1}{\beta^{2}(a_{2}-a_{1})} - \frac{a_{2}-a_{1}}{2}\right] \right\}$$

$$\sigma_{2} = \left(\frac{\Xi\alpha'}{1-\nu}\right) \left(\frac{q_{0}}{k_{CS}\beta}\right) \left\{ \frac{e^{-\beta a_{1}}}{\beta^{2}(a_{2}-a_{1})} - e^{-\beta a_{2}} \left[\frac{1}{\beta^{2}(a_{2}-a_{1})}\right] + \frac{1}{\beta} + \frac{a_{2}-a_{1}}{2} \right] \right\}$$
where:

 σ_1 = Tangential thermal stress at x=a₁

 σ_2 = Tangential thermal stress at $x=a_2$ E = Modulus of elasticity

v = Poisson's ratio

 α' = Linear coefficient of thermal expansion

B-12

B.3.6 Thermal moment: A term used in the structural analysis generally at locations of discontinuity where cuts are taken. The moment is due to a radial temperature gradient and is defined mathematically as:

$$\mathbf{M}_{\mathbf{T}} = \frac{\mathbf{E}\alpha'}{1-\mathbf{v}} \int_{a}^{b} \mathbf{T} (\mathbf{R}-\mathbf{r}) d(\mathbf{R}-\mathbf{r})$$

The equation for the mean temperature at a cut through a cylinderical section is:

$$T_{M} = \frac{2}{b^{2} - a^{2}} \int_{a}^{b} Trdr$$

where,

- a = Dimension to inside surface
- b = Dimension to outside surface
- r = Dimension (a < r < b)
- R = Mean radius
- α' = Coefficient of thermal expansion

 ν = Poisson's ratio

B.3.7 Material Properties and Film Coefficients:

Properties of materials used in this appendix are presented below. All were evaluated at $325^{\circ}F$.

Stainless Steel

Carbon Steel

k = 9.8 Btu/hr-ft-^oF ρ = 495 lb/ft³ c_p = .127 Btu/lb-^oF $k = 26.2 \text{ Btu/hr-ft-}^{\circ}\text{F}$ $\rho = 490 \text{ lb/ft}^{3}$ $c_{p} = .12 \text{ Btu/lb-}^{\circ}\text{F}$

Air

 $k = .0204 \text{ Btu/hr-ft-}^{\circ}\text{F}$ $\psi = 3.0 \times 10^{5}$

$k = .40 \text{ Btu/hr-ft-}^{\circ}\text{F}$ $\psi = 4.7 \times 10^{9}$

The following equations were used to calculate the heat transfer coefficients used in the analysis of the head and vessel flanges.

Water

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Convection film coefficient in a vertically enclosed gap:

$$\frac{h_c x}{k} = \frac{0.071}{(L/x)^{\frac{1}{9}}} \left[\frac{x^3 \rho^2 g\beta \Delta T}{\mu^2} \left(\frac{c_p \mu}{k} \right) \right]^{\frac{1}{3}}$$
$$h_c = \frac{0.071 k}{(L/x)^{\frac{1}{9}}} \left[\psi \Delta T \right]^{\frac{1}{3}}$$

where,

$$\psi = \frac{\rho^2 g\beta}{\mu^2} \left(\frac{c_p \mu}{k}\right)$$

Convection film coefficient in a horizontal enclosed gap:

$$\frac{h_c x}{k} = 0.075 \left[\frac{x^3 \rho^2 g \beta \Delta T}{\mu^2} \left(\frac{c_p \mu}{k} \right) \right]^{\frac{1}{3}}$$
$$h_c = 0.075 k \left[\psi \Delta T \right]^{\frac{1}{3}}$$

Convection film off the top of a heated plate:

$$\frac{h_{c}L}{k} = 0.14 \left[\frac{L^{3} \rho^{2} g\beta \Delta T}{\mu^{2}} \left(\frac{c_{p} \mu}{k} \right) \right]^{\frac{1}{3}}$$
$$h_{c} = 0.14 \kappa [\Delta T]^{\frac{1}{3}}$$

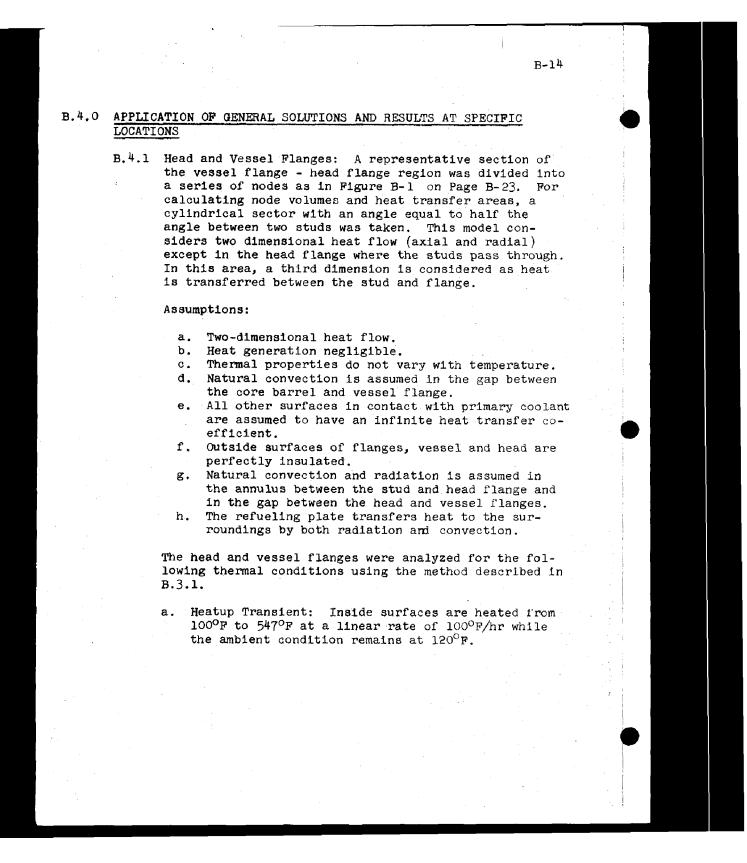
The convection film coefficient on the bottom side of the same plate is assumed to be half that on the top side.

The equation for the radiation coefficient across the air gaps and off the top and bottom of the refueling plate is as follows:

$$h_{r} = \frac{0.173 \times 10^{-8}}{\frac{1}{\epsilon_{1}} + \frac{1}{\epsilon_{2}} - 1} \frac{(T_{1}^{4} - T_{2}^{4})}{(T_{1} - T_{2})}$$

 $\epsilon_1 = \epsilon_2 = 0.65$

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b. Steady State: Inside surfaces are held constant at $547^{\rm o}F$ and the ambient at $120^{\rm o}F.$

c. Cooldown Transient: The inside surfaces are cooled from $547^{\circ}F$ to $100^{\circ}F$ at a linear rate of $100^{\circ}F/hr$ while the ambient is held at $120^{\circ}F$. The initial condition for this transient is the steady state condition described in b.

Results:

Nodal layouts of the flanges showing temperature distributions at times during heatup and cooldown transients plus steady state are presented in Figures B-1 thru B-9. Figure B-39 is a sketch of the flange region showing the locations of discontinuity where the effects of radial gradients were considered. At these locations, the radial gradients were plotted, and from these gradients values were obtained for the mean temperature at the cut and the thermal moment. The radial gradients are shown in Figures B-40 thru B-49, and the thermal moments resulting from these are tabulated on Page B-100.

Axial gradients in the flanges were also plotted from the temperature distributions at times during heatup, cooldown and at steady state. These gradients are presented in Figures B-78 thru B-83.

For the Plant Hydrostatic Test (2500 psia), the inside surfaces are heated from $100^{\circ}F$ to $400^{\circ}F$ at $100^{\circ}F/hr$ while the plant is being pressurized. During plant depressurization, the inside surfaces are cooled back to $100^{\circ}F$ at $100^{\circ}F/hr$. These heatup and cooldown transients are at the same rate but over a shorter range than the normal heatup and cooldown. Therefore, it would be conservative to use the results of normal heatup and cooldown for the hydrostatic test transients.

Other operating transients applied to this region have faster rates than heatup and cooldown, but the range of temperature change is much shorter. Therefore, it was conservative to consider the mean temperature of the body did not change from the initial condition while the temperature of the inside surface followed the fluid transient. Differences between the mean temperature and the inside surface temperature at times during these transients are tabulated on Page B-121. Inlet Nozzle: A cross section of the nozzle was disector with an angle of one radian, was used to per-This model, consisting of a cylindrical vided into a series of nodes as in Figure B-10 on form a two-dimensional thermal analysis using the technique described in B.3.1 and the following Page B-32. B.4.2

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Two-dimensional heat flow: а Ю

assumptions.

- Heat generation negligible. . م
- с.
- Thermal properties do not vary with temperature.
 - All surfaces in contact with the primary coolant are assumed to have an infinite heat transfer coefficient. с,
 - Outside surfaces are perfectly insulated. e e

Results:

in Figures B-51 thru B-55 and the thermal moments are Temperature distributions were obtained for times during a 100°F/hr heatup from 100°F to 547°F. These distributions are shown on nodal layouts in Figures B-10 considered. At these locations, the radial gradients continuity where the effects of radial gradients were obtained for the mean temperature at the cut and the Figure B-50 shows the locations of dis-The radial gradient plots are found were plotted, and from these gradients values were tabulated on Page B-101. thermal moment. thru B-13.

These Gradients in the axial direction were also plotted for the nozzle at times during the heatup transient. plots are found in Figures B-84 and B-85.

simply be mirror images of those for the heatup transfent. Temperature distributions were not obtained for the cooland at the same rate as heatup, cooldown gradients would Also, the values for thermal moments which were obtained down translent. Since cooldown is over the same range for heatup, with signs reversed, can be used for corresponding times during cooldown.

The results of normal heatup and cooldown were used for the hydrostatic test transients as described for the flanges in B.4.1.

inlet coolant temperature since there is no heat sink. At steady state, the nozzle will be isothermal at the

 The operating transients for the inlet nozzle were investigated in the same manner as for the flange analysis in Section B.4.1. The results are presented on Page B-122. B.4.3 Outlet Nozzle: A representative section of the outlet mozzle was divided into a series of nodes as in Figure B-14 on Page B-36. This model, consisting of a cylindrical sector with an angle of one redian, was used to perform a thermal analysis using the method described in B.3.1. Assumptions: a. Two-dimensional heat flow. b. Heat generation negligible. c. Thermal properties do not vary with temperature. d. Huurfaces in contact with the primary coolant are assumed to have an infinite heat transfer coefficient. e. Outside surfaces perfectly insulated. Temperature distributions in the outlet nozzle were obtained for the following translent. d. Heatup: Inside surfaces are heated from 100°F to 547°F at a linear rate of 100°F/hr. Both inlet and outlet fuldis follow the same translent. d. 100% Fower Steady State: The coolant inside the nozzle is held at 555°F. Operating Transients: Temperature distributions were obtained for operating translent folloding provident build provide the sol of sol Full fullies on the following step reduction from 100% to 50% load, reactor trip from full power, bas of flow, one pump and loss of load. Fluid translents for these cases are found in the Equipment Specification. 		B-17	
 nozzle was divided into a series of notes as in Figure B-14 on Page B-36. This model, consisting of a cylindrical sector with an angle of one radian, was used to perform a thermal analysis using the method described in B.3.1. Assumptions: a. Two-dimensional heat flow. b. Heat generation negligible. c. Thermal properties do not vary with temperature. d. All surfaces in contact with the primary coolant are assumed to have an infinite heat transfer coefficient. e. Outside surfaces perfectly insulated. Temperature distributions in the outlet nozzle were obtained for the following translent and steady state conditions. a. Heatup: Inside surfaces are heated from 100°F to 547°F at a linear rate of 100°F/nr. Both inlet and outlet fluids follow the same transient. b. 100% Power Steady State: The coolant inside the nozzle is held at 555°F. c. Operating Transients: Temperature distributions were obtained for operating transients including plant loading and unloading, step reduction from 100% to 50% load, reactor trip from flui power, Noss of flow, one pump and loss of load. Fluid transients for these cases are found in the Equipment Specification. 		investigated in the same manner as for the flange analysis in Section B.4.1. The results are presented	
 a. Two-dimensional heat flow. b. Heat generation negligible. c. Thermal properties do not vary with temperature. d. All surfaces in contact with the primary coolant are assumed to have an infinite heat transfer coefficient. e. Outside surfaces perfectly insulated. Temperature distributions in the outlet nozzle were obtained for the following transient and steady state conditions. a. Heatup: Inside surfaces are heated from 100°F to 547°F at a linear rate of 100°F/hr. Both inlet and outlet fluids follow the same transient. b. 100% Power Steady State: The coolant inside the nozzle is held constant at 613°P while the coolant contacting the vessel shell adjacent to the nozzle is held at 555°F. c. Operating Transients: Temperature distributions were obtained for operating transients including plant loading and unloading, step reduction from 100% to 50% load, reactor trip from full power, loss of flow, one pump and loss of load. Fluid transients for these cases are found in the Equipment Specification. Results: 	в.4.3	nozzle was divided into a series of nodes as in Figure B-14 on Page B-36. This model, consisting of a cylindrical sector with an angle of one radian, was used to perform a thermal analysis using the method	
 b. Heat generation negligible. c. Thermal properties do not vary with temperature. d. All surfaces in contact with the primary coolant are assumed to have an infinite heat transfer coefficient. e. Outside surfaces perfectly insulated. Temperature distributions in the outlet nozzle were obtained for the following transient and steady state conditions. a. Heatup: Inside surfaces are heated from 100°F to 547°F at a linear rate of 100°F/hr. Both inlet and outlet fluids follow the same transient. b. 100% Power Steady State: The coolant inside the nozzle is held constant at 613°F while the coolant contacting the vessel shell adjacent to the nozzle is held at 555°F. c. Operating Transients: Temperature distributions were obtained for orpherating transients including plant loading and unloading, step reduction from 100% to 50% load, reactor trip from full power, loss of flow, one pump and loss of load. Fluid transients for these cases are found in the Equipment Specification. Results: Nodal layouts of the outlet nozzle showing temperature distributions for times during heat uploading the plant uploading, at 100% power steady state and during plant uploading 		Assumptions:	
 tained for the following transient and steady state conditions. a. Heatup: Inside surfaces are heated from 100°F to 547°F at a linear rate of 100°F/hr. Both inlet and outlet fluids follow the same transient. b. 100% Power Steady State: The coolant inside the nozzle is held constant at 613°F while the coolant contacting the vessel shell adjacent to the nozzle is held at 555°F. c. Operating Transients: Temperature distributions were obtained for operating transients including plant loading and unloading, step reduction from 100% to 50% load, reactor trip from full power, loss of flow, one pump and loss of load. Fluid transients for these cases are found in the Equipment Specification. Results: Nodal layouts of the outlet nozzle showing temperature distributions for times during heatup, plant loading, at 100% power steady state and during plant unloading 		 b. Heat generation negligible. c. Thermal properties do not vary with temperature. d. All surfaces in contact with the primary coolant are assumed to have an infinite heat transfer coefficient. 	125
 547°F at a linear rate of 100°F/hr. Both inlet and outlet fluids follow the same transient. b. 100% Power Steady State: The coolant inside the nozzle is held constant at 613°F while the coolant contacting the vessel shell adjacent to the nozzle is held at 555°F. c. Operating Transients: Temperature distributions were obtained for operating transients including plant loading and unloading, step reduction from 100% to 50% load, reactor trip from full power, loss of flow, one pump and loss of load. Fluid transients for these cases are found in the Equipment Specification. Results: Nodal layouts of the outlet nozzle showing temperature distributions for times during heatup, plant loading, at 100% power steady state and during plant unloading 		tained for the following transient and steady state	
 nozzle is held constant at 613°F while the coolant contacting the vessel shell adjacent to the nozzle is held at 555°F. c. Operating Transients: Temperature distributions were obtained for operating transients including plant loading and unloading, step reduction from 100% to 50% load, reactor trip from full power, loss of flow, one pump and loss of load. Fluid transients for these cases are found in the Equipment Specification. Results: Nodal layouts of the outlet nozzle showing temperature distributions for times during heatup, plant loading, at 100% power steady state and during plant unloading 		$547^{\circ}F$ at a linear rate of $100^{\circ}F/hr$. Both inlet and	
obtained for operating transients including plant loading and unloading, step reduction from 100% to 50% load, reactor trip from full power, loss of flow, one pump and loss of load. Fluid transients for these cases are found in the Equipment Specification. Results: Nodal layouts of the outlet nozzle showing temperature distributions for times during heatup, plant loading, at 100% power steady state and during plant unloading		nozzle is held constant at $613^{\circ}F$ while the coolant contacting the vessel shell adjacent to the nozzle	
Nodal layouts of the outlet nozzle showing temperature distributions for times during heatup, plant loading, at 100% power steady state and during plant unloading		obtained for operating transients including plant loading and unloading, step reduction from 100% to 50% load, reactor trip from full power, loss of flow, one pump and loss of load. Fluid transients for	
distributions for times during heatup, plant loading, at 100% power steady state and during plant unloading		Results:	
		distributions for times during heatup, plant loading, at 100% power steady state and during plant unloading	•
			•

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is a sketch of the nozzle showing the locations of discontinuity where effects of radial gradients were considered. At these locations, radial gradients were plotted for the conditions above. From these gradients, values were obtained for the mean temperature at the cut and the thermal moment. The radial gradient plots are found in Figures B-57 thru B-71 and the resulting thermal moments are tabulated on Pages B-102 and B-103.

Axial gradients were also plotted for the nozzle at times during heatup, plant loading at 100% power steady state and during plant unloading. They are found in Figures B-86 thru B-91.

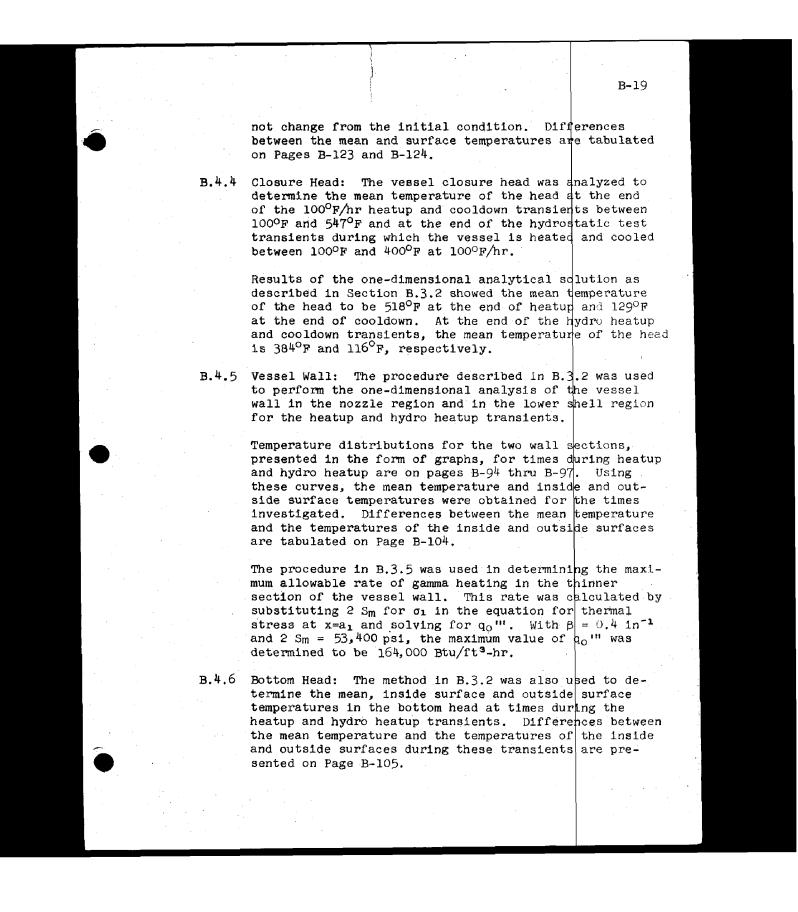
As in the inlet nozzle analysis, the cooldown transient was not completely analyzed. The gradients are mirror images of those for heatup and the thermal moments, with reversed signs, can be used for corresponding times during cooldown.

At zero power steady state, both inlet and outlet fluids are at $547^{\circ}F$. With the outer surface of the nozzle insulated there is no heat sink. Therefore, at this steady state the nozzle will be isothermal at $547^{\circ}F$.

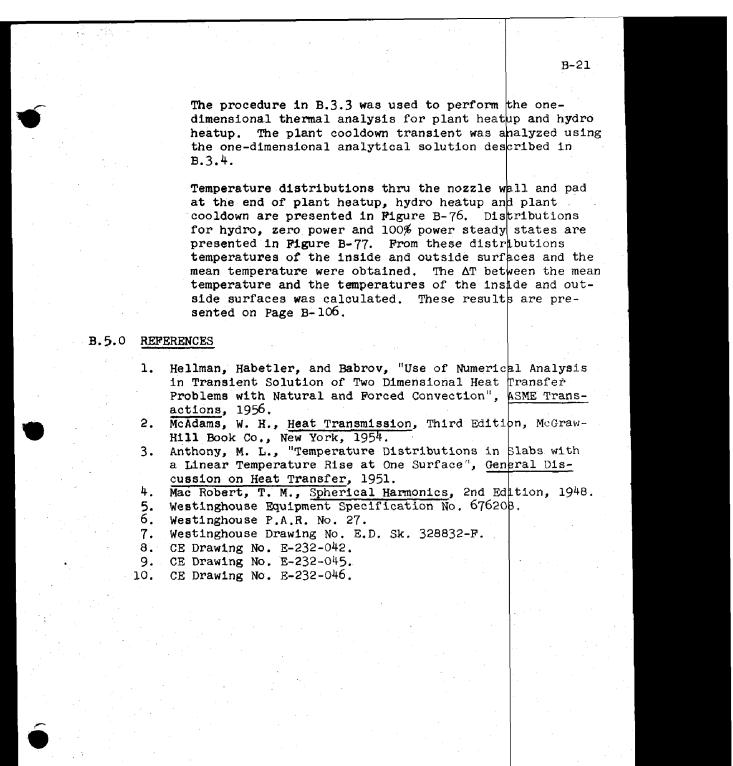
The results of heatup and cooldown were also used for the plant hydrostatic test transients as described for the flange analysis in B.4.1.

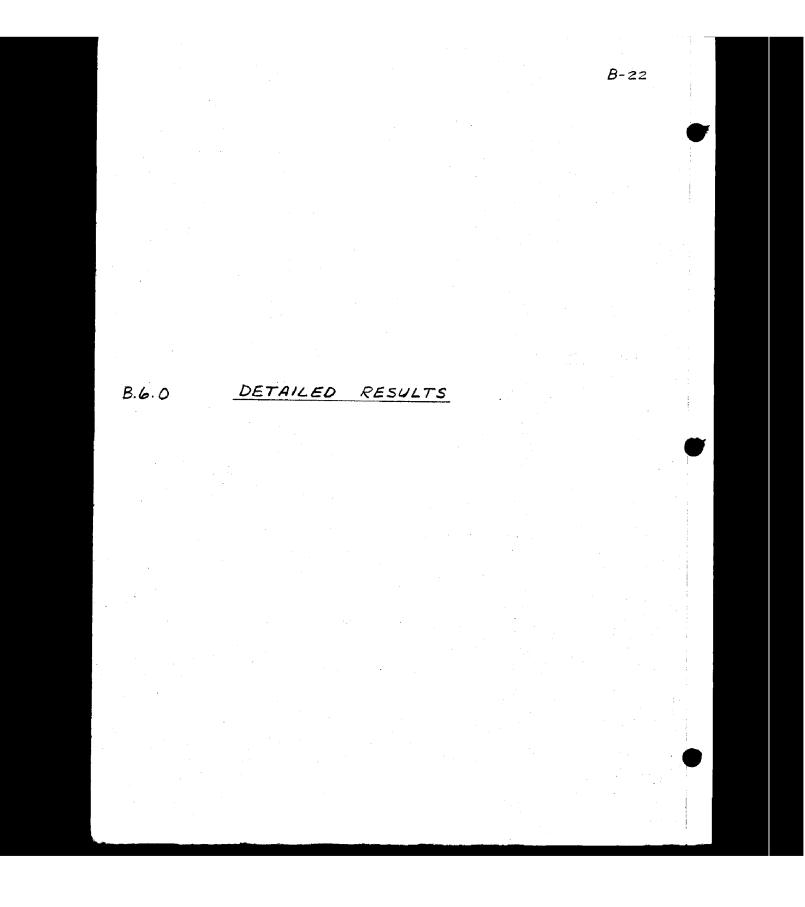
Temperature distributions for operating transients including step reduction from 100% to 50% load, reactor trip from full power, loss of flow, one pump and loss of load are presented in Figures B-27 thru B-38. These transients have faster rates than heatup, plant loading and plant unloading, and their effects are only seen a short distance from the surface. In view of this, it was conservative to consider the inside surface follows the fluid temperature and calculate the ΔT between the mean temperature differences are tabulated on Pages B-123 and B-124.

For the step load transients of $\pm 10\%$ of full power and steam break from hot zero power where both inlet and outlet fluids follow the same transient, the inside surface temperature was assumed to follow the fluid temperature while the mean temperature of the nozzle did



 B.4.7 Vessel Supports: The vessel is supported off the nonzoles. Four nozzles, two inlet and two outlet, are used in the support arrangement. These nozzles have integral pads built up on the bottom sides and rest on support shoes. The support shoes are attached to a ring girder which rests on a concrete foundation. Although both inlet and outlet nozzles are used for supports, the geometry of the inlet nozzle presents the more severe case and was used for both nozzles in the analysis. The following transients and steady state conditions were investigated. For all conditions, the back surface is held at 100°P. This temperature represents the temperature at the bottom of the support shoe and is assumed to be equal to the ambient temperature? a. Plant Heatup - Inside surface is heated from 100°F to 547°F at a linear rate of 100°F/hr. b. Hydro Heatup - Inside surface is heated from 100°F to 400°P at a linear rate of 100°F/hr. c. Steady State - at steady state, the temperature distribution through the nozzle wall and pad is assumed to be linear batween the fluid temperature inside the nozzle and 100°F at the bottom of the support shoe. Inside temperatures for the steady states investigated are: Hydro Steady State - 400°F (inlet and outlet nozzles). Zero Power Steady State - 557°F (inlet nozzle only). Godowr Steady State - 613° (outlet nozzle only). 4. Hodro Prot the surface is cooled from 547°F to 100°F at insertions is cooled from 547°F to 100°F at a linear rate of 100°F/hr. The initial condition for this transient is the zero power steady state distribution. 		В-20
 zles. Four nozzles, two inlet and two outlet, are used in the support arrangement. These nozzles have integral pads built up on the bottom sides and rest on support shoes. The support shoes are attached to a ring girder which rests on a concrete foundation. Although both inlet and outlet nozzles are used for supports, the geometry of the inlet nozzle presents the more severe case and was used for both nozzles in the analysis. The following transients and steady state conditions were investigated. For all conditions, the back surface is held at 100°P. This temperature represents the temperature at the bottom of the support shoe and is assumed to be equal to the ambient temperature. a. Plant Heatup - Inside surface is heated from 100°F to 547°P at a linear rate of 100°P/hr. b. Hydro Heatup - Inside surface is heated from 100°F to 400°P at a linear rate of 100°P/Hr. c. Steady State - at steady state, the temperature distribution through the nozzle wall and pad is assumed to be linear between the fluid temperature inside the nozzle and 100°P at the bottom of the support shoe. Inside temperatures for the steady states investigated are: Hydro Steady State - 547°F (inlet and outlet nozzles). 100% Power Steady State - 547°F (inlet nozzle only). 100% Power Steady State - 613° (outlet nozzle only). d. Plant Cooldown - Inside surface is cooled from 547°F to 100°F at a linear rate of 100°F/hr. The initial condition for this transient is the zero power steady state distribution. e. Hydro Cooldown - This transient starts from the hydro steedy state. The inside surface is cooled from 400°P to 100°F at 100°F/hr. The distribution at the end of hydro cooldown is assumed to be the same as that for 	<u></u>	Voggel Gumenter The second
 ring girder which rests on a concrete foundation. Although both inlet and outlet nozzles are used for supports, the geometry of the inlet nozzle presents the more severe case and was used for both nozzles in the analysis. The following transients and steady state conditions were investigated. For all conditions, the back surface is held at 100°P. This temperature represents the tempera- ture at the bottom of the support shoe and is assumed to be equal to the ambient temperature. a. Plant Heatup - Inside surface is heated from 100°F to 547°F at a linear rate of 100°F/hr. b. Hydro Heatup - Inside surface is heated from 100°F to 400°F at a linear rate of 100°F/Hr. c. Steady State - at steady state, the temperature dis- tribution through the nozzle wall and pis assumed to be linear between the fluid temperature inside the nozzle and 100°F at the bottom of the support shoe. Inside temperatures for the steady states investi- gated are: 1. Hydro Steady State - 400°F (inlet and outlet nozzles). 3. 100% Fower Steady State - 557°F (inlet nozzle only). 4. 100% Fower Steady State - 613° (outlet nozzle only). d. Flant Cooldown - Inside surface is cooled from 547°F to 100°F at a linear rate of 100°F/hr. The initial condition for this transient is the zero power steady state distribution. e. Hydro Cooldown - This transient starts from the hydro steady state. The inside surface is cooled from 400°F to 100°F at 100°F/hr. The distribution at the ed of hydro cooldown he assumed to be the same as that for 	B.4.7	zles. Four nozzles, two inlet and two outlet, are used in the support arrangement. These nozzles have inte- gral pads built up on the bottom sides and rest on
 the more severe case and was used for both nozzles in the analysis. The following transients and steady state conditions were investigated. For all conditions, the back surface is held at 100°P. This temperature represents the temperature at the bottom of the support shoe and is assumed to be equal to the ambient temperature. a. Plant Heatup - Inside surface is heated from 100°P to 547°P at a linear rate of 100°P/hr. b. Hydro Heatup - Inside surface is heated from 100°F to 400°P at a linear rate of 100°P/hr. c. Steady State - at steady state, the temperature distribution through the nozzle wall and pad is assumed to be linear between the fluid temperature inside the nozzle and 100°P at the bottom of the support shoe. Inside temperatures for the steady states investigated are: Hydro Steady State - 597°F (inlet and outlet nozzles). 100% Power Steady State - 597°F (inlet nozzle only). Flant Cooldown - Inside surface is cooled from 547°F to 100°P at a linear rate of 100°P/hr. The initial condition for this transient is the zero power steady state distribution. 		ring girder which rests on a concrete foundation. Although both inlet and outlet nozzles are used for
 investigated. For all conditions, the back surface is held at 100°P. This temperature represents the temperature at the bottom of the support shoe and is assumed to be equal to the ambient temperature. a. Plant Heatup - Inside surface is heated from 100°F to 547°F at a linear rate of 100°F/hr. b. Hydro Heatup - Inside surface is heated from 100°F to 400°F at a linear rate of 100°F/Hr. c. Steady State - at steady state, the temperature distribution through the nozzle wall and pad is assumed to be linear between the fluid temperature inside the nozzle and 100°F at the bottom of the support shoe. Inside temperatures for the steady states investigated are: Hydro Steady State - 400°F (inlet and outlet nozzles). Zero Power Steady State - 555°F (inlet nozzle only). 100% Power Steady State - 613° (outlet nozzle only). d. Plant Cooldown - Inside surface is cooled from 547°F to 100°F at linear rate of 100°F/hr. The initial condition for this transient is the zero power steady state distribution. e. Hydro Cooldown - This transient starts from the hydro steady state. The inside surface is cooled from 400°F to 100°F at 100°F/hr. The initial condition for this transient starts from the hydro steady state. The inside surface is cooled from 400°F to 100°F at 100°F/hr. The initial condition for this transient starts from the hydro steady state. The inside surface is cooled from 400°F to 100°F at 100°F/hr. The initial condition for this transient starts from the hydro steady state. The inside surface is cooled from 400°F to 100°F at 100°F/hr. The initial condition for this transient starts from the hydro steady state. The inside surface is cooled from 400°F to 100°F at 100°F/hr. The initial condition for this transient starts from the hydro steady state. The inside surface is cooled from 400°F to 100°F at 100°F/hr. The initial condition for this transient starts from the hydro steady state. The inside surface is cooled from 400°F to 100°		the more severe case and was used for both nozzles in
 a. Plant Heatup - Inside surface is heated from 100°F to 547°F at a linear rate of 100°F/hr. b. Hydro Heatup - Inside surface is heated from 100°F to 400°F at a linear rate of 100°F/Hr. c. Steady State - at steady state, the temperature distribution through the nozzle wall and pad is assumed to be linear between the fluid temperature inside the nozzle and 100°F at the bottom of the support shoe. Inside temperatures for the steady states investigated are: Hydro Steady State - 400°F (inlet and outlet nozzles). Zero Power Steady State - 547°F (inlet nozzle only). I00% Power Steady State - 547°F (inlet nozzle only). d. Plant Cooldown - Inside surface is cooled from 547°F to 100°F at a linear rate of 100°F/hr. The initial condition for this transient is the zero power steady state distribution. e. Hydro Cooldown - This transient starts from the hydro steady state. The inside surface is cooled from 400°F to 100°F to 100°F/hr. The distribution at the end of hydro cooldown is assumed to be the same as that for 		investigated. For all conditions, the back surface is held at 100°F. This temperature represents the tempera- ture at the bottom of the support shoe and is assumed to
 b. Hydro Heatup - Inside surface is heated from 100°F to 400°F at a linear rate of 100°F/Hr. c. Steady State - at steady state, the temperature distribution through the nozzle wall and pad is assumed to be linear between the fluid temperature inside the nozzle and 100°F at the bottom of the support shoe. Inside temperatures for the steady states investigated are: Hydro Steady State - 400°F (inlet and outlet nozzles). Zero Power Steady State - 547°F (inlet nozzle only). 100% Power Steady State - 555°F (inlet nozzle only). 100% Power Steady State - 613° (outlet nozzle only). d. Plant Cooldown - Inside surface is cooled from 547°F to 100°F at a linear rate of 100°F/hr. The initial condition for this transient is the zero power steady state distribution. e. Hydro Cooldown - This transient starts from the hydro steady state. The inside surface is cooled from 400°F to 100°F at 100°F/hr. The distribution at the end of hydro cooldown is assumed to be the same as that for 		a. Plant Heatup - Inside surface is heated from 100 ⁰ F
 tribution through the nozzle wall and pad is assumed to be linear between the fluid temperature inside the nozzle and 100°F at the bottom of the support shoe. Inside temperatures for the steady states investigated are: Hydro Steady State - 400°F (inlet and outlet nozzles). Zero Power Steady State - 547°F (inlet and outlet nozzles). 100% Power Steady State - 555°F (inlet nozzle only). 100% Power Steady State - 613° (outlet nozzle only). Plant Cooldown - Inside surface is cooled from 547°F to 100°F at a linear rate of 100°F/hr. The initial condition for this transient is the zero power steady state distribution. Hydro Cooldown - This transient starts from the hydro steady state. The inside surface is cooled from 400°F to 100°F/hr. The distribution at the end of hydro cooldown is assumed to be the same as that for 		b. Hydro Heatup - Inside surface is heated from 100°F
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(38) B-1 - B38 11x17	
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