

EagleBurgmann EJS

expansion joint solutions

Prepared By :

Date : 11/30/2015

Analysis of Stress in an Unreinforced Universal Convoluted Bellows

Customer:

Reference:

Drawing/Sketch:

<u>Design Parameters and Bellows Dimensions</u>			
Design Pressure	95.00 psig	Effective Area	151.20 IN ²
Design Temperature	1400 Deg. F	Pressure Thrust	14,364 Lbs.
Bellows ID (Db)	12.750 IN.	Convolution Height (w)	1.029 IN.
Bellows OD	15.000 IN.	Skirt Length (Lt)	1.000 IN.
No. Convs. (N)	6 + 6	Cp = 0.644, Cf = 1.641, Cd = 1.763	
Thickness (t)	0.048 IN.	Band Thk. (tc)	0.250 IN.
No. Piles (n)	2	Band Length (Lc)	1.000 IN.
Roll Size	0.400 IN.		
Convoluted Length (Lb)	6.250 IN.	Bellows P No: P45	
Bellows Pitch (q)	1.042 IN.	C'Spool Length	23.5 IN. Lu=36 IN.

<u>Design Movements: (Concurrent)</u>				<u>Equivalent Axial</u>	
Compression	0 IN. Lateral	1.442 IN. Angular	0 Deg.	exc = 0, exe = 0	
Extension	0 IN. Lateral	0 IN. Angular	0 Deg.	ey = 0.067, ey = 0	
Bottom Out Per Bellows = 0.401 IN. < 2.549 IN. Max.				etheta = 0, etheta = 0	

<u>Material Constants</u>			
<u>Bellows Material: B409-800H</u>		<u>Band Material: A479-316</u>	
Sa @ Amb	16700 psi	Sa @ Amb	20000 psi
Sa @ Temp	3000 psi	Sa @ Temp	2300 psi
Su @ Amb	70000 psi	E @ Amb	28300000 psi
Su @ Temp	32000 psi	E @ Temp	19200000 psi
E @ Amb	28500000 psi	Efficiency	0.85
E @ Temp	21900000 psi		
Efficiency	1.00		
Condition	As Rolled		

<u>Design Analysis</u>			
Req'd Design Cycle Life	3,000 EJMA	Squirm Pressure	345 psig
Actual Design Cycle Life	1,096,916 EJMA	Max Safe Operating	98 psig
		Max Safe operating pressure reflects lowest value of S1, S2, S4 or squirm. Both ends rigid.	
	<u>Stress @ Design</u>	<	<u>Allowable Stress</u>
	S1 = 1807 psi		3000 psi
	S'1 = 1670 psi		1955 psi
	S2 = 2903 psi		3000 psi
	S3 = 531 psi		
	S4 = 7647 psi		
	S3 + S4 = 8179 psi		9000 psi
	S5 = 1128 psi		
	S6 = 78263 psi		
	St = 85117 psi		
			<u>Max Pressure</u>
			158 psig
			111 psig
			98 psig
			105 psig

	<u>Spring Rate</u>	<u>Max Movement</u>	<u>Max Force</u>	<u>Max Moment</u>
Axial	3,128 Lbs./IN.	0.000 IN.	0.00 Lbs.	
Lateral	335 Lbs./IN.	1.442 IN.	483.07 Lbs.	8,702.1 in-Lbs.
Angular	1,317 in-Lbs/Deg	0.000 Deg		0.0 in-Lbs.
Torsional	72.17E+4 in-Lbs/Deg	Max Torsion	0.0255 deg.	

<u>Miscellaneous Calculations</u>			
Bellows Weight	19.85 Lbs.	Moment of Inertia	0.167 IN ⁴
Developed Length	17.92 IN.	Eq. Pipe Wall Thk.	0.664 IN.

This bellows has been designed in accordance with the latest edition and standards of the Expansion Joint Manufacturers Association and industry accepted standards.

FLOWING MEDIA	PROCESS GAS	95	PSIG
DESIGN PRESSURE	DESIGN TEMPERATURE	400	DEG. F
AXIAL COMPRESSION	AXIAL EXTENSION	0	INCHES
LATERAL MOVEMENT	ANGULAR MOVEMENT	1.37(X) .45(Z)	INCHES
ANGULARITY	AXIAL SPRING RATE	0	DEGREES
ANGULAR SPRING RATE	ANGULAR SPRING RATE	N/A	LBS/INCH
LATERAL SPRING RATE	DESIGN CYCLE LIFE	350	IN/LBS DEG
DESIGN CYCLE LIFE	PRESSURE THROUGH BT RODS	N/A	CYCLES
PRESSURE THROUGH BT RODS	FLOW VELOCITY	3000	POUNDS
FLOW VELOCITY		80	FT/SEC

REV	DATE	DESCRIPTION	BY	APP'D

321
321
321

NDE AND TESTING:
LEAK TEST WELDS USING EJS STANDARD AIR AND SOAP BUBBLE METHOD. HYDRO TEST COMPLETED ASSEMBLY AT 105 PSIG BY EJS.

SPECIALS:
NO PAINT - ALL STAINLESS STEEL CONSTRUCTION.
▲ RESULTANT LATERAL MOVEMENT IS 1.442 INCHES.

ITEM	QTY	DESCRIPTION	MATERIAL
13	12	COVER CLIP - ES-003/2" WITH BOLTING	S/S
12	2	COVER - .062 THK X 18 7/8" ID X 10" LONG	A240-T316
11	32	BAND CLIP - 1/8" THK X 1 1/2" X 1 1/2"	A479-T316/ A240-T316
10	4	BAND - 1/4" THK X 1" WIDE X 13 1/16" ID	A479-T316/ A240-T316
9	16	NUT - 1" DIA HEAVY HEX	A194-2H
8	4	TIE ROD - 1" DIA X 77" LONG 12" TBE	A193-87
7	4	SUPPORT LUG - 1/2" THK X 3" WIDE X 7 3/8" HIGH SEE DETAIL SHEET 3	A479-T316/ A240-T316
6	4	GUSSET - 3/4" THK X 12" WIDE X 20" HIGH SEE DETAIL SHEET 3	A240-T316
5	2	TIE PLATE - 1" THK X 20" SQUARE CUT TO FIT 12" 90 DEG LR ELBOW SEE DETAIL SHEET 3	A240-T316
4	1	PIPE - 12" SCHED STD (.575 WALL) X 24 3/4" LG	A312-TP346
3	2	ELBOW - 12" SCHED STD (.575 WALL) 90 DEG LR	A403-WR346
2	2	LINER - .062 THK X 7 1/2" LONG X 11 1/4" OD	A240-T316
1	2	BELLOWS - 12 3/4" ID X 15" OD X .048 THK X 2 PLIES X 6 CONVOLUTIONS X 6 1/4" LT	INCO 800H

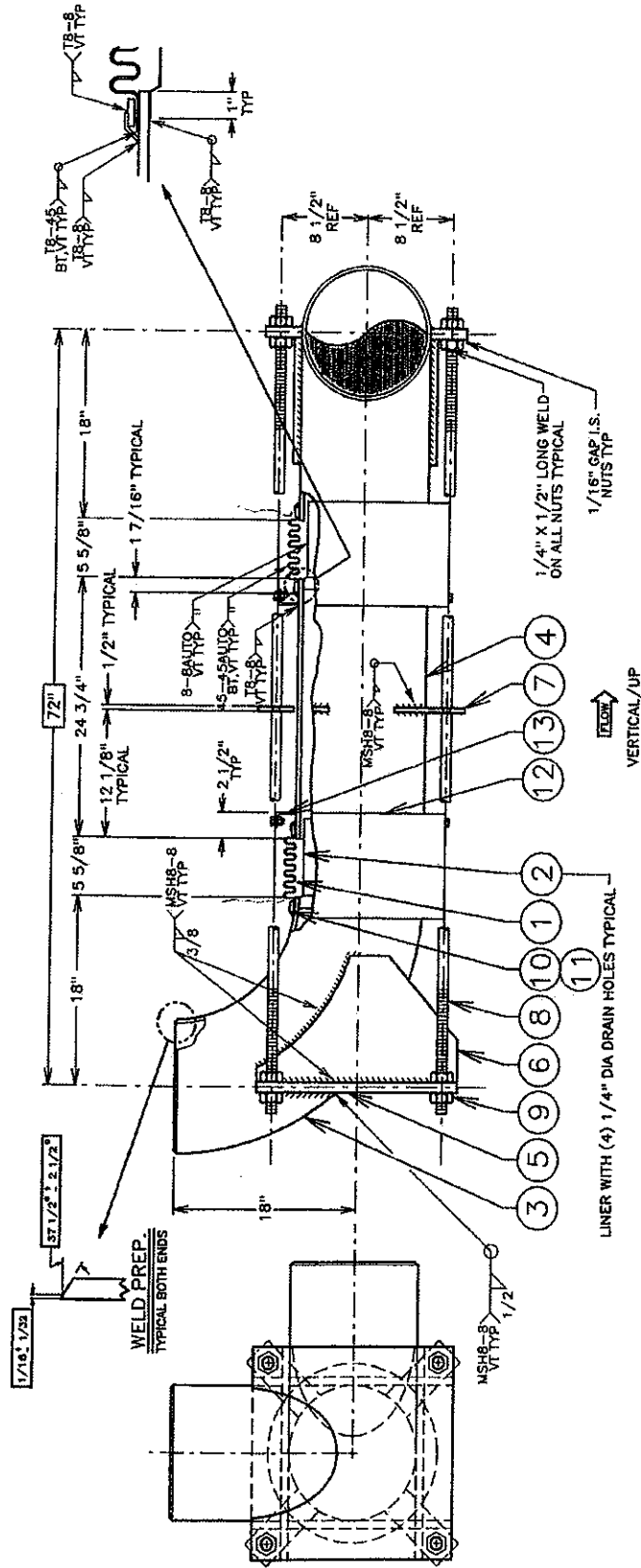
EXPANSION JOINT SYSTEMS, INC.
10035 PROSPECT SUITE 202
SANTEE, CA 92071-1288
P.O. BOX 11
SANTEE, CA 92072-1288
(818) 562-6083
(818) 562-0536 (FAX)

MANUFACTURING TOLERANCES (UNLESS OTHERWISE SPECIFIED):
DIMENSIONS OVER 84" ± .010
DIMENSIONS 48-84" ± .005
ANGULAR DIMENSIONS ± .05°
OVER 84" ± .03°
ANGULARITY ± .1°
CYLINDRICITY ± .005 I

TITLE: 12" NOMINAL DIAMETER TIED TANDEM EXPANSION JOINT ASSEMBLY
CUSTOMER REF. NO.:
E.J.S. REF. NO.:
SCALE: 10-8-96
DATE: 10-11-96
DESIGNER: KAC
CHECKED: KAC
APPROVED: [Signature]
DATE: 8-17-96

ESTIMATED WEIGHT: 1085 LBS
SIZE: B
DRAWING NUMBER: M3402
REVISION:

- NOTES:**
- THIS ASSEMBLY IS DESIGNED AND SHALL BE FABRICATED IN ACCORDANCE WITH STANDARDS FROM THE EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA) LATEST EDITION AND ADDENDUMS.
 - ALL WELDS SHALL BE INSPECTED PER THE N.D.E. PROCEDURE LOCATED ON THE WELDING SYMBOL. FURTHER N.D.E. AND TESTING IS LISTED ABOVE.
 - SHIPPING BARS ARE REQUIRED. SHIPPING BARS SHALL BE PAINTED YELLOW AND TAGGED "REMOVE AFTER INSTALLATION AND PRIOR TO SYSTEM START-UP".
 - COMPLETED ASSEMBLY SHALL BE CLEAN AND FREE OF ALL LOOSE FOREIGN MATTER.
 - ASSEMBLY SHALL BE ADEQUATELY PACKAGED AND PROTECTED FOR SHIPMENT TO AND FOR THE STORAGE OF AT THE JOBSITE.
 - ASSEMBLY TO BE IDENTIFIED USING A PERMANENT STAINLESS STEEL NAMETAG TO READ AS FOLLOWS:
MANUFACTURED BY "EXPANSION JOINT SYSTEMS, INC."
SANTEE, CA.
W.O.: 4800 P/N: M3402
DATE: 1998 TAG: 662-G-2020211J
7. DIMENSIONS NOT SHOWN IN BOX ARE REFERENCE DIMENSIONS ONLY. BOXED DIMENSIONS WILL BE HELD WITHIN THE TOLERANCES SHOWN ON THIS DRAWING.



E J SYSTEMS INC.

10035 PROSPECT SUITE 202
 SANTEE, CA 92071-1288
 P.O. BOX 71 1288
 SANTEE, CA 92072-1288
 (619) 352-0852
 (619) 352-0853 (FAX)

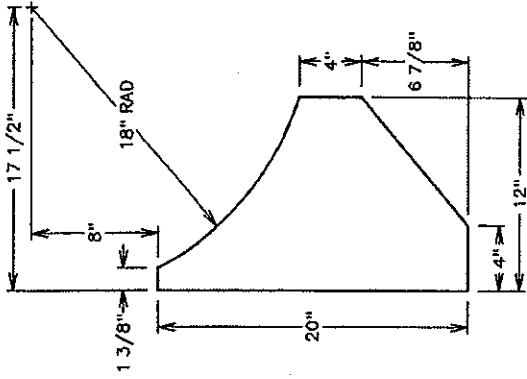
TITLE: 1 1/2" NOMINAL DIAMETER TIED TANDEM EXPANSION JOINT ASSEMBLY

DESIGN	KLW	DATE	10-8-98
CHECKED	JZA	SCALE	10-8-98
APPROVED	JZA	SIZE	NONE
DRAWING NUMBER	M3402	REVISION	2 OF 3

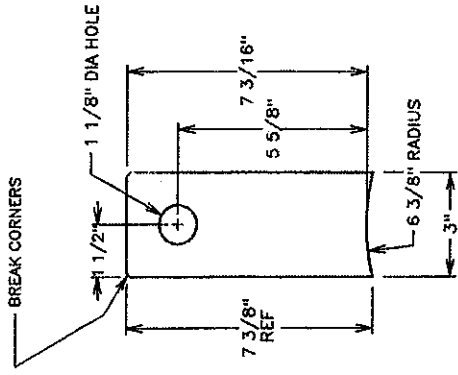
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 SANTEE, CA 92072-1288
 (619) 352-0852
 (619) 352-0853 (FAX)

0 INCL. 45° OVER 0.4"	OVER 0.4"	CUSTOMER REF. NO.:	
± 1/16"	± 1/16"	E.J.S. REF. NO.:	
ANGULAR (RADIANT)	ANGULAR	SCALE	10-8-98
± 1/2°	± 1/2°	CHECKED	JZA
		APPROVED	JZA
		DRAWING NUMBER	M3402
		REVISION	2 OF 3

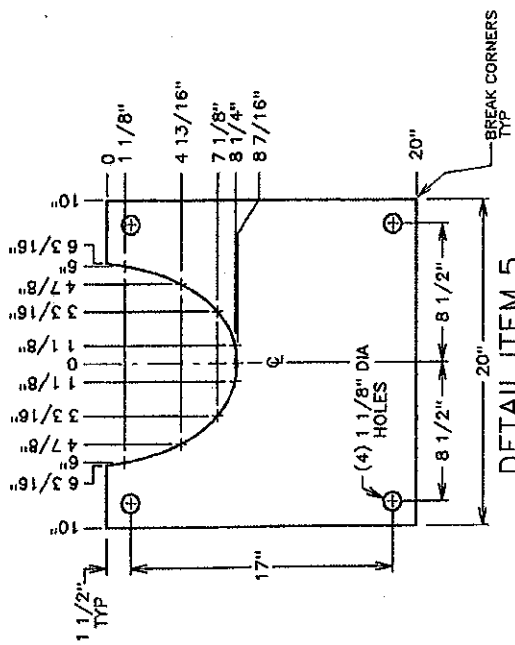
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 SANTEE, CA 92071-1288
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 SANTEE, CA 92072-1288
 (619) 352-0852
 (619) 352-0853 (FAX)



DETAIL ITEM 6



DETAIL ITEM 7



DETAIL ITEM 5

E J S EXPANSION JOINT SYSTEMS INC.

10035 PROSPECT SUITE 202
 SANTEE, CA. 92071-1288
 P.O. BOX 71 1288
 SANTEE, CA. 92072-1288
 (619) 582-0838
 (619) 582-0838 (FAX)

TITLE: 12" NOMINAL DIAMETER TIED TANDEM EXPANSION JOINT ASSEMBLY		CUSTOMER:	
MANUFACTURING TOLERANCES UNLESS OTHERWISE SPECIFIED	LINE/AS	DESIGN KLN	10-8-96
OVER 84"	±0.03	CHECKED KAA	10-11-96
84" - 1/4"	±0.04	APPROVED [Signature]	10-11-96
1/4" - 1/2"	±0.05	DATE	
1/2" - 1"	±0.06	NAME	
1" - 2"	±0.08	ANGULAR (CIRCULAR)	
2" - 4"	±0.10	CYLINDRICITY	
4" - 84"	±0.12	SCALE	NONE
84" - 1/4"	±0.15	CUSTOMER REF. NO.:	
1/4" - 1/2"	±0.20	E.J.S. REF. NO.:	
1/2" - 1"	±0.25	DRAWING NUMBER	M3402
1" - 2"	±0.30	REVISION	
2" - 4"	±0.40	SHEET	3 OF 3
4" - 84"	±0.50	SIZE	B
84" - 1/4"	±0.60		
1/4" - 1/2"	±0.70		
1/2" - 1"	±0.80		
1" - 2"	±0.90		
2" - 4"	±1.00		
4" - 84"	±1.10		
84" - 1/4"	±1.20		
1/4" - 1/2"	±1.30		
1/2" - 1"	±1.40		
1" - 2"	±1.50		
2" - 4"	±1.60		
4" - 84"	±1.70		
84" - 1/4"	±1.80		
1/4" - 1/2"	±1.90		
1/2" - 1"	±2.00		
1" - 2"	±2.10		
2" - 4"	±2.20		
4" - 84"	±2.30		
84" - 1/4"	±2.40		
1/4" - 1/2"	±2.50		
1/2" - 1"	±2.60		
1" - 2"	±2.70		
2" - 4"	±2.80		
4" - 84"	±2.90		
84" - 1/4"	±3.00		
1/4" - 1/2"	±3.10		
1/2" - 1"	±3.20		
1" - 2"	±3.30		
2" - 4"	±3.40		
4" - 84"	±3.50		
84" - 1/4"	±3.60		
1/4" - 1/2"	±3.70		
1/2" - 1"	±3.80		
1" - 2"	±3.90		
2" - 4"	±4.00		
4" - 84"	±4.10		
84" - 1/4"	±4.20		
1/4" - 1/2"	±4.30		
1/2" - 1"	±4.40		
1" - 2"	±4.50		
2" - 4"	±4.60		
4" - 84"	±4.70		
84" - 1/4"	±4.80		
1/4" - 1/2"	±4.90		
1/2" - 1"	±5.00		
1" - 2"	±5.10		
2" - 4"	±5.20		
4" - 84"	±5.30		
84" - 1/4"	±5.40		
1/4" - 1/2"	±5.50		
1/2" - 1"	±5.60		
1" - 2"	±5.70		
2" - 4"	±5.80		
4" - 84"	±5.90		
84" - 1/4"	±6.00		
1/4" - 1/2"	±6.10		
1/2" - 1"	±6.20		
1" - 2"	±6.30		
2" - 4"	±6.40		
4" - 84"	±6.50		
84" - 1/4"	±6.60		
1/4" - 1/2"	±6.70		
1/2" - 1"	±6.80		
1" - 2"	±6.90		
2" - 4"	±7.00		
4" - 84"	±7.10		
84" - 1/4"	±7.20		
1/4" - 1/2"	±7.30		
1/2" - 1"	±7.40		
1" - 2"	±7.50		
2" - 4"	±7.60		
4" - 84"	±7.70		
84" - 1/4"	±7.80		
1/4" - 1/2"	±7.90		
1/2" - 1"	±8.00		
1" - 2"	±8.10		
2" - 4"	±8.20		
4" - 84"	±8.30		
84" - 1/4"	±8.40		
1/4" - 1/2"	±8.50		
1/2" - 1"	±8.60		
1" - 2"	±8.70		
2" - 4"	±8.80		
4" - 84"	±8.90		
84" - 1/4"	±9.00		
1/4" - 1/2"	±9.10		
1/2" - 1"	±9.20		
1" - 2"	±9.30		
2" - 4"	±9.40		
4" - 84"	±9.50		
84" - 1/4"	±9.60		
1/4" - 1/2"	±9.70		
1/2" - 1"	±9.80		
1" - 2"	±9.90		
2" - 4"	±10.00		