Quality Assurance Block

Caepipe

Version 7.60

Client	:	Users
Project	:	Tutorial
File Number	:	
Report Number	:	Sample Problem
Model Name	:	Sample
Title	:	Sample problem
Analyzed	:	Fri Sep 23 17:28:17 2016

Prepared by : _____ Date:
SST Systems, Inc.

Checked by : _____ Date:

Table of Contents

Table of Contents

Analysis Options

Code : Piping code = B31.3 (2014)
Include axial force in stress calculations
Do not use liberal allowable stresses

Temperature : Reference temperature = 70 (F)
Number of thermal cycles = 7000
Number of thermal loads = 1
Thermal = Operating - Sustained
Use modulus at reference temperature

Pressure : Pressure stress = PD / 4t
Peak pressure factor = 1.00
Do not include Bourdon effect
Use pressure correction for bends

Dynamics : Cut off frequency = 33 Hz
Number of modes = 20
Include missing mass correction
Do not use friction in dynamic analysis

Misc. : Include hanger stiffness
Vertical direction = Y

Layout (11)

#	Node	Type	DX (ft'in")	DY (ft'in")	DZ (ft'in")	Matl	Sect	Load	Data
1	Title = Sample problem								
2	10	From							Anchor
3	20	Bend	9'0"			A53	8	1	
4	30				6'0"	A53	8	1	Hanger
5	40	Bend			6'0"	A53	8	1	
6	50			-6'0"		A53	8	1	Anchor
7	6" std pipe								
8	30	From							
9	60		6'0"			A53	6	1	
10	70	Valve	2'0"			A53	6	1	
11	80		6'0"			A53	6	1	Anchor

Anchors (3)

Node	Tag	KX/kx (lb/inch)	KY/ky (lb/inch)	KZ/kz (lb/inch)	KXX/kxx (in-lb/deg)	KYY/kyy (in-lb/deg)	KZZ/kzz (in-lb/deg)	Releases						Anchor in Pipe
								X	Y	Z	XX	YY	ZZ	
10		Rigid	Rigid	Rigid	Rigid	Rigid	Rigid							GCS
50		Rigid	Rigid	Rigid	Rigid	Rigid	Rigid							GCS
80		Rigid	Rigid	Rigid	Rigid	Rigid	Rigid							GCS

Bends (2)

Bend Node	Radius (inch)	Rad. Type	Thk (inch)	Bend Matl	Flex. Fact.	SIF	Int. Node	Angle (deg)	Int. Node	Angle (deg)
20	12	Long								
40	18	User								

Hangers (1)

Node	Tag	Type	No of	Load var%	Short range	Spring rate (lb/inch)	Load (lb)	Load Type	CNode
30		Grinnell	1	25					

Specified Displacements (1)

Node	Type	Load	X/x (inch)	Y/y (inch)	Z/z (inch)	XX/xx (deg)	YY/yy (deg)	ZZ/zz (deg)	Disp. in Pipe
50	Anchor	T1		0.5					GCS

Valves (1)

From	To	Weight (lb)	Length (inch)	Thick X	Insul Wgt X	Add.Wgt (lb)	Offsets of Add.Wgt		
							DX (inch)	DY (inch)	DZ (inch)
60	70	200		3.00	1.75	50	0	18	0

Coordinates (12)

Node	X (ft'in")	Y (ft'in")	Z (ft'in")
10	0	0	0
20A	8'0"	0	0
20	9'0"	0	0
20B	9'0"	0	1'0"
30	9'0"	0	6'0"
40A	9'0"	0	10'6"
40	9'0"	0	12'0"
40B	9'0"	-1'6"	12'0"
50	9'0"	-6'0"	12'0"
60	15'0"	0	6'0"
70	17'0"	0	6'0"
80	23'0"	0	6'0"

Pipe material A53: A53 Grade B

Density = 0.283 (lb/in3), Nu = 0.300, Joint factor = 1.00, Type = CS
Yield strength =

Temp (F)	E (psi)	Alpha (in/in/F)	Allowable (psi)
-325	31.4E+6	5.00E-6	20000
-200	30.8E+6	5.35E-6	20000
-100	30.2E+6	5.65E-6	20000
70	29.5E+6	6.07E-6	20000
200	28.8E+6	6.38E-6	20000
300	28.3E+6	6.60E-6	20000
400	27.7E+6	6.82E-6	20000
500	27.3E+6	7.02E-6	18900
600	26.7E+6	7.23E-6	17300
650	26.1E+6	7.33E-6	17000
700	25.5E+6	7.44E-6	16500
750	24.9E+6	7.54E-6	13000
800	24.2E+6	7.65E-6	10800
850	23.3E+6	7.75E-6	8700
900	22.4E+6	7.84E-6	6500
950	21.4E+6	7.91E-6	4500
1000	20.4E+6	7.97E-6	2500
1050	19.2E+6	8.05E-6	1600
1100	18.0E+6	8.12E-6	1000

Pipe Sections (2)

Name	Nom Dia	Sch	OD (inch)	Thk (inch)	Cor.Al (inch)	M.Tol (%)	Ins.Dens (lb/ft3)	Ins.Thk (inch)	Lin.Dens (lb/ft3)	Lin.Thk (inch)	Soil
8	8"	80	8.625	0.5			11	2			
6	6"	STD	6.625	0.28			11	2			

Pipe Loads (1)

Name	T1 (F)	P1 (psi)	Specific gravity	Add.Wgt. (lb/ft)	Wind Load
1	600	200	0.8		

B31.3 (2014) Code compliance (Sorted stresses)

Sustained				Expansion			
Node	SL (psi)	SH (psi)	SL / SH	Node	SE (psi)	SA (psi)	SE / SA
80	2494	17300	0.14	30	52599	29325	1.79
60	2177	17300	0.13	50	50206	29325	1.71
70	2108	17300	0.12	20A	47227	29325	1.61
30	2011	17300	0.12	20B	33453	29325	1.14
10	1426	17300	0.08	10	32036	29325	1.09
40B	1049	17300	0.06	80	27059	29325	0.92
20B	976	17300	0.06	40A	18684	29325	0.64
20A	935	17300	0.05	60	17392	29325	0.59
50	923	17300	0.05	70	11772	29325	0.40
40A	900	17300	0.05	40B	10185	29325	0.35

B31.3 (2014) Code Compliance

Node	Press. Allow. (psi)	Sustained SL (psi)	Sustained SH (psi)	Sustained SL / SH	Expansion SE (psi)	Expansion SA (psi)	Expansion SE / SA
10	200	1426	17300	0.08	32036	29325	1.09
20A	2006	929	17300	0.05	28048	29325	0.96
20A	200	935	17300	0.05	47227	29325	1.61
20B	2006	976	17300	0.06	33453	29325	1.14
20B	200	964	17300	0.06	19604	29325	0.67
30	2006	1745	17300	0.10	52599	29325	1.79
30	200	1737	17300	0.10	47275	29325	1.61
40A	2006	900	17300	0.05	15733	29325	0.54
40A	200	900	17300	0.05	18684	29325	0.64
40B	2006	1049	17300	0.06	10185	29325	0.35
40B	200	1049	17300	0.06	9174	29325	0.31
50	2006	923	17300	0.05	50206	29325	1.71
30	200	2011	17300	0.12	37277	29325	1.27
60	1462	2177	17300	0.13	17392	29325	0.59
70	200	2108	17300	0.12	11772	29325	0.40
80	1462	2494	17300	0.14	27059	29325	0.92

Hanger Report

Node	No of	Type	Figure No.	Size	Spring rate (lb/inch)	Vert travel (inch)	Horz travel (inch)	Hot load (lb)	Cold load (lb)	Var (%)
30	1	Grinnell	B-268	10	260	0.600	0.604	1249	1405	12

Support load summary for anchor at node 10

Load combination	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)	Displacements (global) X (inch)	Y (inch)	Z (inch)
Sustained	-13	-385	26	-365	-171	-1118	0.000	0.000	0.000
Operating1	-28550	1474	-13762	-6909	57834	16248	0.000	0.000	0.000
Maximum	-13	1474	26	-365	57834	16248	0.000	0.000	0.000
Minimum	-28550	-385	-13762	-6909	-171	-1118	0.000	0.000	0.000
Allowables	0	0	0	0	0	0	0.000	0.000	0.000

Support load summary for anchor at node 50

Load combination	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)	Displacements (global)		
							X (inch)	Y (inch)	Z (inch)
Sustained	-40	-194	-27	124	103	-87	0.000	0.000	0.000
Operating1	-17724	-4258	12531	48050	13222	88895	0.000	0.500	0.000
Maximum	-40	-194	12531	48050	13222	88895	0.000	0.500	0.000
Minimum	-17724	-4258	-27	124	103	-87	0.000	0.000	0.000
Allowables	0	0	0	0	0	0	0.000	0.000	0.000

Support load summary for anchor at node 80

Load combination	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)	Displacements (global)		
							X (inch)	Y (inch)	Z (inch)
Sustained	54	-365	1	-23	17	935	0.000	0.000	0.000
Operating1	46275	1685	1231	-1594	5074	-11290	0.000	0.000	0.000
Maximum	46275	1685	1231	-23	5074	935	0.000	0.000	0.000
Minimum	54	-365	1	-1594	17	-11290	0.000	0.000	0.000
Allowables	0	0	0	0	0	0	0.000	0.000	0.000

Support load summary for hanger at node 30

Load combination	Load (lb)	Displacements (global)		
		X (inch)	Y (inch)	Z (inch)
Sustained	-1404	0.000	0.004	0.002
Operating1	-1249	-0.601	0.600	-0.055
Maximum	-1249	0.000	0.600	0.002
Minimum	-1404	-0.601	0.004	-0.055

Loads on Anchors: Sustained (W+P)

Node	Tag	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)
10		-13	-385	26	-365	-171	-1118
50		-40	-194	-27	124	103	-87
80		54	-365	1	-23	17	935

Loads on Hangers: Sustained (W+P)

Node	Tag	Type	Load (lb)	No.of	Total (lb)
30		Grinnell	-1404	1	-1404

Pipe forces in local coordinates: Sustained (W+P)

Node	Axial (lb)	y Shear (lb)	z Shear (lb)	Torque (ft-lb)	Inplane(ft-lb)		Outplane(ft-lb)		SL (psi)
					Moment	SIF	Moment	SIF	
10	-13	-385	26	-365	-1118		-171		1426
20A	-13	129	26	-365	-97		35		929
20A	-13	26	-129	-365	-35	1.75	-97	1.46	935
20B	26	13	-230	-264	-74	1.75	171	1.46	976
20B	26	230	13	-264	171		74		964
30	26	552	13	-264	-1784		140		1745
30	27	-536	-40	329	-1762		139		1737
40A	27	-247	-40	329	-1		-43		900
40A	27	247	40	329	1	1.33	43	1.11	900
40B	95	-27	40	103	-245	1.33	-269	1.11	1049
40B	95	-40	-27	103	-269		245		1049
50	-194	-40	-27	103	-87		124		923
30	-54	-316	-1	23	-593		1		2011
60	-54	-118	-1	23	710		-7		2177

Pipe forces in local coordinates: Sustained (W+P)

Node	Axial (lb)	y Shear (lb)	z Shear (lb)	Torque (ft-lb)	Inplane(ft-lb)		Outplane(ft-lb)		SL (psi)
					Moment	SIF	Moment	SIF	
70	-54	167	-1	23	661		-9		2108
80	-54	365	-1	23	-935		-17		2494

Other forces in local coordinates: Sustained (W+P)

Node	Type	fx (lb)	fy (lb)	fz (lb)	mx (ft-lb)	my (ft-lb)	mz (ft-lb)
60	Valve	-54	-93	-1	23	-7	735
70		-54	142	-1	23	-9	686

Pipe forces in global coordinates: Sustained (W+P)

Node	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)
10	13	385	-26	365	171	1118
20A	-13	129	26	-365	35	-97
20A	13	-129	-26	365	-35	97
20B	-13	230	26	-171	74	-264
20B	13	-230	-26	171	-74	264
30	-13	552	26	1784	140	-264
30	-40	536	-27	-1762	-139	-329
40A	40	-247	27	1	-43	329
40A	-40	247	-27	-1	43	-329
40B	40	-95	27	-245	-103	269
40B	-40	95	-27	245	103	-269
50	40	194	27	-124	-103	87
30	54	316	1	-23	-1	593
60	-54	-118	-1	23	-7	710
70	54	-167	1	-23	9	-661
80	-54	365	-1	23	-17	-935

Other forces in global coordinates: Sustained (W+P)

Node	Type	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)
60	Valve	54	93	1	-23	7	-735
70		-54	142	-1	23	-9	686

Displacements: Sustained (W+P)

Node	Displacements (global)					
	X (inch)	Y (inch)	Z (inch)	XX (deg)	YY (deg)	ZZ (deg)
10	0.000	0.000	0.000	0.0000	0.0000	0.0000
20A	0.000	-0.008	0.002	-0.0100	-0.0014	-0.0056
20B	-0.000	-0.007	0.002	-0.0125	-0.0004	-0.0064
30	0.000	0.004	0.002	-0.0036	0.0010	-0.0110
40A	0.001	0.002	0.002	0.0056	0.0016	-0.0059
40B	0.001	0.000	0.001	0.0022	0.0016	-0.0021
50	0.000	0.000	0.000	0.0000	0.0000	0.0000
60	0.000	-0.012	0.001	-0.0019	0.0008	-0.0016
70	0.000	-0.012	0.001	-0.0017	0.0008	0.0022
80	0.000	0.000	0.000	0.0000	0.0000	0.0000

Loads on Anchors: Expansion (T1)

Node	Tag	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)
10		-28537	1859	-13787	-6544	58005	17366

Loads on Anchors: Expansion (T1)

Node	Tag	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)
50		-17684	-4064	12558	47926	13118	88983
80		46221	2051	1230	-1572	5057	-12225

Loads on Hangers: Expansion (T1)

Node	Tag	Type	Load (lb)	No.of	Total (lb)
30		Grinnell	155	1	155

Pipe forces in local coordinates: Expansion (T1)

Node	Axial (lb)	y Shear (lb)	z Shear (lb)	Torque (ft-lb)	Inplane(ft-lb)		Outplane(ft-lb)		SE (psi)
					Moment	SIF	Moment	SIF	
10	-28537	1859	-13787	-6544	17366		58005		32036
20A	-28537	1859	-13787	-6544	2496		-52294		28048
20A	-28537	-13787	-1859	-6544	52294	1.75	2496	1.46	47227
20B	-13787	28537	-1859	637	37545	1.75	4686	1.46	33453
20B	-13787	1859	28537	637	4686		-37545		19604
30	-13787	1859	28537	637	-4608		105142		52599
30	-12558	4064	-17684	17121	-3036		92985		47275
40A	-12558	4064	-17684	17121	-21325		13407		15733
40A	-12558	-4064	17684	17121	21325	1.33	-13407	1.11	18684
40B	-4064	12558	17684	13118	8584	1.33	9405	1.11	10185
40B	-4064	-17684	12558	13118	9405		-8584		9174
50	-4064	-17684	12558	13118	88983		47926		50206
30	-46221	-2051	-1230	1572	-16483		12157		37277
60	-46221	-2051	-1230	1572	-4180		4779		17392
70	-46221	-2051	-1230	1572	-79		2320		11772
80	-46221	-2051	-1230	1572	12225		-5057		27059

Other forces in local coordinates: Expansion (T1)

Node	Type	fx (lb)	fy (lb)	fz (lb)	mx (ft-lb)	my (ft-lb)	mz (ft-lb)
60	Valve	-46221	-2051	-1230	1572	4779	-4180
70		-46221	-2051	-1230	1572	2320	-79

Pipe forces in global coordinates: Expansion (T1)

Node	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)
10	28537	-1859	13787	6544	-58005	-17366
20A	-28537	1859	-13787	-6544	-52294	2496
20A	28537	-1859	13787	6544	52294	-2496
20B	-28537	1859	-13787	-4686	-37545	637
20B	28537	-1859	13787	4686	37545	-637
30	-28537	1859	-13787	4608	105142	637
30	-17684	-4064	12558	-3036	-92985	-17121
40A	17684	4064	-12558	21325	13407	17121
40A	-17684	-4064	12558	-21325	-13407	-17121
40B	17684	4064	-12558	8584	-13118	-9405
40B	-17684	-4064	12558	-8584	13118	9405
50	17684	4064	-12558	-47926	-13118	-88983
30	46221	2051	1230	-1572	-12157	16483
60	-46221	-2051	-1230	1572	4779	-4180
70	46221	2051	1230	-1572	-2320	79
80	-46221	-2051	-1230	1572	-5057	12225

Other forces in global coordinates: Expansion (T1)

Node	Type	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)
60	Valve	46221	2051	1230	-1572	-4779	4180
70		-46221	-2051	-1230	1572	2320	-79

Displacements: Expansion (T1)

Node	Displacements (global)					
	X (inch)	Y (inch)	Z (inch)	XX (deg)	YY (deg)	ZZ (deg)
10	0.000	0.000	0.000	0.0000	0.0000	0.0000
20A	0.361	0.223	-0.395	-0.1801	0.0605	0.2102
20B	0.283	0.318	-0.285	-0.2535	-0.8884	0.2538
30	-0.601	0.596	-0.057	-0.2540	-0.4414	0.2647
40A	-0.631	0.787	0.148	-0.1090	0.1919	0.5297
40B	-0.364	0.706	0.173	0.2342	0.2030	0.5857
50	0.000	0.500	0.000	0.0000	0.0000	0.0001
60	-0.346	0.460	0.131	-0.1322	0.0636	-0.3513
70	-0.256	0.309	0.100	-0.1218	0.0816	-0.3621
80	0.000	0.000	0.000	0.0000	0.0000	0.0000

Loads on Anchors: Operating (W+P1+T1)

Node	Tag	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)
10		-28550	1474	-13762	-6909	57834	16248
50		-17724	-4258	12531	48050	13222	88895
80		46275	1685	1231	-1594	5074	-11290

Loads on Hangers: Operating (W+P1+T1)

Node	Tag	Type	Load (lb)	No.of	Total (lb)
30		Grinnell	-1249	1	-1249

Pipe forces in local coordinates: Operating (W+P1+T1)

Node	Axial (lb)	y Shear (lb)	z Shear (lb)	Torque (ft-lb)	Inplane(ft-lb)		Outplane(ft-lb)		Sopr (psi)
					Moment	SIF	Moment	SIF	
10	-28550	1474	-13762	-6909	16248		57834		28226
20A	-28550	1988	-13762	-6909	2399		-52260		24457
20A	-28550	-13762	-1988	-6909	52260	1.75	2399	1.46	43603
20B	-13762	28550	-2089	374	37471	1.75	4857	1.46	32106
20B	-13762	2089	28550	374	4857		-37471		18281
30	-13762	2410	28550	374	-6392		105281		51416
30	-12531	3528	-17724	17450	-4798		93123		46319
40A	-12531	3818	-17724	17450	-21326		13365		14872
40A	-12531	-3818	17724	17450	21326	1.33	-13365	1.11	17758
40B	-3969	12531	17724	13222	8339	1.33	9136	1.11	10361
40B	-3969	-17724	12531	13222	9136		-8339		9415
50	-4258	-17724	12531	13222	88895		48050		50417
30	-46275	-2367	-1231	1594	-17076		12158		22586
60	-46275	-2168	-1231	1594	-3470		4773		1525
70	-46275	-1884	-1231	1594	582		2311		3058
80	-46275	-1685	-1231	1594	11290		-5074		10520

Other forces in local coordinates: Operating (W+P1+T1)

Node	Type	fx (lb)	fy (lb)	fz (lb)	mx (ft-lb)	my (ft-lb)	mz (ft-lb)
60	Valve	-46275	-2143	-1231	1594	4773	-3445
70		-46275	-1909	-1231	1594	2311	607

Pipe forces in global coordinates: Operating (W+P1+T1)

Node	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)
10	28550	-1474	13762	6909	-57834	-16248
20A	-28550	1988	-13762	-6909	-52260	2399
20A	28550	-1988	13762	6909	52260	-2399
20B	-28550	2089	-13762	-4857	-37471	374
20B	28550	-2089	13762	4857	37471	-374
30	-28550	2410	-13762	6392	105281	374
30	-17724	-3528	12531	-4798	-93123	-17450
40A	17724	3818	-12531	21326	13365	17450
40A	-17724	-3818	12531	-21326	-13365	-17450
40B	17724	3969	-12531	8339	-13222	-9136
40B	-17724	-3969	12531	-8339	13222	9136
50	17724	4258	-12531	-48050	-13222	-88895
30	46275	2367	1231	-1594	-12158	17076
60	-46275	-2168	-1231	1594	4773	-3470
70	46275	1884	1231	-1594	-2311	-582
80	-46275	-1685	-1231	1594	-5074	11290

Other forces in global coordinates: Operating (W+P1+T1)

Node	Type	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)
60	Valve	46275	2143	1231	-1594	-4773	3445
70		-46275	-1909	-1231	1594	2311	607

Displacements: Operating (W+P1+T1)

	Displacements (global)					
Node	X (inch)	Y (inch)	Z (inch)	XX (deg)	YY (deg)	ZZ (deg)
10	0.000	0.000	0.000	0.0000	0.0000	0.0000
20A	0.361	0.215	-0.393	-0.1901	0.0590	0.2046
20B	0.283	0.311	-0.283	-0.2661	-0.8888	0.2473
30	-0.601	0.600	-0.055	-0.2577	-0.4404	0.2537
40A	-0.630	0.788	0.150	-0.1035	0.1935	0.5238
40B	-0.363	0.706	0.173	0.2364	0.2046	0.5836
50	0.000	0.500	0.000	0.0000	0.0000	0.0001
60	-0.346	0.448	0.132	-0.1341	0.0644	-0.3529
70	-0.256	0.297	0.101	-0.1236	0.0824	-0.3599
80	0.000	0.000	0.000	0.0000	0.0000	0.0000

Frequencies

#	Frequency (Hz)	Period (second)	Participation factors			Modal mass / Total mass		
			X	Y	Z	X	Y	Z
1	14.467	0.0691	0.0232	-1.7618	-0.7857	0.0001	0.5108	0.1016
2	20.716	0.0483	-0.0006	0.5874	-1.9972	0.0000	0.0568	0.6565
3	27.703	0.0361	-0.0833	0.4591	-0.0836	0.0011	0.0347	0.0012
4	31.172	0.0321	-0.1765	-0.0071	0.1134	0.0051	0.0000	0.0021
5	47.239	0.0212	-1.1025	-0.1361	0.0559	0.2000	0.0030	0.0005
6					Total	0.2064	0.6054	0.7618

Mode 1: 14.47 Hz

Node	X (inch)	Y (inch)	Z (inch)	XX (deg)	YY (deg)	ZZ (deg)
10	0.000	0.000	0.000	0.0000	0.0000	-0.0000
20A	-0.000	-0.599	-0.178	-0.0838	0.1259	-0.4887

Mode 1: 14.47 Hz						
Node	X (inch)	Y (inch)	Z (inch)	XX (deg)	YY (deg)	ZZ (deg)
20B	0.010	-0.662	-0.196	-0.1829	0.0111	-0.3598
30	0.003	-0.417	-0.196	-0.2936	-0.0028	-0.1715
40A	0.016	-0.099	-0.196	-0.3471	0.0211	-0.0867
40B	0.008	-0.001	-0.110	-0.2058	0.0248	-0.0253
50	0.000	0.000	0.000	-0.0000	0.0000	0.0000
60	0.001	-0.396	-0.147	-0.1528	-0.0932	0.2329
70	0.001	-0.291	-0.105	-0.1408	-0.1026	0.2658
80	0.000	0.000	0.000	0.0000	0.0000	0.0000
Mode 2: 20.72 Hz						
Node	X (inch)	Y (inch)	Z (inch)	XX (deg)	YY (deg)	ZZ (deg)
10	0.000	0.000	0.000	0.0000	0.0000	0.0000
20A	-0.001	0.312	-0.409	0.1620	0.2830	0.2541
20B	0.023	0.315	-0.448	0.2475	0.0243	0.1838
30	0.003	0.051	-0.448	0.2182	-0.0165	0.1205
40A	-0.019	-0.069	-0.446	-0.0165	-0.0230	0.0666
40B	-0.011	0.001	-0.332	-0.4759	-0.0201	0.0272
50	0.000	0.000	0.000	-0.0001	0.0000	0.0000
60	0.002	0.133	-0.459	0.1136	-0.1921	-0.0420
70	0.001	0.110	-0.365	0.1047	-0.2551	-0.0658
80	0.000	0.000	0.000	0.0000	-0.0000	0.0000
Mode 3: 27.70 Hz						
Node	X (inch)	Y (inch)	Z (inch)	XX (deg)	YY (deg)	ZZ (deg)
10	0.000	0.000	0.000	0.0000	0.0000	-0.0000
20A	0.000	-0.389	-0.025	-0.1672	0.0225	-0.2163
20B	0.005	-0.349	-0.030	-0.3291	0.0157	0.0796
30	-0.004	-0.043	-0.030	-0.1696	-0.0526	0.4581
40A	-0.085	0.004	-0.030	0.0106	-0.0903	0.2623
40B	-0.054	0.001	-0.028	-0.0308	-0.0763	0.1187
50	0.000	0.000	0.000	-0.0000	0.0000	0.0000
60	-0.002	0.820	0.013	-0.0882	-0.0059	0.0330
70	-0.002	0.782	0.014	-0.0813	-0.0000	-0.2072
80	0.000	0.000	0.000	0.0000	0.0000	-0.0000
Mode 4: 31.17 Hz						
Node	X (inch)	Y (inch)	Z (inch)	XX (deg)	YY (deg)	ZZ (deg)
10	0.000	0.000	0.000	0.0000	0.0000	0.0000
20A	0.002	0.088	-0.230	0.1161	0.1788	0.0774
20B	0.030	0.074	-0.262	0.1518	0.0908	0.0730
30	-0.006	-0.066	-0.260	0.0745	-0.2488	0.1033
40A	-0.182	-0.058	-0.260	-0.0941	-0.1285	0.1773
40B	-0.140	-0.000	-0.185	-0.2751	-0.0432	0.2191
50	0.000	0.000	0.000	-0.0000	0.0000	0.0000
60	-0.003	-0.014	0.756	0.0388	-0.2163	0.0096
70	-0.003	-0.010	0.788	0.0357	0.0642	0.0097
80	0.000	0.000	0.000	0.0000	0.0000	0.0000

Mode 5: 47.24 Hz

Node	X (inch)	Y (inch)	Z (inch)	XX (deg)	YY (deg)	ZZ (deg)
10	0.000	0.000	0.000	0.0000	-0.0000	0.0000
20A	0.005	0.061	0.078	0.2044	0.0093	0.0927
20B	0.033	0.043	0.058	0.2217	0.1261	0.1834
30	-0.057	-0.131	0.058	0.0216	-0.5074	0.3887
40A	-0.959	-0.031	0.058	-0.1476	-1.0061	0.8328
40B	-0.845	-0.001	0.066	0.0598	-0.4482	1.2419
50	0.000	0.000	0.000	0.0000	-0.0000	0.0002
60	-0.030	-0.037	-0.100	0.0112	0.2076	-0.0367
70	-0.028	-0.049	-0.170	0.0103	0.1196	-0.0180
80	0.000	0.000	0.000	0.0000	-0.0000	0.0000

Dynamic susceptibility

Mode	Frequency (Hz)	Maxima Nodes		Susceptibility (psi / ips)
		Velocity	Stress	
2	20.716	20A	50	651
4	31.172	70	80	526
3	27.703	60	80	522
1	14.467	20B	10	458
5	47.239	40A	50	384

Dynamic stresses for mode 2: 20.72 Hz, susceptibility = 651

Node	Displacement	Nominal Stress	SIF	Intensified Stress
10	0.0000E+00	2.4253E+04	1.00	2.4253E+04
20A	5.1464E-01	7.2042E+03	1.75	1.2621E+04
20B	3.1603E-01	6.5586E+03	1.75	1.1490E+04
30	4.5042E-01	1.1026E+04	1.00	1.1026E+04
40A	7.1095E-02	1.5026E+04	1.33	2.0036E+04
40B	3.3247E-01	4.6789E+03	1.33	6.2390E+03
50	0.0000E+00	4.3594E+04	1.00	4.3594E+04
60	4.7791E-01	2.0719E+04	1.00	2.0719E+04
70	3.8088E-01	1.6773E+04	1.00	1.6773E+04
80	0.0000E+00	2.9217E+04	1.00	2.9217E+04

Dynamic stresses for mode 4: 31.17 Hz, susceptibility = 526

Node	Displacement	Nominal Stress	SIF	Intensified Stress
10	0.0000E+00	1.0999E+04	1.00	1.0999E+04
20A	2.4583E-01	2.1307E+03	1.75	3.7328E+03
20B	8.0321E-02	4.1783E+03	1.75	7.3199E+03
30	2.6826E-01	7.6524E+04	1.00	7.6524E+04
40A	1.9138E-01	8.4854E+03	1.33	1.1315E+04
40B	2.3230E-01	1.3824E+03	1.33	1.8433E+03
50	0.0000E+00	2.9275E+04	1.00	2.9275E+04
60	7.5608E-01	7.7947E+04	1.00	7.7947E+04
70	7.8791E-01	7.8185E+04	1.00	7.8185E+04
80	0.0000E+00	8.1229E+04	1.00	8.1229E+04

Dynamic stresses for mode 3: 27.70 Hz, susceptibility = 522

Node	Displacement	Nominal Stress	SIF	Intensified Stress
10	0.0000E+00	2.1321E+04	1.00	2.1321E+04
20A	3.8978E-01	1.1293E+04	1.75	1.9784E+04

Dynamic stresses for mode 3: 27.70 Hz, susceptibility = 522				
Node	Displacement	Nominal Stress	SIF	Intensified Stress
20B	3.4884E-01	2.5351E+03	1.75	4.4412E+03
30	5.2118E-02	4.8964E+04	1.00	4.8964E+04
40A	8.5110E-02	1.8179E+03	1.33	2.4240E+03
40B	6.0834E-02	5.5023E+03	1.33	7.3370E+03
50	0.0000E+00	6.1334E+03	1.00	6.1334E+03
60	8.1961E-01	6.9123E+04	1.00	6.9123E+04
70	7.8222E-01	6.4624E+04	1.00	6.4624E+04
80	0.0000E+00	7.4437E+04	1.00	7.4437E+04

Dynamic stresses for mode 1: 14.47 Hz, susceptibility = 458				
Node	Displacement	Nominal Stress	SIF	Intensified Stress
10	0.0000E+00	2.7555E+04	1.00	2.7555E+04
20A	6.2501E-01	4.5257E+03	1.75	7.9286E+03
20B	6.6251E-01	4.2845E+03	1.75	7.5060E+03
30	4.6106E-01	7.7924E+03	1.00	7.7924E+03
40A	1.0051E-01	1.4102E+03	1.33	1.8804E+03
40B	1.0993E-01	5.9954E+03	1.33	7.9945E+03
50	0.0000E+00	1.1278E+04	1.00	1.1278E+04
60	4.2228E-01	1.1895E+04	1.00	1.1895E+04
70	3.0912E-01	7.1478E+03	1.00	7.1478E+03
80	0.0000E+00	2.0625E+04	1.00	2.0625E+04

Dynamic stresses for mode 5: 47.24 Hz, susceptibility = 384				
Node	Displacement	Nominal Stress	SIF	Intensified Stress
10	0.0000E+00	6.5612E+03	1.00	6.5612E+03
20A	9.9151E-02	7.7322E+03	1.75	1.3546E+04
20B	5.4273E-02	3.2373E+03	1.75	5.6714E+03
30	1.4272E-01	6.4541E+04	1.00	6.4541E+04
40A	9.5935E-01	2.1619E+04	1.33	2.8827E+04
40B	8.4760E-01	8.9896E+03	1.33	1.1987E+04
50	0.0000E+00	1.0937E+05	1.00	1.0937E+05
60	1.0650E-01	2.0268E+04	1.00	2.0268E+04
70	1.7723E-01	2.9808E+04	1.00	2.9808E+04
80	0.0000E+00	2.4102E+04	1.00	2.4102E+04

Weight & Center of gravity

Empty weight = 1601.2 (lb)
Insulation weight = 196.38 (lb)
Content weight = 550.32 (lb)
Lining weight = 0 (lb)
Total weight = 2347.9 (lb)
Center of Gravity for Total weight
X = 9.9221, Y = -0.4651, Z = 5.4697 (ft'in")

Bill of materials: Materials

#	Name	Description
1	A53	A53 Grade B

Bill of materials: Pipes

#	Material	OD (inch)	Thk (inch)	Total length (ft'in")	Total weight (lb)
1	A53	6.625	0.28	12'0"	227.45

Bill of materials: Pipes

#	Material	OD (inch)	Thk (inch)	Total length (ft'in")	Total weight (lb)
2	A53	8.625	0.5	22'0"	953.53

Bill of materials: Bends

#	Material	OD (inch)	Thk (inch)	Radius (inch)	Angle (deg)	Count	Total weight (lb)
1	A53	8.625	0.5	12	90.00	1	68.082
2	A53	8.625	0.5	18	90.00	1	102.12

Bill of materials: Valves

#	OD (inch)	Thk (inch)	Weight (lb)	Add.Weight (lb)	Count	Total weight (lb)
1	6.625	0.28	200	50	1	250