VOLUME II ATTACHMENTS

ATTACHMENT 3 Part II

LIGO-C960964-01-V

TITLE	DOCUMENT NO.	REVISION
I. Adapters And Spools		
Spool BE-3 & BE-3A(60 in)	V049-1-049	0
Spool BE-2 (60 in)	V049-1-050	0
Spool B-5 (30 in.)	V049-1-057	1
Spool B-6 (48 in)	V049-1-058	0
Spool B-7 (48 in)	V049-1-059	0
Spool B-8 (72 in)	V049-1-060	0
Spool B-9 (72 in)	V049-1-061	0
Spool BE-4 (44 in)	V049-1-076	0
Generic Spool Design	V049-1-077	0
Spool BE-5 (44 in)	V049-1-085	1
II. Supports		
Design of Flexible Support for Adapter A-7	V049-1-062	1
Design of Gate Valve Support	V049-1-086	0
Support Design for Mode Cleaner Tubes (B-2/B-3/B-5)	V049-1-087	1
Support Design for Beam Tube Manifold (BE-5)	V049-1-088	1
Support Design for Beam Tube Manifold (B-9)	V049-1-089	1
Support Design for Beam Tube Manifold (B-6/B-7)	V049-1-095	1
Turbo Cart Frame Extension	V049-1-098	0
III. Miscellanous		
Flange Bolting for Gate Valves	V049-1-063	0
Bellows Deflection Study	V049-1-068	0
Analysis of BSC Support Leg to Cross Beam Connection	V049-1-079	0
Analysis of Bolted Flange for Initial Out of Flatness	V049-1-080	0
Expansion Joint Tie Rod Lug Design	V049-1-084	2
Stiffener Rings At Axial Restraints	V049-1-108	0
BSC Portable Clean Room	V049-1-112	0
HAM Portable Clean Room	V049-1-113	0

DETERMINE LOADING CONDITIONS

BEAM MANIFOLD B-9 WAS DESIGNED USING THE COMPUTER AIDED DESIGN PROGRAM COMPRESS. THE WEIGHT SUMMARY INCLUDES THE WEIGHT OF VESSEL (INCLUDING STIFFENER RINGS, SUPPORT RINGS) ADDITIONALLY FLANGES WERE MODELED TO OBTAIN THEIR RESPECTIVE WEIGHTS.

VESSEL WEIGHT = 6737 lbs

$$\frac{6737\text{ lbs}}{408\text{ in}} = 16.5\text{ lbs/in.}$$

FLANGE WEIGHTS

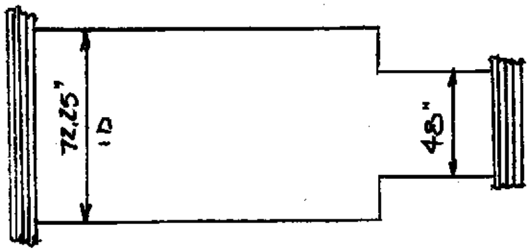
@ BE-5 BELLOWS - 2 FLANGES

370 lbs + 370 lbs = 740 lbs.

@ A-1 BELLOWS - 2 FLANGES (ONE REDUCING)

1381 lbs + 370 lbs. = 1751 lbs

UNBALANCED VACUUM LOAD



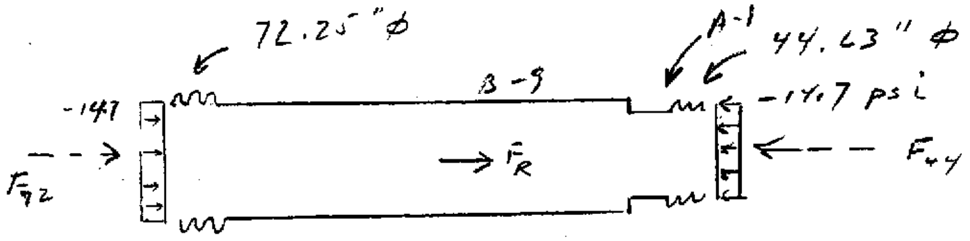
$$F_{72.25"} = (14.7\#/in^2)\left[\frac{\pi\,(72.25\text{in})^2}{4}\right] = 60267\text{ lbs}$$

$$F_{48"} = 29500\text{ lbs (ref. Calc V049-1-032)}$$

$$\therefore \text{UNBALANCED FORCE} = 60267\text{ lbs} - 29500\text{ lbs}$$
$$\hat{=}\ 30800\text{ lbs.}$$

SEE FOLLOWING SHEET FOR
"EXACT" UNBAL FORCE

SPOOL B-9 UNBALANCED AXIAL FORCE:



F_R = AXIAL REACTION (TBD)

F_{72} = 72.25" BELLOWS VAC FORCE
$= -64.1^K$ (CALC V049-1-032, P5)

F_{44} = 44.63" BELLOWS VAC FORCE

$= -25.37$ SAY -25.4^K
(CALC V049-1-032, P.4

$+ \rightarrow$

$$F_R + F_{72} - F_{44} = 0$$

$$F_R = F_{44} - F_{72}$$
$$= -25.4 - (-64.1)$$
$$= 38.7^K$$

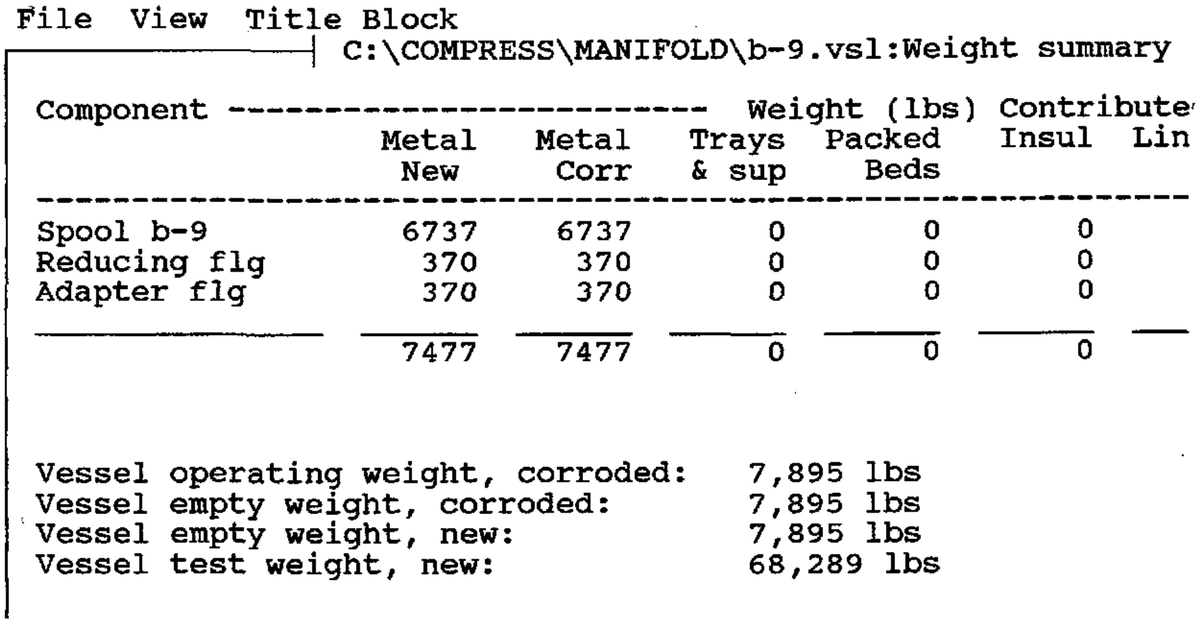
RECALCULATE USING LATEST BELLOWS D_M

$F_{72} = -62.522$ K ← D_M (HYSPAN CALC 7/9/96)

$$F_{44} = -14.7\,\pi \left(\frac{45.964}{2}\right)^2$$
$$= -24,392^K$$

$$F_R = -24,292 - (-62.522) =$$
$$= 38.13 \text{ K}$$

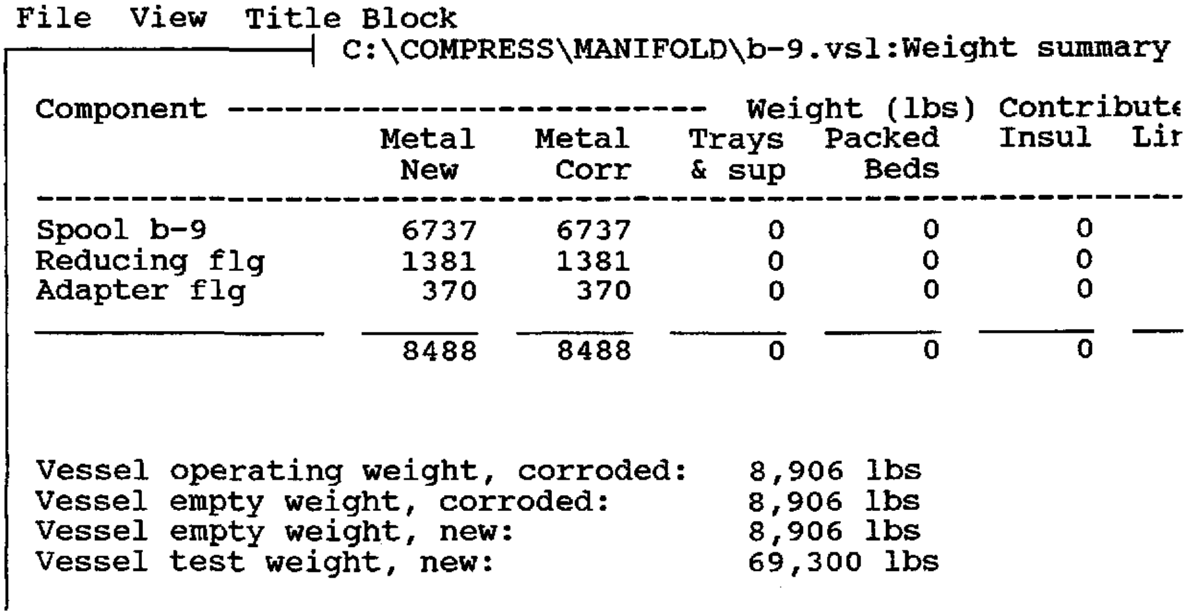
COMPRESS - WEIGHT SUMMARY



```
C:\COMPRESS\MANIFOLD\b-9.vsl:Weight summary

Component ------------------------- Weight (lbs) Contribute
                      Metal   Metal   Trays  Packed   Insul  Lin
                       New     Corr   & sup   Beds
--------------------------------------------------------------
Spool b-9             6737    6737       0       0       0
Reducing flg           370     370       0       0       0
Adapter flg            370     370       0       0       0
_______________       _____   _____   _____   _____   _____   ___
                      7477    7477       0       0       0


Vessel operating weight, corroded:   7,895 lbs
Vessel empty weight, corroded:       7,895 lbs
Vessel empty weight, new:            7,895 lbs
Vessel test weight, new:            68,289 lbs
```



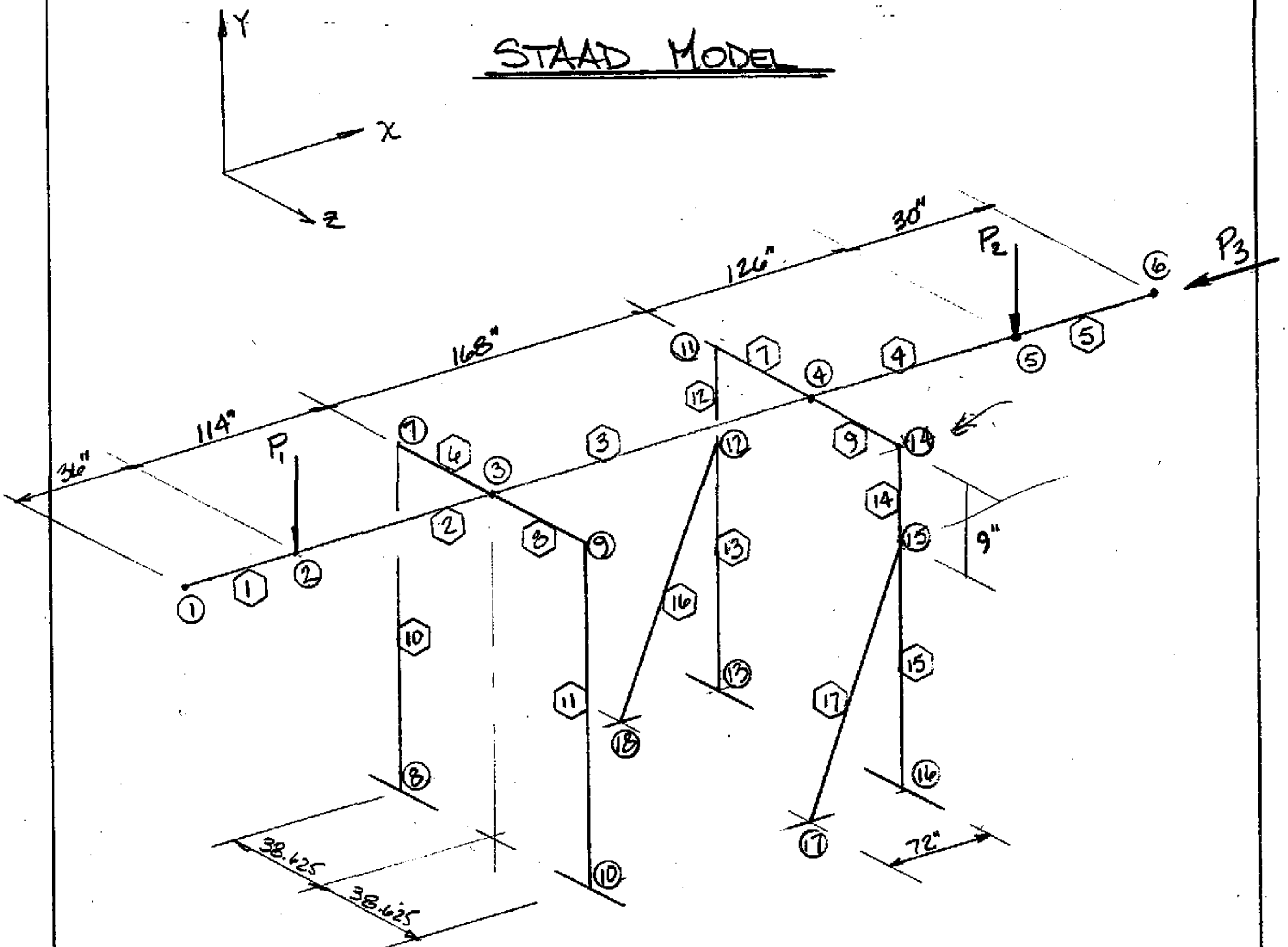
```
C:\COMPRESS\MANIFOLD\b-9.vsl:Weight summary

Component ------------------------- Weight (lbs) Contribute
                      Metal   Metal   Trays  Packed   Insul  Lir
                       New     Corr   & sup   Beds
--------------------------------------------------------------
Spool b-9             6737    6737       0       0       0
Reducing flg          1381    1381       0       0       0
Adapter flg            370     370       0       0       0
_______________       _____   _____   _____   _____   _____   ___
                      8488    8488       0       0       0


Vessel operating weight, corroded:   8,906 lbs
Vessel empty weight, corroded:       8,906 lbs
Vessel empty weight, new:            8,906 lbs
Vessel test weight, new:            69,300 lbs
```

B-9 BEAM TUBE MANIFOLD SUPPORT SCHEME

STAAD MODEL



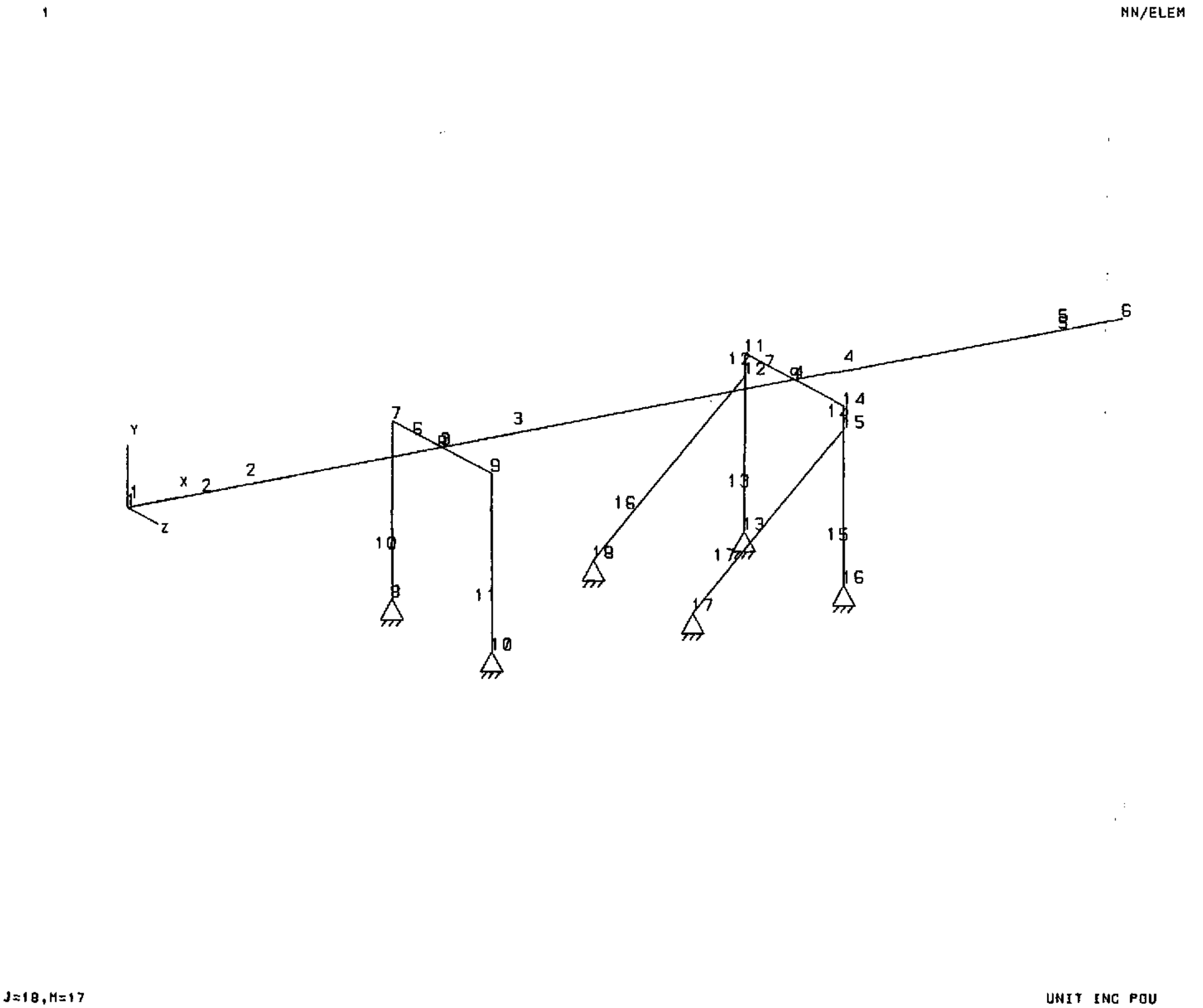
P1 = 740 lbs

P2 = 1751 lbs

P3 = 38130. lbs

STRUCTURE DATA

TYPE = SPACE
NJ = 18
NM = 17
NE = 0
NS = 6
NL = 4
XMAX= 474.0
YMAX= 70.0
ZMAX= 77.3



USER ID:Process Systems International

S T A A D P O S T - P L O T (REV: 21.0)

TITLE: 85 MODE CLEANER TUBE SUPPORTS

DATE: MAR 29, 1996

```
     ****************************************************
     *                                                  *
     *           S T A A D - III                        *
     *           Revision 21.0                          *
     *           Proprietary Program of                 *
     *           Research Engineers, Inc.               *
     *           Date=    SEP 17, 1996                  *
     *           Time=    14:18:40                      *
     *                                                  *
     *      USER ID: PROCESS SYSTEMS INTERNATIONAL IN   *
     ****************************************************

  1. STAAD SPACE B-9 BEAM TUBE MANIFOLD SUPPORT
  2. INPUT WIDTH 72
  3. UNIT INCHES POUND
  4. JOINT COORDINATES
  5. 1 0. 0. 0.; 2 36. 0. 0.; 3 150. 0. 0.; 4 318. 0. 0.; 5 444. 0. 0.
  6. 6 474. 0. 0.; 7 150. 0. -38.625; 8 150. -70. -38.625; 9 150. 0. 38.625
  7. 10 150. -70. 38.625; 11 318. 0. -38.625; 12 318. -9. -38.625
  8. 13 318. -70. -38.625; 14 318. 0. 38.625; 15 318. -9. 38.625
  9. 16 318. -70. 38.625; 17 246. -70. 38.625; 18 246. -70. -38.625
 10. MEMBER INCIDENCES
 11. 1 1 2; 2 2 3; 3 3 4; 4 4 5; 5 5 6; 6 3 7; 7 4 11; 8 3 9; 9 4 14; 10 8 7
 12. 11 10 9; 12 12 11; 13 13 12; 14 15 14; 15 16 15; 16 18 12; 17 17 15
 13. MEMBER PROPERTY AMER
 14. 10 11 TABLE ST TUB40203
 15. 1 TO 5 TABLE ST PIPE OD 72.75 ID 72.25
 16. 12 TO 17 TABLE ST TUB40408
 17. 6 TO 9 TABLE ST TUB1401408
 18. MEMBER RELEASE
 19. 10 TO 12 14 END MX MY MZ
 20. CONSTANTS
 21. E STEEL ALL
 22. POISSON STEEL ALL
 23. DENSITY STEEL ALL
 24. BETA 90. MEMB 10 TO 15
 25. ALPHA 0.00000919 MEMB 1 TO 9
 26. SUPPORTS
 27. 8 10 FIXED BUT MZ
 28. 13 16 TO 18 FIXED
 29. ***********************************
 30. LOAD 1 DEADWEIGHT
 31. JOINT LOAD
 32. 2 FY -740.
 33. * FLANGE WEIGHT
 34. 5 FY -1751.
 35. * FLANGE WEIGHT
 36. MEMBER LOAD
 37. 1 TO 5 UNI Y -16.15
 38. * VESSEL WGHT = 6737.#/408"
 39. ***********************************
 40. LOAD 2 DW+TH+VACUUM
 41. JOINT LOAD
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42. 2 FY -740.
43. 5 FY -1751.
44. 5 FX -38129.992
45. * UNBALANCED VACUUM LOAD @ A-1 BELLOWS
46. MEMBER LOAD
47. 1 TO 5 UNI Y -16.15
48. TEMPERATURE LOAD
49. 1 TO 5 TEMP 330.
50. **********************************
51. LOAD 3 DW+TH+SEIS-AXIAL
52. JOINT LOAD
53. 2 FY -740.
54. 5 FY -1751.
55. 5 FX -38129.992
56. 2 FX -42.
57. 5 FX -98.
58. MEMBER LOAD
59. 1 TO 5 UNI Y -16.15
60. 1 TO 5 UNI X -0.908
61. TEMPERATURE LOAD
62. 1 TO 5 TEMP 330.
63. **********************************
64. LOAD 4 DW+TH+SEIS-LAT
65. JOINT LOAD
66. 2 FY -740.
67. 5 FY -1751.
68. 5 FX -38129.992
69. 2 FZ 42.
70. 5 FZ 98.
71. MEMBER LOAD
72. 1 TO 5 UNI Y -16.15
73. 1 TO 5 UNI Z 0.908
74. TEMPERATURE LOAD
75. 1 TO 5 TEMP 330.
76. **********************************
77. LOAD 5 THERMAL DISPL "BAKEOUT"
78. TEMPERATURE LOAD
79. 1 TO 5 TEMP 330.
80. **********************************
81. PERFORM ANALYSIS


       P R O B L E M   S T A T I S T I C S
       -----------------------------------

  NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =     18/    17/     6
  ORIGINAL/FINAL BAND-WIDTH =    10/     5
  TOTAL PRIMARY LOAD CASES  =     5, TOTAL DEGREES OF FREEDOM =      74
  SIZE OF STIFFNESS MATRIX =     2664 DOUBLE PREC. WORDS
  REQRD/AVAIL. DISK SPACE =  12.05/  954.8 MB,  EXMEM = 14.83 MB

++ PROCESSING ELEMENT STIFFNESS MATRIX.              14:18:42
++ PROCESSING GLOBAL STIFFNESS MATRIX.               14:18:42
++ PROCESSING TRIANGULAR FACTORIZATION.              14:18:42
++ CALCULATING JOINT DISPLACEMENTS.                  14:18:42
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```
++ CALCULATING MEMBER  FORCES.                              14:18:42

  82. PRINT MATERIAL PROPERTIES ALL
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MATERIAL PROPERTIES..
---------------------
ALL UNITS ARE - POUN INCH

MEMBER          E            G          DEN        ALPHA

   1      29000000.0   11153846.0   0.28299999  0.00000919
   2      29000000.0   11153846.0   0.28299999  0.00000919
   3      29000000.0   11153846.0   0.28299999  0.00000919
   4      29000000.0   11153846.0   0.28299999  0.00000919
   5      29000000.0   11153846.0   0.28299999  0.00000919
   6      29000000.0   11153846.0   0.28299999  0.00000919
   7      29000000.0   11153846.0   0.28299999  0.00000919
   8      29000000.0   11153846.0   0.28299999  0.00000919
   9      29000000.0   11153846.0   0.28299999  0.00000919
  10      29000000.0   11153846.0   0.28299999  0.00000000
  11      29000000.0   11153846.0   0.28299999  0.00000000
  12      29000000.0   11153846.0   0.28299999  0.00000000
  13      29000000.0   11153846.0   0.28299999  0.00000000
  14      29000000.0   11153846.0   0.28299999  0.00000000
  15      29000000.0   11153846.0   0.28299999  0.00000000
  16      29000000.0   11153846.0   0.28299999  0.00000000
  17      29000000.0   11153846.0   0.28299999  0.00000000

 ************ END OF DATA FROM INTERNAL STORAGE ************


   83. PRINT MEMBER INFORMATION ALL
```

```
 MEMBER INFORMATION
 ------------------

 MEMBER      START     END          LENGTH      BETA
             JOINT    JOINT         (INCH)      (DEG)       RELEASES

    1          1        2           36.000      0.00
    2          2        3          114.000      0.00
    3          3        4          168.000      0.00
    4          4        5          126.000      0.00
    5          5        6           30.000      0.00
    6          3        7           38.625      0.00
    7          4       11           38.625      0.00
    8          3        9           38.625      0.00
    9          4       14           38.625      0.00
   10          8        7           70.000     90.00     000000000111
   11         10        9           70.000     90.00     000000000111
   12         12       11            9.000     90.00     000000000111
   13         13       12           61.000     90.00
   14         15       14            9.000     90.00     000000000111
   15         16       15           61.000     90.00
   16         18       12           94.366      0.00
   17         17       15           94.366      0.00

 ************ END OF DATA FROM INTERNAL STORAGE ************

  84. PRINT JOINT COORDINATES ALL
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JOINT COORDINATES
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COORDINATES ARE INCH UNIT

JOINT            X              Y              Z

  1            0.000          0.000          0.000
  2           36.000          0.000          0.000
  3          150.000          0.000          0.000
  4          318.000          0.000          0.000
  5          444.000          0.000          0.000
  6          474.000          0.000          0.000
  7          150.000          0.000        -38.625
  8          150.000        -70.000        -38.625
  9          150.000          0.000         38.625
 10          150.000        -70.000         38.625
 11          318.000          0.000        -38.625
 12          318.000         -9.000        -38.625
 13          318.000        -70.000        -38.625
 14          318.000          0.000         38.625
 15          318.000         -9.000         38.625
 16          318.000        -70.000         38.625
 17          246.000        -70.000         38.625
 18          246.000        -70.000        -38.625

************ END OF DATA FROM INTERNAL STORAGE ************


 85. PRINT SUPPORT INFORMATION ALL


SUPPORT INFORMATION (1=FIXED, 0=RELEASED)
------------------
UNITS FOR SPRING CONSTANTS ARE POUN INCH DEGREES

JOINT    FORCE-X/    FORCE-Y/    FORCE-Z/    MOM-X/     MOM-Y/     MOM-Z/
           KFX         KFY         KFZ        KMX        KMY        KMZ

  8       1           1           1           1          1          0
              0.0         0.0         0.0        0.0        0.0        0.0
 10       1           1           1           1          1          0
              0.0         0.0         0.0        0.0        0.0        0.0
 13       1           1           1           1          1          1
              0.0         0.0         0.0        0.0        0.0        0.0
 16       1           1           1           1          1          1
              0.0         0.0         0.0        0.0        0.0        0.0
 17       1           1           1           1          1          1
              0.0         0.0         0.0        0.0        0.0        0.0
 18       1           1           1           1          1          1
              0.0         0.0         0.0        0.0        0.0        0.0
```

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************ END OF DATA FROM INTERNAL STORAGE ************

86. PRINT ANALYSIS RESULTS
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JOINT DISPLACEMENT (INCH RADIANS)    STRUCTURE TYPE = SPACE
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JOINT  LOAD   X-TRANS    Y-TRANS    Z-TRANS    X-ROTAN    Y-ROTAN    Z-ROTAN

  1     1     0.00111   -0.00856    0.00000    0.00000    0.00000    0.00003
        2    -1.07093   -0.01434    0.00000    0.00000    0.00000    0.00007
        3    -1.07258   -0.01443    0.00000    0.00000    0.00000    0.00007
        4    -1.07093   -0.01434    0.06129    0.00000    0.00003    0.00007
        5    -0.96440    0.00000    0.00000    0.00000    0.00000    0.00000
  2     1     0.00111   -0.00752    0.00000    0.00000    0.00000    0.00003
        2    -0.96175   -0.01192    0.00000    0.00000    0.00000    0.00007
        3    -0.96340   -0.01198    0.00000    0.00000    0.00000    0.00007
        4    -0.96175   -0.01192    0.06005    0.00000    0.00003    0.00007
        5    -0.85522    0.00000    0.00000    0.00000    0.00000    0.00000
  3     1     0.00111   -0.00413    0.00000    0.00000    0.00000    0.00002
        2    -0.61603   -0.00413    0.00000    0.00000    0.00000    0.00005
        3    -0.61766   -0.00413    0.00000    0.00000    0.00000    0.00005
        4    -0.61603   -0.00413    0.05613    0.00000    0.00003    0.00005
        5    -0.50949    0.00000    0.00000    0.00000    0.00000    0.00000
  4     1     0.00111   -0.00478    0.00000    0.00000    0.00000   -0.00003
        2    -0.10653    0.00170    0.00000    0.00000    0.00000    0.00001
        3    -0.10814    0.00179    0.00000    0.00000    0.00000    0.00001
        4    -0.10653    0.00170    0.05070    0.00000    0.00003    0.00001
        5     0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
  5     1     0.00111   -0.01174    0.00000    0.00000    0.00000   -0.00005
        2     0.27268   -0.00041    0.00000    0.00000    0.00000   -0.00002
        3     0.27105   -0.00024    0.00000    0.00000    0.00000   -0.00001
        4     0.27268   -0.00041    0.04712    0.00000    0.00003   -0.00002
        5     0.38212    0.00000    0.00000    0.00000    0.00000    0.00000
  6     1     0.00111   -0.01338    0.00000    0.00000    0.00000   -0.00005
        2     0.36366   -0.00089    0.00000    0.00000    0.00000   -0.00002
        3     0.36203   -0.00070    0.00000    0.00000    0.00000   -0.00001
        4     0.36366   -0.00089    0.04627    0.00000    0.00003   -0.00002
        5     0.47310    0.00000    0.00000    0.00000    0.00000    0.00000
  7     1     0.00111   -0.00216    0.00000    0.00006    0.00000    0.00002
        2    -0.61603   -0.00216    0.00000    0.00006    0.00000    0.00005
        3    -0.61766   -0.00216    0.00000    0.00006    0.00000    0.00005
        4    -0.61732   -0.00214    0.05613    0.00006    0.00003    0.00005
        5    -0.50949    0.00000    0.00000    0.00000    0.00000    0.00000
  8     1     0.00000    0.00000    0.00000    0.00000    0.00000   -0.00002
        2     0.00000    0.00000    0.00000    0.00000    0.00000    0.00880
        3     0.00000    0.00000    0.00000    0.00000    0.00000    0.00882
        4     0.00000    0.00000    0.00000    0.00000    0.00000    0.00882
        5     0.00000    0.00000    0.00000    0.00000    0.00000    0.00728
  9     1     0.00111   -0.00216    0.00000   -0.00006    0.00000    0.00002
        2    -0.61603   -0.00216    0.00000   -0.00006    0.00000    0.00005
        3    -0.61766   -0.00216    0.00000   -0.00006    0.00000    0.00005
        4    -0.61473   -0.00218    0.05613   -0.00006    0.00003    0.00005
        5    -0.50949    0.00000    0.00000    0.00000    0.00000    0.00000
 10     1     0.00000    0.00000    0.00000    0.00000    0.00000   -0.00002
        2     0.00000    0.00000    0.00000    0.00000    0.00000    0.00880
        3     0.00000    0.00000    0.00000    0.00000    0.00000    0.00882
```

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JOINT DISPLACEMENT (INCH RADIANS)    STRUCTURE TYPE = SPACE
------------------

JOINT  LOAD   X-TRANS    Y-TRANS    Z-TRANS    X-ROTAN    Y-ROTAN    Z-ROTAN

         4    0.00000    0.00000    0.00000    0.00000    0.00000    0.00878
         5    0.00000    0.00000    0.00000    0.00000    0.00000    0.00728
  11     1    0.00111   -0.00124    0.00000    0.00011    0.00000   -0.00003
         2   -0.08585    0.00524    0.00000    0.00011   -0.00062    0.00001
         3   -0.08715    0.00533    0.00000    0.00011   -0.00063    0.00001
         4   -0.08678    0.00530    0.05069    0.00011   -0.00060    0.00001
         5    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
  12     1    0.00091   -0.00108    0.00000    0.00000    0.00000   -0.00002
         2   -0.02402    0.00540    0.00000    0.00000    0.00000    0.00500
         3   -0.02440    0.00549    0.00000    0.00000    0.00000    0.00507
         4   -0.02429    0.00546    0.04139    0.00101   -0.00010    0.00505
         5    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
  13     1    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         2    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         3    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         4    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         5    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
  14     1    0.00111   -0.00124    0.00000   -0.00011    0.00000   -0.00003
         2   -0.08585    0.00524    0.00000   -0.00011    0.00062    0.00001
         3   -0.08715    0.00533    0.00000   -0.00011    0.00063    0.00001
         4   -0.08493    0.00517    0.05069   -0.00010    0.00064    0.00001
         5    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
  15     1    0.00091   -0.00108    0.00000    0.00000    0.00000   -0.00002
         2   -0.02402    0.00540    0.00000    0.00000    0.00000    0.00500
         3   -0.02440    0.00549    0.00000    0.00000    0.00000    0.00507
         4   -0.02376    0.00533    0.04139    0.00101   -0.00010    0.00495
         5    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
  16     1    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         2    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         3    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         4    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         5    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
  17     1    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         2    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         3    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         4    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         5    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
  18     1    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         2    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         3    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         4    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         5    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
```

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 SUPPORT REACTIONS -UNIT POUN INCH    STRUCTURE TYPE = SPACE
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JOINT  LOAD    FORCE-X    FORCE-Y    FORCE-Z      MOM-X       MOM-Y       MOM Z

    8    1       0.00    1809.87       0.00        0.00        0.00        0.00
         2       0.00    1809.87       0.00       -0.10        0.00        0.00
         3       0.00    1809.87       0.00       -0.02        0.00        0.00
         4       0.00    1793.91     -55.29    -3870.62        0.00        0.00
         5       0.00       0.00       0.00       -0.08        0.00        0.00
   10    1       0.00    1809.87       0.00        0.00        0.00        0.00
         2       0.00    1809.88       0.00       -0.10        0.00        0.00
         3       0.00    1809.87       0.00       -0.02        0.00        0.00
         4       0.00    1825.84     -55.29    -3870.62        0.00        0.00
         5       0.00       0.00       0.00       -0.08        0.00        0.00
   13    1      -4.22    3257.23       0.00        0.00        0.00      258.77
         2   -2361.71  -16318.38       0.00       -0.01        0.00    42796.62
         3   -2396.97  -16611.12       0.00       -0.04        0.00    43432.74
         4   -2386.98  -16512.10    -194.01   -11828.66      379.88    43253.45
         5      -0.01      -0.09       0.00       -0.02        0.00        0.20
   16    1      -4.22    3257.23       0.00        0.00        0.00      258.77
         2   -2361.70  -16318.28       0.00       -0.01        0.00    42796.38
         3   -2396.97  -16611.11       0.00       -0.04        0.00    43432.71
         4   -2336.43  -16124.54    -194.01   -11828.66      379.88    42339.50
         5       0.00      -0.01       0.00       -0.02        0.00        0.02
   17    1       4.22       5.95       0.00        0.00        0.00      169.52
         2   21426.66   19581.45       0.00        0.00        0.00    32520.79
         3   21747.13   19874.29       0.00       -0.01        0.01    33004.74
         4   21197.19   19371.75     -35.89    -4264.39     2204.37    32173.45
         5       0.01       0.01       0.00       -0.01        0.00        0.02
   18    1       4.22       5.95       0.00        0.00        0.00      169.52
         2   21426.78   19581.56       0.00        0.00        0.00    32520.97
         3   21747.14   19874.30       0.00       -0.01        0.01    33004.76
         4   21656.23   19791.24     -35.89    -4264.39     2204.37    32868.27
         5       0.10       0.09       0.00       -0.01        0.00        0.15
```

```
 MEMBER END FORCES    STRUCTURE TYPE = SPACE
 -----------------
 ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT     AXIAL    SHEAR-Y  SHEAR-Z    TORSION      MOM-Y       MOM-Z


    1     1    1      0.00       0.00     0.00       0.00       0.00       -0.03
               2      0.00     581.40     0.00       0.00       0.00   -10465.34
          2    1      0.49      -0.01     0.00       0.00       0.00       -0.16
               2     -0.49     581.41     0.00       0.00       0.00   -10465.63
          3    1     -2.93       0.00     0.00       0.00       0.00        0.03
               2     35.64     581.40     0.00       0.00       0.00   -10465.08
          4    1      2.93       0.00     0.01       0.00      -0.42       -0.14
               2     -2.93     581.40   -32.70       0.00    -588.49   -10465.39
          5    1      1.95       0.00     0.00       0.00       0.00        0.00
               2     -1.95       0.00     0.00       0.00       0.00        0.00

    2     1    2      0.00   -1321.40     0.00       0.00       0.00    10465.23
               3      0.00    3162.50     0.00       0.00       0.00  -266047.50
          2    2      0.00   -1321.40     0.00       0.00       0.00    10465.15
               3      0.00    3162.50     0.00       0.00       0.00  -266047.50
          3    2    -74.22   -1321.40     0.00       0.00       0.00    10465.20
               3    177.73    3162.50     0.00       0.00       0.00  -266047.50
          4    2      0.00   -1321.40    74.70       0.00     588.75    10465.25
               3      0.00    3162.50  -178.21       0.00  -15002.89  -266047.44
          5    2     -0.49       0.00     0.00       0.00       0.00        0.00
               3      0.49       0.00     0.00       0.00       0.00        0.00

    3     1    3      0.00     457.24     0.00       0.00       0.00   266047.53
               4      0.00    2255.96     0.00       0.00       0.00  -417139.16
          2    3      0.49     457.24     0.01      -0.30       1.46   266047.47
               4     -0.49    2255.96    -0.01       0.30      -3.82  -417139.13
          3    3   -178.22     457.24    -0.02      -0.04       2.89   266047.50
               4    330.57    2255.96     0.02       0.04      -0.19  -417139.09
          4    3     -0.49     457.24    67.66   -1233.42   14995.23   266047.47
               4      0.49    2255.96  -220.20    1233.42  -39175.46  -417139.16
          5    3      0.00       0.00     0.01      -0.24       2.37        0.00
               4      0.00       0.00    -0.01       0.24      -3.81        0.00

    4     1    4      0.00    4270.40     0.00       0.00       0.00   417139.16
               5      0.00   -2235.50     0.00       0.00       0.00    -7267.55
          2    4  38130.37    4270.40     0.00       0.00       0.23   417139.16
               5 -38130.37   -2235.50     0.00       0.00      -0.11    -7267.49
          3    4  38369.63    4270.40     0.00       0.02       0.59   417139.13
               5 -38255.37   -2235.50     0.00      -0.02      -0.11    -7267.50
          4    4  38129.88    4270.40  -239.63      -0.01   23396.63   417139.16
               5 -38129.88   -2235.50   125.22       0.01    -410.18    -7267.50
          5    4      0.00       0.00    -0.02       0.00       2.59        0.00
               5      0.00       0.00     0.02       0.00      -0.29        0.00

    5     1    5      0.00     484.49     0.00       0.00       0.00     7267.37
               6      0.00       0.01     0.00       0.00       0.00        0.08
```

```
  MEMBER END FORCES    STRUCTURE TYPE = SPACE
  -----------------
  ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT      AXIAL   SHEAR-Y  SHEAR-Z    TORSION      MOM-Y       MOM-Z

         2     5       1.95    484.50     0.00      -0.02       0.06     7267.50
               6      -1.95      0.00     0.00       0.02      -0.08       -0.04
         3     5      27.83    484.50     0.00       0.02       0.17     7267.52
               6      -0.49      0.00     0.00      -0.02      -0.03       -0.05
         4     5      -0.49    484.50   -27.34      -0.02     409.81     7267.50
               6       0.49      0.00     0.10       0.02       1.07       -0.04
         5     5       1.95      0.00    -0.02       0.00       0.29        0.00
               6      -1.95      0.00     0.02       0.00       0.23        0.00

    6    1     3       0.00  -1809.87     0.00       0.00       0.00   -69906.29
               7       0.00   1809.87     0.00       0.00       0.00        0.02
         2     3       0.01  -1809.87     0.04       0.00      -1.51   -69906.16
               7      -0.01   1809.87    -0.04       0.00       0.41        0.00
         3     3       0.00  -1809.87     0.04       0.00       0.01   -69906.28
               7       0.00   1809.87    -0.04       0.00      -0.10        0.00
         4     3     -55.36  -1793.91    -0.03       0.00       0.98   -69289.60
               7      55.36   1793.91     0.03       0.00       1.41        0.01
         5     3       0.02      0.00     0.05       0.00      -1.95        0.12
               7      -0.02      0.00    -0.05       0.00      -0.01        0.00

    7    1     4       0.00  -3263.18     0.00       0.00       0.01 -126040.25
              11       0.00   3263.18     0.00       0.00       0.01       -0.02
         2     4       0.00  -3263.18-19064.99       0.00 736386.69 -126040.35
              11       0.00   3263.18 19064.99       0.00      -1.80        0.02
         3     4       0.00  -3263.18-19350.11       0.00 747398.69 -126040.27
              11       0.00   3263.18 19350.11       0.00      -0.87       -0.02
         4     4    -229.99  -3279.14-19269.24       0.00 744275.00 -126656.92
              11     229.99   3279.14 19269.24       0.00      -0.69        0.03
         5     4      -0.01      0.00     0.01       0.00       1.79       -0.12
              11       0.01      0.00    -0.01       0.00      -2.02        0.00

    8    1     3       0.00  -1809.87     0.00       0.00       0.00   -69906.29
               9       0.00   1809.87     0.00       0.00       0.00        0.02
         2     3      -0.01  -1809.88    -0.16       0.00       1.57   -69906.48
               9       0.01   1809.88     0.16       0.00       3.29        0.00
         3     3       0.01  -1809.87     0.13       0.00      -0.66   -69906.34
               9      -0.01   1809.87    -0.13       0.00      -1.84        0.02
         4     3      55.36  -1825.84    -0.23       0.00       5.13   -70523.03
               9     -55.36   1825.84     0.23       0.00       4.98        0.01
         5     3       0.01      0.00     0.06       0.00      -0.05       -0.12
               9      -0.01      0.00    -0.06       0.00       2.00        0.00

    9    1     4       0.00  -3263.18     0.00       0.00      -0.01 -126040.23
              14       0.00   3263.18     0.00       0.00       0.00       -0.02
         2     4       0.01  -3263.17 19064.91       0.00-736383.00 -126040.06
              14      -0.01   3263.17-19064.91       0.00       0.87        0.00
         3     4      -0.01  -3263.18 19350.14       0.00-747399.25 -126040.20
              14       0.01   3263.18-19350.14       0.00      -0.14        0.01
```

```
 MEMBER END FORCES    STRUCTURE TYPE = SPACE
 -----------------
 ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z    TORSION     MOM-Y      MOM-Z

          4    4    229.99  -3247.21 18860.74       0.00-728496.25 -125423.51
              14   -229.99   3247.21-18860.74       0.00      0.54      -0.01
          5    4      0.01      0.00     0.01       0.00     -0.55       0.12
              14     -0.01      0.00    -0.01       0.00      0.18       0.00

   10     1    8   1809.87      0.00     0.00       0.00      0.00       0.00
               7  -1809.87      0.00     0.00       0.00      0.00       0.00
          2    8   1809.87      0.00     0.00       0.00      0.00      -0.10
               7  -1809.87      0.00     0.00       0.00      0.00       0.00
          3    8   1809.87      0.00     0.00       0.00      0.00      -0.02
               7  -1809.87      0.00     0.00       0.00      0.00       0.00
          4    8   1793.91    -55.29     0.00       0.00      0.00   -3870.62
               7  -1793.91     55.29     0.00       0.00      0.00       0.00
          5    8      0.00      0.00     0.00       0.00      0.00      -0.08
               7      0.00      0.00     0.00       0.00      0.00       0.00

   11     1   10   1809.87      0.00     0.00       0.00      0.00       0.00
               9  -1809.87      0.00     0.00       0.00      0.00       0.00
          2   10   1809.88      0.00     0.00       0.00      0.00      -0.10
               9  -1809.88      0.00     0.00       0.00      0.00       0.00
          3   10   1809.87      0.00     0.00       0.00      0.00      -0.02
               9  -1809.87      0.00     0.00       0.00      0.00       0.00
          4   10   1825.84    -55.29     0.00       0.00      0.00   -3870.62
               9  -1825.84     55.29     0.00       0.00      0.00       0.00
          5   10      0.00      0.00     0.00       0.00      0.00      -0.08
               9      0.00      0.00     0.00       0.00      0.00       0.00

   12     1   12   3263.17      0.00     0.00       0.00      0.00       0.00
              11  -3263.17      0.00     0.00       0.00      0.00       0.00
          2   12   3263.19      0.00 19065.08       0.00-171585.75       0.00
              11  -3263.19      0.00-19065.08       0.00      0.00       0.00
          3   12   3263.16      0.00 19350.21       0.00-174151.81      -0.01
              11  -3263.16      0.00-19350.21       0.00      0.00       0.00
          4   12   3279.16   -229.90 19269.28       0.00-173423.52   -2069.08
              11  -3279.16    229.90-19269.28       0.00      0.00       0.00
          5   12      0.00      0.00     0.15       0.00     -1.39       0.00
              11      0.00      0.00    -0.15       0.00      0.00       0.00

   13     1   13   3257.23      0.00    -4.22       0.00    258.77       0.00
              12  -3257.23      0.00     4.22       0.00     -1.37       0.00
          2   13 -16318.38      0.00 -2361.71       0.00  42796.62      -0.01
              12  16318.38      0.00  2361.71       0.00 101267.85       0.00
          3   13 -16611.12      0.00 -2396.97       0.00  43432.74      -0.04
              12  16611.12      0.00  2396.97       0.00 102782.24       0.00
          4   13 -16512.10   -194.01 -2386.98     379.88  43253.45  -11828.66
              12  16512.10    194.01  2386.98    -379.88 102352.40      -5.85
          5   13     -0.09      0.00    -0.01       0.00      0.20      -0.02
              12      0.09      0.00     0.01       0.00      0.48       0.00
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  MEMBER END FORCES    STRUCTURE TYPE = SPACE
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  ALL UNITS ARE -- POUN INCH

 MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y       MOM-Z


    14    1    15   3263.17      0.00     0.00      0.00      0.00        0.00
               14  -3263.17      0.00     0.00      0.00      0.00        0.00
          2    15   3263.17      0.00 19064.98      0.00-171584.78        0.00
               14  -3263.17      0.00-19064.98      0.00      0.00        0.00
          3    15   3263.18      0.00 19350.17      0.00-174151.56       -0.01
               14  -3263.18      0.00-19350.17      0.00      0.00        0.00
          4    15   3247.21   -229.90 18860.77      0.00-169746.97    -2069.08
               14  -3247.21    229.90-18860.77      0.00      0.00        0.00
          5    15      0.00      0.00    -0.01      0.00      0.08        0.00
               14      0.00      0.00     0.01      0.00      0.00        0.00

    15    1    16   3257.23      0.00    -4.22      0.00    258.77        0.00
               15  -3257.23      0.00     4.22      0.00     -1.37        0.00
          2    16 -16318.28      0.00 -2361.70      0.00  42796.38       -0.01
               15  16318.28      0.00  2361.70      0.00 101267.29        0.00
          3    16 -16611.11      0.00 -2396.97      0.00  43432.71       -0.04
               15  16611.11      0.00  2396.97      0.00 102782.19        0.00
          4    16 -16124.54   -194.01 -2336.43    379.88  42339.50   -11828.66
               15  16124.54    194.01  2336.43   -379.88 100182.63       -5.85
          5    16     -0.01      0.00     0.00      0.00      0.02       -0.02
               15      0.01      0.00     0.00      0.00      0.05        0.00

    16    1    18      7.06      1.81     0.00      0.00      0.00      169.52
               12     -7.06     -1.81     0.00      0.00      0.00        1.37
          2    18  29006.15   1089.78     0.00      0.00      0.00    32520.97
               12 -29006.15  -1089.78     0.00      0.00      0.00    70317.77
          3    18  29439.81   1106.05     0.00     -0.01      0.01    33004.76
               12 -29439.81  -1106.05     0.00      0.01      0.00    71369.30
          4    18  29316.76   1101.44   -35.89  -1828.72   4438.47    32868.27
               12 -29316.76  -1101.44    35.89   1828.72  -1051.45    71070.84
          5    18      0.14      0.01     0.00      0.00      0.01        0.15
               12     -0.14     -0.01     0.00      0.00      0.00        0.34

    17    1    17      7.06      1.81     0.00      0.00      0.00      169.52
               15     -7.06     -1.81     0.00      0.00      0.00        1.37
          2    17  29005.99   1089.78     0.00      0.00      0.00    32520.79
               15 -29005.99  -1089.78     0.00      0.00      0.00    70317.38
          3    17  29439.79   1106.05     0.00     -0.01      0.01    33004.74
               15 -29439.79  -1106.05     0.00      0.01      0.00    71369.26
          4    17  28695.36   1078.11   -35.89  -1828.72   4438.47    32173.45
               15 -28695.36  -1078.11    35.89   1828.72  -1051.45    69564.24
          5    17      0.02      0.00     0.00      0.00      0.01        0.02
               15     -0.02      0.00     0.00      0.00      0.00        0.04
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************** END OF LATEST ANALYSIS RESULT **************

87. PRINT MEMBER STRESSES ALL
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    MEMBER STRESSES
    ---------------
    ALL UNITS ARE POUN/SQ INCH

  MEMB    LD  SECT     AXIAL      BEND-Y      BEND-Z   COMBINED  SHEAR-Y  SHEAR-Z


      1    1    .0      0.0 T       0.0         0.0        0.0      0.0      0.0
              1.00      0.0 T       0.0        10.2       10.2     17.0      0.0
           2    .0      0.0 C       0.0         0.0        0.0      0.0      0.0
              1.00      0.0 C       0.0        10.2       10.2     17.0      0.0
           3    .0      0.1 T       0.0         0.0        0.1      0.0      0.0
              1.00      0.6 T       0.0        10.2       10.8     17.0      0.0
           4    .0      0.1 C       0.0         0.0        0.1      0.0      0.0
              1.00      0.1 C       0.6        10.2       10.2     17.0      1.0
           5    .0      0.0 C       0.0         0.0        0.0      0.0      0.0
              1.00      0.0 C       0.0         0.0        0.0      0.0      0.0

      2    1    .0      0.0 T       0.0        10.2       10.2     38.7      0.0
              1.00      0.0 T       0.0       258.7      258.7     92.6      0.0
           2    .0      0.0         0.0        10.2       10.2     38.7      0.0
              1.00      0.0         0.0       258.7      258.7     92.6      0.0
           3    .0      1.3 T       0.0        10.2       11.5     38.7      0.0
              1.00      3.1 T       0.0       258.7      261.8     92.6      0.0
           4    .0      0.0         0.6        10.2       10.2     38.7      2.2
              1.00      0.0        14.6       258.7      259.1     92.6      5.2
           5    .0      0.0 T       0.0         0.0        0.0      0.0      0.0
              1.00      0.0 T       0.0         0.0        0.0      0.0      0.0

      3    1    .0      0.0 T       0.0       258.7      258.7     13.4      0.0
              1.00      0.0 T       0.0       405.6      405.6     66.0      0.0
           2    .0      0.0 C       0.0       258.7      258.7     13.4      0.0
              1.00      0.0 C       0.0       405.6      405.6     66.0      0.0
           3    .0      3.1 T       0.0       258.7      261.8     13.4      0.0
              1.00      5.8 T       0.0       405.6      411.4     66.0      0.0
           4    .0      0.0 T      14.6       258.7      259.1     13.4      2.0
              1.00      0.0 T      38.1       405.6      407.4     66.0      6.4
           5    .0      0.0         0.0         0.0        0.0      0.0      0.0
              1.00      0.0         0.0         0.0        0.0      0.0      0.0

      4    1    .0      0.0 T       0.0       405.6      405.6    125.0      0.0
              1.00      0.0 T       0.0         7.1        7.1     65.4      0.0
           2    .0    669.6 C       0.0       405.6     1075.2    125.0      0.0
              1.00    669.6 C       0.0         7.1      676.7     65.4      0.0
           3    .0    673.8 C       0.0       405.6     1079.4    125.0      0.0
              1.00    671.8 C       0.0         7.1      678.9     65.4      0.0
           4    .0    669.6 C      22.7       405.6     1075.8    125.0      7.0
              1.00    669.6 C       0.4         7.1      676.7     65.4      3.7
           5    .0      0.0         0.0         0.0        0.0      0.0      0.0
              1.00      0.0         0.0         0.0        0.0      0.0      0.0

      5    1    .0      0.0 T       0.0         7.1        7.1     14.2      0.0
              1.00      0.0 T       0.0         0.0        0.0      0.0      0.0
           2    .0      0.0 C       0.0         7.1        7.1     14.2      0.0
              1.00      0.0 C       0.0         0.0        0.0      0.0      0.0
```

```
  MEMBER STRESSES
  ---------------
  ALL UNITS ARE POUN/SQ INCH

MEMB    LD  SECT      AXIAL     BEND-Y      BEND-Z    COMBINED   SHEAR-Y   SHEAR-Z

         3    .0      0.5 C       0.0         7.1        7.6       14.2       0.0
            1.00      0.0 C       0.0         0.0        0.0        0.0       0.0
         4    .0      0.0 T       0.4         7.1        7.1       14.2       0.8
            1.00      0.0 T       0.0         0.0        0.0        0.0       0.0
         5    .0      0.0 C       0.0         0.0        0.0        0.0       0.0
            1.00      0.0 C       0.0         0.0        0.0        0.0       0.0

   6     1    .0      0.0 T       0.0       618.6      618.6      129.3       0.0
            1.00      0.0 T       0.0         0.0        0.0      129.3       0.0
         2    .0      0.0 C       0.0       618.6      618.7      129.3       0.0
            1.00      0.0 C       0.0         0.0        0.0      129.3       0.0
         3    .0      0.0 T       0.0       618.6      618.6      129.3       0.0
            1.00      0.0 T       0.0         0.0        0.0      129.3       0.0
         4    .0      2.1 T       0.0       613.2      615.3      128.1       0.0
            1.00      2.1 T       0.0         0.0        2.1      128.1       0.0
         5    .0      0.0 C       0.0         0.0        0.0        0.0       0.0
            1.00      0.0 C       0.0         0.0        0.0        0.0       0.0

   7     1    .0      0.0 C       0.0      1115.4     1115.4      233.1       0.0
            1.00      0.0 C       0.0         0.0        0.0      233.1       0.0
         2    .0      0.0 T    6516.7      1115.4     7632.1      233.1    1361.8
            1.00      0.0 T       0.0         0.0        0.0      233.1    1361.8
         3    .0      0.0 C    6614.1      1115.4     7729.5      233.1    1382.2
            1.00      0.0 C       0.0         0.0        0.0      233.1    1382.2
         4    .0      8.7 T    6586.5      1120.9     7716.1      234.2    1376.4
            1.00      8.7 T       0.0         0.0        8.7      234.2    1376.4
         5    .0      0.0 T       0.0         0.0        0.0        0.0       0.0
            1.00      0.0 T       0.0         0.0        0.0        0.0       0.0

   8     1    .0      0.0 T       0.0       618.6      618.6      129.3       0.0
            1.00      0.0 T       0.0         0.0        0.0      129.3       0.0
         2    .0      0.0 T       0.0       618.6      618.7      129.3       0.0
            1.00      0.0 T       0.0         0.0        0.0      129.3       0.0
         3    .0      0.0 C       0.0       618.6      618.6      129.3       0.0
            1.00      0.0 C       0.0         0.0        0.0      129.3       0.0
         4    .0      2.1 C       0.0       624.1      626.2      130.4       0.0
            1.00      2.1 C       0.0         0.0        2.1      130.4       0.0
         5    .0      0.0 C       0.0         0.0        0.0        0.0       0.0
            1.00      0.0 C       0.0         0.0        0.0        0.0       0.0

   9     1    .0      0.0 T       0.0      1115.4     1115.4      233.1       0.0
            1.00      0.0 T       0.0         0.0        0.0      233.1       0.0
         2    .0      0.0 C    6516.7      1115.4     7632.1      233.1    1361.8
            1.00      0.0 C       0.0         0.0        0.0      233.1    1361.8
         3    .0      0.0 T    6614.2      1115.4     7729.6      233.1    1382.2
            1.00      0.0 T       0.0         0.0        0.0      233.1    1382.2
         4    .0      8.7 C    6446.9      1109.9     7565.5      231.9    1347.2
            1.00      8.7 C       0.0         0.0        8.7      231.9    1347.2
         5    .0      0.0 C       0.0         0.0        0.0        0.0       0.0
            1.00      0.0 C       0.0         0.0        0.0        0.0       0.0
```

```
   MEMBER STRESSES
   ---------------
   ALL UNITS ARE POUN/SQ INCH

 MEMB   LD  SECT    AXIAL     BEND-Y     BEND-Z    COMBINED  SHEAR-Y  SHEAR-Z


   10    1    .0    896.0 C      0.0        0.0       896.0      0.0      0.0
            1.00    896.0 C      0.0        0.0       896.0      0.0      0.0
         2    .0    896.0 C      0.0        0.0       896.0      0.0      0.0
            1.00    896.0 C      0.0        0.0       896.0      0.0      0.0
         3    .0    896.0 C      0.0        0.0       896.0      0.0      0.0
            1.00    896.0 C      0.0        0.0       896.0      0.0      0.0
         4    .0    888.1 C      0.0     1984.9      2873.0     36.9      0.0
            1.00    888.1 C      0.0        0.0       888.1     36.9      0.0
         5    .0      0.0 T      0.0        0.0         0.0      0.0      0.0
            1.00      0.0 T      0.0        0.0         0.0      0.0      0.0

   11    1    .0    896.0 C      0.0        0.0       896.0      0.0      0.0
            1.00    896.0 C      0.0        0.0       896.0      0.0      0.0
         2    .0    896.0 C      0.0        0.0       896.0      0.0      0.0
            1.00    896.0 C      0.0        0.0       896.0      0.0      0.0
         3    .0    896.0 C      0.0        0.0       896.0      0.0      0.0
            1.00    896.0 C      0.0        0.0       896.0      0.0      0.0
         4    .0    903.9 C      0.0     1984.9      2888.8     36.9      0.0
            1.00    903.9 C      0.0        0.0       903.9     36.9      0.0
         5    .0      0.0 C      0.0        0.0         0.0      0.0      0.0
            1.00      0.0 C      0.0        0.0         0.0      0.0      0.0

   12    1    .0    513.1 C      0.0        0.0       513.1      0.0      0.0
            1.00    513.1 C      0.0        0.0       513.1      0.0      0.0
         2    .0    513.1 C  27900.1        0.0     28413.2      0.0   4766.3
            1.00    513.1 C      0.0        0.0       513.1      0.0   4766.3
         3    .0    513.1 C  28317.4        0.0     28830.4      0.0   4837.6
            1.00    513.1 C      0.0        0.0       513.1      0.0   4837.6
         4    .0    515.6 C  28198.9      336.4     29051.0     57.5   4817.3
            1.00    515.6 C      0.0        0.0       515.6     57.5   4817.3
         5    .0      0.0 C      0.2        0.0         0.2      0.0      0.0
            1.00      0.0 C      0.0        0.0         0.0      0.0      0.0

   13    1    .0    512.1 C     42.1        0.0       554.2      0.0      1.1
            1.00    512.1 C      0.2        0.0       512.4      0.0      1.1
         2    .0   2565.8 T   6958.8        0.0      9524.6      0.0    590.4
            1.00   2565.8 T  16466.3        0.0     19032.1      0.0    590.4
         3    .0   2611.8 T   7062.2        0.0      9674.1      0.0    599.2
            1.00   2611.8 T  16712.6        0.0     19324.4      0.0    599.2
         4    .0   2596.2 T   7033.1     1923.4     11552.7     48.5    596.7
            1.00   2596.2 T  16642.7        1.0     19239.9     48.5    596.7
         5    .0      0.0 T      0.0        0.0         0.0      0.0      0.0
            1.00      0.0 T      0.1        0.0         0.1      0.0      0.0

   14    1    .0    513.1 C      0.0        0.0       513.1      0.0      0.0
            1.00    513.1 C      0.0        0.0       513.1      0.0      0.0
         2    .0    513.1 C  27900.0        0.0     28413.0      0.0   4766.2
            1.00    513.1 C      0.0        0.0       513.1      0.0   4766.2
```

```
 MEMBER STRESSES
 ---------------
 ALL UNITS ARE POUN/SQ INCH

MEMB   LD  SECT     AXIAL     BEND-Y      BEND-Z   COMBINED   SHEAR-Y  SHEAR-Z

         3   .0     513.1 C  28317.3         0.0    28830.4       0.0   4837.5
           1.00     513.1 C      0.0         0.0      513.1       0.0   4837.5
         4   .0     510.6 C  27601.1       336.4    28448.1      57.5   4715.2
           1.00     510.6 C      0.0         0.0      510.6      57.5   4715.2
         5   .0       0.0 T      0.0         0.0        0.0       0.0      0.0
           1.00       0.0 T      0.0         0.0        0.0       0.0      0.0

   15    1   .0     512.1 C     42.1         0.0      554.2       0.0      1.1
           1.00     512.1 C      0.2         0.0      512.4       0.0      1.1
         2   .0    2565.8 T   6958.8         0.0     9524.5       0.0    590.4
           1.00    2565.8 T  16466.2         0.0    19032.0       0.0    590.4
         3   .0    2611.8 T   7062.2         0.0     9674.0       0.0    599.2
           1.00    2611.8 T  16712.6         0.0    19324.4       0.0    599.2
         4   .0    2535.3 T   6884.5      1923.4    11343.1      48.5    584.1
           1.00    2535.3 T  16289.9         1.0    18826.1      48.5    584.1
         5   .0       0.0 T      0.0         0.0        0.0       0.0      0.0
           1.00       0.0 T      0.0         0.0        0.0       0.0      0.0

   16    1   .0       1.1 C      0.0        27.6       28.7       0.5      0.0
           1.00       1.1 C      0.0         0.2        1.3       0.5      0.0
         2   .0    4560.7 C      0.0      5288.0     9848.7     272.4      0.0
           1.00    4560.7 C      0.0     11433.8    15994.5     272.4      0.0
         3   .0    4628.9 C      0.0      5366.6     9995.5     276.5      0.0
           1.00    4628.9 C      0.0     11604.8    16233.7     276.5      0.0
         4   .0    4609.6 C    721.7      5344.4    10675.7     275.4      9.0
           1.00    4609.6 C    171.0     11556.2    16336.8     275.4      9.0
         5   .0       0.0 C      0.0         0.0        0.0       0.0      0.0
           1.00       0.0 C      0.0         0.1        0.1       0.0      0.0

   17    1   .0       1.1 C      0.0        27.6       28.7       0.5      0.0
           1.00       1.1 C      0.0         0.2        1.3       0.5      0.0
         2   .0    4560.7 C      0.0      5287.9     9848.6     272.4      0.0
           1.00    4560.7 C      0.0     11433.7    15994.4     272.4      0.0
         3   .0    4628.9 C      0.0      5366.6     9995.5     276.5      0.0
           1.00    4628.9 C      0.0     11604.8    16233.7     276.5      0.0
         4   .0    4511.8 C    721.7      5231.5    10465.0     269.5      9.0
           1.00    4511.8 C    171.0     11311.3    15994.1     269.5      9.0
         5   .0       0.0 C      0.0         0.0        0.0       0.0      0.0
           1.00       0.0 C      0.0         0.0        0.0       0.0      0.0

  ************** END OF LATEST ANALYSIS RESULT **************

   88. PARAMETER
   89. CODE AISC
   90. PUNCH 3. MEMB 12 TO 17
   91. FYLD 45999.969 MEMB 10 TO 17
   92. WSTR 21000. MEMB 10 TO 17
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93. WMIN 0.188 MEMB 10 TO 17
94. CB 1. MEMB 10 TO 17
95. CMY 1. MEMB 10 TO 17
96. MAIN 0. MEMB 10 TO 17
97. RATIO 1. MEMB 10 TO 17
98. CHECK CODE MEMB 10 TO 17
```

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                         STAAD-III CODE CHECKING - (AISC)
                         ************************

ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE           RESULT/   CRITICAL COND/     RATIO/     LOADING/
                              FX           MY             MZ       LOCATION
=======================================================================

    10   ST   TUB 40203        PASS      AISC- H1-3        0.125         4
                       1793.91 C           0.00       -3870.62        0.00
    11   ST   TUB 40203        PASS      AISC- H1-3        0.126         4
                       1825.84 C           0.00       -3870.62        0.00
*   12   ST   TUB 40408        FAIL      AISC- H1-3        1.053**       4
                       3279.16 C     -173423.52       -2069.08        0.00
    13   ST   TUB 40408        PASS      AISC- H2-1        0.700         3
                      16611.12 T      102782.24           0.00       61.00
*   14   ST   TUB 40408        FAIL      AISC- H1-3        1.045**       3
                       3263.18 C     -174151.56          -0.01        0.00
    15   ST   TUB 40408        PASS      AISC- H2-1        0.700         3
                      16611.11 T      102782.19           0.00       61.00
    16   ST   TUB 40408        PASS      AISC- H1-1        0.652         4
                      29316.76 C       -1051.45       71070.84       94.37
    17   ST   TUB 40408        PASS      AISC- H1-1        0.647         3
                      29439.79 C           0.00       71369.26       94.37
   99. SELECT WELD MEMB 10 TO 17
```

** NOTE: STRESS RATIO IS ACCEPTABLE BASED ON CONSERVATIVE LOADING. APPLIED LOAD DOES NOT TAKE INTO ACCOUNT STIFFENER RING'S BEHAVIOR DURING LOADING. ADDITIONALLY ACCEPTANCE RATIO CAN BE INCREASED BY 1.33 DUE TO SEISMIC LOAD CONDITION.

```
                    STAAD-III WELD DESIGN
                    *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/      WELD TYPE/        WELD SIZE/        COMB STRESS/
         LOADING        HOR STRESS        VERT STRESS        DIR STRESS
======================================================================

   10       STA             1               3/16               2345.67
             4                0.00              24.58          2345.54

   10       END             1               3/16                804.39
             3                0.00               0.00           804.39

   11       STA             1               3/16               2359.86
             4                0.00              24.58          2359.73

   11       END             1               3/16                811.86
             4                0.00              24.58           811.48

   12       STA             1               7/16              19466.87
             4             2752.75              32.84         19271.23

   12       END             1               3/16               6541.14
             3             6450.07               0.00          1087.72

   13       STA             1               3/16              19293.32
             4              843.15             112.15         19274.56

   13       END             1               5/16              18745.69
             3              479.39               0.00         18739.56

   14       STA             1               7/16              19324.00
             3             2764.31               0.00         19125.27

   14       END             1               3/16               6541.13
             3             6450.06               0.00          1087.73

   15       STA             1               3/16              18935.26
             4              826.29             112.15         18916.89

   15       END             1               5/16              18745.68
             3              479.39               0.00         18739.55

   16       STA             1               3/16              19109.74
             4              240.55             595.74         19098.94

   16       END             1               4/16              20857.69
             4              180.42             446.80         20852.12

   17       STA             1               3/16              18728.88
             4              240.55             587.96         18718.10

   17       END             1               4/16              20743.53
             3                0.00             276.51         20741.69
```

```
                         STAAD-III WELD DESIGN
                         *********************

ALL UNITS ARE - INCH POUN

MEMBER    LOCATION/      WELD TYPE/        WELD SIZE/        COMB STRESS/
          LOADING        HOR STRESS       VERT STRESS         DIR STRESS
==========================================================================


****************** END OF TABULATED WELD DESIGN ******************

100. STEEL TAKEOFF
```

```
STEEL TAKE-OFF
--------------

PROFILE                  LENGTH(INCH)       WEIGHT(POUN)

ST   PIP E                  474.00            7638.229
ST   TUB 1401408            154.50            1154.300
ST   TUB 40203              140.00              80.032
ST   TUB 40408              328.73             591.679
                                         ----------------
                               TOTAL =         9464.24

************ END OF DATA FROM INTERNAL STORAGE ************

101. FINISH

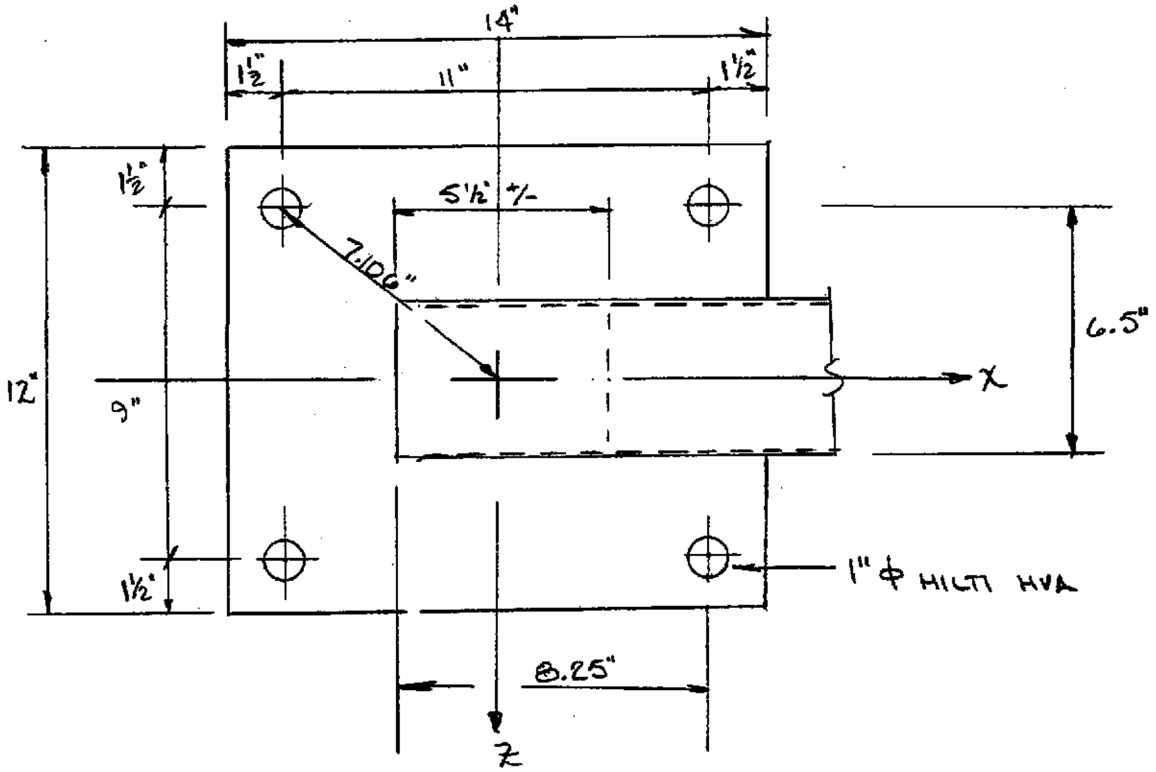
          *************** END OF STAAD-III ***************

            **** DATE= SEP 17,1996   TIME= 14:18:44 ****

      ********************************************************
      *        For questions on  STAAD-III,   contact:       *
      *              Research Engineers, Inc at              *
      *        Ph: (714) 974-2500   Fax:  (714) 921-2543     *
      ********************************************************
```

⅊ 14"×12"×1"

BASEPLATE @ KICKER LEGS. (JOINTS 17 & 18)



Fx = 21656 lbs

Mx = 4264. in-lbs

FY = 19791 lbs (compression)

MY = 2204 in-lbs

Fz = 36. lbs

Mz = 32868 in-lbs.

BOLT TENSION

$$T = \frac{4264 \text{ in-lbs}}{(2 \text{ BOLTS})(6.5 \text{ in})} + \frac{32868 \text{ in-lbs}}{(2 \text{ BOLTS})(8.25 \text{ in})}$$

$$= 2320 \text{ lbs/BOLT } \underset{\uparrow \text{PRYING}}{(1.2)} = 2784 \text{ \#/BOLT}$$

BOLT SHEAR

$$V = \frac{21656.\text{lbs.} + 36.\text{lbs.}}{4 \text{ BOLTS}} + \frac{2204}{(4 \text{ BOLTS})(7.106 \text{ in})}$$

$$= 5501. \text{ lbs/BOLT.}$$

BOLT INTERACTION

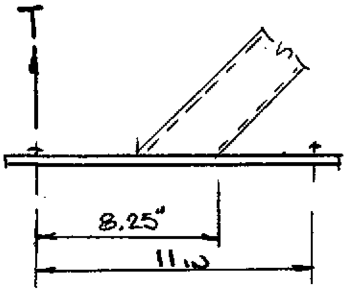
1" ϕ HILTI HVA @ 8 1/4" EMBED'T

T_{ALL} = 10960 lbs. V_{ALL} = 7630. lbs.

$$\frac{2784 \text{ lbs/BOLT}}{10960 \text{ lbs/BOLT}} + \frac{5501 \text{ lbs/BOLT}}{7630 \text{ lbs/BOLT}} = .975 < 1.0 \therefore \underline{\text{OK}}$$

$$\boxed{\therefore \text{ USE } 1"\phi \text{ HILTI HVA @ } 8\tfrac{1}{4}" \text{ EMB'T}}$$

BASEPLATE 14" x12"



T = 2784 lbs

F_y = 36000 #/in²

F_{by} = .75 (F_y) = 27000 #/in²

$$f_b = \frac{M}{S} = \frac{T(8.25)}{S}$$

$$S_{REQ'D} = \frac{M}{f_b} = \frac{M}{F_{yb}}$$

$$S = \frac{(2784 \text{ lbs.})(8.25 \text{ in})}{27000. \text{ lbs/in}^2} = .851 \text{ in}^3$$

$$S = \frac{bd^2}{6} \Rightarrow d = \sqrt{\frac{6S}{b}}$$

$$d = \sqrt{\frac{6(.851 \text{ in}^3)}{11 \text{ in.}}} = .68 \text{ in}$$

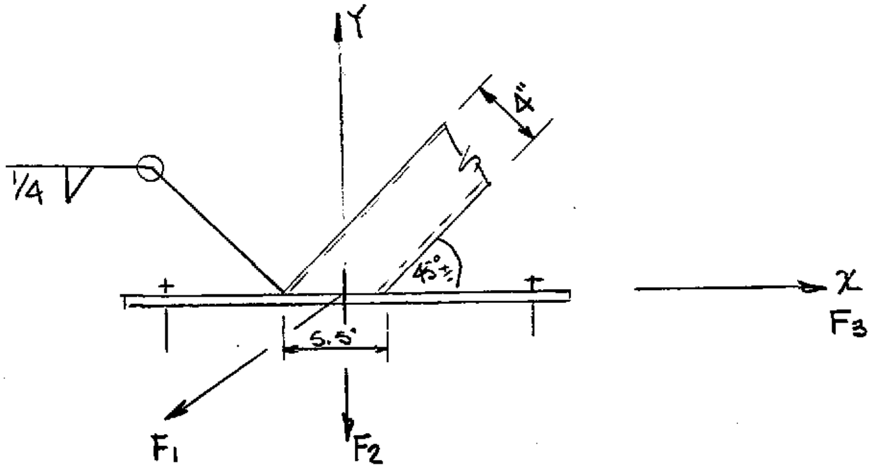
t = 1 3/8 will be used

$$\boxed{\text{USE } 1" \text{ THK PL} \times 14" \times 12"}$$

Filename: B-9 SUPPORT

ALL AROUND RECTANGULAR OR SQUARE FILLET WELD

Between part MEM 16 & 17 and BASEPLTS



LOAD INPUT (LBS., INCH-LBS.)

F1	F2	F3	M1	M2	M3
36.00	0.00	21656.00	4264.00	2204.00	32868.00

GEOMETRIC DIMENSIONS

a	b	WELD STRESS (PSI)	SKEWED ANGLE(90ø>á<120ø)
5.500	4.000	21000	45.000

SECTION PROPERTIES

A	Sw1	Sw3	J	C1	C3
19.000	32.083	27.333	142.896	2.750	2.000

EFFECTIVE THROAT CORRECTION FACTOR

Mf

0.54

MAXIMUM WELD LOAD (f) - #/INCH

f=

1776

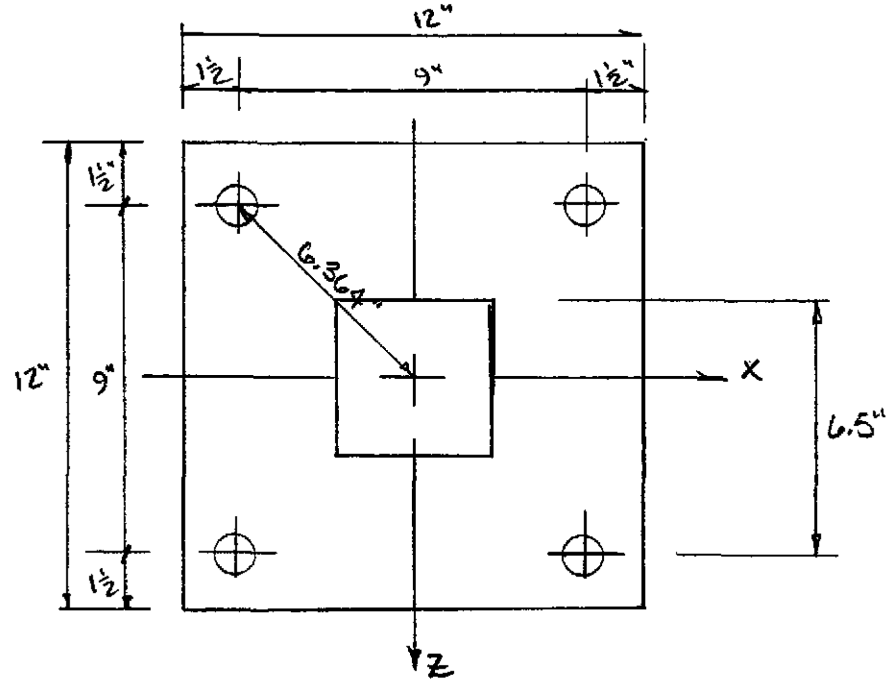
REQUIRED FILLET WELD SIZE (INCHES)

w=

0.065 USE 1/4" fillet

PLATE 12"x12"

(JOINTS 13 & 16)



Fx = 2387. lbs. Mx = 11829. in-lbs

FY = 16512. lbs MY = 380. in-lbs

Fz = 194. lbs Mz = 43253. in-lbs.

Bolt Tension

$$T = \frac{16512 \text{ lbs}}{4 \text{ BOLTS}} + \frac{11829 \text{ in-lbs}}{2(6.5 \text{ in})} + \frac{43253 \text{ in-lbs}}{2(6.5 \text{ in})}$$

$$= 4128. + 910. + 3327$$

$$= 8365 \text{ lbs.} \underset{\uparrow \text{PRYING}}{(1.2)} = 10038. \text{ lbs/BOLT}$$

Bolt Shear

$$V = \frac{2387 + 194}{4 \text{ BOLTS}} + \frac{380}{(4 \text{ BOLTS})(6.364 \text{ in})}$$

$$= 660 \text{ lbs/BOLT}$$

BOLT INTERACTION

FOR 1"ϕ HILTI HVA @ 8¼" EMB'T

$T_{ALL} = 10960$ lbs $V_{ALL} = 7630$ lbs.

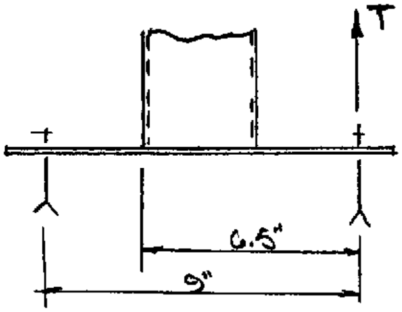
$$\frac{10038}{10960} + \frac{660}{7630} = .91 + .08 \approx 1.0 \approx 1.0$$

$\therefore$ O.K.

USE $\boxed{\text{1"}\phi\text{ HILTI HVA@8¼" EMB'T}}$

BASE PLATE

12" x 12"



$F_Y = 36000$

$F_{by} = .75\,(F_y) = 27000\,{}^{\#}/\text{in}^2$

$$f_b = \frac{M}{S} = \frac{T\,(6.5\text{in})}{S}$$

$$S_{REQ'D} = \frac{M}{f_b} = \frac{M}{F_{yb}} = \frac{10038\,(6.5\text{in})}{27000.{}^{\#}/\text{in}} = 2.42\ \text{in}^3$$

$$S = \frac{bd^2}{6} \Rightarrow d = \sqrt{\frac{6S}{b}}$$

$$= \sqrt{\frac{6\,(2.42\text{in}^3)}{9\text{in}}}$$

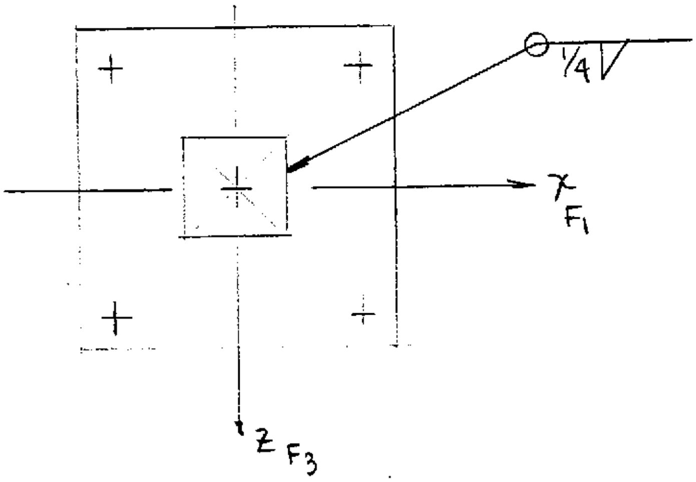
$$d = 1.27\text{in}$$

$\boxed{\text{USE PL } 1\tfrac{3}{8}\text{" THK} \times 12\text{"} \times 12\text{"}}$

Filename: B-9 SUPPORT

ALL AROUND RECTANGULAR OR SQUARE FILLET WELD

Between part MEM 13 & 15 and BASEPLTS



LOAD INPUT (LBS., INCH-LBS.)

F1	F2	F3	M1	M2	M3
2387.00	16512.00	194.00	11829.00	380.00	43253.00

GEOMETRIC DIMENSIONS

a	b	WELD STRESS (PSI)	SKEWED ANGLE(90ø>â<120ø)
4.000	4.000	21000	90.000

SECTION PROPERTIES

A	Sw1	Sw3	J	C1	C3
16.000	21.333	21.333	85.333	2.000	2.000

EFFECTIVE THROAT CORRECTION FACTOR

Mf

1.00

MAXIMUM WELD LOAD (f) - #/INCH

f=

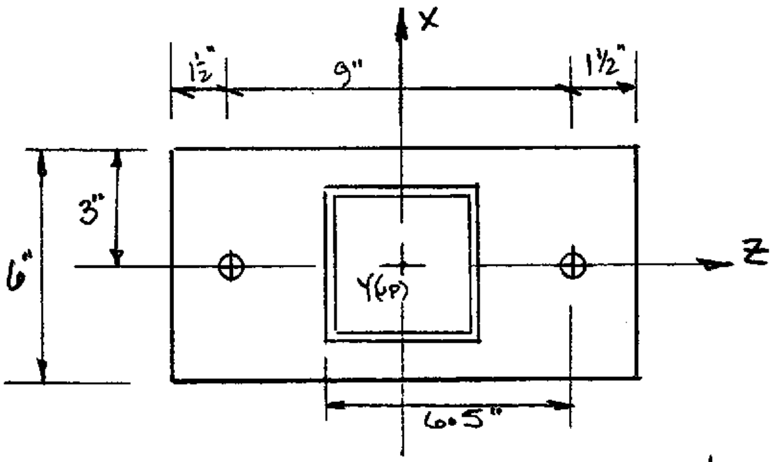
3617

REQUIRED FILLET WELD SIZE (INCHES)

w=

0.244 USE 1/4" fillet

PL 6"×12" JTS 8 & 10



1"φ HILTI HVA

$T_{ALL} = 10960.$ lbs

$V_{ALL} = 7630.$ lbs.

ENVELOPE OF LOADS @ JTS 8, 10, 13 & 16 (MEMBERS 10, 11, 13 & 15)

$Fx = 0.$ $Mx = 3871.$
$FY = 1826$ (compression) $MY = 0.$
$FZ = 55.0$ $MZ = 0.$

BOLT TENSION

$$T = \frac{1826 \text{ lbs}}{2 \text{ BOLTS}} + \frac{3871. \text{ IN-lbs}}{(1 \text{ BOLT})(6.5 \text{ IN})}$$

$$= 1508.5 \text{ lbs } (\underset{\uparrow \text{PRYING}}{1.2}) = 1810 \text{ lbs}$$

BOLT SHEAR

$$V = \frac{55 \text{ lbs}}{2 \text{ BOLTS}}$$

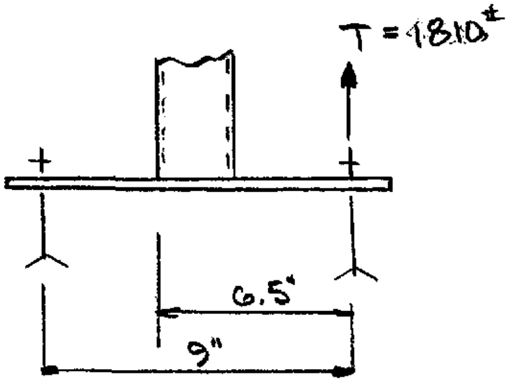
$$= 27.5 \text{ lbs/BOLT}$$

BOLT INTERACTION

$$\frac{1810 \text{ lbs}}{10960. \text{ lbs}} + \frac{27.5 \text{ lbs}}{7630. \text{ lbs}} = .17 < 1.0 \therefore \text{O.K.}$$

USE 1"φ HILTI HVA
@8¼" EMBED'T.

BASEPLATE



$F_y = 36000\ \#/in^2$

$F_{by} = .75(36000\ \#/in^2)$

$= 27000\ \#/in^2$

$f_b = \frac{M}{S} = \frac{T(6.5\,in)}{S}$

$S_{REQ'D} = \frac{M}{f_b} = \frac{M}{F_b}$

S REQ'D

$S = \frac{1810\,lbs\,(6.5\,in)}{27000\ \#/in^2}$

$S_{req'd} = 0.436\,in^3$

$S = \frac{bd^2}{6} \Rightarrow d = \sqrt{\frac{6(S)}{b}}$

$d = \sqrt{\frac{6(0.436\,in^3)}{9\,in}}$

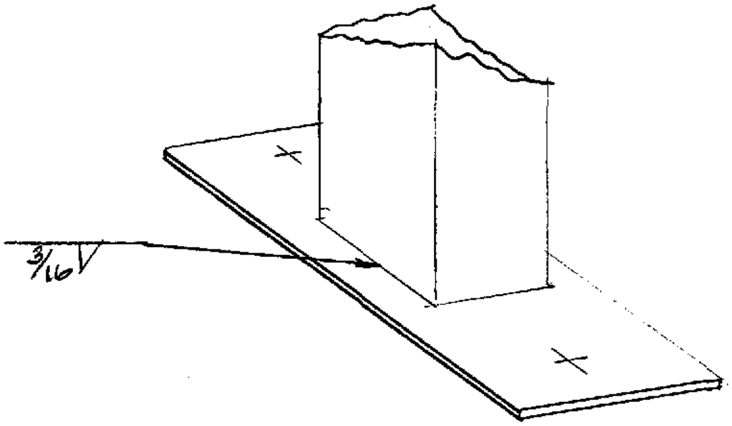
$d = .54\,in$

$\boxed{\text{USE 1" THK PLATE x 12" x 6"}}$

Filename: B-9 SUPPORT

ALL AROUND RECTANGULAR OR SQUARE FILLET WELD

Between part_ MEM 10 & 11 and BASEPLTS



LOAD INPUT (LBS., INCH-LBS.)

F1	F2	F3	M1	M2	M3
0.00	1826.00	55.00	3871.00	0.00	0.00

GEOMETRIC DIMENSIONS

a	b	WELD STRESS (PSI)	SKEWED ANGLE(90ø>á<120ø)
4.000	4.000	21000	90.000

SECTION PROPERTIES

A	Sw1	Sw3	J	C1	C3
16.000	21.333	21.333	85.333	2.000	2.000

EFFECTIVE THROAT CORRECTION FACTOR

Mf

1.00

MAXIMUM WELD LOAD (f) - #/INCH

f=

296

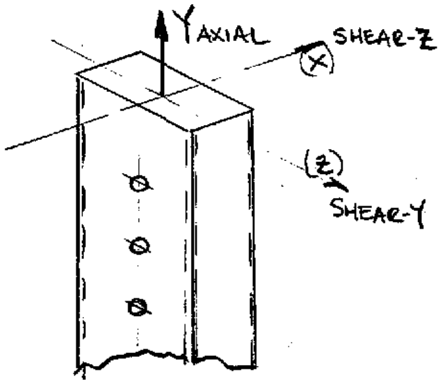
REQUIRED FILLET WELD SIZE (INCHES)

w=

0.020 USE 3/16 in fillet all around

DESIGN BOLTED CONNECTIONS

MEMBER END FORCES @ 10, 11, 12 & 14



ENVELOPE (WORST CASE) LOADS

FY = AXIAL = 3279 (MEM 12)

Fx = Shear-Z = 19350. (MEM 12 & 14)

Fz = Shear-Y = 230. (MEM 12 & 14)

$$\text{MAX SHEAR} = V_{MAX} = \frac{3279.\text{ lbs} + 230.\text{ lbs.}}{3\text{ BOLTS}}$$

$$V_{MAX} = 1170\ \#/\text{BOLT}$$

$$\text{MAX TENSION} = T_{MAX} = 19350.\text{ lbs.}/3\text{ BOLTS} = 6450\ \#/\text{BOLT}$$

USE 5/8"φ A325 BOLTS

$$\text{ALLOWABLE} = V_{MAX} = 5220.\text{ lbs}$$

$$\text{ALLOWABLE} = T_{MAX} = 13500.\text{ lbs}$$

BOLT INTERACTION

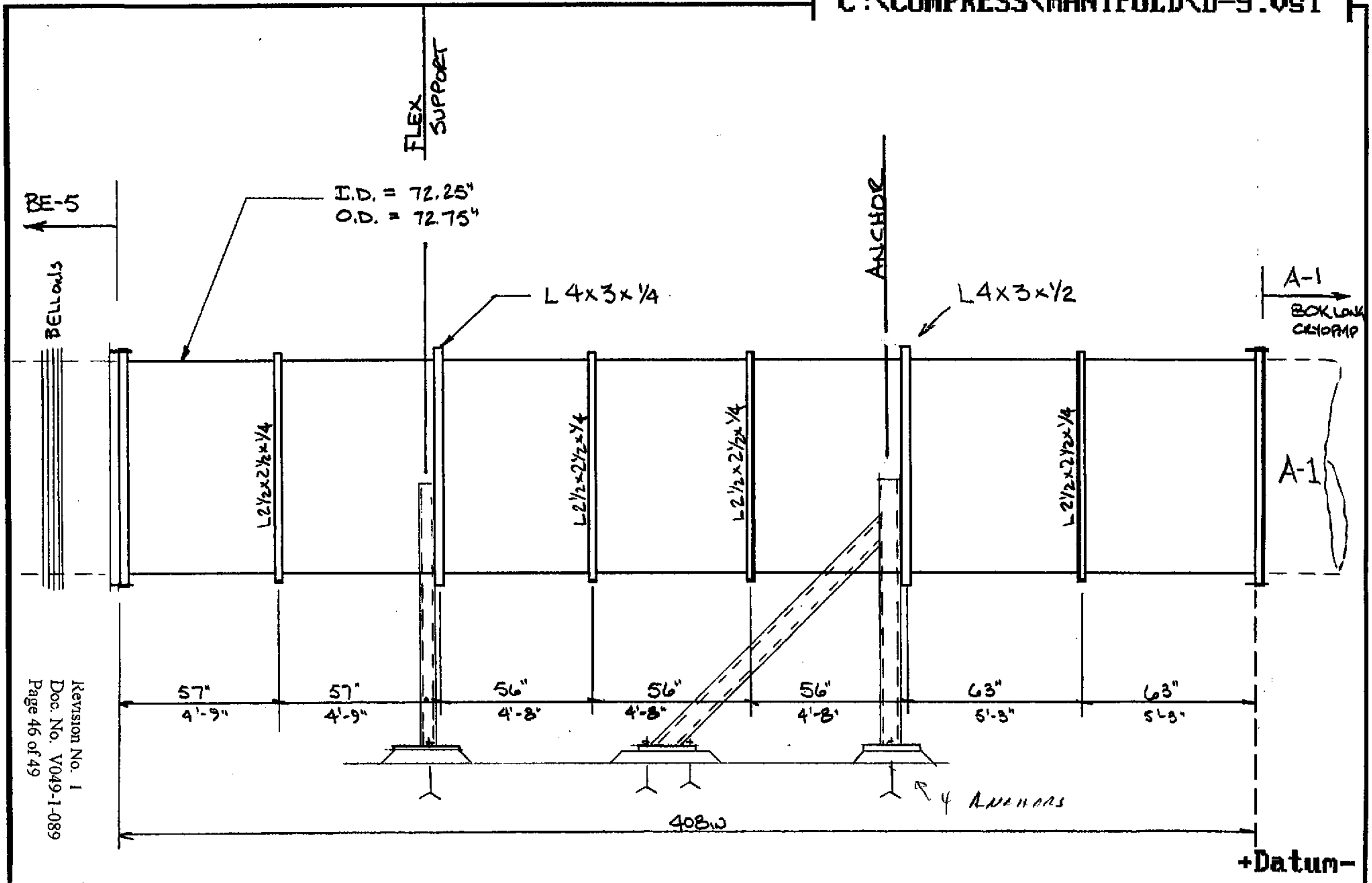
$$\frac{V_{MAX}}{V_{MAX\ ALLOW}} + \frac{T_{MAX}}{T_{MAX\ ALLOW}} = \frac{1170}{5220.} + \frac{6450(1.2)\text{PRYING}}{13500.}$$

$$= 0.80 < 1.0 \therefore OK$$

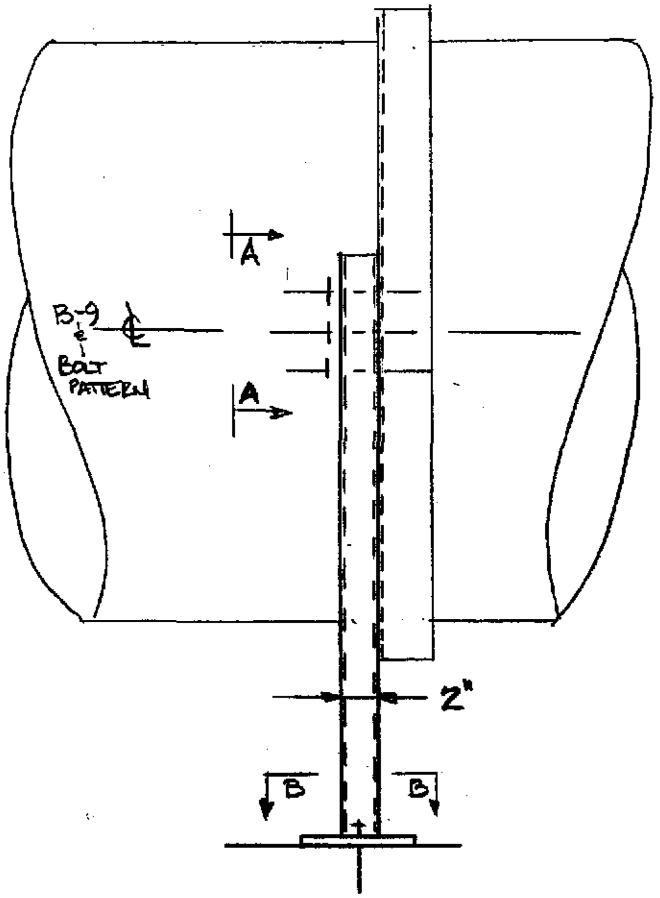
NOTE: TO ACCOUNT FOR ANY
LOCAL PRYING AFFECTS
AT THE BOLTED CONNECTIONS
USE 1.2 FACTOR.

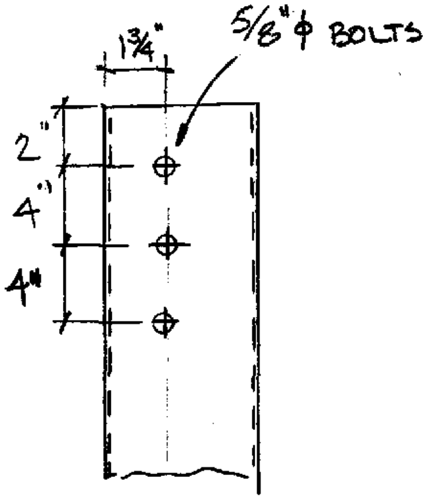
$$\boxed{\text{USE 5/8"}\phi\text{ A325 BOLTS}}$$

C:\COMPRESS\MANIFOLD\b-9.vsl

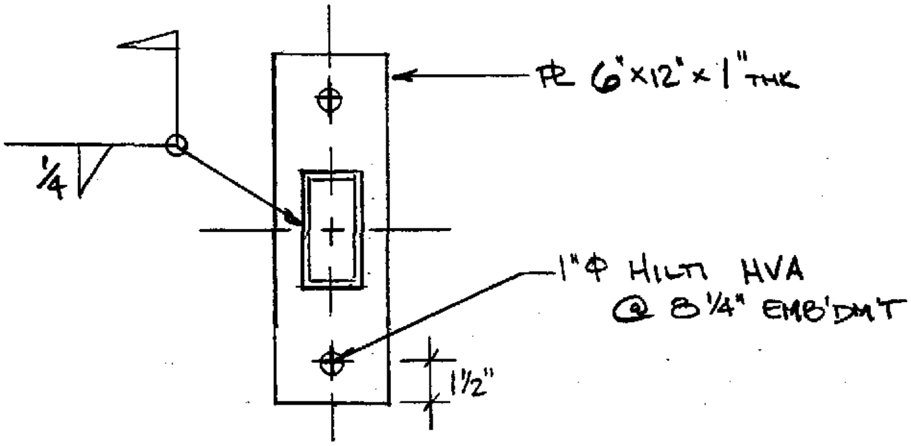


B-9 FLEX SUPPORT





SECTION A-A

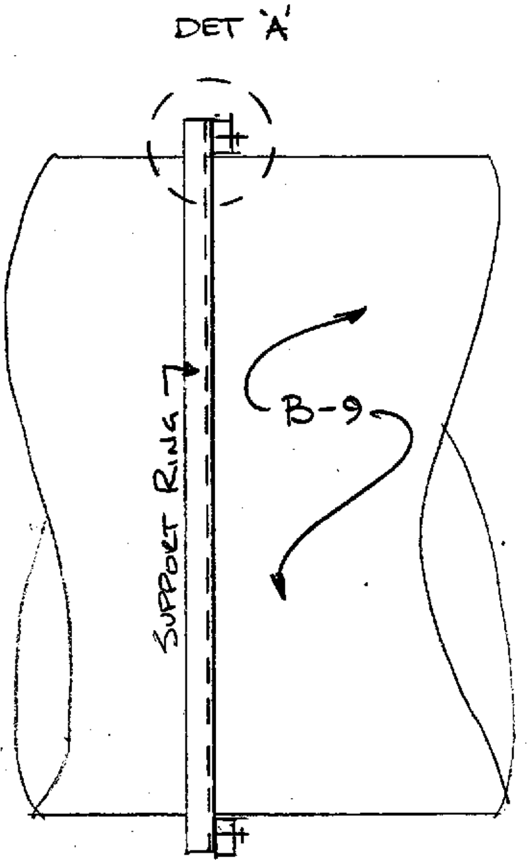


SECTION B-B

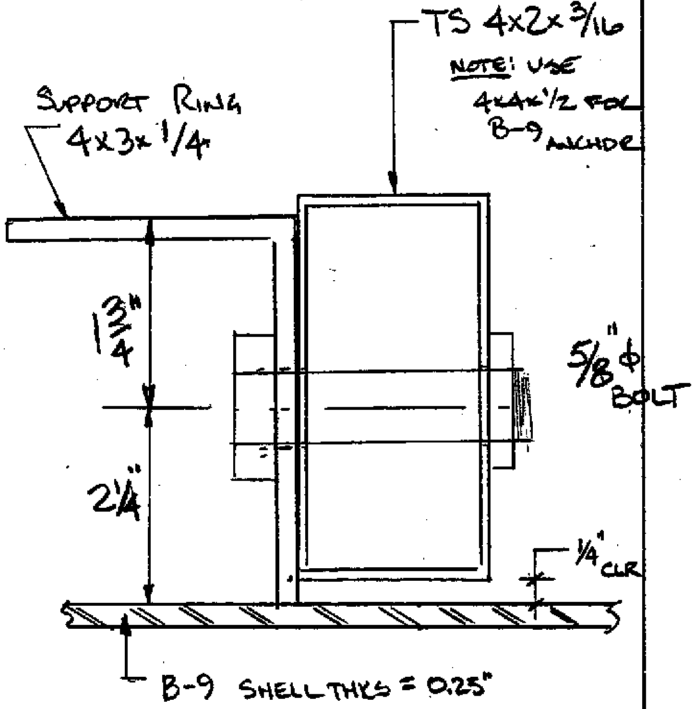
BEAM TUBE MANIFOLD SUPPORTS

B-9

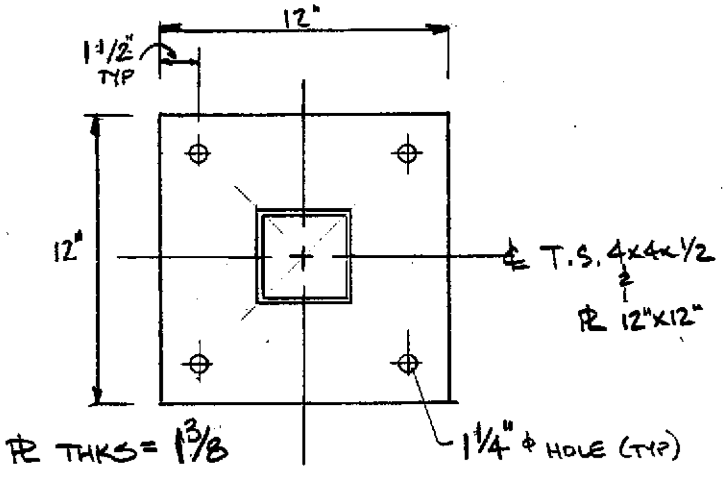
FLEX SUPPORT



PLAN VIEW



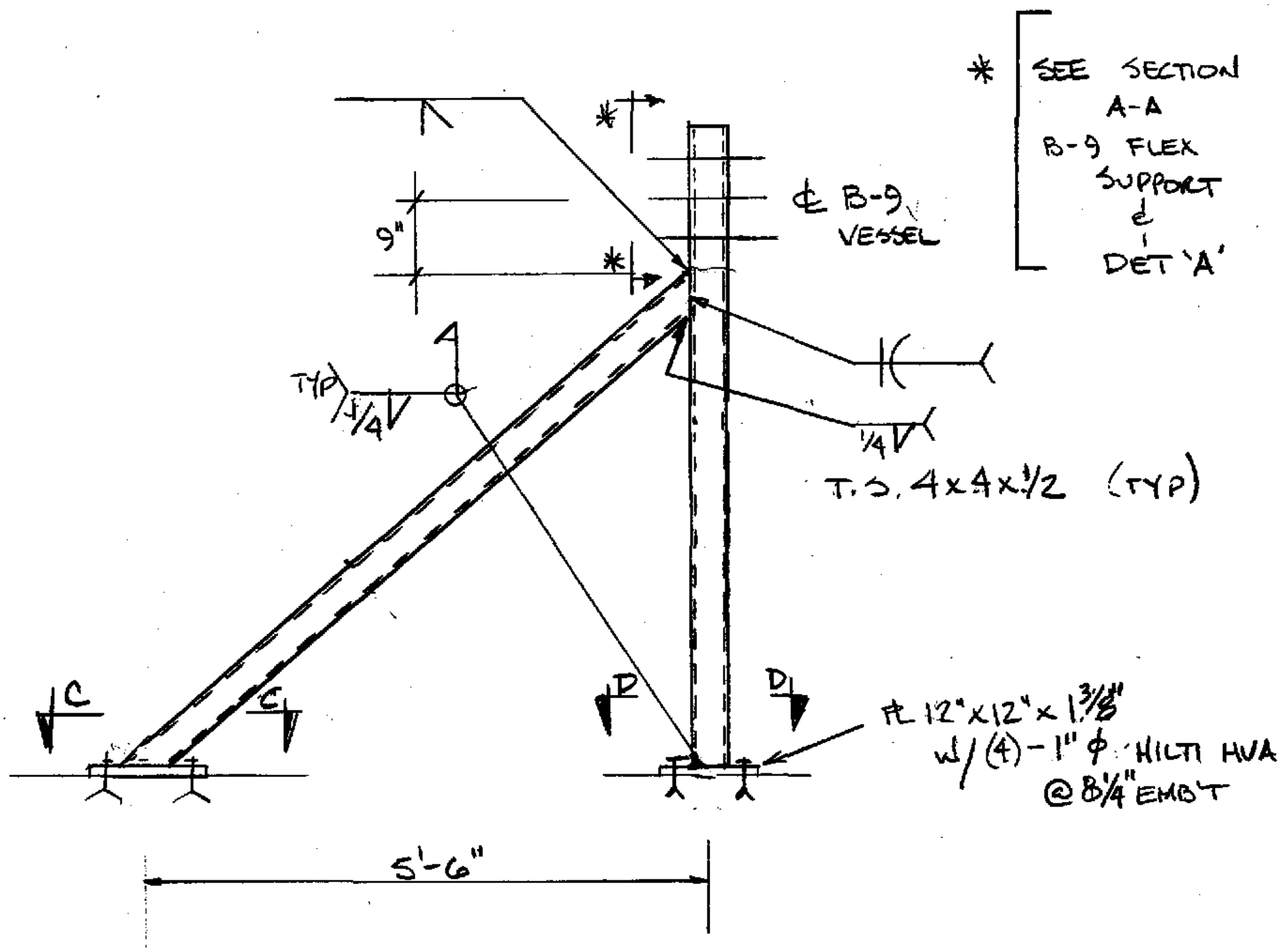
DETAIL 'A'

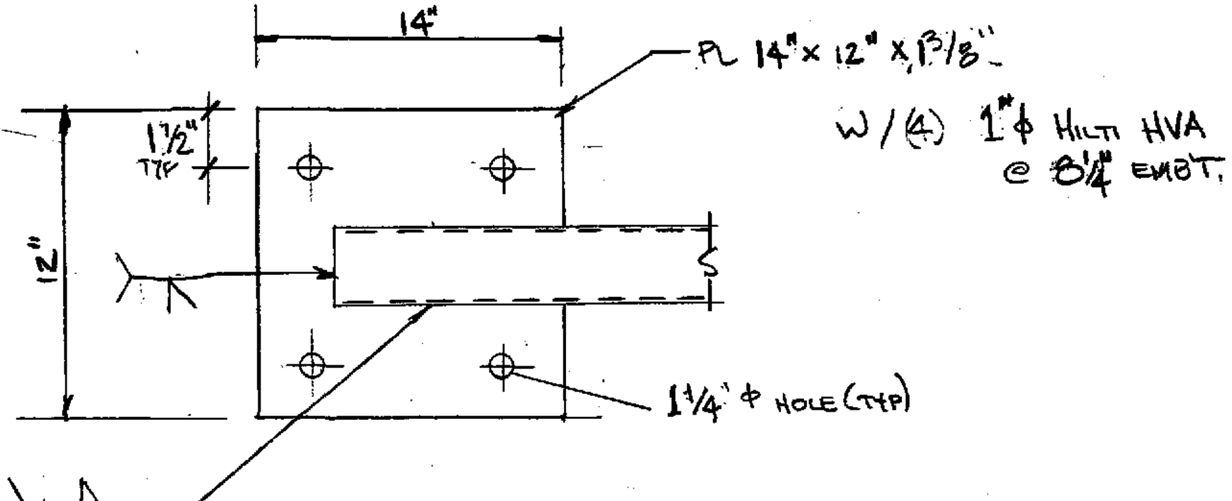


SECTION D-D

BEAM TUBE MANIFOLD SUPPORTS

B-9 ANCHOR





SECTION C-C

PROCESS SYSTEMS INTERNATIONAL, INC.
WESTBOROUGH, MA

ENGINEERING CALCULATIONS

NO: V049-1-095
PAGE 1 OF 46

REV.	DEO #	DATE	BY:	CHECK
0	0139	4/24/96	WDB	AGR
1	0293	9/23/96	WDB	RDC

TITLE:
Design of Generic Support Scheme for;
Beam Tube Manifold B-6 & B-7

BY: W. Bilynsky
DEPT.: 744

PROJECT: LIGO Vacuum Equipment

PROJECT NO: V59049

PURPOSE:.
The purpose of this calculation is to design a generic support for B-6/B-7 Beam Tube Manifolds (BTM). The design of BTM B-6/B-7 is governed by the gate valve's vacuum load which occurs during system regeneration.

METHOD:
A STAAD model of BTM B-6/B-7 was generated and used for design. Baseplates, anchor bolts and thru-bolted connections were designed using AISC standards and STAAD computer output. Load cases included; DW, Thermal, Vacuum and Seismic (static g load). DW included the weight of the vessel and its flanges. Thermal included a temperature load along the length of the vessel. Vacuum loads occur from the gate valves opening/closing. An additional unbalanced vacuum load occurs at the turbo pump nozzle opening.

ASSUMPTIONS See Calculation

INPUTS:
Vessel weight = 1083.0 lbs, Flange weight = 253.0 lbs
Seismic Acceleration = 0.05625 g.
Vacuum Load @ Gate Valve = 32170.0 lbs
Vacuum Load @ Turbo Pump = 1155.0 lbs. (B-7)

REFERENCES:
1. STAAD-III release 21, Research Engineers
2. ASD - AISC 9th edition
3. Doc. No. V049-1-066 - LIGO Vacuum Equipment Structural Design Criteria

CALCULATIONS:

V049-1- 058	Design of Spool B-6
V049-1- 059	Design of Spool B-7

CONCLUSIONS: The requirements of the AISC Code and the LIGO Vacuum Equipment Structural Design Criteria are met.

NOTES: STAAD-III Computer file: B67BTMR1.*

TABLE OF CONTENTS

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Spool B-6/B-7 (48 in dia) COMPRESS Plot 4

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Anchorage Design 39

    Anchor Bolts

    Baseplates

    Welded Connections @ Baseplate

Bolted Connections 45

B-6/B-7 Support Detail 46

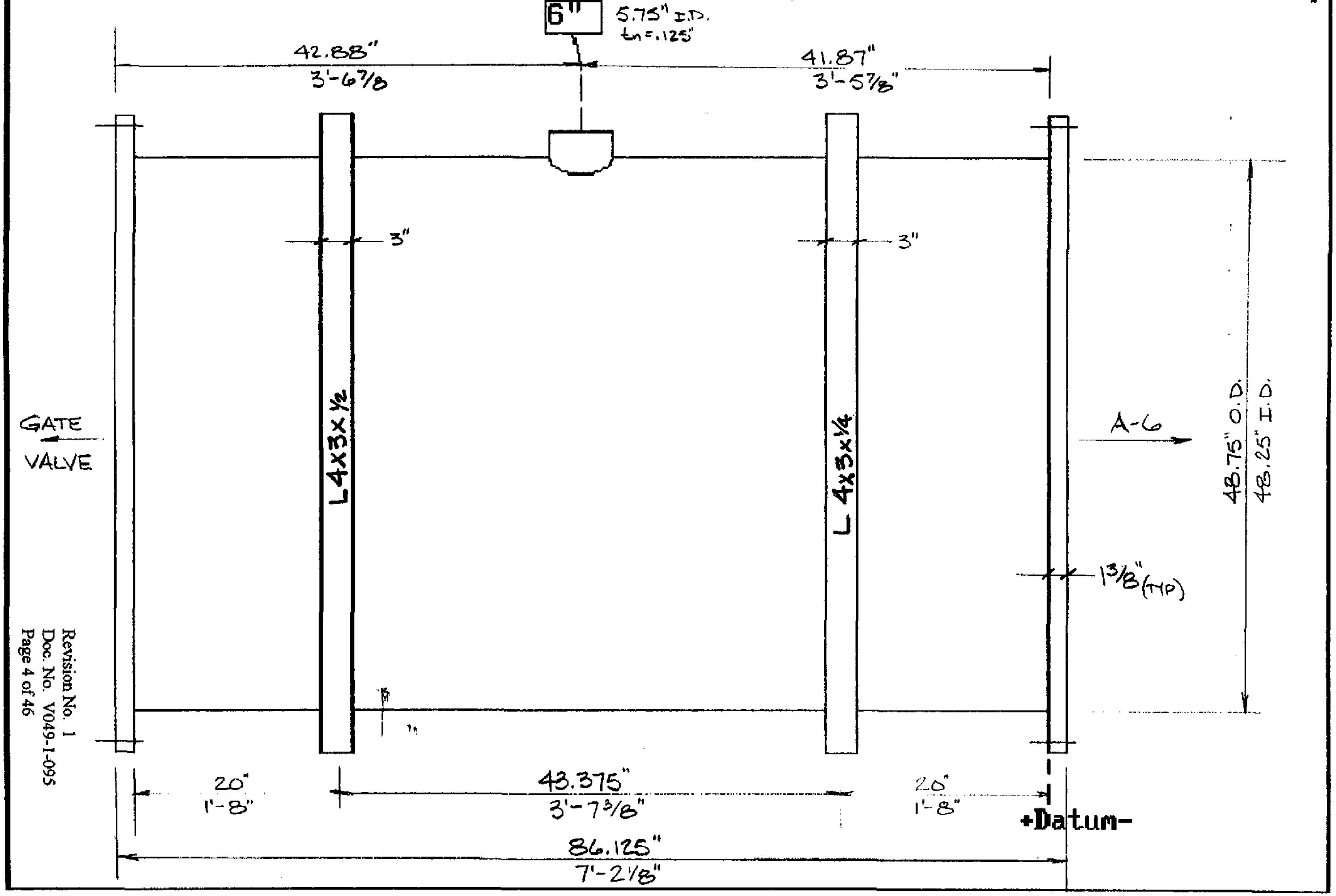
REVISION HISTORY

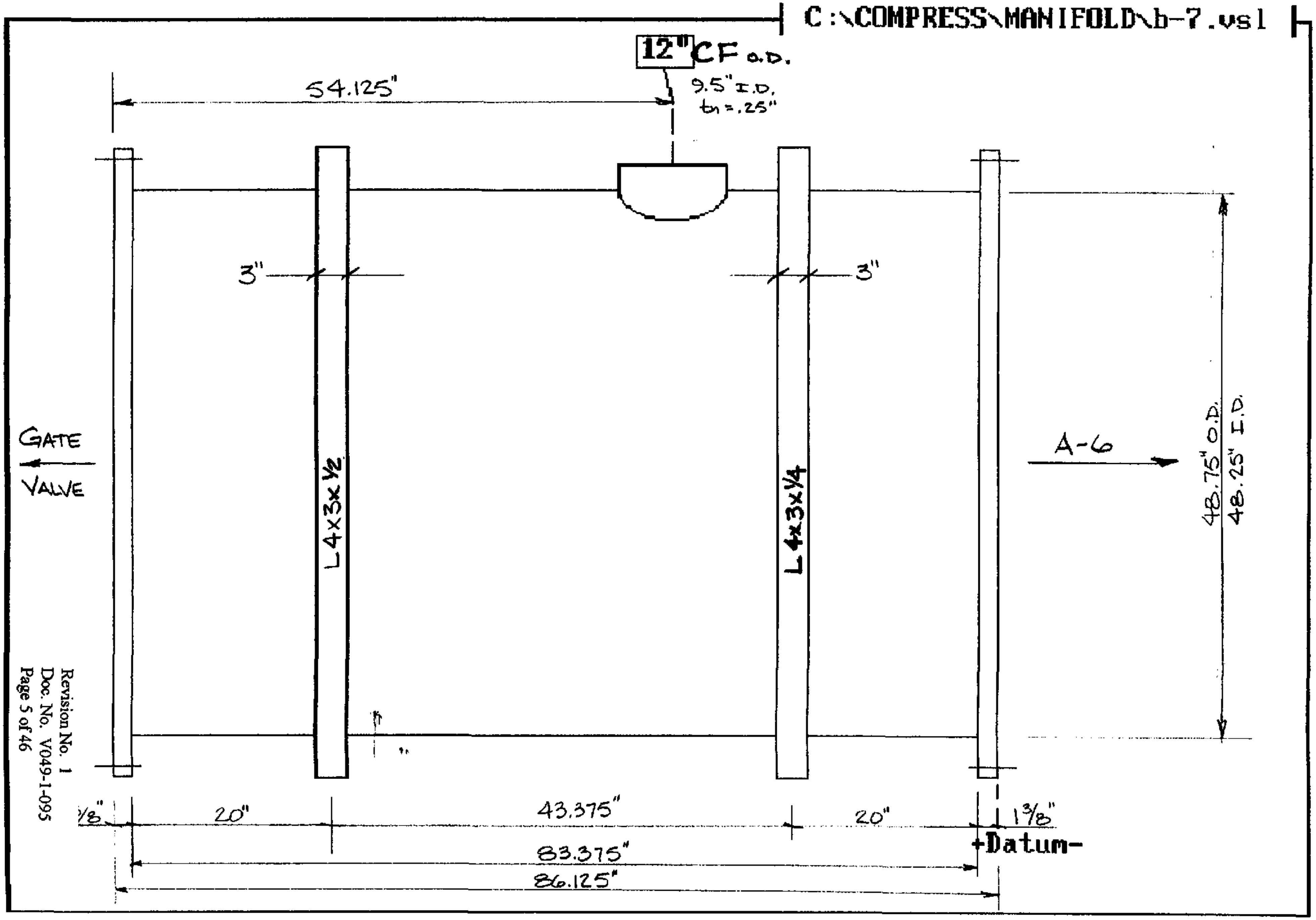
Rev. 0 Original Issue
April 24, 1996

Rev. 1 Issue Date
September 23, 1996

- Revised the unbalanced vacuum load at the gate valve (32.17k).
- Revised the baseplate thickness.
- Revised the anchor bolts.
- Revised body of calc to reflect changes due to new vacuum load.
- Added weld calculations.
- Revised design details to reflect change in members.
- Checked for punching shear at the tube steel connections using *STAAD*.

C:\COMPRESS\MANIFOLD\b-6.vsl




C:\COMPRESS\MANIFOLD\b-7.vsl
12" CF O.D.
9.5" I.D.
tn=.25"
54.125"
3"
3"
GATE VALVE
L 4x3x½
L 4x3x¼
A-6
48.75" O.D.
48.25" I.D.
⅛"
20"
43.375"
20"
1⅜"
+Datum-
83.375"
86.125"

LOAD CONDITIONS

- DEADWEIGHT

VESSEL WEIGHT - REF COMPRESS OUTPUT,
CALC No. V049-1-058 & 059

$$1589^{\#} - ②(253^{\#}) = 1083 \text{ lbs}$$

$$\text{uniform load} = \frac{1083 \text{ lbs}}{83.375 \text{in}} = 12.99 \approx 13.0^{\#}/\text{in}$$

FLANGE WEIGHT = 253 lbs.
(2 FLANGES)

VALVE = 150 lbs.

- THERMAL

$$\text{"BAKEOUT" @ } 400°F \Rightarrow \Delta T = 400°F - 70°F$$

$$\Delta T = 330°F$$

- VACUUM

VACUUM LOAD FROM GATE VALVE = 32170 lbs
(see following Page)

VACUUM LOAD FROM UNBALANCED CONDITION
@ TURBO PUMP (10" ϕ).

$$F = PA$$

$$= (14.7^{\#}/\text{in}^2)\frac{(10\text{in})^2\pi}{4}$$

$$= 1155. \text{ lbs.}$$

- SEISMIC -

SEISMIC (HORIZONTAL ONLY) - ONE DIRECTION

VESSEL = $F_H = (13.0^{\#}/\text{in})(0.05625_g) = 0.73^{\#}/\text{in}$

FLANGE = $253. \text{ lbs} (0.05625_g) = 14.23 \text{ lbs} = F_{HOR.}$

VALVE = $150. \text{ lbs} (0.05625_g) = 8.4 \text{ lbs} = F_{HOR}$

UNBALANCED FORCE AT 48.25 IN VALVE

$D_m = 49.589$ IN (HYSCAN CALC. 7/9/96)

VACUUM FORCE

$$F = \pi \frac{D_m^2}{4} (14.7)$$

$$= 28.4^K$$

PURGE PRESSURE = 2 psig

$$F' = \pi \frac{G^2}{4} (2)$$

G = INNER O-RING DIAM *

= 49 IN

$$F' = \pi \frac{49^2}{4} (2) = 3.77^K$$

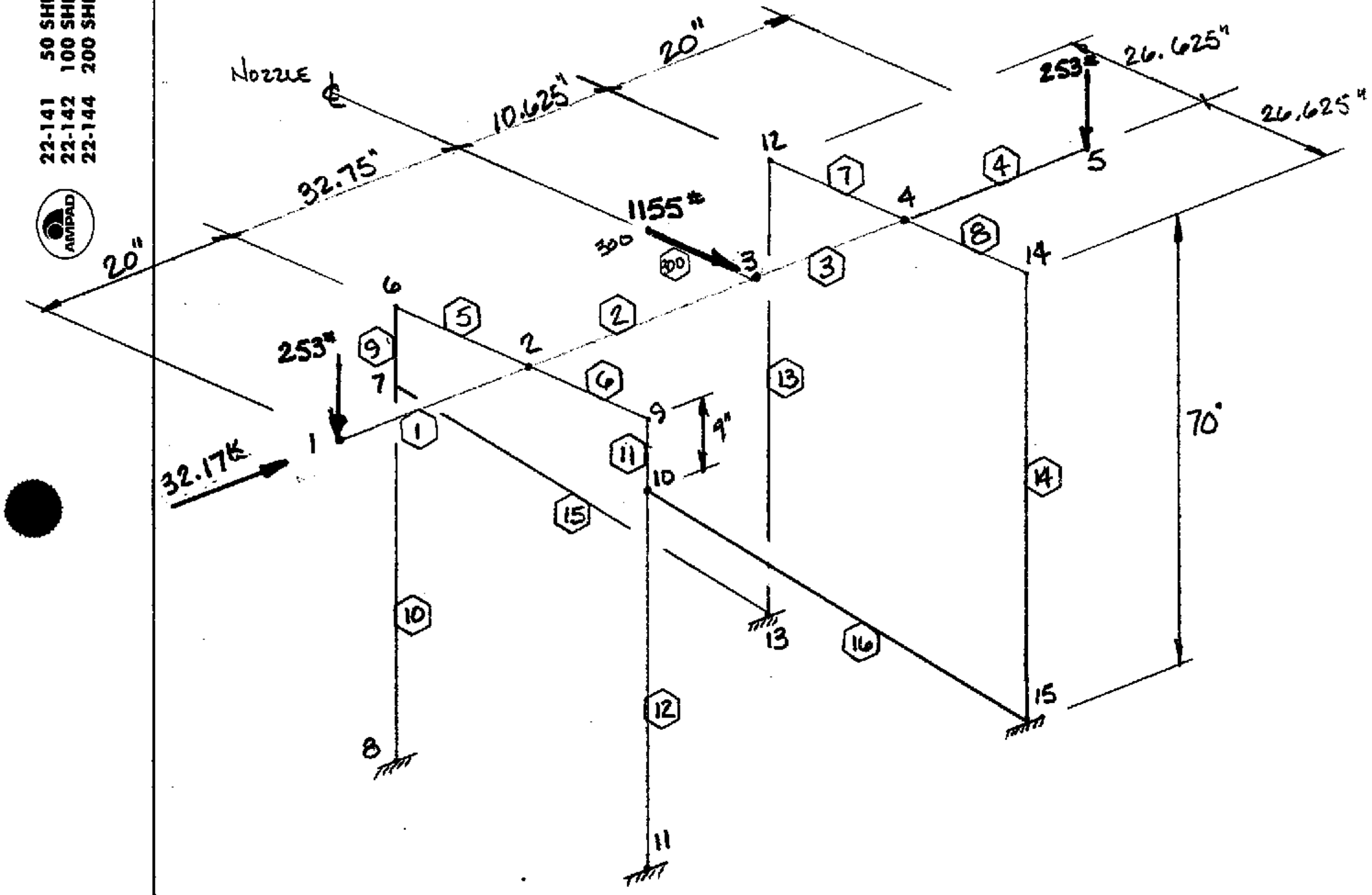
TOTAL FORCE

$$F = 28.4 + 3.77 = 32.17$$

* REF CALC 042, P. 25 . DEFLECTION UNDER POS PRESSURE WILL NOT UNSEAT THE INNER O-RING. ∴ PRESSURE ACTS TO THE INNER O-RING. CALCS 019 & 042 CONSERVATIVELY ASSUMED THAT PRESSURE ACTS TO THE OUTER O-RING.

B6 ¢ B7 STAAD MODEL

B6 ¢ B7 = 48in ϕ = 48.25in I.D. / 48.75in. O.D.

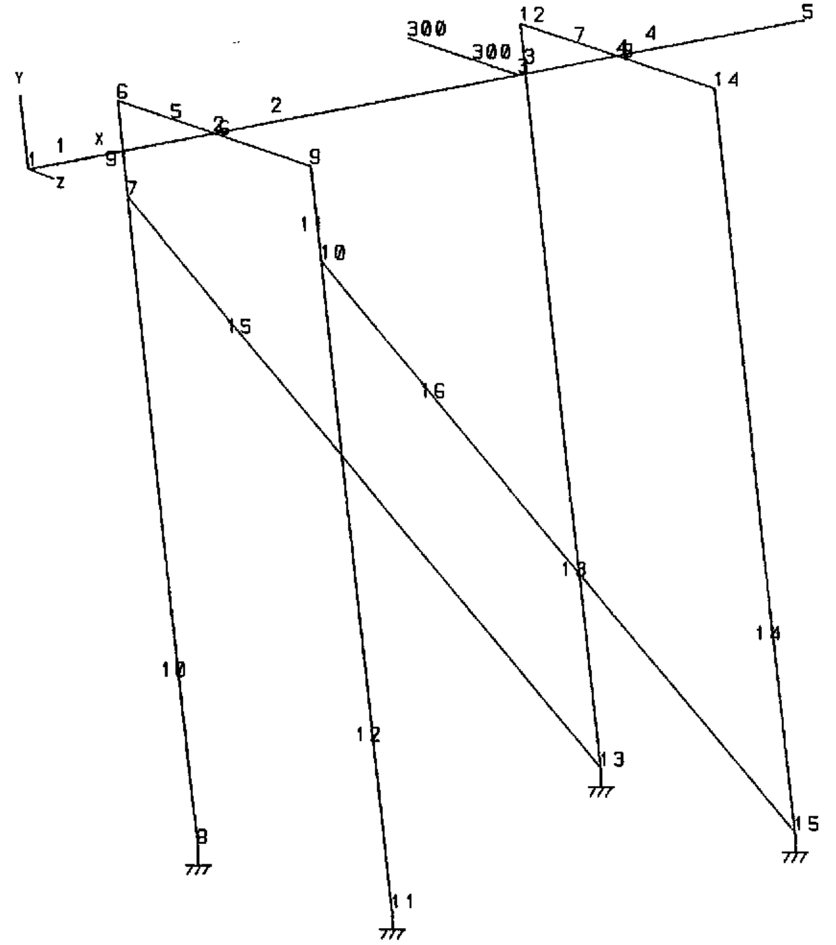


1

NN/ELEM

STRUCTURE DATA

TYPE = SPACE
NJ = 16
NM = 17
NE = 0
NS = 4
NL = 8
XMAX= 83.4
YMAX= 70.0
ZMAX= 57.0



J=16,M=17

UNIT INC POU

USER ID:Process Systems International

STAAD POST-PLOT (REV: 21.0)

TITLE: B6 & B7 MANIFOLD SUPPORT

DATE: APR 17, 1996

```
          **************************************************
          *                                                *
          *            S T A A D - III                     *
          *            Revision 21.0                       *
          *            Proprietary Program of              *
          *            Research Engineers, Inc.            *
          *            Date=    SEP 25, 1996               *
          *            Time=    16:11: 3                   *
          *                                                *
          *      USER ID: PROCESS SYSTEMS INTERNATIONAL IN *
          **************************************************


    1. STAAD SPACE B6 & B7 MANIFOLD SUPPORT
    2. ***  ( B-7 BOUNDING CASE )
    3. INPUT WIDTH 72
    4. UNIT INCHES POUND
    5. JOINT COORDINATES
    6. 1 0. 0. 0.; 2 20. 0. 0.; 3 52.75 0. 0.; 4 63.375 0. 0.; 5 83.375 0. 0.
    7. 6 20. 0. -26.625; 7 20. -9. -26.625; 8 20. -70. -26.625; 9 20. 0. 26.625
    8. 10 20. -9. 26.625; 11 20. -70. 26.625; 12 63.375 0. -26.625
    9. 13 63.375 -70. -26.625; 14 63.375 0. 26.625; 15 63.375 -70. 26.625
   10. 300 52.75 0. -30.375
   11. MEMBER INCIDENCES
   12. 1 1 2; 2 2 3; 3 3 4; 4 4 5; 5 2 6; 6 2 9; 7 4 12; 8 4 14; 9 7 6; 10 8 7
   13. 11 10 9; 12 11 10; 13 13 12; 14 15 14; 15 7 13; 16 10 15; 300 3 300
   14. MEMBER PROPERTY AMER
   15. 9 TO 12 15 16 TABLE ST TUB40408
   16. 13 14 TABLE ST TUB40203
   17. 5 TO 8 TABLE ST TUB80805
   18. 1 TO 4 TABLE ST PIPE OD 48.75 ID 48.25
   19. 300 TABLE ST PIPE OD 10. ID 9.5
   20. MEMBER RELEASE
   21. 9 11 13 14 END MX MY MZ
   22. CONSTANTS
   23. E STEEL ALL
   24. POISSON STEEL ALL
   25. DENSITY STEEL ALL
   26. BETA 90. MEMB 13 14
   27. ALPHA 0.00000919 MEMB 1 TO 8
   28. SUPPORTS
   29. 8 11 13 15 FIXED
   30. ***********************************
   31. LOAD 1 DEADWEIGHT
   32. JOINT LOAD
   33. 1 5 FY -506.
   34. * FLANGE WEIGHT = 2 @ 253 LBS.
   35. 300 FY -150.
   36. * VALVE WEIGHT
   37. MEMBER LOAD
   38. 1 TO 4 UNI Y -13.
   39. * UNIFORM  1083.#/83.375" = 13.0
   40. ***********************************
   41. LOAD 2 DW+TH+VACUUM(+)
```

```
B6 & B7 MANIFOLD SUPPORT                                   -- PAGE NO.    2
***  ( B-7 BOUNDING CASE )
42. JOINT LOAD
43. 1    FX 32170.
44. * UNBALANCED (+)VACUUM LOAD @ GATE VALVE
45. 1 5 FY -506.
46. 300 FY -150.
47. 300 FZ 1155.
48. * UNBALANCED VACUUM LOAD @ TURBO PMP
49. MEMBER LOAD
50. 1 TO 4 UNI Y -13.
51. TEMPERATURE LOAD
52. 1 TO 8 300 TEMP 330.
53. *********************************
54. LOAD 3 DW+TH+VACUUM(-)
55. JOINT LOAD
56. 1    FX -32170.
57. * UNBALANCED (-)VACUUM LOAD @ GATE VALVE
58. 1 5 FY -506.
59. 300 FY -150.
60. 300 FZ 1155.
61. * UNBALANCED VACUUM LOAD @ TURBO PMP
62. MEMBER LOAD
63. 1 TO 4 UNI Y -13.
64. TEMPERATURE LOAD
65. 1 TO 8 300 TEMP 330.
66. *********************************
67. LOAD 4 DW+TH+VACUUM(+)+SEIS-AXIAL(+)
68. JOINT LOAD
69. 1    FX 32170.
70. * UNBALANCED (+)VACUUM LOAD @ GATE VALVE
71. 1 5 FY -506.
72. 300 FY -150.
73. 1 5 FX 14.23
74. * FLANGE WEIGHT X 0.05625
75. 300 FX 8.5
76. * VALVE WEIGHT X 0.05625
77. 300 FZ 1155.
78. * UNBALANCED VACUUM LOAD @ TURBO PMP
79. MEMBER LOAD
80. 1 TO 4 UNI Y -13.
81. 1 TO 4 UNI X 0.73
82. * UNIFORM WEIGHT X 0.05625
83. TEMPERATURE LOAD
84. 1 TO 8 300 TEMP 330.
85. *********************************
86. LOAD 5 DW+TH+VACUUM(-)+SEIS-AXIAL(-)
87. JOINT LOAD
88. 1    FX -32170.
89. * UNBALANCED (-)VACUUM LOAD @ GATE VALVE
90. 1 5 FY -506.
91. 300 FY -150.
92. 1 5 FX -14.23
93. * FLANGE WEIGHT X 0.05625
94. 300 FX -8.5
95. * VALVE WEIGHT X 0.05625
96. 300 FZ 1155.
97. * UNBALANCED VACUUM LOAD @ TURBO PMP
```

```
 ***   ( B-7 BOUNDING CASE )
 98. MEMBER LOAD
 99. 1 TO 4 UNI Y -13.
100. 1 TO 4 UNI X -0.73
101. * UNIFORM WEIGHT X 0.05625
102. TEMPERATURE LOAD
103. 1 TO 8 300 TEMP 330.
104. **********************************
105. LOAD 6 DW+TH+VACUUM(+)+SEIS-LAT(+)
106. JOINT LOAD
107. 1    FX  32170.
108. * UNBALANCED (+)VACUUM LOAD @ GATE VALVE
109. 1 5 FY -502.
110. 300 FY -150.
111. 1 5 FZ 14.23
112. 300 FZ 8.5
113. 300 FZ 1155.
114. * UNBALANCED VACUUM LOAD @ TURBO PMP
115. MEMBER LOAD
116. 1 TO 4 UNI Y -13.
117. 1 TO 4 UNI Z 0.73
118. TEMPERATURE LOAD
119. 1 TO 8 300 TEMP 330.
120. **********************************
121. LOAD 7 DW+TH+VACUUM(-)+SEIS-LAT(-)
122. JOINT LOAD
123. 1    FX -32170.
124. * UNBALANCED (-)VACUUM LOAD @ GATE VALVE
125. 1 5 FY -502.
126. 300 FY -150.
127. 1 5 FZ -14.23
128. 300 FZ -8.5
129. 300 FZ 1155.
130. * UNBALANCED VACUUM LOAD @ TURBO PMP
131. MEMBER LOAD
132. 1 TO 4 UNI Y -13.
133. 1 TO 4 UNI Z -0.73
134. TEMPERATURE LOAD
135. 1 TO 8 300 TEMP 330.
136. **********************************
137. LOAD 8 THERMAL "BAKEOUT"
138. TEMPERATURE LOAD
139. 1 TO 8 300 TEMP 330.
140. PERFORM ANALYSIS


         P R O B L E M   S T A T I S T I C S
         -----------------------------------

   NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =     16/    17/     4
   ORIGINAL/FINAL BAND-WIDTH =    13/     4
   TOTAL PRIMARY LOAD CASES  =     8, TOTAL DEGREES OF FREEDOM =     72
   SIZE OF STIFFNESS MATRIX =     2160 DOUBLE PREC. WORDS
   REQRD/AVAIL. DISK SPACE =  12.05/  952.1 MB,  EXMEM = 14.83 MB

++ PROCESSING ELEMENT STIFFNESS MATRIX.            16:11: 5
```

```
 *** ( B-7 BOUNDING CASE )
++ PROCESSING GLOBAL STIFFNESS MATRIX.                   16:11: 5
++ PROCESSING TRIANGULAR FACTORIZATION.                  16:11: 5
++ CALCULATING JOINT DISPLACEMENTS.                      16:11: 5
++ CALCULATING MEMBER  FORCES.                           16:11: 6

 141. PRINT MATERIAL PROPERTIES ALL
```

```
MATERIAL PROPERTIES.
--------------------
ALL UNITS ARE - POUN INCH

MEMBER          E             G            DEN          ALPHA

   1       29000000.0    11153846.0     0.28299999   0.00000919
   2       29000000.0    11153846.0     0.28299999   0.00000919
   3       29000000.0    11153846.0     0.28299999   0.00000919
   4       29000000.0    11153846.0     0.28299999   0.00000919
   5       29000000.0    11153846.0     0.28299999   0.00000919
   6       29000000.0    11153846.0     0.28299999   0.00000919
   7       29000000.0    11153846.0     0.28299999   0.00000919
   8       29000000.0    11153846.0     0.28299999   0.00000919
   9       29000000.0    11153846.0     0.28299999   0.00000000
  10       29000000.0    11153846.0     0.28299999   0.00000000
  11       29000000.0    11153846.0     0.28299999   0.00000000
  12       29000000.0    11153846.0     0.28299999   0.00000000
  13       29000000.0    11153846.0     0.28299999   0.00000000
  14       29000000.0    11153846.0     0.28299999   0.00000000
  15       29000000.0    11153846.0     0.28299999   0.00000000
  16       29000000.0    11153846.0     0.28299999   0.00000000
 300       29000000.0    11153846.0     0.28299999   0.00000000


************ END OF DATA FROM INTERNAL STORAGE ************


142. PRINT MEMBER INFORMATION ALL
```

```
MEMBER INFORMATION
------------------

MEMBER    START   END          LENGTH     BETA
          JOINT   JOINT        (INCH)     (DEG)     RELEASES

   1        1       2          20.000     0.00
   2        2       3          32.750     0.00
   3        3       4          10.625     0.00
   4        4       5          20.000     0.00
   5        2       6          26.625     0.00
   6        2       9          26.625     0.00
   7        4      12          26.625     0.00
   8        4      14          26.625     0.00
   9        7       6           9.000     0.00    000000000111
  10        8       7          61.000     0.00
  11       10       9           9.000     0.00    000000000111
  12       11      10          61.000     0.00
  13       13      12          70.000    90.00    000000000111
  14       15      14          70.000    90.00    000000000111
  15        7      13          74.849     0.00
  16       10      15          74.849     0.00
 300        3     300          30.375     0.00


************ END OF DATA FROM INTERNAL STORAGE ************

143. PRINT JOINT COORDINATES ALL
```

```
JOINT COORDINATES
-----------------
COORDINATES ARE INCH UNIT

JOINT           X           Y           Z

  1           0.000       0.000       0.000
  2          20.000       0.000       0.000
  3          52.750       0.000       0.000
  4          63.375       0.000       0.000
  5          83.375       0.000       0.000
  6          20.000       0.000     -26.625
  7          20.000      -9.000     -26.625
  8          20.000     -70.000     -26.625
  9          20.000       0.000      26.625
 10          20.000      -9.000      26.625
 11          20.000     -70.000      26.625
 12          63.375       0.000     -26.625
 13          63.375     -70.000     -26.625
 14          63.375       0.000      26.625
 15          63.375     -70.000      26.625
300          52.750       0.000     -30.375

************ END OF DATA FROM INTERNAL STORAGE ************


144. PRINT SUPPORT INFORMATION ALL


SUPPORT INFORMATION (1=FIXED, 0=RELEASED)
-------------------
UNITS FOR SPRING CONSTANTS ARE POUN INCH DEGREES

JOINT   FORCE-X/   FORCE-Y/   FORCE-Z/   MOM-X/   MOM-Y/   MOM-Z/
          KFX        KFY        KFZ       KMX      KMY      KMZ

  8     1          1          1          1        1        1
              0.0        0.0        0.0      0.0      0.0      0.0
 11     1          1          1          1        1        1
              0.0        0.0        0.0      0.0      0.0      0.0
 13     1          1          1          1        1        1
              0.0        0.0        0.0      0.0      0.0      0.0
 15     1          1          1          1        1        1
              0.0        0.0        0.0      0.0      0.0      0.0
```

```
************ END OF DATA FROM INTERNAL STORAGE ************

145. PRINT ANALYSIS RESULTS
```

```
 JOINT DISPLACEMENT (INCH RADIANS)    STRUCTURE TYPE = SPACE
 ------------------

JOINT  LOAD   X-TRANS    Y-TRANS    Z-TRANS    X-ROTAN    Y-ROTAN    Z-ROTAN

   1     1   -0.00030   -0.00155    0.00003   -0.00001    0.00000   -0.00001
         2    0.07282    0.01153    0.08897    0.00000   -0.00017   -0.00022
         3   -0.19546   -0.01470    0.08897    0.00000   -0.00017    0.00019
         4    0.07323    0.01157    0.08893    0.00000   -0.00017   -0.00022
         5   -0.19586   -0.01474    0.08901    0.00000   -0.00017    0.00020
         6    0.07282    0.01154    0.09666    0.00000   -0.00018   -0.00022
         7   -0.19545   -0.01470    0.08129    0.00000   -0.00016    0.00019
         8   -0.06101   -0.00004    0.00000    0.00000    0.00000    0.00000
   2     1   -0.00030   -0.00176    0.00001   -0.00001    0.00000   -0.00001
         2    0.13290    0.00719    0.09236    0.00000   -0.00017   -0.00022
         3   -0.13422   -0.01076    0.09236    0.00000   -0.00017    0.00019
         4    0.13330    0.00722    0.09235    0.00000   -0.00017   -0.00022
         5   -0.13462   -0.01079    0.09238    0.00000   -0.00017    0.00020
         6    0.13290    0.00720    0.10022    0.00000   -0.00018   -0.00022
         7   -0.13422   -0.01075    0.08451    0.00000   -0.00016    0.00019
         8   -0.00036   -0.00002    0.00000    0.00000    0.00000    0.00000
   3     1   -0.00030   -0.00222   -0.00002   -0.00001    0.00000   -0.00001
         2    0.23221   -0.00003    0.09807    0.00000   -0.00017   -0.00022
         3   -0.03490   -0.00442    0.09808    0.00000   -0.00017    0.00019
         4    0.23262   -0.00002    0.09811    0.00000   -0.00017   -0.00022
         5   -0.03531   -0.00443    0.09804    0.00000   -0.00017    0.00019
         6    0.23221   -0.00002    0.10623    0.00000   -0.00018   -0.00022
         7   -0.03490   -0.00442    0.08992    0.00000   -0.00016    0.00019
         8    0.09896   -0.00001    0.00000    0.00000    0.00000    0.00000
   4     1   -0.00030   -0.00236   -0.00004   -0.00001    0.00000   -0.00001
         2    0.26443   -0.00236    0.09988    0.00000   -0.00017   -0.00022
         3   -0.00268   -0.00236    0.09989    0.00000   -0.00017    0.00019
         4    0.26484   -0.00236    0.09994    0.00000   -0.00017   -0.00022
         5   -0.00308   -0.00236    0.09983    0.00000   -0.00017    0.00019
         6    0.26443   -0.00235    0.10814    0.00000   -0.00018   -0.00022
         7   -0.00267   -0.00235    0.09164    0.00000   -0.00016    0.00019
         8    0.13118    0.00000    0.00000    0.00000    0.00000    0.00000
   5     1   -0.00030   -0.00270   -0.00005   -0.00001    0.00000   -0.00001
         2    0.32509   -0.00683    0.10330    0.00000   -0.00017   -0.00022
         3    0.05798    0.00145    0.10331    0.00000   -0.00017    0.00019
         4    0.32550   -0.00684    0.10339    0.00000   -0.00017   -0.00022
         5    0.05757    0.00146    0.10322    0.00000   -0.00017    0.00019
         6    0.32509   -0.00682    0.11174    0.00000   -0.00018   -0.00022
         7    0.05798    0.00146    0.09488    0.00000   -0.00016    0.00019
         8    0.19184    0.00001    0.00000    0.00000    0.00000    0.00000
   6     1   -0.00033   -0.00022    0.00001    0.00007    0.00000   -0.00001
         2    0.09002    0.00902    0.01161    0.00009    0.00206   -0.00022
         3   -0.08521   -0.00893    0.01161    0.00009   -0.00226    0.00019
         4    0.09032    0.00905    0.01160    0.00009    0.00206   -0.00022
         5   -0.08550   -0.00896    0.01162    0.00009   -0.00226    0.00020
         6    0.09018    0.00904    0.01947    0.00009    0.00205   -0.00022
         7   -0.08536   -0.00895    0.00376    0.00008   -0.00225    0.00019
         8   -0.00024   -0.00002   -0.08070    0.00000   -0.00001    0.00000
```

```
B6 & B7 MANIFOLD SUPPORT                                  -- PAGE NO.   10
***   ( B-7 BOUNDING CASE )

 JOINT DISPLACEMENT (INCH RADIANS)    STRUCTURE TYPE = SPACE
 -----------------

JOINT  LOAD   X-TRANS   Y-TRANS   Z-TRANS   X-ROTAN   Y-ROTAN   Z-ROTAN

    7     1  -0.00027  -0.00019   0.00001   0.00000   0.00000   0.00001
          2   0.03615   0.00905   0.00946   0.00023   0.00003  -0.00436
          3  -0.03450  -0.00890   0.00946   0.00023   0.00003   0.00411
          4   0.03627   0.00908   0.00945   0.00023   0.00003  -0.00438
          5  -0.03462  -0.00893   0.00947   0.00023   0.00003   0.00412
          6   0.03621   0.00907   0.01585   0.00039   0.00005  -0.00437
          7  -0.03456  -0.00892   0.00306   0.00008   0.00001   0.00412
          8  -0.00009  -0.00002  -0.06572  -0.00162  -0.00019   0.00001
    8     1   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          2   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          3   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          4   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          5   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          6   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          7   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          8   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
    9     1  -0.00028  -0.00019   0.00001  -0.00007   0.00000  -0.00001
          2   0.08413   0.00847   0.17302  -0.00006  -0.00225  -0.00022
          3  -0.09110  -0.00948   0.17302  -0.00006   0.00207   0.00019
          4   0.08437   0.00850   0.17301  -0.00006  -0.00225  -0.00022
          5  -0.09134  -0.00950   0.17303  -0.00006   0.00207   0.00020
          6   0.08398   0.00846   0.18088  -0.00006  -0.00225  -0.00022
          7  -0.09095  -0.00946   0.16517  -0.00006   0.00207   0.00019
          8  -0.00024  -0.00002   0.08070   0.00000   0.00001   0.00000
   10     1  -0.00023  -0.00016   0.00001   0.00000   0.00000   0.00001
          2   0.03381   0.00850   0.14089   0.00348   0.00041  -0.00407
          3  -0.03684  -0.00946   0.14089   0.00348   0.00041   0.00440
          4   0.03391   0.00852   0.14088   0.00348   0.00041  -0.00409
          5  -0.03693  -0.00948   0.14090   0.00348   0.00041   0.00441
          6   0.03375   0.00848   0.14729   0.00364   0.00042  -0.00407
          7  -0.03678  -0.00944   0.13450   0.00332   0.00039   0.00439
          8  -0.00009  -0.00002   0.06572   0.00162   0.00019   0.00001
   11     1   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          2   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          3   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          4   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          5   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          6   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          7   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          8   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   12     1  -0.00033  -0.00074  -0.00004   0.00008   0.00000  -0.00001
          2   0.26873  -0.00069   0.01914   0.00008  -0.00016  -0.00022
          3   0.00188  -0.00069   0.01914   0.00008  -0.00017   0.00019
          4   0.26918  -0.00069   0.01919   0.00008  -0.00016  -0.00022
          5   0.00143  -0.00069   0.01908   0.00008  -0.00017   0.00019
          6   0.26897  -0.00069   0.02739   0.00008  -0.00017  -0.00022
          7   0.00164  -0.00069   0.01089   0.00008  -0.00016   0.00019
          8   0.13106   0.00000  -0.08074   0.00000   0.00001   0.00000
```

```
  B6 & B7 MANIFOLD SUPPORT                                         -- PAGE NO.   11
  ***   ( B-7 BOUNDING CASE )

 JOINT DISPLACEMENT (INCH RADIANS)     STRUCTURE TYPE = SPACE
 ------------------

JOINT  LOAD   X-TRANS    Y-TRANS    Z-TRANS    X-ROTAN    Y-ROTAN    Z-ROTAN

  13     1    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         2    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         3    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         4    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         5    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         6    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         7    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         8    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
  14     1   -0.00028   -0.00065   -0.00004   -0.00008    0.00000   -0.00001
         2    0.25963   -0.00070    0.18061   -0.00008   -0.00018   -0.00022
         3   -0.00722   -0.00070    0.18061   -0.00008   -0.00017    0.00019
         4    0.26000   -0.00070    0.18067   -0.00008   -0.00018   -0.00022
         5   -0.00759   -0.00070    0.18056   -0.00008   -0.00017    0.00019
         6    0.25940   -0.00070    0.18886   -0.00008   -0.00019   -0.00022
         7   -0.00698   -0.00069    0.17236   -0.00008   -0.00016    0.00019
         8    0.13106    0.00000    0.08074    0.00000   -0.00001    0.00000
  15     1    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         2    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         3    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         4    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         5    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         6    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         7    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
         8    0.00000    0.00000    0.00000    0.00000    0.00000    0.00000
 300     1   -0.00033   -0.00302   -0.00002   -0.00003    0.00000   -0.00001
         2    0.23741   -0.00064    0.09823   -0.00003   -0.00017   -0.00022
         3   -0.02970   -0.00503    0.09823   -0.00003   -0.00017    0.00019
         4    0.23790   -0.00063    0.09827   -0.00003   -0.00017   -0.00022
         5   -0.03019   -0.00504    0.09820   -0.00003   -0.00017    0.00019
         6    0.23768   -0.00062    0.10639   -0.00003   -0.00018   -0.00022
         7   -0.02997   -0.00504    0.09008   -0.00003   -0.00016    0.00019
         8    0.09896   -0.00001    0.00000    0.00000    0.00000    0.00000
```

```
 ***  ( B-7 BOUNDING CASE )


 SUPPORT REACTIONS -UNIT POUN INCH    STRUCTURE TYPE = SPACE
 -----------------

JOINT  LOAD   FORCE-X   FORCE-Y   FORCE-Z     MOM-X     MOM-Y     MOM Z

    8    1       1.27    585.53     -0.02     -1.53     -0.06    -77.30
         2    1781.52 -27372.30    -42.82  -2672.16   -108.57 -28826.29
         3   -1670.06  26914.09    -42.82  -2672.54   -108.59  26905.35
         4    1787.30 -27462.96    -42.78  -2669.78   -108.47 -28919.76
         5   -1675.81  27004.16    -42.86  -2675.17   -108.69  26998.22
         6    1784.55 -27419.98    -71.79  -4480.21   -182.03 -28875.35
         7   -1673.10  26957.66    -13.86   -864.90    -35.14  26954.80
         8      -4.63     72.86    297.58  18572.61    754.62     74.80
   11    1       1.06    492.85     -0.02     -1.53     -0.06    -64.86
         2    1663.11 -25689.65   -637.99 -39817.56  -1617.81 -26897.57
         3   -1788.46  28596.71   -637.99 -39817.92  -1617.83  28834.03
         4    1667.88 -25765.04   -637.95 -39815.16  -1617.71 -26974.55
         5   -1793.19  28671.43   -638.03 -39820.54  -1617.93  28910.34
         6    1660.06 -25645.91   -666.96 -41625.59  -1691.27 -26847.94
         7   -1785.41  28548.74   -609.03 -38010.27  -1544.38  28784.69
         8      -4.64     72.92   -297.59 -18572.77   -754.62     74.87
   13    1      -1.33    622.97      0.02      1.53     -0.37    -71.20
         2  -18416.44  28580.80    -36.30  -2865.68   -648.09 -21316.82
         3   17205.11 -25705.59    -36.30  -2866.00   -648.18  25725.86
         4  -18476.16  28671.46    -36.33  -2868.02   -647.51 -21395.66
         5   17264.44 -25795.66    -36.27  -2863.85   -648.82  25804.20
         6  -18447.80  28624.49    -56.23  -4480.72  -1086.60 -21358.15
         7   17236.38 -25753.16    -16.37  -1251.28   -209.77  25767.56
         8       4.65    -72.86    200.78  16313.16   4504.46   3083.94
   15    1      -1.01    544.52      0.02      1.53     -0.37    -59.76
         2  -17197.91  26727.02   -437.87 -35492.18  -9657.06 -19688.66
         3   18423.61 -27559.33   -437.87 -35492.49  -9657.14  27353.99
         4  -17247.15  26802.41   -437.90 -35494.52  -9656.48 -19753.61
         5   18472.41 -27634.05   -437.84 -35490.34  -9657.78  27418.36
         6  -17166.52  26679.27   -457.80 -37107.22 -10095.57 -19646.81
         7   18392.07 -27515.37   -417.94 -33877.77  -9218.73  27312.42
         8       4.70    -72.92   -200.79 -16313.33  -4504.50   3084.00
```

```
 B6 & B7 MANIFOLD SUPPORT                                    -- PAGE NO.   13
 ***   ( B-7 BOUNDING CASE )


 MEMBER END FORCES    STRUCTURE TYPE = SPACE
 -----------------
 ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT      AXIAL   SHEAR-Y  SHEAR-Z    TORSION     MOM-Y       MOM-Z


    1     1    1       0.00   -506.00     0.00       0.00      0.00       -0.01
               2       0.00    766.00     0.00       0.00      0.00   -12720.00
          2    1   32169.43   -506.00    -0.15      -0.02      0.85       -0.24
               2  -32169.43    766.00     0.15       0.02      0.47   -12720.14
          3    1  -32169.92   -505.99    -0.12      -0.01      1.37       -0.07
               2   32169.92    765.99     0.12       0.01      0.57   -12719.61
          4    1   32185.06   -505.99    -0.01       0.00     -0.33        0.05
               2  -32199.71    765.99     0.01       0.00     -0.28   -12720.37
          5    1  -32183.35   -506.00     0.05       0.00     -0.06        0.23
               2   32198.00    766.00    -0.05       0.00     -0.39   -12719.91
          6    1   32169.19   -501.99    14.32       0.02     -2.41        0.21
               2  -32169.19    761.99   -28.92      -0.02   -431.33   -12640.07
          7    1  -32170.41   -502.00   -14.21       0.01     -0.65        0.09
               2   32170.41    762.00    28.81      -0.01    428.68   -12639.51
          8    1       0.24      0.00     0.01       0.00     -0.17       -0.01
               2      -0.24      0.00    -0.01       0.00     -0.05        0.00

    2     1    2      -0.20    318.68    -0.07    2487.18      3.44    12720.03
               3       0.20    107.07     0.07   -2487.18     -1.18    -9254.86
          2    2     174.07    318.68  -958.27    4653.05  29209.49    12720.15
               3    -174.07    107.07   958.27   -4653.05   2174.12    -9255.10
          3    2      -1.71    318.69  -958.16    4652.99  29210.20    12720.23
               3       1.71    107.06   958.16   -4652.99   2169.84    -9254.59
          4    2     104.98    318.68  -958.00    4671.68  29462.71    12719.96
               3    -128.91    107.07   958.00   -4671.68   1914.44    -9254.76
          5    2      66.89    318.68  -958.37    4634.29  28957.67    12719.72
               3     -42.97    107.07   958.37   -4634.29   2428.08    -9254.89
          6    2     174.07    318.68 -1010.87    4764.58  31146.25    12639.84
               3    -174.07    107.07   986.97   -4764.58   1570.24    -9174.68
          7    2      -1.95    318.69  -905.59    4541.29  27274.61    12640.17
               3       1.95    107.06   929.50   -4541.29   2773.61    -9175.02
          8    2      86.43      0.00    -0.02       0.08      0.73        0.00
               3     -86.43      0.00     0.02      -0.08      0.07        0.01

    3     1    3      -0.20   -257.06    -0.07   -2069.07      1.18     9254.93
               4       0.20    395.19     0.07    2069.07     -0.44   -12719.99
          2    3     173.10   -257.07   196.73      96.83  -2172.25     9255.08
               4    -173.10    395.19  -196.73     -96.83     81.89   -12720.37
          3    3      -2.69   -257.08   196.63      96.73  -2167.61     9254.34
               4       2.69    395.20  -196.63     -96.73     76.74   -12719.59
          4    3     136.96   -257.07   196.93     115.42  -2171.04     9254.42
               4    -144.78    395.19  -196.93    -115.42     78.05   -12719.78
          5    3      33.45   -257.07   196.56      78.04  -2170.85     9254.05
               4     -25.63    395.20  -196.56     -78.04     82.14   -12719.35
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  MEMBER END FORCES    STRUCTURE TYPE = SPACE
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  ALL UNITS ARE -- POUN INCH

 MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z    TORSION     MOM-Y       MOM-Z

          6     3    175.29   -257.07   176.79    208.31  -1571.44     9174.91
                4   -175.29    395.19  -184.54   -208.31   -349.56   -12639.68
          7     3     -2.20   -257.06   217.40    -14.96  -2777.10     9175.06
                4      2.20    395.19  -209.64     14.96    508.45   -12640.69
          8     3     87.40      0.00    -0.02      0.08     -0.44       -0.02
                4    -87.40      0.00     0.02     -0.08      0.61        0.02

    4     1     4      0.00    766.00     0.00     -0.01      0.00    12720.01
                5      0.00   -506.00     0.00      0.01      0.00        0.01
          2     4      2.69    766.00     0.20      0.00     -2.14    12720.33
                5     -2.69   -506.00    -0.20      0.00     -1.89       -0.21
          3     4     -0.24    766.00     0.12      0.00      0.26    12720.09
                5      0.24   -506.00    -0.12      0.00     -1.87       -0.14
          4     4    -28.08    765.99    -0.08      0.00      3.00    12719.55
                5     13.43   -505.99     0.08      0.00      1.25        0.35
          5     4     28.56    766.00    -0.04      0.01     -1.65    12720.41
                5    -13.92   -506.00     0.04     -0.01      0.92       -0.67
          6     4      2.20    762.00   -28.84     -0.01    429.89    12640.05
                5     -2.20   -502.00    14.24      0.01     -0.15        0.08
          7     4      0.00    762.00    28.96     -0.01   -431.15    12639.84
                5      0.00   -502.00   -14.36      0.01     -1.56        0.11
          8     4      0.98      0.00    -0.02      0.00     -0.03        0.02
                5     -0.98      0.00     0.02      0.00      0.33       -0.01

    5     1     2     -0.03   -589.05     0.16      0.00     -4.36   -15683.40
                6      0.03    589.05    -0.16      0.00      0.00        0.00
          2     2    -60.24   -629.72 16546.68      0.00-440555.34   -16766.36
                6     60.24    629.72-16546.68      0.00     -0.02        0.00
          3     2    -60.30   -629.72-15535.66      0.00 413636.94   -16766.28
                6     60.30    629.72 15535.66      0.00     -0.15       -0.01
          4     2    -60.24   -630.07 16600.46      0.00-441987.34   -16775.63
                6     60.24    630.07-16600.46      0.00     -0.01        0.00
          5     2    -60.30   -629.37-15589.10      0.00 415059.91   -16756.95
                6     60.30    629.37 15589.10      0.00      0.00        0.00
          6     2   -101.01   -629.82 16574.91      0.00-441307.16   -16768.88
                6    101.01    629.82-16574.91      0.00      0.01        0.01
          7     2    -19.47   -625.62-15563.82      0.00 414386.72   -16657.22
                6     19.47    625.62 15563.82      0.00     -0.02        0.01
          8     2    418.82      0.00   -43.06      0.00   1146.41       -0.05
                6   -418.82      0.00    43.06      0.00      0.00        0.00

    6     1     2      0.03   -495.63    -0.03      0.00      0.92   -13196.22
                9     -0.03    495.63     0.03      0.00      0.00        0.00
          2     2    897.95   -454.96-15449.57      0.00 411344.75   -12113.29
                9   -897.95    454.96 15449.57      0.00      0.14        0.01
          3     2    897.89   -454.96 16632.78      0.00-442847.53   -12113.30
                9   -897.89    454.96-16632.78      0.00     -0.09        0.01
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  MEMBER END FORCES    STRUCTURE TYPE = SPACE
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  ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z

         4     2    897.89   -454.61-15493.90      0.00 412525.09  -12103.95
               9   -897.89    454.61 15493.90      0.00     -0.11       0.01
         5     2    898.01   -455.31 16676.73      0.00-444017.81  -12122.67
               9   -898.01    455.31-16676.73      0.00     -0.05       0.01
         6     2    938.66   -450.87-15421.33      0.00 410592.50  -12004.32
               9   -938.66    450.87 15421.33      0.00      0.48      -0.01
         7     2    857.18   -455.06 16604.39      0.00-442091.63  -12115.92
               9   -857.18    455.06-16604.39      0.00     -0.08      -0.03
         8     2    418.82      0.00    43.08      0.00  -1147.10       0.03
               9   -418.82      0.00   -43.08      0.00      0.04       0.00

    7    1     4      0.03   -619.45    -0.11      0.00      2.87  -16492.93
              12     -0.03    619.45     0.11      0.00      0.00       0.00
         2     4    -18.86   -578.78    88.25      0.00  -2349.54  -15410.01
              12     18.86    578.78   -88.25      0.00     -0.01       0.00
         3     4    -18.86   -578.78     0.62      0.00    -16.40  -15410.02
              12     18.86    578.78    -0.62      0.00      0.00       0.00
         4     4    -18.92   -578.43    88.37      0.00  -2353.33  -15400.70
              12     18.92    578.43   -88.37      0.00      0.27       0.00
         5     4    -18.80   -579.13     0.47      0.00    -12.49  -15419.39
              12     18.80    579.13    -0.47      0.00      0.00       0.00
         6     4    -26.92   -574.69    88.34      0.00  -2351.57  -15300.99
              12     26.92    574.69   -88.34      0.00      0.09       0.00
         7     4    -10.80   -578.88     0.54      0.00    -14.34  -15412.61
              12     10.80    578.88    -0.54      0.00      0.00       0.00
         8     4     79.47      0.00    43.02      0.00  -1145.78       0.03
              12    -79.47      0.00   -43.02      0.00      0.04       0.00

    8    1     4     -0.03   -541.74     0.09      0.00     -2.42  -14423.86
              14      0.03    541.74    -0.09      0.00      0.00       0.00
         2     4    178.10   -582.41   -85.29      0.00   2270.58  -15506.78
              14   -178.10    582.41    85.29      0.00      0.56       0.00
         3     4    178.04   -582.41     2.38      0.00    -63.28  -15506.77
              14   -178.04    582.41    -2.38      0.00     -0.14       0.00
         4     4    177.86   -582.76   -85.38      0.00   2273.27  -15516.11
              14   -177.86    582.76    85.38      0.00      0.11      -0.01
         5     4    177.86   -582.06     2.49      0.00    -66.37  -15497.41
              14   -177.86    582.06    -2.49      0.00      0.02      -0.01
         6     4    185.97   -582.51   -85.23      0.00   2268.70  -15509.30
              14   -185.97    582.51    85.23      0.00      0.81       0.00
         7     4    169.92   -578.32     2.30      0.00    -61.16  -15397.67
              14   -169.92    578.32    -2.30      0.00     -0.11       0.01
         8     4     79.53      0.00   -43.05      0.00   1146.12      -0.04
              14    -79.53      0.00    43.05      0.00      0.25       0.00

    9    1     7    589.05      0.16    -0.03      0.00      0.31       1.48
               6   -589.05     -0.16     0.03      0.00      0.00       0.00
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 MEMBER END FORCES    STRUCTURE TYPE = SPACE
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 ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z

         2     7    629.73  16546.68   -60.26      0.00    542.34  148920.14
               6   -629.73 -16546.68    60.26      0.00      0.00       0.00
         3     7    629.72 -15535.66   -60.27      0.00    542.41 -139820.94
               6   -629.72  15535.66    60.27      0.00      0.00       0.00
         4     7    630.06  16600.47   -60.21      0.00    541.86  149404.19
               6   -630.06 -16600.47    60.21      0.00      0.00       0.00
         5     7    629.37 -15589.10   -60.33      0.00    542.95 -140301.88
               6   -629.37  15589.10    60.33      0.00      0.00       0.00
         6     7    629.82  16574.92  -101.03      0.00    909.31  149174.25
               6   -629.82 -16574.92   101.03      0.00      0.00       0.00
         7     7    625.62 -15563.83   -19.50      0.00    175.54 -140074.48
               6   -625.62  15563.83    19.50      0.00      0.00       0.00
         8     7      0.00    -43.06   418.83      0.00  -3769.48    -387.52
               6      0.00     43.06  -418.83      0.00      0.00       0.00

   10    1     8    585.53     -1.27    -0.02     -0.06      1.53     -77.30
               7   -585.53      1.27     0.02      0.06     -0.03      -0.44
         2     8 -27372.30  -1781.52   -42.82   -108.57   2672.16  -28826.29
               7  27372.30   1781.52    42.82    108.57    -60.42  -79846.21
         3     8  26914.09   1670.06   -42.82   -108.59   2672.54   26905.35
               7 -26914.09  -1670.06    42.82    108.59    -60.43   74968.27
         4     8 -27462.96  -1787.30   -42.78   -108.47   2669.78  -28919.76
               7  27462.96   1787.30    42.78    108.47    -60.37  -80105.75
         5     8  27004.16   1675.81   -42.86   -108.69   2675.17   26998.22
               7 -27004.16  -1675.81    42.86    108.69    -60.49   75226.13
         6     8 -27419.98  -1784.55   -71.79   -182.03   4480.21  -28875.35
               7  27419.98   1784.55    71.79    182.03   -101.31  -79982.47
         7     8  26957.66   1673.10   -13.86    -35.14    864.90   26954.80
               7 -26957.66  -1673.10    13.86     35.14    -19.56   75104.15
         8     8     72.86      4.63   297.58    754.62 -18572.61      74.80
               7    -72.86     -4.63  -297.58   -754.62    419.97     207.78

   11    1    10    495.63      0.03    -0.03      0.00      0.31       0.31
               9   -495.63     -0.03     0.03      0.00      0.00       0.00
         2    10    454.98  15449.55  -897.89      0.00   8081.00  139045.97
               9   -454.98 -15449.55   897.89      0.00      0.00       0.00
         3    10    454.95 -16632.78  -897.98      0.00   8081.87 -149695.08
               9   -454.95  16632.78   897.98      0.00      0.00       0.00
         4    10    454.61  15493.89  -897.87      0.00   8080.79  139445.05
               9   -454.61 -15493.89   897.87      0.00      0.00       0.00
         5    10    455.33 -16676.73  -898.01      0.00   8082.13 -150090.58
               9   -455.33  16676.73   898.01      0.00      0.00       0.00
         6    10    450.85  15421.30  -938.72      0.00   8448.36  138791.64
               9   -450.85 -15421.30   938.72      0.00      0.00       0.00
         7    10    455.02 -16604.37  -857.18      0.00   7714.52 -149439.33
               9   -455.02  16604.37   857.18      0.00      0.00       0.00
         8    10      0.00    -43.09  -418.84      0.00   3769.54    -387.77
               9      0.00     43.09   418.84      0.00      0.00       0.00
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MEMBER END FORCES    STRUCTURE TYPE = SPACE
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ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


  12     1    11    492.85     -1.06    -0.02     -0.06      1.53     -64.86
              10   -492.85      1.06     0.02      0.06     -0.03       0.13
         2    11 -25689.65  -1663.11  -637.99  -1617.81  39817.56  -26897.57
              10  25689.65   1663.11   637.99   1617.81   -900.35  -74552.06
         3    11  28596.71   1788.46  -637.99  -1617.83  39817.92   28834.03
              10 -28596.71  -1788.46   637.99   1617.83   -900.38   80262.31
         4    11 -25765.04  -1667.88  -637.95  -1617.71  39815.16  -26974.55
              10  25765.04   1667.88   637.95   1617.71   -900.32  -74766.05
         5    11  28671.43   1793.19  -638.03  -1617.93  39820.54   28910.34
              10 -28671.43  -1793.19   638.03   1617.93   -900.45   80474.39
         6    11 -25645.91  -1660.06  -666.96  -1691.27  41625.59  -26847.94
              10  25645.91   1660.06   666.96   1691.27   -941.26  -74415.70
         7    11  28548.74   1785.41  -609.03  -1544.38  38010.27   28784.69
              10 -28548.74  -1785.41   609.03   1544.38   -859.52   80125.26
         8    11     72.92      4.64  -297.59   -754.62  18572.77      74.87
              10    -72.92     -4.64   297.59    754.62   -419.98     207.96

  13     1    13    619.45      0.03     0.11      0.00     -7.54       2.42
              12   -619.45     -0.03    -0.11      0.00      0.00       0.00
         2    13    578.78    -18.85   -88.25      0.00   6177.23   -1319.65
              12   -578.78     18.85    88.25      0.00      0.00       0.00
         3    13    578.78    -18.85    -0.62      0.00     43.12   -1319.75
              12   -578.78     18.85     0.62      0.00      0.00       0.00
         4    13    578.43    -18.91   -88.39      0.00   6187.57   -1323.37
              12   -578.43     18.91    88.39      0.00      0.00       0.00
         5    13    579.13    -18.80    -0.47      0.00     32.85   -1316.08
              12   -579.13     18.80     0.47      0.00      0.00       0.00
         6    13    574.69    -26.98   -88.32      0.00   6182.71   -1888.61
              12   -574.69     26.98    88.32      0.00      0.00       0.00
         7    13    578.88    -10.73    -0.54      0.00     37.70    -750.88
              12   -578.88     10.73     0.54      0.00      0.00       0.00
         8    13      0.00     79.54   -43.04      0.00   3012.57    5567.60
              12      0.00    -79.54    43.04      0.00      0.00       0.00

  14     1    15    541.74      0.03     0.09      0.00     -6.36       2.42
              14   -541.74     -0.03    -0.09      0.00      0.00       0.00
         2    15    582.41   -177.93   -85.26      0.00   5968.08  -12454.92
              14   -582.41    177.93    85.26      0.00      0.00       0.00
         3    15    582.41   -177.93     2.37      0.00   -166.03  -12455.03
              14   -582.41    177.93    -2.37      0.00      0.00       0.00
         4    15    582.76   -177.98   -85.38      0.00   5976.59  -12458.65
              14   -582.76    177.98    85.38      0.00      0.00       0.00
         5    15    582.06   -177.88     2.49      0.00   -174.46  -12451.36
              14   -582.06    177.88    -2.49      0.00      0.00       0.00
         6    15    582.51   -186.06   -85.18      0.00   5962.64  -13023.89
              14   -582.51    186.06    85.18      0.00      0.00       0.00
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 MEMBER END FORCES    STRUCTURE TYPE = SPACE
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 ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT     AXIAL    SHEAR-Y   SHEAR-Z    TORSION      MOM-Y       MOM-Z

          7   15    578.32    -169.80      2.29       0.00    -160.51   -11886.16
              14   -578.32     169.80     -2.29       0.00       0.00        0.00
          8   15      0.00     -79.54    -43.04       0.00    3012.56    -5567.68
              14      0.00      79.54     43.04       0.00       0.00        0.00

   15     1    7      3.70      -0.86      0.01       0.21       0.19       -1.03
              13     -3.70       0.86     -0.01      -0.21      -0.94      -63.67
          2    7  33442.06   -1290.17     17.44     367.75     329.83   -69073.90
              13 -33442.06    1290.17    -17.44    -367.75   -1635.54   -27494.05
          3    7 -31391.75    1209.57     17.45     367.80     329.88    64852.72
              13  31391.75   -1209.57    -17.45    -367.80   -1635.77    25682.74
          4    7  33550.75   -1294.36     17.43     367.42     329.54   -69298.42
              13 -33550.75    1294.36    -17.43    -367.42   -1634.08   -27583.23
          5    7 -31499.74    1213.74     17.46     368.17     330.20    65075.79
              13  31499.74   -1213.74    -17.46    -368.17   -1637.38    25771.35
          6    7  33499.13   -1292.37     29.25     616.58     553.00   -69191.77
              13 -33499.13    1292.37    -29.25    -616.58   -2742.19   -27540.86
          7    7 -31448.68    1211.77      5.65     119.03     106.76    64970.27
              13  31448.68   -1211.77     -5.65    -119.03    -529.37    25729.86
          8    7    -87.01       3.35   -121.25   -2556.03   -2292.46      179.74
              13     87.01      -3.35    121.25    2556.03   11367.67       71.37

   16     1   10      2.90      -0.72      0.01       0.21       0.19       -0.44
              15     -2.90       0.72     -0.01      -0.21      -0.94      -53.40
          2   10  31223.92   -1204.43    259.94    5479.83    4914.75   -64493.86
              15 -31223.92    1204.43   -259.94   -5479.83  -24371.00   -25656.74
          3   10 -33609.85    1295.31    259.94    5479.88    4914.81    69432.66
              15  33609.85   -1295.31   -259.94   -5479.88  -24371.21    27520.02
          4   10  31313.53   -1207.89    259.92    5479.50    4914.46   -64678.97
              15 -31313.53    1207.89   -259.92   -5479.50  -24369.53   -25730.20
          5   10 -33698.66    1298.73    259.96    5480.24    4915.14    69616.13
              15  33698.66   -1298.73   -259.96   -5480.24  -24372.82    27592.83
          6   10  31166.78   -1202.22    271.74    5728.66    5137.93   -64375.89
              15 -31166.78    1202.22   -271.74   -5728.66  -25477.63   -25609.46
          7   10 -33552.45    1293.10    248.14    5231.11    4691.70    69314.11
              15  33552.45   -1293.10   -248.14   -5231.11  -23264.81    27472.94
          8   10    -87.09       3.36    121.25    2556.05    2292.48      179.90
              15     87.09      -3.36   -121.25   -2556.05  -11367.77       71.43

  300     1    3      0.00     150.00      0.00       0.00       0.00     4556.26
             300      0.00    -150.00      0.00       0.00       0.00        0.01
          2    3   1154.90     150.00      0.02       0.00      -0.68     4556.25
             300  -1154.90    -150.00     -0.02       0.00      -0.52        0.00
          3    3   1155.03     150.00     -0.02       0.00       0.26     4556.25
             300  -1155.03    -150.00      0.02       0.00       0.25        0.00
          4    3   1155.04     150.00     -8.46       0.00     257.75     4556.25
             300  -1155.04    -150.00      8.46       0.00      -0.41        0.00
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MEMBER END FORCES    STRUCTURE TYPE = SPACE
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ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT      AXIAL   SHEAR-Y  SHEAR-Z    TORSION     MOM-Y      MOM-Z

           5     3  1154.94    150.00     8.49       0.00   -258.07    4556.25
               300 -1154.94   -150.00    -8.49       0.00      0.10       0.00
           6     3  1163.53    150.00     0.03       0.00     -0.43    4556.25
               300 -1163.53   -150.00    -0.03       0.00     -0.52       0.00
           7     3  1146.31    150.00    -0.01       0.00      0.09    4556.25
               300 -1146.31   -150.00     0.01       0.00      0.08       0.01
           8     3     0.03      0.00     0.02       0.00     -0.26       0.00
               300    -0.03      0.00    -0.02       0.00     -0.30       0.00


************** END OF LATEST ANALYSIS RESULT **************


146. PRINT MEMBER STRESSES ALL
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 MEMBER STRESSES
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 ALL UNITS ARE POUN/SQ INCH

MEMB    LD  SECT     AXIAL      BEND-Y      BEND-Z    COMBINED   SHEAR-Y   SHEAR-Z


     1     1    .0      0.0 C       0.0         0.0        0.0      22.1       0.0
              1.00      0.0 C       0.0        27.7       27.7      33.5       0.0
           2    .0    844.5 C       0.0         0.0      844.5      22.1       0.0
              1.00    844.5 C       0.0        27.7      872.2      33.5       0.0
           3    .0    844.5 T       0.0         0.0      844.5      22.1       0.0
              1.00    844.5 T       0.0        27.7      872.2      33.5       0.0
           4    .0    844.9 C       0.0         0.0      844.9      22.1       0.0
              1.00    845.3 C       0.0        27.7      873.0      33.5       0.0
           5    .0    844.9 T       0.0         0.0      844.9      22.1       0.0
              1.00    845.3 T       0.0        27.7      873.0      33.5       0.0
           6    .0    844.5 C       0.0         0.0      844.5      22.0       0.6
              1.00    844.5 C       0.9        27.5      872.0      33.3       1.3
           7    .0    844.5 T       0.0         0.0      844.6      22.0       0.6
              1.00    844.5 T       0.9        27.5      872.1      33.3       1.3
           8    .0      0.0 C       0.0         0.0        0.0       0.0       0.0
              1.00      0.0 C       0.0         0.0        0.0       0.0       0.0

     2     1    .0      0.0 T       0.0        27.7       27.7      13.9       0.0
              1.00      0.0 T       0.0        20.1       20.1       4.7       0.0
           2    .0      4.6 C      63.6        27.7       73.9      13.9      41.9
              1.00      4.6 C       4.7        20.1       25.3       4.7      41.9
           3    .0      0.0 T      63.6        27.7       69.4      13.9      41.9
              1.00      0.0 T       4.7        20.1       20.7       4.7      41.9
           4    .0      2.8 C      64.1        27.7       72.6      13.9      41.9
              1.00      3.4 C       4.2        20.1       24.0       4.7      41.9
           5    .0      1.8 C      63.0        27.7       70.6      13.9      41.9
              1.00      1.1 C       5.3        20.1       22.0       4.7      41.9
           6    .0      4.6 C      67.8        27.5       77.7      13.9      44.2
              1.00      4.6 C       3.4        20.0       24.8       4.7      43.2
           7    .0      0.1 T      59.4        27.5       65.5      13.9      39.6
              1.00      0.1 T       6.0        20.0       20.9       4.7      40.7
           8    .0      2.3 C       0.0         0.0        2.3       0.0       0.0
              1.00      2.3 C       0.0         0.0        2.3       0.0       0.0

     3     1    .0      0.0 T       0.0        20.1       20.1      11.2       0.0
              1.00      0.0 T       0.0        27.7       27.7      17.3       0.0
           2    .0      4.5 C       4.7        20.1       25.2      11.2       8.6
              1.00      4.5 C       0.2        27.7       32.2      17.3       8.6
           3    .0      0.1 T       4.7        20.1       20.8      11.2       8.6
              1.00      0.1 T       0.2        27.7       27.8      17.3       8.6
           4    .0      3.6 C       4.7        20.1       24.3      11.2       8.6
              1.00      3.8 C       0.2        27.7       31.5      17.3       8.6
           5    .0      0.9 C       4.7        20.1       21.6      11.2       8.6
              1.00      0.7 C       0.2        27.7       28.4      17.3       8.6
           6    .0      4.6 C       3.4        20.0       24.9      11.2       7.7
              1.00      4.6 C       0.8        27.5       32.1      17.3       8.1
           7    .0      0.1 T       6.0        20.0       20.9      11.2       9.5
              1.00      0.1 T       1.1        27.5       27.6      17.3       9.2
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MEMBER STRESSES
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ALL UNITS ARE POUN/SQ INCH

MEMB    LD   SECT      AXIAL       BEND-Y      BEND-Z    COMBINED    SHEAR-Y    SHEAR-Z

          8     .0       2.3 C        0.0         0.0         2.3        0.0        0.0
              1.00       2.3 C        0.0         0.0         2.3        0.0        0.0

    4     1     .0       0.0 C        0.0        27.7        27.7       33.5        0.0
              1.00       0.0 C        0.0         0.0         0.0       22.1        0.0
          2     .0       0.1 C        0.0        27.7        27.8       33.5        0.0
              1.00       0.1 C        0.0         0.0         0.1       22.1        0.0
          3     .0       0.0 T        0.0        27.7        27.7       33.5        0.0
              1.00       0.0 T        0.0         0.0         0.0       22.1        0.0
          4     .0       0.7 T        0.0        27.7        28.4       33.5        0.0
              1.00       0.4 T        0.0         0.0         0.4       22.1        0.0
          5     .0       0.7 C        0.0        27.7        28.4       33.5        0.0
              1.00       0.4 C        0.0         0.0         0.4       22.1        0.0
          6     .0       0.1 C        0.9        27.5        27.6       33.3        1.3
              1.00       0.1 C        0.0         0.0         0.1       22.0        0.6
          7     .0       0.0          0.9        27.5        27.5       33.3        1.3
              1.00       0.0          0.0         0.0         0.0       22.0        0.6
          8     .0       0.0 C        0.0         0.0         0.0        0.0        0.0
              1.00       0.0 C        0.0         0.0         0.0        0.0        0.0

    5     1     .0       0.0 T        0.2       690.1       690.3      117.8        0.0
              1.00       0.0 T        0.0         0.0         0.0      117.8        0.0
          2     .0       6.4 T    19386.4       737.8     20130.6      125.9     3309.3
              1.00       6.4 T        0.0         0.0         6.4      125.9     3309.3
          3     .0       6.4 T    18201.8       737.8     18946.1      125.9     3107.1
              1.00       6.4 T        0.0         0.0         6.4      125.9     3107.1
          4     .0       6.4 T    19449.4       738.2     20194.0      126.0     3320.1
              1.00       6.4 T        0.0         0.0         6.4      126.0     3320.1
          5     .0       6.4 T    18264.5       737.4     19008.3      125.9     3117.8
              1.00       6.4 T        0.0         0.0         6.4      125.9     3117.8
          6     .0      10.8 T    19419.5       737.9     20168.2      126.0     3315.0
              1.00      10.8 T        0.0         0.0        10.8      126.0     3315.0
          7     .0       2.1 T    18234.8       733.0     18969.9      125.1     3112.8
              1.00       2.1 T        0.0         0.0         2.1      125.1     3112.8
          8     .0      44.7 C       50.4         0.0        95.2        0.0        8.6
              1.00      44.7 C        0.0         0.0        44.7        0.0        8.6

    6     1     .0       0.0 C        0.0       580.7       580.7       99.1        0.0
              1.00       0.0 C        0.0         0.0         0.0       99.1        0.0
          2     .0      95.9 C    18101.0       533.0     18730.0       91.0     3089.9
              1.00      95.9 C        0.0         0.0        95.9       91.0     3089.9
          3     .0      95.9 C    19487.2       533.0     20116.2       91.0     3326.6
              1.00      95.9 C        0.0         0.0        95.9       91.0     3326.6
          4     .0      95.9 C    18152.9       532.6     18781.5       90.9     3098.8
              1.00      95.9 C        0.0         0.0        95.9       90.9     3098.8
          5     .0      95.9 C    19538.7       533.5     20168.1       91.1     3335.3
              1.00      95.9 C        0.0         0.0        95.9       91.1     3335.3
          6     .0     100.3 C    18067.9       528.2     18696.4       90.2     3084.3
              1.00     100.3 C        0.0         0.0       100.3       90.2     3084.3
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MEMBER STRESSES
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ALL UNITS ARE POUN/SQ INCH

MEMB   LD  SECT     AXIAL     BEND-Y      BEND-Z    COMBINED   SHEAR-Y   SHEAR-Z

        7    .0     91.6 C  19454.0       533.2    20078.7      91.0    3320.9
           1.00     91.6 C      0.0         0.0       91.6      91.0    3320.9
        8    .0     44.7 C     50.5         0.0       95.2       0.0       8.6
           1.00     44.7 C      0.0         0.0       44.7       0.0       8.6

   7    1    .0      0.0 C      0.1       725.8      725.9     123.9       0.0
           1.00      0.0 C      0.0         0.0        0.0     123.9       0.0
        2    .0      2.0 T    103.4       678.1      783.5     115.8      17.7
           1.00      2.0 T      0.0         0.0        2.0     115.8      17.7
        3    .0      2.0 T      0.7       678.1      680.8     115.8       0.1
           1.00      2.0 T      0.0         0.0        2.0     115.8       0.1
        4    .0      2.0 T    103.6       677.7      783.3     115.7      17.7
           1.00      2.0 T      0.0         0.0        2.0     115.7      17.7
        5    .0      2.0 T      0.5       678.5      681.1     115.8       0.1
           1.00      2.0 T      0.0         0.0        2.0     115.8       0.1
        6    .0      2.9 T    103.5       673.3      779.7     114.9      17.7
           1.00      2.9 T      0.0         0.0        2.9     114.9      17.7
        7    .0      1.2 T      0.6       678.2      680.0     115.8       0.1
           1.00      1.2 T      0.0         0.0        1.2     115.8       0.1
        8    .0      8.5 C     50.4         0.0       58.9       0.0       8.6
           1.00      8.5 C      0.0         0.0        8.5       0.0       8.6

   8    1    .0      0.0 T      0.1       634.7      634.8     108.3       0.0
           1.00      0.0 T      0.0         0.0        0.0     108.3       0.0
        2    .0     19.0 C     99.9       682.4      801.3     116.5      17.1
           1.00     19.0 C      0.0         0.0       19.1     116.5      17.1
        3    .0     19.0 C      2.8       682.4      704.2     116.5       0.5
           1.00     19.0 C      0.0         0.0       19.0     116.5       0.5
        4    .0     19.0 C    100.0       682.8      801.8     116.6      17.1
           1.00     19.0 C      0.0         0.0       19.0     116.6      17.1
        5    .0     19.0 C      2.9       682.0      703.9     116.4       0.5
           1.00     19.0 C      0.0         0.0       19.0     116.4       0.5
        6    .0     19.9 C     99.8       682.5      802.2     116.5      17.0
           1.00     19.9 C      0.0         0.0       19.9     116.5      17.0
        7    .0     18.2 C      2.7       677.6      698.4     115.7       0.5
           1.00     18.2 C      0.0         0.0       18.2     115.7       0.5
        8    .0      8.5 C     50.4         0.0       58.9       0.0       8.6
           1.00      8.5 C      0.0         0.0        8.5       0.0       8.6

   9    1    .0     92.6 C      0.1         0.2       92.9       0.0       0.0
           1.00     92.6 C      0.0         0.0       92.6       0.0       0.0
        2    .0     99.0 C     88.2     24214.7    24401.9    4136.7      15.1
           1.00     99.0 C      0.0         0.0       99.0    4136.7      15.1
        3    .0     99.0 C     88.2     22735.1    22922.3    3883.9      15.1
           1.00     99.0 C      0.0         0.0       99.0    3883.9      15.1
        4    .0     99.1 C     88.1     24293.4    24480.5    4150.1      15.1
           1.00     99.1 C      0.0         0.0       99.1    4150.1      15.1
        5    .0     99.0 C     88.3     22813.3    23000.6    3897.3      15.1
           1.00     99.0 C      0.0         0.0       99.0    3897.3      15.1
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MEMBER STRESSES
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ALL UNITS ARE POUN/SQ INCH

MEMB    LD  SECT     AXIAL      BEND-Y      BEND-Z   COMBINED   SHEAR-Y   SHEAR-Z

         6     .0      99.0 C      147.9     24256.0    24502.9    4143.7      25.3
             1.00      99.0 C        0.0         0.0       99.0    4143.7      25.3
         7     .0      98.4 C       28.5     22776.3    22903.3    3891.0       4.9
             1.00      98.4 C        0.0         0.0       98.4    3891.0       4.9
         8     .0       0.0 C      612.9        63.0      675.9      10.8     104.7
             1.00       0.0 C        0.0         0.0        0.0      10.8     104.7

   10    1     .0      92.1 C        0.2        12.6      104.9       0.3       0.0
             1.00      92.1 C        0.0         0.1       92.1       0.3       0.0
         2     .0    4303.8 T      434.5      4687.2     9425.5     445.4      10.7
             1.00    4303.8 T        9.8     12983.1    17296.8     445.4      10.7
         3     .0    4231.8 C      434.6      4374.9     9041.2     417.5      10.7
             1.00    4231.8 C        9.8     12190.0    16431.6     417.5      10.7
         4     .0    4318.1 T      434.1      4702.4     9454.6     446.8      10.7
             1.00    4318.1 T        9.8     13025.3    17353.2     446.8      10.7
         5     .0    4245.9 C      435.0      4390.0     9070.9     419.0      10.7
             1.00    4245.9 C        9.8     12231.9    16487.7     419.0      10.7
         6     .0    4311.3 T      728.5      4695.2     9735.0     446.1      17.9
             1.00    4311.3 T       16.5     13005.3    17333.1     446.1      17.9
         7     .0    4238.6 C      140.6      4382.9     8762.2     418.3       3.5
             1.00    4238.6 C        3.2     12212.1    16453.9     418.3       3.5
         8     .0      11.5 C     3019.9        12.2     3043.6       1.2      74.4
             1.00      11.5 C       68.3        33.8      113.5       1.2      74.4

   11    1     .0      77.9 C        0.1         0.1       78.0       0.0       0.0
             1.00      77.9 C        0.0         0.0       77.9       0.0       0.0
         2     .0      71.5 C     1314.0     22609.1    23994.6    3862.4     224.5
             1.00      71.5 C        0.0         0.0       71.5    3862.4     224.5
         3     .0      71.5 C     1314.1     24340.7    25726.3    4158.2     224.5
             1.00      71.5 C        0.0         0.0       71.5    4158.2     224.5
         4     .0      71.5 C     1313.9     22674.0    24059.4    3873.5     224.5
             1.00      71.5 C        0.0         0.0       71.5    3873.5     224.5
         5     .0      71.6 C     1314.2     24405.0    25790.7    4169.2     224.5
             1.00      71.6 C        0.0         0.0       71.6    4169.2     224.5
         6     .0      70.9 C     1373.7     22567.7    24012.4    3855.3     234.7
             1.00      70.9 C        0.0         0.0       70.9    3855.3     234.7
         7     .0      71.5 C     1254.4     24299.1    25625.0    4151.1     214.3
             1.00      71.5 C        0.0         0.0       71.5    4151.1     214.3
         8     .0       0.0 T      612.9        63.1      676.0      10.8     104.7
             1.00       0.0 T        0.0         0.0        0.0      10.8     104.7

   12    1     .0      77.5 C        0.2        10.5       88.3       0.3       0.0
             1.00      77.5 C        0.0         0.0       77.5       0.3       0.0
         2     .0    4039.3 T     6474.4      4373.6    14887.2     415.8     159.5
             1.00    4039.3 T      146.4     12122.3    16307.9     415.8     159.5
         3     .0    4496.3 C     6474.5      4688.5    15659.3     447.1     159.5
             1.00    4496.3 C      146.4     13050.8    17693.5     447.1     159.5
         4     .0    4051.1 T     6474.0      4386.1    14911.2     417.0     159.5
             1.00    4051.1 T      146.4     12157.1    16354.6     417.0     159.5
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   MEMBER STRESSES
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   ALL UNITS ARE POUN/SQ INCH

 MEMB    LD  SECT     AXIAL     BEND-Y      BEND-Z    COMBINED   SHEAR-Y   SHEAR-Z

          5    .0    4508.1 C    6474.9      4700.9    15683.8     448.3     159.5
             1.00    4508.1 C     146.4     13085.3    17739.8     448.3     159.5
          6    .0    4032.4 T    6768.4      4365.5    15166.3     415.0     166.7
             1.00    4032.4 T     153.1     12100.1    16285.5     415.0     166.7
          7    .0    4488.8 C    6180.5      4680.4    15349.8     446.4     152.3
             1.00    4488.8 C     139.8     13028.5    17657.1     446.4     152.3
          8    .0      11.5 C    3020.0        12.2     3043.6       1.2      74.4
             1.00      11.5 C      68.3        33.8      113.6       1.2      74.4

    13    1    .0     306.7 C       5.8         1.2      313.7       0.0       0.2
             1.00     306.7 C       0.0         0.0      306.7       0.0       0.2
          2    .0     286.5 C    4751.7       676.7     5715.0      12.6     176.5
             1.00     286.5 C       0.0         0.0      286.5      12.6     176.5
          3    .0     286.5 C      33.2       676.8      996.5      12.6       1.2
             1.00     286.5 C       0.0         0.0      286.5      12.6       1.2
          4    .0     286.4 C    4759.7       678.7     5724.7      12.6     176.8
             1.00     286.4 C       0.0         0.0      286.4      12.6     176.8
          5    .0     286.7 C      25.3       674.9      986.9      12.5       0.9
             1.00     286.7 C       0.0         0.0      286.7      12.5       0.9
          6    .0     284.5 C    4755.9       968.5     6008.9      18.0     176.6
             1.00     284.5 C       0.0         0.0      284.5      18.0     176.6
          7    .0     286.6 C      29.0       385.1      700.6       7.2       1.1
             1.00     286.6 C       0.0         0.0      286.6       7.2       1.1
          8    .0       0.0 T    2317.4      2855.2     5172.5      53.0      86.1
             1.00       0.0 T       0.0         0.0        0.0      53.0      86.1

    14    1    .0     268.2 C       4.9         1.2      274.3       0.0       0.2
             1.00     268.2 C       0.0         0.0      268.2       0.0       0.2
          2    .0     288.3 C    4590.8      6387.1    11266.3     118.6     170.5
             1.00     288.3 C       0.0         0.0      288.3     118.6     170.5
          3    .0     288.3 C     127.7      6387.2     6803.2     118.6       4.7
             1.00     288.3 C       0.0         0.0      288.3     118.6       4.7
          4    .0     288.5 C    4597.4      6389.1    11274.9     118.7     170.8
             1.00     288.5 C       0.0         0.0      288.5     118.7     170.8
          5    .0     288.1 C     134.2      6385.3     6807.7     118.6       5.0
             1.00     288.1 C       0.0         0.0      288.1     118.6       5.0
          6    .0     288.4 C    4586.6      6678.9    11553.9     124.0     170.4
             1.00     288.4 C       0.0         0.0      288.4     124.0     170.4
          7    .0     286.3 C     123.5      6095.5     6505.2     113.2       4.6
             1.00     286.3 C       0.0         0.0      286.3     113.2       4.6
          8    .0       0.0 C    2317.4      2855.2     5172.6      53.0      86.1
             1.00       0.0 C       0.0         0.0        0.0      53.0      86.1

    15    1    .0       0.6 C       0.0         0.2        0.8       0.2       0.0
             1.00       0.6 C       0.2        10.4       11.1       0.2       0.0
          2    .0    5258.2 C      53.6     11231.5    16543.3     322.5       4.4
             1.00    5258.2 C     265.9      4470.6     9994.7     322.5       4.4
          3    .0    4935.8 T      53.6     10545.2    15534.6     302.4       4.4
             1.00    4935.8 T     266.0      4176.1     9377.8     302.4       4.4
```

```
 MEMBER STRESSES
 ---------------
 ALL UNITS ARE POUN/SQ INCH

MEMB    LD  SECT     AXIAL      BEND-Y      BEND-Z    COMBINED   SHEAR-Y   SHEAR-Z

         4    .0    5275.3 C      53.6     11268.0    16596.9     323.6       4.4
            1.00    5275.3 C     265.7      4485.1    10026.1     323.6       4.4
         5    .0    4952.8 T      53.7     10581.4    15587.9     303.4       4.4
            1.00    4952.8 T     266.2      4190.5     9409.5     303.4       4.4
         6    .0    5267.2 C      89.9     11250.7    16607.8     323.1       7.3
            1.00    5267.2 C     445.9      4478.2    10191.2     323.1       7.3
         7    .0    4944.8 T      17.4     10564.3    15526.4     302.9       1.4
            1.00    4944.8 T      86.1      4183.7     9214.6     302.9       1.4
         8    .0      13.7 T     372.8        29.2      415.7       0.8      30.3
            1.00      13.7 T    1848.4        11.6     1873.7       0.8      30.3

   16    1    .0       0.5 C       0.0         0.1        0.6       0.2       0.0
            1.00       0.5 C       0.2         8.7        9.3       0.2       0.0
         2    .0    4909.4 C     799.1     10486.8    16195.4     301.1      65.0
            1.00    4909.4 C    3962.8      4171.8    13044.0     301.1      65.0
         3    .0    5284.6 T     799.2     11289.9    17373.6     323.8      65.0
            1.00    5284.6 T    3962.8      4474.8    13722.2     323.8      65.0
         4    .0    4923.5 C     799.1     10516.9    16239.5     302.0      65.0
            1.00    4923.5 C    3962.5      4183.8    13069.8     302.0      65.0
         5    .0    5298.5 T     799.2     11319.7    17417.4     324.7      65.0
            1.00    5298.5 T    3963.1      4486.6    13748.2     324.7      65.0
         6    .0    4900.4 C     835.4     10467.6    16203.5     300.6      67.9
            1.00    4900.4 C    4142.7      4164.1    13207.3     300.6      67.9
         7    .0    5275.5 T     762.9     11270.6    17309.0     323.3      62.0
            1.00    5275.5 T    3782.9      4467.1    13525.6     323.3      62.0
         8    .0      13.7 T     372.8        29.3      415.7       0.8      30.3
            1.00      13.7 T    1848.4        11.6     1873.7       0.8      30.3

  300    1    .0       0.0 T       0.0       250.2      250.2      32.6       0.0
            1.00       0.0 T       0.0         0.0        0.0      32.6       0.0
         2    .0     150.8 C       0.0       250.2      401.0      32.6       0.0
            1.00     150.8 C       0.0         0.0      150.8      32.6       0.0
         3    .0     150.8 C       0.0       250.2      401.0      32.6       0.0
            1.00     150.8 C       0.0         0.0      150.8      32.6       0.0
         4    .0     150.8 C      14.2       250.2      401.4      32.6       1.8
            1.00     150.8 C       0.0         0.0      150.9      32.6       1.8
         5    .0     150.8 C      14.2       250.2      401.4      32.6       1.8
            1.00     150.8 C       0.0         0.0      150.8      32.6       1.8
         6    .0     151.9 C       0.0       250.2      402.1      32.6       0.0
            1.00     151.9 C       0.0         0.0      152.0      32.6       0.0
         7    .0     149.7 C       0.0       250.2      399.9      32.6       0.0
            1.00     149.7 C       0.0         0.0      149.7      32.6       0.0
         8    .0       0.0 C       0.0         0.0        0.0       0.0       0.0
            1.00       0.0 C       0.0         0.0        0.0       0.0       0.0


   ************** END OF LATEST ANALYSIS RESULT **************
```

```
 *** ( B-7 BOUNDING CASE )
147. PARAMETER
148. CODE AISC
149. FYLD 45999.969 MEMB 9 TO 16
150. WSTR 21000. MEMB 9 TO 16
151. WMIN 0.188 MEMB 9 TO 16
152. PUNCH 2.0 MEMB 9 TO 14
153. CB 1. MEMB 9 TO 16
154. CMY 1. MEMB 9 TO 16
155. MAIN 0. MEMB 9 TO 16
156. RATIO 1. MEMB 9 TO 16
157. CHECK CODE MEMB 9 TO 16
```

```
                              STAAD-III CODE CHECKING - (AISC)
                              ***********************

ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE        RESULT/   CRITICAL COND/      RATIO/     LOADING/
                           FX            MY              MZ      LOCATION
=======================================================================

     9  ST  TUB 40408       PASS     AISC- H1-3         0.888          6
                     629.82 C       909.31     149174.25          0.00
    10  ST  TUB 40408       PASS     AISC- H2-1         0.629          4
                   27462.96 T       -60.37     -80105.75         61.00
    11  ST  TUB 40408       PASS     AISC- H1-3         0.934          5
                     455.33 C      8082.13    -150090.58          0.00
    12  ST  TUB 40408       PASS     AISC- H1-2         0.643          5
                   28671.43 C      -900.45      80474.39         61.00
    13  ST  TUB 40203       PASS     PUNCHING SHR       0.689          4
                     578.43 C      6187.57      -1323.37          0.00
    14  ST  TUB 40203       PASS     PUNCHING SHR       0.694          5
                     582.06 C      -174.46     -12451.36          0.00
    15  ST  TUB 40408       PASS     AISC- H1-1         0.627          6
                   33499.13 C       553.00     -69191.77          0.00
    16  ST  TUB 40408       PASS     AISC- H2-1         0.631          5
                   33698.66 T      4915.14      69616.13          0.00
  158. SELECT WELD MEMB 9 TO 16
```

```
                        STAAD-III WELD DESIGN
                        *********************

ALL UNITS ARE - INCH POUN

MEMBER    LOCATION/      WELD TYPE/        WELD SIZE/       COMB STRESS/
          LOADING        HOR STRESS        VERT STRESS       DIR STRESS
======================================================================


    9       STA               1               6/16             19066.61
             6                 16.84           2762.49          18865.41

    9       END               1               3/16              5537.51
             4                 20.07           5533.49            210.02

   10       STA               1               3/16             17489.86
             6                 46.68            617.61          17478.89

   10       END               1               5/16             17521.33
             4                 16.69            365.60          17517.51

   11       STA               1               6/16             20041.71
             5                149.67           2779.46          19847.48

   11       END               1               3/16              5569.03
             5                299.34           5558.91            151.78

   12       STA               1               4/16             20066.28
             5                311.19            599.98          20054.90

   12       END               1               5/16             17948.66
             5                248.95            479.98          17940.51

   13       STA               1               3/16              4544.02
             6                 39.26             11.99           4543.84

   13       END               1               3/16               275.31
             1                  0.05              0.02            275.31

   14       STA               1               3/16              8876.14
             6                 37.86             82.69           8875.67

   14       END               1               3/16               274.40
             6                 37.86             82.69            258.89

   15       STA               1               5/16             17164.33
             6                 52.09            304.72          17161.54

   15       END               1               3/16             18744.22
             6                 86.82            507.86          18737.14

   16       STA               1               5/16             17937.95
             5                463.01            670.76          17919.42

   16       END               1               4/16             18196.77
             5                578.76            838.46          18168.22
```

```
                    STAAD-III WELD DESIGN
                    *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/     WELD TYPE/      WELD SIZE/       COMB STRESS/
         LOADING       HOR STRESS     VERT STRESS        DIR STRESS
======================================================================


****************** END OF TABULATED WELD DESIGN ******************


159. FINISH


          *************** END OF STAAD-III ***************

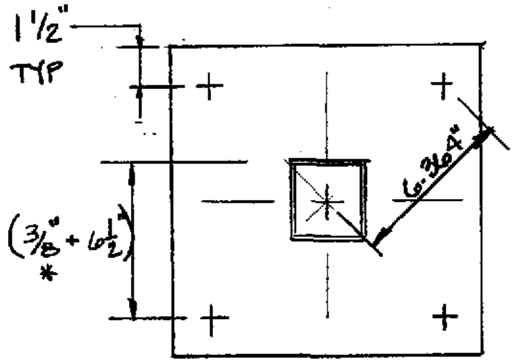
            **** DATE= SEP 25,1996   TIME= 16:11: 7 ****

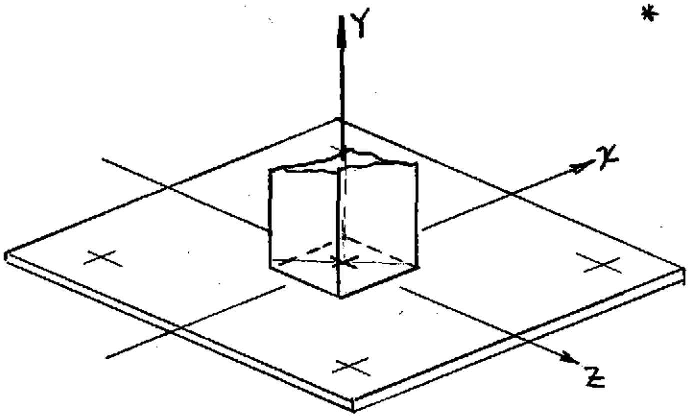
      *********************************************************
      *         For questions on  STAAD-III,   contact:       *
      *               Research Engineers, Inc at              *
      *        Ph: (714) 974-2500   Fax:  (714) 921-2543      *
      *********************************************************
```

DESIGN ANCHORAGE

TRY PL 12"x12"

JT's 8 & 11





* DIMENSION considers weld at T.S. to PL.

WORST CASE SUPPORT REACTIONS @ JT 11 LOADCASE 6

$F_X = 1660$ lbs $M_X = 41626$ in-lbs

$F_Y = 25646.$ lbs (TENSION) $M_Y = 1691.$ in-lbs

$F_Z = 667.$ lbs $M_Z = 26848$ in-lbs.

BOLTS

TENSION

$$T = \frac{25646.\text{ lbs}}{4 \text{ BOLTS}} + \frac{41626 \text{ in-lbs} + 26848 \text{ in-lbs}}{2\,(\underset{*}{6.875}\text{ in})}$$

$$= 11391.\text{ lbs/BOLT}$$

* include 3/8" fillet allaround weld

SHEAR

$$V = \frac{1660.\text{ lbs} + 667\text{ lbs}}{4 \text{ BOLTS}} + \frac{1691 \text{ in-lbs}}{4 \text{ BOLTS}\,(6.364 \text{ in})}$$

$$= 648.\text{ lbs/BOLT}$$

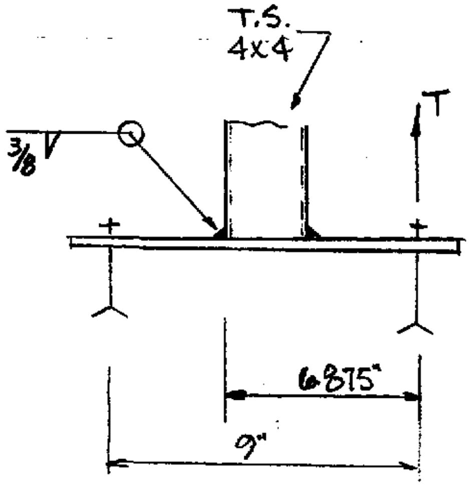
TRY 1"Φ HILTI HVA @ 12 3/8" EMB'T $T_{ALL} = 12120$ lbs $V_{ALL} = 7630$ lbs

$$\left(\frac{11391}{12120}\right)^{5/3} + \left(\frac{648}{7630}\right)^{5/3} = 0.92 < 1.0 \therefore \text{O.K.}$$

STD BOLT OK

USE 1"Φ HILTI HVA @ 12 3/8" EMB'T

DETERMINE PLATE THICKNESS

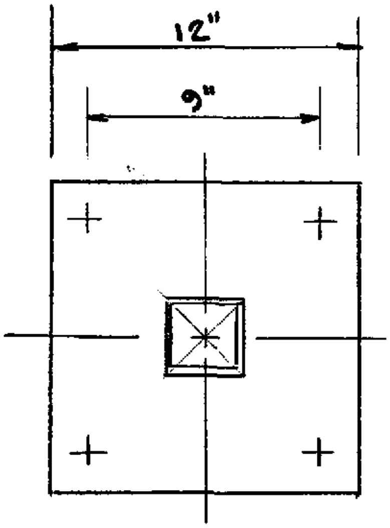


$F_y = 36000\ \#/in^2$

$F_b = .75\ F_y = 27000\ \#/in^2$

$f_b = \frac{M}{S} \Rightarrow S = \frac{M}{f_b}$

$T = 11391.$



$S_{req} = \frac{M}{f_b} = \frac{T\,(6.875in)}{27000\ \#/in^2} =$

$= \frac{(11391.lbs)\,(6.875in)}{27000\ \#/in^2}$

$S_{req'd} = 2.90\ in^3$

$S = bd^2/6 \Rightarrow d = \sqrt{\frac{6S}{b}}$

$= \sqrt{\frac{6\,(2.90in^3)}{12in}}$

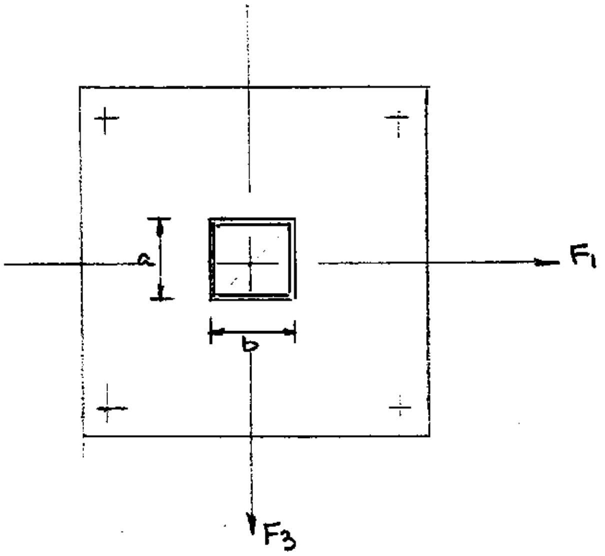
$d = THKS = 1.20\ IN$

USE PL $1\,3/8"$ THK.

Filename: B-6 & B-7

ALL AROUND RECTANGULAR OR SQUARE FILLET WELD

Between part Jts. 11 & 8 and BASEPLTS



LOAD INPUT (LBS., INCH-LBS.)

F1	F2	F3	M1	M2	M3
1660.00	25646.00	667.00	41626.00	1691.00	26848.00

GEOMETRIC DIMENSIONS

a	b	WELD STRESS (PSI)	SKEWED ANGLE(90ø>á<120ø)
4.000	4.000	21000	90.000

SECTION PROPERTIES

A	Sw1	Sw3	J	C1	C3
16.000	21.333	21.333	85.333	2.000	2.000

EFFECTIVE THROAT CORRECTION FACTOR

Mf
1.00

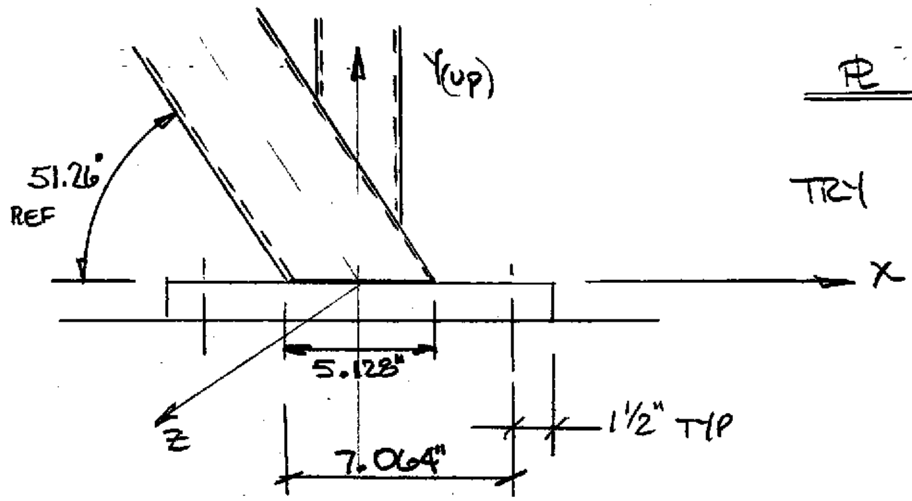
MAXIMUM WELD LOAD (f) - #/INCH

f=
4815

REQUIRED FILLET WELD SIZE (INCHES)

w=
0.324

DESIGN ANCHORAGE AT JTS 13 & 15



PL 12" x 12"

TRY 1"Φ HILTI HVA

- FOR JTS 13 & 15 WORST LOADING OCCURS AT JT 15 L.C.#5

$F_X = 18472.$ lbs $M_X = 35490$ IN-lbs

$F_Y = 27634$ lbs (TENSION) $M_Y = 9658$ IN-lbs

$F_Z = 438.$ lbs $M_Z = 27418$ IN-lbs.

TENSION

$$T = \frac{27634 \text{ lbs}}{4 \text{ BOLTS}} + \frac{35490 \text{ IN-lbs}}{2 \text{ BOLTS } (6.5 \text{ IN})} + \frac{27418 \text{ IN-lbs}}{2 \text{ BOLTS } (7.064 \text{ IN})}$$

$$= 11579 \text{ lbs/BOLT}$$

SHEAR

$$V = \frac{18472 \text{ lbs} + 438 \text{ lbs}}{4 \text{ BOLTS}} + \frac{9658 \text{ IN-lbs}}{4 \text{ BOLTS } (6.364 \text{ IN})}$$

$$= 5107^{\#}/\text{BOLT}$$

TRY 1" ϕ HILTI @ $12\,^3/_8$" EMB'T

T_{ALL} = 12120 lbs V_{ALL} = 7630 lbs

$$\left(\frac{11579.\text{ lbs}}{12120.\text{ lbs}}\right)^{5/3} + \left(\frac{5107.\text{ lbs.}}{7630.\text{ lbs}}\right)^{5/3} = .93 + .51 = 1.44$$

$1.44 > 1.0 \therefore$ N.G.

TRY 1" ϕ HILTI HVA - HAS SUPER
SAE 4140

T_{ALL} = 16450 lbs. V_{ALL} = 13760 lbs.

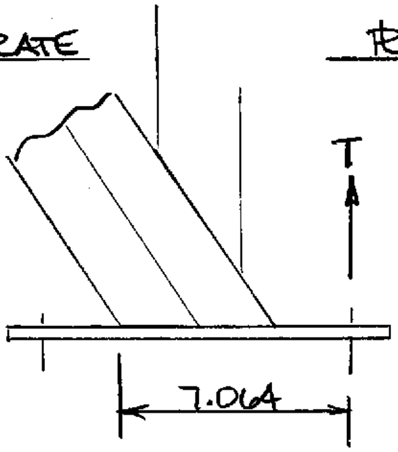
$$\left(\frac{11579.\text{ lbs}}{16450.\text{ lbs}}\right)^{5/3} + \left(\frac{5107.\text{ lbs}}{13760.\text{ lbs}}\right)^{5/3} = .56 + .19 = .75$$

$.75 < 1.0 \therefore$ O.K.

USE 1" ϕ HILTI HVA - HAS SUPER
SAE-4140
@ $12\,^3/_8$" EMB'T

BASEPLATE

℞ 12" x 12"



T = 11579 lbs.

$F_y = 36000\#/in^2$ $F_b = .75\,F_y = 27000\#/in^2$

$f_b = M/S \therefore S = M/f_b$

$S_{REQ'D} = M/f_b = T(7.064 in)/27000\#/in^2$

$S_{req'd} = 3.029\ in^3$

$S = bd^2/6$

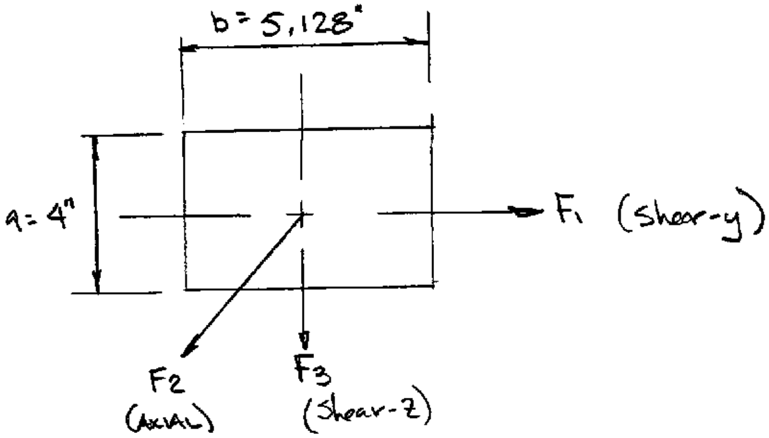
$$d = \sqrt{\frac{6S}{b}} = \sqrt{\frac{6(3.029)}{12 in}} = 1.23 in$$

USE ℞ 12" x 12" x $1\,^3/_8$"

Filename: B-6 & B-7

ALL AROUND RECTANGULAR OR SQUARE FILLET WELD

Between part MEM 15 & 16 and BASEPLTS



LOAD INPUT (LBS., INCH-LBS.)

F1	F2	F3	M1	M2	M3
1294.00	33551.00	17.43	1634.00	367.00	27583.00

GEOMETRIC DIMENSIONS

a	b	WELD STRESS (PSI)	SKEWED ANGLE(90ø>â<120ø)
4.000	5.128	21000	90.000

SECTION PROPERTIES

A	Sw1	Sw3	J	C1	C3
18.256	25.845	29.277	126.758	2.000	2.564

EFFECTIVE THROAT CORRECTION FACTOR

Mf

1.00

MAXIMUM WELD LOAD (f) - #/INCH

f=

2844

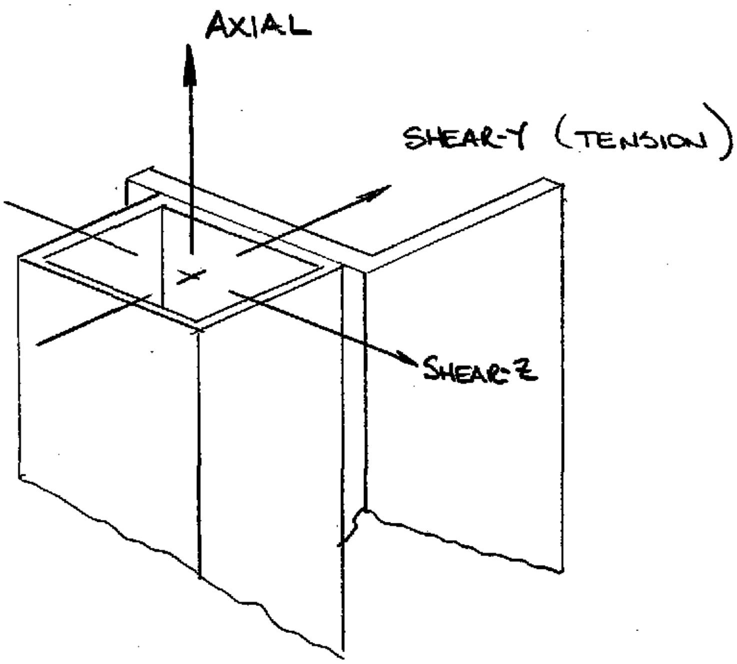
REQUIRED FILLET WELD SIZE (INCHES)

w=

0.192 USE 1/4" fillet 3 sides + 1 side, full penetration

DESIGN THRU BOLT CONNECTION

MEMBER	9	JOINT	6
MEMBER	11	JOINT	9
MEMBER	13	JOINT	12
MEMBER	14	JOINT	14



Worst Loading occurs @ MEMBER 11 JT 9.

ENVELOPE OF LOADS

Axial = 496. lbs

SHEAR-Y = 16677. lbs.

SHEAR-Z = 939. lbs.

SHEAR

$$V = \frac{496.\text{ lbs} + 939.\text{ lbs}}{3\text{ BOLTS}} = 478.\text{ lbs/BOLT}$$

TENSION

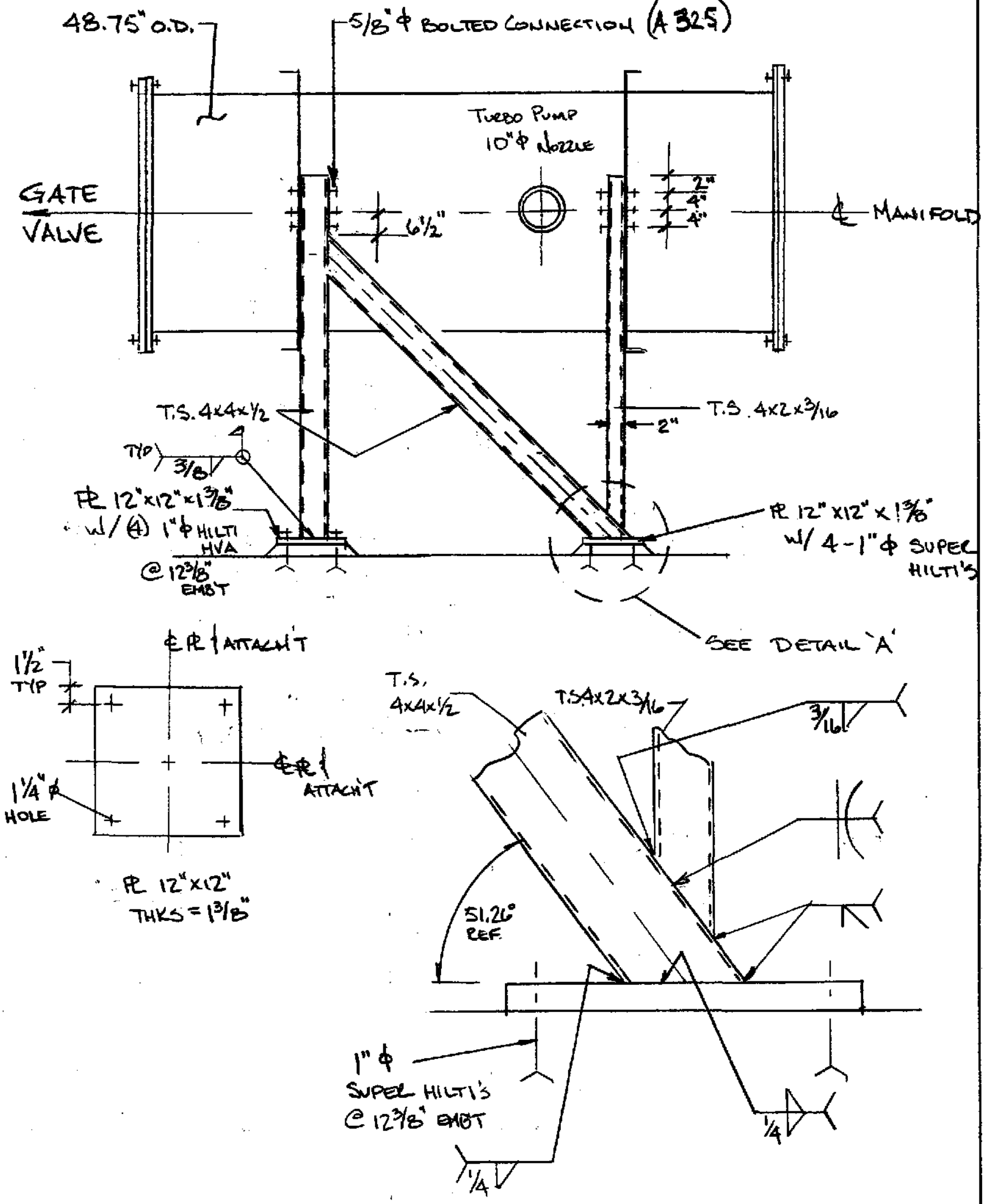
$$T = \frac{16677.\text{ lbs}}{3\text{ BOLTS}} = 5559.\text{ lbs/BOLT}$$

TRY 5/8" ϕ A325 BOLTS $T_{ALL} = 13500.$ $V_{ALL} = 5220$ lbs.

$$\frac{5559(1.2)}{13500} + \frac{478}{5220} = .59 < 1.0 \therefore \underline{OK.}$$

$$\boxed{\text{USE } 5/8" \phi \text{ A325 BOLTS}}$$

B6 & B7 SUPPORT DETAIL



PROCESS SYSTEMS INTERNATIONAL, INC.
WESTBOROUGH, MA

REV.	DEO #	DATE	BY:	CHECK
0	139	4-22-96	AGR	RDC

ENGINEERING CALCULATIONS

NO: V049-1-098

PAGE 1 OF 17

TITLE:
MAIN TURBO CART
FRAME EXTENSION

By: ART ROUSSOPOULOS

DEPT.: 749

PROJECT: LIGO

PROJECT NO: V59049

PURPOSE: VERIFY THE STRUCTURAL ADEQUACY OF THE FRAME EXTENSION

METHOD: • CLASSICAL STRESS ANALYSIS

ASSUMPTIONS: SEE CALCS

INPUTS:
EDWARDS DWG D-4507
PSI DWG V049-4-012

REFERENCES:
BLODGETT "DESIGN OF WELDED STRUCTURES" -1982
AISC - SCM - 9TH ED.
ROARK, "FORMULAS OF STRESS + STRAIN, 5TH ED.
MACHINE DESIGN - THEORY + PRACTICE - 1975

CALCULATIONS: **(SEE ATTACHED)**

CONCLUSIONS: THE SUBJECT FRAME CART IS STRUCTURALLY ADEQUATE PER THE DESIGN SKETCHES

NOTES:

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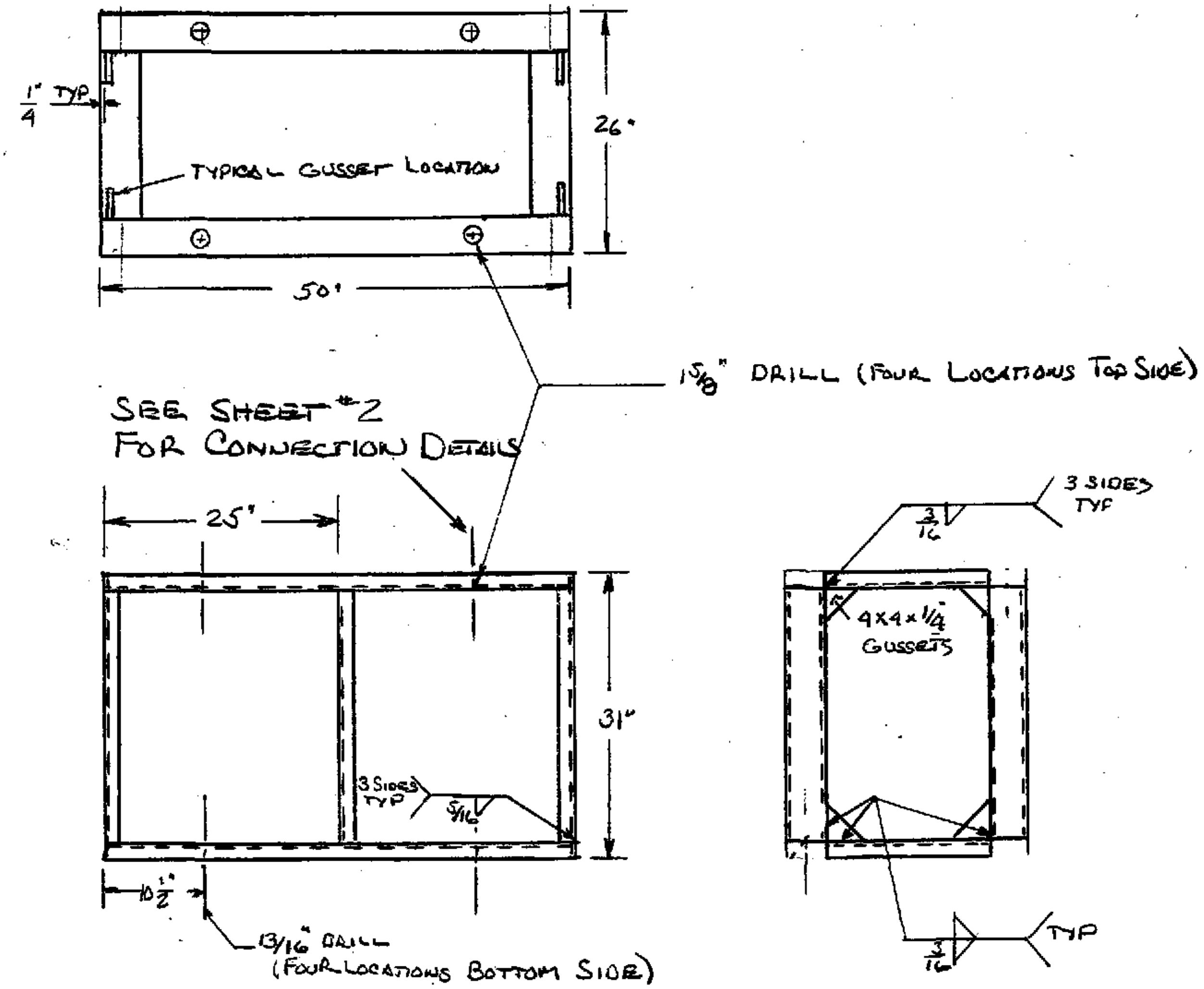
1.0 -

DESIGN SKETCH

SK-V049-1-098, REV 0 - SHEET 1 OF 2

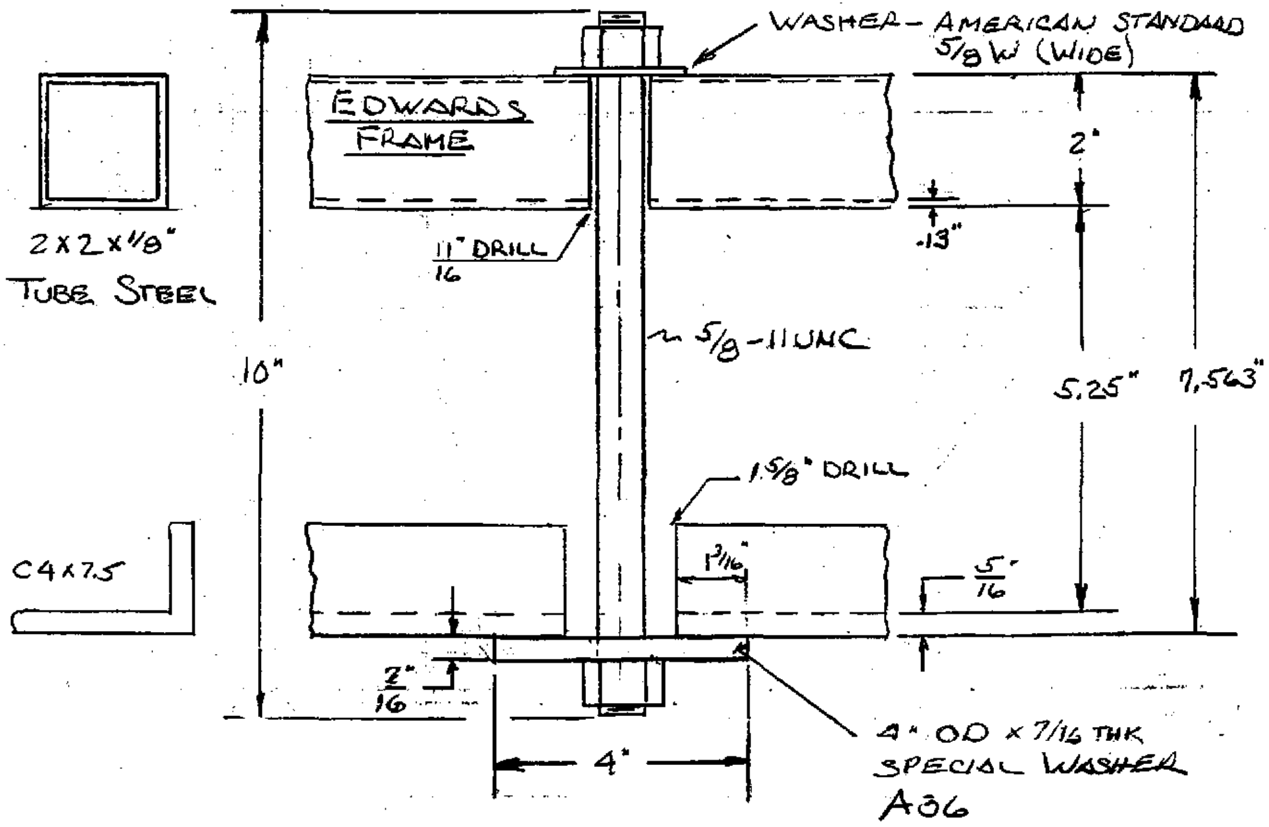
- ALL MEMBERS ARE C 4 x 7.25
- MATERIAL: A36

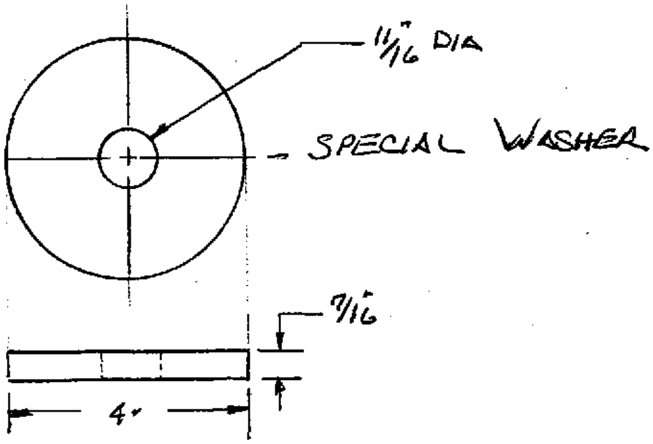


- SPECIFY: HILTI HFA 3/4 FOR 6 5/8" EMBEDMENT DEPTH

DESIGN SKETCH

SK-V049-1-098, REV 0 SHEET 2 OF 2





CONNECTION DETAILS

2. – DESIGN CRITERIA

- OPERATIONAL LOAD AT ℄ OF TURBO PUMP

$$F = PA = 15 \frac{\#}{IN^2} \times \frac{\pi}{4} (10)^2 \, IN^2 = 1178^{\#}$$

WHERE $P_{ATM} = 15 \, \#/IN^2$

10" = PUMP I.D.

- EXCURSION LOAD

EXCURSION LOAD SHALL BE BASED ON AN ACCIDENT CONDITION OF STALLED TORQUE GENERATING A MOMENT LOAD OF 5200# AT ANCHOR BOLT LOCATIONS IN THE DIRECTION OF ROTATION

- DESIGN TEMP = 100°F

3. – ALLOWABLE STRESSES

- OPERATIONAL LOAD:

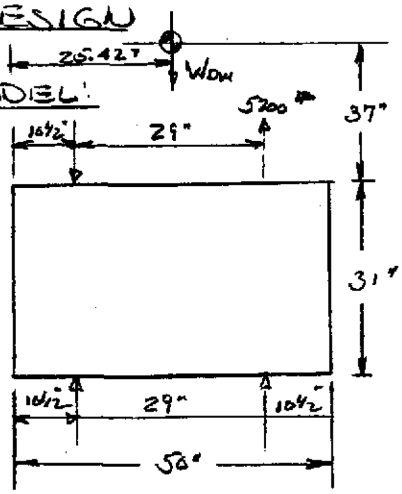
– $\sigma_{ALLOW} = .6 \, S_Y = .6(36,000) = 21,600 \, PSI$

- EXCURSION LOAD

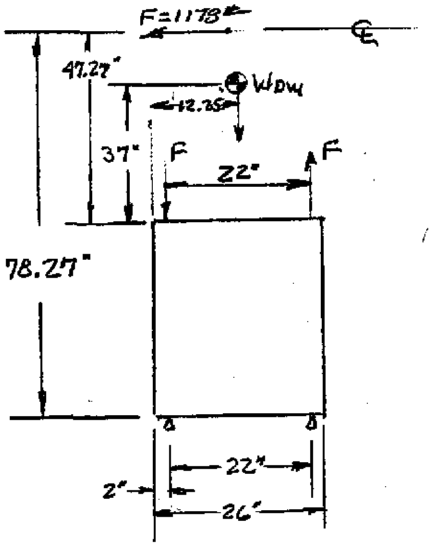
– $\sigma_{ALLOW} = .9 \, S_Y = .9(36,000) - 32,400 \, PSI$

4. – DESIGN

4.1 MODEL:

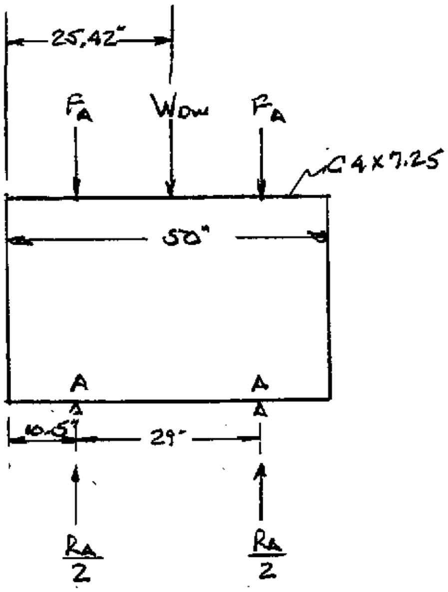


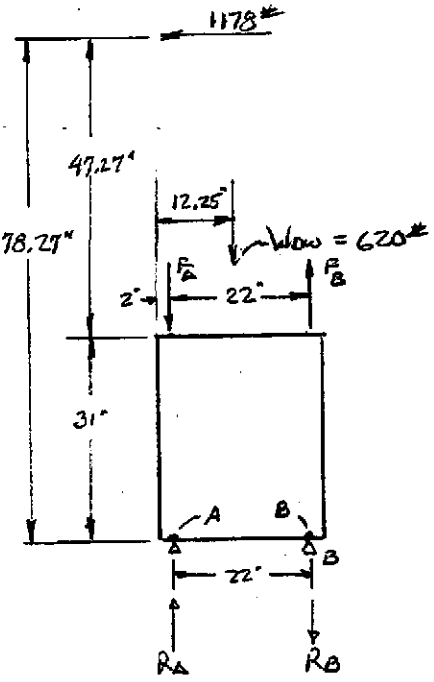
EXCURSION CONDITION



OPERATING CONDITION

4.2 OPERATIONAL STRESSES





• REACTION LOADS R_A, R_B

$$\circlearrowleft\!+ \sum M_A = 0 = -78.27(1178) + 10.25(620) + 22\,R_B = 0$$

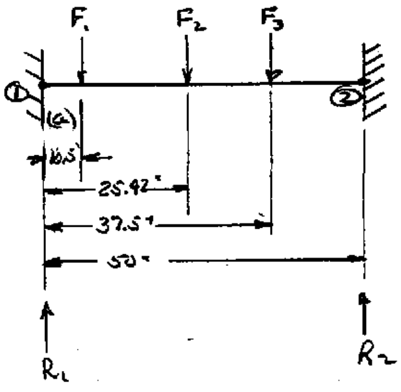
$$R_B = \frac{78.27(1178) - 10.25(620)}{22} = 3902\#$$

$$\circlearrowleft\!+ \sum M_B = 0 = -78.27(1178) - 11.75(620) + 22\,R_A = 0$$

$$R_A = \frac{78.27(1178) + 11.75(620)}{22} = 4522\#$$

$$\therefore\ F_A = \frac{R_A}{2} = \frac{4522}{2} = 2261\#$$

4.2.1 • STRESS ON C4×7.25 BEAM 50" LONG - A SIDE



REF. BLODGETT, CASE 4Ab, P. 8.1-11

$$R_1 = \frac{Fb^2(3a+b)}{L^3}\ ;\ R_2 = \frac{Fa^2(a+3b)}{L^3}$$

$$M_1 = \frac{Pab^2}{L^2}\ ;\ M_2 = \frac{Pa^2b}{L^2}\ ;\ M_a = \frac{2Pa^2b^2}{L^3}$$

C4 × 7.25

$S_x = 2.29\ IN^3$, $r_x = .450"$, $r_y = 1.47"$

$A = 2.13\ IN^2$

4.2.1 CONT

- $\underline{\text{LOAD } F_1 = F_A = 2261^{\#}}$

$$R_1 = \frac{2261(50-10.5)^2(3\times10.5+39.5)}{50^3} = 2{,}004^{\#}$$

$R_2 = 2261 - 2004 = 257^{\#}$

$M_1 = 2261(10.5)(39.5)^2/(50)^2 = 14{,}816 \text{ IN-}\#$

$M_2 = 2261(10.5)^2(39.5)/(50)^2 = 3{,}939 \text{ IN-}\#$

$M_{a_1} = 2(2261)(10.5)^2(39.5)^2/(50)^3 = 6223 \text{ IN-}\#$

$\sigma_{a_1} = 6223/2.29 = 2{,}717 \ \#/\text{IN}^2$

- $\underline{\text{LOAD } F_2 = W_{OW} = 620^{\#}}$

$R_1 = 620(24.58)^2(3\times25.42+24.58)/(50)^3 = 302^{\#}$

$R_2 = 620 - 302 = 318^{\#}$

$M_1 = 620(25.42)(24.58)^2/(50)^2 = 3{,}809 \text{ IN-}\#$

$M_2 = 620(25.42)^2(24.58)/(50)^2 = 3{,}939 \text{ IN-}\#$

$M_{a_2} = 2(620)(25.42)^2(24.58)^2/(50)^3 = 3{,}873 \text{ IN-}\#$

$\sigma_{a_2} = 3{,}873/2.29 = 1{,}691 \ \#/\text{IN}^2$

- $\underline{\text{LOAD } F_3 = F_A = 2261^{\#}}$

$R_1 = 2261(12.5)^2(3\times37.5+12.5)/(50)^3 = 353^{\#}$

$R_2 = 2261 - 353 = 1908^{\#}$

$M_1 = 2261(37.5)(12.5)^2/(50)^2 = 5{,}299 \text{ IN-}\#$

$M_2 = 2261(37.5)^2(12.5)/(50)^2 = 15{,}898 \text{ IN-}\#$

$M_{a_3} = 2(2261)(37.5)^2(12.5)^2/(50)^3 = 7{,}949 \text{ IN-}\#$

$\sigma_{a_3} = 7949/2.29 = 3{,}471 \text{ PSI}$

4.2.1 CONT.

SUMMATION OF MOMENTS BY SUPERPOSITION

- AT ①

$\Sigma M_1 = 14,816 + 3809 + 5299 = 23,924$ IN-#

$\sigma_1 = 23,929/2.29 = 10,447$ PSI $< .6S_Y$ ∴ OK

- AT ②

$\Sigma M_2 = 3939 + 3939 + 15898 = 23,776$ IN-#

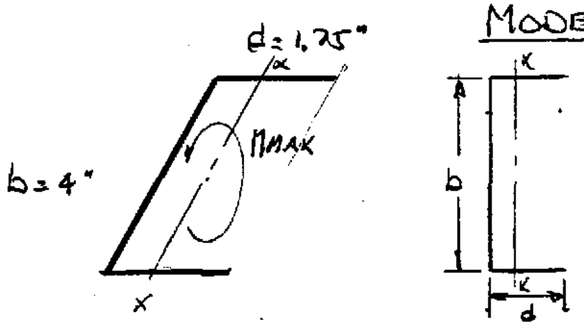
$\sigma_2 = 23,776/2.29 = 10,383$ PSI $< .6S_Y$ ∴ OK

- AT ⓐ

$\Sigma M_a = 6223 + 3873 + 7949 = 18,045$ IN-#

$\sigma_a = 18,045/2.29 = 7,880$ PSI $< .6S_Y$ ∴ OK

• CHECK WELD FOR WORSE CASE END CONDITION



MODEL: REF: BLODGETT, TABLE 5, P. 7.4-7

$$S_W = \frac{2bd + d^2}{3}$$

$$S_W = \frac{2(4)(1.75) + (1.75)^2}{3}$$

$$S_W = 5.69 \text{ IN}^2$$

$$f_{MAX} = \frac{23924}{5.69} = 4205 \text{ \#/IN}$$

- ALLOWABLE WELD ROD STRESS:

• $.3 S_T = .3(70,000) = 21,000$ PSI

• ALLOWABLE WELD LOAD IS: $.707(21000) = 14,847$ PSI

∴ REQUIRED WELD SIZE IS:

$$\omega = \frac{4205}{14847} = .283 < 5/16\ (.3125) \therefore \text{OK}$$

4.2.1 CON'T

4.2.2 • CHECK VERTICAL C4X7.25 LEG - FOR BUCKLING

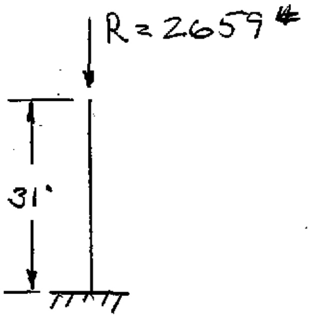
Σ R's

AT ① $R_{TOT} = 2004 + 302 + 353 = 2659^{\#}$

AT ② $R_{2TOT} = 257 + 318 + 1908 = 2483^{\#}$

$R = 2659^{\#}$ - WORSE CASE

MODEL: REF. AISC, E2-1,2, P.5-42



K = .7 (BOTH ENDS FIXED)

$$\frac{KL}{r} = \frac{(.7)(31)}{1.47} = 14.8$$

$$C_c = \sqrt{\frac{2\pi^2 E}{F_y}} = \sqrt{\frac{2\pi^2(29\times10^6)}{(36{,}000)}} = 126$$

$\frac{KL}{r} < C_c$ ∴

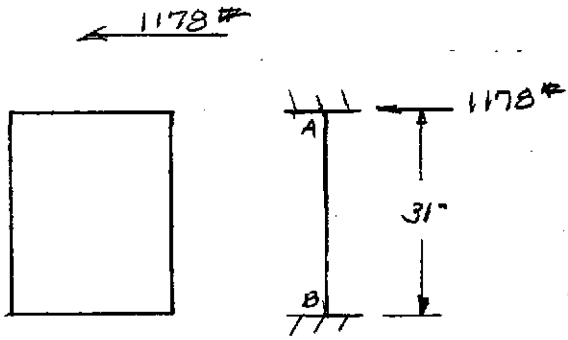
$$F_a = \frac{\left[1 - \frac{(KL/r)^2}{2C_c^2}\right] F_y}{\frac{5}{3} + \frac{3(KL/r)}{8C_c} - \frac{(KL/r)^3}{8C_c^3}}$$

$$F_a = \frac{\left[1 - \frac{14.8^2}{2(126)^3}\right] 36000}{\frac{5}{3} + \frac{3(14.8)}{8(126)} - \frac{(14.8)^3}{8(126)^3}} = 29901^{\#} > 2659^{\#} \therefore OK$$

- COMPRESSIVE STRESS:

$$\sigma = \frac{2659}{2.13} = 1248 \ \#/IN^2 \quad \therefore OK$$

• CHECK FOR LATERAL LOAD



REF: ROARK, 5TH. ED., CASE 5d, P. 106

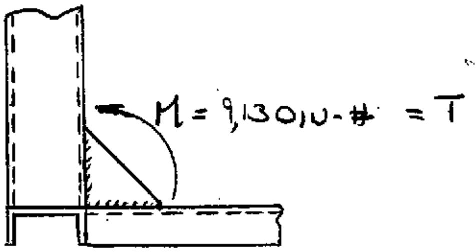
$M_A = M_B$

$\therefore M_{A,B} = 1178(31) = \frac{36518 \text{ IN-\#}}{4}$

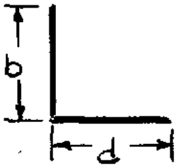
$M_{A \text{ OR } B} = 9{,}130$ IN-# PER VERTICAL SUPPORT

$\therefore \sigma_{MAX} = \frac{9{,}130}{2.29} = 3{,}987 \text{ PSI} < .6 S_Y \therefore OK$

DESIGN GUSSET FOR CORNER WELD CONNECTION



MODEL:



REF: BLODGETT, TABLE 5, P. 7.4-7

$b = 4"$

$d = 4"$

$$J = \frac{(b+d)^4 - 6b^2d^2}{12(b+d)}$$

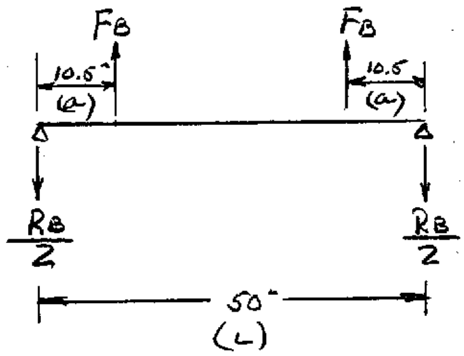
$$J = \frac{(4+4)^4 - 6(4)^2(4)^2}{12(4+4)} = 26.7 \text{ IN}^3$$

$$f = \frac{Tc}{J_w} = \frac{9130(4)}{(26.7)} = 1368 \text{ \#/IN}$$

REQUIRED WELD SIZE:

$$\omega = \frac{1368}{14847} = .0921" < \quad " \therefore OK$$

4.2.3 - STRESS ON C4X7.25 BEAM 50" LONG - B SIDE



REF: BLODGETT, CASE 3AC, P. 8.1-6

$R_1, R_2 = F$

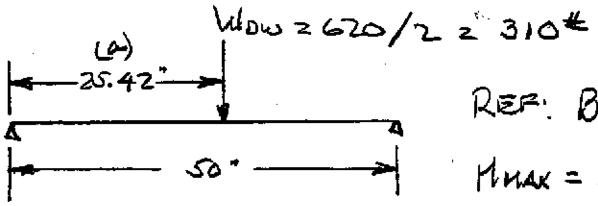
$M_{MAX} = F_B\, a$

$a = 10.5"$

$M_{MAX_1} = 10.5\, F_B = 10.5(1951) = 20{,}486$ IN-#

WHERE: $F_B = \frac{R_B}{2} = \frac{3902}{2} = 1{,}951$ #

$\sigma_{MAX_1} = 20486 / 2.29 = 8{,}946$ PSI



REF: BLODGETT, CASE 4Ab

$M_{MAX} = M_2 = \frac{F a^2 b}{L^2}$

$M_{MAX_2} = \frac{(310)(25.42)^2(24.58)}{50^2} = 1969$ IN-#

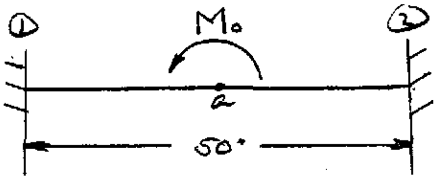
$\sigma_{MAX_2} = 1969 / 2.29 = 859$ PSI

ACTUAL MAX STRESS ON B SIDE

$\sigma_{MAX\ ACTUAL} = 8946 - 859 = 8{,}087$ PSI $< .6 S_y$ ∴ OK

MAX MOMENT GENERATED ON WELD END
CONNECTION IS LESS THAN THE ONE EVALUATED
FOR "A" SIDE ∴ "B" SIDE WELD IS OK

4.3 EXCURSION STRESSES



$M_o = FL = 6200^{\#} \times 29" = 150,800 \text{ IN-}\#$

REF: BLODGETT, CASE 4E, P. 8.1-14

$$M_1 = \frac{M_o b}{L^2}(L-3a) \quad ; \quad M_2 = -\frac{M_o a}{L^2}(2L-3a)$$

$$① - M_1 = \frac{(150,800)(25)(50-3\times25)}{(50)^2} = 37,700 \text{ IN-}\#$$

$$② - M_2 = -\frac{(150,800)(25)(2\times50-3\times25)}{(50)^2} = -37,700 \text{ IN-}\#$$

$$\sigma_{MAX} = \frac{37,700}{2.29} = 16,463 \text{ PSI} < .9S_y \therefore \text{OK}$$

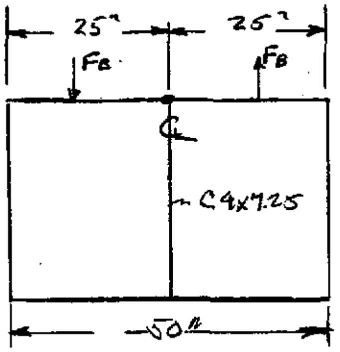
AT CENTER

$M_{MAX} = M_o = 150,800 \text{ IN-}\#$

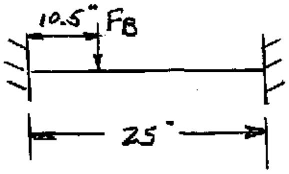
$$\sigma_{MAX} = \frac{150,800}{2.29} = 65,851 \text{ PSI} > .9S_y = 33,400 \text{ PSI} \therefore \text{N.G.}$$

SOLUTION:

PROVIDE VERTICAL C4 x 7.25 SUPPORT AT ℄ TO REDUCE MAX MOMENT



NEW MODEL



REF: BLODGETT, CASE 4Ab, P. 8.1-11

4.3 CON'T

$$M_{MAX} = \frac{F a b^2}{L^2} = \frac{5200(10.5)(14.5)^2}{(25)^2} = 18,367 \text{ IN-\#}$$

$$\sigma_{MAX} = \frac{18,367}{2.29} = 8,021 \text{ PSI} < .9S_Y \therefore \text{OK}$$

4.4 - CONNECTION DESIGNS

4.4.1 - ANCHOR BOLT SIZING

- LOADS:

MAX TENSILE OPERATING LOAD: $F_B = 1951\#$
EXCURSION: 5200#/BOLT

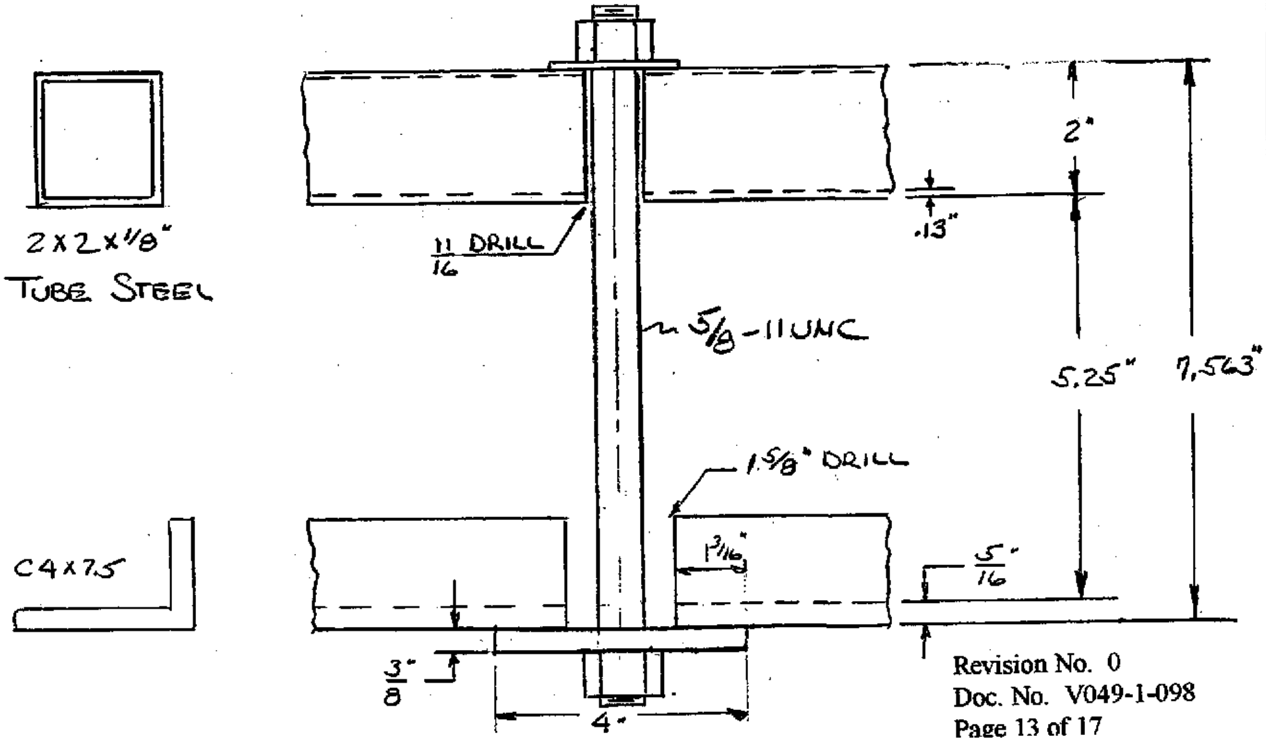
TOTAL TENSILE LOAD = 5200 + 1951 = 7,151#

$$\text{LATERAL SHEAR LOAD} = \frac{1178}{4} = 295\#/\text{BOLT}$$

SPECIFY HILTI - HFA 3/4 - 6 5/8" EMBEDMENT DEPTH

HVA ALLOWABLE BOND STRENGTH AND STEEL STRENGTH FOR HFA INSERTS - REF: HILTI PRODUCT TECH GUIDE, P. 87
- BOND STRENGTH (4000PSI) = 7,260# > 7,150# ∴ OK
- SHEAR STRENGTH = 7315# > 295# ∴ OK

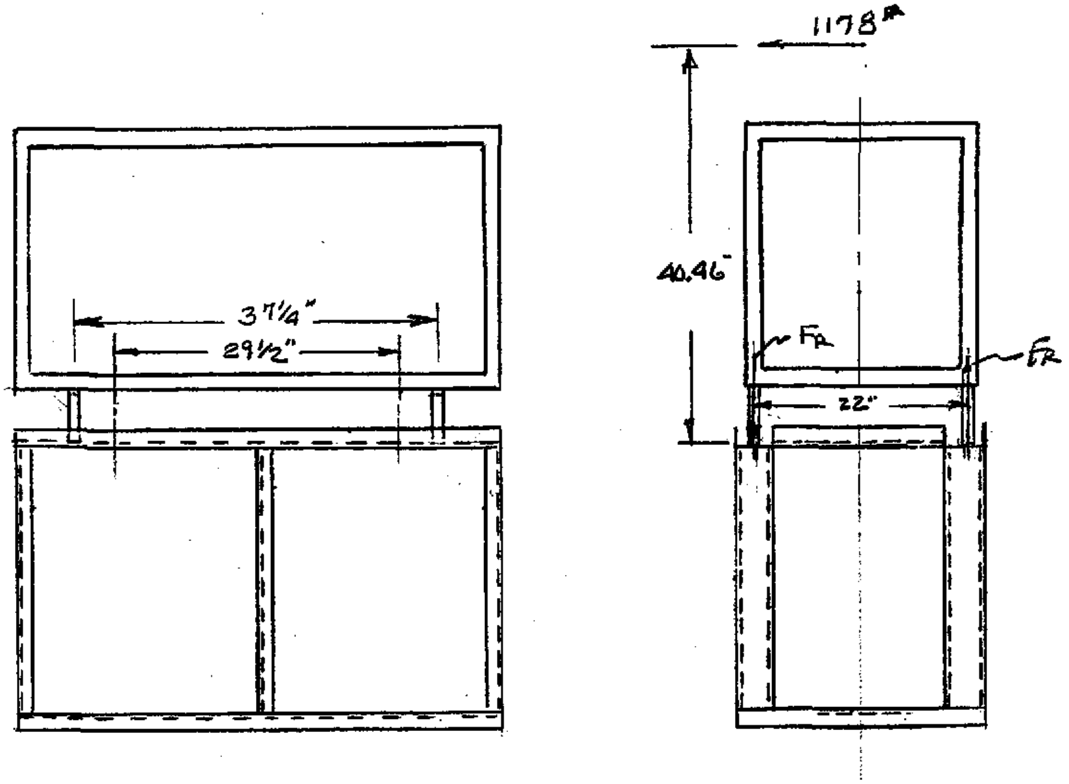
4.4.2 - PUMP FRAME TO EXTENSION FRAME CONNECTION



4.4.2 CONT

4.4.2.1 • LOADS

- OPERATIONAL



$$FR = \frac{40.46(1178)}{22} = 2166^{\#}$$

LOAD PER BOLT = 2166 / 2 = 1,083# - TENSILE

SHEAR / SLIP LOAD = 1178/4 = 295#

- EXCURSION

LOAD PER BOLT = 5200#

TOTAL LOAD - WORSE CASE = 5200 + 1083 = 6283# - TENSILE

4.4.2 - CONT

4.4.2.2 • <u>BOLTING</u>: - SPECIFY A36

<u>ALLOWABLE LOADS</u>:

- <u>OPERATIONAL</u>: REF: AISC, TABLE 1-A, P. 4-3.

5/8-11UNC TENSION - 5900# > 1083# ∴ OK
SHEAR - 3000# > 295# ∴ OK

- <u>EXCURSION</u>:

$S_y = 36,000 \text{ PSI}$

$.9S_y = .9(36000) = 32,400 \text{ PSI}$

$$\sigma = \frac{F}{A} = \frac{6283}{.202} = 31,104 \text{ PSI} < 32,400 \text{ PSI} \therefore \text{OK}$$

WHERE: $A = .202 \text{ IN}^2$ - ROOT AREA

4.4.2.3 • <u>BOLT PRELOAD</u>

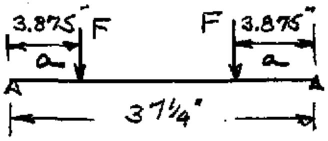
- BOLT PRELOAD SHALL BE BASED ON OPERATIONAL BOLT LOAD PLUS 10%

DESIGN PRELOAD = 1.1 (1083) = 1191# → 1200#

- CHECK EDWARDS FRAME FOR STRUCTURAL ADEQUACY:

$$2 \times 2 \times 1/8" \quad S = \frac{bh^2}{6} = \frac{2(2)^2 - 1.75(1.75)^2}{6} = .515 \text{ IN}^3$$

<u>MODEL</u>: REF: BLODGETT, CASE 3Ac, P. 8.1-6

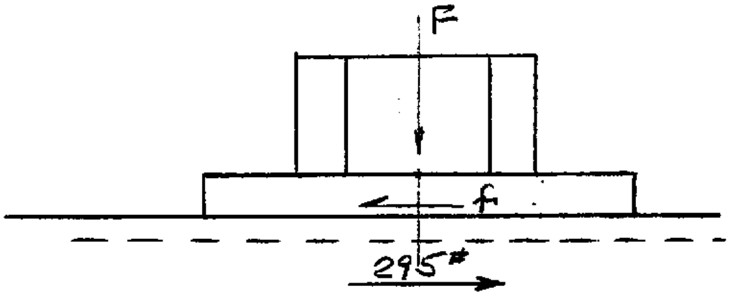


$M_{MAX} = Fa = 1200(3.875) = 4650 \text{ IN-\#}$

$$\sigma_{MAX} = \frac{4650}{.515} = 9,029 \text{ PSI} < .6S_y \therefore \text{OK}$$

4.4.2 CONT

- CHECK FOR SLIP



WASHER - AMERICAN
STANDARD TYPE B
5/8 - W (WIDE)

.666" ID
2.25" OD
.160" THK

$F = 1200\#$
$\mu = .2$ (ASSUME)

$f = \mu F = .2(1200) = 240\# < 295\#$ ACTUAL SHEAR
∴ N.G.

∴ CRITERIA FOR PRELOAD
SHALL BE BASED ON OPERATIONAL
SHEAR LOAD PLUS 10%

NEW DESIGN PRELOAD

$(295)(1.1) = 324.5 \rightarrow 325$

$F = \frac{f}{\mu} = \frac{325}{.2} = 1625\#$ PRELOAD

- CHECK EDWARDS 2x2x1/8" FRAME

$\sigma = \frac{(1625)(3.875)}{.515} = 13{,}227$ PSI $< .6S_y$ ∴ OK

4.4.2.4 • BOLT TORQUE REF: MACHINE DESIGN, "THEORY + PRACTICE," 1975
P. 816

$T = \mu D F$

$T = .2(.625)(1625) = 203$ in-# /12 = 17 FT-#

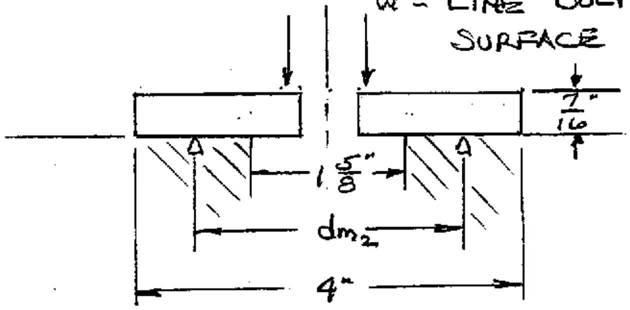
SPECIFY 20FT-# FOR BOLT TORQUE

- CHECK FRAME

$F = \frac{20 \times 12}{.2(.625)} = 1920\#$ $\sigma = \frac{1920(3.875)}{.515} = 14{,}447$ PSI
$< .6S_y = 21{,}600$ PSI ∴ OK

4.4.2.5 SPECIAL WASHER DESIGN

W = LINE BOLT LOAD AT d_{m_1} OF NUT BEARING SURFACE

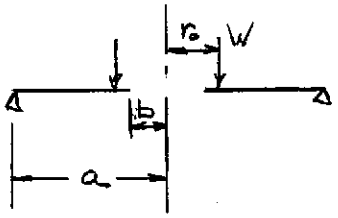


REACTION LOAD IS ASSUMED TO OCCUR AT THE MEAN DIAMETER OF CONTACT SURFACE:

$$\therefore\ d_{m_1} = \frac{1.06 - .6875}{2} = .8738"$$

$$d_{m_2} = \frac{4 + 1.625}{2} = 2.8125"$$

MODEL: REF: ROARK, CASE 1a, P. 334



$$r_o = \frac{d_{m_1}}{2} = \frac{.8738}{2} = .4369"$$

$$a = \frac{d_{m_2}}{2} = \frac{2.8125}{2} = 1.406"$$

$$b = \frac{.6875}{2} = .3438"$$

$$M_{MAX} = M_{tb} = K_{Mtb}\, w a$$

$$b/a = .3438/1.406 = .2445\ ;\ K_{Mtb} = .5423$$

$$w = \frac{W}{\pi d_{m_1}} = \frac{1920}{\pi(.8738)} = 699\ \#/\text{IN}$$

$$\therefore\ M_{MAX} = .5423(699)(1.406) = 533$$

$$\sigma = \frac{6M}{t^2} = \frac{6(533)}{(.4375)^2} = 16{,}708\ \text{PSI} < .6 S_y\ \therefore \text{OK}$$

PROCESS SYSTEMS INTERNATIONAL, INC.
WESTBOROUGH, MA

ENGINEERING CALCULATIONS

NO: V049-1-063

PAGE 1 OF 6

REV.	DEO #	DATE	BY:	CHECK
0	0136	3/4/96	WDB	RDC

TITLE:

Flange Bolting

Analysis of flange bolting for Gate Valves
112 CM & 122 CM

BY: W.Bilynsky

DEPT.: 744

PROJECT: LIGO Vacuum Equipment

PROJECT NO: V59049

PURPOSE: Evaluate the gate valves threaded fastening details. Bolts and their mating threaded (tapped) flange section are potential areas of failure due to thread stripping between differing materials.

METHOD:

Hand calculations utilizing standard formulas for Stress Areas and Length of Engagement of Screw Threads as specified in MACHINERY's HANDBOOK

ASSUMPTIONS:

INPUTS:

1. PSI Calc No. V049-1-042
2. GNB Drawings 103098

REFERENCES:

1. Machinery's Handbook. Oberg & Jones 19th Ed. 1973.
2. Standard Handbook for Mechanical Engineers. Baumeister & Marks 7th Ed.
3. Specification for 112 and 122 CM Gate Valves
   PSI - V049-2-005 rev. 3
4. Doc. No. V049-1-066 LIGO Vacuum Equipment Structural Design Criteria

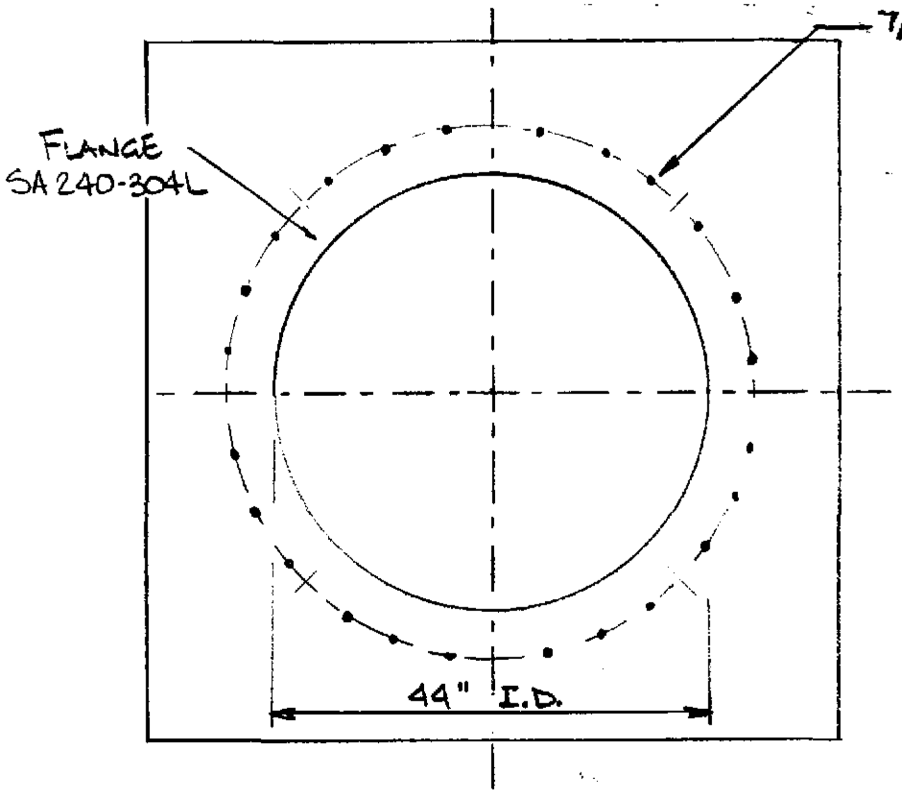
CALCULATIONS:

(See Attached)

CONCLUSIONS: The requirements for proper and adequate bolting as specified in the Machinery's Handbook are satisfactorily met.

NOTES:

BOLTS - 24 REQ'D



7/8" = nom size
9 = no. of threads per inch
UNC = thread series
2B = thread class

UNC = Coarse thread Series

2B = Permits external threads to be plated.

7/8" BOLT - Ref. Standard Handbook for Mechanical Engineers 7th ed. Section 8-12

REF. TABLE 1 pg. 8-14

Major Diam, Dmax = 0.8750 in. (SCREW BASIC DIAMETERS)
Pitch Diam, Emax = 0.8028 in.
Esmin = 0.7946 in.
Basic minor diam, K = 0.7387 in. (EXTERNAL THREADS)
Minor Diam, Kn max = 0.778 in (internal threads)
Minor Diam, Kn min = 0.7547 in. (INTERNAL THREADS)
Minor Diam tolerances Class 2B = 0.0134 in. (INTERNAL THREADS)

Areas of Section
Basic Min. Minor Diam = 0.4193 in^2
Stress Area = 0.4612 in^2

FORCE ON BOLTS

Ref. PSI CALC No. V049-1-042 $Force_{TONS}$ = 25.37 K on 44"ϕ flange

Ref. SPECIFICATION FOR 112 AND 122 CM
GATE VALVES
PSI - V049-2-005 REV. 3
SECTION 4.1.14 = 21.0 K

TOTAL TENSILE FORCE = 46.37 KIPS

TENSILE FORCE PER BOLT $= F_{TENS.} = \dfrac{46370 \text{ lbs}}{24 \text{ BOLTS}}$

$F_{TENS.} = 1932.1 \text{ lbs/BOLT}$

The critical areas of stress of mating screw threads are:

1) The effective cross-sectional area, or tensile stress area, of the external thread.

2) The shear area of the external thread, which depends principally on the minor diameter of the tapped hole.

3) The shear area of the internal thread, which depends principally on the major diameter of the external thread.

To prevent stripping of the external thread, the minimum length of engagement required is:

$$Le_{MIN.} = \frac{2 \times A_t}{\pi \; K_n max \left[1/2 + 0.57735\, n \left(E_s min - K_n max \right) \right]}$$

where: n = no. of threads per inch = 9

$K_n max$ = max. minor diameter of internal threads
= .778 in

$E_s min$ = min. pitch diameter of external thread
= .7946 in

A_t = tensile stress area = .4612 in^2
$= .7854 \left(D - \frac{0.9743}{n} \right)^2$

$$Le_{min} = \frac{(2)(.4612)}{\pi \; (.778 in) \left[1/2 + .57735 (9) [.7946 - .778] \right]}$$

$= .643$ in.

REF. MACHINERY'S HANDBOOK
Pg. 1141

STRIPPING OF INTERNAL THREAD.

IF THE INTERNAL THREAD (I.E. TAPPED FLANGE) IS MADE OF MATERIAL OF LOWER STRENGTH THAN THE EXTERNAL THREAD (I.E. BOLT), STRIPPING OF THE INTERNAL THREAD MAY TAKE PLACE BEFORE THE SCREW/BOLT BREAKS (DESIRED FAILURE MODE).

RELATIVE STRENGTH OF THE EXTERNAL AND INTERNAL THREADS IS;

$$J = \frac{A_s \times \text{Tensile strength of external thread mat'l}}{A_n \times \text{Tensile strength of internal thread mat'l}}$$

IF $J \leq 1.0$ the length of engagement Le_{min} is adequate

IF $J > 1.0$ the length of engagement to prevent stripping of the internal threads is multiplied by J

OR $Q = J\, Le_{min}$

$$A_s = \pi\, n\, L_e\, K_{n\,max}\left[\frac{1}{2n} + 0.57735\left(E_{s\,min} - K_{n\,max}\right)\right]$$

ref. table 4 Machinery Handbook

n = number of threads = 9
L_e = .643in
$K_{n\,max}$ = .778in = max minor dia. internal thrds.
$E_{s\,min}$ = .7946in = min pitch dia. external thrd.

$$A_s = \pi(9)(.643\text{in})(.778\text{in})\left[\tfrac{1}{2}(9) + 0.57735(.7946\text{in} - .778\text{in})\right]$$
$$= .9214\,\text{in}^2$$

$$A_n = \pi\, n\, L_e\, D_{s\,min}\left[\tfrac{1}{2}n + 0.57735\left(D_{s\,min} - E_{n\,max}\right)\right]$$

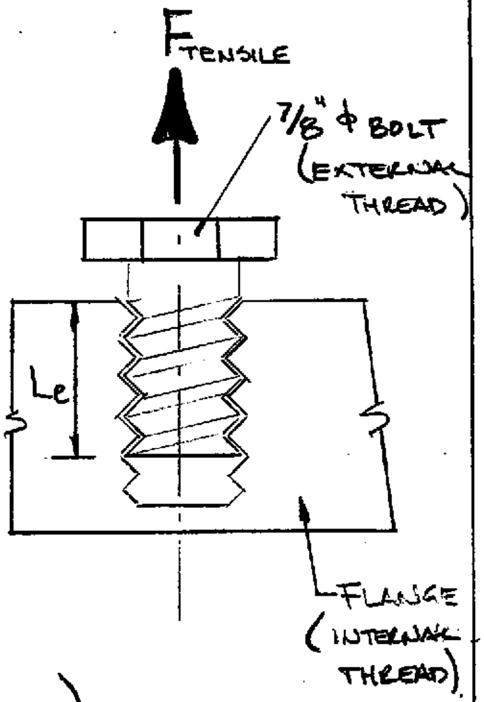
$D_{s\,min}$ = .8592in = min major dia of external thrd.
$E_{n\,max}$ = .8110in = max pitch dia. of internal thrd.

$$A_n = \pi(9)(.643\text{in})(.8592\text{in})\left[\tfrac{1}{2}(9) + 0.57735(.8592\text{in} - .8110\text{in})\right]$$
$$= 1.303\,\text{in}^2$$

- tensile strength of valve flange

material = SA240 - 304 L

$S = 14.7$ ksi



- tensile strength of Bolts

material = SA-193-B7

$S = 25.0$ ksi

$$J = \frac{A_s \times \text{Tensile strength (BOLT)}}{A_n \times \text{Tensile strength (Flange)}}$$

$$= \frac{.9214 \text{ in}^2 \times 25.0}{1.303 \text{ in}^2 \times 14.7}$$

$J = 1.202$ in $\quad \therefore$ Le = .643 in inadequate

required engagement length

$$Q = J\,Le$$

$$= (1.202 \text{ in})(.643 \text{ in})$$

$$= .773 \text{ in}$$

$.773 \text{ in} < 1.42 \text{ in}$ (actual depth)

∴ Engagement length adequate

Stripping of internal thread is unlikely. Bolts + Flange are adequately sized.

Average Thread Stress (SCREW)

$$\sigma_{AVER} = \frac{2\ F_{TENSILE}}{\pi\ K\ Le}$$

$$= \frac{2\ (1932.1\ \text{lbs})}{\pi\ (0.7387\ \text{in})(0.643\ \text{in})}$$

$$\sigma_{AVER} = 2589.6\ \#/\text{in}^2/\text{BOLT}$$

Allow Stress = .6 Sm ref. ASME SECTION $\underline{\text{VIII}}$ DIV. II
AD - 132.2

$$\sigma_{ALL} = .6\ (14700\text{psi}) \qquad (\text{FOR: SA 240-304 L})$$

$$\sigma_{ALLOW} = 8820\ \#/\text{in}^2$$

$$\sigma_{ALL} > \sigma_{AVER} \qquad F.S. = 3.4$$

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NO: V049-1-068
PAGE 1 OF 5

REV.	DEO #	DATE	BY:	CHECK
0	0141	4/19/96	RDC	WDB

TITLE:

Study of Required Bellows Deflections for Installation Fitup

BY: R. D. Ciatto

DEPT.: 744

PROJECT: LIGO Vacuum Equipment

PROJECT NO: V59049

PURPOSE: Determine the maximum deformations required of the bellows to facilitate installation of equipment considering component construction tolerances.

METHOD: Hand calculation methods are used to determine the geometric configurations that bellows must assume to connect adjacent components.

ASSUMPTIONS: See calculations attached.

INPUTS: LIGO project drawings and sketches.

REFERENCES: Specification V049-2-017, Bellows Expansion Joints for LIGO Vacuum Equipment

CALCULATIONS: (SEE ATTACHED)

CONCLUSIONS: The required bellows axial and bending deflections have been determined.
Axial deflection.....................+/- 2 in.
Bending rotation....................+/- .5°.

NOTES: The above deformations will be included in Specification V049-2-017. Shear deformation of bellows is not required.

MAXIMUM DEFLECTIONS REQUIRED AT ENDS OF BELLOWS

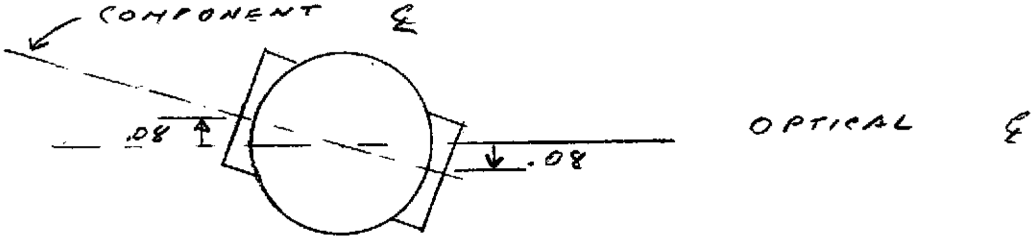
GIVEN:

1. EQUIPMENT TOLERANCES ARE AS SHOWN ON DWGS

2. EQUIPMENT ℄ WILL BE INSTALLED TO WITHIN ± 2mm (±.08 IN) OF THE OPTICAL ℄

ASSUME:

1. EACH MAJOR COMPONENT (BSC, HAM FOR PUMA, ETC) MAY BE INSTALLED AT AN ANGLE TO THE OPTICAL ℄ THAT IS LIMITED BY NO. 2 ABOVE

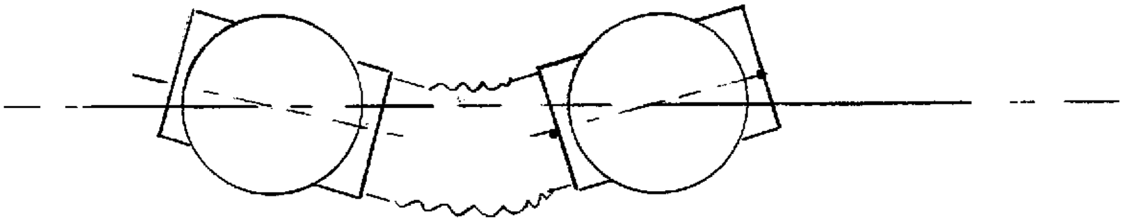


2. THE MISALIGNMENT SHOWN ABOVE CAN OCCUR IN THE HORIZONTAL PLANE AND THE VERTICAL PLANE SIMULTANEOUSLY

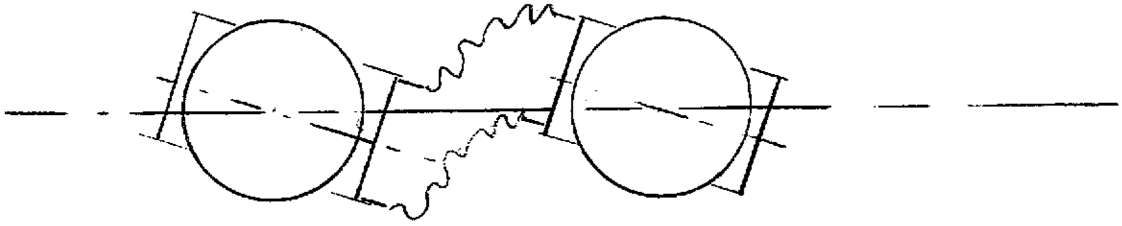
3. ASSUME THAT FLANGE PARALLELISM AND PERPENDICULARITY REQUIREMENTS FOR BSC (DWG V049-4-001) HOLD FOR ALL COMPONENTS.

4. MISALIGNMENT OF 2 ADJACENT COMPONENTS CAN OCCUR SUCH THAT AN ADAPTER WILL BE BENT IN EITHER SINGLE OR DOUBLE CURVATURE.

SINGLE CURVATURE



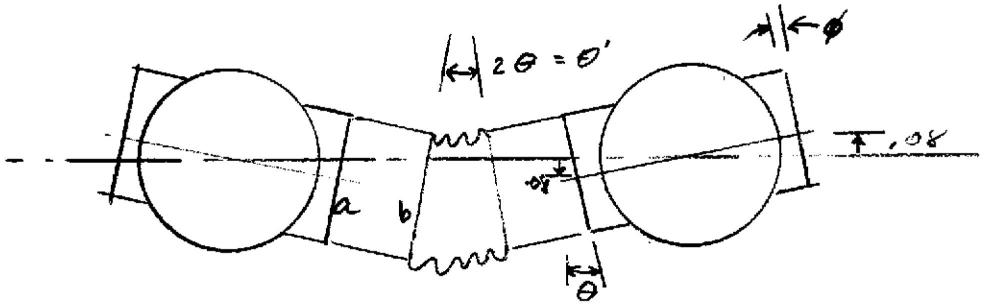
DOUBLE CURVATURE



CLEARLY, DOUBLE CURVATURE IMPOSES GREATER STRAIN ON THE ADAPTER BELLOWS THAN SINGLE CURVATURE.

HOWEVER, IT SHOULD BE POSSIBLE TO CONTROL INSTALLATION ALIGNMENT SO THAT ADAPTERS BETWEEN ADJACENT COMPONENTS ARE BENT IN SINGLE CURVATURE. EACH COMPONENT CAN BE SET IN ITS FINAL POSITION AFTER THE NEXT COMPONENT AND BELLOWS/ADAPTER ARE INSTALLED FOR ROUGH ALIGNMENT, I.E. CONCRETE ANCHORS ARE NOT INSTALLED.

THE MAXIMUM ROTATION AT THE BELLOWS IS A FUNCTION OF THE ANGULAR MISALIGNMENT OF ADJACENT COMPONENTS AT INSTALLATION AND THE MISALIGNMENT OF FLANGES THAT ARE OUT OF PARALLEL AND NOT PERPENDICULAR TO THE OPTICAL ℄. ROTATION FOR SINGLE CURVATURE IS INDEPENDENT OF ADAPTER LENGTH



ASSUME THAT ENDS OF ADAPTER SPOOLS, a & b ARE PARALLEL

θ IS LIKELY TO BE MAXIMUM FOR THE CORNER STATION BSCs. THE DISTANCE FROM THE BSC ℄ TO THE FACE OF THE 60 IN FLANGE IS 113.75/2 = 56.9 IN (DWG V049-4-001).

$$\theta = \frac{.08}{56.9} + \phi$$

$$= 1.407(10)^{-3} \text{ RAD} + \phi$$

Φ IS THE ANGULAR MISALIGNMENT RESULTING FROM TOLERANCES ON PARALLELISM AND PERPENDICULARITY. THIS ANGLE IS MAXIMUM WHEN THE FLANGE FACE IS OUT OF PERPENDICULARITY.

$$\phi = \frac{.03}{r}$$ WHERE .03 IS TOLERANCE ON PERPENDICULARITY SEE DWG 4049-4-001

r = FLANGE MAX RADIUS

$$= \frac{68.25}{2}$$

$$= 34.125$$

$$\phi = \frac{.03}{34.125} =$$

$$= .879\,(10)^{-3}\ \text{RAD}$$

$$\theta = (1.407 + .879)(10)^{-3}$$

$$= 2.286\,(10)^{-3}\ \text{RAD}$$

THE MAX CHANGE IN ROTATION BETWEEN THE ENDS OF A BELLOWS IS $\theta' = 2\theta$

$$\theta' = 2\,(2.286)(10)^{-3}$$

$$= .0046\ \text{RAD}$$

SINCE ROTATION CAN OCCUR IN BOTH THE VERTICAL & HORIZONTAL PLANES

$$\theta_{MAX} = \left[2(\theta')^2\right]^{\frac{1}{2}}$$

$$= .0065$$

$$= 0.37^\circ \quad \text{SAY } 0.50^\circ$$

LONGITUDINAL COMPRESSION OR EXTENSION

ASSUME THAT COMPONENT INSTALLATION CAN BE WITHIN ± .25 IN IN AXIAL DIRECTION OF OPTICAL BEAM. HENCE, FOR 2 ADJACENT COMPONENTS, THE MAX BELLOWS ELONGATION OR COMPRESSION DURING INSTALLATION IS

$$\delta = \pm .50 \text{ IN}$$

IT IS REASONABLE TO ASSUME THAT THE ± 2" OF MOTION REQUIRED BY THE SPEC (# 4.2, VOYS-2-017) IS ENOUGH TO ALLOW FOR δ

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NO: V049-1-079

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REV.	DEO #	DATE	BY:	CHECK
0	0131	4/19/96	RDC	WDB

TITLE:

Analysis of BSC Support Leg to Cross Beam Connection

BY: R. D. Ciatto

DEPT.: 744

PROJECT: LIGO Vacuum Equipment

PROJECT NO: V59049

PURPOSE: Analyze welded tube steel connection at junction of support leg and cross member to confirm structural integrity of the side of the support leg which is required to resist a high bending moment at the end of the cross member.

METHOD: A local finite element model of the connection was created to analyze the support leg stresses. The IMAGES program was used.

ASSUMPTIONS: See calculations attached.

INPUTS: Forces and moments at end of cross member from Doc. No. V049-1-024

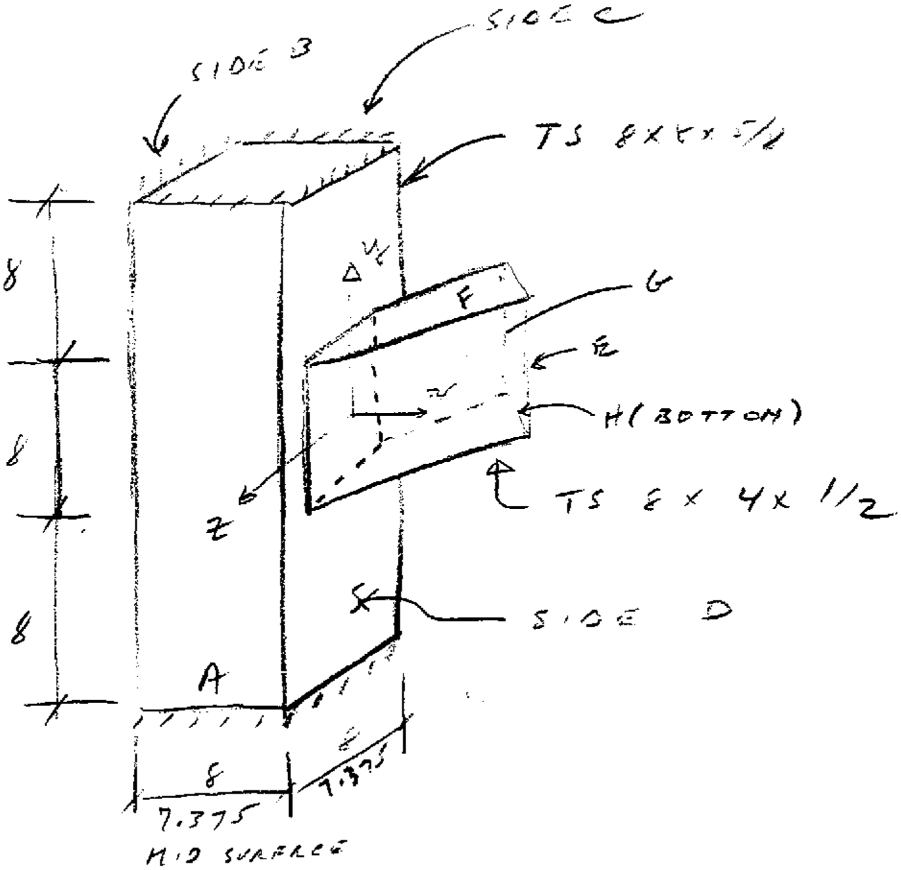
REFERENCES:
1. LIGO project drawings V049-4-001 and V049-4-023
2. Calculation V049-1-024, Design of Support Legs and Base Plates
3. IMAGES-3D, Version 3.0, R. L. Cloud and Associates
4. V049-1-066, LIGO VACUUM EQUIP. STRUCT. DESIGN CRITERIA

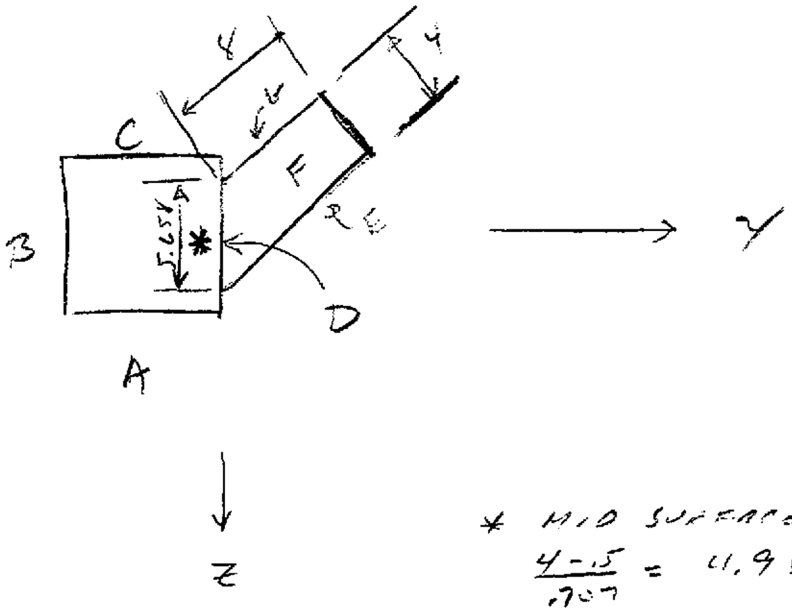
CALCULATIONS: (SEE ATTACHED)

CONCLUSIONS: The cross member was changed from a 7x4 tube steel member to an 8x4 in tube steel member to reduce the bending stress applied to the support leg. Stresses in the 8x8 tube steel leg member are within AISC code limits.

NOTES: Load case 1 includes the 3 forces, load case 2 includes the 3 moments and load case 3 is the combined forces and moments. The IMAGES file is SUPPCONN.*

RE MODEL





* MID SURFACE LENGTH

$$\frac{4-.5}{.707} = 4.950$$

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DOC NO V049-1-079
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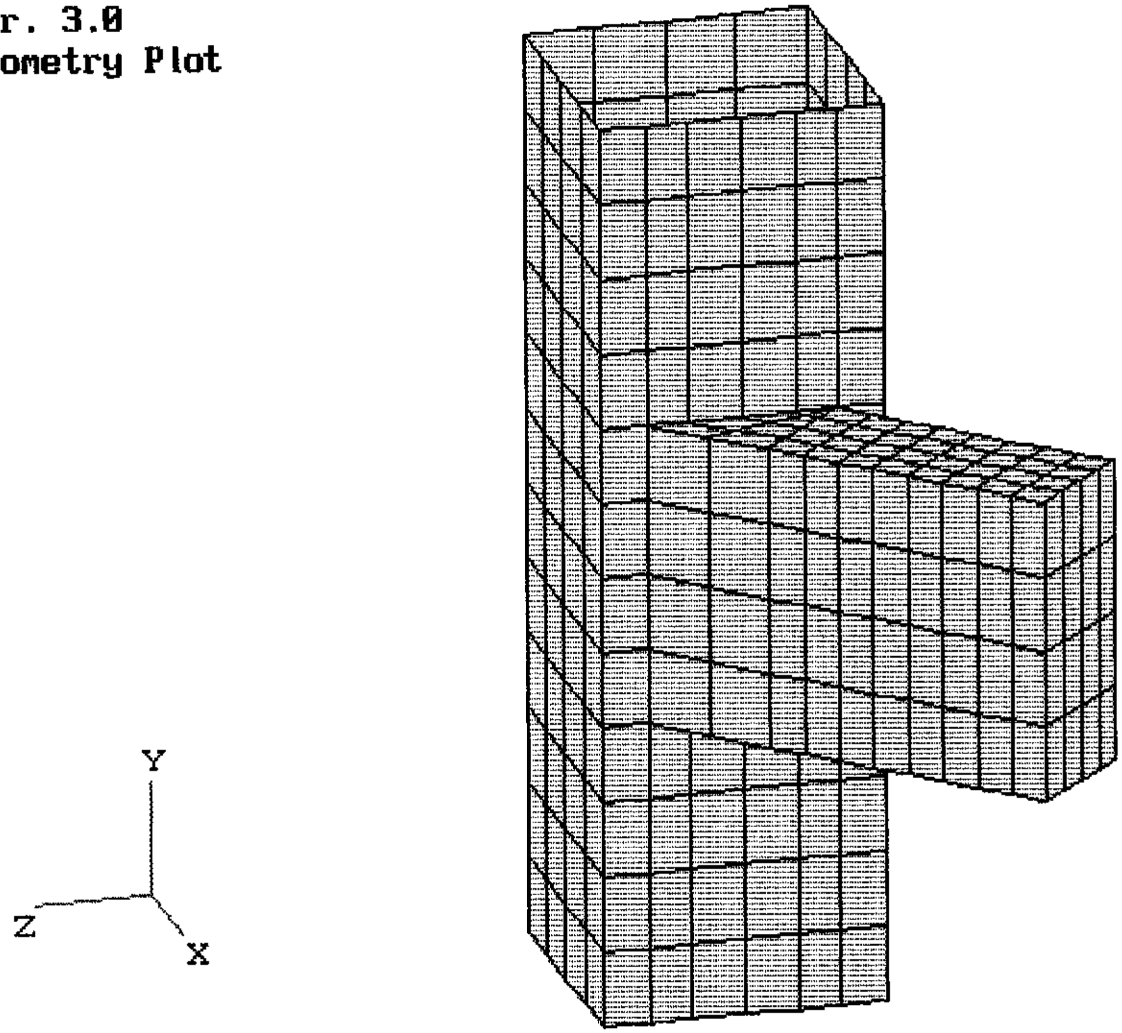
IMAGES-3D
Ver. 3.0
Geometry Plot



BSC Support Connection
Hidden Line Removal

4/ 1/96
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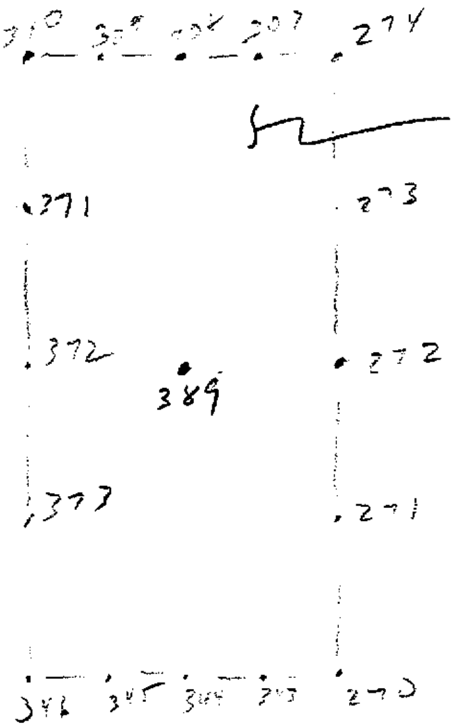
DOC. NO. V048-1-077
P. 3 OF 7

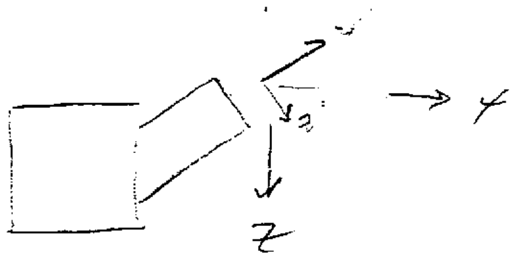
END VIEW OF CROSS MEMBER [illegible]



STIFF PLATE ELEMENTS AT END OF MODEL TRANSFER FORCES & MOMENTS FROM NODE 389 TO PERIMETER NODES. SEE PLOT ON P. 3

FORCES AT NODE 389

FROM CALC VOV9-1-024, THE MAX CROSS MEMBER STRESSES ARE IN ELEMENT B-9. THE GLOBAL LOADS FROM THE FRAME MODEL ARE AT 45° TO THE GLOBAL AXIS OF THE FE PLATE MODEL. NODE 5 HAS THE LARGER LOADS. LET THE FRAME MODEL GLOBAL AXES BE THE PRIME AXES, x', y', z'.



$F_{x'}$ = 1235 LB
$F_{y'}$ = 9287
$F_{z'}$ = [illegible] SAY 0
$M_{x'}$ = 4593 IN LB
$M_{y'}$ = 712
$M_{z'}$ = 404300

REV 0
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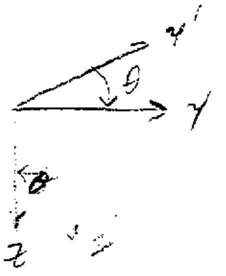

$F_y = F_{y'} \cos\theta + F_{z'} \sin\theta$

$F_z = -F_{y'} \sin\theta + F_{z'} \cos\theta$

$F_x = F_{x'}$

$F_y = 8235(.707) + 0$

$= 5822$

$F_x = 9287$

$F_z = -8235(.707) + 0$

$= -5822$

$M_y = 4993(.707) + 404300(.707)$
$= 289370$

$M_x = M_{x'} = 713$

$M_z = -4993(.707) + 404300(.707)$
$= 282310$

THESE FORCES ARE APPLIED TO NODE 389 WHICH IS AT THE CENTER OF A STIFF ($E = 90 \times 10^6$ psi), THICK (3 IN) PLATE AT THE END OF THE 8 X 4 STUB IN THE MODEL.

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STRESS IN SIDE D OF 8x8x5/8 TS COLUMN

THE LOCAL STRESS INTENSITY IS SHOWN IN THE STRESS CONTOUR PLOT ON THE FOLLOWING SHEET. THE MAX SI IS LOCATED AT THE CORNER OF THE JUNCTION WITH THE 4x4x1/2 TS CROSS MEMBER.

$$SI = 34,200 \text{ PSI}$$

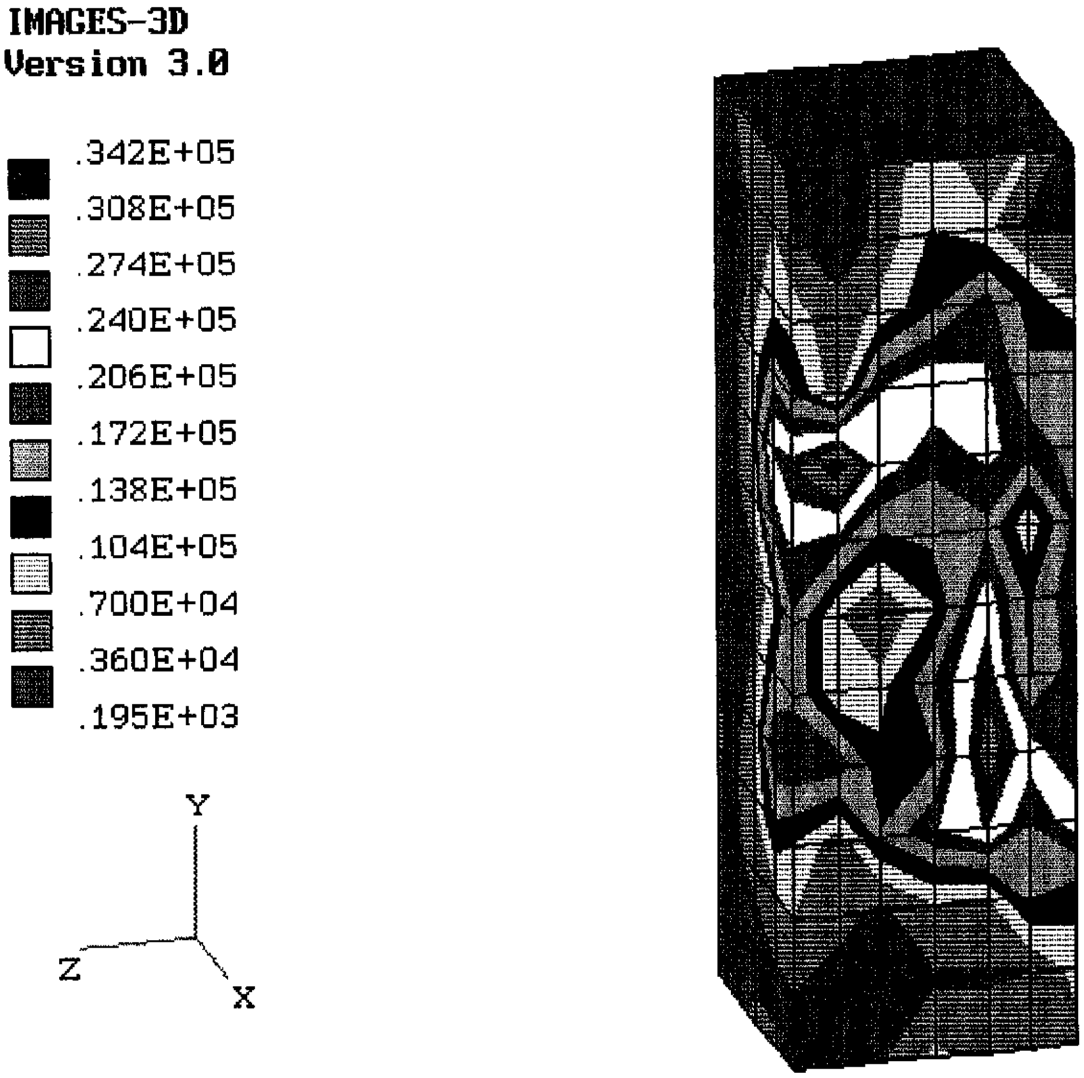
$$< .75 F_y^{*}$$

$$= .75(46)$$

$$= 34.5 \text{ KSI}$$

* $F_y = 46$ KSI FOR A500 GR B

THE SI IS MUCH LESS (10 TO 24 KSI) FOR OTHER LOCATIONS AT THE WELDED CONNECTION WHICH WILL BE A FULL PEN. WELD.



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Load Case 3

Stress Contour Plot

Surf: Top **Stress Intensity**

4/ 1/96
12:48:49

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NO: V049-1-080

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REV.	DEO #	DATE	BY:	CHECK
0	0141	4/25/96	RDC	AGR

TITLE: Analysis of Bolted Flange for Initial Out of Flatness

BY: R. D. Ciatto

DEPT.: 744

PROJECT: LIGO Vacuum Equipment

PROJECT NO: V59049

PURPOSE:. To determine if Viton O-rings in the bolted flanges will seal if flange flatness is at maximum tolerance considering the stiffening effects of the attached shell.

METHOD: A 3D IMAGES finite element model of a segment of the bolted flange was created. The flange out of flatness was analyzed using gap elements, with the gap equial to the flatness tolerance at the flange mating surface. A nonlinear analysis of this model was performed. Loads included the bolt preload, which is 10 kips, and the maximum tensile load in the shell.

ASSUMPTIONS: The maximum gap occurs at the bolt centerline. The amplitude of the gap is the same as the flatness tolerance for the 60 in flange.

INPUTS: Drawing V049-4-019 for the flatness tolerance
Calculation V049-1-016 for the initial 3D finite element model
Calculations V049-1-018 and -042 for Viton properties and shell forces, respectively.

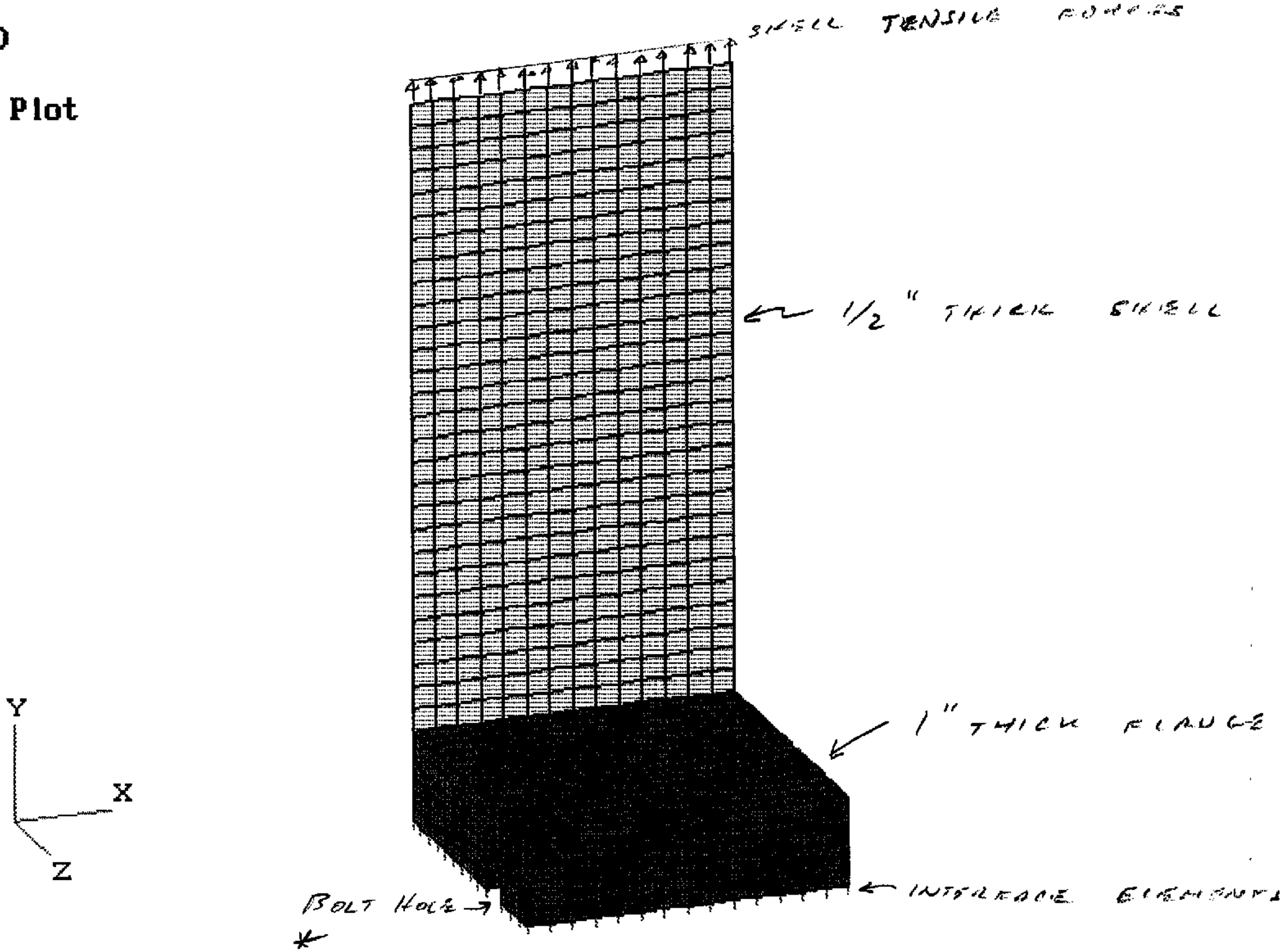
REFERENCES: See Inputs

CALCULATIONS: (SEE ATTACHED)

CONCLUSIONS: Even though the bolt clamping force must resist the shell stiffness, the bolt will bring the flanges together and the seal will be maintained. When the maximum gap occurs between bolts, the clamping force connot close the gap but the seal is maintained even with the maximum tolerance.

NOTES: The computer file is FLANGED.*

IMAGES-3D
Ver. 3.0
Geometry Plot



Bolted Flange - 48.25 in, 24 bolts
Hidden Line Removal

4/3/96
15:6:5

* BOLT FORCE NOT SHOWN

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Doc. No V045-1-020
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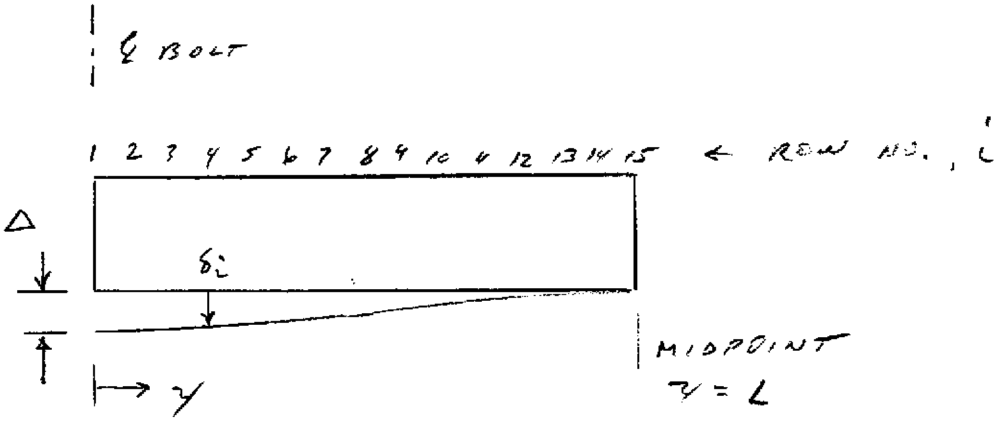
THERE ARE 15 ROWS OF NONLINEAR FOUNDATION ELEMENTS. THE NONLINEAR SPRING CONSTANTS CAN BE VARIED FROM ROW TO ROW TO SIMULATE A GAP THAT CAN RESULT FROM THE FLATNESS TOLERANCE

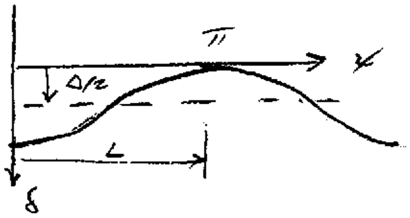
IT IS ASSUMED THAT FLANGE FACES ARE IN CONTACT AT THE MIDPOINT BETWEEN BOLTS AND THAT THE GAP IS MAXIMUM AT THE BOLTS. THEN BOLTUP CAN BE USED TO CLOSE THE GAP.



Δ = .010 IN (FLATNESS TOLERANCE - DWG V049-4-019

ASSUME THAT GAP VARIES AS A SINE FUNCTION

$$\delta = \frac{\Delta}{2} + \frac{\Delta}{2} \cos \frac{y}{L} \pi$$



$$\delta_i = \frac{\Delta}{2} + \frac{\Delta}{2} \cos \frac{(i-1)\frac{L}{14}}{L} \pi$$

$$= \frac{\Delta}{2}\left(1 + \cos \left(\frac{i-1}{14}\right) \pi\right)$$

$$= .005\left(1 + \cos \left(\frac{i-1}{14}\right) \pi\right)$$

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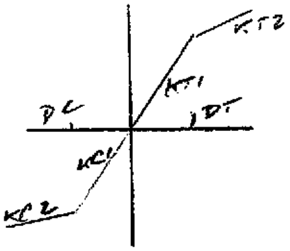
Row i	i-1	Theta (i-1)*Pi/15	A cos Theta	B A+1	delta .005*B
1	0	0	1	2	0.0100
2	1	0.2094393	0.978148	1.978148	0.0099
3	2	0.4188787	0.913546	1.913546	0.0096
4	3	0.628318	0.809017	1.809017	0.0090
5	4	0.8377573	0.669131	1.669131	0.0083
6	5	1.0471967	0.500001	1.500001	0.0075
7	6	1.256636	0.309018	1.309018	0.0065
8	7	1.4660753	0.10453	1.10453	0.0055
9	8	1.6755147	-0.10453	0.895473	0.0045
10	9	1.884954	-0.30902	0.690985	0.0035
11	10	2.0943933	-0.5	0.500002	0.0025
12	11	2.3038327	-0.66913	0.330871	0.0017
13	12	2.513272	-0.80902	0.190984	0.0010
14	13	2.7227113	-0.91354	0.086455	0.0004
15	14	2.9321507	-0.97815	0.021853	0.0001

IMAGES NONLINEAR SPRING CONSTANTS



KT1 = 0

KC1 = 0 (EXCEPT ROW 15, KC1 = 1X10^8)

KT2 = 0

KC2 = 1X10^8

DT = 1

DC = δ FROM ABOVE FOR EA ROW OF NON LIN SPRINGS

FOR ROWS 1 TO 14 SPRING CONSTANT NUMBERS ARE 2 TO 15, RESPECTIVELY FOR ROW 15, THE SPRING CONSTANT NUMBER IS 1. FOR THAT ROW

KT1 = 0

KC1 = 1E+8

KT2 = 0

KC2 = 1E+8

DT = 1

DC = 1

REV 0
DOC. NO. V047-1-080
P. 4 OF 10

ADDED NODES/ELEMENT TO REPRESENT SHELL

USE MAX SHELL THICKNESS

$$t = .5 \text{ IN}$$

SHELL WILL BE IN X-Y PLANE ($Z = 0$)
ADD ENOUGH PLATE ELEMENTS TO GIVE A LONG SHELL LENGTH. FOR THE 30 IN DIA FLANGE,

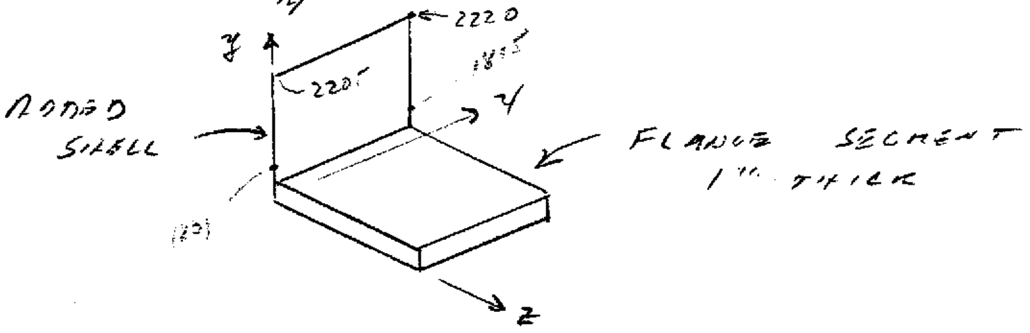
$$\ell = 2.5\sqrt{Rt}$$

$$= 2.5(15(.5))^{\frac{1}{2}}$$

$$= 6.8 \text{ IN} \quad \text{SAY } 7 \text{ IN}$$

FOR 1/4 IN WIDE ELEMENTS ADD

$$\frac{7}{1/4} = 28$$ ROWS TO TOP OF FLANGE



SEE CALC 018, P. 5 FOR SPRING STIFFNESS OF VITON O-RING

$$K_s = 709 \text{ LB/IN}$$

INNER VITON O-RING IS REPRESENTED BY THE LINEAR SPRINGS

FIRST: NODE 1576 TO NODE 1, INCR = 15

DOF = 1
SPRING CONST = 1

LAST: NODE 1786 TO NODE 211

OUTER O-RING IS REPRESENTED BY SIMILAR ELEMENTS, SEE CALC 016, P. 18

MAXIMUM AXIAL FORCE IN SHELL (F_y) OCCURS IN 30 1/4 TUBE (SEE CALC 042)

F_{yi} = 93.1 @ NODES 2207 TO 2219 (INCR = 1)

F_{yi} = 46.6 @ NODE 2206 & 2220

REF PP 18 & 19 CALC V049-1-042

BOLT FORCE

EACH BOLT IS PRELOADED TO 10K. FOR THE HALF MODEL, THE NODAL FORCES FOR PRELOAD ARE GIVEN IN CALC 042, P. 20

THE DISPLACEMENT CONTOUR PLOT ON THE FOLLOWING SHEET SHOWS THAT THE BOLT CLAMPING FORCE IS BRINGING THE TWO FLANGES TOGETHER WHEN THEY HAVE A HIGH SPOT THAT IS MIDWAY BETWEEN TWO BOLTS.

HOWEVER, THE MAXIMUM TENSILE FORCE IN THE SHELL TENDS TO OPEN THE GAP SLIGHTLY. THE MAXIMUM GAP OPENING IS AT THE INNER O-RING,

$$\Delta_y = .00136 \quad \text{REF: p. 8}$$

THIS IS AT THE MID-POINT BETWEEN FLANGES AND THE OUT OF FLATNESS DOES NOT ADD TO THE GAP. FOR 2 FLANGES

$$\Delta_y = 2(.00136) = .00272 \text{ IN}$$

$$<< .058 \text{ IN}$$ WHICH IS THE MIN O-RING COMPRESSION

AT THE BOLT ℄, THE MAXIMUM OPENING IS .000953 WHICH ADDS TO THE INITIAL GAP CAUSED BY OUT OF FLATNESS.

$$\Delta_y = .000953 + .010 = .0110 \text{ IN}$$

REF: p. 8

FOR 2 FLANGES

$$\Delta_y = 2(.0110) = .022$$

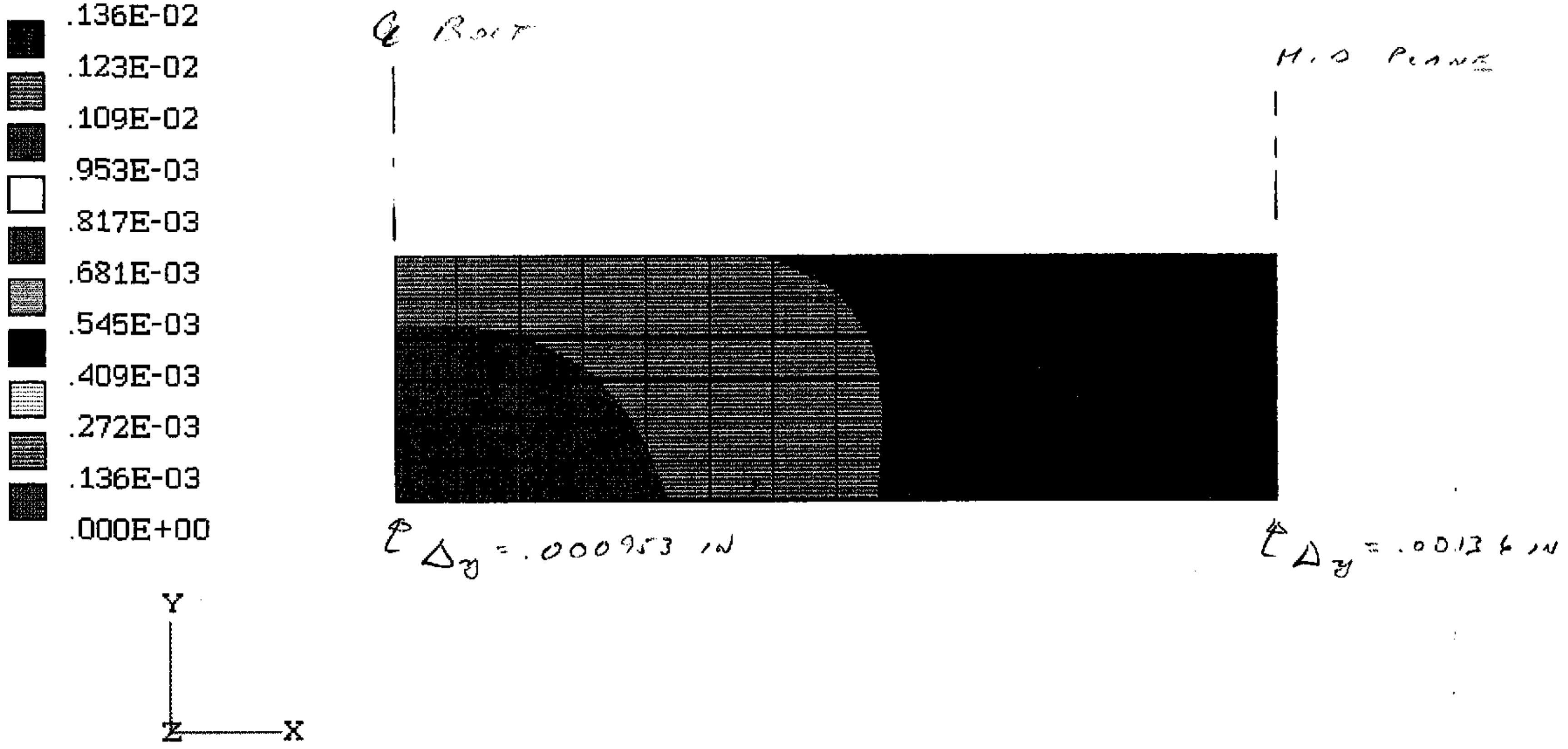
$$< .058$$ MIN O-RING COMPRESSION

OK

$$\text{RATIO} = \frac{.058}{.022} = 2.6$$

IMAGES-3D
Version 3.0

Displacement Contour at
Inner O-Ring



Rev 0
Doc No. V045-1-040
P. 4 of 10

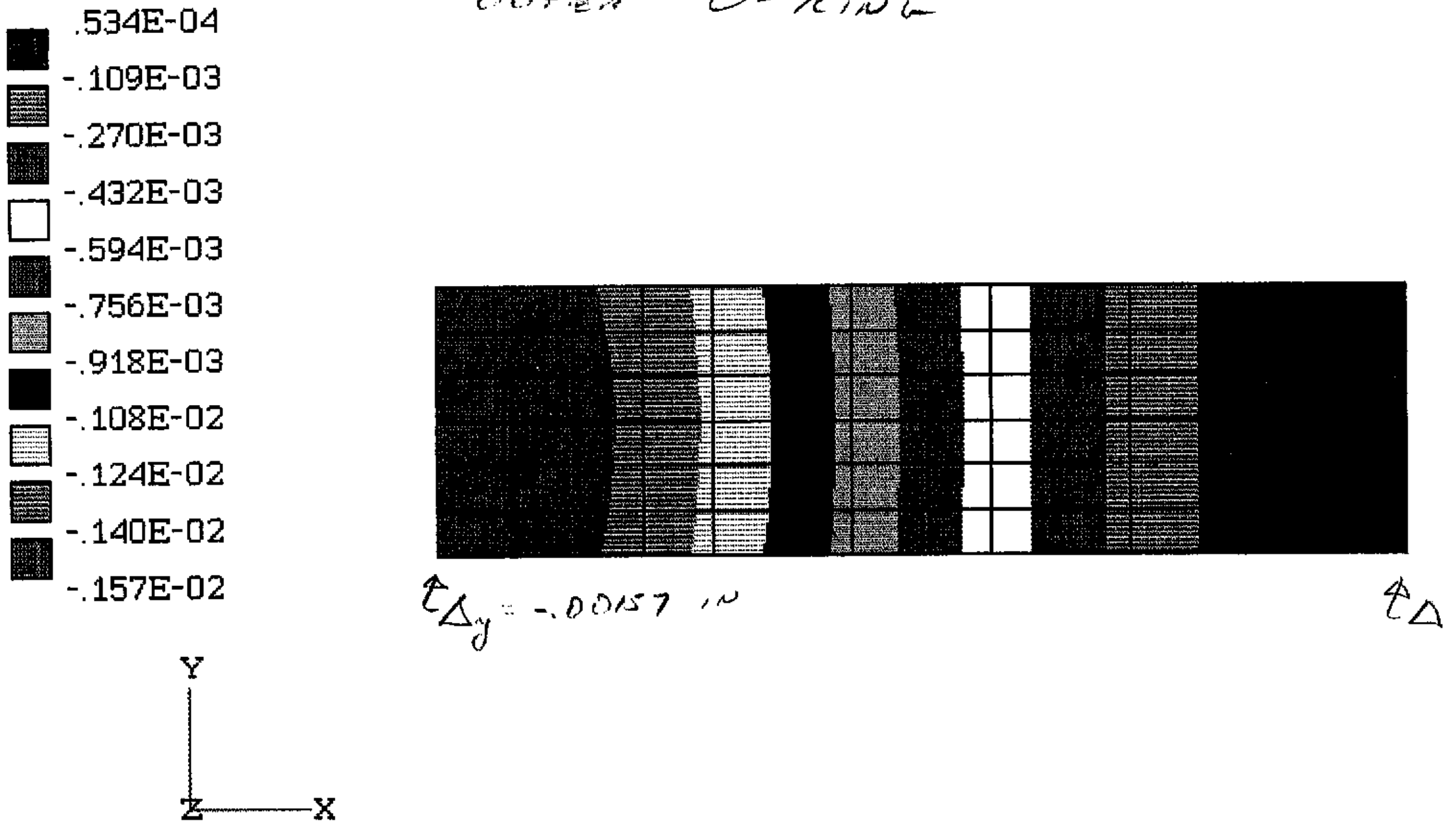
Load Case
1

Displacement Contour Plot
DY

4/ 3/96
14:22:37

DISPLACEMENT CONTOURS AT OUTER O-RING

IMAGES-3D
Version 3.0



℄ Δ_y = -.00157 IN

℄ Δ_y = .53(10)$^{-4}$ IN

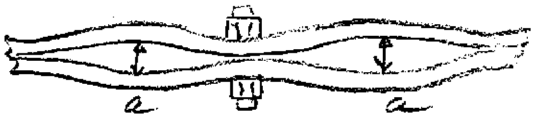
Load Case
1

Displacement Contour Plot
DY

4/ 3/96
14:25:53

QUESTION:

WHAT HAPPENS WHEN THE MAXIMUM OUT OF FLATNESS OCCURS AT THE MIDPOINT BETWEEN TWO FLANGES? BOLT TIGHTENING WILL NOT CLOSE THE GAP.



THE OPENING INCREASES DUE TO TENSILE FORCE IN THE SHELL. THE MAX DEFLECTION AT THE INNER O-RING IS

$\Delta = .00372$ CALC V049-1-042 P. 25

TOTAL DEFL FOR 2 FLANGES

$$a = 2(.010 + .00372)$$
$$= .0274$$
$$< .058$$

RATIO $\frac{.058}{.0274} = 2.1$

PROCESS SYSTEMS INTERNATIONAL, INC.
WESTBOROUGH, MA

ENGINEERING
CALCULATIONS

NO: V049-1-084
PAGE 1 OF 37

REV.	DEO #	DATE	BY:	CHECK
0	0024	4/12/96	AGR	RDC
1	0293	6/7/96	WDB	RDC
2		11/26/96	WDB	RDC

TITLE:
Expansion Joint Tie Rod
"Lug" Design

BY: W. Bilynsky

DEPT.: 744

PROJECT: LIGO Vacuum Equipment

PROJECT NO: V59049

PURPOSE:

The purpose of this calculation is to provide a single lug design for all expansion joint/tube sizes up to and including 72 ¼ in. I.D.

METHOD:

COMPRESS 5.53R computer pressure vessel software

ASSUMPTIONS

See Calculation

INPUTS:

"Design Loads" from Doc. No. V049-1-048
"Structural Design Criteria" Doc. No. V049-1-066
Doc. No. V049-1-032 Component Interface Loads

REFERENCES:

1. Doc. No. V049-1-048
2. COMPRESS - Computer Aided Vessel Design program - version 5.53
3. Doc. No. V049-1-066, LIGO Vacuum Equipment Structural Design Criteria

CALCULATIONS:

(SEE ATTACHED)

CONCLUSIONS:

A single lug design as shown in design sketch utilizing 4 lugs per expansion joint is adequate for 60.5 in to and 72 ¼ in I.D. and 3 lugs per expansion joint for smaller diameters.

NOTES:

This lug design requires a reinforcing pad/washer as shown in the design sketch

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3.0	Lug To Shell Stress Summary	8
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	Spool BE-5	9
	Spool BE-3	13
	Spool A-13	18
	Spool A-2	23
	Spool A-1	28
	Spool B-2	33
	Appendix 'A'	A-1 to A-30
	Revised Stress Summary	
	Appendix 'B'	B-1 to B-3
	Lug Detail For Test Condition	
	Appendix 'C'	C-1 to C-3
	Reinforcing Washer As An Option To A Welded Pad	

REVISION HISTORY

Rev. 0 Original Issue
April 12, 1996

Rev. 1 Issue Date
June 7, 1996

- Added Appendices 'A', 'B', and 'C'.

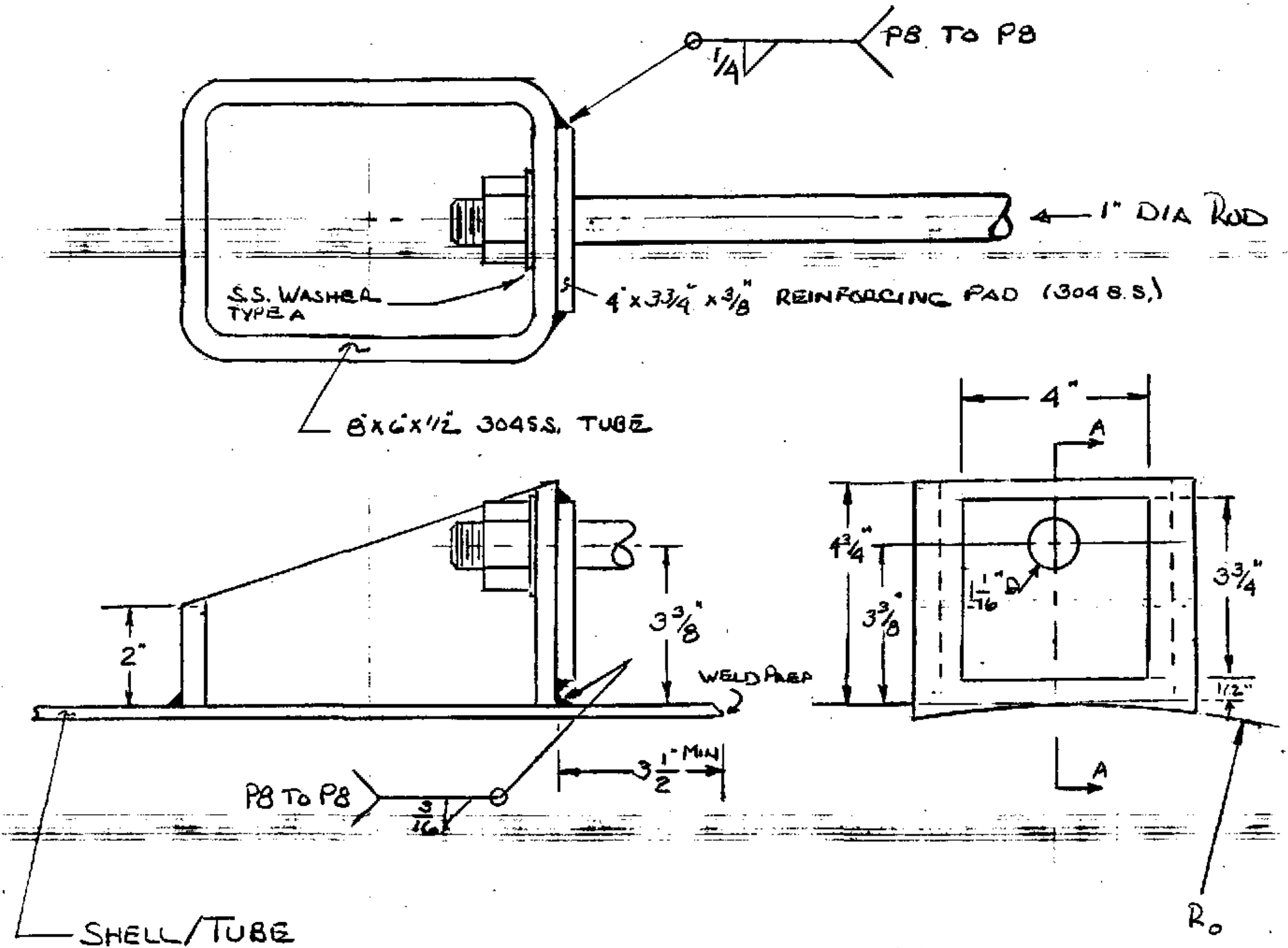
Rev. 2 Issue Date
November 26, 1996

- Corrected Max Bolt Forces for the rod compression. (Appendix 'B')
- Added analysis of BE-1 for 1/4" thick shell with repad at each lug.

1.0 – DESIGN SKETCH SHEET 1 OF 2

SK-V049-1-084 REV0

- LUG TO SHELL ATTACHMENT FOR EXPANSION JOINT TIE ROD CONNECTIONS UP TO AND INCLUDING 72 1/4"ID TUBE SIZE FOR SPOOL BE-3 SEE SHEET 2 FOR MODIFIED DESIGN



WHERE:
Ro = OUTSIDE RADIUS OF TUBE
TYPICAL FRONT + REAR

NOTE:
THIS DESIGN IS BASED ON USING FOUR (4) LUGS SPACED AT 90°

LUG WELD STRESS FOR 72"Φ TUBE
F = 16.075 K

$A_w = [2(6) + 2(6)]\ 3/16\ (.707) = 3.71\ in^2$

$f_v = \frac{F}{A_w} = \frac{16.075}{3.71} = 4.3$ KSI ok

SHEAR STRESS DUE TO BENDING

$M = 4507$ LB-FT × 12 $\frac{IN}{FT}$ = 54 014 IN-LB
= 54 IN-K

$I = \left[2\frac{(16)^3}{12} + 2(6)(4)^2\right]\left(\frac{3}{16}\right)(.707$
$= [682 + 192]\ (3/16)(.707)$
$= 116$

$f_v = \frac{54\ (4)}{116} = 1.86$ KSI

TOTAL

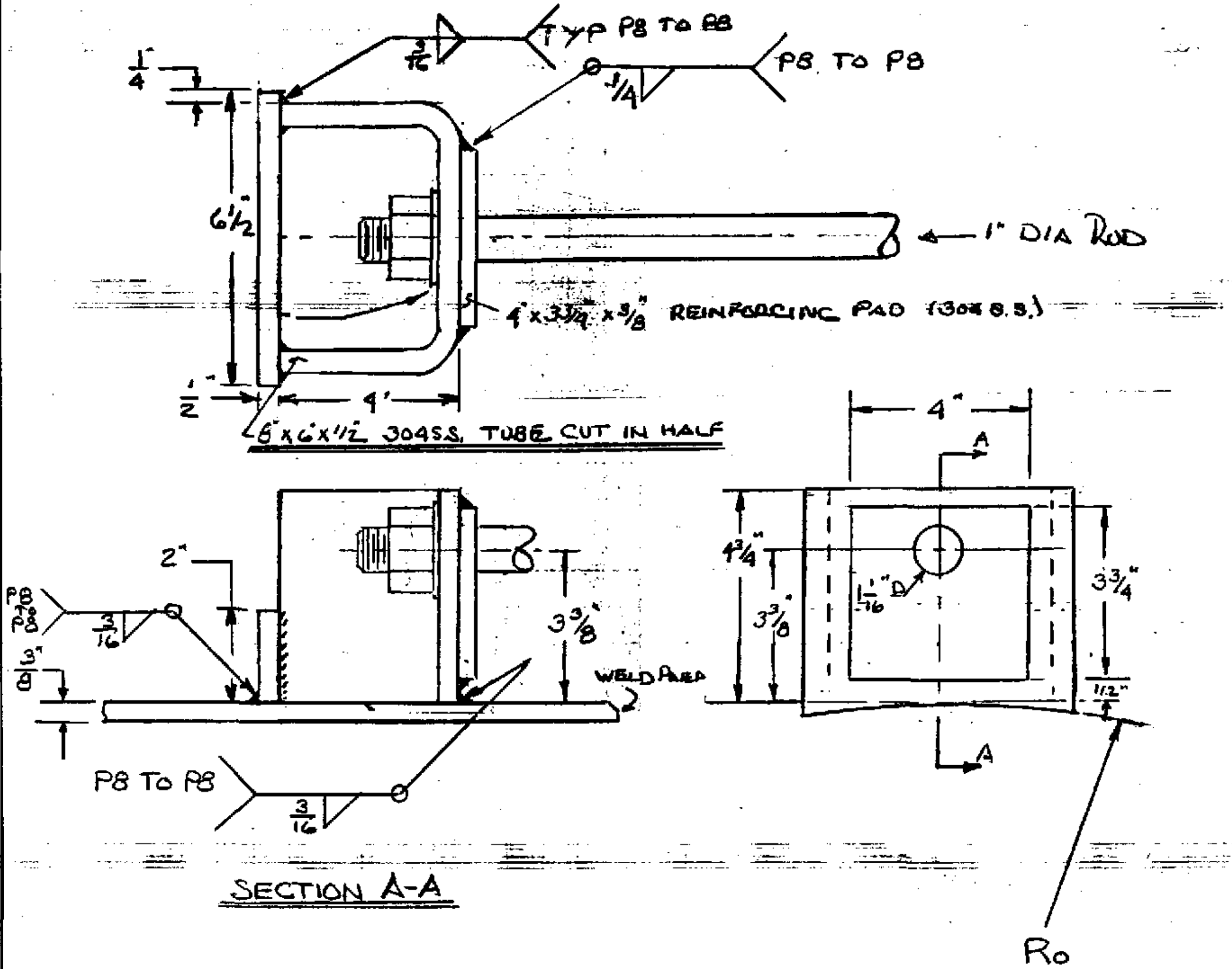
$f_v = 1.86 + 4.3 = 6.2$ KSI ok

DESIGN SKETCH

SHEET 2 OF 2

SK-V049-1-084 REV0

MODIFIED DESIGN FOR SPOOL BE-3 WITH 3/8" THK WALL



SECTION A-A

WHERE:
Ro = OUTSIDE RADIUS OF TUBE
TYPICAL FRONT + REAR

NOTE: THIS DESIGN IS
BASED ON USING FOUR (4)
LUGS SPACED AT 90°

2.0 – COMPRESS INPUT FOR SPOOL A-13 (TYPICAL)

- SHELL / TUBE
  - MATERIAL: SA 304L HIGH
  - EXTERNAL / INTERNAL PRESSURE = 0 PSI
  - TEMP =
  - ID = 60.5" (SPOOL A-13)
  - LENGTH = 23" (SPOOL A-13)
  - THK'S = 3/16"

- LUG
  - MATERIAL: SA 240 304
  - LUG ALLOWABLE STRESS = 16,200 PSI
  - WP = 2" - HEIGHT OF LUG - BACKSIDE
  - WB = 4.75" - HEIGHT OF LUG - TIE ROD SIDE
  - t = .5" - THK'S OF LUG - BACKSIDE
  - tB = .75" - THK'S OF LUG - TIE ROD SIDE (INCLUDES 1/4" THK PAD)
  - L = 6" - LUG WIDTH / CIRC. LENGTH
  - h = 8 - 2 x 1/2" THK = 7" - GUSSET HEIGHT / LUG SIDES
  - tg = .5" - GUSSET THKS / SIDE THK
  - NUMBER OF LUGS – 4
  - ANGULAR POSITION 1ST LUG = 0° (NOTE FOR DART VESSEL LAYOUT INFO ONLY)
  - FILLET WELD SIZE - 3/16" - LUG TO VESSEL WELD
  - FORCE BEARING WIDTH = 2" - DIAMETER OF 1" ROD WASHER

- DESIGN LOAD INPUT FROM DOC. NO. V049-1-048 FOR SPOOL BE-3; ID = 60.5"

LOAD PER ROD = 6,400# (REVISED SEE APPENDIX 'A')

DISTANCE FROM SHELL TO ROD = 3 3/8"

- d = 3.375" – DISTANCE TO LOAD

- VL = 6400# – LONGITUDINAL SHEAR LOAD

- ML = 1800 FT-# - LONGITUDINAL MOMENT LOAD

WHERE: ML = 6400# X 3.38"/12"/FT = 1800 FT-#

- DESIGN FACTOR = 3 ; STRESS CONCENTRATION = 0
- NO PAD

- MIN DISTANCE OF LUG TO WELD $= \sqrt{Dt} = \sqrt{(60.5)(.1875)} = 3.37"$

∴ TO DATUM: 4 + 3.37 = 7.37" MIN → 7 1/2"

• DESIGN LOADS FOR OTHER TUBE SIZES

- SHALL BE BASED ON A DESIGN AXIAL SPRING RATE OF 7500 #/IN FOR 2" TRAVEL REF: DOC. NO. V049-1-048 (EX. JT. FOR SPOOL BE-3)

∴ CIRCUMFERENTIAL LOADING IS:

$$-\frac{7500}{\pi D}\frac{\#/\text{IN}}{\text{IN}} = \frac{7500}{\pi(60.5)} = \frac{39.5\ \#/\text{IN}}{\text{IN}}$$

- FOR 2" TRAVEL:

LOAD = 39.5 x 2 = 79 #/IN OF CIRCUMFERENCE

- SPECIFY 100 #/IN OF CIRCUMFERENCE FOR DESIGN

∴ THE DESIGN ATTACHMENT INPUT LOADS, BASED ON LOADING ONLY 3 RODS, FOR THE FOLLOWING SIZE ARE:

- 72.25" I.D.:
  - $V_L = \pi(72.25)(100)/3 = 7,566$ #
  - $M_L = (7566)(3.375/12) = 2128$ FT-#
- 48.25" I.D.:
  - $V_L = \pi(48.25)(100)/3 = 5,053$ #
  - $M_L = (5053)(3.375/12) = 1,421$ FT-#
- 44.625" I.D.:
  - $V_L = \pi(44.625)(100)/3 = 4,673$ #
  - $M_L = (4673)(3.375/12) = 1,314$ FT-#
- 30.5" I.D.:
  - $V_L = \pi(30.5)(100)/3 = 3,194$ #
  - $M_L = (3194)(3.375/12) = 898$ #

3.0 - LUG TO SHELL STRESS SUMMARY

- 8" X 6" X 1/2" 304 S.S. TUBE ; $S_{\text{ALLOWABLE AT 100°F}}$ = 18,800 PSI
- SHELL - SA 304L HIGH ; $S_{\text{ALLOWABLE AT 100°F}}$ = 16,700 PSI
- PRIMARY MEMBRANE ALLOWABLE STRESS:

  1.5S = 1.5(16,700) = 25,050 PSI
- PRIMARY MEMBRANE PLUS SECONDARY ALLOWABLE STRESS:

  3S = 3(16,700) = 50,100 PSI

SPOOL PIECE	ID	THK'S	LOADS		PRIMARY MEMBRANE	PRIMARY + SECONDARY
			VL [#]	ML [FT-#]		
BE5 & BE1	72.25"	1/4" (1)	7566	2128	-9,537	-29,777
& BE-3 BE-3A	60.5	3/8"	6400	1800	-6,062	-24,261
* A-13	60.5	3/16"	6400	1800	-12,905	-37,235
* A-2	48.25	3/16"	5053	1421	- 9583	-26,071
* A-1	44.625	3/16"	4673	1314	-8672	-22614
B-2	30.5	1/4"	3194	898	-4966	-12259

* STRESS SUMMARY FOR 1/4 THK IN LIEU OF 3/16"

A-13	60.5	1/4"	6400	1800	-7903	-23871
A-2	48.25	1/4"	5053	1421	- 6030	-16274
A-1	44.625	1/4"	4673	1314	-5482	-14739

NOTE: THE FINAL DESIGN FOR SPOOL PIECES A-1, A-2 + A-13 HAS INCORPORATED A 1/4" WALL THICKNESS

(1) NOW t = 3/8" FOR BE-5
SEE Pg. A-9 (REV. 1)

BELLOWS BE-5

ASME Section VIII Division 1, 1995 Edition, A95 Addenda

Component:	Cylinder
Material specification:	SA 240 304L HIGH

Corrosion allowance: Inner C = 0 Outer = 0 in

* PWHT is performed

Radiography:	Category A joints -	Spot UW-11(b) type 1
	Category B joints -	Spot UW-11(b) type 1

Estimated weight:	new = 1033.1	corr = 1033.1	lb
capacity:	new = 1102.711	corr = 1102.711	US ga

OD = 72.25 length Lc = 63 t = 0.25 in (new)

MAP: (New & at 0 deg F) Appendix 1-1(a)

P = S*E*t/(Ro - 0.4*t) - Ps
= 16700*0.85*0.25/(36.125 - 0.4*0.25) - 0
= 98.50798 psi

MAWP: (Corroded & at 0 deg F) Appendix 1-1(a)

P = S*E*t/(Ro - 0.4*t) - Ps
= 16700*0.85*0.25/(36.125 - 0.4*0.25) - 0
= 98.50798 psi

BE-5 Lug (No Pad)

Lug material specification = A 240 304
Lug allowable stress = 18800 psi
Top plate width wp = 2 in
Base plate width wb = 4.75 in
Top plate thickness t = 0.5 in
Base plate thickness tb = 0.875 in
Lug length circ. direction L = 6 in
Gusset height h = 7 in
Gusset thickness tg = 0.5 in
Number of lugs = 4
Angular position, first lug = 0 degrees
Fillet weld size tw = 0.1875 in
Force bearing width Fb = 2 in
Distance to load d = 3.375 in

Lug top plate required thickness, Bednar pg 153

ta = 0.75*(VL*d*L)/(Sa*wpˆ2*h)
= 0.75*(7566*3.375*6)/(18800*2ˆ2*7)
= 0.25 in

Lug gusset required thickness

Sc = 18000/(1 + (1/18000)*(h/(0.289*tg))ˆ2)
= 18000/(1 + (1/18000)*(7/(0.289*0.5))ˆ2)
= 15923.95 psi

tg = VL*(3*d - wb)/(Sc*wbˆ2*SIN(Alpha)ˆ2)
= 7566*(3*3.375 - 4.75)/(15923.95*4.75ˆ2*SIN(68.552)ˆ2)
= 0.1307 in

Lug base plate required thickness

From Escoe table 4-8

fc = VL/(Fb*L) = 630.5 psi

Mx = Cx*fc*Gsˆ2
= 0.0923*630.5*5ˆ2 = 1454.879

My = Cy*fc*wbˆ2
= -.126*630.5*4.75ˆ2 =-1792.433

tb = Sqr(6*Mmax / Sa)
= Sqr(6*1792.433 / 18800)
= 0.7563 in

Check lug attachment stresses

Radial load Pr = 0 lbf
Circumferential moment Mc = 0 lbf-ft
Circumferential shear Vc = 0 lbf
Longitudinal moment ML = 2128 lbf-ft
Longitudinal shear VL = 7566 lbf

BE-5 Lug (No Pad)

Internal pressure P = 0 psi

Stresses at the lug edge per WRC bulletin 107 (psi)

Mean radius Rm = 36 in
Rm/t = 144

C1 = 3, C2 = 4.1875 in

Stress concentration factor Kn (tension) = 1
Stress concentration factor Kb (bending) = 1

Local circ. pressure stress = P*Rm/t = 0 psi

Local long. pressure stress = P*Rm/2t = 0 psi

Maximum combined stress = -29777 psi
Allowable combined stress = +-3*S = +-50100 psi

The maximum combined stress is within allowable limits.

Maximum primary membrane stress = -9537 psi
Allowable primary membrane stress = +-1.5*S = +- 25050 psi

The maximum primary membrane stress is within allowable limits.

BE-5 Lug (No Pad)

```
 ________________________________________________________________________________________
| From| Value  | beta|
| Fig.| read   |     |    Au      Al      Bu      Bl      Cu      Cl      Du      Dl
|_____|________|_____|__________________________________________________________________
| 3C* |12.092  |0.116|
| 4C* |20.080  |0.106|
| 1C  |0.0826  |0.094|
| 2C-1|0.0493  |0.094|
| 3A* |5.5740  |0.093|
| 1A  |0.0798  |0.097|
| 3B* |14.704  |0.104|  -9537   -9537    9537    9537
| 1B-1|0.0287  |0.097| -20240   20240   20240  -20240
| pressure stress*   |
|____________________|__________________________________________________________________
| Total circ stress  | -29777   10703   29777  -10703
| Primary membrane   |
| circ stress*       |  -9537   -9537    9537    9537
|____________________|__________________________________________________________________
| 3C* |13.227  |0.106|
| 4C* |19.332  |0.116|
| 1C-1|0.0731  |0.108|
| 2C  |0.0440  |0.108|
| 4A* |10.076  |0.093|
| 2A  |0.0378  |0.109|
| 4B* |5.6219  |0.104|  -4517   -4517    4517    4517
| 2B-1|0.0356  |0.108| -22539   22539   22539  -22539
| pressure stress*   |
|____________________|__________________________________________________________________
| Total long stress  | -27056   18022   27056  -18022
| Primary membrane   |
| long stress*       |  -4517   -4517    4517    4517
|____________________|__________________________________________________________________
| torsion moment Mt  |
| Circ shear from Vc |
| Long shear from VL |                                  -1807   -1807    1807    1807
|____________________|__________________________________________________________________
| Total Shear stress |                                  -1807   -1807    1807    1807
|____________________|__________________________________________________________________
| Combined stress    | -29777   18022   29777  -18022    3614    3614    3614    3614
|____________________|__________________________________________________________________
```

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8X6 LUG - WITH NO PAD 2

Total Pages In This Report 4

SPOOL BE-3

ASME Section VIII Division 1, 1992 Edition, A94 Addenda

Component: Cylinder
Material specification: SA 240 304L HIGH

Corrosion allowance: Inner C = 0 Outer= 0 in

* PWHT is performed

Radiography: Category A joints - Spot UW-11(b) type 1
Category B joints - Spot UW-11(b) type 1

Estimated weight:	new = 478.4	corr = 478.4	lb
capacity:	new = 286.231	corr = 286.231	US ga

ID = 60.5 length Lc= 23 t = 0.375 in (new)

MAP: (New & at 0 deg F) UG-27(c)(1)

$P = S*E*t/(R + 0.6*t) - Ps$
$= 16700*0.85*0.375/(30.25 + 0.6*0.375) - 0$
$= 174.6719$ psi

MAWP: (Corroded & at 100 deg F) UG-27(c)(1)

$P = S*E*t/(R + 0.6*t) - Ps$
$= 16700*0.85*0.375/(30.25 + 0.6*0.375) - 0$
$= 174.6719$ psi

3.12.1996

8X6 LUG - WITH NO PAD

```
Lug material specification      = A 240 304
Lug allowable stress            = 18800 psi
Top plate width              wp = 2 in
Base plate width             wb = 4.75 in
Top plate thickness           t = 0.5 in
Base plate thickness         tb = 0.75 in
Lug length circ. direction    L = 6 in
Gusset height                 h = 3.25 in
Gusset thickness             tg = 0.5 in
Number of lugs                  = 4
Angular position, first lug     = 0 degrees
Fillet weld size             tw = 0.1875 in
Force bearing width          Fb = 2 in
Distance to load              d = 3.375 in
```

Lug top plate required thickness. Bednar pg 153

```
ta = 0.75*(VL*d*L)/(Sa*wp^2*h)
   = 0.75*(6400*3.375*6)/(18800*2^2*3.25)
   = 0.3977 in
```

Lug gusset required thickness

```
Sc = 18000/(1 + (1/18000)*(h/(0.289*tg))^2 )
   = 18000/(1 + (1/18000)*(3.25/(0.289*0.5))^2 )
   = 17507.97 psi

tg = VL*(3*d - wb)/(Sc*wb^2*SIN(Alpha)^2)
   = 6400*(3*3.375 - 4.75)/(17507.97*4.75^2*SIN(49.764)^2)
   = 0.1494 in
```

Lug base plate required thickness

```
From Escoe table 4-8

fc = VL/(Fb*L) = 533.3333 psi

Mx = Cx*fc*Gs^2
   = 0.0923*533.3333*5^2 = 1230.667

My = Cy*fc*wb^2
   = -.126*533.3333*4.75^2 =-1516.2

tb = Sqr(6*Mmax / Sa)
   = Sqr(6*1516.2 / 18800)
   = 0.6956 in
```

Check lug attachment stresses

```
Radial load                  Pr =  0 lbf
Circumferential moment       Mc =  0 lbf-ft
Circumferential shear        Vc =  0 lbf
```

8X6 LUG - WITH NO PAD

Longitudinal moment ML = 1800 lbf-ft
Longitudinal shear VL = 6400 lbf
Internal pressure P = 0 psi

Stresses at the lug edge per WRC bulletin 107 (psi)

Mean radius Rm = 30.4375 in
Rm/t = 81.16666

C1 = 3, C2 = 2.25 in

Stress concentration factor Kn (tension) = 1
Stress concentration factor Kb (bending) = 1

Local circ. pressure stress = P*Rm/t = 0 psi

Local long. pressure stress = P*Rm/2t = 0 psi

Maximum combined stress =-24621 psi
Allowable combined stress = +-3*S = +- 50100 psi

The maximum combined stress is within allowable limits.

Maximum primary membrane stress =-6062 psi
Allowable primary membrane stress = +-1.5*S = +- 25050 psi

The maximum primary membrane stress is within allowable limits.

8X6 LUG - WITH NO PAD

From Fig.	Value read	beta	Au	Al	Bu	Bl	Cu	Cl	Du	D
3C*	11.520	0.085								
4C*	13.244	0.092								
1C	0.1040	0.093								
2C-1	0.0696	0.093								
3A*	2.8538	0.09								
1A	0.0879	0.099								
3B*	8.6001	0.081	-6062	-6062	6062	6062				
1B-1	0.0421	0.083	-15275	15275	15275	-15275				
pressure stress*										
Total circ stress			-21337	9213	21337	-9213				
Primary membrane circ stress*			-6062	-6062	6062	6062				
3C*	10.947	0.092								
4C*	13.484	0.085								
1C-1	0.1104	0.087								
2C	0.0740	0.087								
4A*	4.4600	0.09								
2A	0.0475	0.095								
4B*	2.6643	0.081	-1663	-1663	1663	1663				
2B-1	0.0642	0.085	-22958	22958	22958	-22958				
pressure stress*										
Total long stress			-24621	21295	24621	-21295				
Primary membrane long stress*			-1663	-1663	1663	1663				
torsion moment Mt										
Circ shear from Vc										
Long shear from VL							-1896	-1896	1896	18
Total Shear stress							-1896	-1896	1896	18
Combined stress			-24621	21295	24621	-21295	3792	3792	3792	37

3.12.1996

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8X6 LUG - WITH NO PAD 2

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SPOOL A-13

ASME Section VIII Division 1, 1992 Edition, A94 Addenda

Component: Cylinder
Material specification: SA 240 304L HIGH

Corrosion allowance: Inner C = 0 Outer= 0 in

* PWHT is performed

Radiography: Category A joints - Spot UW-11(b) type 1
Category B joints - Spot UW-11(b) type 1

Estimated weight:	new = 238.4	corr = 238.4	lb
capacity:	new = 286.231	corr = 286.231	US ga

ID = 60.5 length Lc= 23 t = 0.1875 in (new)

MAP: (New & at 0 deg F) UG-27(c)(1)

P = S*E*t/(R + 0.6*t) - Ps
= 16700*0.85*0.1875/(30.25 + 0.6*0.1875) - 0
= 87.65953 psi

MAWP: (Corroded & at 100 deg F) UG-27(c)(1)

P = S*E*t/(R + 0.6*t) - Ps
= 16700*0.85*0.1875/(30.25 + 0.6*0.1875) - 0
= 87.65953 psi

8X6 LUG - WITH NO PAD

Lug material specification = A 240 304
Lug allowable stress = 18800 psi
Top plate width wp = 2 in
Base plate width wb = 4.75 in
Top plate thickness t = 0.5 in
Base plate thickness tb = 0.75 in
Lug length circ. direction L = 6 in
Gusset height h = 7 in
Gusset thickness tg = 0.5 in
Number of lugs = 4
Angular position, first lug = 0 degrees
Fillet weld size tw = 0.1875 in
Force bearing width Fb = 2 in
Distance to load d = 3.375 in

Lug top plate required thickness, Bednar pg 153

ta = 0.75*(VL*d*L)/(Sa*wp^2*h)
= 0.75*(6400*3.375*6)/(18800*2^2*7)
= 0.25 in

Lug gusset required thickness

Sc = 18000/(1 + (1/18000)*(h/(0.289*tg))^2)
= 18000/(1 + (1/18000)*(7/(0.289*0.5))^2)
= 15923.95 psi

tg = VL*(3*d - wb)/(Sc*wb^2*SIN(Alpha)^2)
= 6400*(3*3.375 - 4.75)/(15923.95*4.75^2*SIN(68.552)^2)
= 0.1105 in

Lug base plate required thickness

From Escoe table 4-8

fc = VL/(Fb*L) = 533.3333 psi

Mx = Cx*fc*Gs^2
= 0.0923*533.3333*5^2 = 1230.667

My = Cy*fc*wb^2
= -.126*533.3333*4.75^2 =-1516.2

tb = Sqr(6*Mmax / Sa)
= Sqr(6*1516.2 / 18800)
= 0.6956 in

Check lug attachment stresses

Radial load Pr = 0 lbf
Circumferential moment Mc = 0 lbf-ft
Circumferential shear Vc = 0 lbf

8X6 LUG - WITH NO PAD

Longitudinal moment	ML =	1800 lbf-ft
Longitudinal shear	VL =	6400 lbf
Internal pressure	P =	0 psi

Stresses at the lug edge per WRC bulletin 107 (psi)

Mean radius Rm = 30.34375 in
Rm/t = 161.8333

C1 = 3, C2 = 4.125 in

Stress concentration factor Kn (tension) = 1
Stress concentration factor Kb (bending) = 1

Local circ. pressure stress = P*Rm/t = 0 psi

Local long. pressure stress = P*Rm/2t = 0 psi

Maximum combined stress =-37235 psi
Allowable combined stress = +-3*S = +- 50100 psi

The maximum combined stress is within allowable limits.

Maximum primary membrane stress =-12905 psi
Allowable primary membrane stress = +-1.5*S = +- 25050 psi

The maximum primary membrane stress is within allowable limits.

8X6 LUG - WITH NO PAD

From Fig.	Value read	beta	Au	Al	Bu	Bl	Cu	Cl	Du	D
3C*	10.354	0.136								
4C*	20.589	0.124								
1C	0.0707	0.111								
2C-1	0.0366	0.111								
3A*	6.3028	0.11								
1A	0.0729	0.114								
3B*	14.701	0.122	-12905	-12905	12905	12905				
1B-1	0.0226	0.113	-24330	24330	24330	-24330				
pressure stress*										
Total circ stress			-37235	11425	37235	-11425				
Primary membrane circ stress*			-12905	-12905	12905	12905				
3C*	11.749	0.124								
4C*	19.629	0.136								
1C-1	0.0613	0.126								
2C	0.0391	0.126								
4A*	12.653	0.11								
2A	0.0328	0.127								
4B*	5.9259	0.122	-6520	-6520	6520	6520				
2B-1	0.0273	0.125	-26506	26506	26506	-26506				
pressure stress*										
Total long stress			-33026	19986	33026	-19986				
Primary membrane long stress*			-6520	-6520	6520	6520				
torsion moment Mt										
Circ shear from Vc										
Long shear from VL							-2069	-2069	2069	20
Total Shear stress							-2069	-2069	2069	20
Combined stress			-37235	19986	37235	-19986	4138	4138	4138	41

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8X6 LUG - WITH NO PAD 2

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SPOOL A-2

ASME Section VIII Division 1, 1992 Edition, A94 Addenda

Component:	Cylinder
Material specification:	SA 240 304L HIGH

Corrosion allowance: Inner C = 0 Outer= 0 in

* PWHT is performed

Radiography: Category A joints - Spot UW-11(b) type 1
Category B joints - Spot UW-11(b) type 1

Estimated weight:	new = 224.5	corr = 224.5	lb
capacity:	new = 214.744	corr = 214.744	US ga

ID = 48.25 length Lc= 27.13 t = 0.1875 in (new)

MAP: (New & at 0 deg F) UG-27(c)(1)

$P = S*E*t/(R + 0.6*t) - Ps$
$= 16700*0.85*0.1875/(24.125 + 0.6*0.1875) - 0$
$= 109.8118$ psi

MAWP: (Corroded & at 100 deg F) UG-27(c)(1)

$P = S*E*t/(R + 0.6*t) - Ps$
$= 16700*0.85*0.1875/(24.125 + 0.6*0.1875) - 0$
$= 109.8118$ psi

8X6 LUG - WITH NO PAD

Lug material specification = A 240 304
Lug allowable stress = 18800 psi
Top plate width wp = 2 in
Base plate width wb = 4.75 in
Top plate thickness t = 0.5 in
Base plate thickness tb = 0.625 in
Lug length circ. direction L = 6 in
Gusset height h = 7 in
Gusset thickness tg = 0.5 in
Number of lugs = 4
Angular position, first lug = 0 degrees
Fillet weld size tw = 0.1875 in
Force bearing width Fb = 2 in
Distance to load d = 3.375 in

Lug top plate required thickness, Bednar pg 153

ta = 0.75*(VL*d*L)/(Sa*wp^2*h)
= 0.75*(5053*3.375*6)/(18800*2^2*7)
= 0.25 in

Lug gusset required thickness

Sc = 18000/(1 + (1/18000)*(h/(0.289*tg))^2)
= 18000/(1 + (1/18000)*(7/(0.289*0.5))^2)
= 15923.95 psi

tg = VL*(3*d - wb)/(Sc*wb^2*SIN(Alpha)^2)
= 5053*(3*3.375 - 4.75)/(15923.95*4.75^2*SIN(68.552)^2)
= 0.0873 in

Lug base plate required thickness

From Escoe table 4-8

fc = VL/(Fb*L) = 421.0833 psi

Mx = Cx*fc*Gs^2
= 0.0923*421.0833*5^2 = 971.6498

My = Cy*fc*wb^2
= -.126*421.0833*4.75^2 =-1197.087

tb = Sqr(6*Mmax / Sa)
= Sqr(6*1197.087 / 18800)
= 0.6181 in

Check lug attachment stresses

Radial load Pr = 0 lbf
Circumferential moment Mc = 0 lbf-ft
Circumferential shear Vc = 0 lbf

8X6 LUG - WITH NO PAD

Longitudinal moment ML = 1421 lbf-ft
Longitudinal shear VL = 5053 lbf
Internal pressure P = 0 psi

Stresses at the lug edge per WRC bulletin 107 (psi)

Mean radius Rm = 24.21875 in
Rm/t = 129.1667

C1 = 3, C2 = 4.0625 in

Stress concentration factor Kn (tension) = 1
Stress concentration factor Kb (bending) = 1

Local circ. pressure stress = P*Rm/t = 0 psi

Local long. pressure stress = P*Rm/2t = 0 psi

Maximum combined stress =-26071 psi
Allowable combined stress = +-3*S = +- 50100 psi

The maximum combined stress is within allowable limits.

Maximum primary membrane stress =-9583 psi
Allowable primary membrane stress = +-1.5*S = +- 25050 psi

The maximum primary membrane stress is within allowable limits.

8X6 LUG - WITH NO PAD

From Fig.	Value read	beta	Au	Al	Bu	Bl	Cu	Cl	Du	D
3C*	7.1556	0.168								
4C*	15.373	0.154								
1C	0.0648	0.138								
2C-1	0.0308	0.138								
3A*	4.9415	0.137								
1A	0.0672	0.143								
3B*	10.889	0.152	-9583	-9583	9583	9583				
1B-1	0.0195	0.142	-16488	16488	16488	-16488				
pressure stress*										
Total circ stress			-26071	6905	26071	-6905				
Primary membrane circ stress*			-9583	-9583	9583	9583				
3C*	7.9455	0.154								
4C*	14.630	0.168								
1C-1	0.0520	0.157								
2C	0.0357	0.157								
4A*	10.505	0.137								
2A	0.0289	0.16								
4B*	4.6023	0.152	-4863	-4863	4863	4863				
2B-1	0.0220	0.158	-16744	16744	16744	-16744				
pressure stress*										
Total long stress			-21607	11881	21607	-11881				
Primary membrane long stress*			-4863	-4863	4863	4863				
torsion moment Mt										
Circ shear from Vc										
Long shear from VL							-1658	-1658	1658	1
Total Shear stress							-1658	-1658	1658	1
Combined stress			-26071	11881	26071	-11881	3316	3316	3316	3

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SPOOL A-1

ASME Section VIII Division 1, 1992 Edition, A94 Addenda

Component:	Cylinder
Material specification:	SA 240 304L HIGH

Corrosion allowance: Inner C = 0 Outer= 0 in

* PWHT is performed

Radiography: Category A joints - Spot UW-11(b) type 1
Category B joints - Spot UW-11(b) type 1

Estimated weight:	new = 229.7	corr = 229.7	lb
capacity:	new = 203.121	corr = 203.121	US ga

ID = 44.625 length Lc= 30 t = 0.1875 in (new)

MAP: (New & at 0 deg F) UG-27(c)(1)

P = S*E*t/(R + 0.6*t) - Ps
= 16700*0.85*0.1875/(22.3125 + 0.6*0.1875) - 0
= 118.6873 psi

MAWP: (Corroded & at 100 deg F) UG-27(c)(1)

P = S*E*t/(R + 0.6*t) - Ps
= 16700*0.85*0.1875/(22.3125 + 0.6*0.1875) - 0
= 118.6873 psi

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8X6 LUG - WITH NO PAD

Lug material specification = A 240 304
Lug allowable stress = 18800 psi
Top plate width wp = 2 in
Base plate width wb = 4.75 in
Top plate thickness t = 0.5 in
Base plate thickness tb = 0.625 in
Lug length circ. direction L = 6 in
Gusset height h = 7 in
Gusset thickness tg = 0.5 in
Number of lugs = 4
Angular position, first lug = 0 degrees
Fillet weld size tw = 0.1875 in
Force bearing width Fb = 2 in
Distance to load d = 3.375 in

Lug top plate required thickness, Bednar pg 153

ta = 0.75*(VL*d*L)/(Sa*wp^2*h)
= 0.75*(4673*3.375*6)/(18800*2^2*7)
= 0.25 in

Lug gusset required thickness

Sc = 18000/(1 + (1/18000)*(h/(0.289*tg))^2)
= 18000/(1 + (1/18000)*(7/(0.289*0.5))^2)
= 15923.95 psi

tg = VL*(3*d - wb)/(Sc*wb^2*SIN(Alpha)^2)
= 4673*(3*3.375 - 4.75)/(15923.95*4.75^2*SIN(68.552)^2)
= 0.0807 in

Lug base plate required thickness

From Escoe table 4-8

fc = VL/(Fb*L) = 389.4167 psi

Mx = Cx*fc*Gs^2
= 0.0923*389.4167*5^2 = 898.5789

My = Cy*fc*wb^2
= -.126*389.4167*4.75^2 =-1107.063

tb = Sqr(6*Mmax / Sa)
= Sqr(6*1107.063 / 18800)
= 0.5944 in

Check lug attachment stresses

Radial load Pr = 0 lbf
Circumferential moment Mc = 0 lbf-ft
Circumferential shear Vc = 0 lbf

8X6 LUG - WITH NO PAD

Longitudinal moment	ML =	1314 lbf-ft
Longitudinal shear	VL =	4673 lbf
Internal pressure	P =	0 psi

Stresses at the lug edge per WRC bulletin 107 (psi)

Mean radius Rm = 22.40625 in
Rm/t = 119.5

C1 = 3, C2 = 4.0625 in

Stress concentration factor Kn (tension) = 1
Stress concentration factor Kb (bending) = 1

Local circ. pressure stress = P*Rm/t = 0 psi

Local long. pressure stress = P*Rm/2t = 0 psi

Maximum combined stress =-22614 psi
Allowable combined stress = +-3*S = +- 50100 psi

The maximum combined stress is within allowable limits.

Maximum primary membrane stress =-8672 psi
Allowable primary membrane stress = +-1.5*S = +- 25050 psi

The maximum primary membrane stress is within allowable limits.

8X6 LUG - WITH NO PAD

From Fig.	Value read	beta	Au	Al	Bu	Bl	Cu	Cl	Du	D
3C*	6.2968	0.182								
4C*	13.925	0.167								
1C	0.0603	0.149								
2C-1	0.0271	0.149								
3A*	4.6292	0.148								
1A	0.0651	0.155								
3B*	9.8548	0.164	-8672	-8672	8672	8672				
1B-1	0.0179	0.154	-13942	13942	13942	-13942				
pressure stress*										
Total circ stress			-22614	5270	22614	-5270				
Primary membrane circ stress*			-8672	-8672	8672	8672				
3C*	7.1198	0.167								
4C*	13.186	0.182								
1C-1	0.0491	0.169								
2C	0.0352	0.169								
4A*	10.031	0.148								
2A	0.0277	0.174								
4B*	4.2361	0.164	-4428	-4428	4428	4428				
2B-1	0.0209	0.172	-14636	14636	14636	-14636				
pressure stress*										
Total long stress			-19064	10208	19064	-10208				
Primary membrane long stress*			-4428	-4428	4428	4428				
torsion moment Mt										
Circ shear from Vc										
Long shear from VL							-1534	-1534	1534	15
Total Shear stress							-1534	-1534	1534	15
Combined stress			-22614	10208	22614	-10208	3068	3068	3068	30

NOTE: LAST COLUMN IS "DL" WITH VALUES IDENTICAL TO "DU"

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8X6 LUG - WITH NO PAD 2

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SPOOL B-2

ASME Section VIII Division 1, 1992 Edition, A94 Addenda

Component:	Cylinder
Material specification:	SA 240 304L HIGH

Corrosion allowance: Inner C = 0 Outer= 0 in

* PWHT is performed

Radiography: Category A joints - Spot UW-11(b) type 1
Category B joints - Spot UW-11(b) type 1

Estimated weight:	new = 546.3	corr = 546.3	lb
capacity:	new = 246.702	corr = 246.702	US ga

ID = 30.5 length Lc= 78 t = 0.25 in (new)

MAP: (New & at 0 deg F) UG-27(c)(1)

P = S*E*t/(R + 0.6*t) - Ps
= 16700*0.85*0.25/(15.25 + 0.6*0.25) - 0
= 230.4383 psi

MAWP: (Corroded & at 100 deg F) UG-27(c)(1)

P = S*E*t/(R + 0.6*t) - Ps
= 16700*0.85*0.25/(15.25 + 0.6*0.25) - 0
= 230.4383 psi

8X6 LUG - WITH NO PAD

```
Lug material specification        = A 240 304
Lug allowable stress              = 18800 psi
Top plate width                wp = 2 in
Base plate width               wb = 4.75 in
Top plate thickness             t = 0.5 in
Base plate thickness           tb = 0.625 in
Lug length circ. direction      L = 6 in
Gusset height                   h = 7 in
Gusset thickness               tg = 0.5 in
Number of lugs                    = 4
Angular position, first lug       = 0 degrees
Fillet weld size               tw = 0.1875 in
Force bearing width            Fb = 2 in
Distance to load                d = 3.375 in
```

Lug top plate required thickness, Bednar pg 153

```
ta = 0.75*(VL*d*L)/(Sa*wp^2*h)
   = 0.75*(3200*3.375*6)/(18800*2^2*7)
   = 0.25 in
```

Lug gusset required thickness

```
Sc = 18000/(1 + (1/18000)*(h/(0.289*tg))^2 )
   = 18000/(1 + (1/18000)*(7/(0.289*0.5))^2 )
   = 15923.95 psi

tg = VL*(3*d - wb)/(Sc*wb^2*SIN(Alpha)^2)
   = 3200*(3*3.375 - 4.75)/(15923.95*4.75^2*SIN(68.552)^2)
   = 0.0553 in
```

Lug base plate required thickness

```
From Escoe table 4-8

fc = VL/(Fb*L) = 266.6667 psi

Mx = Cx*fc*Gs^2
   = 0.0923*266.6667*5^2 = 615.3333

My = Cy*fc*wb^2
   = -.126*266.6667*4.75^2 =-758.1

tb = Sqr(6*Mmax / Sa)
   = Sqr(6*758.1 / 18800)
   = 0.4919 in
```

Check lug attachment stresses

```
Radial load                  Pr =  0 lbf
Circumferential moment       Mc =  0 lbf-ft
Circumferential shear        Vc =  0 lbf
```

8X6 LUG - WITH NO PAD

Longitudinal moment ML = 900 lbf-ft
Longitudinal shear VL = 3200 lbf
Internal pressure P = 0 psi

Stresses at the lug edge per WRC bulletin 107 (psi)

Mean radius Rm = 15.375 in
Rm/t = 61.5

C1 = 3, C2 = 4.0625 in

Stress concentration factor Kn (tension) = 1
Stress concentration factor Kb (bending) = 1

Local circ. pressure stress = P*Rm/t = 0 psi

Local long. pressure stress = P*Rm/2t = 0 psi

Maximum combined stress =-8055 psi
Allowable combined stress = +-3*S = +- 50100 psi

The maximum combined stress is within allowable limits.

Maximum primary membrane stress =-3214 psi
Allowable primary membrane stress = +-1.5*S = +- 25050 psi

The maximum primary membrane stress is within allowable limits.

8X6 LUG - WITH NO PAD

From Fig.	Value read	beta	Au	Al	Bu	Bl	Cu	Cl	Du	D
3C*	2.9982	0.265								
4C*	6.9678	0.243								
1C	0.0648	0.218								
2C-1	0.0231	0.218								
3A*	2.3063	0.216								
1A	0.0633	0.235								
3B*	4.8286	0.239	-3214	-3214	3214	3214				
1B-1	0.0164	0.231	-4792	4792	4792	-4792				
pressure stress*										
Total circ stress			-8006	1578	8006	-1578				
Primary membrane circ stress*			-3214	-3214	3214	3214				
3C*	3.3975	0.243								
4C*	6.5477	0.265								
1C-1	0.0403	0.247								
2C	0.0321	0.247								
4A*	5.4408	0.216								
2A	0.0254	0.263								
4B*	2.2933	0.239	-1831	-1831	1831	1831				
2B-1	0.0237	0.257	-6224	6224	6224	-6224				
pressure stress*										
Total long stress			-8055	4393	8055	-4393				
Primary membrane long stress*			-1831	-1831	1831	1831				
torsion moment Mt										
Circ shear from Vc										
Long shear from VL							-788	-788	788	8
Total Shear stress							-788	-788	788	8
Combined stress			-8055	4393	8055	-4393	1576	1576	1576	15

NOTE: LAST COLUMN IS "DL" WITH VALUES IDENTICAL TO "DU"

APPENDIX - A

Revised Stress Summary

Revision 0 of Doc No. V049-1-084 provided the design for the LIGO Expansion Joint Tie Rod "Lugs". The original design used 6400. lbs per rod for the "Lugs" on spool pieces BE–3 & BE–3A. The design loads for all other vacuum tubes with expansion joints used an axial spring rate of 7500. #/in.

All vacuum tubes are to undergo vacuum testing to check against leakage. Although the design loads are valid for operating conditions, the vacuum test will produce forces equivalent to those generated in Doc. No. V049-1-032 *Component Interface Loads*. Revision 1 uses these interface loads to evaluate stresses in vacuum tubes having tie rod lugs for expansion joints.

Revision 1 includes appendices to the original calculation. The force per lug from the component interface loads is factored against the loads used in Rev. 0. This ratio is applied to the tabulated stresses in Rev. 0 additionally, the local circumferential and longitudinal stresses at the lug are calculated and added to the membrane stresses. The resulting primary and primary plus secondary membrane stresses are compared against allowable stress limits at 400° F ("Bakeout" conditions).

Previous revisions inexplicably omitted spool BE–1, Revision 2 of Doc No. V049-1-084 evaluates BE–1. BE–1 has a shell thickness of 1/4 in. to alleviate the overstress condition due to the lugs *interaction* with the thin shell, repads are required at the lugs.

The results indicate that all vacuum tubes are within allowable Primary Membrane Stress limits at 400 F. All vacuum tubes require a minimum shell thickness of 0.250 inches. The exception is Beam Tube Manifolds: BE-3, BE-3A and BE-5 require a minimum shell thickness of 0.375 in. and Beam Tube Manifold BE–1 requires repads at the lugs (see pg A-16).

Note: To economize on material costs, vacuum tube BE-5 may be 0.250 in thick with the bellows section (60 inch length) at 0.375 in.

CORRECTED PRIMARY MEMBRANE STRESSES

SPOOL PIECE	I. D. Ø	Shell Thickness	Primary Stress (psi)	Stress Correction Factor Force/Rod ÷ Force/Rod	Local Stress		Corrected Primary Stress (psi)	Allowable Primary Stress (psi)	Stress Result
					Circ.σ	Long.σ			
BE-5	72.25 in.	3/8 in.	9588.	See page A-29	1431.	715.	11734.	22050. @ 400.° F	√
* BE-1	72.25 in.	1/4in.	9820.	See page A-20	2140.	1070.	13030.	22050. @ 400.° F	√
BE-3 & BE-3A	60.5 in.	3/8 in.	6062.	11365. ÷ 6400. = 1.776	1193.	597.	12555.	22050. @ 400.° F	√
A-13	60.5 in.	1/4in.	12905.	11365. ÷ 6400. = 2.362	1793.	897.	16725.	22050. @ 400.° F	√
A-2	48.25 in.	1/4in.	9583.	9813. ÷ 5053. = 1.942	1433.	717.	13861.	22050. @ 400.° F	√
A-1	44.63 in.	1/4in.	5482.	8467. ÷ 4673. = 1.812	1327.	663.	11923.	22050. @ 400.° F	√
B-2	30.5 in.	1/4in.	4966.	4128. ÷ 3194. = 1.292	911.	456.	7785.	22050. @ 400.° F	√

* BE-1 with 3/8 in. repads at lugs

CORRECTED PRIMARY + SECONDARY MEMBRANE STRESSES

SPOOL PIECE	I. D. Ø	Shell Thickness	Primary + Secondary σ	Stress Correction Factor (Force/Rod ÷ Force/Rod)	Local Stress		Corrected Stress Primary + Secondary	Allowable Stress Primary + Secondary	Stress Result
					Circ.σ	Long.σ			
BE-5	72.25 in.	3/8 in.	31316.	See page A-29	1431.	715.	33462.	44100. @ 400.° F	√
* BE-1	72.25 in.	1/4in.	25126.	See page A-20	2140.	1070.	28336.	44100. @ 400.° F	√
BE-3 & BE-3A	60.5 in.	3/8 in.	24261.	11365. ÷ 6400. = 1.776	1193.	597.	44872.	44100. @ 400.° F	2% over
A-13	60.5 in.	1/4in.	23871.	11365. ÷ 6400. = 2.362	1793.	897.	45080.	44100. @ 400.° F	2% over
A-2	48.25 in.	1/4in.	16274.	9813. ÷ 5053. = 1.942	1433.	717.	33755.	44100. @ 400.° F	√
A-1	44.63 in.	1/4in.	14739.	8467. ÷ 4673. = 1.812	1327.	663.	28696.	44100. @ 400.° F	√
B-2	30.5 in.	1/4in.	12259.	4128. ÷ 3194. = 1.292	911.	456.	17211.	44100. @ 400.° F	√

* BE-1 with 3/8 in. repads at lugs

COMPONENT INTERFACE LOADS   REF DOC No. V049-1-032

44.625" ϕ TUBE

$F = 25.4^{K}$

3 LUGS $\Rightarrow 25.4K/3 = 8.467\ ^{K}/\text{LUG}$

48.25" ϕ TUBE

$F = 29.44\ K$

3 LUGS $\Rightarrow 29.44\ K/3 = 9.8133\ ^{K}/\text{LUG}$

60.5" ϕ TUBE

$F = 45.46^{K}$

4 LUGS $\Rightarrow 45.46^{K}/4 = 11.365\ K/\text{LUG}$

72.25" ϕ TUBE

$F = 64.1^{K}$

4 LUGS $\Rightarrow 64.1^{K}/4 = 16.025\ ^{K}/\text{LUG}$

30.5" ϕ TUBE

$$F = \left(14.7\ \frac{\text{lbs}}{\text{IN}^2}\right)\frac{\left(30.5" + 2.25"\right)^2 \pi}{4} = 12383.\ \text{lbs.}$$

3 LUGS $\Rightarrow$ 12383 lbs / 3 LUGS = 4128 lbs/LUG.

B-2 30.5" ϕ TUBE 1/4" SHELL

Primary Membrane Stress

$$\sigma_M = 4966 \text{ psi} \left(\frac{4128 \text{ lbs.}}{3194 \text{ lbs}} \right)$$

$$= 6418 \text{ psi}$$

Primary + Secondary Stress

$$\sigma_{M_{P+S}} = 12259 \text{psi} \left(\frac{4128 \text{ lbs}}{3194 \text{ lbs}} \right) = 15844 \text{ psi}$$

· Local Circ. Stress (@ lug)

$$\sigma_C = \frac{(14.7 \text{\#}/\text{in}^2)(15.5 \text{ in})}{.25 \text{in}} = 911. \text{ psi}$$

· Local Long Stress (@ lug)

$$\sigma_L = \frac{(14.7 \text{\#}/\text{in}^2)(15.5 \text{in})}{2\ (.25 \text{in})} = 456 \text{psi}$$

Max Primary Membrane Stress

$$\sigma M = 6418 \text{psi} + 911 \text{psi} + 456 \text{ psi} = 7785 \text{ psi}$$

$$7785 \text{psi} < 22050 \text{ psi} @ 400°F$$
$$< 25050 \text{ psi} @ 100°F$$

Max Primary + Secondary Membrane Stress

$$\sigma M_{P+S} = 15844 \text{ psi} + 911 \text{ psi} + 456 \text{psi} = 17211 \text{ psi}$$

$$17211 \text{psi} < 44100 \text{psi} @ 400°F$$
$$< 50100 \text{psi} @ 100°F$$

44.625" ⌀ TUBE w/ 1/4" SHELL

A-1

- Primary Membrane Stress

$$\sigma_M = 5482\,\text{psi}\left(\frac{8467\ \text{lbs}}{4673\ \text{lbs}}\right) = 9933\,\text{psi}$$

- Primary + Secondary Membrane Stress

$$\sigma_{M_{P+S}} = 14739\,\text{psi}\left(\frac{8467\ \text{lbs}}{4673\ \text{lbs}}\right) = 26706\,\text{psi}$$

- Local Circ. Stress (@ Lug)

$$\sigma_C = \frac{(14.7\,\#/\text{in}^2)(22.5625\,\text{in})}{.25\,\text{in}} = 1327\,\text{psi}$$

- Local Long. Stress (@ Lug)

$$\sigma_L = \frac{(14.7\,\#/\text{in}^2)(22.5625\,\text{in})}{2\,(.25\,\text{in})} = 663.\,\text{psi}$$

Max Primary Membrane Stress

$$\sigma_M = 9933\,\text{psi} + 1327\,\text{psi} + 663\,\text{psi} = 11923\,\text{psi}$$

$$11923\,\text{psi} < 22050\,\text{psi}$$
$$< 25050\,\text{psi}$$

Max Primary + Secondary Membrane Stress

$$\sigma_{M_{P+S}} = 26706\,\text{psi} + 1327\,\text{psi} + 663\,\text{psi} = 28696\,\text{psi}$$

$$28696\,\text{psi} < 44100\,\text{psi}$$
$$< 50100\,\text{psi}$$

48.25" ϕ TUBE w/ 1/4" SHELL

A-2

- Primary Membrane Stress

$$\sigma_M = 6030\,psi\left(\frac{9813.3\,lbs}{5053\,lbs}\right) = 11711\,psi$$

- Primary + Secondary Membrane Stress

$$\sigma_{M_{P+S}} = 16274\,psi\left(\frac{9813.3\,lbs}{5053\,lbs}\right) = 31605.\,psi$$

- Local Circ. Stress (@ Lug)

$$\sigma_C = \frac{(14.7\#/in^2)(24.375\,in)}{.25\,in} = 1433.25\,psi \approx 1433\,psi$$

- Local Long. Stress (@ Lug)

$$\sigma_L = \frac{(14.7\#/in^2)(24.375\,in)}{2\,(.25\,in)} = 716.6\,psi \approx 717\,psi$$

Max Primary MEMBRANE STRESS

$$\sigma_M = 11711\,psi + 1433\,psi + 717\,psi = 13861\,psi$$

$$13861\,psi < 22050\,psi @ 400°F$$
$$< 25050\,psi @ 100°F$$

Max Primary + Secondary Membrane Stress

$$\sigma_{M_{P+S}} = 31605\,psi + 1433\,psi + 717\,psi = 33755\,psi$$

$$33755\,psi < 44100\,psi @ 400°F$$
$$< 50100\,psi @ 100°F$$

60.5"ϕ TUBE WITH 1/4" SHELL

A-13

- Primary Membrane Stress

$$\sigma_M = 7903\,psi \left(\frac{11365\ lbs}{6400\ lbs}\right) = 14035\ psi$$

- Primary + Secondary Membrane Stress

$$\sigma_{M_{P+S}} = 23871\,psi \left(\frac{11365\ lbs}{6400\ lbs}\right) = 42390\,psi$$

- Local circumferential stress (@ Lug)

$$\sigma_c = \frac{(14.7\,\#/in^2)(30.50\,in)}{.25\,in} = 1793.4 \approx 1793\ psi$$

- Local longitudinal stress (@ Lug)

$$\sigma_L = \frac{(14.7\,\#/in^2)(30.50\,in)}{2(.25\,in)} = 896.7\,psi \approx 897\,psi$$

Max Primary Membrane Stress

$$\sigma_M = 14035\,psi + 1793\,psi + 897\,psi = 16725\ psi$$

$$16725\,psi < 22050\ psi\ @\ 400°F$$
$$< 25050\ psi\ @\ 100°F$$

Max Primary + Secondary Membrane Stress

$$\sigma_{M_{P+S}} = 42390\,psi + 1793\,psi + 897\,psi = 45080\,psi$$

$$45080\,psi > 44100\,psi\ @\ 400°F \quad (2\%)$$
$$< 50100\,psi\ @\ 100°F$$

60.5" ϕ TUBE WITH 3/8" SHELL

BE-3 & BE-3A

Primary Membrane Stress

$$\sigma_M = 6062 \text{ psi} \left(\frac{11365 \text{ lbs}}{6400 \text{ lbs}} \right)$$

$$\sigma_M = 10765 \text{ psi}$$

Primary + Secondary Membrane Stress

$$\sigma_{M_{P+S}} = 24261 \text{ psi} \left(\frac{11365 \text{ lbs}}{6400. \text{ lbs}} \right)$$

$$\sigma_{M_{P+S}} = 43082. \text{ psi}$$

$$\sigma_L = \frac{(14.7^{\#}/in^2)(30.4375 in)}{2(.375 in)} = 596.6 psi \approx 597 psi$$

$$\sigma_C = \frac{(14.7^{\#}/in^2)(30.4375 in)}{.375 in} = 1193.15 psi \approx 1193 psi$$

Max Primary Membrane Stress

$$\sigma_M = 10765 psi + 597. psi + 1193 psi = 12555 psi$$

12555 psi < 22050 psi @ 400°F
< 25050 psi @ 100°F

Max Primary + Secondary Stress

$$\sigma_{M_{P+S}} = 43082 psi + 597 + 1193 = 44872 psi$$

44872 psi > 44100 psi @ 400°F (2%)
< 50100 psi @ 100°F

72.25" Φ TUBE w/ 1/4" SHELL

BE-1

I.D. = 72.25"
t = .25"

P = 16025 lbs. (PG A-3)

LOCAL CIRCUM. STRESS (@ LUG)

~~$\sigma_c = \frac{(14.7\#/in^2)(36\,3/8\,in)}{.25\,in} = 2138.85 \approx 2140$ psi~~

Local Long. stress

$$\sigma_L = \frac{(14.7\,\#/in^2)(36\,3/8\,in)}{2(.25\,in)} = 1070 \text{ psi}$$

BELLOWS BE-1 W/NO REPADS

ASME Section VIII Division 1, 1995 Edition, A95 Addenda

Component: Cylinder
Material specification: SA 240 304L HIGH

External design pressure: Pe= 14.7 psi @ 400 deg F

Corrosion allowance: Inner C = 0 Outer= 0 in

* PWHT is performed

Radiography: Category A joints - Spot UW-11(b) type 1
Category B joints - Spot UW-11(b) type 1

Estimated weight: new = 983.9 corr = 983.9 lb
capacity: new = 1050.201 corr = 1050.201 US ga

OD = 72.25 length Lc= 60 t = 0.25 in (new)

MAP: (New & at 400 deg F) Appendix 1-1(a)

P = S*E*t/(Ro - 0.4*t) - Ps
= 14700*0.85*0.25/(36.125 - 0.4*0.25) - 0
= 86.71062 psi

MAWP: (Corroded & at 400 deg F) Appendix 1-1(a)

P = S*E*t/(Ro - 0.4*t) - Ps
= 14700*0.85*0.25/(36.125 - 0.4*0.25) - 0
= 86.71062 psi

External Pressure: (Corroded & at 400 deg F) UG-28

L/Do = 75.95833/72.25 = 1.0513 Do/t = 72.25/0.24489 = 295.0304
From table G: A = 0.000249
From table HA-3: B = 3287

Pa= 4*B/(3*Do/t)
= 4*3287/(3*72.25/0.24489)
= 14.855 psi

Design thickness for external pressure Pa = 14.855 psi:

= t + Corrosion
= 0.24489 + 0
= 0.24489 in

Maximum Allowable External Pressure: (Corroded @ 400 deg F)

L/Do = 75.95833/72.25 = 1.0513 Do/t = 72.25/0.25 = 289
From table G: A = 0.000258
From table HA-3: B = 3407

Pa= 4*B/(3*Do/t)

BELLOWS BE-1 W/NO REPADS

= 4*3407/(3*72.25/0.25)
= 15.7186 psi

BE-1 Lug (Without Pad)

Lug material specification = A 240 304
Lug allowable stress = 18800 psi
Top plate width wp = 2 in
Base plate width wb = 4.75 in
Top plate thickness t = 0.5 in
Base plate thickness tb = 1.125 in
Lug length circ. direction L = 6 in
Gusset height h = 7 in
Gusset thickness tg = 0.5 in
Number of lugs = 4
Angular position, first lug = 0 degrees
Fillet weld size tw = 0.1875 in
Force bearing width Fb = 2 in
Distance to load d = 3.375 in

Lug top plate required thickness, Bednar pg 153

ta = 0.75*(VL*d*L)/(Sa*wp^2*h)
= 0.75*(16025*3.375*6)/(18800*2^2*7)
= 0.4623 in

Lug gusset required thickness

Sc = 18000/(1 + (1/18000)*(h/(0.289*tg))^2)
= 18000/(1 + (1/18000)*(7/(0.289*0.5))^2)
= 15923.95 psi

tg = VL*(3*d - wb)/(Sc*wb^2*SIN(Alpha)^2)
= 16025*(3*3.375 - 4.75)/(15923.95*4.75^2*SIN(68.552)^2)
= 0.2767 in

Lug base plate required thickness

From Escoe table 4-8

fc = VL/(Fb*L) = 1335.417 psi

Mx = Cx*fc*Gs^2
= 0.0923*1335.417*5^2 = 3081.474

My = Cy*fc*wb^2
= -.126*1335.417*4.75^2 =-3796.423

tb = Sqr(6*Mmax / Sa)
= Sqr(6*3796.423 / 18800)
= 1.1007 in

Check lug attachment stresses

Radial load Pr = 0 lbf
Circumferential moment Mc = 0 lbf-ft
Circumferential shear Vc = 0 lbf
Longitudinal moment ML = 4507 lbf-ft
Longitudinal shear VL = 16025 lbf

BE-1 Lug (Without Pad)

Internal pressure P = 0 psi

Stresses at the lug edge per WRC bulletin 107 (psi)

Mean radius Rm = 36 in
Rm/t = 144

C1 = 3, C2 = 4.3125 in

Stress concentration factor Kn (tension) = 1
Stress concentration factor Kb (bending) = 1

Local circ. pressure stress = P*Rm/t = 0 psi

Local long. pressure stress = P*Rm/2t = 0 psi

Maximum combined stress = -61030 psi
Allowable combined stress = +-3*S = +- 44100 psi

WARNING! The maximum combined stress is excessive.

Maximum primary membrane stress = -19543 psi
Allowable primary membrane stress = +-1.5*S = +- 22050 psi

The maximum primary membrane stress is within allowable limits.

BE-1 Lug (Without Pad)

From Fig.	Value read	beta	Au	Al	Bu	Bl	Cu	Cl	Du	Dl
3C*	11.760	0.119								
4C*	19.928	0.108								
1C	0.0817	0.095								
2C-1	0.0484	0.095								
3A*	5.5914	0.094								
1A	0.0795	0.098								
3B*	14.567	0.106	-19543	-19543	19543	19543				
1B-1	0.0282	0.098	-41487	41487	41487	-41487				
pressure stress*										
Total circ stress			-61030	21944	61030	-21944				
Primary membrane circ stress*			-19543	-19543	19543	19543				
3C*	12.996	0.108								
4C*	19.113	0.119								
1C-1	0.0720	0.11								
2C	0.0436	0.11								
4A*	10.157	0.094								
2A	0.0375	0.11								
4B*	5.5915	0.106	-9432	-9432	9432	9432				
2B-1	0.0349	0.11	-45885	45885	45885	-45885				
pressure stress*										
Total long stress			-55317	36453	55317	-36453				
Primary membrane long stress*			-9432	-9432	9432	9432				
torsion moment Mt										
Circ shear from Vc										
Long shear from VL							-3716	-3716	3716	3716
Total Shear stress							-3716	-3716	3716	3716
Combined stress			-61030	36453	61030	-36453	7432	7432	7432	7432

BELLOWS BE-1 W/REPADS

ASME Section VIII Division 1, 1995 Edition, A95 Addenda

Component:	Cylinder
Material specification:	SA 240 304L HIGH

External design pressure: Pe= 14.7 psi @ 400 deg F

Corrosion allowance: Inner C = 0 Outer= 0 in

* PWHT is performed

Radiography: Category A joints - Spot UW-11(b) type 1
Category B joints - Spot UW-11(b) type 1

Estimated weight: new = 983.9 corr = 983.9 lb
capacity: new = 1050.201 corr = 1050.201 US ga

OD = 72.25 length Lc= 60 t = 0.25 in (new)

MAP: (New & at 400 deg F) Appendix 1-1(a)

P = S*E*t/(Ro - 0.4*t) - Ps
= 14700*0.85*0.25/(36.125 - 0.4*0.25) - 0
= 86.71062 psi

MAWP: (Corroded & at 400 deg F) Appendix 1-1(a)

P = S*E*t/(Ro - 0.4*t) - Ps
= 14700*0.85*0.25/(36.125 - 0.4*0.25) - 0
= 86.71062 psi

External Pressure: (Corroded & at 400 deg F) UG-28

L/Do = 75.95833/72.25 = 1.0513 Do/t = 72.25/0.24489 = 295.0304
From table G: A = 0.000249
From table HA-3: B = 3287

Pa= 4*B/(3*Do/t)
= 4*3287/(3*72.25/0.24489)
= 14.855 psi

Design thickness for external pressure Pa = 14.855 psi:

= t + Corrosion
= 0.24489 + 0
= 0.24489 in

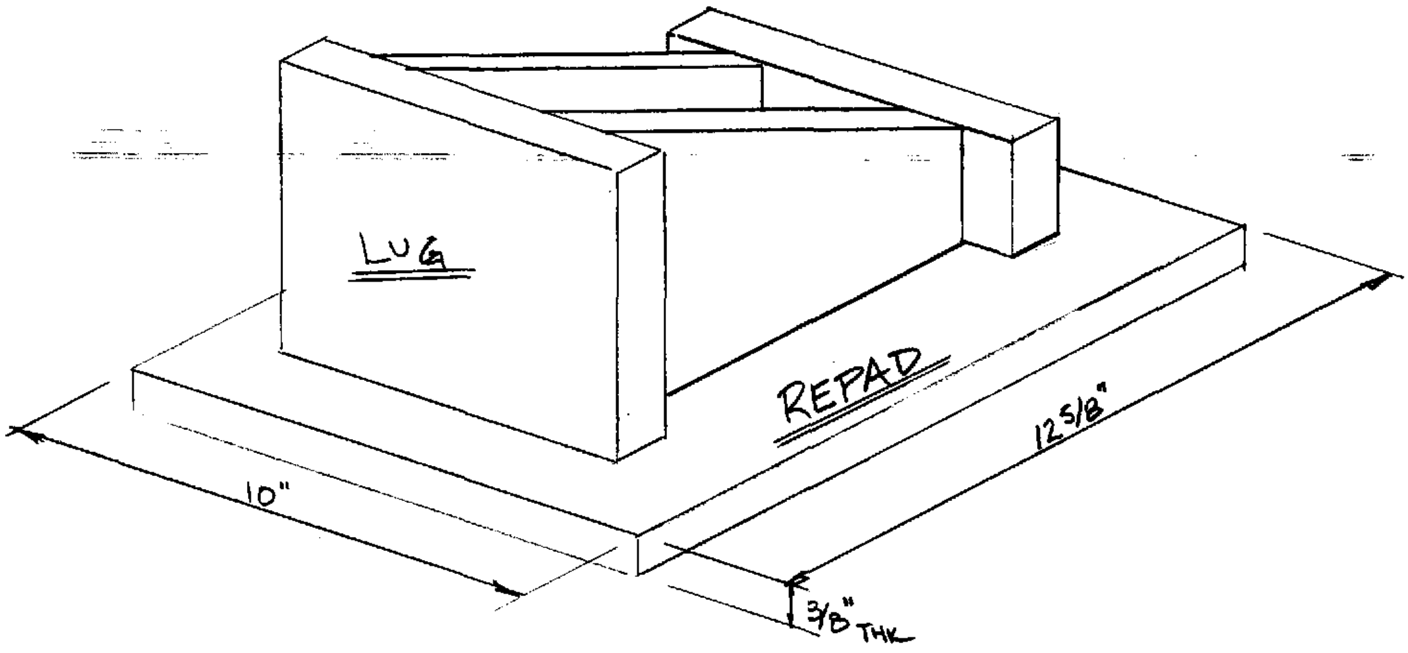
Maximum Allowable External Pressure: (Corroded @ 400 deg F)

L/Do = 75.95833/72.25 = 1.0513 Do/t = 72.25/0.25 = 289
From table G: A = 0.000258
From table HA-3: B = 3407

Pa= 4*B/(3*Do/t)

BELLOWS BE-1 W/REPADS

= 4*3407/(3*72.25/0.25)
= 15.7186 psi



REPAD 3/8" THK × 12 3/8" LONG × 10" WIDE

NOTE:

PAD TO SHELL WELD IS 3/16" fillet (all-around)

LUG TO REPAD WELD IS 1/4" fillet (all-around)

BE-1 Lug (With Pad)

Lug material specification = A 240 304
Lug allowable stress = 18800 psi
Top plate width wp = 2 in
Base plate width wb = 4.75 in
Top plate thickness t = 0.5 in
Base plate thickness tb = 1.125 in ✳ ACTUAL THKS 1/2" but WASHER PL IS 1" THK
∴ TOTAL THKS = 1 1/2" > 1.125"
CONSERVATIVE
Lug length circ. direction L = 6 in
Gusset height h = 7 in
Gusset thickness tg = 0.5 in
Number of lugs = 4
Angular position, first lug = 0 degrees
Fillet weld size tw = 0.1875 in
Force bearing width Fb = 2 in
Distance to load d = 3.375 in

Lug top plate required thickness, Bednar pg 153

ta = 0.75*(VL*d*L)/(Sa*wp^2*h)
= 0.75*(16025*3.375*6)/(18800*2^2*7)
= 0.4623 in

Lug gusset required thickness

Sc = 18000/(1 + (1/18000)*(h/(0.289*tg))^2)
= 18000/(1 + (1/18000)*(7/(0.289*0.5))^2)
= 15923.95 psi

tg = VL*(3*d - wb)/(Sc*wb^2*SIN(Alpha)^2)
= 16025*(3*3.375 - 4.75)/(15923.95*4.75^2*SIN(68.552)^2)
= 0.2767 in

Lug base plate required thickness

From Escoe table 4-8

fc = VL/(Fb*L) = 1335.417 psi

Mx = Cx*fc*Gs^2
= 0.0923*1335.417*5^2 = 3081.474

My = Cy*fc*wb^2
= -.126*1335.417*4.75^2 =-3796.423

tb = Sqr(6*Mmax / Sa)
= Sqr(6*3796.423 / 18800)
= 1.1007 in

Check lug attachment stresses

Radial load Pr = 0 lbf
Circumferential moment Mc = 0 lbf-ft
Circumferential shear Vc = 0 lbf
Longitudinal moment ML = 4507 lbf-ft
Longitudinal shear VL = 16025 lbf

BE-1 Lug (With Pad)

Internal pressure P = 0 psi

Stresses at the lug edge per WRC bulletin 107 (psi)

Mean radius Rm = 36 in
Rm/t = 57.6

C1 = 3, C2 = 4.3125 in

Stress concentration factor Kn (tension) = 1
Stress concentration factor Kb (bending) = 1

Local circ. pressure stress = P*Rm/t = 0 psi

Local long. pressure stress = P*Rm/2t = 0 psi

Maximum combined stress = -12922 psi
Allowable combined stress = +-3*S = +- 44100 psi

The maximum combined stress is within allowable limits.

Maximum primary membrane stress = -3546 psi
Allowable primary membrane stress = +-1.5*S = +- 22050 psi

The maximum primary membrane stress is within allowable limits.

BE-1 Lug (With Pad)

```
 ___________________________________________________________________________________________
| From| Value  | beta|
| Fig.| read   |     |    Au      Al      Bu      Bl      Cu      Cl      Du      Dl
|_____|________|_____|______________________________________________________________________
| 3C* |7.3557  |0.119|
| 4C* |9.5108  |0.108|
| 1C  |0.1138  |0.095|
| 2C-1|0.0794  |0.095|
| 3A* |1.9292  |0.094|
| 1A  |0.0925  |0.102|
| 3B* |6.5090  |0.106|  -3546   -3546    3546    3546
| 1B-1|0.0410  |0.102|  -9272    9272    9272   -9272
| pressure stress*   |
|____________________|______________________________________________________________________
| Total circ stress  | -12818    5726   12818   -5726
| Primary membrane   |
| circ stress*       |  -3546   -3546    3546    3546
|____________________|______________________________________________________________________
| 3C* |7.8410  |0.108|
| 4C* |9.2595  |0.119|
| 1C-1|0.1038  |0.11 |
| 2C  |0.0684  |0.11 |
| 4A* |2.8344  |0.094|
| 2A  |0.0468  |0.116|
| 4B* |1.9932  |0.106|  -1341   -1341    1341    1341
| 2B-1|0.0575  |0.115| -11581   11581   11581  -11581
| pressure stress*   |
|____________________|______________________________________________________________________
| Total long stress  | -12922   10240   12922  -10240
| Primary membrane   |
| long stress*       |  -1341   -1341    1341    1341
|____________________|______________________________________________________________________
| torsion moment Mt  |
| Circ shear from Vc |
| Long shear from VL |                                  -1486   -1486    1486    1486
|____________________|______________________________________________________________________
| Total Shear stress |                                  -1486   -1486    1486    1486
|____________________|______________________________________________________________________
| Combined stress    | -12922   10240   12922  -10240    2972    2972    2972    2972
|____________________|______________________________________________________________________
```

BE-1 Lug (With Pad)

Stresses at the pad edge per WRC bulletin 107 (psi)

Mean radius Rm = 36 in
Rm/t = 144

C1 = 5, C2 = 6.3125 in

Stress concentration factor Kn (tension) = 1
Stress concentration factor Kb (bending) = 1

Local circ. pressure stress = P*Rm/t = 0 psi

Local long. pressure stress = P*Rm/2t = 0 psi

Maximum combined stress = -25126 psi
Allowable combined stress = +-3*S = +- 44100 psi

The maximum combined stress is within allowable limits.

Maximum primary membrane stress = -9820 psi
Allowable primary membrane stress = +-1.5*S = +- 22050 psi

The maximum primary membrane stress is within allowable limits.

BE-1 Lug (With Pad)

From Fig.	Value read	beta	Au	Al	Bu	Bl	Cu	Cl	Du	Dl
3C*	6.8370	0.177								
4C*	16.042	0.165								
1C	0.0600	0.151								
2C-1	0.0238	0.151								
3A*	5.2855	0.15								
1A	0.0626	0.157								
3B*	10.997	0.162	-9820	-9820	9820	9820				
1B-1	0.0162	0.153	-15306	15306	15306	-15306				
pressure stress*										
Total circ stress			-25126	5486	25126	-5486				
Primary membrane circ stress*			-9820	-9820	9820	9820				
3C*	7.5546	0.165								
4C*	15.323	0.177								
1C-1	0.0470	0.167								
2C	0.0353	0.167								
4A*	12.228	0.15								
2A	0.0267	0.172								
4B*	4.7200	0.162	-4972	-4972	4972	4972				
2B-1	0.0194	0.168	-16694	16694	16694	-16694				
pressure stress*										
Total long stress			-21666	11722	21666	-11722				
Primary membrane long stress*			-4972	-4972	4972	4972				
torsion moment Mt										
Circ shear from Vc										
Long shear from VL							-2539	-2539	2539	2539
Total Shear stress							-2539	-2539	2539	2539
Combined stress			-25126	11722	25126	-11722	5078	5078	5078	5078

72.25" ϕ TUBE w/ 3/8" SHELL

BE-5

PRIMARY MEMBRANE STRESS

$\sigma_M = 9588 psi$

PRIMARY + SECONDARY MEMBRANE STRESS

$\sigma_{M_{P+S}} = 31316 psi$

Local circ. stress (@ Lug)

$$\sigma_C = \frac{(14.7^{\#}/in^2)(36.5 in)}{.375 in} = 1430.8 psi \approx 1431 psi$$

Local Long. stress (@ Lug)

$$\sigma_L = \frac{(14.7^{\#}/in^2)(36.5 in)}{2(.375 in)} = 715 psi$$

Max Primary Membrane Stress

$\sigma_M = 9588 psi + 1431 psi + 715 psi = 11734 psi$

$\sigma_M = 11734 psi < 22050 psi @ 400°F$
$< 25050 psi @ 100°F$

Max Primary + Secondary Membrane Stress

$\sigma_{M_{P+S}} = 31316 psi + 1431 psi + 715 psi$
$= 33462 psi < 44100 psi @ 400°F$
$< 50100 psi @ 100°F$

Pressure Summary

Pressure summary for pressure chamber 1

Identifier	P design (psi)	T design (deg F)	MAWP (psi)	MAP (psi)	Pe external (psi)	UG-99 Ratio	UCS-66 MDMT (deg F)	Exemption or Stress Reduction	Corrosion Allowance (in)
Bellows Spool BE-5	0.0	400.0	128.9	146.4	33.5	1.136		Not applicable	0.000

Vessel MAWP hot & corroded is 128.9 psi @ 400 degrees F.

Vessel MAP new & cold is 146.44 psi @ 0 degrees F.

Vessel allowable external pressure is 33.54 psi @ 400 degrees F.

Hydrotest pressure calculation based on MAWP

= 1.5*(MAWP + Operating Liquid Head)*1.136 = 219.7 psi

Vessel hydrotest pressure is 219.7 psi.

Note: vessel MAP rating not valid unless hydrotest pressure based on MAP.

Weight Summary

```
Component -------------------------  Weight (lbs) Contributed by Vessel Elements ----------------------------
                 Metal   Metal   Trays  Packed   Insul  Lining  Piping  Ladder   Rings    Oper    Test  Nozzle
                   New    Corr   & sup    Beds                          & plat  & Misc  Liquid  Liquid   & flg
-------------------------------------------------------------------------------------------------------------
Bellows spool b   1563    1563       0       0       0       0       0       0       0       0    9326       0
_______________ _______ _______ _______ _______ _______ _______ _______ _______ _______ _______ _______ _______
                  1563    1563       0       0       0       0       0       0       0       0    9326       0


Vessel operating weight, corroded:   1,563 lbs
Vessel empty weight, corroded:       1,563 lbs
Vessel empty weight, new:            1,563 lbs
Vessel test weight, new:             10,889 lbs
```

Vessel center of gravity location (from right weld seam)

Vessel lift weight, new: 1,563 lbs
Center of gravity to seam: 31.5 in

Thickness Summary

```
-----------------------------------------------------------------------------------------------
Component                ID       Length    Nom t    Req t   Joint         Governing          Deflect
Identifier              (in)       (in)     (in)     (in)      E      Load    Status   Stress   (in)
-----------------------------------------------------------------------------------------------
Bellows spool be-5     72.25      63.00    0.3750   0.2503   0.85   external
-----------------------------------------------------------------------------------------------
```

Nom t - vessel wall thickness
Req t - required vessel wall thickness due to governing loading
E - longitudinal seam joint efficiency

Load:
internal - circ stress due to internal pressure governs
external - external pressure governs
wind - combined long stress due to STATUS + wind governs
seismic - combined long stress due to STATUS + seismic governs

Bellows Spool BE-5

ASME Section VIII Division 1, 1995 Edition, A95 Addenda

Component:	Cylinder
Material specification:	SA 240 304L HIGH

External design pressure: Pe= 14.7 psi @ 400 deg F

Corrosion allowance: Inner C = 0 Outer= 0 in

* PWHT is performed

Radiography: Category A joints - Spot UW-11(b) type 1
Category B joints - Spot UW-11(b) type 1

Estimated weight: new = 1563.2 corr = 1563.2 lb
capacity: new = 1118.134 corr = 1118.134 US ga

ID = 72.25 length Lc= 63 t = 0.375 in (new)

MAP: (New & at 0 deg F) UG-27(c)(1)

P = S*E*t/(R + 0.6*t) - Ps
= 16700*0.85*0.375/(36.125 + 0.6*0.375) - 0
= 146.4409 psi

MAWP: (Corroded & at 400 deg F) UG-27(c)(1)

P = S*E*t/(R + 0.6*t) - Ps
= 14700*0.85*0.375/(36.125 + 0.6*0.375) - 0
= 128.903 psi

External Pressure: (Corroded & at 400 deg F) UG-28

L/Do = 79.04167/73 =1.0828 Do/t = 73/0.25037 = 291.5685
From table G: A = 0.000247
From table HA-3: B = 3260.4

Pa= 4*B/(3*Do/t)
= 4*3260.4/(3*73/0.25037)
= 14.9097 psi

Design thickness for external pressure Pa = 14.9097 psi:

= t + Corrosion
= 0.25037 + 0
= 0.25037 in

Maximum Allowable External Pressure: (Corroded @ 400 deg F)

L/Do = 79.04167/73 =1.0828 Do/t = 73/0.375 = 194.6667
From table G: A = 0.000457
From table HA-3: B = 4896.7

Bellows Spool BE-5

Pa= 4*B/(3*Do/t)
= 4*4896.7/(3*73/0.375)
= 33.539 psi

8x6 LUG - WITH NO PAD

Lug material specification	= A 240 304
Lug allowable stress	= 18800 psi
Top plate width	wp = 2 in
Base plate width	wb = 4.75 in
Top plate thickness	t = 0.5 in
Base plate thickness	tb = 1.125 in
Lug length circ. direction	L = 6 in
Gusset height	h = 7 in
Gusset thickness	tg = 0.5 in
Number of lugs	= 4
Angular position, first lug	= 0 degrees
Fillet weld size	tw = 0.25 in
Force bearing width	Fb = 2 in
Distance to load	d = 3.375 in

Lug top plate required thickness, Bednar pg 153

ta = 0.75*(VL*d*L)/(Sa*wp^2*h)
= 0.75*(16025*3.375*6)/(18800*2^2*7)
= 0.4623 in

Lug gusset required thickness

Sc = 18000/(1 + (1/18000)*(h/(0.289*tg))^2)
= 18000/(1 + (1/18000)*(7/(0.289*0.5))^2)
= 15923.95 psi

tg = VL*(3*d - wb)/(Sc*wb^2*SIN(Alpha)^2)
= 16025*(3*3.375 - 4.75)/(15923.95*4.75^2*SIN(68.552)^2)
= 0.2767 in

Lug base plate required thickness

From Escoe table 4-8

fc = VL/(Fb*L) = 1335.417 psi

Mx = Cx*fc*Gs^2
= 0.0923*1335.417*5^2 = 3081.474

My = Cy*fc*wb^2
= -.126*1335.417*4.75^2 =-3796.423

tb = Sqr(6*Mmax / Sa)
= Sqr(6*3796.423 / 18800)
= 1.1007 in

Check lug attachment stresses

Radial load	Pr = 0 lbf
Circumferential moment	Mc = 0 lbf-ft
Circumferential shear	Vc = 0 lbf

8x6 LUG - WITH NO PAD

Longitudinal moment	ML = 4507 lbf-ft
Longitudinal shear	VL = 16025 lbf
Internal pressure	P = 0 psi

Stresses at the lug edge per WRC bulletin 107 (psi)

Mean radius Rm = 36.3125 in
Rm/t = 96.83334

C1 = 3, C2 = 4.3125 in

Stress concentration factor Kn (tension) = 1
Stress concentration factor Kb (bending) = 1

Local circ. pressure stress = P*Rm/t = 0 psi

Local long. pressure stress = P*Rm/2t = 0 psi

Maximum combined stress =-31316 psi
Allowable combined stress = +-3*S = +- 44100 psi

The maximum combined stress is within allowable limits.

Maximum primary membrane stress =-9588 psi
Allowable primary membrane stress = +-1.5*S = +- 22050 psi

The maximum primary membrane stress is within allowable limits.

8x6 LUG - WITH NO PAD

From Fig.	Value read	beta	Au	Al	Bu	Bl	Cu	Cl	Du	Dl
3C*	10.196	0.118								
4C*	14.666	0.107								
1C	0.0937	0.094								
2C-1	0.0598	0.094								
3A*	3.6058	0.093								
1A	0.0843	0.098								
3B*	10.778	0.105	-9588	-9588	9588	9588				
1B-1	0.0339	0.099	-21728	21728	21728	-21728				
pressure stress*										
Total circ stress			-31316	12140	31316	-12140				
Primary membrane circ stress*			-9588	-9588	9588	9588				
3C*	11.128	0.107								
4C*	14.149	0.118								
1C-1	0.0812	0.109								
2C	0.0513	0.109								
4A*	5.8491	0.093								
2A	0.0409	0.112								
4B*	3.7668	0.105	-4010	-4010	4010	4010				
2B-1	0.0427	0.112	-24320	24320	24320	-24320				
pressure stress*										
Total long stress			-28330	20310	28330	-20310				
Primary membrane long stress*			-4010	-4010	4010	4010				
torsion moment Mt										
Circ shear from Vc										
Long shear from VL							-2477	-2477	2477	2477
Total Shear stress							-2477	-2477	2477	2477
Combined stress			-31316	20310	31316	-20310	4954	4954	4954	4954

APPENDIX - B

Lug Detail For Test Condition

Revision 0 of Doc No. V049-1-084 provided the design for the LIGO Expansion Joint Tie Rod "Lugs". The original design used 6400. lbs per rod for the "Lugs" on spool pieces BE-3 and BE-3A. The design loads for all other vacuum tubes with expansion joints used an axial spring rate of 7500. #/in.

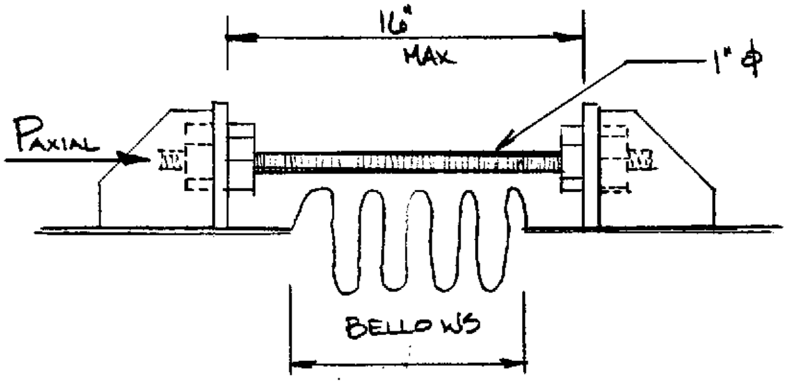
All vacuum tubes are to undergo vacuum testing to check against leakage. Although the design loads are valid for operating conditions, the vacuum test will produce compressive forces at the expansion joint rods which may produce minor bending. Revision 1 uses these compressive forces to evaluate the tie rods.

The evaluation indicated a 15% overstress in the tie rods due to the applied compressive load. Revision 1, Appendix 'B' provided a tie rod/lug detail to be used during vacuum/pressure testing of the vacuum tubes.. Though a margin exists between local bending and member yielding, tie rods were to be sleeved during testing conditions to ensure against potential bending.

Revision 2, Appendix 'B' uses the maximum axial forces indicated in appendix 'A'. The evaluation denotes that for tube sizes of 48-1/2"∅ and smaller, the 1"∅ (A-36) rods were acceptable. However, for 60-1/2"∅ and 72-1/4"∅ tubes, 1-1/4"∅ (A-36) rods are required.

COMPRESSION IN LUG BOLTS

(TEST CONDITION)



1"φ A-36 THREADED ROD
DOUBLE NUTS @ ENDS.

ROD MAT'L
A-36
$F_y = 36000$ psi

ASSUME : DOUBLE NUTS ACT AS A RIGID ANCHOR AT EACH END.

$$KL/r = .5\,(16\,in)/r$$

1"φ rod ⇒ root dia. = 0.865 in (AISC pg 4-147)

$$r = 0.865/4 = 0.21625$$

$$KL/r = 0.5\,(16\,in)/0.21625 = 36.994 \approx 37$$

$F_A = 19420$ psi (AISC pg 3-16)

For Tubes up to 48 1/4" I.D. $P_{MAX} = 9813$ lbs (ref. Pg A-3)

$$f_A = \frac{P}{A} = \frac{9813\text{ lbs}}{\text{AREA ROD}}$$

A = MIN ROOT AREA (pg. 4-147)
= 0.551 in²

$$= \frac{12300\text{ lbs}}{0.551\text{ in}}$$

$$f_A = 17800.\text{ psi}$$

$f_A < F_A$ ∴ O.K. for 48 1/4"φ (I.D.) & smaller tube sizes.

FOR 60.5" ϕ & 72.25" ϕ TUBES

$P_{MAX} = 16.025K$ (REF. Pg A-3)

$$f_a = \frac{16025 \text{ lbs}}{.551 \text{ in}^2} \approx 29000 \text{ \#/in}^2$$

$f_a > F_a$

29000. psi > 19420. psi ∴ N.G.

TRY 1¼" ϕ THREADED ROD (A-36)

$A_{min} = .890 \text{ in}^2$

$$f_a = \frac{16025 \text{ lbs}}{.890 \text{ in}^2} \approx 18000 \text{ psi}$$

$D_{min} = 1.095 \text{ in}$

$$I = \frac{\pi R^4}{4} = \frac{\pi (1.095\text{in}/2)^4}{4}$$

$$= .07057 \text{ in}^4$$

$$r = \left(\frac{I}{A}\right)^{1/2} = \left(\frac{.07057\text{ in}^4}{.890 \text{ in}^2}\right)^{1/2} = .2816 \text{ in}$$

$$\frac{KL}{r} = \frac{.5(16\text{ in})}{.2816\text{ in}} = 28.4$$

$F_a = 20\text{ksi} > f_a$ ∴ O.K.

APPENDIX - C

Reinforcing Washer Plate as an Option to Welded Pad

Revision 0 of Doc No. V049-1-084 provided the design for the LIGO Expansion Joint Tie Rod "Lugs". The original design required a welded 4″ x 3 ¾″ x 3/8″ thick reinforcing pad. To minimize welding and ensure design integrity the option of using a thicker washer was evaluated.

The evaluation indicated that a washer plate 3″ x 5″ x 1″ thick could be used in lieu of the welded pad. Revision 1, Appendix 'C' provides a washer design and detail which may be used for the expansion joint tie-rod "Lugs".

WASHER PLATE (BEARING PLATE) FOR LOG

MTL: A588 , $F_y = 50$ KSI MIN

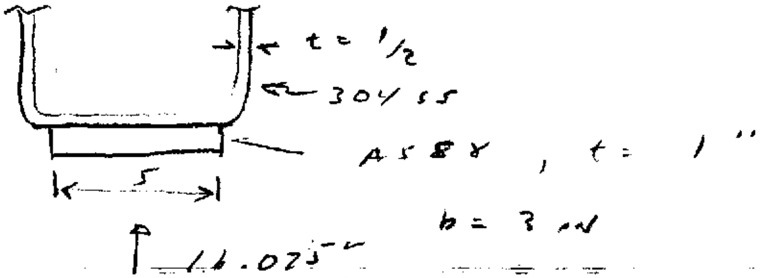
$t = .5$

REF DWG V049-4-124

$L = 5$ IN

THE MAX FORCE DURING LEAK CHECK IS

$P = 16.025^k$ (P. A-2)

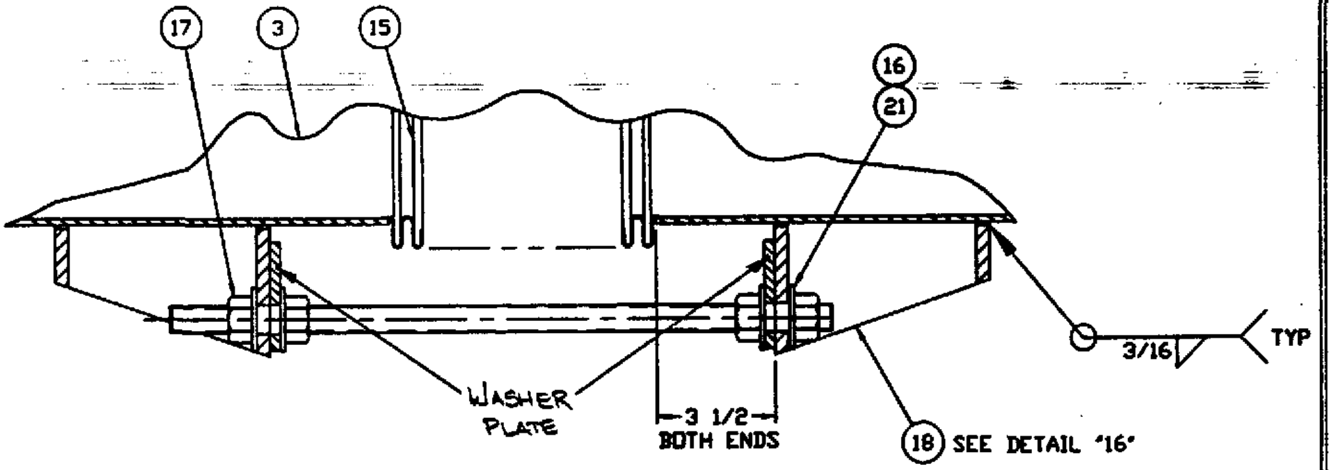


NEGLECT BENDING RESISTANCE OF 304 SS TUBE, ASSUME A588 PLATE TAKES ALL BENDING FOR LEAK CHECK

$$M = \frac{16.025(5)}{4} \quad 20.0 \text{ IN-K}$$

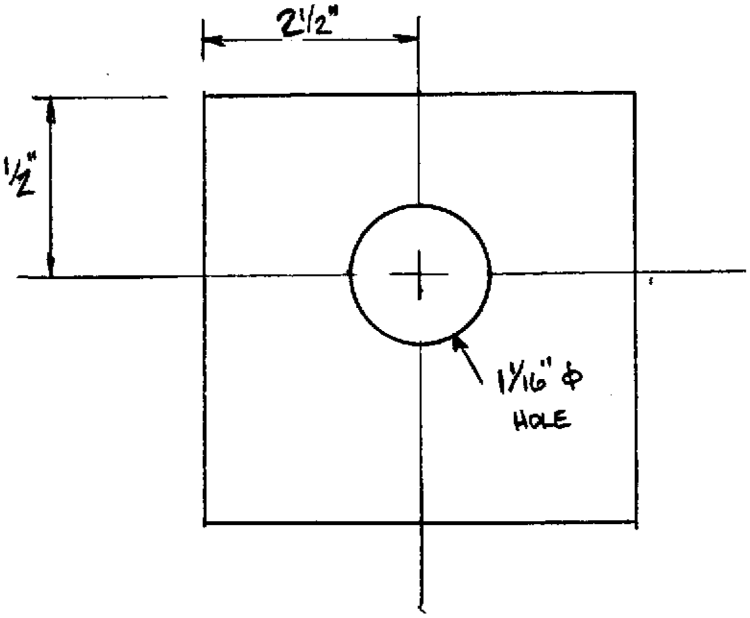
$$f_b = \frac{6M}{bt^2} = \frac{6(20.0)}{3(1)^2} = 40 \text{ KSI}$$

$< F_y$ OK FOR TEST CONDITION, NEGLECTS SHAPE ACTION FOR RECTANGULAR SECTION



TYPICAL

EXPANSION JOINT & TIE-ROD ASSY.
QTY: 3



WASHER
PL 3" x 5" x 1" THK

PROCESS SYSTEMS INTERNATIONAL, INC.
WESTBOROUGH, MA

ENGINEERING
CALCULATIONS

NO: V049-1-108
PAGE 1 OF 34

REV.	DEO #	DATE	BY:	CHECK
0	0293	9/30/96	RDC	WDB

TITLE:

Stiffener Rings at Axial Restraints of Tubular Components

BY: R. D. Ciatto
DEPT.: 744

PROJECT: LIGO Vacuum Equipment

PROJECT NO: V59049

PURPOSE: Determine size and thickness of stiffener rings at axial restraints of tubular components including mode cleaner tubes (30.5 in), adapters B-6 and B-7 (48.25 in), beam tube manifolds (72.25 in), and outer shells of 80k pumps (80 in).

METHOD: Local finite element models of shells at the stiffener rings were generated at axial restraints. The shell models extended at least a long shell distance from the stiffener ring. Axial forces resulting from closed valves or unbalanced forces due to different size bellows were applied to the ring at the junction of the axial restraint diagonal member.

ASSUMPTIONS: The axial restraint at the 80k pump is assumed to be enveloped by the beam tube manifold which is almost the same diameter (72.25 in vs. 80 in) but which has a significantly higher axial force (38.13 k vs. 27.57 k).

INPUTS: LIGO project drawings of spools and adapters.
Calc. No. V049-1-066, Structural Design Criteria
Calc. No. V049-1-083 for axial force on 80k pump (27.57 k).
Calc. No. V049-1-095 for axial force on 48.25 in tube (32.17 k).
Calc. No. V049-1-089 for axial force on beam tube manifold (38.13 k).

REFERENCES: ASME Boiler & Pressure Vessel Code, Sect. VIII, Div. 2, Pressure Vessels
IMAGES-3D, R. L. Cloud & Assoc.

CALCULATIONS: (SEE ATTACHED)

CONCLUSIONS: Stiffener rings at axial restraints must be thicker than those at other locations in order to transfer the large axial loads between the shell and the support. The thicker rings, which are 3x3x3/8 and 4x3x1/2 angles, result in ring stress and shell stresses that meet Section VIII, Div. 2.

NOTES: IMAGES computer files are: MDCLEAN.*, BMTUBEMN.*, ADAPB6.*, & 80KRING.*

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Beam Tube Manifolds 13

Adapters B6 & B7 24

Ring Analysis of 80k Stiffener for Reservoir Supp. Load 29

SUMMARY OF RESULTS

The required angle stiffeners at the axial restraints are as follows:

Mode cleaner tubes:	L3x3x3/8
Beam tube manifold:	L4x3x1/2
Adapters B6 & B7:	L3x3x3/8
80k pump:	L4x3x1/2

304ss will be used for all stiffeners which will be rolled the "hard" way. For the 4x3 angles, the 4 in dimension will be in the radial direction.

The finite element models consist of plate elements. Surface stresses in the ring stiffeners are categorized as primary bending stresses and the stress intensities are compared to 1.5 Sm in accordance with Section VIII, Div. 2 of the ASME code.

The analysis of the beam tube manifold envelopes the 80k pump shell which has a slightly larger diameter (80 in compared to 72.25 in) but which also has a significantly smaller axial load (27.57 k compared to 38.13k). Stiffeners for the 80k pumps also support the reservoir which is hung internally by 2 spring hangers. An analysis of the beam tube manifold was performed to simulate the spring hanger load in addition to the axial restraint load to which the 80k pump stiffener is subjected. It was found that the stress in the stiffener is low for the hanger load.

Also, an independent analysis *of the stiffener* at the 80k pump is included in this calculation for a 4x3x1/4 in thick angle that supports the internal reservoir. In this analysis the ring is subjected to the spring hanger loads; the axial restraint force was not included since this model represents the ring that is not located at the axial restraint. Beam elements were used to represent the 4x3x1/4 in angle. The results showed that stresses are acceptable for the vertical hanger loads but it also showed that 2x2x1/4 stiffeners are not acceptable for supporting the reservoir.

MODE CLEANER TUBE FILES: MDCLEAN.*

$ID = 30.5$

$t = .25$

$r = \frac{ID}{2} + \frac{t}{2} = 15.375$ M.S RADIUS

LONG. SHELL DISTANCE

$L = 2.5\sqrt{rt}$

$= 2.5\sqrt{15.375(.25)} = 4.90$ IN

FOR 10° SPACING, ELEMENT ARC IS

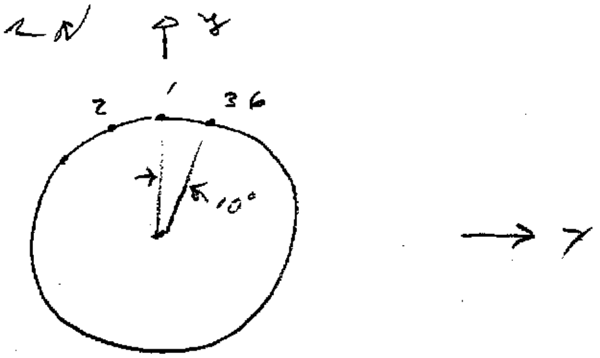
$s = r\theta$

$\theta = 10° = \frac{10}{180}\pi = .175$ RAD

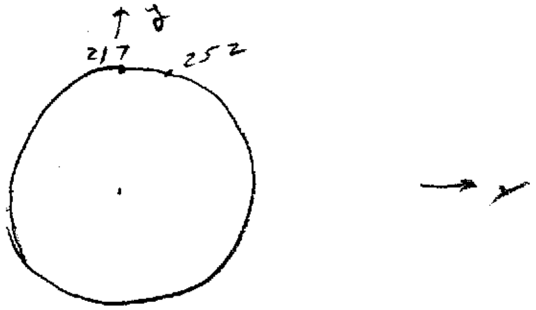
$s = 15.375(.175) = 2.69$

SPACE RINGS AT 3 IN. USE 18 IN LENGTH => 6 SEGMENTS (7 RINGS)

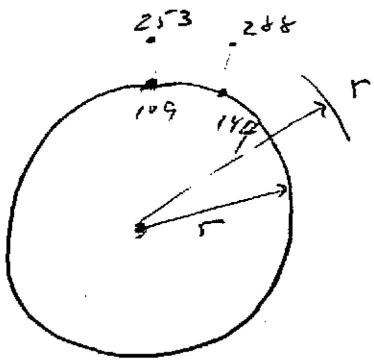
1ST PATTERN



LAST PATTERN

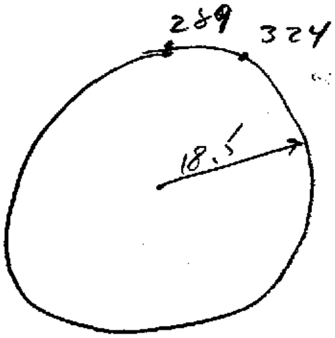


STIFFENER IS ON 4TH PATTERN



$r' = 15.375 + 3 + .125$
$= 18.5$ IN
STIFF IS ∠ 3x3x1/4

NODES AT END OF STIFFENER



LOADS IN Z DIR AT FOLLOWING NODES

117, 118, 119 , 135, 136, 137
261, 262, 263, 279, 280, 281

MAX AXIAL REACTION FROM UNBALANCED FORCE IS 33,780* LB. THIS WILL BE APPLIED TO THE 12 NODES LISTED ABOVE

*REF:
CALC 087

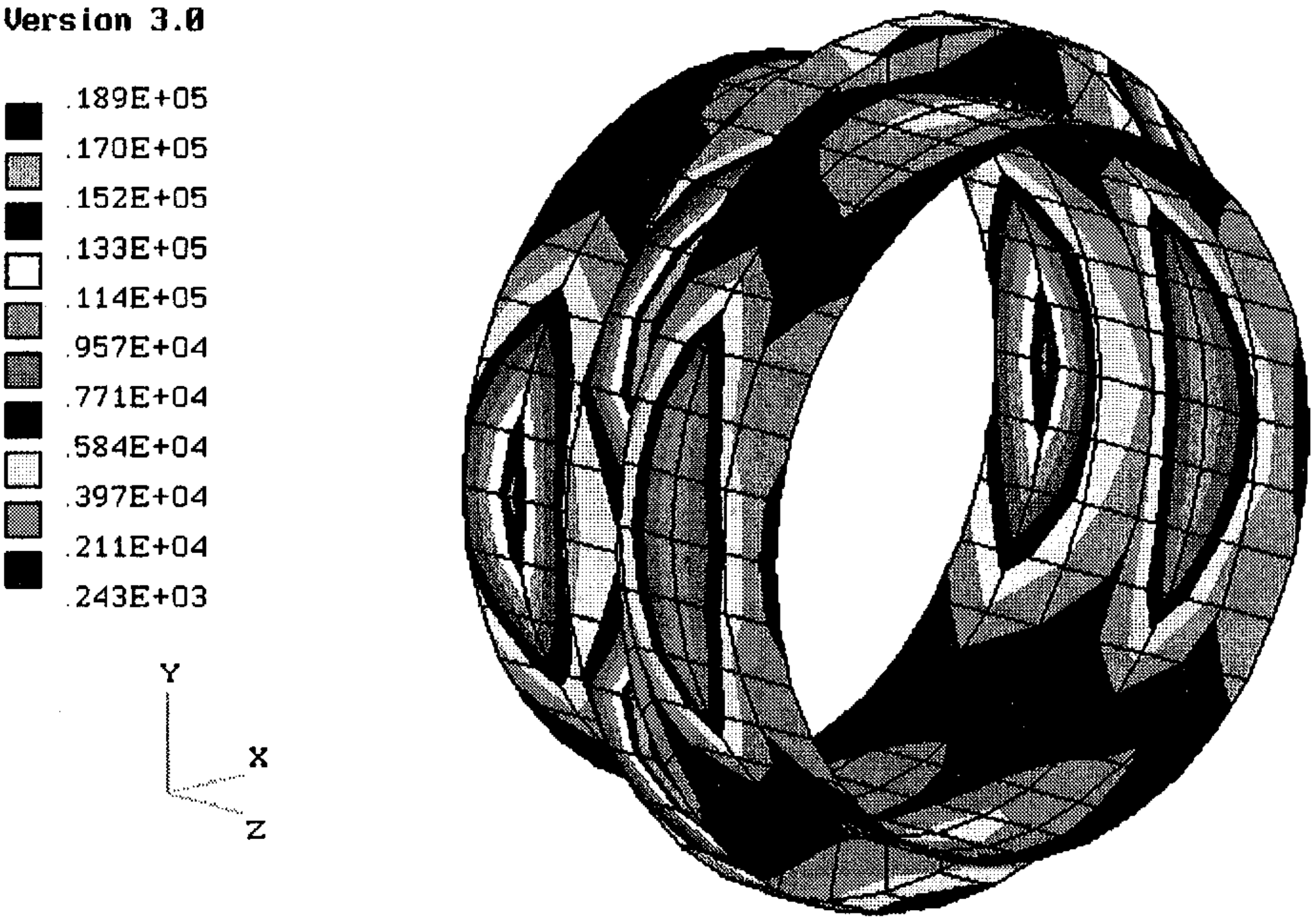
$F_{z_1} = \frac{33780}{12} = 2815$

PRESS = -14.7 EL 1 TO 216

NO END CAP FORCE DUE TO BELLOWS

3x3x1/2 ANGLE STIFFENER
SHELL THICKNESS = 1/4 IN
I D = 30.5 IN

IMAGES-3D
Version 3.0



MODE CLEANER TUBE

Load Case 3

Stress Contour Plot

Surf: Bottom **Stress Intensity**

9/20/96
9: 2:54

LOAD CASE 1: EXTERNAL PRESSURE = 14.7 PSI
LOAD CASE 2: AXIAL RESTRAINT FORCE
LOAD CASE 3: CASE 1 + CASE 2

NOTE: UNBAL FORCE IS CONSERVATIVE. USING DIMENSIONS OF HYSPAN BELLOWS, FORCE IS ACTUALLY

$$F_R = 37.6^K < 33.8^K$$

SEE FOLLOWING SHEET

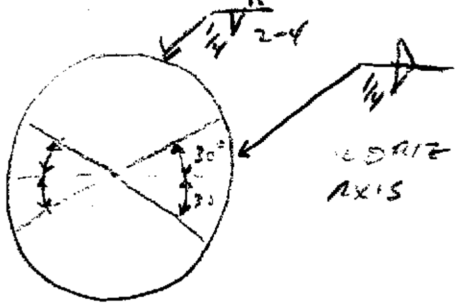
STRESS EVALUATION AT STIFFENER

MAX SI = 18.9 KSI FROM PLOT

ALTHOUGH THIS IS A LOCAL STRESS IT WILL BE COMPARED TO 1.5 SM FOR PRIMARY BENDING PER SECT. $\underline{VIII}$, DIV 2.

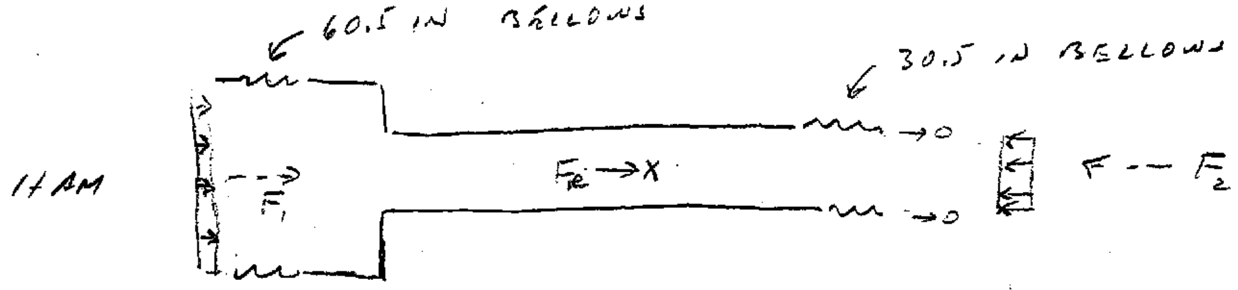
$$\Rightarrow P_b = 18.9$$
$$< 1.5\, S_m = 1.5(18.7) \text{ KSI @ } 400°F$$
$$= 28.0 \text{ KSI FOR 304 SS} \quad \text{OK}$$

STIFFENER TO SHELL WELD AT AXIAL REST.



REF CALC 015 P. 13
FOR STITCH WELD

MODE CLEANER TUBE UNBALANCED FORCE



F_R = AXIAL REACTION

$F_R = F_2 - F_1$

F_1 = 60" BELLOWS $= -45.46^K$

F_2 = 30.5" BELLOWS

$= P \pi r^2$

$r = \frac{D_M}{2}$

D_M = 31.803 (HYSPAN CALC - 7/9/96)

$$F_2 = \pi \left(\frac{31.803}{2}\right)^2 \times -14.7$$

$$= -11.68^K$$

$$F_R = -11.68 - (-45.46)$$

$= 33.78^K$ (34.36^K USED)

BUT $F_1 = -14.7 \pi \left(\frac{D_M}{2}\right)^2$

D_M = 61.928 (HYSPAN CALC - 7/9/96)

$F_1 = -14.7\pi \left(\frac{61.928}{2}\right)^2 = -44277$ LB

=> $F_R = -11.68 - (-44.28) = 32.597$ K

∴ ACTUAL UNBALANCED FORCE IS 32.6^K

MODE CLEANER TUBE CONT.

TRY REDUCING ANGLE THICKNESS TO 3/8"
(USE 3 × 3 × 3/8 ANGLE STIFFENER

PLOT ON THE FOLLOWING SHEET
SHOWS THAT THE MAX SI = 27.2 KSI

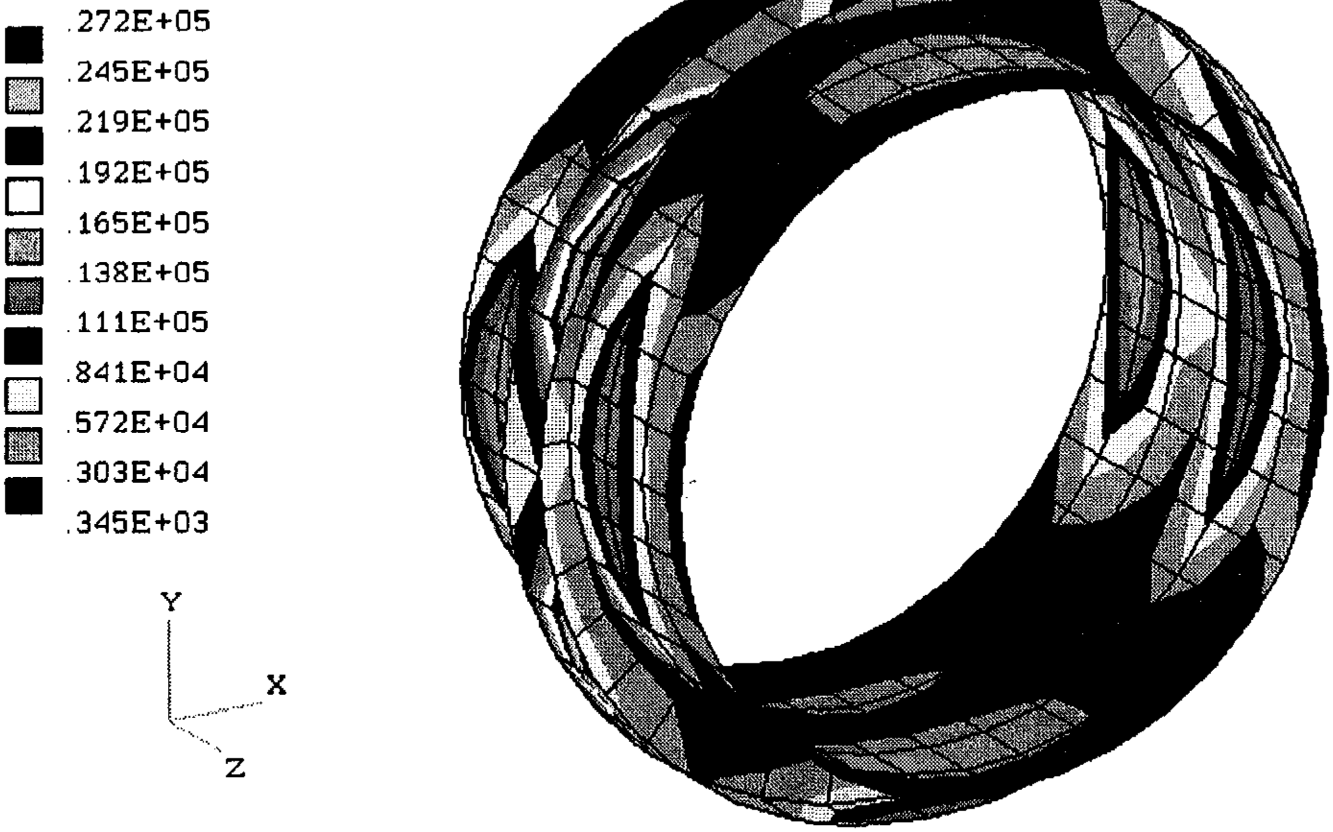
P_b = 27.2 KSI

< 1.5 S_M = 28.0 KSI @ 400°F

FOR 304 SS

3 x 3 x 3/8 ANGLE STIFFENER
SHELL THICKNESS = 1/4 IN
I.D. = 30.5 IN

IMAGES-3D
Version 3.0



MODE CLEANER TUBE

Load Case **Stress Contour Plot** **9/30/96**
3 **Surf: Bottom** **Stress Intensity** **9: 3:49**

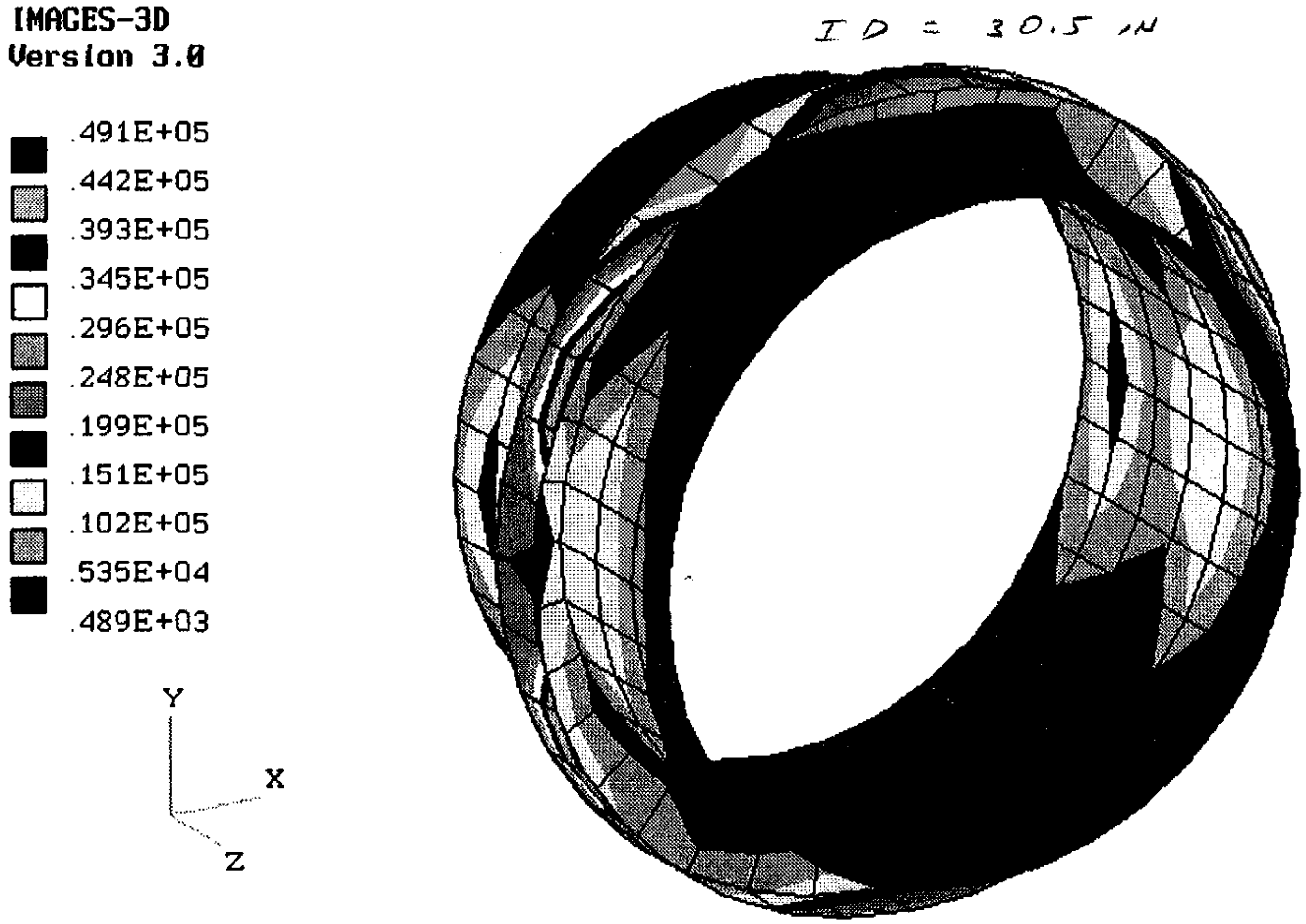
MODE CLEANER TUBE CONT.

TRY ANOTHER REDUCTION OF THE STIFFENER THICKNESS TO 1/4"

THE FOLLOWING PLOT SHOWS THAT THE STRESS IN THE STIFFENER IS TOO HIGH. SI = 49.1 KSI

∴ USE L 3 x 3 x 3/8 FOR STIFFENER RING AT AXIAL RESTRAINT OF MODE CLEANER TUBE

3 x 3 x 1/4 IN ANGLE STIFFENER
SHELL THICKNESS = 1/4 IN
ID = 30.5 IN



MODE CLEANER TUBE

Load Case	**Stress Contour Plot**	**9/30/96**
3	**Surf: Bottom** **Stress Intensity**	**14:14:46**

IMAGES MODEL FOR <u>BEAM TUBE MANIFOLD</u>

$ID = 72.25$, SHELL THICKNESS, $t = .25$

MID RADIUS $= r = \frac{72.25}{2} + .125$

$= 36.25$ IN

SPACE NODES AT 10°

LONG SHELL DISTANCE

$$L = 2.5\sqrt{rt}$$

$$= 2.5\sqrt{36.25(.25)}$$

$$= 7.53$$

ELEMENT ARC LENGTH

$$S = r\ \theta$$

$$\theta = 10^\circ = \frac{10}{180}\pi = .175 \text{ RAD}$$

$$S = 36.25\ (.175) = 6.34$$

IF ARC IS 5°, $S = 36.25 \times \frac{5}{180}\pi = 3.16$ IN

SPACE RINGS AT 3 IN ALONG AXIS

USE 18 IN LENGTH $\Rightarrow \frac{360}{5} = 72$ NODES/RING

$\Rightarrow\ 72\ \frac{\text{NODES}}{\text{RING}} \times \left(\frac{18}{3} + 1\right) = 504$ NODES

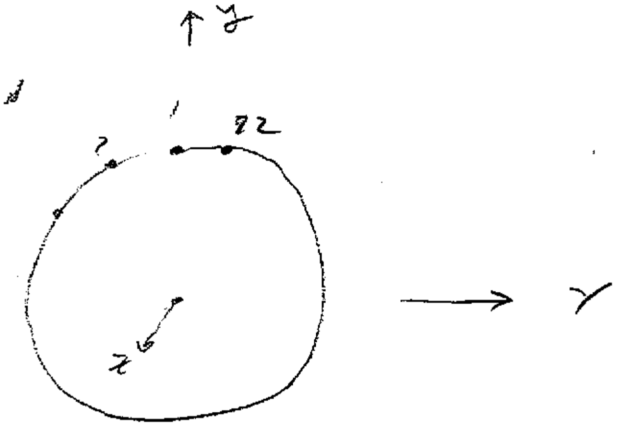
$+$ 144 NODES FOR STIFFENER

FILES: BHTUBEMN.*

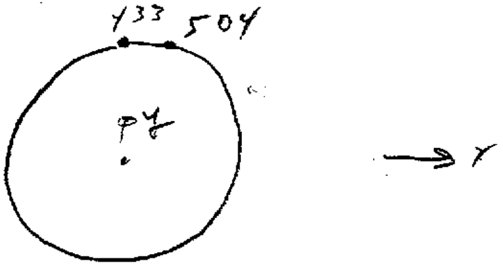
SHELL ELEMENTS – PLATE 1

STIFFENER ELEM – PLATE 2

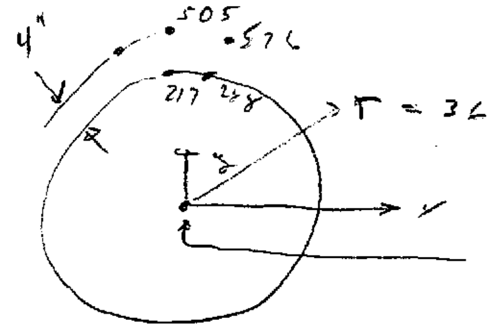
1ST PATTERN



LAST PATTERN AT Z = 14"



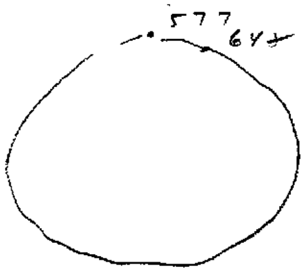
STIFFENER IS ON 4TH PATTERN
Z = 9



r = 36.25 + .125 + 4 = 40.375

CENTER NODE
649 - (0, 0, 9)
(DELETED)

NODES AT END OF STIFFENER



RESTRAINTS

NODES 1 TO 72 RESTRAINED IN Z - DIRECTION

NODES 1 & 36 RESTRAINED IN X - DIR

NODES 18 & 54 " " Y -

THESE PREVENT TORSION & TRANSLATION

LOADS

MAX AXIAL FORCE IS 38,130 LB* OR

$$F_z = \frac{38130}{2} = 19065 \text{ LB EA SIDE}$$

DIVIDE OVER 8 NODES ON EA SIDE

$$F_{z_i} = \frac{19065}{8} = 2383 \text{ LB / NODE}$$

THESE NODES ARE 233, 234, 235, 236
269, 270, 271, 272

521, 522, 523, 524

557, 558, 559, 560

PRESSURE

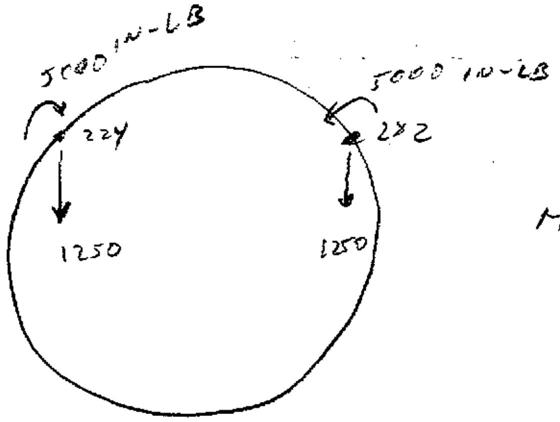
-14.7, EL 1 TO 432

END CAP FORCE ON LAST RING

F = 0 DUE TO BELLOWS

* REF CALC V049-1-089, p. 8A

WT LOAD FROM RESERVOIR HANGERS ON 80K **



$M_Z = 1750 \times 4"$
$= 5000$ IN LB

LOAD CASE 4 - ABOVE LOADS

LOAD CASE 5 - ABOVE COMBINED WITH VACUUM PRESS & UNBAL AXIAL FORCE (LC 3)

LOAD CASE 1 - EXTERNAL PRESSURE = 14.7 PSI

" " 2 - AXIAL RESTRAINT LOAD

" " 3 - CASE 1 + CASE 2

* REF CALC V049-1-070, P.5
WT = 5000 LB

$= \frac{5000}{4} = 1250$ LB PER HANGER

** THIS ANALYSIS IS PERFORMED ON MODEL OF BEAM TUBE MANIFOLD SINCE DIAMETERS ARE ALMOST THE SAME.

LOAD CASE 1 UNBAL AXIAL FORCE

$F_z = 38130$ LB

LOAD CASE 2 VAC PRESS = -14.7 psi

LOAD CASE 3 : 1 & 2 COMBINED

LOAD CASE 4 : HANGER FORCE REPRESENTING WT OF 80K PUMP INCLUDES MOMENT DUE TO OFFSET OF ROD SUPPORT BRACKET

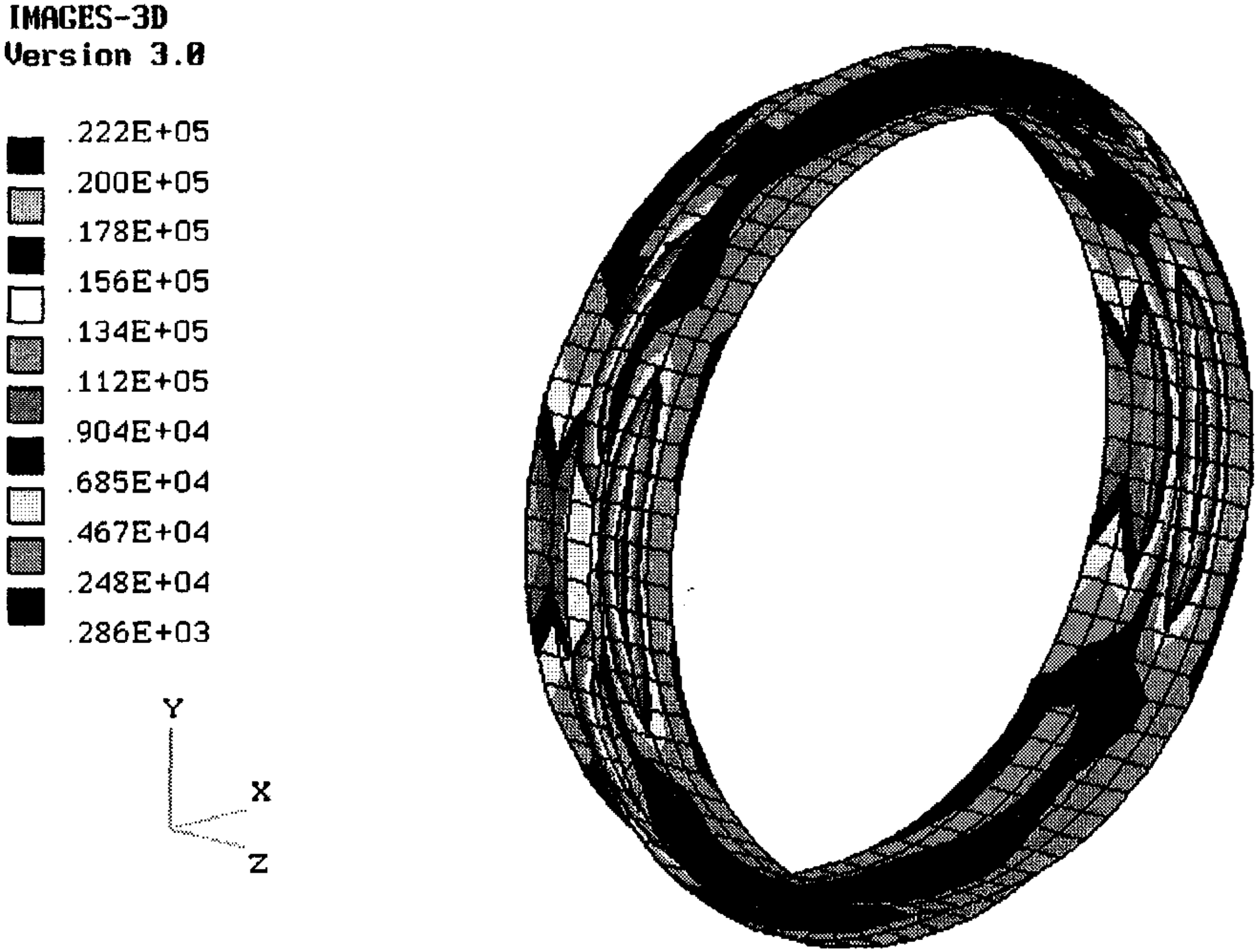
$F_x = -1250$ LB

$M_z = \pm 5000$ IN-LB
(4 IN OFFSET)

LOAD CASE 5 : ALL LOADS

3 COMBINED WITH 4

4 x 3 x 1/2 ANGLE STIFFEN
SHELL THICKNESS = 1/4
I D = 76.25
4 IN LEG IS IN RADIAL DIRECTION

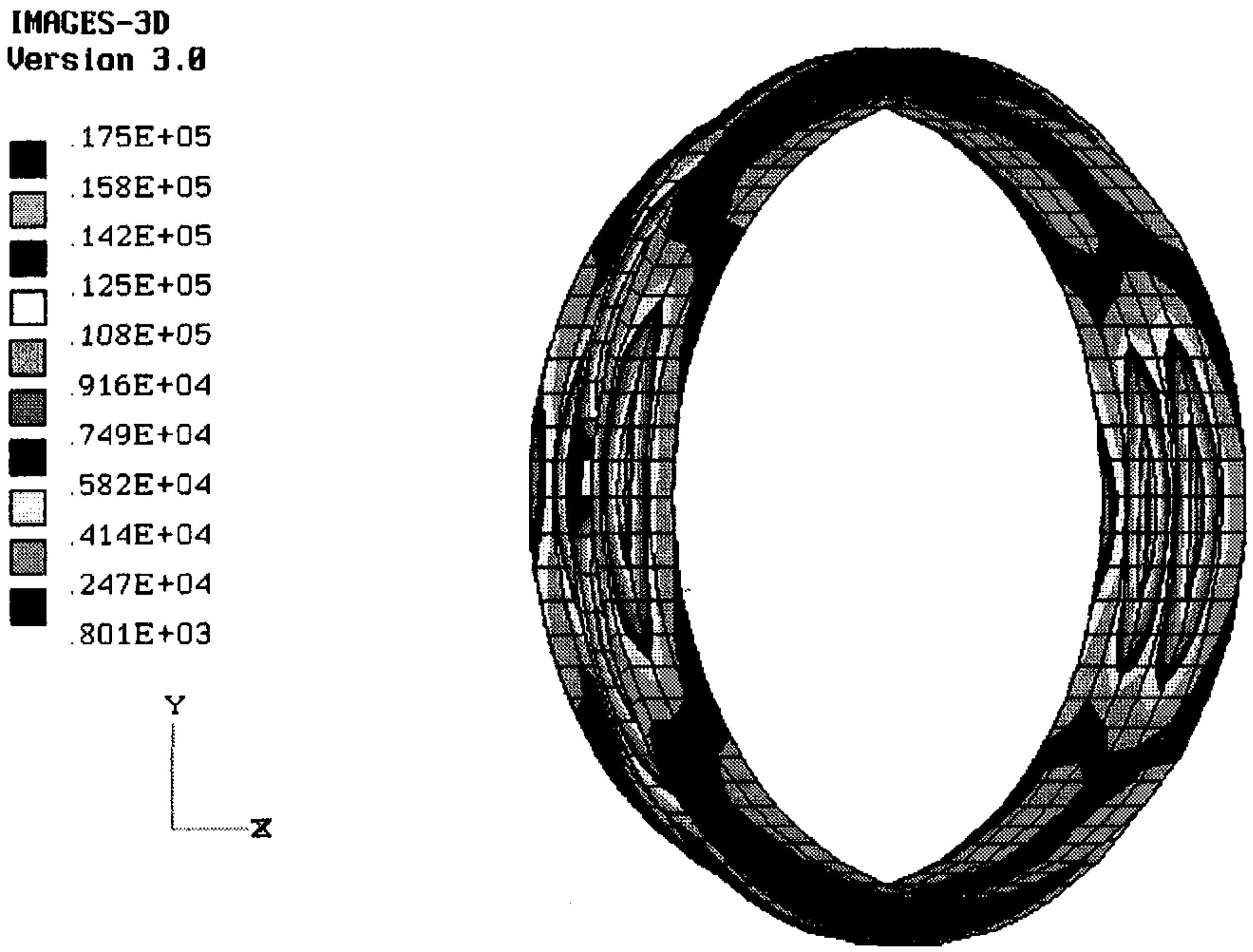


BEAM TUBE MANIFOLD

Load Case **Stress Contour Plot** **9/20/96**
3 **Surf: Bottom** **Stress Intensity** **11:17:35**

COMBINED UNBALANCED AXIAL FORCE
& VACUUM PRESSURE

4 x 3 x 1/2 ANGLE STIFFENER
SHELL THICKNESS = 1/4
ID = 72,25

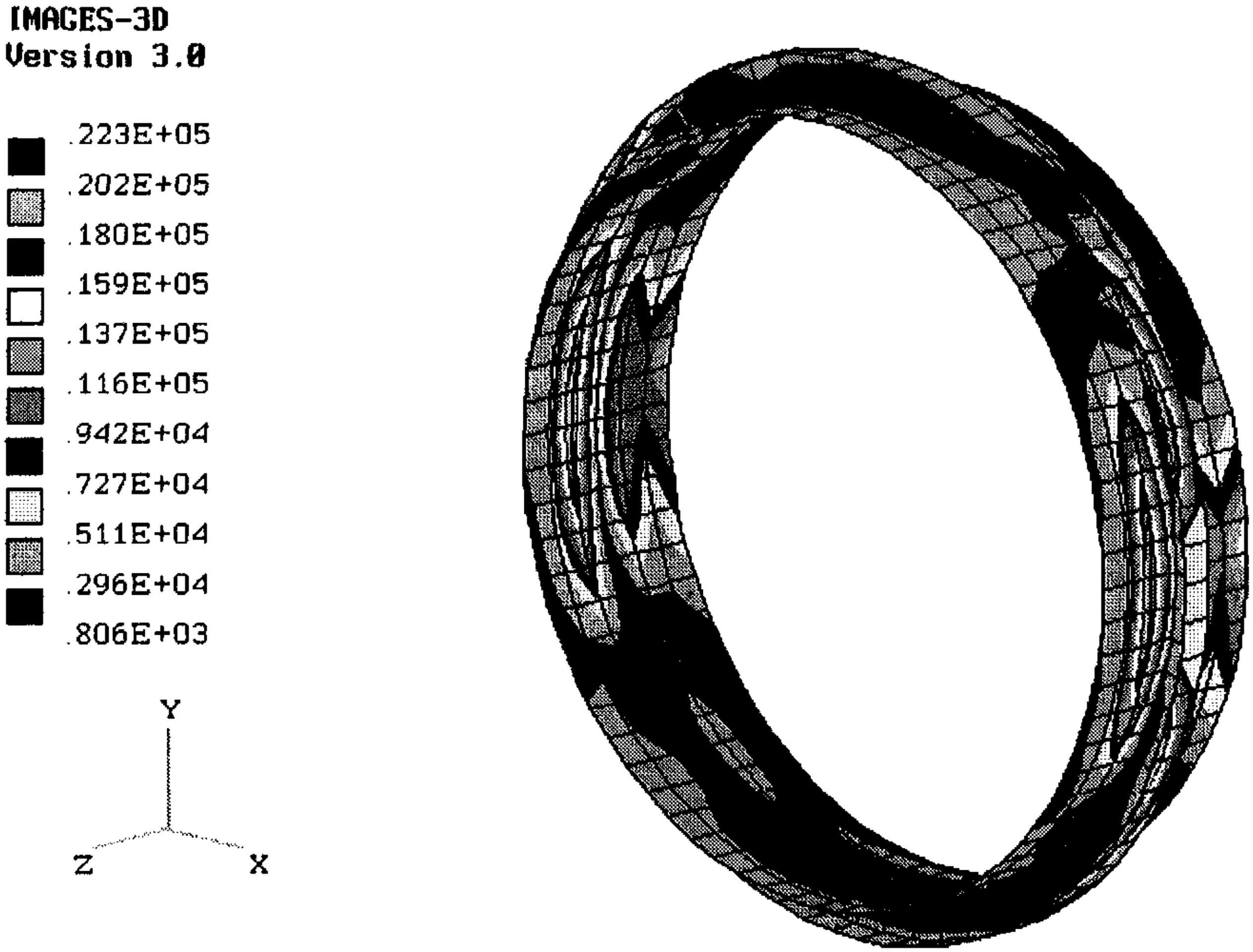


* 4IN LEG IS IN RADIAL DIRECTION

BEAM TUBE MANIFOLD

Load Case 3 Stress Contour Plot 9/16/96
Surf: Top Stress Intensity 11: 6: 9

SAME CONFIGURATION



BEAM TUBE MANIFOLD

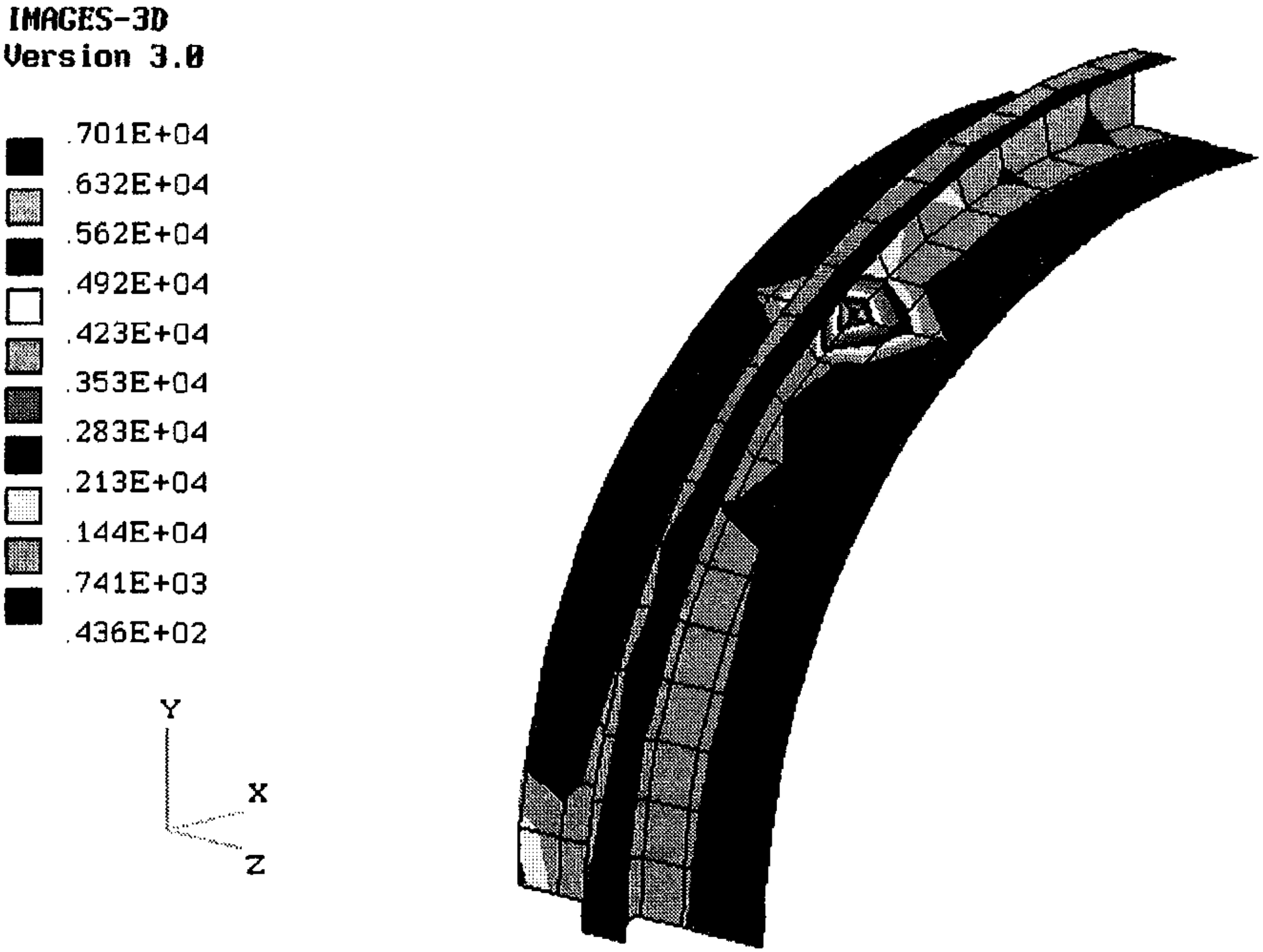
Load Case 5

Stress Contour Plot

Surf: Bottom **Stress Intensity**

9/20/96 **11:27:35**

LOAD CASE 3 COMBINED WITH HANGER LOAD FROM 80K PUMP RESERVOIR



BEAM TUBE MANIFOLD

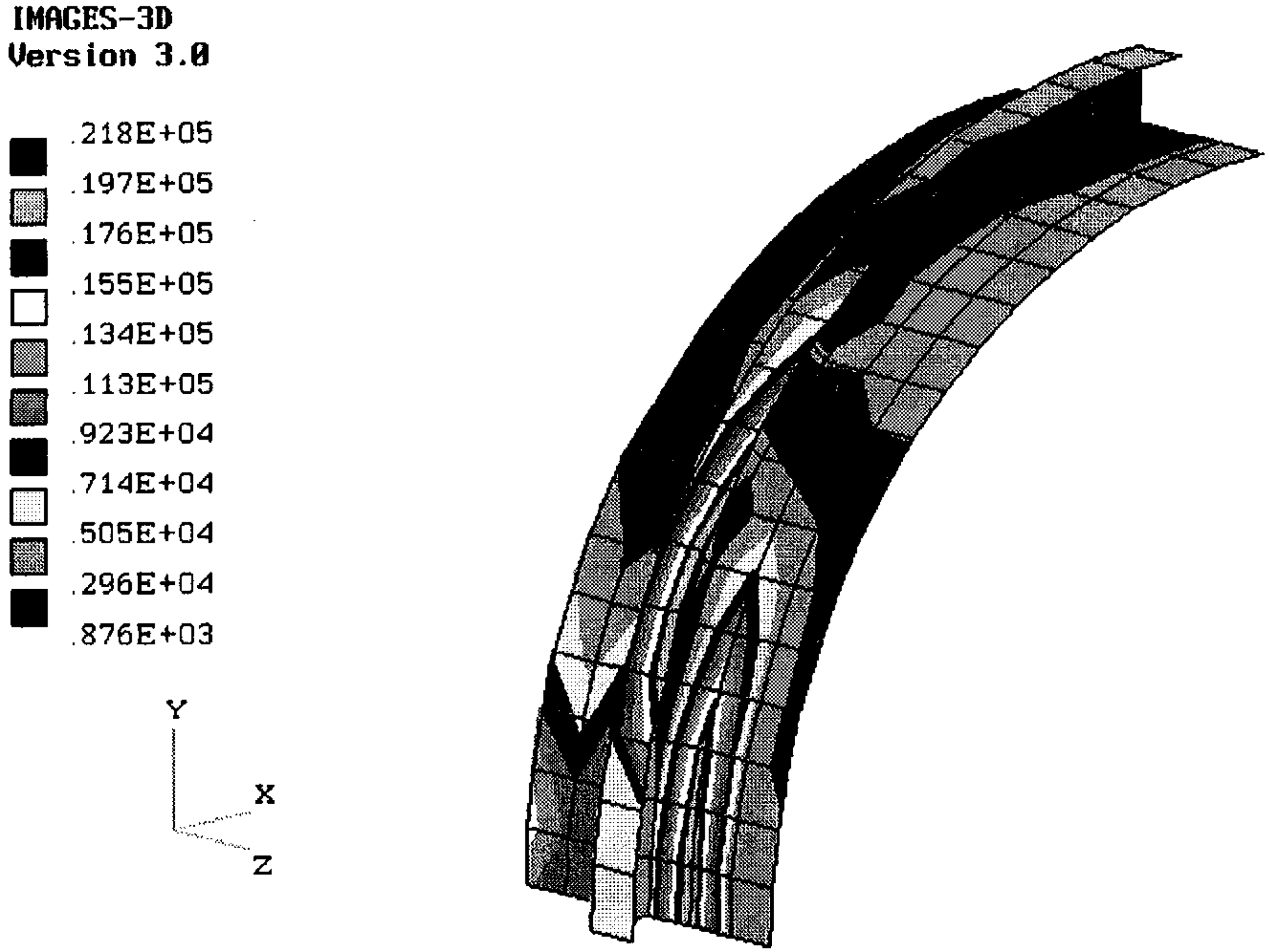
Load Case **4**

Stress Contour Plot

Surf: Middle **Stress Intensity**

9/20/96
10:58:38

℄ 1250 LB HANGER FORCE FROM FOR PUMP
+ 5000 IN-LB MOMENT AT SAME LOCATION



BEAM TUBE MANIFOLD

Load Case **Stress Contour Plot** **9/20/96**
5 **Surf: Bottom** **Stress Intensity** **11: 8: 5**

BEAM TUBE MANIFOLD & 80 K PUMP
STRESS EVALUATION

MAX STRESS INTENSITY IS 22,300 psi

$\Rightarrow$ $P_M = 22.3$ KSI

$< 1.5\ S_M = 28.0$ KSI @ 400 °F

ADAPTERS B6 & B7

$ID = 48.25$
$t = .25$

MID RADIUS $r = \frac{48.25 + .25}{2}$
$= 24.25$ IN

LONG SHELL DIST

$L = 2.5 \sqrt{rt}$
$= 2.5 \left(24.25 (.25)\right)^{\frac{1}{2}}$
$= 6.16$ IN

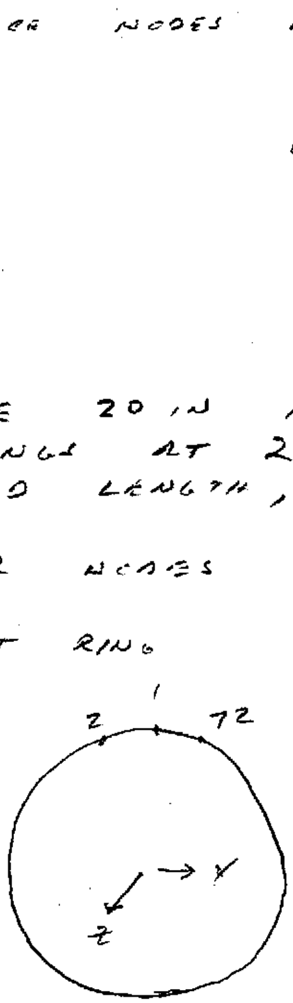
SPACE NODES AT 5°

$S = r\theta$
$\theta = 5° \times \frac{\pi}{180} = .0873$ RAD
$S = 24.25(.0873) = 2.116$ IN

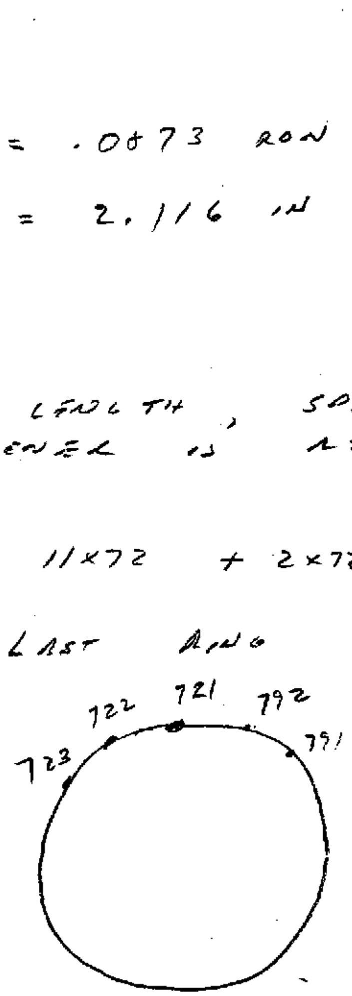
USE 20 IN FOR MODEL LENGTH, SPACE RINGS AT 2 IN. STIFFENER IS AT MID LENGTH, Z = 10 IN

72 NODES PER RING => $11 \times 72 + 2 \times 72 = 936$ NODES

1ST RING

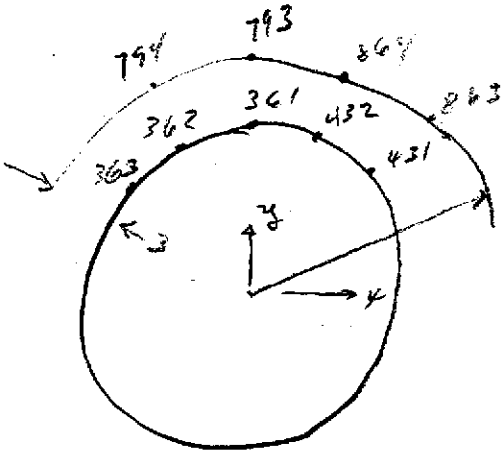


LAST RING



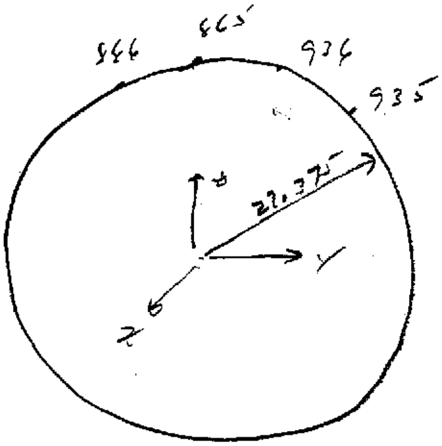
B6 & B7 CONT

STIFFENER IS ON 6TH RING (∠ 3x3x3/8)



r = 24.25 + .125 + 3 = 27.375

NODES AT END OF STIFFENER



RESTRAINTS

AT Z = 0, AXIAL RESTRAINT - Z

NODES 1, 36 - X DIR RESTRAINED

NODES 18, 54 - Y DIR RESTRAINED

B-6 & B-7 CONT

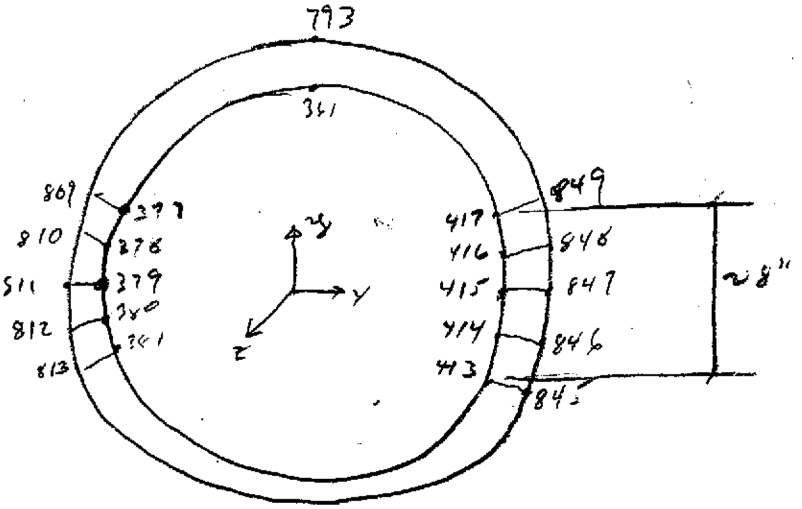
LOADS

PRESSURE -14.7 EL 1 TO 720

AXIAL FORCES

F_z = 32170 LB REF CALC V049-1-095 P.7

DIVIDE LOAD OVER 10 NODES ON EA SIDE AT STIFF. RING



$$F_{zi} = \frac{32170}{20} = 1608.5 \text{ LB}$$

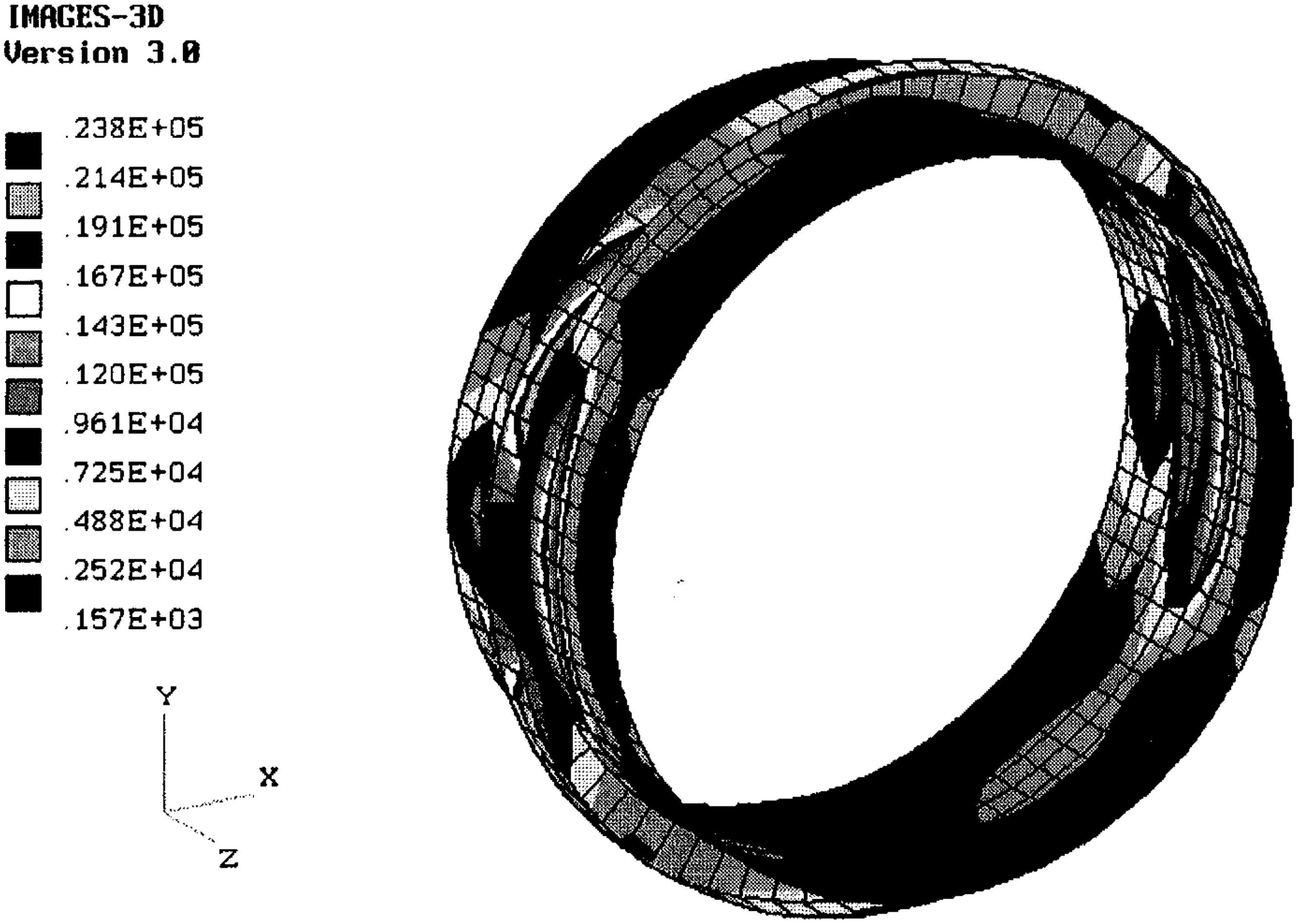
PLOTS ON FOLLOWING SHEETS SHOW

P_b = 23.8 KSI

< 1.5 S_m = 28 KSI @ 400°F
FOR 304 SS

OR

3 x 3 x 3/8 ANGLE STIFFENER,
SHELL THICKNESS = 1/4"
ID = 48.25 IN



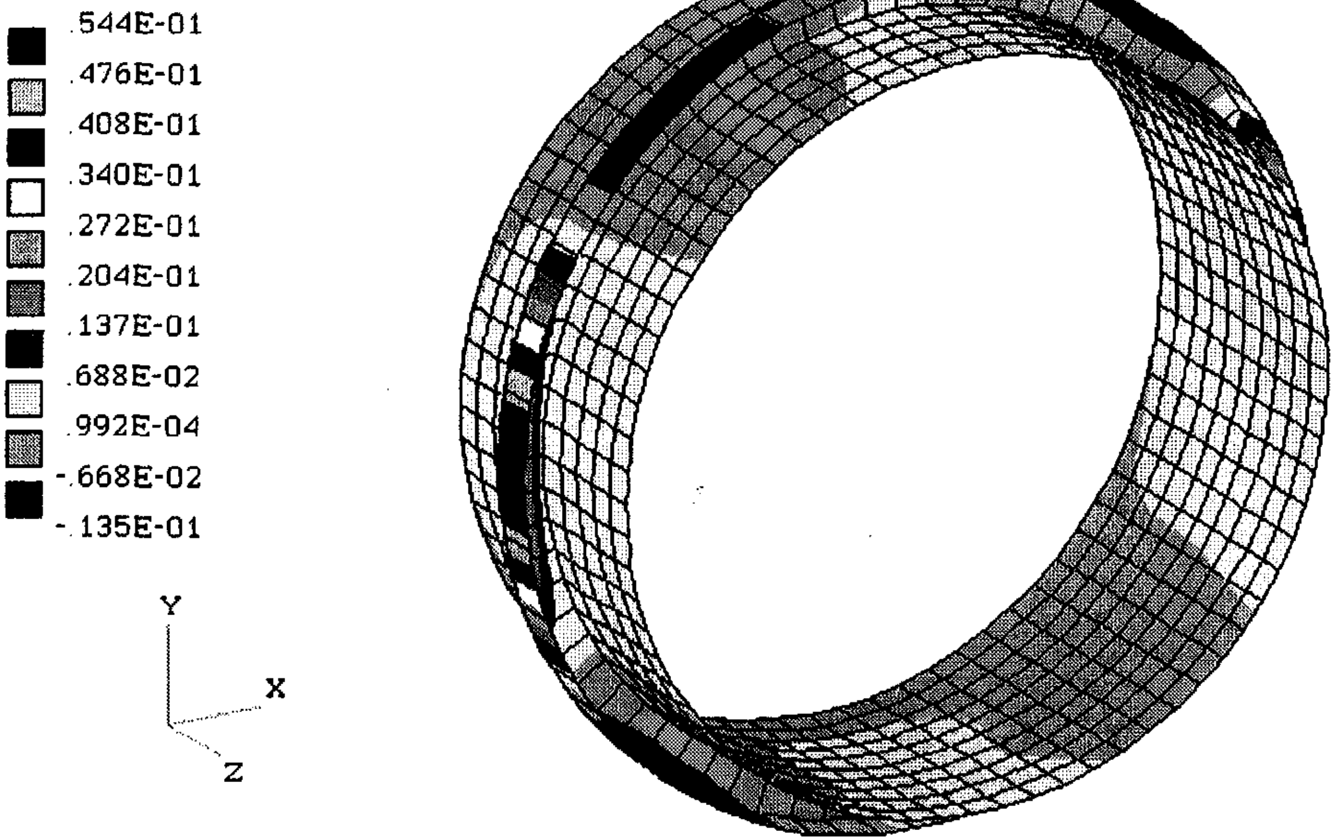
ADAPTERS B-6 & B-7

Load Case **Stress Contour Plot** **9/30/96**
3 * **Surf: Bottom** **Stress Intensity** **11:58:45**

* AXIAL FORCE + PRESSURE

3 x 3 x 3/8 ANGLE STIFFENER
SHELL THICKNESS = 1/4"
ID = 48.75 IN

IMAGES-3D
Version 3.0



ADAPTERS B-6 & B-7

Load Case
3

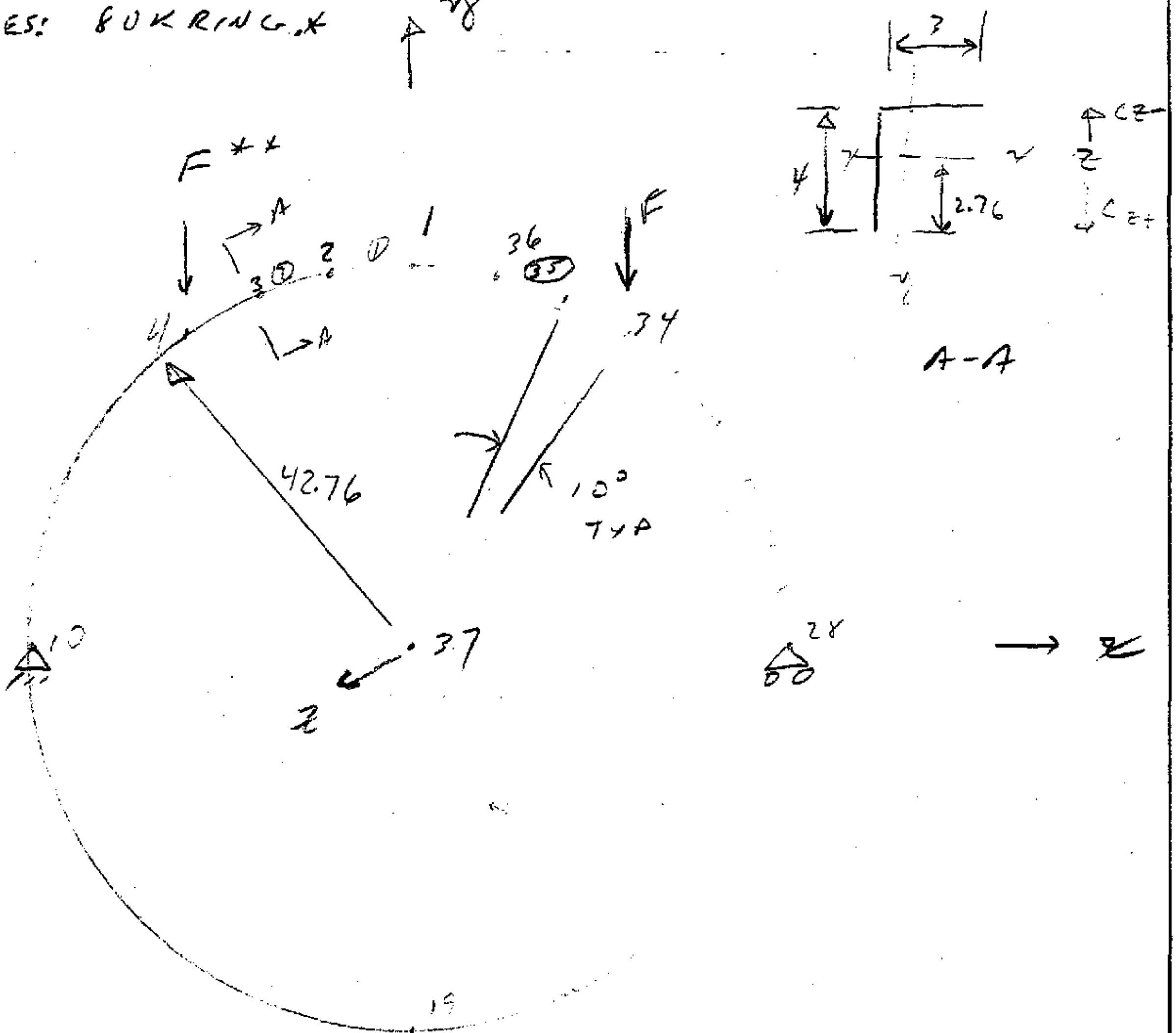
Displacement Contour Plot
DZ

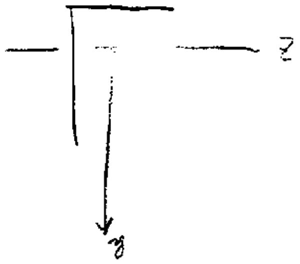
9/30/96
12:10:12

28

80K STIFFENER RING *

FILES: 80KRING.*





SHELL OD = 80 IN

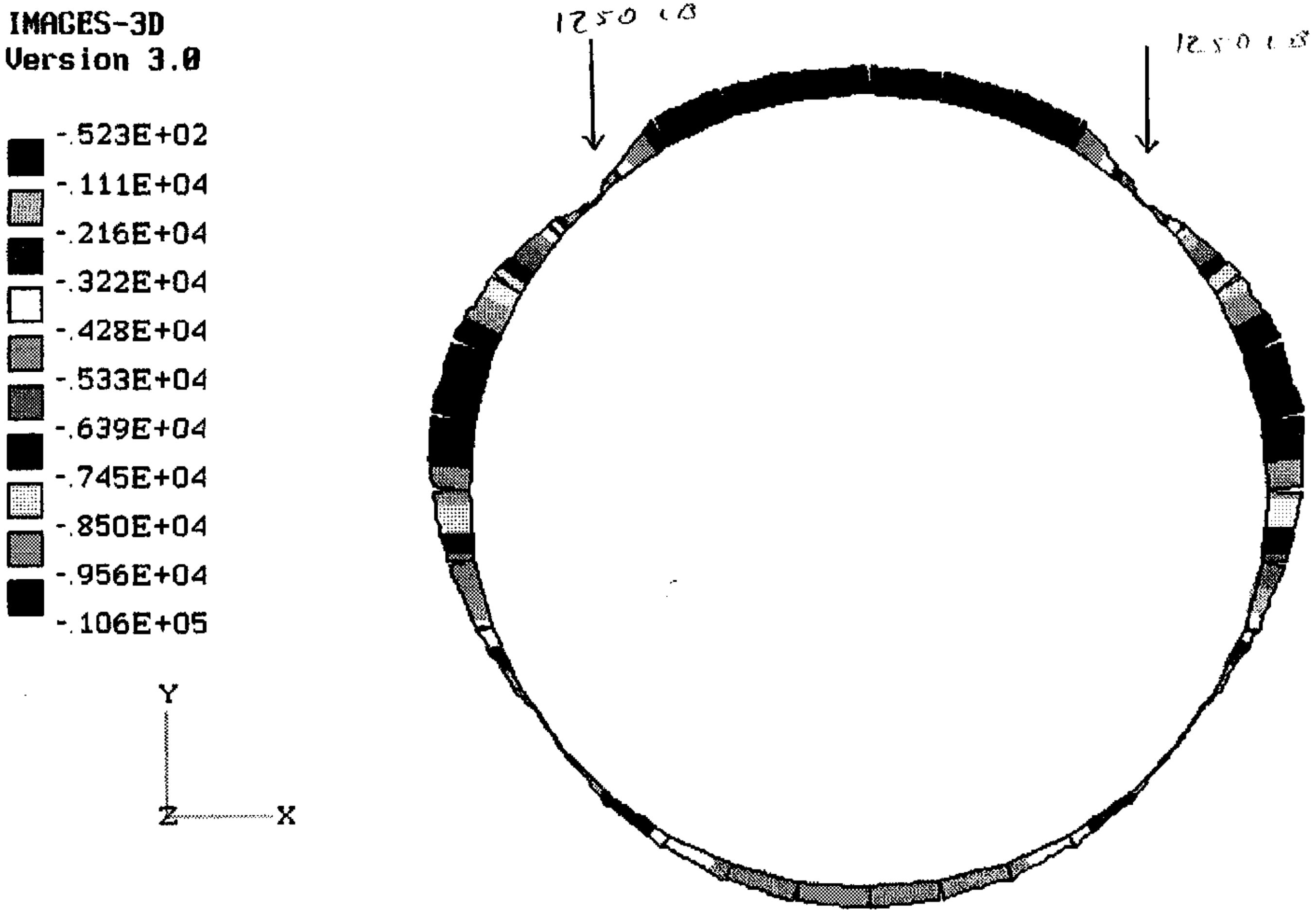
STIFFENER: ∠ 4×3×1/4

* THIS ANALYSIS PERTAINS TO RING THAT SUPPORTS RESERVOIR BUT NOT EXTERNAL AXIAL RESTRAINT.

** F = 1250 LB DEAD WT ONLY - LOAD CASE 1

F = 1500 LB SHIPPING FORCE - LOAD CASE 2

L 4x3x1/4 STIFFENER - 304 SS



80 K PUMP STIFFENER RING

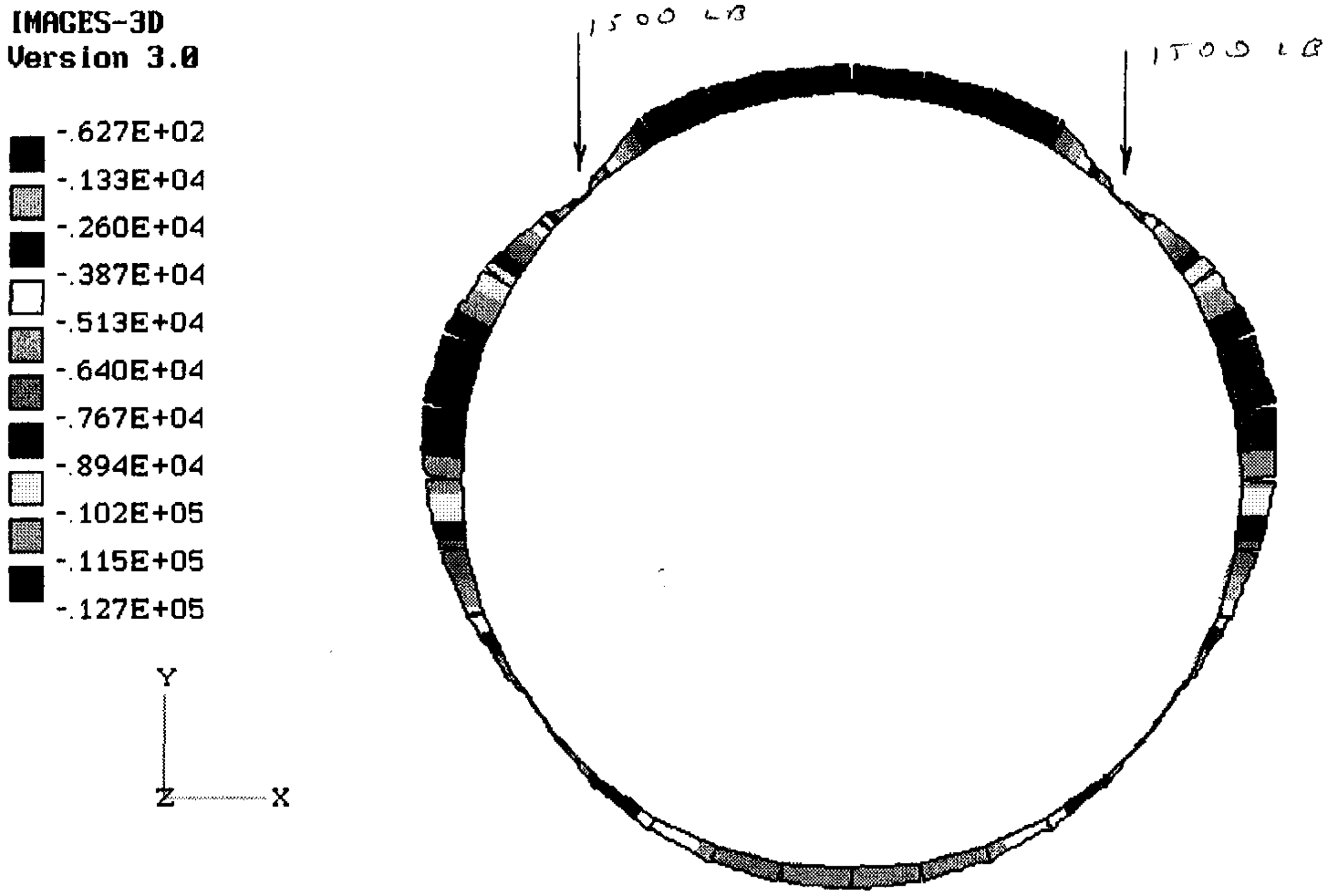
Load Case *
1

Stress Diagram
Minimum Normal

9/ 9/96
13:30:47

* VERTICAL - WT ONLY
RESERVOIR FILLED

L 4x3x1/4 STIFFENER - 304 SS



80K PUMP STIFFENER RING

Load Case *
2

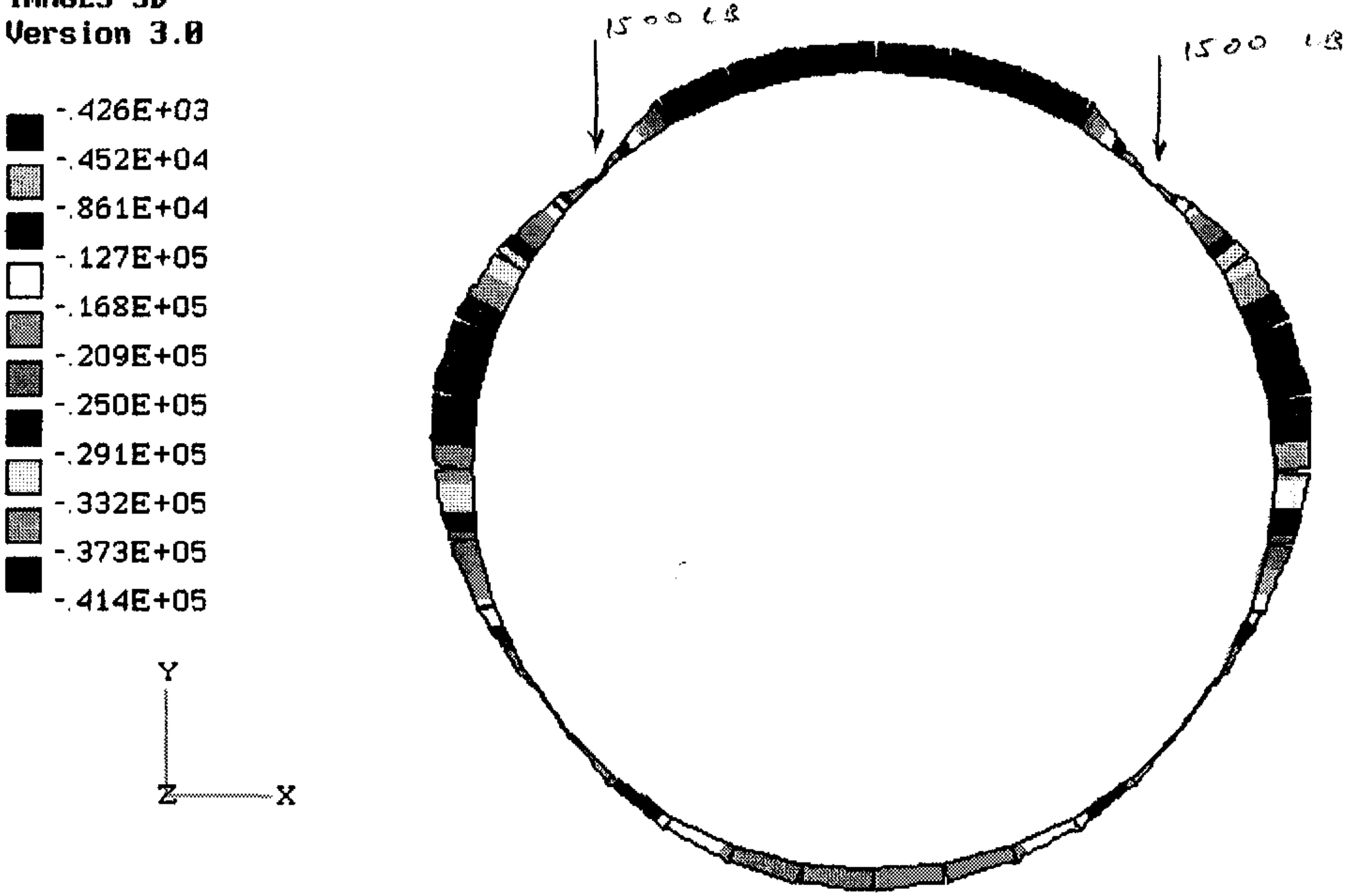
Stress Diagram
Minimum Normal

9/ 9/96
13:43:51

* VERTICAL WT + SHIPPING LOAD
RESERVOIR EMPTY

L 2x2x1/4 STIFFENER - 304 SS

IMAGES-3D
Version 3.0



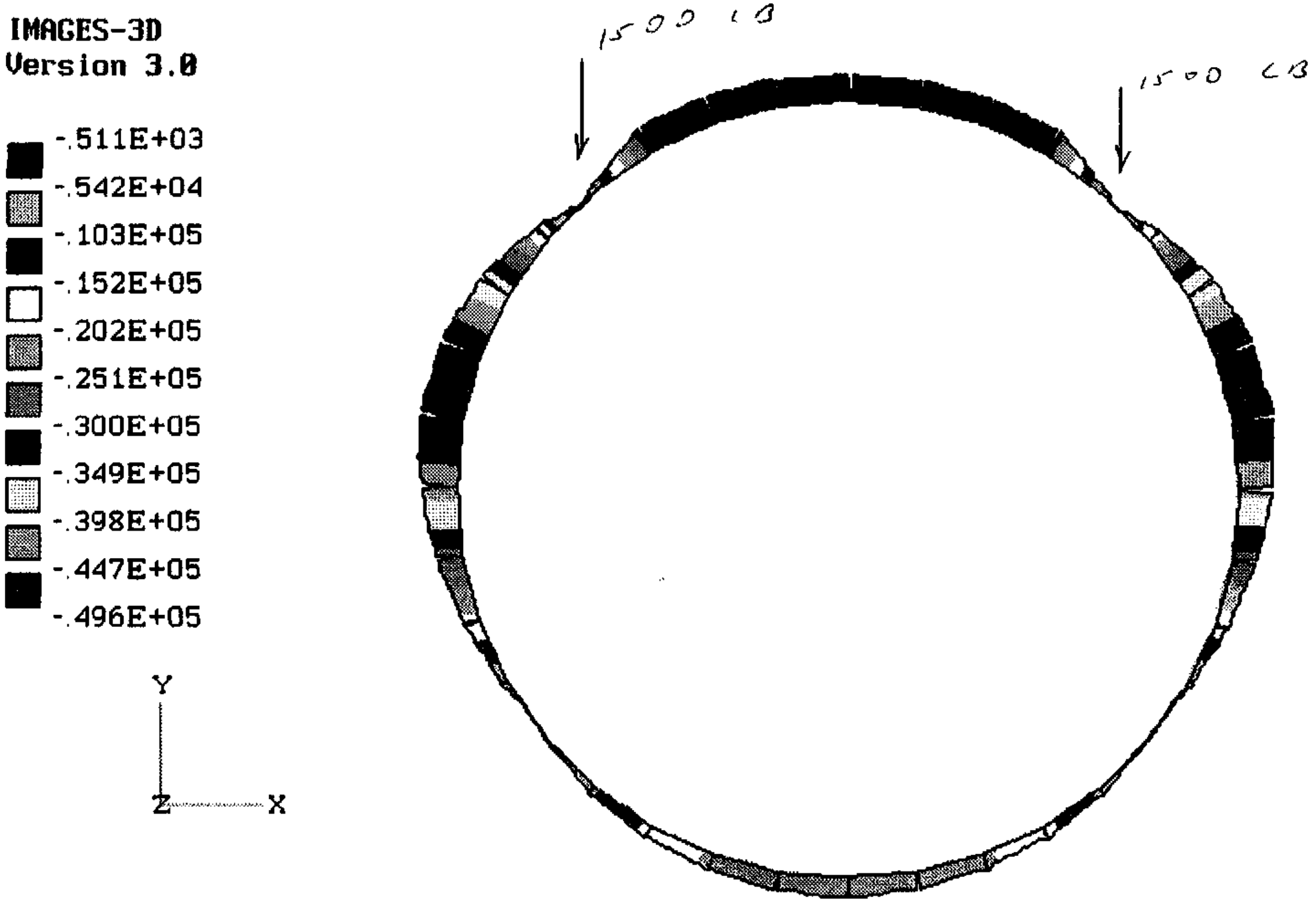
Load Case
1 *

Stress Diagram
Minimum Normal

9/ 9/96
14: 5: 1

* VERT LOAD - WT ONLY
RESERVOIR FILLED

∠ 2 x 2 x 1/4 STIFFENER - 304 SS



Load Case *
2

Stress Diagram
Minimum Normal

9/ 9/96
14: 1:53

* VENT WT + SHIPPING LOAD
RESERVOIR EMPTY

80K STIFFENER RING ($\angle$ 4×3×1/4)

STRESS EVAL

MAXIMUM STRESS RESULTING FROM BENDING OF RING DURING SHIPPING IS 12,700 psi

P_M = 12.7 ksi

$< 1.5 S_M$ = 28.0 ksi

ok

PROCESS SYSTEMS INTERNATIONAL, INC.
WESTBOROUGH, MA

ENGINEERING
CALCULATIONS

NO: V049-1-112
PAGE 1 OF 107

REV.	DEO #	DATE	BY:	CHECK
0	349	10.8.96	WDB	RDC ✓

TITLE:

BSC Portable Clean Room

BY: W. Bilynsky

DEPT.: 744

PROJECT: LIGO Vacuum Equipment

PROJECT NO: V59049

PURPOSE:

Design mobile (portable) Clean Room for the Beam Splitter Chamber (BSC). The frame design must be able to withstand the installed weight of the air circulators and various pumps and must also be fairly lightweight to allow unconstrained mobility. Additionally, the BSC clean room frame will have adjustable (telescoping) legs for fitup and alignment and will also be easily assembled and disassembled as needed.

METHOD:

Support frame is designed to AISC standards using classical hand calculations and STAAD-III computer program (release 21).

ASSUMPTIONS:

See calculation

INPUTS:

2. Design load = 10.0 lbs/ft^2
3. Non-standard AISC Structural Members (see calculation)

REFERENCES:

1. STAAD-III , Research Engineers, Release 21
2. AISC - ASD 9th edition
3. Doc. No. V049-1-066 LIGO Vacuum Equipment Structural Design Criteria
4. Aluminum Construction Manual, Section 3, Engineering data for aluminum structures.

CALCULATIONS:

CONCLUSIONS:

The requirements of the AISC Codes and Standards and the Ligo Vacuum Equipment Structural Design Criteria are met.

NOTES: STAAD-III Computer File: BSCLNRM3.*

TABLE OF CONTENTS

Revision History 3

BSC Cleanroom Design/Analysis

- Member Properties 4
- Loading Condition 5
- STAAD Input Model 6
- STAAD Computer Generated Plot 8
- STAAD Output File 11
- Moment (Bolted) Connection Design 104
- Lifting Lug 106
  - Design Details
  - Weld Calculation

Attachment 'A'

- Detail Design Sketches A1 - A5

Attachment 'B'

- Final Design Drawing B1 - B2

REVISION HISTORY

Rev. 0	Original Issue October 8, 1996

MEMBER PROPERTIES

AISC TABLE (CARBON STEEL)

- TUBE STEEL 6" x 3" x 3/16"

  TABLE ST TUB60303

- TUBE STEEL 3" x 2" x 3/16"

  TABLE ST TUB30203

- TUBE STEEL 3 1/2" x 3 1/2" x 3/16"

  TABLE ST TUB35353

- TUBE STEEL 2"x2"x3/16"

  TABLE ST TUB20203

PRISMATIC PROPERTIES (ALUMINUM STRUCTURAL MEMBERS)

- ALUMINUM COLUMN TUBE LEGS 3"x3" x 1/8"

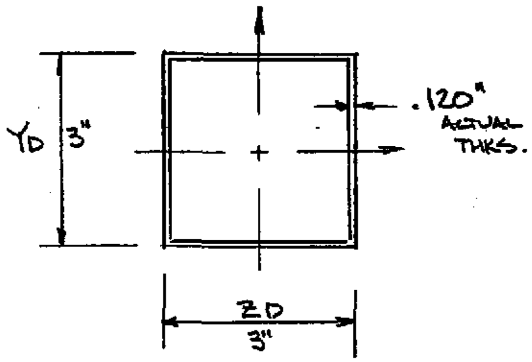
A_X = 1.382 in^2

I_Y = 1.914 in^4

I_Z = 1.914 in^4

Y_D = 3.0 in

Z_D = 3.0 in



REF. ALUMINUM CONSTRUCTION MANUAL
SECTION 3
Engineering data for aluminum structures
THE ALUMINUM ASSOCIATION

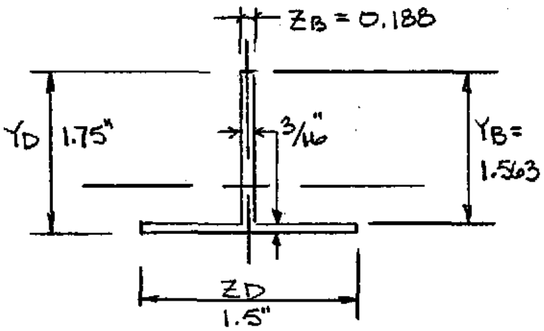
- ALUMINUM TEES

Y_D = 1.75 IN

Z_D = 1.50 IN

Y_B = 1.563 IN

Z_B = 0.188 IN



LOADING CONDITION

PER PANEL

$2'\text{-}0'' \times 3'\text{-}0'' = 6 \text{ FT}^2$

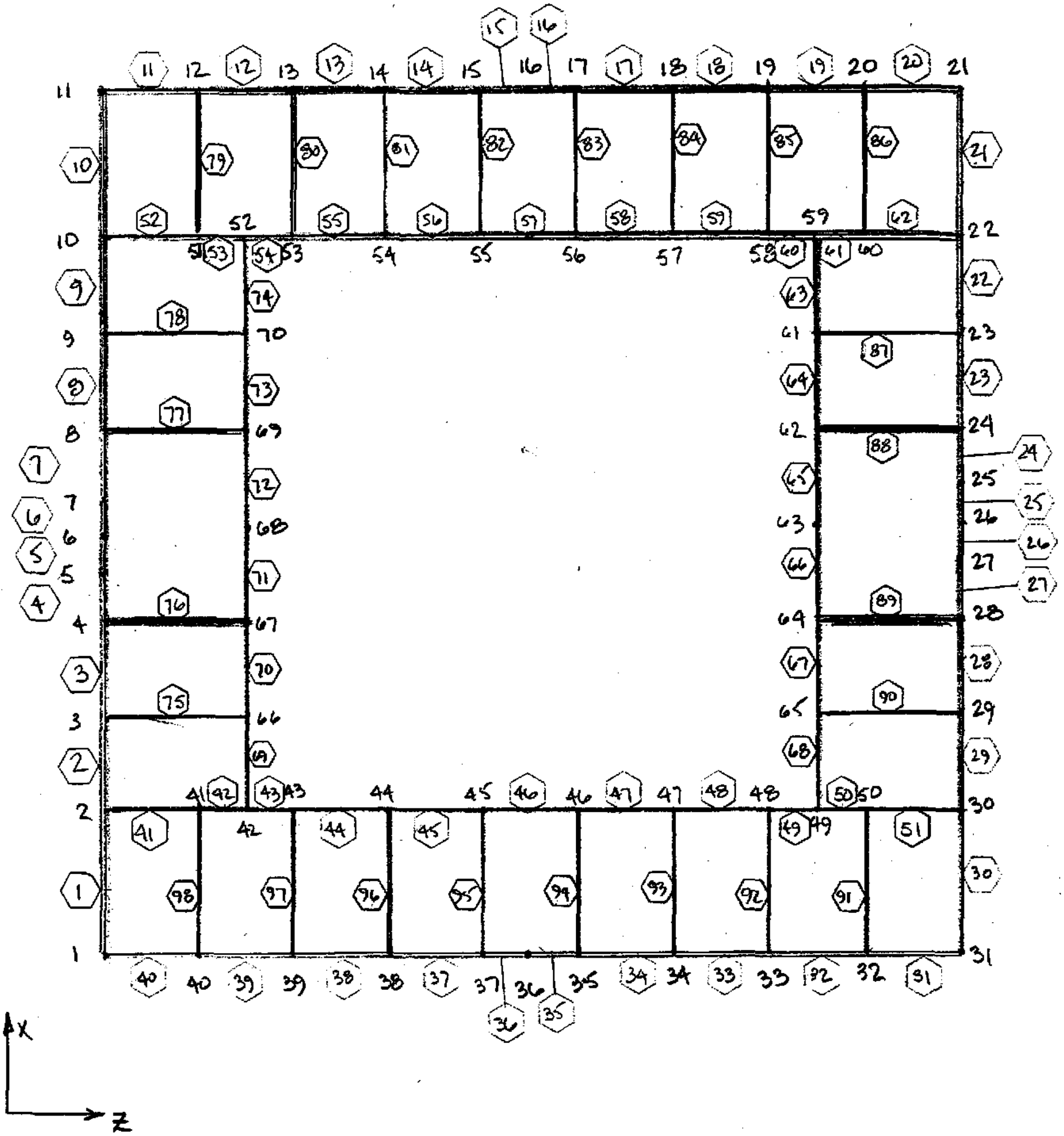
SAY: 50 lbs / PANEL (AIR CIRCULATORS & PUMPS)

$\therefore \frac{50 \text{ lbs / PANEL}}{6 \text{ FT}^2} = 8.33 \text{ lbs/FT}^2$

ADD ADDITIONAL MISC DEAD WGHT $\cong$ $\underline{\underline{10.0}}$ lbs/FT² TOTAL

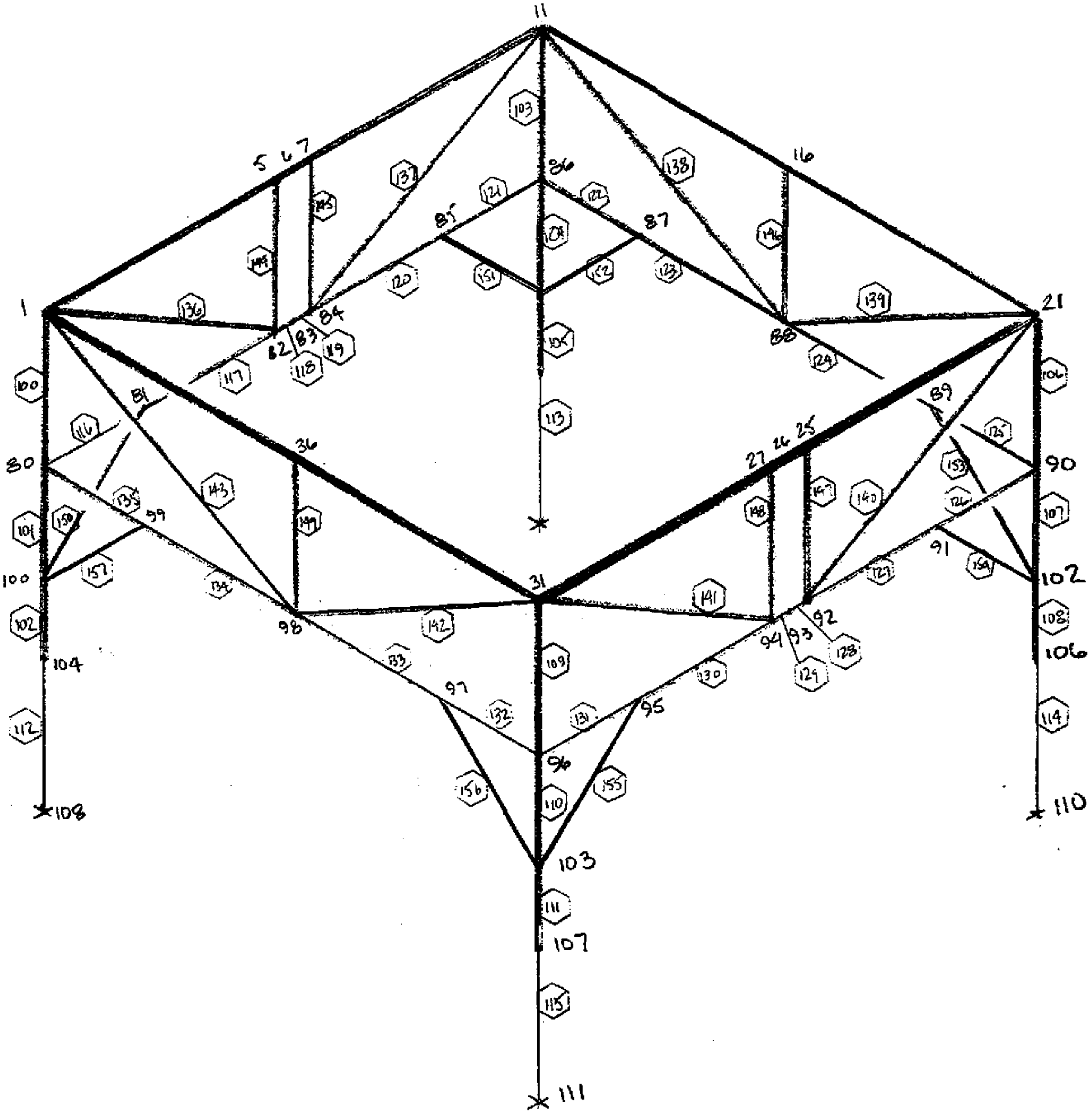
$10 \frac{\text{lbs}}{\text{FT}^2} = 0.0694 \frac{\text{lbs}}{\text{IN}^2} \approx 0.10 \text{ lbs/in}^2$

$\boxed{\text{DESIGN FOR } 0.10 \text{ lbs/in}^2 + \text{SELF WEIGHT}}$



ALUMINUM 75 78 to 87
90 to 98

BSCLNRM3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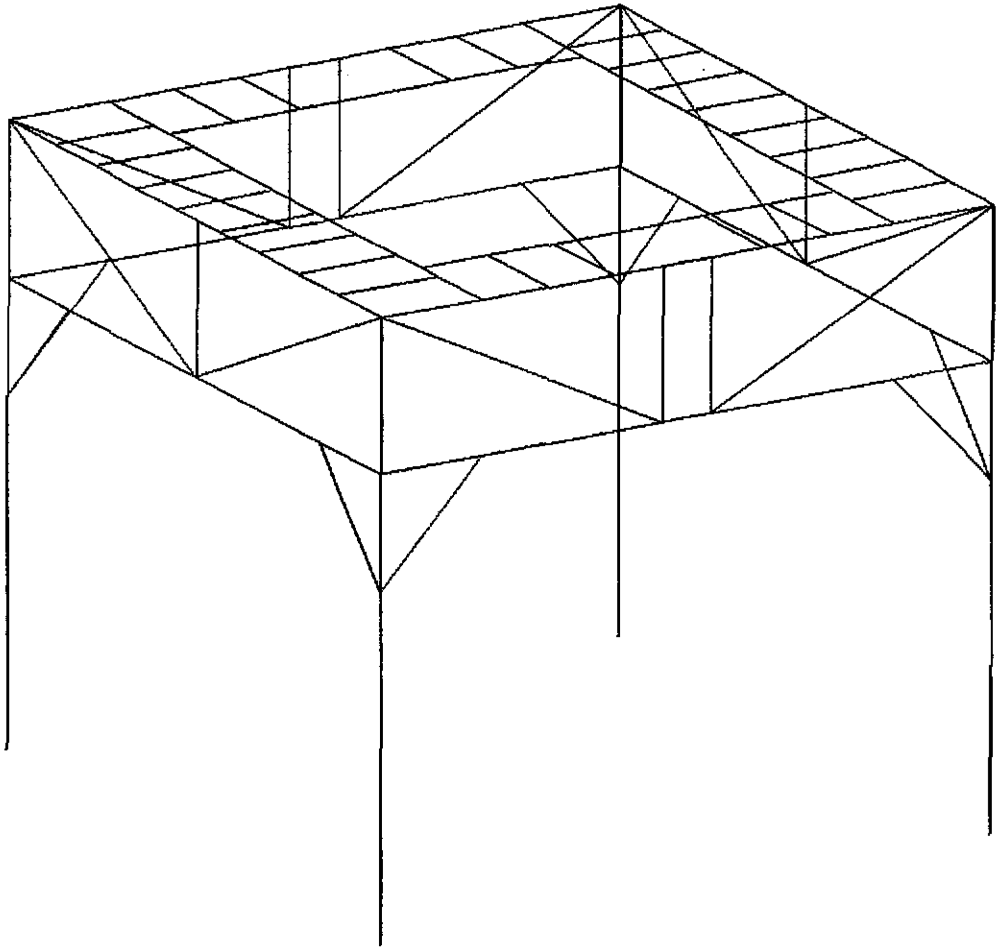
115
111

1

MN/ELEM

STRUCTURE DATA

TYPE = SPACE
NJ = 102
NM = 156
NE = 0
NS = 4
NL = 1
XMAX= 223.0
YMAX= 192.0
ZMAX= 223.0



J=102,M=156

UNIT INC POU

S T A A D P O S T - P L O T (REV: 21.0)

USER ID:PROCESS SYSTEMS INTERNATIONAL IN

TITLE: BSC PORTABLE CLEANROOM

DATE: OCT 7, 1996

STRUCTURE DATA

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NM = 156
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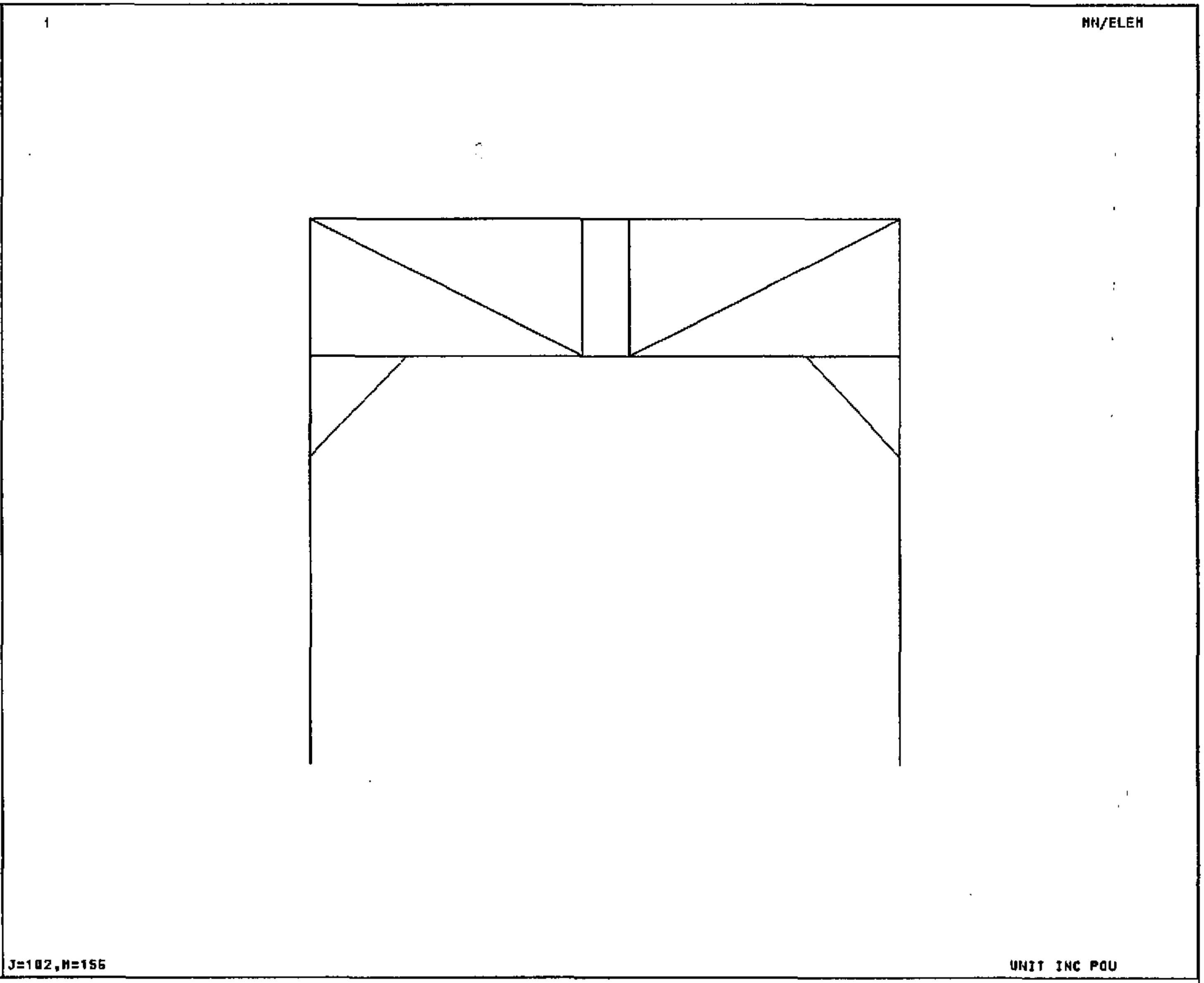

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USER ID:PROCESS SYSTEMS INTERNATIONAL IN

TITLE: BSC PORTABLE CLEANROOM

DATE: OCT 7, 1996

STRUCTURE DATA

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NJ = 102
NM = 156
NE = 0
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NL = 1
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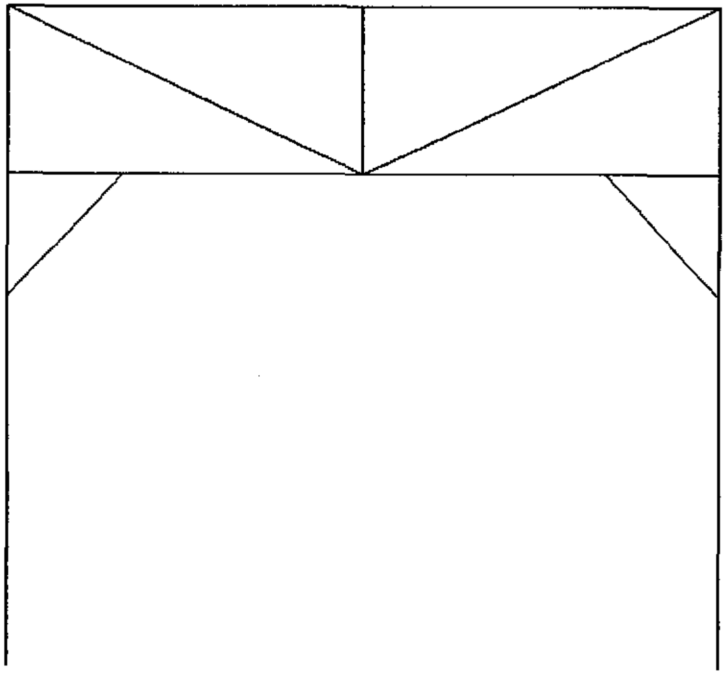
YMAX= 192.0
ZMAX= 223.0



S T A A D P O S T - P L O T (REV: 21.0)

USER ID:PROCESS SYSTEMS INTERNATIONAL IN
TITLE: BSC PORTABLE CLEANROOM
DATE: OCT 7, 1996

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**************************************************
*                                                *
*           S T A A D - III                      *
*           Revision 21.0                        *
*           Proprietary Program of               *
*           Research Engineers, Inc.             *
*           Date=    SEP 25, 1996                *
*           Time=     8:38:27                    *
*                                                *
*      USER ID: PROCESS SYSTEMS INTERNATIONAL IN *
**************************************************


  1. STAAD SPACE BSC PORTABLE CLEANROOM
  2. INPUT WIDTH 72
  3. UNIT INCHES POUND
  4. JOINT COORDINATES
  5. 1 0. 0. 0.; 2 36. 0. 0.; 3 60. 0. 0.; 4 84. 0. 0.; 5 102.333 0. 0.
  6. 6 111.5 0. 0.; 7 120.667 0. 0.; 8 139. 0. 0.; 9 163. 0. 0.
  7. 10 187. 0. 0.; 11 223. 0. 0.; 12 223. 0. 26.5; 13 223. 0. 50.5
  8. 14 223. 0. 74.5; 15 223. 0. 98.5; 16 223. 0. 111.5; 17 223. 0. 124.5
  9. 18 223. 0. 148.5; 19 223. 0. 172.5; 20 223. 0. 196.5; 21 223. 0. 223.
 10. 22 187. 0. 223.; 23 163. 0. 223.; 24 139. 0. 223.; 25 120.667 0. 223.
 11. 26 111.5 0. 223.; 27 102.333 0. 223.; 28 84. 0. 223.; 29 60. 0. 223.
 12. 30 36. 0. 223.; 31 0. 0. 223.; 32 0. 0. 196.5; 33 0. 0. 172.5
 13. 34 0. 0. 148.5; 35 0. 0. 124.5; 36 0. 0. 111.5; 37 0. 0. 98.5
 14. 38 0. 0. 74.5; 39 0. 0. 50.5; 40 0. 0. 26.5; 41 36. 0. 26.5
 15. 42 36. 0. 36.; 43 36. 0. 50.5; 44 36. 0. 74.5; 45 36. 0. 98.5
 16. 46 36. 0. 124.5; 47 36. 0. 148.5; 48 36. 0. 172.5; 49 36. 0. 187.
 17. 50 36. 0. 196.5; 51 187. 0. 26.5; 52 187. 0. 36.; 53 187. 0. 50.5
 18. 54 187. 0. 74.5; 55 187. 0. 98.5; 56 187. 0. 124.5; 57 187. 0. 148.5
 19. 58 187. 0. 172.5; 59 187. 0. 187.; 60 187. 0. 196.5; 61 163. 0. 187.
 20. 62 139. 0. 187.; 63 111.5 0. 187.; 64 84. 0. 187.; 65 60. 0. 187.
 21. 66 60. 0. 36.; 67 84. 0. 36.; 68 111.5 0. 36.; 69 139. 0. 36.
 22. 70 163. 0. 36.; 80 0. -48. 0.; 81 36. -48. 0.; 82 102.333 -48. 0.
 23. 83 111.5 -48. 0.; 84 120.667 -48. 0.; 85 187. -48. 0.; 86 223. -48. 0.
 24. 87 223. -48. 36.; 88 223. -48. 111.5; 89 223. -48. 187.
 25. 90 223. -48. 223.; 91 187. -48. 223.; 92 120.667 -48. 223.
 26. 93 111.5 -48. 223.; 94 102.333 -48. 223.; 95 36. -48. 223.
 27. 96 0. -48. 223.; 97 0. -48. 187.; 98 0. -48. 111.5; 99 0. -48. 36.
 28. 100 0. -84. 0.; 101 223. -84. 0.; 102 223. -84. 223.; 103 0. -84. 223.
 29. 104 0. -90. 0.; 105 223. -90. 0.; 106 223. -90. 223.; 107 0. -90. 223.
 30. 108 0. -192. 0.; 109 223. -192. 0.; 110 223. -192. 223.
 31. 111 0. -192. 223.
 32. MEMBER INCIDENCES
 33. 1 1 2; 2 2 3; 3 3 4; 4 4 5; 5 5 6; 6 6 7; 7 7 8; 8 8 9; 9 9 10; 10 10 11
 34. 11 11 12; 12 12 13; 13 13 14; 14 14 15; 15 15 16; 16 16 17; 17 17 18
 35. 18 18 19; 19 19 20; 20 20 21; 21 21 22; 22 22 23; 23 23 24; 24 24 25
 36. 25 25 26; 26 26 27; 27 27 28; 28 28 29; 29 29 30; 30 30 31; 31 31 32
 37. 32 32 33; 33 33 34; 34 34 35; 35 35 36; 36 36 37; 37 37 38; 38 38 39
 38. 39 39 40; 40 40 1; 41 2 41; 42 41 42; 43 42 43; 44 43 44; 45 44 45
 39. 46 45 46; 47 46 47; 48 47 48; 49 48 49; 50 49 50; 51 50 30; 52 10 51
 40. 53 51 52; 54 52 53; 55 53 54; 56 54 55; 57 55 56; 58 56 57; 59 57 58
 41. 60 58 59; 61 59 60; 62 60 22; 63 59 61; 64 61 62; 65 62 63; 66 63 64
```

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42. 67 64 65; 68 65 49; 69 42 66; 70 66 67; 71 67 68; 72 68 69; 73 69 70
43. 74 70 52; 75 3 66; 76 4 67; 77 8 69; 78 9 70; 79 12 51; 80 13 53
44. 81 14 54; 82 15 55; 83 17 56; 84 18 57; 85 19 58; 86 20 60; 87 23 61
45. 88 24 62; 89 28 64; 90 29 65; 91 32 50; 92 33 48; 93 34 47; 94 35 46
46. 95 37 45; 96 38 44; 97 39 43; 98 40 41; 100 1 80; 101 80 100
47. 102 100 104; 103 11 86; 104 86 101; 105 101 105; 106 21 90; 107 90 102
48. 108 102 106; 109 31 96; 110 96 103; 111 103 107; 112 104 108
49. 113 105 109; 114 106 110; 115 107 111; 116 80 81; 117 81 82; 118 82 83
50. 119 83 84; 120 84 85; 121 85 86; 122 86 87; 123 87 88; 124 88 89
51. 125 89 90; 126 90 91; 127 91 92; 128 92 93; 129 93 94; 130 94 95
52. 131 95 96; 132 96 97; 133 97 98; 134 98 99; 135 99 80; 136 1 82
53. 137 11 84; 138 11 88; 139 21 88; 140 21 92; 141 31 94; 142 31 98
54. 143 1 98; 144 5 82; 145 7 84; 146 16 88; 147 25 92; 148 27 94; 149 36 98
55. 150 100 81; 151 101 85; 152 101 87; 153 102 89; 154 102 91; 155 103 95
56. 156 103 97; 157 100 99
57. MEMBER PROPERTY AMER
58. 1 TO 62 TABLE ST TUB60303
59. 63 TO 74 TABLE ST TUB30203
60. 75 78 TO 87 90 TO 98 PRI YD 1.75 ZD 1.5 YB 1.563 ZB 0.188
61. ***              ALUM. TEES @ 180 DEG.
62. 100 TO 111 TABLE ST TUB35353
63. *** COLUMN TUBE STEEL LEGS
64. 112 TO 115 PRI AX 1.382 IY 1.914 IZ 1.914 YD 3. ZD 3.
65. *** ALUMINUM COLUMN TUBE LEGS (3" X 3" X 1/8")
66. 76 77 88 89 116 TO 157 TABLE ST TUB20203
67. MEMBER RELEASE
68. 75 78 TO 87 90 TO 98 START MX MY MZ
69. 75 78 TO 87 90 TO 98 END MX MY MZ
70. CONSTANTS
71. E STEEL MEMB 1 TO 74 76 77 88 89 100 TO 111 116 TO 157
72. E ALUMINUM MEMB 75 78 TO 87 90 TO 98 112 TO 115
73. POISSON STEEL MEMB 1 TO 74 76 77 88 89 100 TO 111 116 TO 157
74. POISSON ALUMINUM MEMB 75 78 TO 87 90 TO 98 112 TO 115
75. DENSITY STEEL MEMB 1 TO 74 76 77 88 89 100 TO 111 116 TO 157
76. DENSITY ALUMINUM MEMB 75 78 TO 87 90 TO 98 112 TO 115
77. BETA 180. MEMB 75 78 TO 87 90 TO 98
78. SUPPORTS
79. 108 FIXED BUT FX FZ MX MZ
80. 109 FIXED BUT FX FZ MX MZ
81. 110 FIXED BUT FX FZ MX MZ
82. 111 FIXED BUT FX FZ MX MZ
83. LOAD 1 AREA LOAD
84. SELFWEIGHT Y -1.
85. AREA LOAD
86. 1 TO 98 ALOAD -0.1
87. PERFORM ANALYSIS
```

```
        P R O B L E M   S T A T I S T I C S
        -----------------------------------

  NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =   102/  156/    4
  ORIGINAL/FINAL BAND-WIDTH =   88/   13
  TOTAL PRIMARY LOAD CASES  =    1, TOTAL DEGREES OF FREEDOM =    604
  SIZE OF STIFFNESS MATRIX =   50736 DOUBLE PREC. WORDS
  REQRD/AVAIL. DISK SPACE =  12.49/  952.0 MB,  EXMEM = 14.83 MB

++ PROCESSING ELEMENT STIFFNESS MATRIX.               8:38:30
++ PROCESSING GLOBAL STIFFNESS MATRIX.                8:38:31
++ PROCESSING TRIANGULAR FACTORIZATION.               8:38:31

 ***WARNING - IMPROPER LOAD WILL CAUSE INSTABILITY AT JOINT   57  *
  DIRECTION = FZ  PROBABLE CAUSE MODELING PROBLEM     0.727E-11
++ CALCULATING JOINT DISPLACEMENTS.                   8:38:32
++ CALCULATING MEMBER  FORCES.                        8:38:33

 88. PRINT MATERIAL PROPERTIES ALL
```

* PROGRAM RECOVERING FROM INSTABILITY

```
MATERIAL PROPERTIES.
--------------------
ALL UNITS ARE - POUN INCH

MEMBER          E            G            DEN         ALPHA

   1       29000000.0   11153846.0   0.28299999  0.00000000
   2       29000000.0   11153846.0   0.28299999  0.00000000
   3       29000000.0   11153846.0   0.28299999  0.00000000
   4       29000000.0   11153846.0   0.28299999  0.00000000
   5       29000000.0   11153846.0   0.28299999  0.00000000
   6       29000000.0   11153846.0   0.28299999  0.00000000
   7       29000000.0   11153846.0   0.28299999  0.00000000
   8       29000000.0   11153846.0   0.28299999  0.00000000
   9       29000000.0   11153846.0   0.28299999  0.00000000
  10       29000000.0   11153846.0   0.28299999  0.00000000
  11       29000000.0   11153846.0   0.28299999  0.00000000
  12       29000000.0   11153846.0   0.28299999  0.00000000
  13       29000000.0   11153846.0   0.28299999  0.00000000
  14       29000000.0   11153846.0   0.28299999  0.00000000
  15       29000000.0   11153846.0   0.28299999  0.00000000
  16       29000000.0   11153846.0   0.28299999  0.00000000
  17       29000000.0   11153846.0   0.28299999  0.00000000
  18       29000000.0   11153846.0   0.28299999  0.00000000
  19       29000000.0   11153846.0   0.28299999  0.00000000
  20       29000000.0   11153846.0   0.28299999  0.00000000
  21       29000000.0   11153846.0   0.28299999  0.00000000
  22       29000000.0   11153846.0   0.28299999  0.00000000
  23       29000000.0   11153846.0   0.28299999  0.00000000
  24       29000000.0   11153846.0   0.28299999  0.00000000
  25       29000000.0   11153846.0   0.28299999  0.00000000
  26       29000000.0   11153846.0   0.28299999  0.00000000
  27       29000000.0   11153846.0   0.28299999  0.00000000
  28       29000000.0   11153846.0   0.28299999  0.00000000
  29       29000000.0   11153846.0   0.28299999  0.00000000
  30       29000000.0   11153846.0   0.28299999  0.00000000
  31       29000000.0   11153846.0   0.28299999  0.00000000
  32       29000000.0   11153846.0   0.28299999  0.00000000
  33       29000000.0   11153846.0   0.28299999  0.00000000
  34       29000000.0   11153846.0   0.28299999  0.00000000
  35       29000000.0   11153846.0   0.28299999  0.00000000
  36       29000000.0   11153846.0   0.28299999  0.00000000
  37       29000000.0   11153846.0   0.28299999  0.00000000
  38       29000000.0   11153846.0   0.28299999  0.00000000
  39       29000000.0   11153846.0   0.28299999  0.00000000
  40       29000000.0   11153846.0   0.28299999  0.00000000
  41       29000000.0   11153846.0   0.28299999  0.00000000
  42       29000000.0   11153846.0   0.28299999  0.00000000
  43       29000000.0   11153846.0   0.28299999  0.00000000
  44       29000000.0   11153846.0   0.28299999  0.00000000
  45       29000000.0   11153846.0   0.28299999  0.00000000
  46       29000000.0   11153846.0   0.28299999  0.00000000
```

```
MATERIAL PROPERTIES.
--------------------
ALL UNITS ARE - POUN INCH

MEMBER          E            G            DEN         ALPHA

  47       29000000.0   11153846.0   0.28299999  0.00000000
  48       29000000.0   11153846.0   0.28299999  0.00000000
  49       29000000.0   11153846.0   0.28299999  0.00000000
  50       29000000.0   11153846.0   0.28299999  0.00000000
  51       29000000.0   11153846.0   0.28299999  0.00000000
  52       29000000.0   11153846.0   0.28299999  0.00000000
  53       29000000.0   11153846.0   0.28299999  0.00000000
  54       29000000.0   11153846.0   0.28299999  0.00000000
  55       29000000.0   11153846.0   0.28299999  0.00000000
  56       29000000.0   11153846.0   0.28299999  0.00000000
  57       29000000.0   11153846.0   0.28299999  0.00000000
  58       29000000.0   11153846.0   0.28299999  0.00000000
  59       29000000.0   11153846.0   0.28299999  0.00000000
  60       29000000.0   11153846.0   0.28299999  0.00000000
  61       29000000.0   11153846.0   0.28299999  0.00000000
  62       29000000.0   11153846.0   0.28299999  0.00000000
  63       29000000.0   11153846.0   0.28299999  0.00000000
  64       29000000.0   11153846.0   0.28299999  0.00000000
  65       29000000.0   11153846.0   0.28299999  0.00000000
  66       29000000.0   11153846.0   0.28299999  0.00000000
  67       29000000.0   11153846.0   0.28299999  0.00000000
  68       29000000.0   11153846.0   0.28299999  0.00000000
  69       29000000.0   11153846.0   0.28299999  0.00000000
  70       29000000.0   11153846.0   0.28299999  0.00000000
  71       29000000.0   11153846.0   0.28299999  0.00000000
  72       29000000.0   11153846.0   0.28299999  0.00000000
  73       29000000.0   11153846.0   0.28299999  0.00000000
  74       29000000.0   11153846.0   0.28299999  0.00000000
  75        9999999.0    3999999.8   0.09548600  0.00000000
  76       29000000.0   11153846.0   0.28299999  0.00000000
  77       29000000.0   11153846.0   0.28299999  0.00000000
  78        9999999.0    3999999.8   0.09548600  0.00000000
  79        9999999.0    3999999.8   0.09548600  0.00000000
  80        9999999.0    3999999.8   0.09548600  0.00000000
  81        9999999.0    3999999.8   0.09548600  0.00000000
  82        9999999.0    3999999.8   0.09548600  0.00000000
  83        9999999.0    3999999.8   0.09548600  0.00000000
  84        9999999.0    3999999.8   0.09548600  0.00000000
  85        9999999.0    3999999.8   0.09548600  0.00000000
  86        9999999.0    3999999.8   0.09548600  0.00000000
  87        9999999.0    3999999.8   0.09548600  0.00000000
  88       29000000.0   11153846.0   0.28299999  0.00000000
  89       29000000.0   11153846.0   0.28299999  0.00000000
  90        9999999.0    3999999.8   0.09548600  0.00000000
  91        9999999.0    3999999.8   0.09548600  0.00000000
  92        9999999.0    3999999.8   0.09548600  0.00000000
```

```
MATERIAL PROPERTIES.
--------------------
ALL UNITS ARE - POUN INCH

MEMBER         E              G            DEN         ALPHA

  93        9999999.0     3999999.8     0.09548600   0.00000000
  94        9999999.0     3999999.8     0.09548600   0.00000000
  95        9999999.0     3999999.8     0.09548600   0.00000000
  96        9999999.0     3999999.8     0.09548600   0.00000000
  97        9999999.0     3999999.8     0.09548600   0.00000000
  98        9999999.0     3999999.8     0.09548600   0.00000000
 100       29000000.0    11153846.0     0.28299999   0.00000000
 101       29000000.0    11153846.0     0.28299999   0.00000000
 102       29000000.0    11153846.0     0.28299999   0.00000000
 103       29000000.0    11153846.0     0.28299999   0.00000000
 104       29000000.0    11153846.0     0.28299999   0.00000000
 105       29000000.0    11153846.0     0.28299999   0.00000000
 106       29000000.0    11153846.0     0.28299999   0.00000000
 107       29000000.0    11153846.0     0.28299999   0.00000000
 108       29000000.0    11153846.0     0.28299999   0.00000000
 109       29000000.0    11153846.0     0.28299999   0.00000000
 110       29000000.0    11153846.0     0.28299999   0.00000000
 111       29000000.0    11153846.0     0.28299999   0.00000000
 112        9999999.0     3999999.8     0.09548600   0.00000000
 113        9999999.0     3999999.8     0.09548600   0.00000000
 114        9999999.0     3999999.8     0.09548600   0.00000000
 115        9999999.0     3999999.8     0.09548600   0.00000000
 116       29000000.0    11153846.0     0.28299999   0.00000000
 117       29000000.0    11153846.0     0.28299999   0.00000000
 118       29000000.0    11153846.0     0.28299999   0.00000000
 119       29000000.0    11153846.0     0.28299999   0.00000000
 120       29000000.0    11153846.0     0.28299999   0.00000000
 121       29000000.0    11153846.0     0.28299999   0.00000000
 122       29000000.0    11153846.0     0.28299999   0.00000000
 123       29000000.0    11153846.0     0.28299999   0.00000000
 124       29000000.0    11153846.0     0.28299999   0.00000000
 125       29000000.0    11153846.0     0.28299999   0.00000000
 126       29000000.0    11153846.0     0.28299999   0.00000000
 127       29000000.0    11153846.0     0.28299999   0.00000000
 128       29000000.0    11153846.0     0.28299999   0.00000000
 129       29000000.0    11153846.0     0.28299999   0.00000000
 130       29000000.0    11153846.0     0.28299999   0.00000000
 131       29000000.0    11153846.0     0.28299999   0.00000000
 132       29000000.0    11153846.0     0.28299999   0.00000000
 133       29000000.0    11153846.0     0.28299999   0.00000000
 134       29000000.0    11153846.0     0.28299999   0.00000000
 135       29000000.0    11153846.0     0.28299999   0.00000000
 136       29000000.0    11153846.0     0.28299999   0.00000000
 137       29000000.0    11153846.0     0.28299999   0.00000000
 138       29000000.0    11153846.0     0.28299999   0.00000000
 139       29000000.0    11153846.0     0.28299999   0.00000000
```

```
MATERIAL PROPERTIES.
--------------------
ALL UNITS ARE - POUN INCH

MEMBER           E             G             DEN          ALPHA

  140      29000000.0    11153846.0     0.28299999   0.00000000
  141      29000000.0    11153846.0     0.28299999   0.00000000
  142      29000000.0    11153846.0     0.28299999   0.00000000
  143      29000000.0    11153846.0     0.28299999   0.00000000
  144      29000000.0    11153846.0     0.28299999   0.00000000
  145      29000000.0    11153846.0     0.28299999   0.00000000
  146      29000000.0    11153846.0     0.28299999   0.00000000
  147      29000000.0    11153846.0     0.28299999   0.00000000
  148      29000000.0    11153846.0     0.28299999   0.00000000
  149      29000000.0    11153846.0     0.28299999   0.00000000
  150      29000000.0    11153846.0     0.28299999   0.00000000
  151      29000000.0    11153846.0     0.28299999   0.00000000
  152      29000000.0    11153846.0     0.28299999   0.00000000
  153      29000000.0    11153846.0     0.28299999   0.00000000
  154      29000000.0    11153846.0     0.28299999   0.00000000
  155      29000000.0    11153846.0     0.28299999   0.00000000
  156      29000000.0    11153846.0     0.28299999   0.00000000
  157      29000000.0    11153846.0     0.28299999   0.00000000

************ END OF DATA FROM INTERNAL STORAGE ************

  89. PRINT MEMBER INFORMATION ALL
```

```
 MEMBER INFORMATION
 ------------------

 MEMBER     START    END         LENGTH     BETA
            JOINT   JOINT        (INCH)     (DEG)       RELEASES

     1         1      2          36.000     0.00
     2         2      3          24.000     0.00
     3         3      4          24.000     0.00
     4         4      5          18.333     0.00
     5         5      6           9.167     0.00
     6         6      7           9.167     0.00
     7         7      8          18.333     0.00
     8         8      9          24.000     0.00
     9         9     10          24.000     0.00
    10        10     11          36.000     0.00
    11        11     12          26.500     0.00
    12        12     13          24.000     0.00
    13        13     14          24.000     0.00
    14        14     15          24.000     0.00
    15        15     16          13.000     0.00
    16        16     17          13.000     0.00
    17        17     18          24.000     0.00
    18        18     19          24.000     0.00
    19        19     20          24.000     0.00
    20        20     21          26.500     0.00
    21        21     22          36.000     0.00
    22        22     23          24.000     0.00
    23        23     24          24.000     0.00
    24        24     25          18.333     0.00
    25        25     26           9.167     0.00
    26        26     27           9.167     0.00
    27        27     28          18.333     0.00
    28        28     29          24.000     0.00
    29        29     30          24.000     0.00
    30        30     31          36.000     0.00
    31        31     32          26.500     0.00
    32        32     33          24.000     0.00
    33        33     34          24.000     0.00
    34        34     35          24.000     0.00
    35        35     36          13.000     0.00
    36        36     37          13.000     0.00
    37        37     38          24.000     0.00
    38        38     39          24.000     0.00
    39        39     40          24.000     0.00
    40        40      1          26.500     0.00
    41         2     41          26.500     0.00
    42        41     42           9.500     0.00
    43        42     43          14.500     0.00
    44        43     44          24.000     0.00
    45        44     45          24.000     0.00
    46        45     46          26.000     0.00
```

MEMBER INFORMATION

MEMBER	START JOINT	END JOINT	LENGTH (INCH)	BETA (DEG)	RELEASES
47	46	47	24.000	0.00	
48	47	48	24.000	0.00	
49	48	49	14.500	0.00	
50	49	50	9.500	0.00	
51	50	30	26.500	0.00	
52	10	51	26.500	0.00	
53	51	52	9.500	0.00	
54	52	53	14.500	0.00	
55	53	54	24.000	0.00	
56	54	55	24.000	0.00	
57	55	56	26.000	0.00	
58	56	57	24.000	0.00	
59	57	58	24.000	0.00	
60	58	59	14.500	0.00	
61	59	60	9.500	0.00	
62	60	22	26.500	0.00	
63	59	61	24.000	0.00	
64	61	62	24.000	0.00	
65	62	63	27.500	0.00	
66	63	64	27.500	0.00	
67	64	65	24.000	0.00	
68	65	49	24.000	0.00	
69	42	66	24.000	0.00	
70	66	67	24.000	0.00	
71	67	68	27.500	0.00	
72	68	69	27.500	0.00	
73	69	70	24.000	0.00	
74	70	52	24.000	0.00	
75	3	66	36.000	180.00	000111000111
76	4	67	36.000	0.00	
77	8	69	36.000	0.00	
78	9	70	36.000	180.00	000111000111
79	12	51	36.000	180.00	000111000111
80	13	53	36.000	180.00	000111000111
81	14	54	36.000	180.00	000111000111
82	15	55	36.000	180.00	000111000111
83	17	56	36.000	180.00	000111000111
84	18	57	36.000	180.00	000111000111
85	19	58	36.000	180.00	000111000111
86	20	60	36.000	180.00	000111000111
87	23	61	36.000	180.00	000111000111
88	24	62	36.000	0.00	
89	28	64	36.000	0.00	
90	29	65	36.000	180.00	000111000111
91	32	50	36.000	180.00	000111000111
92	33	48	36.000	180.00	000111000111

```
MEMBER INFORMATION
------------------

MEMBER     START    END             LENGTH     BETA
           JOINT   JOINT            (INCH)     (DEG)       RELEASES

  93         34      47             36.000    180.00     000111000111
  94         35      46             36.000    180.00     000111000111
  95         37      45             36.000    180.00     000111000111
  96         38      44             36.000    180.00     000111000111
  97         39      43             36.000    180.00     000111000111
  98         40      41             36.000    180.00     000111000111
 100          1      80             48.000      0.00
 101         80     100             36.000      0.00
 102        100     104              6.000      0.00
 103         11      86             48.000      0.00
 104         86     101             36.000      0.00
 105        101     105              6.000      0.00
 106         21      90             48.000      0.00
 107         90     102             36.000      0.00
 108        102     106              6.000      0.00
 109         31      96             48.000      0.00
 110         96     103             36.000      0.00
 111        103     107              6.000      0.00
 112        104     108            102.000      0.00
 113        105     109            102.000      0.00
 114        106     110            102.000      0.00
 115        107     111            102.000      0.00
 116         80      81             36.000      0.00
 117         81      82             66.333      0.00
 118         82      83              9.167      0.00
 119         83      84              9.167      0.00
 120         84      85             66.333      0.00
 121         85      86             36.000      0.00
 122         86      87             36.000      0.00
 123         87      88             75.500      0.00
 124         88      89             75.500      0.00
 125         89      90             36.000      0.00
 126         90      91             36.000      0.00
 127         91      92             66.333      0.00
 128         92      93              9.167      0.00
 129         93      94              9.167      0.00
 130         94      95             66.333      0.00
 131         95      96             36.000      0.00
 132         96      97             36.000      0.00
 133         97      98             75.500      0.00
 134         98      99             75.500      0.00
 135         99      80             36.000      0.00
 136          1      82            113.031      0.00
 137         11      84            113.031      0.00
 138         11      88            121.393      0.00
 139         21      88            121.393      0.00
```

```
MEMBER INFORMATION
------------------

MEMBER     START     END        LENGTH     BETA
           JOINT    JOINT       (INCH)     (DEG)      RELEASES

  140       21       92        113.031     0.00
  141       31       94        113.031     0.00
  142       31       98        121.393     0.00
  143        1       98        121.393     0.00
  144        5       82         48.000     0.00
  145        7       84         48.000     0.00
  146       16       88         48.000     0.00
  147       25       92         48.000     0.00
  148       27       94         48.000     0.00
  149       36       98         48.000     0.00
  150      100       81         50.912     0.00
  151      101       85         50.912     0.00
  152      101       87         50.912     0.00
  153      102       89         50.912     0.00
  154      102       91         50.912     0.00
  155      103       95         50.912     0.00
  156      103       97         50.912     0.00
  157      100       99         50.912     0.00


************ END OF DATA FROM INTERNAL STORAGE ************


  90. PRINT JOINT COORDINATES ALL
```

JOINT COORDINATES

COORDINATES ARE INCH UNIT

JOINT	X	Y	Z
1	0.000	0.000	0.000
2	36.000	0.000	0.000
3	60.000	0.000	0.000
4	84.000	0.000	0.000
5	102.333	0.000	0.000
6	111.500	0.000	0.000
7	120.667	0.000	0.000
8	139.000	0.000	0.000
9	163.000	0.000	0.000
10	187.000	0.000	0.000
11	223.000	0.000	0.000
12	223.000	0.000	26.500
13	223.000	0.000	50.500
14	223.000	0.000	74.500
15	223.000	0.000	98.500
16	223.000	0.000	111.500
17	223.000	0.000	124.500
18	223.000	0.000	148.500
19	223.000	0.000	172.500
20	223.000	0.000	196.500
21	223.000	0.000	223.000
22	187.000	0.000	223.000
23	163.000	0.000	223.000
24	139.000	0.000	223.000
25	120.667	0.000	223.000
26	111.500	0.000	223.000
27	102.333	0.000	223.000
28	84.000	0.000	223.000
29	60.000	0.000	223.000
30	36.000	0.000	223.000
31	0.000	0.000	223.000
32	0.000	0.000	196.500
33	0.000	0.000	172.500
34	0.000	0.000	148.500
35	0.000	0.000	124.500
36	0.000	0.000	111.500
37	0.000	0.000	98.500
38	0.000	0.000	74.500
39	0.000	0.000	50.500
40	0.000	0.000	26.500
41	36.000	0.000	26.500
42	36.000	0.000	36.000
43	36.000	0.000	50.500
44	36.000	0.000	74.500
45	36.000	0.000	98.500
46	36.000	0.000	124.500
47	36.000	0.000	148.500

JOINT COORDINATES

COORDINATES ARE INCH UNIT

JOINT	X	Y	Z
48	36.000	0.000	172.500
49	36.000	0.000	187.000
50	36.000	0.000	196.500
51	187.000	0.000	26.500
52	187.000	0.000	36.000
53	187.000	0.000	50.500
54	187.000	0.000	74.500
55	187.000	0.000	98.500
56	187.000	0.000	124.500
57	187.000	0.000	148.500
58	187.000	0.000	172.500
59	187.000	0.000	187.000
60	187.000	0.000	196.500
61	163.000	0.000	187.000
62	139.000	0.000	187.000
63	111.500	0.000	187.000
64	84.000	0.000	187.000
65	60.000	0.000	187.000
66	60.000	0.000	36.000
67	84.000	0.000	36.000
68	111.500	0.000	36.000
69	139.000	0.000	36.000
70	163.000	0.000	36.000
80	0.000	-48.000	0.000
81	36.000	-48.000	0.000
82	102.333	-48.000	0.000
83	111.500	-48.000	0.000
84	120.667	-48.000	0.000
85	187.000	-48.000	0.000
86	223.000	-48.000	0.000
87	223.000	-48.000	36.000
88	223.000	-48.000	111.500
89	223.000	-48.000	187.000
90	223.000	-48.000	223.000
91	187.000	-48.000	223.000
92	120.667	-48.000	223.000
93	111.500	-48.000	223.000
94	102.333	-48.000	223.000
95	36.000	-48.000	223.000
96	0.000	-48.000	223.000
97	0.000	-48.000	187.000
98	0.000	-48.000	111.500
99	0.000	-48.000	36.000
100	0.000	-84.000	0.000
101	223.000	-84.000	0.000
102	223.000	-84.000	223.000
103	0.000	-84.000	223.000

```
JOINT COORDINATES
-----------------
COORDINATES ARE INCH UNIT

JOINT            X              Y              Z

 104           0.000        -90.000          0.000
 105         223.000        -90.000          0.000
 106         223.000        -90.000        223.000
 107           0.000        -90.000        223.000
 108           0.000       -192.000          0.000
 109         223.000       -192.000          0.000
 110         223.000       -192.000        223.000
 111           0.000       -192.000        223.000

************ END OF DATA FROM INTERNAL STORAGE ************


 91. PRINT SUPPORT INFORMATION ALL


SUPPORT INFORMATION (1=FIXED, 0=RELEASED)
-------------------
UNITS FOR SPRING CONSTANTS ARE POUN INCH DEGREES

JOINT    FORCE-X/    FORCE-Y/    FORCE-Z/    MOM-X/    MOM-Y/    MOM-Z/
           KFX         KFY         KFZ        KMX       KMY       KMZ

 108        0           1           0          0         1         0
              0.0         0.0         0.0       0.0       0.0       0.0
 109        0           1           0          0         1         0
              0.0         0.0         0.0       0.0       0.0       0.0
 110        0           1           0          0         1         0
              0.0         0.0         0.0       0.0       0.0       0.0
 111        0           1           0          0         1         0
              0.0         0.0         0.0       0.0       0.0       0.0

************ END OF DATA FROM INTERNAL STORAGE ************


 92. PRINT ANALYSIS RESULTS
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```
  JOINT DISPLACEMENT (INCH RADIANS)    STRUCTURE TYPE = SPACE
  ------------------

JOINT  LOAD   X-TRANS    Y-TRANS    Z-TRANS    X-ROTAN    Y-ROTAN    Z-ROTAN

    1     1    0.00012   -0.01037    0.00086    0.00046    0.00003   -0.00042
    2     1   -0.00021   -0.02588    0.00005    0.00214   -0.00001   -0.00026
    3     1   -0.00043   -0.02750    0.00094    0.00222   -0.00005    0.00009
    4     1   -0.00065   -0.02306    0.00218    0.00231   -0.00004    0.00022
    5     1   -0.00082   -0.01947    0.00281    0.00219   -0.00002    0.00011
    6     1   -0.00091   -0.01897    0.00289    0.00219    0.00000    0.00000
    7     1   -0.00099   -0.01947    0.00281    0.00219    0.00002   -0.00011
    8     1   -0.00116   -0.02306    0.00218    0.00231    0.00004   -0.00022
    9     1   -0.00138   -0.02750    0.00095    0.00222    0.00005   -0.00009
   10     1   -0.00160   -0.02588    0.00005    0.00214    0.00001    0.00026
   11     1   -0.00193   -0.01037    0.00087    0.00046   -0.00003    0.00042
   12     1   -0.00138   -0.02009    0.00067    0.00025    0.00003    0.00039
   13     1   -0.00073   -0.02355    0.00048    0.00004    0.00002    0.00037
   14     1   -0.00049   -0.02238    0.00030   -0.00011    0.00000    0.00034
   15     1   -0.00049   -0.01928    0.00011   -0.00010    0.00000    0.00032
   16     1   -0.00050   -0.01841    0.00001    0.00000    0.00000    0.00030
   17     1   -0.00049   -0.01928   -0.00009    0.00010    0.00000    0.00032
   18     1   -0.00050   -0.02238   -0.00027    0.00011    0.00000    0.00034
   19     1   -0.00073   -0.02355   -0.00045   -0.00004   -0.00002    0.00037
   20     1   -0.00139   -0.02009   -0.00064   -0.00025   -0.00003    0.00039
   21     1   -0.00194   -0.01037   -0.00084   -0.00046    0.00003    0.00042
   22     1   -0.00161   -0.02588   -0.00003   -0.00214   -0.00001    0.00026
   23     1   -0.00139   -0.02750   -0.00092   -0.00222   -0.00005   -0.00009
   24     1   -0.00117   -0.02306   -0.00216   -0.00231   -0.00004   -0.00022
   25     1   -0.00100   -0.01947   -0.00279   -0.00219   -0.00002   -0.00011
   26     1   -0.00091   -0.01897   -0.00287   -0.00219    0.00000    0.00000
   27     1   -0.00083   -0.01947   -0.00279   -0.00219    0.00002    0.00011
   28     1   -0.00066   -0.02306   -0.00216   -0.00231    0.00004    0.00022
   29     1   -0.00044   -0.02750   -0.00093   -0.00222    0.00005    0.00009
   30     1   -0.00022   -0.02588   -0.00003   -0.00214    0.00001   -0.00026
   31     1    0.00011   -0.01037   -0.00085   -0.00046   -0.00003   -0.00042
   32     1   -0.00043   -0.02009   -0.00064   -0.00025    0.00003   -0.00039
   33     1   -0.00109   -0.02355   -0.00046   -0.00004    0.00002   -0.00037
   34     1   -0.00132   -0.02238   -0.00028    0.00011    0.00000   -0.00034
   35     1   -0.00133   -0.01928   -0.00009    0.00010    0.00000   -0.00032
   36     1   -0.00131   -0.01841    0.00001    0.00000    0.00000   -0.00030
   37     1   -0.00133   -0.01928    0.00011   -0.00010    0.00000   -0.00032
   38     1   -0.00132   -0.02238    0.00029   -0.00011    0.00000   -0.00034
   39     1   -0.00108   -0.02355    0.00048    0.00004   -0.00002   -0.00037
   40     1   -0.00043   -0.02009    0.00066    0.00025   -0.00003   -0.00039
   41     1   -0.00060   -0.08498    0.00004    0.00220   -0.00002   -0.00040
   42     1   -0.00086   -0.10553    0.00003    0.00209   -0.00002   -0.00045
   43     1   -0.00111   -0.13418    0.00003    0.00183   -0.00001   -0.00045
   44     1   -0.00131   -0.17101    0.00002    0.00120    0.00000   -0.00045
   45     1   -0.00134   -0.19096    0.00001    0.00044    0.00000   -0.00045
   46     1   -0.00134   -0.19096    0.00000   -0.00044    0.00000   -0.00045
   47     1   -0.00132   -0.17101    0.00000   -0.00120    0.00000   -0.00045
   48     1   -0.00112   -0.13418   -0.00001   -0.00183    0.00001   -0.00045
```

```
JOINT DISPLACEMENT (INCH RADIANS)    STRUCTURE TYPE = SPACE
------------------

JOINT  LOAD   X-TRANS   Y-TRANS   Z-TRANS   X-ROTAN   Y-ROTAN   Z-ROTAN

  49     1   -0.00087  -0.10553  -0.00002  -0.00209   0.00002  -0.00045
  50     1   -0.00060  -0.08498  -0.00002  -0.00220   0.00002  -0.00040
  51     1   -0.00121  -0.08498   0.00004   0.00220   0.00002   0.00040
  52     1   -0.00095  -0.10553   0.00004   0.00209   0.00002   0.00045
  53     1   -0.00070  -0.13418   0.00003   0.00183   0.00001   0.00045
  54     1   -0.00050  -0.17101   0.00003   0.00120   0.00000   0.00045
  55     1   -0.00047  -0.19096   0.00002   0.00044   0.00000   0.00045
  56     1   -0.00047  -0.19096   0.00001  -0.00044   0.00000   0.00045
  57     1   -0.00050  -0.17101   0.00000  -0.00120   0.00000   0.00045
  58     1   -0.00070  -0.13418  -0.00001  -0.00183  -0.00001   0.00045
  59     1   -0.00095  -0.10553  -0.00001  -0.00209  -0.00002   0.00045
  60     1   -0.00122  -0.08498  -0.00002  -0.00220  -0.00002   0.00040
  61     1   -0.00094  -0.11778  -0.00096  -0.00248  -0.00005   0.00047
  62     1   -0.00092  -0.12606  -0.00215  -0.00288  -0.00002   0.00023
  63     1   -0.00091  -0.12939  -0.00249  -0.00288   0.00000   0.00000
  64     1   -0.00090  -0.12606  -0.00215  -0.00288   0.00002  -0.00023
  65     1   -0.00088  -0.11778  -0.00096  -0.00248   0.00005  -0.00047
  66     1   -0.00088  -0.11778   0.00098   0.00248  -0.00005  -0.00047
  67     1   -0.00089  -0.12606   0.00217   0.00288  -0.00002  -0.00023
  68     1   -0.00091  -0.12939   0.00251   0.00288   0.00000   0.00000
  69     1   -0.00092  -0.12606   0.00217   0.00288   0.00002   0.00023
  70     1   -0.00093  -0.11778   0.00098   0.00248   0.00005   0.00047
  80     1   -0.00145  -0.00963  -0.00040  -0.00004   0.00021   0.00002
  81     1   -0.00131  -0.01220  -0.01865   0.00016   0.00074  -0.00013
  82     1   -0.00112  -0.01906  -0.06606   0.00097   0.00026   0.00006
  83     1   -0.00091  -0.01881  -0.06724   0.00097   0.00000   0.00000
  84     1   -0.00069  -0.01906  -0.06606   0.00097  -0.00026  -0.00006
  85     1   -0.00050  -0.01220  -0.01864   0.00016  -0.00074   0.00013
  86     1   -0.00036  -0.00963  -0.00040  -0.00004  -0.00021  -0.00002
  87     1   -0.00326  -0.01171  -0.00024   0.00011   0.00002   0.00003
  88     1    0.00463  -0.01784   0.00001   0.00000   0.00000   0.00005
  89     1   -0.00326  -0.01171   0.00027  -0.00011  -0.00002   0.00003
  90     1   -0.00037  -0.00963   0.00043   0.00004   0.00021  -0.00002
  91     1   -0.00050  -0.01220   0.01867  -0.00016   0.00074   0.00013
  92     1   -0.00070  -0.01906   0.06608  -0.00097   0.00026  -0.00006
  93     1   -0.00091  -0.01881   0.06726  -0.00097   0.00000   0.00000
  94     1   -0.00112  -0.01906   0.06608  -0.00097  -0.00026   0.00006
  95     1   -0.00132  -0.01220   0.01866  -0.00016  -0.00074  -0.00013
  96     1   -0.00146  -0.00963   0.00042   0.00004  -0.00021   0.00002
  97     1    0.00144  -0.01171   0.00027  -0.00011   0.00002  -0.00003
  98     1   -0.00644  -0.01784   0.00001   0.00000   0.00000  -0.00005
  99     1    0.00145  -0.01171  -0.00025   0.00011  -0.00002  -0.00003
 100     1   -0.00438  -0.00905  -0.00283   0.00011   0.00023  -0.00012
 101     1    0.00257  -0.00905  -0.00282   0.00011  -0.00023   0.00012
 102     1    0.00256  -0.00905   0.00285  -0.00011   0.00023   0.00012
 103     1   -0.00438  -0.00905   0.00284  -0.00011  -0.00023  -0.00012
 104     1   -0.00511  -0.00895  -0.00347   0.00011   0.00023  -0.00012
 105     1    0.00330  -0.00895  -0.00346   0.00011  -0.00023   0.00012
```

```
  JOINT DISPLACEMENT (INCH RADIANS)    STRUCTURE TYPE = SPACE
  ------------------

 JOINT  LOAD   X-TRANS    Y-TRANS    Z-TRANS    X-ROTAN    Y-ROTAN    Z-ROTAN

   106     1    0.00329   -0.00895    0.00349   -0.00011    0.00023    0.00012
   107     1   -0.00512   -0.00895    0.00348   -0.00011   -0.00023   -0.00012
   108     1   -0.01760    0.00000   -0.01435    0.00011    0.00000   -0.00012
   109     1    0.01579    0.00000   -0.01434    0.00011    0.00000    0.00012
   110     1    0.01578    0.00000    0.01437   -0.00011    0.00000    0.00012
   111     1   -0.01761    0.00000    0.01437   -0.00011    0.00000   -0.00012
```

```
   SUPPORT REACTIONS -UNIT POUN INCH    STRUCTURE TYPE = SPACE
   -----------------

 JOINT  LOAD   FORCE-X   FORCE-Y   FORCE-Z     MOM-X     MOM-Y     MOM Z

   108     1      0.00   1219.11      0.00      0.00    -88.55      0.00
   109     1      0.00   1219.10      0.00      0.00     88.57      0.00
   110     1      0.00   1219.10      0.00      0.00    -88.55      0.00
   111     1      0.00   1219.10      0.00      0.00     88.57      0.00
```

```
 MEMBER END FORCES    STRUCTURE TYPE = SPACE
 -----------------
 ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


     1    1     1    833.35    333.56    16.82  -6178.02   -167.52    3696.44
                2   -833.35   -253.87   -16.82   6178.02   -438.09    6877.31

     2    1     2    837.10   -115.98   -14.75   -491.53    416.62   -7571.42
                3   -837.10    137.30    14.75    491.53    -62.60    4532.09

     3    1     3    837.10   -181.49    -9.24   -491.53     62.60   -4532.09
                4   -837.10    202.82     9.24    491.53    159.10     -79.54

     4    1     4    842.06   -280.02   -14.98    878.28    -59.44     -86.68
                5   -842.06    296.31    14.98   -878.28    334.06   -5196.25

     5    1     5    832.85      8.15     0.00     -0.01   -257.39    4952.47
                6   -832.85     -0.01     0.00      0.01    257.38   -4915.09

     6    1     6    832.85      0.00     0.00      0.00   -257.39    4915.10
                7   -832.85      8.15     0.00      0.00    257.39   -4952.46

     7    1     7    842.06    296.31    14.98   -878.29   -334.06    5196.24
                8   -842.06   -280.02   -14.98    878.29     59.44      86.66

     8    1     8    837.10    202.82     9.24    491.53   -159.10      79.55
                9   -837.10   -181.49    -9.24   -491.53    -62.60    4532.11

     9    1     9    837.10    137.30    14.75    491.53     62.60   -4532.11
               10   -837.10   -115.97   -14.75   -491.53   -416.61    7571.40

    10    1    10    833.36   -253.87   -16.82   6178.02    438.09   -6877.31
               11   -833.36    333.56    16.82  -6178.02    167.52   -3696.44

    11    1    11    698.75     65.53    29.22    140.26   -701.48   -2445.48
               12   -698.75    -41.98   -29.22   -140.26    -72.80    3869.94

    12    1    12    698.75     -4.46     1.87    140.26     72.79   -3869.95
               13   -698.75     25.79    -1.87   -140.26   -117.65    3507.04

    13    1    13    698.75    -69.97    -2.79    140.26    117.65   -3507.04
               14   -698.75     91.30     2.79   -140.26    -50.69    1571.80

    14    1    14    698.75   -135.49    -1.74    140.26     50.69   -1571.81
               15   -698.75    156.81     1.74   -140.26     -8.87   -1935.79

    15    1    15    698.75   -202.80    -3.57    140.26      8.87    1935.74
               16   -698.75    214.36     3.57   -140.26     37.57   -4647.30
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  MEMBER END FORCES    STRUCTURE TYPE = SPACE
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  ALL UNITS ARE -- POUN INCH

 MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


     16    1   16    698.75    214.36     3.57   -140.26    -37.57    4647.30
               17   -698.75   -202.80    -3.57    140.26     -8.87   -1935.75

     17    1   17    698.75    156.81     1.74   -140.26      8.87    1935.80
               18   -698.75   -135.49    -1.74    140.26    -50.69    1571.81

     18    1   18    698.75     91.30     2.79   -140.26     50.69   -1571.80
               19   -698.75    -69.97    -2.79    140.26   -117.65    3507.03

     19    1   19    698.75     25.78    -1.87   -140.26    117.65   -3507.03
               20   -698.75     -4.46     1.87    140.26    -72.79    3869.96

     20    1   20    698.75    -41.98   -29.22   -140.26     72.79   -3869.93
               21   -698.75     65.53    29.22    140.26    701.48    2445.48

     21    1   21    833.35    333.56    16.82  -6178.02   -167.52    3696.44
               22   -833.35   -253.87   -16.82   6178.02   -438.09    6877.32

     22    1   22    837.10   -115.98   -14.75   -491.53    416.62   -7571.46
               23   -837.10    137.31    14.75    491.53    -62.60    4532.05

     23    1   23    837.10   -181.49    -9.24   -491.53     62.60   -4532.09
               24   -837.10    202.82     9.24    491.53    159.09     -79.55

     24    1   24    842.06   -280.02   -14.98    878.28    -59.44     -86.64
               25   -842.06    296.31    14.98   -878.28    334.06   -5196.21

     25    1   25    832.85      8.14     0.00      0.00   -257.39    4952.43
               26   -832.85      0.00     0.00      0.00    257.39   -4915.13

     26    1   26    832.85      0.00     0.00      0.00   -257.39    4915.14
               27   -832.85      8.14     0.00      0.00    257.39   -4952.43

     27    1   27    842.06    296.31    14.98   -878.28   -334.06    5196.22
               28   -842.06   -280.02   -14.98    878.28     59.44      86.66

     28    1   28    837.10    202.82     9.24    491.53   -159.10      79.57
               29   -837.10   -181.49    -9.24   -491.53    -62.60    4532.12

     29    1   29    837.10    137.30    14.75    491.53     62.60   -4532.12
               30   -837.10   -115.97   -14.75   -491.53   -416.61    7571.40

     30    1   30    833.35   -253.87   -16.82   6178.02    438.09   -6877.30
               31   -833.35    333.56    16.82  -6178.02    167.52   -3696.42

     31    1   31    698.75     65.53    29.22    140.26   -701.48   -2445.48
               32   -698.75    -41.98   -29.22   -140.26    -72.79    3869.93
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MEMBER END FORCES    STRUCTURE TYPE = SPACE
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ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


    32    1   32    698.75     -4.46     1.87    140.26     72.80   -3869.94
              33   -698.75     25.78    -1.87   -140.26   -117.65    3507.05

    33    1   33    698.75    -69.97    -2.79    140.26    117.65   -3507.05
              34   -698.75     91.30     2.79   -140.26    -50.69    1571.79

    34    1   34    698.75   -135.49    -1.74    140.26     50.69   -1571.80
              35   -698.75    156.81     1.74   -140.26     -8.87   -1935.78

    35    1   35    698.75   -202.80    -3.57    140.26      8.87    1935.78
              36   -698.75    214.35     3.57   -140.26     37.57   -4647.28

    36    1   36    698.75    214.35     3.57   -140.26    -37.57    4647.27
              37   -698.75   -202.80    -3.57    140.26     -8.87   -1935.78

    37    1   37    698.75    156.81     1.74   -140.26      8.87    1935.78
              38   -698.75   -135.49    -1.74    140.26    -50.69    1571.79

    38    1   38    698.75     91.30     2.79   -140.26     50.69   -1571.80
              39   -698.75    -69.97    -2.79    140.26   -117.65    3507.04

    39    1   39    698.75     25.78    -1.87   -140.26    117.65   -3507.04
              40   -698.75     -4.46     1.87    140.26    -72.79    3869.95

    40    1   40    698.75    -41.98   -29.22   -140.26     72.79   -3869.95
               1   -698.75     65.53    29.22    140.26    701.48    2445.47

    41    1    2     31.57    369.84     3.75    694.11     21.48    5686.48
              41    -31.57   -314.50    -3.75   -694.11   -120.74    3381.02

    42    1   41     31.57    268.08   -23.60    694.11    120.74   -3380.96
              42    -31.57   -259.63    23.60   -694.11    103.49    5887.55

    43    1   42     31.80    201.46     5.44      0.00   -142.29   -6286.47
              43    -31.80   -188.57    -5.44      0.00     63.39    9114.08

    44    1   43     31.80    144.38     0.78      0.00    -63.39   -9114.13
              44    -31.80   -123.05    -0.78      0.00     44.62   12323.27

    45    1   44     31.80     78.86     1.83      0.00    -44.62  -12323.29
              45    -31.80    -57.54    -1.83      0.00      0.70   13960.17

    46    1   45     31.80     11.55     0.00      0.00     -0.70  -13960.21
              46    -31.80     11.55     0.00      0.00      0.70   13960.14

    47    1   46     31.80    -57.54    -1.83      0.00     -0.70  -13960.16
              47    -31.80     78.87     1.83      0.00     44.62   12323.28
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  MEMBER END FORCES    STRUCTURE TYPE = SPACE
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  ALL UNITS ARE -- POUN INCH

 MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


    48    1    47     31.80   -123.05    -0.78      0.00    -44.62  -12323.26
               48    -31.80    144.38     0.78      0.00     63.39    9114.14

    49    1    48     31.80   -188.59    -5.44      0.00    -63.39   -9114.19
               49    -31.80    201.47     5.44      0.00    142.29    6286.36

    50    1    49     31.57   -259.63    23.60   -694.11   -103.49   -5887.60
               50    -31.57    268.08   -23.60    694.11   -120.74    3380.98

    51    1    50     31.57   -314.50    -3.75   -694.11    120.74   -3381.07
               30    -31.57    369.85     3.75    694.11    -21.48   -5686.53

    52    1    10     31.57    369.84    -3.75   -694.11    -21.48    5686.48
               51    -31.57   -314.50     3.75    694.11    120.74    3381.03

    53    1    51     31.57    268.08    23.60   -694.11   -120.74   -3380.95
               52    -31.57   -259.63   -23.60    694.11   -103.49    5887.57

    54    1    52     31.80    201.45    -5.44      0.00    142.29   -6286.47
               53    -31.80   -188.57     5.44      0.00    -63.39    9114.02

    55    1    53     31.80    144.38    -0.78      0.00     63.39   -9114.13
               54    -31.80   -123.05     0.78      0.00    -44.62   12323.28

    56    1    54     31.80     78.86    -1.83      0.00     44.62  -12323.33
               55    -31.80    -57.53     1.83      0.00     -0.70   13960.13

    57    1    55     31.80     11.55     0.00      0.00      0.70  -13960.18
               56    -31.80     11.55     0.00      0.00     -0.70   13960.17

    58    1    56     31.80    -57.54     1.83      0.00      0.70  -13960.19
               57    -31.80     78.87    -1.83      0.00    -44.62   12323.26

    59    1    57     31.80   -123.06     0.78      0.00     44.62  -12323.33
               58    -31.80    144.38    -0.78      0.00    -63.39    9114.09

    60    1    58     31.80   -188.57     5.44      0.00     63.39   -9114.10
               59    -31.80    201.46    -5.44      0.00   -142.29    6286.45

    61    1    59     31.57   -259.61   -23.60    694.11    103.49   -5887.42
               60    -31.57    268.06    23.60   -694.11    120.74    3381.12

    62    1    60     31.57   -314.49     3.75    694.11   -120.74   -3380.99
               22    -31.57    369.84    -3.75   -694.11     21.48   -5686.46

    63    1    59     29.04     58.16    -0.23   -398.96     38.80     694.10
               61    -29.04    -47.03     0.23    398.96    -33.31     568.18
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MEMBER END FORCES    STRUCTURE TYPE = SPACE
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ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


   64    1    61     29.04      2.84    -5.74   -398.96     33.31    -568.20
              62    -29.04      8.30     5.74    398.96    104.51     502.64

   65    1    62     24.09     12.76     0.00      0.00    -25.70    -336.44
              63    -24.09      0.00     0.00      0.00     25.70     511.94

   66    1    63     24.09      0.00     0.00      0.00    -25.70    -511.94
              64    -24.09     12.76     0.00      0.00     25.70     336.44

   67    1    64     29.04      8.30     5.74    398.96   -104.51    -502.67
              65    -29.04      2.84    -5.74   -398.96    -33.31     568.18

   68    1    65     29.04    -47.03     0.23    398.96     33.31    -568.18
              49    -29.04     58.16    -0.23   -398.96    -38.80    -694.10

   69    1    42     29.04     58.17    -0.23   -398.96     38.80     694.11
              66    -29.04    -47.03     0.23    398.96    -33.31     568.18

   70    1    66     29.04      2.84    -5.74   -398.96     33.31    -568.19
              67    -29.04      8.30     5.74    398.96    104.51     502.66

   71    1    67     24.09     12.76     0.00      0.00    -25.70    -336.44
              68    -24.09      0.00     0.00      0.00     25.70     511.94

   72    1    68     24.09      0.00     0.00      0.00    -25.70    -511.94
              69    -24.09     12.76     0.00      0.00     25.70     336.44

   73    1    69     29.04      8.30     5.74    398.96   -104.51    -502.66
              70    -29.04      2.84    -5.74   -398.96    -33.31     568.19

   74    1    70     29.05    -47.03     0.23    398.96     33.31    -568.21
              52    -29.05     58.17    -0.23   -398.96    -38.80    -694.13

   75    1     3     -5.51    -44.19     0.00      0.00      0.00       0.00
              66      5.51    -44.19     0.00      0.00      0.00       0.00

   76    1     4      5.74     77.20     4.96    166.22    -99.66    1369.81
              67     -5.74    -21.06    -4.96   -166.22    -78.81     398.96

   77    1     8      5.74     77.20    -4.96   -166.22     99.66    1369.81
              69     -5.74    -21.06     4.96    166.22     78.80     398.96

   78    1     9     -5.51    -44.19     0.00      0.00      0.00       0.00
              70      5.51    -44.19     0.00      0.00      0.00       0.00

   79    1    12     27.35    -46.44     0.00      0.00      0.00       0.00
              51    -27.35    -46.44     0.00      0.00      0.00       0.00
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 MEMBER END FORCES    STRUCTURE TYPE = SPACE
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 ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


    80     1    13      4.66    -44.19     0.00      0.00      0.00       0.00
                53     -4.66    -44.19     0.00      0.00      0.00       0.00

    81     1    14     -1.05    -44.19     0.00      0.00      0.00       0.00
                54      1.05    -44.19     0.00      0.00      0.00       0.00

    82     1    15      1.83    -45.99     0.00      0.00      0.00       0.00
                55     -1.83    -45.99     0.00      0.00      0.00       0.00

    83     1    17      1.83    -45.99     0.00      0.00      0.00       0.00
                56     -1.83    -45.99     0.00      0.00      0.00       0.00

    84     1    18     -1.05    -44.19     0.00      0.00      0.00       0.00
                57      1.05    -44.19     0.00      0.00      0.00       0.00

    85     1    19      4.66    -44.19     0.00      0.00      0.00       0.00
                58     -4.66    -44.19     0.00      0.00      0.00       0.00

    86     1    20     27.35    -46.44     0.00      0.00      0.00       0.00
                60    -27.35    -46.44     0.00      0.00      0.00       0.00

    87     1    23     -5.51    -44.19     0.00      0.00      0.00       0.00
                61      5.51    -44.19     0.00      0.00      0.00       0.00

    88     1    24      5.74     77.20     4.96    166.22    -99.66    1369.81
                62     -5.74    -21.06    -4.96   -166.22    -78.81     398.95

    89     1    28      5.74     77.20    -4.96   -166.22     99.66    1369.81
                64     -5.74    -21.06     4.96    166.22     78.80     398.96

    90     1    29     -5.51    -44.19     0.00      0.00      0.00       0.00
                65      5.51    -44.19     0.00      0.00      0.00       0.00

    91     1    32     27.35    -46.44     0.00      0.00      0.00       0.00
                50    -27.35    -46.44     0.00      0.00      0.00       0.00

    92     1    33      4.66    -44.19     0.00      0.00      0.00       0.00
                48     -4.66    -44.19     0.00      0.00      0.00       0.00

    93     1    34     -1.05    -44.19     0.00      0.00      0.00       0.00
                47      1.05    -44.19     0.00      0.00      0.00       0.00

    94     1    35      1.83    -45.99     0.00      0.00      0.00       0.00
                46     -1.83    -45.99     0.00      0.00      0.00       0.00

    95     1    37      1.83    -45.99     0.00      0.00      0.00       0.00
                45     -1.83    -45.99     0.00      0.00      0.00       0.00
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   MEMBER END FORCES    STRUCTURE TYPE = SPACE
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   ALL UNITS ARE -- POUN INCH

  MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y       MOM-Z


     96    1    38     -1.05    -44.19     0.00      0.00      0.00        0.00
                44      1.05    -44.19     0.00      0.00      0.00        0.00

     97    1    39      4.66    -44.19     0.00      0.00      0.00        0.00
                43     -4.66    -44.19     0.00      0.00      0.00        0.00

     98    1    40     27.35    -46.44     0.00      0.00      0.00        0.00
                41    -27.35    -46.44     0.00      0.00      0.00        0.00

    100    1     1   1051.92   -103.63  -114.03    296.99   4034.92    -3644.49
                80  -1084.39    103.63   114.03   -296.99   1438.36    -1329.64

    101    1    80   1105.33     34.06    36.38     59.00  -1163.49     1118.54
               100  -1129.68    -34.06   -36.38    -59.00   -146.28      107.75

    102    1   100   1201.58      0.00     0.00    -88.55      0.00        0.00
               104  -1205.64      0.00     0.00     88.55      0.00        0.00

    103    1    11   1051.92    103.63  -114.03   -296.98   4034.92     3644.49
                86  -1084.39   -103.63   114.03    296.98   1438.36     1329.64

    104    1    86   1105.33    -34.06    36.38    -58.99  -1163.49    -1118.54
               101  -1129.68     34.06   -36.38     58.99   -146.28     -107.75

    105    1   101   1201.62      0.00     0.00     88.57      0.00        0.00
               105  -1205.68      0.00     0.00    -88.57      0.00        0.00

    106    1    21   1051.92    103.63   114.03    296.99  -4034.92     3644.49
                90  -1084.39   -103.63  -114.03   -296.99  -1438.36     1329.64

    107    1    90   1105.33    -34.06   -36.38     59.00   1163.49    -1118.54
               102  -1129.68     34.06    36.38    -59.00    146.28     -107.75

    108    1   102   1201.60      0.00     0.00    -88.55      0.00        0.00
               106  -1205.66      0.00     0.00     88.55      0.00        0.00

    109    1    31   1051.92   -103.63   114.03   -296.98  -4034.92    -3644.49
                96  -1084.39    103.63  -114.03    296.98  -1438.36    -1329.64

    110    1    96   1105.33     34.06   -36.38    -58.99   1163.49     1118.54
               103  -1129.68    -34.06    36.38     58.99    146.28      107.75

    111    1   103   1201.60      0.00     0.00     88.57      0.00        0.00
               107  -1205.66      0.00     0.00    -88.57      0.00        0.00

    112    1   104   1205.65      0.00     0.00    -88.55      0.00        0.00
               108  -1219.11      0.00     0.00     88.55      0.00        0.00
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MEMBER END FORCES    STRUCTURE TYPE = SPACE
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ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT     AXIAL    SHEAR-Y   SHEAR-Z    TORSION      MOM-Y       MOM-Z


  113     1   105   1205.64      0.00      0.00      88.57       0.00        0.00
              109  -1219.10      0.00      0.00     -88.57       0.00        0.00

  114     1   106   1205.64      0.00      0.00     -88.55       0.00        0.00
              110  -1219.10      0.00      0.00      88.55       0.00        0.00

  115     1   107   1205.64      0.00      0.00      88.57       0.00        0.00
              111  -1219.10      0.00      0.00     -88.57       0.00        0.00

  116     1    80   -140.16     10.20      6.19     -75.08    -410.74      189.96
               81    140.16      2.74     -6.19      75.08     187.97      -55.65

  117     1    81   -107.65     15.67     11.91    -162.07    -247.88      200.91
               82    107.65      8.17    -11.91     162.07    -542.02       47.87

  118     1    82   -856.94      3.30      0.00       0.00     571.34      132.09
               83    856.94      0.00      0.00       0.00    -571.37     -116.98

  119     1    83   -856.94      0.00      0.00       0.00     571.37      116.99
               84    856.94      3.29      0.00       0.00    -571.34     -132.08

  120     1    84   -107.65      8.17    -11.91     162.07     542.02      -47.87
               85    107.65     15.67     11.91    -162.07     247.89     -200.91

  121     1    85   -140.16      2.74     -6.19      75.08    -187.97       55.65
               86    140.16     10.20      6.19     -75.08     410.74     -189.96

  122     1    86   -156.60     10.75      2.47     -21.14    -172.75      199.78
               87    156.60      2.19     -2.47      21.14      83.95      -45.76

  123     1    87   -125.93     14.71      4.02      -2.31    -146.35      184.53
               88    125.93     12.43     -4.02       2.31    -157.06      -98.44

  124     1    88   -125.94     12.43     -4.02       2.31     157.06       98.44
               89    125.94     14.71      4.02      -2.31     146.36     -184.53

  125     1    89   -156.60      2.19     -2.47      21.14     -83.95       45.76
               90    156.60     10.75      2.47     -21.14     172.75     -199.78

  126     1    90   -140.16     10.20      6.19     -75.08    -410.74      189.96
               91    140.16      2.74     -6.19      75.08     187.97      -55.65

  127     1    91   -107.65     15.67     11.91    -162.07    -247.88      200.91
               92    107.65      8.17    -11.91     162.07    -542.02       47.87

  128     1    92   -856.94      3.29      0.00       0.00     571.36      132.08
               93    856.94      0.00      0.00       0.00    -571.34     -116.99
```

```
 MEMBER END FORCES    STRUCTURE TYPE = SPACE
 -----------------
 ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y       MOM-Z


  129    1    93   -856.94      0.00     0.00      0.00    571.33      116.99
              94    856.94      3.29     0.00      0.00   -571.38     -132.08

  130    1    94   -107.65      8.17   -11.91    162.07    542.02      -47.87
              95    107.65     15.67    11.91   -162.07    247.89     -200.91

  131    1    95   -140.16      2.74    -6.19     75.08   -187.97       55.65
              96    140.16     10.20     6.19    -75.08    410.74     -189.96

  132    1    96   -156.60     10.75     2.47    -21.14   -172.75      199.78
              97    156.60      2.19    -2.47     21.14     83.95      -45.76

  133    1    97   -125.94     14.71     4.02     -2.31   -146.35      184.53
              98    125.94     12.43    -4.02      2.31   -157.06      -98.44

  134    1    98   -125.93     12.43    -4.02      2.31    157.06       98.44
              99    125.93     14.71     4.02     -2.31    146.36     -184.53

  135    1    99   -156.60      2.19    -2.47     21.14    -83.95       45.76
              80    156.60     10.75     2.47    -21.14    172.75     -199.78

  136    1     1   -845.44     16.31     3.07    -42.47   -249.99      143.26
              82    828.19     20.47    -3.07     42.47    -97.16     -378.21

  137    1    11   -845.45     16.31    -3.07     42.47    249.99      143.26
              84    828.19     20.47     3.07    -42.47     97.16     -378.21

  138    1    11   -665.67     17.22    -0.45     39.14     48.07      157.76
              88    648.42     22.85     0.45    -39.14      6.11     -499.31

  139    1    21   -665.67     17.22     0.45    -39.14    -48.07      157.76
              88    648.42     22.85    -0.45     39.14     -6.11     -499.31

  140    1    21   -845.44     16.31     3.07    -42.47   -249.99      143.26
              92    828.19     20.47    -3.07     42.47    -97.16     -378.21

  141    1    31   -845.44     16.31    -3.07     42.47    249.99      143.26
              94    828.19     20.47     3.07    -42.47     97.16     -378.21

  142    1    31   -665.68     17.22    -0.45     39.14     48.07      157.76
              98    648.42     22.85     0.45    -39.14      6.11     -499.31

  143    1     1   -665.68     17.22     0.45    -39.14    -48.07      157.76
              98    648.42     22.85    -0.45     39.14     -6.11     -499.31

  144    1     5    304.46      9.21   -14.98     76.67    878.28      243.78
              82   -321.71     -9.21    14.98    -76.67   -159.26      198.26
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MEMBER END FORCES    STRUCTURE TYPE = SPACE
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ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


  145    1     7    304.45     -9.21   -14.98    -76.67    878.28    -243.78
              84   -321.70      9.21    14.98     76.67   -159.26    -198.26

  146    1    16    428.70      7.14     0.00      0.00      0.00     280.51
              88   -445.96     -7.14     0.00      0.00      0.00      62.44

  147    1    25    304.46     -9.21    14.98     76.67   -878.28    -243.78
              92   -321.71      9.21   -14.98    -76.67    159.26    -198.26

  148    1    27    304.45      9.21    14.98    -76.67   -878.28     243.78
              94   -321.70     -9.21   -14.98     76.67    159.26     198.26

  149    1    36    428.70     -7.14     0.00      0.00      0.00    -280.51
              98   -445.95      7.14     0.00      0.00      0.00     -62.44

  150    1   100     48.94      2.97     5.72   -103.88   -272.07     -33.05
              81    -36.01      9.97    -5.72    103.88    -19.14    -145.26

  151    1   101     48.94      2.97    -5.72    103.88    272.08     -33.05
              85    -36.01      9.97     5.72   -103.88     19.14    -145.26

  152    1   101     46.57      3.21     1.55    -30.81   -136.46     -27.34
              87    -33.63      9.73    -1.55     30.81     57.44    -138.77

  153    1   102     46.57      3.21    -1.55     30.82    136.46     -27.34
              89    -33.63      9.73     1.55    -30.82    -57.44    -138.77

  154    1   102     48.95      2.97     5.72   -103.88   -272.07     -33.05
              91    -36.01      9.97    -5.72    103.88    -19.14    -145.26

  155    1   103     48.94      2.97    -5.72    103.88    272.08     -33.05
              95    -36.01      9.97     5.72   -103.88     19.14    -145.26

  156    1   103     46.57      3.21     1.55    -30.81   -136.46     -27.34
              97    -33.63      9.73    -1.55     30.81     57.44    -138.77

  157    1   100     46.57      3.21    -1.55     30.82    136.46     -27.34
              99    -33.63      9.73     1.55    -30.82    -57.44    -138.77

************** END OF LATEST ANALYSIS RESULT **************


  93. PRINT MEMBER STRESSES ALL
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  MEMBER STRESSES
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  ALL UNITS ARE POUN/SQ INCH

MEMB    LD  SECT     AXIAL      BEND-Y       BEND-Z    COMBINED  SHEAR-Y  SHEAR-Z


     1     1   .0     265.4 C      52.3       775.5      1093.2    148.2      22.4
              1.00    265.4 C     136.9      1442.8      1845.1    112.8      22.4

     2     1   .0     266.6 C     130.2      1588.4      1985.2     51.5      19.7
              1.00    266.6 C      19.6       950.8      1236.9     61.0      19.7

     3     1   .0     266.6 C      19.6       950.8      1236.9     80.7      12.3
              1.00    266.6 C      49.7        16.7       333.0     90.1      12.3

     4     1   .0     268.2 C      18.6        18.2       304.9    124.5      20.0
              1.00    268.2 C     104.4      1090.1      1462.7    131.7      20.0

     5     1   .0     265.2 C      80.4      1039.0      1384.7      3.6       0.0
              1.00    265.2 C      80.4      1031.1      1376.8      0.0       0.0

     6     1   .0     265.2 C      80.4      1031.1      1376.8      0.0       0.0
              1.00    265.2 C      80.4      1039.0      1384.6      3.6       0.0

     7     1   .0     268.2 C     104.4      1090.1      1462.7    131.7      20.0
              1.00    268.2 C      18.6        18.2       304.9    124.5      20.0

     8     1   .0     266.6 C      49.7        16.7       333.0     90.1      12.3
              1.00    266.6 C      19.6       950.8      1236.9     80.7      12.3

     9     1   .0     266.6 C      19.6       950.8      1236.9     61.0      19.7
              1.00    266.6 C     130.2      1588.4      1985.2     51.5      19.7

    10     1   .0     265.4 C     136.9      1442.8      1845.1    112.8      22.4
              1.00    265.4 C      52.4       775.5      1093.2    148.2      22.4

    11     1   .0     222.5 C     219.2       513.0       954.8     29.1      39.0
              1.00    222.5 C      22.7       811.9      1057.2     18.7      39.0

    12     1   .0     222.5 C      22.7       811.9      1057.2      2.0       2.5
              1.00    222.5 C      36.8       735.7       995.0     11.5       2.5

    13     1   .0     222.5 C      36.8       735.7       995.0     31.1       3.7
              1.00    222.5 C      15.8       329.7       568.1     40.6       3.7

    14     1   .0     222.5 C      15.8       329.7       568.1     60.2       2.3
              1.00    222.5 C       2.8       406.1       631.4     69.7       2.3

    15     1   .0     222.5 C       2.8       406.1       631.4     90.1       4.8
              1.00    222.5 C      11.7       975.0      1209.2     95.3       4.8

    16     1   .0     222.5 C      11.7       975.0      1209.2     95.3       4.8
              1.00    222.5 C       2.8       406.1       631.4     90.1       4.8

    17     1   .0     222.5 C       2.8       406.1       631.4     69.7       2.3
              1.00    222.5 C      15.8       329.8       568.1     60.2       2.3
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 MEMBER STRESSES
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 ALL UNITS ARE POUN/SQ INCH

MEMB   LD  SECT     AXIAL      BEND-Y      BEND-Z    COMBINED   SHEAR-Y   SHEAR-Z


   18    1    .0    222.5 C      15.8       329.7      568.1      40.6       3.7
              1.00  222.5 C      36.8       735.7      995.0      31.1       3.7

   19    1    .0    222.5 C      36.8       735.7      995.0      11.5       2.5
              1.00  222.5 C      22.7       811.9     1057.2       2.0       2.5

   20    1    .0    222.5 C      22.7       811.9     1057.2      18.7      39.0
              1.00  222.5 C     219.2       513.0      954.8      29.1      39.0

   21    1    .0    265.4 C      52.3       775.5     1093.2     148.2      22.4
              1.00  265.4 C     136.9      1442.8     1845.1     112.8      22.4

   22    1    .0    266.6 C     130.2      1588.4     1985.2      51.5      19.7
              1.00  266.6 C      19.6       950.8     1236.9      61.0      19.7

   23    1    .0    266.6 C      19.6       950.8     1236.9      80.7      12.3
              1.00  266.6 C      49.7        16.7      333.0      90.1      12.3

   24    1    .0    268.2 C      18.6        18.2      304.9     124.5      20.0
              1.00  268.2 C     104.4      1090.1     1462.7     131.7      20.0

   25    1    .0    265.2 C      80.4      1039.0     1384.6       3.6       0.0
              1.00  265.2 C      80.4      1031.1     1376.8       0.0       0.0

   26    1    .0    265.2 C      80.4      1031.1     1376.8       0.0       0.0
              1.00  265.2 C      80.4      1039.0     1384.6       3.6       0.0

   27    1    .0    268.2 C     104.4      1090.1     1462.7     131.7      20.0
              1.00  268.2 C      18.6        18.2      304.9     124.5      20.0

   28    1    .0    266.6 C      49.7        16.7      333.0      90.1      12.3
              1.00  266.6 C      19.6       950.8     1236.9      80.7      12.3

   29    1    .0    266.6 C      19.6       950.8     1236.9      61.0      19.7
              1.00  266.6 C     130.2      1588.4     1985.2      51.5      19.7

   30    1    .0    265.4 C     136.9      1442.8     1845.1     112.8      22.4
              1.00  265.4 C      52.4       775.5     1093.2     148.2      22.4

   31    1    .0    222.5 C     219.2       513.0      954.8      29.1      39.0
              1.00  222.5 C      22.7       811.9     1057.2      18.7      39.0

   32    1    .0    222.5 C      22.7       811.9     1057.2       2.0       2.5
              1.00  222.5 C      36.8       735.7      995.0      11.5       2.5

   33    1    .0    222.5 C      36.8       735.7      995.0      31.1       3.7
              1.00  222.5 C      15.8       329.7      568.1      40.6       3.7

   34    1    .0    222.5 C      15.8       329.7      568.1      60.2       2.3
              1.00  222.5 C       2.8       406.1      631.4      69.7       2.3
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  MEMBER STRESSES
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  ALL UNITS ARE POUN/SQ INCH

 MEMB    LD  SECT      AXIAL     BEND-Y      BEND-Z    COMBINED   SHEAR-Y   SHEAR-Z


     35    1    .0    222.5 C       2.8       406.1      631.4      90.1       4.8
              1.00    222.5 C      11.7       975.0     1209.2      95.3       4.8

     36    1    .0    222.5 C      11.7       975.0     1209.2      95.3       4.8
              1.00    222.5 C       2.8       406.1      631.4      90.1       4.8

     37    1    .0    222.5 C       2.8       406.1      631.4      69.7       2.3
              1.00    222.5 C      15.8       329.7      568.1      60.2       2.3

     38    1    .0    222.5 C      15.8       329.7      568.1      40.6       3.7
              1.00    222.5 C      36.8       735.7      995.0      31.1       3.7

     39    1    .0    222.5 C      36.8       735.7      995.0      11.5       2.5
              1.00    222.5 C      22.7       811.9     1057.2       2.0       2.5

     40    1    .0    222.5 C      22.7       811.9     1057.2      18.7      39.0
              1.00    222.5 C     219.2       513.0      954.8      29.1      39.0

     41    1    .0     10.1 C       6.7      1193.0     1209.7     164.4       5.0
              1.00     10.1 C      37.7       709.3      757.1     139.8       5.0

     42    1    .0     10.1 C      37.7       709.3      757.1     119.1      31.5
              1.00     10.1 C      32.3      1235.2     1277.5     115.4      31.5

     43    1    .0     10.1 C      44.5      1318.8     1373.4      89.5       7.3
              1.00     10.1 C      19.8      1912.0     1942.0      83.8       7.3

     44    1    .0     10.1 C      19.8      1912.1     1942.0      64.2       1.0
              1.00     10.1 C      13.9      2585.3     2609.4      54.7       1.0

     45    1    .0     10.1 C      13.9      2585.3     2609.4      35.1       2.4
              1.00     10.1 C       0.2      2928.7     2939.1      25.6       2.4

     46    1    .0     10.1 C       0.2      2928.7     2939.1       5.1       0.0
              1.00     10.1 C       0.2      2928.7     2939.0       5.1       0.0

     47    1    .0     10.1 C       0.2      2928.7     2939.1      25.6       2.4
              1.00     10.1 C      13.9      2585.3     2609.4      35.1       2.4

     48    1    .0     10.1 C      13.9      2585.3     2609.4      54.7       1.0
              1.00     10.1 C      19.8      1912.1     1942.0      64.2       1.0

     49    1    .0     10.1 C      19.8      1912.1     1942.0      83.8       7.3
              1.00     10.1 C      44.5      1318.8     1373.4      89.5       7.3

     50    1    .0     10.1 C      32.3      1235.2     1277.6     115.4      31.5
              1.00     10.1 C      37.7       709.3      757.1     119.1      31.5

     51    1    .0     10.1 C      37.7       709.3      757.1     139.8       5.0
              1.00     10.1 C       6.7      1193.0     1209.7     164.4       5.0
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 MEMBER STRESSES
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 ALL UNITS ARE POUN/SQ INCH

MEMB    LD  SECT     AXIAL     BEND-Y      BEND-Z   COMBINED  SHEAR-Y  SHEAR-Z


   52    1    .0      10.1 C       6.7    1193.0    1209.7    164.4      5.0
            1.00      10.1 C      37.7     709.3     757.1    139.8      5.0

   53    1    .0      10.1 C      37.7     709.3     757.1    119.1     31.5
            1.00      10.1 C      32.3    1235.2    1277.6    115.4     31.5

   54    1    .0      10.1 C      44.5    1318.8    1373.4     89.5      7.3
            1.00      10.1 C      19.8    1912.0    1942.0     83.8      7.3

   55    1    .0      10.1 C      19.8    1912.1    1942.0     64.2      1.0
            1.00      10.1 C      13.9    2585.3    2609.4     54.7      1.0

   56    1    .0      10.1 C      13.9    2585.3    2609.4     35.0      2.4
            1.00      10.1 C       0.2    2928.7    2939.0     25.6      2.4

   57    1    .0      10.1 C       0.2    2928.7    2939.1      5.1      0.0
            1.00      10.1 C       0.2    2928.7    2939.1      5.1      0.0

   58    1    .0      10.1 C       0.2    2928.7    2939.1     25.6      2.4
            1.00      10.1 C      13.9    2585.3    2609.4     35.1      2.4

   59    1    .0      10.1 C      13.9    2585.3    2609.4     54.7      1.0
            1.00      10.1 C      19.8    1912.0    1942.0     64.2      1.0

   60    1    .0      10.1 C      19.8    1912.0    1942.0     83.8      7.3
            1.00      10.1 C      44.5    1318.8    1373.4     89.5      7.3

   61    1    .0      10.1 C      32.3    1235.1    1277.5    115.4     31.5
            1.00      10.1 C      37.7     709.3     757.1    119.1     31.5

   62    1    .0      10.1 C      37.7     709.3     757.1    139.8      5.0
            1.00      10.1 C       6.7    1193.0    1209.7    164.4      5.0

   63    1    .0      17.7 C      38.8     548.0     604.5     51.7      0.5
            1.00      17.7 C      33.3     448.6     499.6     41.8      0.5

   64    1    .0      17.7 C      33.3     448.6     499.6      2.5     11.5
            1.00      17.7 C     104.5     396.8     519.0      7.4     11.5

   65    1    .0      14.7 C      25.7     265.6     306.0     11.3      0.0
            1.00      14.7 C      25.7     404.2     444.6      0.0      0.0

   66    1    .0      14.7 C      25.7     404.2     444.6      0.0      0.0
            1.00      14.7 C      25.7     265.6     306.0     11.3      0.0

   67    1    .0      17.7 C     104.5     396.8     519.1      7.4     11.5
            1.00      17.7 C      33.3     448.6     499.6      2.5     11.5

   68    1    .0      17.7 C      33.3     448.6     499.6     41.8      0.5
            1.00      17.7 C      38.8     548.0     604.5     51.7      0.5
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 MEMBER STRESSES
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 ALL UNITS ARE POUN/SQ INCH

MEMB   LD  SECT     AXIAL     BEND-Y     BEND-Z    COMBINED   SHEAR-Y  SHEAR-Z


  69    1   .0     17.7 C      38.8      548.0      604.5      51.7      0.5
           1.00    17.7 C      33.3      448.6      499.6      41.8      0.5

  70    1   .0     17.7 C      33.3      448.6      499.6       2.5     11.5
           1.00    17.7 C     104.5      396.8      519.1       7.4     11.5

  71    1   .0     14.7 C      25.7      265.6      306.0      11.3      0.0
           1.00    14.7 C      25.7      404.2      444.6       0.0      0.0

  72    1   .0     14.7 C      25.7      404.2      444.6       0.0      0.0
           1.00    14.7 C      25.7      265.6      306.0      11.3      0.0

  73    1   .0     17.7 C     104.5      396.8      519.1       7.4     11.5
           1.00    17.7 C      33.3      448.6      499.6       2.5     11.5

  74    1   .0     17.7 C      33.3      448.6      499.6      41.8      0.5
           1.00    17.7 C      38.8      548.0      604.5      51.7      0.5

  75    1   .0      9.6 T       0.0        0.0        9.6     134.3      0.0
           1.00     9.6 T       0.0        0.0        9.6     134.3      0.0

  76    1   .0      4.5 C     142.4     1956.9     2103.8     102.9      6.6
           1.00     4.5 C     112.6      569.9      687.0      28.1      6.6

  77    1   .0      4.5 C     142.4     1956.9     2103.8     102.9      6.6
           1.00     4.5 C     112.6      569.9      687.0      28.1      6.6

  78    1   .0      9.6 T       0.0        0.0        9.6     134.3      0.0
           1.00     9.6 T       0.0        0.0        9.6     134.3      0.0

  79    1   .0     47.6 C       0.0        0.0       47.6     141.1      0.0
           1.00    47.6 C       0.0        0.0       47.6     141.1      0.0

  80    1   .0      8.1 C       0.0        0.0        8.1     134.3      0.0
           1.00     8.1 C       0.0        0.0        8.1     134.3      0.0

  81    1   .0      1.8 T       0.0        0.0        1.8     134.3      0.0
           1.00     1.8 T       0.0        0.0        1.8     134.3      0.0

  82    1   .0      3.2 C       0.0        0.0        3.2     139.8      0.0
           1.00     3.2 C       0.0        0.0        3.2     139.8      0.0

  83    1   .0      3.2 C       0.0        0.0        3.2     139.8      0.0
           1.00     3.2 C       0.0        0.0        3.2     139.8      0.0

  84    1   .0      1.8 T       0.0        0.0        1.8     134.3      0.0
           1.00     1.8 T       0.0        0.0        1.8     134.3      0.0

  85    1   .0      8.1 C       0.0        0.0        8.1     134.3      0.0
           1.00     8.1 C       0.0        0.0        8.1     134.3      0.0
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 MEMBER STRESSES
 ---------------
 ALL UNITS ARE POUN/SQ INCH

MEMB    LD  SECT      AXIAL     BEND-Y      BEND-Z    COMBINED   SHEAR-Y   SHEAR-Z


    86    1    .0     47.6 C       0.0         0.0        47.6     141.1       0.0
              1.00    47.6 C       0.0         0.0        47.6     141.1       0.0

    87    1    .0      9.6 T       0.0         0.0         9.6     134.3       0.0
              1.00     9.6 T       0.0         0.0         9.6     134.3       0.0

    88    1    .0      4.5 C     142.4      1956.9      2103.8     102.9       6.6
              1.00     4.5 C     112.6       569.9       687.0      28.1       6.6

    89    1    .0      4.5 C     142.4      1956.9      2103.8     102.9       6.6
              1.00     4.5 C     112.6       569.9       687.0      28.1       6.6

    90    1    .0      9.6 T       0.0         0.0         9.6     134.3       0.0
              1.00     9.6 T       0.0         0.0         9.6     134.3       0.0

    91    1    .0     47.6 C       0.0         0.0        47.6     141.1       0.0
              1.00    47.6 C       0.0         0.0        47.6     141.1       0.0

    92    1    .0      8.1 C       0.0         0.0         8.1     134.3       0.0
              1.00     8.1 C       0.0         0.0         8.1     134.3       0.0

    93    1    .0      1.8 T       0.0         0.0         1.8     134.3       0.0
              1.00     1.8 T       0.0         0.0         1.8     134.3       0.0

    94    1    .0      3.2 C       0.0         0.0         3.2     139.8       0.0
              1.00     3.2 C       0.0         0.0         3.2     139.8       0.0

    95    1    .0      3.2 C       0.0         0.0         3.2     139.8       0.0
              1.00     3.2 C       0.0         0.0         3.2     139.8       0.0

    96    1    .0      1.8 T       0.0         0.0         1.8     134.3       0.0
              1.00     1.8 T       0.0         0.0         1.8     134.3       0.0

    97    1    .0      8.1 C       0.0         0.0         8.1     134.3       0.0
              1.00     8.1 C       0.0         0.0         8.1     134.3       0.0

    98    1    .0     47.6 C       0.0         0.0        47.6     141.1       0.0
              1.00    47.6 C       0.0         0.0        47.6     141.1       0.0

   100    1    .0    440.1 C    1642.1      1483.2      3565.5      79.0      86.9
              1.00   453.7 C     585.4       541.1      1580.2      79.0      86.9

   101    1    .0    462.5 C     473.5       455.2      1391.2      26.0      27.7
              1.00   472.7 C      59.5        43.9       576.1      26.0      27.7

   102    1    .0    502.8 C       0.0         0.0       502.8       0.0       0.0
              1.00   504.5 C       0.0         0.0       504.5       0.0       0.0

   103    1    .0    440.1 C    1642.1      1483.2      3565.5      79.0      86.9
              1.00   453.7 C     585.4       541.1      1580.2      79.0      86.9
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 MEMBER STRESSES
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 ALL UNITS ARE POUN/SQ INCH

MEMB   LD  SECT    AXIAL     BEND-Y     BEND-Z    COMBINED  SHEAR-Y  SHEAR-Z


  104   1    .0    462.5 C    473.5      455.2     1391.2     26.0     27.7
           1.00    472.7 C     59.5       43.9      576.1     26.0     27.7

  105   1    .0    502.8 C      0.0        0.0      502.8      0.0      0.0
           1.00    504.5 C      0.0        0.0      504.5      0.0      0.0

  106   1    .0    440.1 C   1642.1     1483.2     3565.5     79.0     86.9
           1.00    453.7 C    585.4      541.1     1580.2     79.0     86.9

  107   1    .0    462.5 C    473.5      455.2     1391.2     26.0     27.7
           1.00    472.7 C     59.5       43.9      576.1     26.0     27.7

  108   1    .0    502.8 C      0.0        0.0      502.8      0.0      0.0
           1.00    504.5 C      0.0        0.0      504.5      0.0      0.0

  109   1    .0    440.1 C   1642.1     1483.2     3565.5     79.0     86.9
           1.00    453.7 C    585.4      541.1     1580.2     79.0     86.9

  110   1    .0    462.5 C    473.5      455.2     1391.2     26.0     27.7
           1.00    472.7 C     59.5       43.9      576.1     26.0     27.7

  111   1    .0    502.8 C      0.0        0.0      502.8      0.0      0.0
           1.00    504.5 C      0.0        0.0      504.5      0.0      0.0

  112   1    .0    872.4 C      0.0        0.0      872.4      0.0      0.0
           1.00    882.1 C      0.0        0.0      882.1      0.0      0.0

  113   1    .0    872.4 C      0.0        0.0      872.4      0.0      0.0
           1.00    882.1 C      0.0        0.0      882.1      0.0      0.0

  114   1    .0    872.4 C      0.0        0.0      872.4      0.0      0.0
           1.00    882.1 C      0.0        0.0      882.1      0.0      0.0

  115   1    .0    872.4 C      0.0        0.0      872.4      0.0      0.0
           1.00    882.1 C      0.0        0.0      882.1      0.0      0.0

  116   1    .0    110.4 T    586.8      271.4      968.5     13.6      8.3
           1.00    110.4 T    268.5       79.5      458.4      3.7      8.3

  117   1    .0     84.8 T    354.1      287.0      725.9     20.9     15.9
           1.00     84.8 T    774.3       68.4      927.5     10.9     15.9

  118   1    .0    674.8 T    816.2      188.7     1679.6      4.4      0.0
           1.00    674.8 T    816.2      167.1     1658.1      0.0      0.0

  119   1    .0    674.8 T    816.2      167.1     1658.1      0.0      0.0
           1.00    674.8 T    816.2      188.7     1679.6      4.4      0.0

  120   1    .0     84.8 T    774.3       68.4      927.5     10.9     15.9
           1.00     84.8 T    354.1      287.0      725.9     20.9     15.9
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  MEMBER STRESSES
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  ALL UNITS ARE POUN/SQ INCH

MEMB    LD  SECT     AXIAL     BEND-Y      BEND-Z    COMBINED  SHEAR-Y  SHEAR-Z


   121    1   .0    110.4 T    268.5        79.5      458.4      3.7       8.3
             1.00   110.4 T    586.8       271.4      968.5     13.6       8.3

   122    1   .0    123.3 T    246.8       285.4      655.5     14.3       3.3
             1.00   123.3 T    119.9        65.4      308.6      2.9       3.3

   123    1   .0     99.2 T    209.1       263.6      571.9     19.6       5.4
             1.00    99.2 T    224.4       140.6      464.2     16.6       5.4

   124    1   .0     99.2 T    224.4       140.6      464.2     16.6       5.4
             1.00    99.2 T    209.1       263.6      571.9     19.6       5.4

   125    1   .0    123.3 T    119.9        65.4      308.6      2.9       3.3
             1.00   123.3 T    246.8       285.4      655.5     14.3       3.3

   126    1   .0    110.4 T    586.8       271.4      968.5     13.6       8.3
             1.00   110.4 T    268.5        79.5      458.4      3.7       8.3

   127    1   .0     84.8 T    354.1       287.0      725.9     20.9      15.9
             1.00    84.8 T    774.3        68.4      927.5     10.9      15.9

   128    1   .0    674.8 T    816.2       188.7     1679.7      4.4       0.0
             1.00   674.8 T    816.2       167.1     1658.1      0.0       0.0

   129    1   .0    674.8 T    816.2       167.1     1658.1      0.0       0.0
             1.00   674.8 T    816.3       188.7     1679.7      4.4       0.0

   130    1   .0     84.8 T    774.3        68.4      927.5     10.9      15.9
             1.00    84.8 T    354.1       287.0      725.9     20.9      15.9

   131    1   .0    110.4 T    268.5        79.5      458.4      3.7       8.3
             1.00   110.4 T    586.8       271.4      968.5     13.6       8.3

   132    1   .0    123.3 T    246.8       285.4      655.5     14.3       3.3
             1.00   123.3 T    119.9        65.4      308.6      2.9       3.3

   133    1   .0     99.2 T    209.1       263.6      571.9     19.6       5.4
             1.00    99.2 T    224.4       140.6      464.2     16.6       5.4

   134    1   .0     99.2 T    224.4       140.6      464.2     16.6       5.4
             1.00    99.2 T    209.1       263.6      571.9     19.6       5.4

   135    1   .0    123.3 T    119.9        65.4      308.6      2.9       3.3
             1.00   123.3 T    246.8       285.4      655.5     14.3       3.3

   136    1   .0    665.7 T    357.1       204.7     1227.5     21.7       4.1
             1.00   652.1 T    138.8       540.3     1331.2     27.3       4.1

   137    1   .0    665.7 T    357.1       204.7     1227.5     21.7       4.1
             1.00   652.1 T    138.8       540.3     1331.2     27.3       4.1
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MEMBER STRESSES
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ALL UNITS ARE POUN/SQ INCH

MEMB   LD  SECT    AXIAL      BEND-Y      BEND-Z   COMBINED  SHEAR-Y  SHEAR-Z


  138   1    .0    524.2 T      68.7       225.4      818.2     23.0      0.6
           1.00    510.6 T       8.7       713.3     1232.6     30.5      0.6

  139   1    .0    524.2 T      68.7       225.4      818.2     23.0      0.6
           1.00    510.6 T       8.7       713.3     1232.6     30.5      0.6

  140   1    .0    665.7 T     357.1       204.7     1227.5     21.7      4.1
           1.00    652.1 T     138.8       540.3     1331.2     27.3      4.1

  141   1    .0    665.7 T     357.1       204.7     1227.5     21.7      4.1
           1.00    652.1 T     138.8       540.3     1331.2     27.3      4.1

  142   1    .0    524.2 T      68.7       225.4      818.2     23.0      0.6
           1.00    510.6 T       8.7       713.3     1232.6     30.5      0.6

  143   1    .0    524.2 T      68.7       225.4      818.2     23.0      0.6
           1.00    510.6 T       8.7       713.3     1232.6     30.5      0.6

  144   1    .0    239.7 C    1254.7       348.3     1842.7     12.3     20.0
           1.00    253.3 C     227.5       283.2      764.1     12.3     20.0

  145   1    .0    239.7 C    1254.7       348.3     1842.7     12.3     20.0
           1.00    253.3 C     227.5       283.2      764.1     12.3     20.0

  146   1    .0    337.6 C       0.0       400.7      738.3      9.5      0.0
           1.00    351.1 C       0.0        89.2      440.3      9.5      0.0

  147   1    .0    239.7 C    1254.7       348.3     1842.7     12.3     20.0
           1.00    253.3 C     227.5       283.2      764.1     12.3     20.0

  148   1    .0    239.7 C    1254.7       348.3     1842.7     12.3     20.0
           1.00    253.3 C     227.5       283.2      764.1     12.3     20.0

  149   1    .0    337.6 C       0.0       400.7      738.3      9.5      0.0
           1.00    351.1 C       0.0        89.2      440.3      9.5      0.0

  150   1    .0     38.5 C     388.7        47.2      474.4      4.0      7.6
           1.00     28.4 C      27.3       207.5      263.2     13.3      7.6

  151   1    .0     38.5 C     388.7        47.2      474.4      4.0      7.6
           1.00     28.4 C      27.3       207.5      263.2     13.3      7.6

  152   1    .0     36.7 C     194.9        39.1      270.7      4.3      2.1
           1.00     26.5 C      82.1       198.2      306.8     13.0      2.1

  153   1    .0     36.7 C     194.9        39.1      270.7      4.3      2.1
           1.00     26.5 C      82.1       198.2      306.8     13.0      2.1

  154   1    .0     38.5 C     388.7        47.2      474.4      4.0      7.6
           1.00     28.4 C      27.3       207.5      263.2     13.3      7.6
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   MEMBER STRESSES
   ---------------
   ALL UNITS ARE POUN/SQ INCH

 MEMB    LD  SECT     AXIAL     BEND-Y      BEND-Z   COMBINED  SHEAR-Y  SHEAR-Z


    155    1    .0      38.5 C    388.7        47.2      474.4       4.0       7.6
              1.00      28.4 C     27.3       207.5      263.2      13.3       7.6

    156    1    .0      36.7 C    194.9        39.1      270.7       4.3       2.1
              1.00      26.5 C     82.1       198.2      306.8      13.0       2.1

    157    1    .0      36.7 C    194.9        39.1      270.7       4.3       2.1
              1.00      26.5 C     82.1       198.2      306.8      13.0       2.1

    ************** END OF LATEST ANALYSIS RESULT **************

     94. PARAMETER
     95. CODE AISC
     96. FYLD 36000. MEMB 1 TO 74 76 77 88 89 100 TO 111 116 TO 135 144 TO 157
     97. FYLD 21999.994 MEMB 75 78 TO 87 90 TO 98 112 TO 115
     98. WMIN 0.188 ALL
     99. DFF 0.063 ALL
    100. LY 223. MEMB 1 TO 62
    101. LZ 223. MEMB 1 TO 62
    102. CB 1. ALL
    103. MAIN 0. ALL
    104. TRACK 1. ALL
    105. RATIO 1. ALL
    106. WELD 1. ALL
    107. LOAD LIST ALL
    108. CHECK CODE ALL
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                         STAAD-III CODE CHECKING - (AISC)
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE         RESULT/  CRITICAL COND/     RATIO/     LOADING/
                           FX           MY             MZ       LOCATION
=======================================================================

     1 ST  TUB 60303      PASS     AISC- H1-3         0.131         1
                        833.35 C     -438.09         6877.31      36.00
|-----------------------------------------------------------------------|
| MEM=     1, UNIT KIP-INCH,  L=  36.0  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
     2 ST  TUB 60303      PASS     AISC- H1-3         0.138         1
                        837.10 C      416.62        -7571.42       0.00
|-----------------------------------------------------------------------|
| MEM=     2, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
     3 ST  TUB 60303      PASS     AISC- H1-3         0.103         1
                        837.10 C       62.60        -4532.09       0.00
|-----------------------------------------------------------------------|
| MEM=     3, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
     4 ST  TUB 60303      PASS     AISC- H1-3         0.114         1
                        842.06 C      334.06        -5196.25      18.33
|-----------------------------------------------------------------------|
| MEM=     4, UNIT KIP-INCH,  L=  18.3  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
     5 ST  TUB 60303      PASS     AISC- H1-3         0.110         1
                        832.85 C     -257.39         4952.47       0.00
|-----------------------------------------------------------------------|
| MEM=     5, UNIT KIP-INCH,  L=   9.2  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
     6 ST  TUB 60303      PASS     AISC- H1-3         0.110         1
                        832.85 C      257.39        -4952.46       9.17
|-----------------------------------------------------------------------|
| MEM=     6, UNIT KIP-INCH,  L=   9.2  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE         RESULT/   CRITICAL COND/     RATIO/     LOADING/
                           FX            MY              MZ       LOCATION
=======================================================================

     7  ST   TUB 60303      PASS      AISC- H1-3         0.114         1
                     842.06 C       -334.06        5196.24        0.00
|-----------------------------------------------------------------------|
| MEM=     7, UNIT KIP-INCH,  L=  18.3  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
     8  ST   TUB 60303      PASS      AISC- H1-3         0.103         1
                     837.10 C        -62.60        4532.11       24.00
|-----------------------------------------------------------------------|
| MEM=     8, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
     9  ST   TUB 60303      PASS      AISC- H1-3         0.138         1
                     837.10 C       -416.61        7571.40       24.00
|-----------------------------------------------------------------------|
| MEM=     9, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    10  ST   TUB 60303      PASS      AISC- H1-3         0.131         1
                     833.36 C        438.09       -6877.31        0.00
|-----------------------------------------------------------------------|
| MEM=    10, UNIT KIP-INCH,  L=  36.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    11  ST   TUB 60303      PASS      AISC- H1-3         0.087         1
                     698.75 C        -72.80        3869.94       26.50
|-----------------------------------------------------------------------|
| MEM=    11, UNIT KIP-INCH,  L=  26.5  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    12  ST   TUB 60303      PASS      AISC- H1-3         0.087         1
                     698.75 C         72.79       -3869.95        0.00
|-----------------------------------------------------------------------|
| MEM=    12, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    13  ST   TUB 60303      PASS      AISC- H1-3         0.084         1
                     698.75 C        117.65       -3507.04        0.00
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER      TABLE         RESULT/   CRITICAL COND/      RATIO/      LOADING/
                             FX            MY              MZ       LOCATION
=======================================================================


|-----------------------------------------------------------------------|
| MEM=    13, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=    3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   14   ST  TUB 60303      PASS      AISC- H1-3          0.067          1
                      698.75 C         -8.87        -1935.79        24.00
|-----------------------------------------------------------------------|
| MEM=    14, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=    3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   15   ST  TUB 60303      PASS      AISC- H1-3          0.094          1
                      698.75 C         37.57        -4647.30        13.00
|-----------------------------------------------------------------------|
| MEM=    15, UNIT KIP-INCH,  L=  13.0  AX=  3.14  SZ=    4.8  SY=    3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   16   ST  TUB 60303      PASS      AISC- H1-3          0.094          1
                      698.75 C        -37.57         4647.30         0.00
|-----------------------------------------------------------------------|
| MEM=    16, UNIT KIP-INCH,  L=  13.0  AX=  3.14  SZ=    4.8  SY=    3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   17   ST  TUB 60303      PASS      AISC- H1-3          0.067          1
                      698.75 C          8.87         1935.80         0.00
|-----------------------------------------------------------------------|
| MEM=    17, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=    3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   18   ST  TUB 60303      PASS      AISC- H1-3          0.084          1
                      698.75 C       -117.65         3507.03        24.00
|-----------------------------------------------------------------------|
| MEM=    18, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=    3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   19   ST  TUB 60303      PASS      AISC- H1-3          0.087          1
                      698.75 C        -72.79         3869.96        24.00
|-----------------------------------------------------------------------|
| MEM=    19, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=    3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE        RESULT/   CRITICAL COND/     RATIO/     LOADING/
                          FX             MY            MZ       LOCATION
=======================================================================

    20  ST  TUB 60303      PASS     AISC- H1-3        0.087         1
                       698.75 C       72.79       -3869.93       0.00

|-----------------------------------------------------------------------|
| MEM=    20, UNIT KIP-INCH,  L=  26.5  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
    21  ST  TUB 60303      PASS     AISC- H1-3        0.131         1
                       833.35 C     -438.09        6877.32      36.00

|-----------------------------------------------------------------------|
| MEM=    21, UNIT KIP-INCH,  L=  36.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
    22  ST  TUB 60303      PASS     AISC- H1-3        0.138         1
                       837.10 C      416.62       -7571.46       0.00

|-----------------------------------------------------------------------|
| MEM=    22, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
    23  ST  TUB 60303      PASS     AISC- H1-3        0.103         1
                       837.10 C       62.60       -4532.09       0.00

|-----------------------------------------------------------------------|
| MEM=    23, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
    24  ST  TUB 60303      PASS     AISC- H1-3        0.114         1
                       842.06 C      334.06       -5196.21      18.33

|-----------------------------------------------------------------------|
| MEM=    24, UNIT KIP-INCH,  L=  18.3  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
    25  ST  TUB 60303      PASS     AISC- H1-3        0.110         1
                       832.85 C     -257.39        4952.43       0.00

|-----------------------------------------------------------------------|
| MEM=    25, UNIT KIP-INCH,  L=   9.2  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
    26  ST  TUB 60303      PASS     AISC- H1-3        0.110         1
                       832.85 C      257.39       -4952.43       9.17
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE          RESULT/   CRITICAL COND/     RATIO/     LOADING/
                            FX            MY             MZ       LOCATION
=======================================================================

|-----------------------------------------------------------------------|
| MEM=    26, UNIT KIP-INCH,  L=   9.2  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    27  ST  TUB 60303      PASS      AISC- H1-3          0.114         1
                      842.06 C       -334.06         5196.22        0.00
|-----------------------------------------------------------------------|
| MEM=    27, UNIT KIP-INCH,  L=  18.3  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    28  ST  TUB 60303      PASS      AISC- H1-3          0.103         1
                      837.10 C        -62.60         4532.12       24.00
|-----------------------------------------------------------------------|
| MEM=    28, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    29  ST  TUB 60303      PASS      AISC- H1-3          0.138         1
                      837.10 C       -416.61         7571.40       24.00
|-----------------------------------------------------------------------|
| MEM=    29, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    30  ST  TUB 60303      PASS      AISC- H1-3          0.131         1
                      833.35 C        438.09        -6877.30        0.00
|-----------------------------------------------------------------------|
| MEM=    30, UNIT KIP-INCH,  L=  36.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    31  ST  TUB 60303      PASS      AISC- H1-3          0.087         1
                      698.75 C        -72.79         3869.93       26.50
|-----------------------------------------------------------------------|
| MEM=    31, UNIT KIP-INCH,  L=  26.5  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    32  ST  TUB 60303      PASS      AISC- H1-3          0.087         1
                      698.75 C         72.80        -3869.94        0.00
|-----------------------------------------------------------------------|
| MEM=    32, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE        RESULT/   CRITICAL COND/     RATIO/     LOADING/
                          FX             MY             MZ      LOCATION
=======================================================================

    33  ST  TUB 60303      PASS      AISC- H1-3        0.084          1
                     698.75 C        117.65      -3507.05         0.00

|-----------------------------------------------------------------------|
| MEM=     33, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
    34  ST  TUB 60303      PASS      AISC- H1-3        0.067          1
                     698.75 C         -8.87      -1935.78        24.00

|-----------------------------------------------------------------------|
| MEM=     34, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
    35  ST  TUB 60303      PASS      AISC- H1-3        0.094          1
                     698.75 C         37.57      -4647.28        13.00

|-----------------------------------------------------------------------|
| MEM=     35, UNIT KIP-INCH,  L=  13.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
    36  ST  TUB 60303      PASS      AISC- H1-3        0.094          1
                     698.75 C        -37.57       4647.27         0.00

|-----------------------------------------------------------------------|
| MEM=     36, UNIT KIP-INCH,  L=  13.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
    37  ST  TUB 60303      PASS      AISC- H1-3        0.067          1
                     698.75 C          8.87       1935.78         0.00

|-----------------------------------------------------------------------|
| MEM=     37, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
    38  ST  TUB 60303      PASS      AISC- H1-3        0.084          1
                     698.75 C       -117.65       3507.04        24.00

|-----------------------------------------------------------------------|
| MEM=     38, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
    39  ST  TUB 60303      PASS      AISC- H1-3        0.087          1
                     698.75 C        -72.79       3869.95        24.00
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE        RESULT/   CRITICAL COND/     RATIO/     LOADING/
                          FX            MY             MZ       LOCATION
=======================================================================


|-----------------------------------------------------------------------|
| MEM=    39, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
    40  ST  TUB 60303      PASS      AISC- H1-3        0.087         1
                        698.75 C        72.79      -3869.95        0.00
|-----------------------------------------------------------------------|
| MEM=    40, UNIT KIP-INCH,  L=  26.5  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
    41  ST  TUB 60303      PASS      AISC- H1-3        0.058         1
                         31.57 C        21.48       5686.48        0.00
|-----------------------------------------------------------------------|
| MEM=    41, UNIT KIP-INCH,  L=  26.5  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
    42  ST  TUB 60303      PASS      AISC- H1-3        0.061         1
                         31.57 C       103.49       5887.55        9.50
|-----------------------------------------------------------------------|
| MEM=    42, UNIT KIP-INCH,  L=   9.5  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
    43  ST  TUB 60303      PASS      AISC- H1-3        0.092         1
                         31.80 C        63.39       9114.08       14.50
|-----------------------------------------------------------------------|
| MEM=    43, UNIT KIP-INCH,  L=  14.5  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
    44  ST  TUB 60303      PASS      AISC- H1-3        0.123         1
                         31.80 C        44.62      12323.27       24.00
|-----------------------------------------------------------------------|
| MEM=    44, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
    45  ST  TUB 60303      PASS      AISC- H1-3        0.138         1
                         31.80 C         0.70      13960.17       24.00
|-----------------------------------------------------------------------|
| MEM=    45, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE          RESULT/   CRITICAL COND/     RATIO/     LOADING/
                            FX            MY             MZ       LOCATION
=======================================================================

  46 ST   TUB 60303       PASS      AISC- H1-3         0.138         1
                       31.80 C          -0.70       -13960.21       0.00

|-----------------------------------------------------------------------|
| MEM=    46, UNIT KIP-INCH,  L=  26.0  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 180.4   CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  47 ST   TUB 60303       PASS      AISC- H1-3         0.138         1
                       31.80 C          -0.70       -13960.16       0.00

|-----------------------------------------------------------------------|
| MEM=    47, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 180.4   CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  48 ST   TUB 60303       PASS      AISC- H1-3         0.123         1
                       31.80 C        -44.62        -12323.26       0.00

|-----------------------------------------------------------------------|
| MEM=    48, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 180.4   CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  49 ST   TUB 60303       PASS      AISC- H1-3         0.092         1
                       31.80 C        -63.39         -9114.19       0.00

|-----------------------------------------------------------------------|
| MEM=    49, UNIT KIP-INCH,  L=  14.5  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 180.4   CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  50 ST   TUB 60303       PASS      AISC- H1-3         0.061         1
                       31.57 C       -103.49         -5887.60       0.00

|-----------------------------------------------------------------------|
| MEM=    50, UNIT KIP-INCH,  L=   9.5  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 180.4   CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  51 ST   TUB 60303       PASS      AISC- H1-3         0.058         1
                       31.57 C        -21.48         -5686.53      26.50

|-----------------------------------------------------------------------|
| MEM=    51, UNIT KIP-INCH,  L=  26.5  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 180.4   CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  52 ST   TUB 60303       PASS      AISC- H1-3         0.058         1
                       31.57 C        -21.48          5686.48       0.00
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE          RESULT/   CRITICAL COND/     RATIO/     LOADING/
                            FX           MY              MZ       LOCATION
=======================================================================


|-----------------------------------------------------------------------|
| MEM=     52, UNIT KIP-INCH,  L=  26.5  AX=  3.14  SZ=    4.8  SY=    3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    53  ST  TUB 60303      PASS     AISC- H1-3          0.061         1
                          31.57 C      -103.49       5887.57        9.50
|-----------------------------------------------------------------------|
| MEM=     53, UNIT KIP-INCH,  L=   9.5  AX=  3.14  SZ=    4.8  SY=    3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    54  ST  TUB 60303      PASS     AISC- H1-3          0.092         1
                          31.80 C       -63.39       9114.02       14.50
|-----------------------------------------------------------------------|
| MEM=     54, UNIT KIP-INCH,  L=  14.5  AX=  3.14  SZ=    4.8  SY=    3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    55  ST  TUB 60303      PASS     AISC- H1-3          0.123         1
                          31.80 C       -44.62      12323.28       24.00
|-----------------------------------------------------------------------|
| MEM=     55, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=    3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    56  ST  TUB 60303      PASS     AISC- H1-3          0.138         1
                          31.80 C        -0.70      13960.13       24.00
|-----------------------------------------------------------------------|
| MEM=     56, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=    3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    57  ST  TUB 60303      PASS     AISC- H1-3          0.138         1
                          31.80 C         0.70     -13960.18        0.00
|-----------------------------------------------------------------------|
| MEM=     57, UNIT KIP-INCH,  L=  26.0  AX=  3.14  SZ=    4.8  SY=    3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    58  ST  TUB 60303      PASS     AISC- H1-3          0.138         1
                          31.80 C         0.70     -13960.19        0.00
|-----------------------------------------------------------------------|
| MEM=     58, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=    3.2 |
| KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
```

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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE          RESULT/   CRITICAL COND/     RATIO/     LOADING/
                             FX            MY             MZ       LOCATION
=======================================================================

   59  ST  TUB 60303       PASS      AISC- H1-3          0.123          1
                        31.80 C         44.62      -12323.33         0.00
 |-----------------------------------------------------------------------|
 | MEM=    59, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=   4.8  SY=   3.2 |
 | KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
 | FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
 |-----------------------------------------------------------------------|
   60  ST  TUB 60303       PASS      AISC- H1-3          0.092          1
                        31.80 C         63.39       -9114.10         0.00
 |-----------------------------------------------------------------------|
 | MEM=    60, UNIT KIP-INCH,  L=  14.5  AX=  3.14  SZ=   4.8  SY=   3.2 |
 | KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
 | FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
 |-----------------------------------------------------------------------|
   61  ST  TUB 60303       PASS      AISC- H1-3          0.061          1
                        31.57 C        103.49       -5887.42         0.00
 |-----------------------------------------------------------------------|
 | MEM=    61, UNIT KIP-INCH,  L=   9.5  AX=  3.14  SZ=   4.8  SY=   3.2 |
 | KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
 | FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
 |-----------------------------------------------------------------------|
   62  ST  TUB 60303       PASS      AISC- H1-3          0.058          1
                        31.57 C         21.48       -5686.46        26.50
 |-----------------------------------------------------------------------|
 | MEM=    62, UNIT KIP-INCH,  L=  26.5  AX=  3.14  SZ=   4.8  SY=   3.2 |
 | KL/R-Y= 180.4  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
 | FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  4.59  FT= 21.60  FV= 14.40   |
 |-----------------------------------------------------------------------|
   63  ST  TUB 30203       PASS      AISC- H1-3          0.028          1
                        29.04 C         38.80         694.10         0.00
 |-----------------------------------------------------------------------|
 | MEM=    63, UNIT KIP-INCH,  L=  24.0  AX=  1.64  SZ=   1.3  SY=   1.0 |
 | KL/R-Y=  30.7  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
 | FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 19.89  FT= 21.60  FV= 14.40   |
 |-----------------------------------------------------------------------|
   64  ST  TUB 30203       PASS      AISC- H1-3          0.024          1
                        29.04 C        104.51         502.64        24.00
 |-----------------------------------------------------------------------|
 | MEM=    64, UNIT KIP-INCH,  L=  24.0  AX=  1.64  SZ=   1.3  SY=   1.0 |
 | KL/R-Y=  30.7  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
 | FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 19.89  FT= 21.60  FV= 14.40   |
 |-----------------------------------------------------------------------|
   65  ST  TUB 30203       PASS      AISC- H1-3          0.021          1
                        24.09 C         25.70         511.94        27.50
```

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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE          RESULT/   CRITICAL COND/     RATIO/     LOADING/
                             FX            MY             MZ      LOCATION
=======================================================================


|-----------------------------------------------------------------------|
| MEM=    65, UNIT KIP-INCH,  L=  27.5  AX=  1.64  SZ=   1.3  SY=   1.0 |
| KL/R-Y=  35.2  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 19.56  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    66   ST  TUB 30203      PASS     AISC- H1-3         0.021         1
                          24.09 C       -25.70       -511.94        0.00
|-----------------------------------------------------------------------|
| MEM=    66, UNIT KIP-INCH,  L=  27.5  AX=  1.64  SZ=   1.3  SY=   1.0 |
| KL/R-Y=  35.2  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 19.56  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    67   ST  TUB 30203      PASS     AISC- H1-3         0.024         1
                          29.04 C      -104.51       -502.67        0.00
|-----------------------------------------------------------------------|
| MEM=    67, UNIT KIP-INCH,  L=  24.0  AX=  1.64  SZ=   1.3  SY=   1.0 |
| KL/R-Y=  30.7  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 19.89  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    68   ST  TUB 30203      PASS     AISC- H1-3         0.028         1
                          29.04 C       -38.80       -694.10       24.00
|-----------------------------------------------------------------------|
| MEM=    68, UNIT KIP-INCH,  L=  24.0  AX=  1.64  SZ=   1.3  SY=   1.0 |
| KL/R-Y=  30.7  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 19.89  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    69   ST  TUB 30203      PASS     AISC- H1-3         0.028         1
                          29.04 C        38.80        694.11        0.00
|-----------------------------------------------------------------------|
| MEM=    69, UNIT KIP-INCH,  L=  24.0  AX=  1.64  SZ=   1.3  SY=   1.0 |
| KL/R-Y=  30.7  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 19.89  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    70   ST  TUB 30203      PASS     AISC- H1-3         0.024         1
                          29.04 C       104.51        502.66       24.00
|-----------------------------------------------------------------------|
| MEM=    70, UNIT KIP-INCH,  L=  24.0  AX=  1.64  SZ=   1.3  SY=   1.0 |
| KL/R-Y=  30.7  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 19.89  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
    71   ST  TUB 30203      PASS     AISC- H1-3         0.021         1
                          24.09 C        25.70        511.94       27.50
|-----------------------------------------------------------------------|
| MEM=    71, UNIT KIP-INCH,  L=  27.5  AX=  1.64  SZ=   1.3  SY=   1.0 |
| KL/R-Y=  35.2  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 19.56  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE          RESULT/   CRITICAL COND/      RATIO/     LOADING/
                            FX            MY              MZ       LOCATION
=======================================================================

  72  ST  TUB 30203       PASS      AISC- H1-3          0.021          1
                      24.09 C        -25.70          -511.94         0.00
|-----------------------------------------------------------------------|
| MEM=    72, UNIT KIP-INCH,  L=  27.5  AX=  1.64  SZ=    1.3  SY=   1.0 |
| KL/R-Y=  35.2  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 19.56  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  73  ST  TUB 30203       PASS      AISC- H1-3          0.024          1
                      29.04 C       -104.51          -502.66         0.00
|-----------------------------------------------------------------------|
| MEM=    73, UNIT KIP-INCH,  L=  24.0  AX=  1.64  SZ=    1.3  SY=   1.0 |
| KL/R-Y=  30.7  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 19.89  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  74  ST  TUB 30203       PASS      AISC- H1-3          0.028          1
                      29.05 C        -38.80          -694.13        24.00
|-----------------------------------------------------------------------|
| MEM=    74, UNIT KIP-INCH,  L=  24.0  AX=  1.64  SZ=    1.3  SY=   1.0 |
| KL/R-Y=  30.7  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 19.89  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  75      PRI SMAT        PASS      SHEAR   -Y          0.015          1
                       5.51 T          0.00             0.00         0.00
|-----------------------------------------------------------------------|
| MEM=    75, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=    0.1  SY=   0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
  76  ST  TUB 20203       PASS      AISC- H1-3          0.097          1
                       5.74 C        -99.66          1369.81         0.00
|-----------------------------------------------------------------------|
| MEM=    76, UNIT KIP-INCH,  L=  36.0  AX=  1.27  SZ=    0.7  SY=   0.7 |
| KL/R-Y=  48.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 18.48  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  77  ST  TUB 20203       PASS      AISC- H1-3          0.097          1
                       5.74 C         99.66          1369.81         0.00
|-----------------------------------------------------------------------|
| MEM=    77, UNIT KIP-INCH,  L=  36.0  AX=  1.27  SZ=    0.7  SY=   0.7 |
| KL/R-Y=  48.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 18.48  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  78      PRI SMAT        PASS      SHEAR   -Y          0.015          1
                       5.51 T          0.00             0.00         0.00
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE        RESULT/   CRITICAL COND/     RATIO/      LOADING/
                          FX            MY             MZ        LOCATION
=======================================================================


|-----------------------------------------------------------------------|
| MEM=     78, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=    0.1  SY=    0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
    79        PRI SMAT       PASS     SHEAR   -Y         0.016        1
                          27.35 C         0.00           0.00       0.00
|-----------------------------------------------------------------------|
| MEM=     79, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=    0.1  SY=    0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
    80        PRI SMAT       PASS     SHEAR   -Y         0.015        1
                           4.66 C         0.00           0.00       0.00
|-----------------------------------------------------------------------|
| MEM=     80, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=    0.1  SY=    0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
    81        PRI SMAT       PASS     SHEAR   -Y         0.015        1
                           1.05 T         0.00           0.00       0.00
|-----------------------------------------------------------------------|
| MEM=     81, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=    0.1  SY=    0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
    82        PRI SMAT       PASS     SHEAR   -Y         0.016        1
                           1.83 C         0.00           0.00       0.00
|-----------------------------------------------------------------------|
| MEM=     82, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=    0.1  SY=    0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
    83        PRI SMAT       PASS     SHEAR   -Y         0.016        1
                           1.83 C         0.00           0.00       0.00
|-----------------------------------------------------------------------|
| MEM=     83, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=    0.1  SY=    0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
    84        PRI SMAT       PASS     SHEAR   -Y         0.015        1
                           1.05 T         0.00           0.00       0.00
|-----------------------------------------------------------------------|
| MEM=     84, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=    0.1  SY=    0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE          RESULT/   CRITICAL COND/      RATIO/     LOADING/
                            FX            MY              MZ       LOCATION
=======================================================================


  85       PRI SMAT        PASS     SHEAR   -Y          0.015         1
                          4.66 C        0.00            0.00        0.00

|-----------------------------------------------------------------------|
| MEM=    85, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=   0.1  SY=   0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
  86       PRI SMAT        PASS     SHEAR   -Y          0.016         1
                         27.35 C        0.00            0.00        0.00

|-----------------------------------------------------------------------|
| MEM=    86, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=   0.1  SY=   0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
  87       PRI SMAT        PASS     SHEAR   -Y          0.015         1
                          5.51 T        0.00            0.00        0.00

|-----------------------------------------------------------------------|
| MEM=    87, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=   0.1  SY=   0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
  88   ST  TUB 20203       PASS     AISC- H1-3          0.097         1
                          5.74 C      -99.66         1369.81        0.00

|-----------------------------------------------------------------------|
| MEM=    88, UNIT KIP-INCH,  L=  36.0  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  48.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 18.48  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  89   ST  TUB 20203       PASS     AISC- H1-3          0.097         1
                          5.74 C       99.66         1369.81        0.00

|-----------------------------------------------------------------------|
| MEM=    89, UNIT KIP-INCH,  L=  36.0  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  48.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 18.48  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  90       PRI SMAT        PASS     SHEAR   -Y          0.015         1
                          5.51 T        0.00            0.00        0.00

|-----------------------------------------------------------------------|
| MEM=    90, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=   0.1  SY=   0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
  91       PRI SMAT        PASS     SHEAR   -Y          0.016         1
                         27.35 C        0.00            0.00        0.00
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE       RESULT/   CRITICAL COND/     RATIO/     LOADING/
                         FX            MY             MZ       LOCATION
=======================================================================


|-----------------------------------------------------------------------|
| MEM=    91, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=   0.1  SY=   0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
   92       PRI SMAT       PASS      SHEAR   -Y          0.015        1
                         4.66 C         0.00             0.00        0.00
|-----------------------------------------------------------------------|
| MEM=    92, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=   0.1  SY=   0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
   93       PRI SMAT       PASS      SHEAR   -Y          0.015        1
                         1.05 T         0.00             0.00        0.00
|-----------------------------------------------------------------------|
| MEM=    93, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=   0.1  SY=   0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
   94       PRI SMAT       PASS      SHEAR   -Y          0.016        1
                         1.83 C         0.00             0.00        0.00
|-----------------------------------------------------------------------|
| MEM=    94, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=   0.1  SY=   0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
   95       PRI SMAT       PASS      SHEAR   -Y          0.016        1
                         1.83 C         0.00             0.00        0.00
|-----------------------------------------------------------------------|
| MEM=    95, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=   0.1  SY=   0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
   96       PRI SMAT       PASS      SHEAR   -Y          0.015        1
                         1.05 T         0.00             0.00        0.00
|-----------------------------------------------------------------------|
| MEM=    96, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=   0.1  SY=   0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
   97       PRI SMAT       PASS      SHEAR   -Y          0.015        1
                         4.66 C         0.00             0.00        0.00
|-----------------------------------------------------------------------|
| MEM=    97, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=   0.1  SY=   0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
```

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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER      TABLE         RESULT/   CRITICAL COND/      RATIO/     LOADING/
                             FX            MY               MZ       LOCATION
=======================================================================

  98       PRI SMAT         PASS     SHEAR   -Y         0.016          1
                         27.35 C        0.00            0.00         0.00
|-----------------------------------------------------------------------|
| MEM=    98, UNIT KIP-INCH,  L=  36.0  AX=  0.57  SZ=    0.1  SY=    0.1 |
| KL/R-Y= 118.0  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.70  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
  100   ST   TUB 35353      PASS     AISC- H1-3         0.167          1
                      1051.92 C      4034.92        -3644.49         0.00
|-----------------------------------------------------------------------|
| MEM=   100, UNIT KIP-INCH,  L=  48.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=  35.8  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 19.51  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  101   ST   TUB 35353      PASS     AISC- H1-3         0.066          1
                      1105.33 C     -1163.49         1118.54         0.00
|-----------------------------------------------------------------------|
| MEM=   101, UNIT KIP-INCH,  L=  36.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=  26.8  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 20.16  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  102   ST   TUB 35353      PASS     AISC- H1-3         0.023          1
                      1201.58 C         0.00            0.00         0.00
|-----------------------------------------------------------------------|
| MEM=   102, UNIT KIP-INCH,  L=   6.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=   4.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 21.41  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  103   ST   TUB 35353      PASS     AISC- H1-3         0.167          1
                      1051.92 C      4034.92         3644.49         0.00
|-----------------------------------------------------------------------|
| MEM=   103, UNIT KIP-INCH,  L=  48.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=  35.8  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 19.51  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  104   ST   TUB 35353      PASS     AISC- H1-3         0.066          1
                      1105.33 C     -1163.49        -1118.54         0.00
|-----------------------------------------------------------------------|
| MEM=   104, UNIT KIP-INCH,  L=  36.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=  26.8  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 20.16  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  105   ST   TUB 35353      PASS     AISC- H1-3         0.023          1
                      1201.62 C         0.00            0.00         0.00
```

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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE        RESULT/   CRITICAL COND/     RATIO/     LOADING/
                          FX            MY              MZ      LOCATION
=======================================================================


|-----------------------------------------------------------------------|
| MEM=   105, UNIT KIP-INCH,  L=   6.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=   4.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 21.41  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   106  ST  TUB 35353      PASS      AISC- H1-3          0.167        1
                     1051.92 C     -4034.92        3644.49        0.00
|-----------------------------------------------------------------------|
| MEM=   106, UNIT KIP-INCH,  L=  48.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=  35.8  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 19.51  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   107  ST  TUB 35353      PASS      AISC- H1-3          0.066        1
                     1105.33 C      1163.49       -1118.54        0.00
|-----------------------------------------------------------------------|
| MEM=   107, UNIT KIP-INCH,  L=  36.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=  26.8  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 20.16  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   108  ST  TUB 35353      PASS      AISC- H1-3          0.023        1
                     1201.60 C         0.00           0.00        0.00
|-----------------------------------------------------------------------|
| MEM=   108, UNIT KIP-INCH,  L=   6.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=   4.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 21.41  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   109  ST  TUB 35353      PASS      AISC- H1-3          0.167        1
                     1051.92 C     -4034.92       -3644.49        0.00
|-----------------------------------------------------------------------|
| MEM=   109, UNIT KIP-INCH,  L=  48.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=  35.8  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 19.51  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   110  ST  TUB 35353      PASS      AISC- H1-3          0.066        1
                     1105.33 C      1163.49        1118.54        0.00
|-----------------------------------------------------------------------|
| MEM=   110, UNIT KIP-INCH,  L=  36.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=  26.8  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 20.16  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   111  ST  TUB 35353      PASS      AISC- H1-3          0.023        1
                     1201.60 C         0.00           0.00        0.00
|-----------------------------------------------------------------------|
| MEM=   111, UNIT KIP-INCH,  L=   6.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=   4.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 21.41  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE         RESULT/   CRITICAL COND/     RATIO/     LOADING/
                           FX            MY             MZ       LOCATION
=======================================================================

  112      PRI SMAT       PASS     AISC- H1-3         0.132         1
                     1219.11 C       0.00             0.00       102.00
|-----------------------------------------------------------------------|
| MEM=   112, UNIT KIP-INCH,  L= 102.0  AX=  1.38  SZ=    1.3  SY=    1.3 |
| KL/R-Y=  86.7  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  6.68  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
  113      PRI SMAT       PASS     AISC- H1-3         0.132         1
                     1219.10 C       0.00             0.00       102.00
|-----------------------------------------------------------------------|
| MEM=   113, UNIT KIP-INCH,  L= 102.0  AX=  1.38  SZ=    1.3  SY=    1.3 |
| KL/R-Y=  86.7  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  6.68  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
  114      PRI SMAT       PASS     AISC- H1-3         0.132         1
                     1219.10 C       0.00             0.00       102.00
|-----------------------------------------------------------------------|
| MEM=   114, UNIT KIP-INCH,  L= 102.0  AX=  1.38  SZ=    1.3  SY=    1.3 |
| KL/R-Y=  86.7  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  6.68  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
  115      PRI SMAT       PASS     AISC- H1-3         0.132         1
                     1219.10 C       0.00             0.00       102.00
|-----------------------------------------------------------------------|
| MEM=   115, UNIT KIP-INCH,  L= 102.0  AX=  1.38  SZ=    1.3  SY=    1.3 |
| KL/R-Y=  86.7  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  6.68  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
  116  ST  TUB 20203      PASS     AISC- H2-1         0.045         1
                       140.16 T    -410.74          189.96         0.00
|-----------------------------------------------------------------------|
| MEM=   116, UNIT KIP-INCH,  L=  36.0  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y=  48.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 18.48  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  117  ST  TUB 20203      PASS     AISC- H2-1         0.043         1
                       107.65 T    -542.02           47.87        66.33
|-----------------------------------------------------------------------|
| MEM=   117, UNIT KIP-INCH,  L=  66.3  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y=  89.3  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 14.28  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  118  ST  TUB 20203      PASS     AISC- H2-1         0.078         1
                       856.94 T     571.34          132.09         0.00
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE          RESULT/   CRITICAL COND/     RATIO/     LOADING/
                              FX            MY             MZ     LOCATION
=======================================================================


|-----------------------------------------------------------------------|
| MEM=   118, UNIT KIP-INCH,  L=   9.2  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y=  12.3  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 21.03  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   119  ST  TUB 20203       PASS      AISC- H2-1          0.078        1
                        856.94 T       -571.34        -132.08       9.17
|-----------------------------------------------------------------------|
| MEM=   119, UNIT KIP-INCH,  L=   9.2  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y=  12.3  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 21.03  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   120  ST  TUB 20203       PASS      AISC- H2-1          0.043        1
                        107.65 T        542.02         -47.87       0.00
|-----------------------------------------------------------------------|
| MEM=   120, UNIT KIP-INCH,  L=  66.3  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y=  89.3  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 14.28  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   121  ST  TUB 20203       PASS      AISC- H2-1          0.045        1
                        140.16 T        410.74        -189.96      36.00
|-----------------------------------------------------------------------|
| MEM=   121, UNIT KIP-INCH,  L=  36.0  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y=  48.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 18.48  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   122  ST  TUB 20203       PASS      AISC- H2-1          0.030        1
                        156.60 T       -172.75         199.78       0.00
|-----------------------------------------------------------------------|
| MEM=   122, UNIT KIP-INCH,  L=  36.0  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y=  48.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 18.48  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   123  ST  TUB 20203       PASS      AISC- H2-1          0.026        1
                        125.93 T       -146.35         184.53       0.00
|-----------------------------------------------------------------------|
| MEM=   123, UNIT KIP-INCH,  L=  75.5  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y= 101.7  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 12.76  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   124  ST  TUB 20203       PASS      AISC- H2-1          0.026        1
                        125.94 T        146.36        -184.53      75.50
|-----------------------------------------------------------------------|
| MEM=   124, UNIT KIP-INCH,  L=  75.5  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y= 101.7  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 12.76  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
```

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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE           RESULT/   CRITICAL COND/      RATIO/     LOADING/
                             FX            MY              MZ       LOCATION
=======================================================================


  125  ST  TUB 20203        PASS      AISC- H2-1          0.030         1
                         156.60 T       172.75         -199.78      36.00
|-----------------------------------------------------------------------|
| MEM=   125, UNIT KIP-INCH,  L=  36.0  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  48.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 18.48  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  126  ST  TUB 20203        PASS      AISC- H2-1          0.045         1
                         140.16 T      -410.74          189.96       0.00
|-----------------------------------------------------------------------|
| MEM=   126, UNIT KIP-INCH,  L=  36.0  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  48.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 18.48  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  127  ST  TUB 20203        PASS      AISC- H2-1          0.043         1
                         107.65 T      -542.02           47.87      66.33
|-----------------------------------------------------------------------|
| MEM=   127, UNIT KIP-INCH,  L=  66.3  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  89.3  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 14.28  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  128  ST  TUB 20203        PASS      AISC- H2-1          0.078         1
                         856.94 T       571.36          132.08       0.00
|-----------------------------------------------------------------------|
| MEM=   128, UNIT KIP-INCH,  L=   9.2  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  12.3  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 21.03  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  129  ST  TUB 20203        PASS      AISC- H2-1          0.078         1
                         856.94 T      -571.38         -132.08       9.17
|-----------------------------------------------------------------------|
| MEM=   129, UNIT KIP-INCH,  L=   9.2  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  12.3  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 21.03  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  130  ST  TUB 20203        PASS      AISC- H2-1          0.043         1
                         107.65 T       542.02          -47.87       0.00
|-----------------------------------------------------------------------|
| MEM=   130, UNIT KIP-INCH,  L=  66.3  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  89.3  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 14.28  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  131  ST  TUB 20203        PASS      AISC- H2-1          0.045         1
                         140.16 T       410.74         -189.96      36.00
```

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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE          RESULT/   CRITICAL COND/     RATIO/      LOADING/
                            FX            MY             MZ        LOCATION
=======================================================================


|-----------------------------------------------------------------------|
| MEM=   131, UNIT KIP-INCH,  L=  36.0  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y=  48.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 18.48  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   132  ST  TUB 20203       PASS      AISC- H2-1         0.030         1
                        156.60 T      -172.75         199.78         0.00
|-----------------------------------------------------------------------|
| MEM=   132, UNIT KIP-INCH,  L=  36.0  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y=  48.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 18.48  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   133  ST  TUB 20203       PASS      AISC- H2-1         0.026         1
                        125.94 T      -146.35         184.53         0.00
|-----------------------------------------------------------------------|
| MEM=   133, UNIT KIP-INCH,  L=  75.5  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y= 101.7  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 12.76  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   134  ST  TUB 20203       PASS      AISC- H2-1         0.026         1
                        125.93 T       146.36        -184.53        75.50
|-----------------------------------------------------------------------|
| MEM=   134, UNIT KIP-INCH,  L=  75.5  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y= 101.7  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 12.76  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   135  ST  TUB 20203       PASS      AISC- H2-1         0.030         1
                        156.60 T       172.75        -199.78        36.00
|-----------------------------------------------------------------------|
| MEM=   135, UNIT KIP-INCH,  L=  36.0  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y=  48.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 18.48  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   136  ST  TUB 20203       PASS      AISC- H2-1         0.062         1
                        828.19 T       -97.16        -378.21       113.03
|-----------------------------------------------------------------------|
| MEM=   136, UNIT KIP-INCH,  L= 113.0  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y= 152.2  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  6.44  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
   137  ST  TUB 20203       PASS      AISC- H2-1         0.062         1
                        828.19 T        97.16        -378.21       113.03
|-----------------------------------------------------------------------|
| MEM=   137, UNIT KIP-INCH,  L= 113.0  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y= 152.2  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  6.44  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
```

```
ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE          RESULT/   CRITICAL COND/      RATIO/      LOADING/
                              FX            MY             MZ       LOCATION
=======================================================================

  138  ST  TUB 20203       PASS     AISC- H2-1          0.057          1
                       648.42 T          6.11         -499.31      121.39

|-----------------------------------------------------------------------|
| MEM=    138, UNIT KIP-INCH,  L= 121.4  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y= 163.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  5.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  139  ST  TUB 20203       PASS     AISC- H2-1          0.057          1
                       648.42 T         -6.11         -499.31      121.39

|-----------------------------------------------------------------------|
| MEM=    139, UNIT KIP-INCH,  L= 121.4  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y= 163.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  5.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  140  ST  TUB 20203       PASS     AISC- H2-1          0.062          1
                       828.19 T        -97.16         -378.21      113.03

|-----------------------------------------------------------------------|
| MEM=    140, UNIT KIP-INCH,  L= 113.0  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y= 152.2  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  6.44  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  141  ST  TUB 20203       PASS     AISC- H2-1          0.062          1
                       828.19 T         97.16         -378.21      113.03

|-----------------------------------------------------------------------|
| MEM=    141, UNIT KIP-INCH,  L= 113.0  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y= 152.2  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  6.44  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  142  ST  TUB 20203       PASS     AISC- H2-1          0.057          1
                       648.42 T          6.11         -499.31      121.39

|-----------------------------------------------------------------------|
| MEM=    142, UNIT KIP-INCH,  L= 121.4  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y= 163.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  5.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  143  ST  TUB 20203       PASS     AISC- H2-1          0.057          1
                       648.42 T         -6.11         -499.31      121.39

|-----------------------------------------------------------------------|
| MEM=    143, UNIT KIP-INCH,  L= 121.4  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y= 163.5  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA=  5.59  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  144  ST  TUB 20203       PASS     AISC- H1-3          0.088          1
                       304.46 C        878.28          243.78        0.00
```

```
 ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

 MEMBER     TABLE        RESULT/   CRITICAL COND/     RATIO/     LOADING/
                           FX           MY              MZ       LOCATION
 =======================================================================


  |-----------------------------------------------------------------------|
  | MEM=   144, UNIT KIP-INCH,  L=  48.0  AX=  1.27  SZ=    0.7  SY=    0.7 |
  | KL/R-Y=  64.7  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
  | FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 16.97  FT= 21.60  FV= 14.40   |
  |-----------------------------------------------------------------------|
     145   ST   TUB 20203       PASS      AISC- H1-3          0.088         1
                          304.45 C        878.28        -243.78        0.00
  |-----------------------------------------------------------------------|
  | MEM=   145, UNIT KIP-INCH,  L=  48.0  AX=  1.27  SZ=    0.7  SY=    0.7 |
  | KL/R-Y=  64.7  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
  | FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 16.97  FT= 21.60  FV= 14.40   |
  |-----------------------------------------------------------------------|
     146   ST   TUB 20203       PASS      AISC- H1-3          0.038         1
                          428.70 C          0.00         280.51        0.00
  |-----------------------------------------------------------------------|
  | MEM=   146, UNIT KIP-INCH,  L=  48.0  AX=  1.27  SZ=    0.7  SY=    0.7 |
  | KL/R-Y=  64.7  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
  | FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 16.97  FT= 21.60  FV= 14.40   |
  |-----------------------------------------------------------------------|
     147   ST   TUB 20203       PASS      AISC- H1-3          0.088         1
                          304.46 C       -878.28        -243.78        0.00
  |-----------------------------------------------------------------------|
  | MEM=   147, UNIT KIP-INCH,  L=  48.0  AX=  1.27  SZ=    0.7  SY=    0.7 |
  | KL/R-Y=  64.7  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
  | FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 16.97  FT= 21.60  FV= 14.40   |
  |-----------------------------------------------------------------------|
     148   ST   TUB 20203       PASS      AISC- H1-3          0.088         1
                          304.45 C       -878.28         243.78        0.00
  |-----------------------------------------------------------------------|
  | MEM=   148, UNIT KIP-INCH,  L=  48.0  AX=  1.27  SZ=    0.7  SY=    0.7 |
  | KL/R-Y=  64.7  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
  | FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 16.97  FT= 21.60  FV= 14.40   |
  |-----------------------------------------------------------------------|
     149   ST   TUB 20203       PASS      AISC- H1-3          0.038         1
                          428.70 C          0.00        -280.51        0.00
  |-----------------------------------------------------------------------|
  | MEM=   149, UNIT KIP-INCH,  L=  48.0  AX=  1.27  SZ=    0.7  SY=    0.7 |
  | KL/R-Y=  64.7  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
  | FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 16.97  FT= 21.60  FV= 14.40   |
  |-----------------------------------------------------------------------|
     150   ST   TUB 20203       PASS      AISC- H1-3          0.023         1
                           48.94 C       -272.07         -33.05        0.00
  |-----------------------------------------------------------------------|
  | MEM=   150, UNIT KIP-INCH,  L=  50.9  AX=  1.27  SZ=    0.7  SY=    0.7 |
  | KL/R-Y=  68.6  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
  | FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 16.57  FT= 21.60  FV= 14.40   |
  |-----------------------------------------------------------------------|
```

```
ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE         RESULT/   CRITICAL COND/      RATIO/     LOADING/
                           FX            MY              MZ       LOCATION
=======================================================================

   151  ST  TUB 20203      PASS     AISC- H1-3         0.023         1
                       48.94 C       272.08          -33.05        0.00
|-----------------------------------------------------------------------|
| MEM=   151, UNIT KIP-INCH,  L=  50.9  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  68.6  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 16.57  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
   152  ST  TUB 20203      PASS     AISC- H1-3         0.015         1
                       33.63 C        57.44         -138.77       50.91
|-----------------------------------------------------------------------|
| MEM=   152, UNIT KIP-INCH,  L=  50.9  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  68.6  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 16.57  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
   153  ST  TUB 20203      PASS     AISC- H1-3         0.015         1
                       33.63 C       -57.44         -138.77       50.91
|-----------------------------------------------------------------------|
| MEM=   153, UNIT KIP-INCH,  L=  50.9  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  68.6  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 16.57  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
   154  ST  TUB 20203      PASS     AISC- H1-3         0.023         1
                       48.95 C      -272.07          -33.05        0.00
|-----------------------------------------------------------------------|
| MEM=   154, UNIT KIP-INCH,  L=  50.9  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  68.6  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 16.57  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
   155  ST  TUB 20203      PASS     AISC- H1-3         0.023         1
                       48.94 C       272.08          -33.05        0.00
|-----------------------------------------------------------------------|
| MEM=   155, UNIT KIP-INCH,  L=  50.9  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  68.6  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 16.57  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
   156  ST  TUB 20203      PASS     AISC- H1-3         0.015         1
                       33.63 C        57.44         -138.77       50.91
|-----------------------------------------------------------------------|
| MEM=   156, UNIT KIP-INCH,  L=  50.9  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  68.6  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 16.57  FT= 21.60  FV= 14.40  |
|-----------------------------------------------------------------------|
   157  ST  TUB 20203      PASS     AISC- H1-3         0.015         1
                       33.63 C       -57.44         -138.77       50.91
```

```
ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE        RESULT/   CRITICAL COND/     RATIO/     LOADING/
                          FX            MY              MZ       LOCATION
=======================================================================

|-----------------------------------------------------------------------|
| MEM=   157, UNIT KIP-INCH,  L=  50.9  AX=  1.27  SZ=    0.7  SY=   0.7 |
| KL/R-Y=  68.6  CB=  1.00  YLD= 36.00  ALLOWABLE STRESSES:  FCZ= 21.60 |
| FTZ= 21.60  FCY= 21.60  FTY= 21.60  FA= 16.57  FT= 21.60  FV= 14.40   |
|-----------------------------------------------------------------------|
  109. SELECT WELD ALL
```

```
                           STAAD-III WELD DESIGN
                           *********************

ALL UNITS ARE - INCH POUN

MEMBER  LOCATION/     WELD TYPE/       WELD SIZE/       COMB STRESS/
         LOADING      HOR STRESS      VERT STRESS        DIR STRESS
====================================================================

   1      STA             1             3/16              1349.72
           1            818.55            505.62            946.61

   1      END             1             3/16              1844.27
           1            818.55            482.00           1580.81

-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------

   2      STA             1             3/16              1702.58
           1             69.10             66.73           1699.87

   2      END             1             3/16              1074.35
           1             69.10             73.05           1069.63

-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------

   3      STA             1             3/16              1075.21
           1             67.46             86.14           1069.63

   3      END             1             3/16               323.50
           1             67.46             92.46            302.58

-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------

   4      STA             1             3/16               335.63
           1            120.10            140.80            280.00

   4      END             1             3/16              1272.20
           1            120.10            145.62           1258.12

-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------

   5      STA             1             3/16              1192.58
           1              0.00              2.42           1192.58

   5      END             1             3/16              1185.93
           1              0.00              0.00           1185.93
```

```
                       STAAD-III WELD DESIGN
                       *********************

ALL UNITS ARE - INCH POUN

MEMBER    LOCATION/      WELD TYPE/       WELD SIZE/        COMB STRESS/
          LOADING        HOR STRESS      VERT STRESS         DIR STRESS
=======================================================================

-----------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-----------------------------------------------------------------------

    6       STA              1               3/16              1185.93
              1                0.00                0.00        1185.93

    6       END              1               3/16              1192.58
              1                0.00                2.41        1192.58

-----------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-----------------------------------------------------------------------

    7       STA              1               3/16              1272.20
              1              120.10              145.63        1258.11

    7       END              1               3/16               335.63
              1              120.10              140.80         280.00

-----------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-----------------------------------------------------------------------

    8       STA              1               3/16               323.50
              1               67.47               92.46         302.58

    8       END              1               3/16              1075.22
              1               67.47               86.14        1069.64

-----------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-----------------------------------------------------------------------

    9       STA              1               3/16              1074.35
              1               69.10               73.05        1069.64

    9       END              1               3/16              1702.58
              1               69.10               66.73        1699.86

-----------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-----------------------------------------------------------------------

   10       STA              1               3/16              1844.27
              1              818.55              482.00        1580.81
```

```
                    STAAD-III WELD DESIGN
                    *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/     WELD TYPE/      WELD SIZE/       COMB STRESS/
         LOADING       HOR STRESS      VERT STRESS        DIR STRESS
=====================================================================

  10       END            1               3/16             1349.72
            1             818.55            505.62           946.61

--------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------

  11       STA            1               3/16              820.89
            1              27.13             28.65           819.94

  11       END            1               3/16              914.17
            1              27.13             21.67           913.51

--------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------

  12       STA            1               3/16              913.77
            1              19.02             10.56           913.51

  12       END            1               3/16              860.77
            1              19.02             16.88           860.39

--------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------

  13       STA            1               3/16              861.13
            1              19.30             29.97           860.39

  13       END            1               3/16              501.03
            1              19.30             36.29           499.34

--------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------

  14       STA            1               3/16              502.14
            1              18.99             49.38           499.34

  14       END            1               3/16              556.55
            1              18.99             55.70           553.43

--------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------
```

```
                    STAAD-III WELD DESIGN
                    *********************

ALL UNITS ARE - INCH POUN

MEMBER    LOCATION/      WELD TYPE/        WELD SIZE/        COMB STRESS/
          LOADING        HOR STRESS       VERT STRESS          DIR STRESS
===========================================================================

   15       STA              1                3/16                558.09
             1                19.53              69.33            553.42

   15       END              1                3/16               1045.48
             1                19.53              72.75           1042.77

--------------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------------

   16       STA              1                3/16               1045.48
             1                19.53              72.75           1042.77

   16       END              1                3/16                558.09
             1                19.53              69.33            553.42

--------------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------------

   17       STA              1                3/16                556.55
             1                18.99              55.70            553.43

   17       END              1                3/16                502.14
             1                18.99              49.38            499.34

--------------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------------

   18       STA              1                3/16                501.03
             1                19.30              36.29            499.34

   18       END              1                3/16                861.13
             1                19.30              29.97            860.39

--------------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------------

   19       STA              1                3/16                860.76
             1                19.02              16.87            860.39

   19       END              1                3/16                913.78
             1                19.02              10.56            913.52
```

```
                        STAAD-III WELD DESIGN
                        *********************

ALL UNITS ARE - INCH POUN

MEMBER    LOCATION/     WELD TYPE/      WELD SIZE/       COMB STRESS/
          LOADING       HOR STRESS     VERT STRESS        DIR STRESS
=====================================================================


-------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=    3.00 CV=   1.50
-------------------------------------------------------------------

   20        STA            1              3/16                914.17
              1              27.13            21.67            913.51

   20        END            1              3/16                820.89
              1              27.13            28.65            819.94

-------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=    3.00 CV=   1.50
-------------------------------------------------------------------

   21        STA            1              3/16               1349.72
              1             818.55           505.62            946.61

   21        END            1              3/16               1844.27
              1             818.55           482.00           1580.82

-------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=    3.00 CV=   1.50
-------------------------------------------------------------------

   22        STA            1              3/16               1702.59
              1              69.10            66.73           1699.87

   22        END            1              3/16               1074.34
              1              69.10            73.05           1069.63

-------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=    3.00 CV=   1.50
-------------------------------------------------------------------

   23        STA            1              3/16               1075.22
              1              67.46            86.14           1069.63

   23        END            1              3/16                323.50
              1              67.46            92.46            302.58

-------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=    3.00 CV=   1.50
-------------------------------------------------------------------

   24        STA            1              3/16                335.63
              1             120.10           140.80            280.00
```

```
                    STAAD-III WELD DESIGN
                    *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/     WELD TYPE/       WELD SIZE/      COMB STRESS/
         LOADING       HOR STRESS      VERT STRESS       DIR STRESS
====================================================================

  24       END              1              3/16             1272.19
            1             120.10            145.62          1258.11

-------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
-------------------------------------------------------------------

  25       STA              1              3/16             1192.57
            1               0.00              2.41          1192.57

  25       END              1              3/16             1185.94
            1               0.00              0.00          1185.94

-------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
-------------------------------------------------------------------

  26       STA              1              3/16             1185.94
            1               0.00              0.00          1185.94

  26       END              1              3/16             1192.57
            1               0.00              2.41          1192.57

-------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
-------------------------------------------------------------------

  27       STA              1              3/16             1272.19
            1             120.10            145.62          1258.11

  27       END              1              3/16              335.63
            1             120.10            140.80           280.00

-------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
-------------------------------------------------------------------

  28       STA              1              3/16              323.51
            1              67.46             92.46           302.58

  28       END              1              3/16             1075.22
            1              67.46             86.14          1069.64

-------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
-------------------------------------------------------------------
```

```
                       STAAD-III WELD DESIGN
                       *********************

ALL UNITS ARE - INCH POUN

MEMBER  LOCATION/      WELD TYPE/       WELD SIZE/      COMB STRESS/
        LOADING        HOR STRESS      VERT STRESS       DIR STRESS
===================================================================


  29      STA              1              3/16              1074.35
           1                69.10            73.05          1069.64

  29      END              1              3/16              1702.57
           1                69.10            66.73          1699.86

------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=   1.50
------------------------------------------------------------------

  30      STA              1              3/16              1844.27
           1               818.55           482.00          1580.81

  30      END              1              3/16              1349.72
           1               818.55           505.62           946.61

------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=   1.50
------------------------------------------------------------------

  31      STA              1              3/16               820.89
           1                27.13            28.65           819.94

  31      END              1              3/16               914.17
           1                27.13            21.67           913.51

------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=   1.50
------------------------------------------------------------------

  32      STA              1              3/16               913.77
           1                19.02            10.56           913.51

  32      END              1              3/16               860.77
           1                19.02            16.87           860.39

------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=   1.50
------------------------------------------------------------------

  33      STA              1              3/16               861.13
           1                19.30            29.97           860.39

  33      END              1              3/16               501.03
           1                19.30            36.29           499.34
```

```
                         STAAD-III WELD DESIGN
                         *********************

ALL UNITS ARE - INCH POUN

MEMBER    LOCATION/      WELD TYPE/        WELD SIZE/         COMB STRESS/
          LOADING        HOR STRESS       VERT STRESS          DIR STRESS
===================================================================


  38        END              1                3/16                 861.13
            1                 19.30               29.97            860.39

-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------

  39        STA              1                3/16                 860.77
            1                 19.02               16.87            860.39

  39        END              1                3/16                 913.78
            1                 19.02               10.56            913.52

-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------

  40        STA              1                3/16                 914.18
            1                 27.13               21.67            913.52

  40        END              1                3/16                 820.89
            1                 27.13               28.65            819.94

-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------

  41        STA              1                3/16                1041.54
            1                 92.52              155.29           1025.74

  41        END              1                3/16                 662.45
            1                 92.52              138.89            641.09

-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------

  42        STA              1                3/16                 660.55
            1                 98.40              125.13            641.08

  42        END              1                3/16                1093.67
            1                 98.40              122.63           1082.31

-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------
```

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                             STAAD-III WELD DESIGN
                             *********************

ALL UNITS ARE - INCH POUN

MEMBER    LOCATION/        WELD TYPE/          WELD SIZE/         COMB STRESS/
          LOADING          HOR STRESS         VERT STRESS          DIR STRESS
==================================================================================

   43       STA                1                  3/16               1164.69
              1                  1.61               59.69            1163.16

   43       END                1                  3/16               1646.75
              1                  1.61               55.87            1645.80

-------------------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------------------

   44       STA                1                  3/16               1646.37
              1                  0.23               42.78            1645.81

   44       END                1                  3/16               2211.86
              1                  0.23               36.46            2211.56

-------------------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------------------

   45       STA                1                  3/16               2211.68
              1                  0.54               23.37            2211.56

   45       END                1                  3/16               2491.47
              1                  0.54               17.05            2491.41

-------------------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------------------

   46       STA                1                  3/16               2491.42
              1                  0.00                3.42            2491.41

   46       END                1                  3/16               2491.41
              1                  0.00                3.42            2491.40

-------------------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------------------

   47       STA                1                  3/16               2491.47
              1                  0.54               17.05            2491.41

   47       END                1                  3/16               2211.68
              1                  0.54               23.37            2211.56
```

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                         STAAD-III WELD DESIGN
                         *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/     WELD TYPE/      WELD SIZE/       COMB STRESS/
         LOADING       HOR STRESS     VERT STRESS        DIR STRESS
====================================================================

--------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------

   48       STA            1              3/16             2211.86
             1              0.23            36.46          2211.56

   48       END            1              3/16             1646.37
             1              0.23            42.78          1645.81

--------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------

   49       STA            1              3/16             1646.77
             1              1.61            55.88          1645.82

   49       END            1              3/16             1164.67
             1              1.61            59.69          1163.14

--------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------

   50       STA            1              3/16             1093.68
             1             98.40           122.63          1082.32

   50       END            1              3/16              660.55
             1             98.40           125.13           641.08

--------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------

   51       STA            1              3/16              662.46
             1             92.51           138.89           641.10

   51       END            1              3/16             1041.55
             1             92.51           155.29          1025.75

--------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------

   52       STA            1              3/16             1041.55
             1             92.52           155.29          1025.74
```

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                        STAAD-III WELD DESIGN
                        *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/     WELD TYPE/      WELD SIZE/      COMB STRESS/
         LOADING       HOR STRESS     VERT STRESS       DIR STRESS
=====================================================================

  52       END            1              3/16              662.45
            1              92.52           138.89           641.09

--------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
--------------------------------------------------------------------

  53       STA            1              3/16              660.55
            1              98.40           125.13           641.08

  53       END            1              3/16             1093.68
            1              98.40           122.63          1082.32

--------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
--------------------------------------------------------------------

  54       STA            1              3/16             1164.69
            1               1.61            59.69          1163.16

  54       END            1              3/16             1646.74
            1               1.61            55.87          1645.79

--------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
--------------------------------------------------------------------

  55       STA            1              3/16             1646.37
            1               0.23            42.78          1645.81

  55       END            1              3/16             2211.86
            1               0.23            36.46          2211.56

--------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
--------------------------------------------------------------------

  56       STA            1              3/16             2211.69
            1               0.54            23.37          2211.57

  56       END            1              3/16             2491.46
            1               0.54            17.05          2491.40

--------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
--------------------------------------------------------------------
```

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                           STAAD-III WELD DESIGN
                           *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/     WELD TYPE/      WELD SIZE/       COMB STRESS/
         LOADING       HOR STRESS     VERT STRESS        DIR STRESS
=====================================================================

   57       STA            1             3/16              2491.41
            1                0.00             3.42         2491.41

   57       END            1             3/16              2491.41
            1                0.00             3.42         2491.41

--------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=   1.50
--------------------------------------------------------------------

   58       STA            1             3/16              2491.47
            1                0.54            17.05         2491.41

   58       END            1             3/16              2211.68
            1                0.54            23.37         2211.56

--------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=   1.50
--------------------------------------------------------------------

   59       STA            1             3/16              2211.87
            1                0.23            36.46         2211.57

   59       END            1             3/16              1646.36
            1                0.23            42.78         1645.80

--------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=   1.50
--------------------------------------------------------------------

   60       STA            1             3/16              1646.76
            1                1.61            55.87         1645.81

   60       END            1             3/16              1164.68
            1                1.61            59.69         1163.15

--------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=   1.50
--------------------------------------------------------------------

   61       STA            1             3/16              1093.65
            1               98.40           122.63         1082.29

   61       END            1             3/16               660.57
            1               98.40           125.13          641.11
```

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                         STAAD-III WELD DESIGN
                         *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/     WELD TYPE/       WELD SIZE/       COMB STRESS/
         LOADING       HOR STRESS      VERT STRESS        DIR STRESS
====================================================================


-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------

   62      STA             1              3/16               662.45
            1               92.52           138.89           641.08

   62      END             1              3/16              1041.54
            1               92.52           155.29          1025.74

-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------

   63      STA             1              3/16               498.29
            1              153.32           133.15           455.03

   63      END             1              3/16               425.89
            1              153.32           127.21           376.41

-------------------------------------------------------------------
AX=  10.00 SZ=     9.00 SY=     7.33 JW=   20.83 CH=    1.50 CV=    1.00
-------------------------------------------------------------------

   64      STA             1              3/16               420.54
            1              156.26           103.65           376.43

   64      END             1              3/16               432.87
            1              156.26           106.56           389.36

-------------------------------------------------------------------
AX=  10.00 SZ=     9.00 SY=     7.33 JW=   20.83 CH=    1.50 CV=    1.00
-------------------------------------------------------------------

   65      STA             1              3/16               231.01
            1                0.00             6.81           230.91

   65      END             1              3/16               334.91
            1                0.00             0.00           334.91

-------------------------------------------------------------------
AX=  10.00 SZ=     9.00 SY=     7.33 JW=   20.83 CH=    1.50 CV=    1.00
-------------------------------------------------------------------

   66      STA             1              3/16               334.91
            1                0.00             0.00           334.91
```

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                         STAAD-III WELD DESIGN
                         *********************

ALL UNITS ARE - INCH POUN

MEMBER    LOCATION/       WELD TYPE/        WELD SIZE/        COMB STRESS/
          LOADING         HOR STRESS      VERT STRESS          DIR STRESS
==================================================================


   66       END                1              3/16                231.01
             1                   0.00             6.81            230.91

-----------------------------------------------------------------
AX=  10.00 SZ=     9.00 SY=     7.33 JW=    20.83 CH=    1.50 CV=    1.00
-----------------------------------------------------------------

   67       STA                1              3/16                432.88
             1                 156.26           106.56            389.37

   67       END                1              3/16                420.53
             1                 156.26           103.65            376.41

-----------------------------------------------------------------
AX=  10.00 SZ=     9.00 SY=     7.33 JW=    20.83 CH=    1.50 CV=    1.00
-----------------------------------------------------------------

   68       STA                1              3/16                425.88
             1                 153.32           127.21            376.41

   68       END                1              3/16                498.29
             1                 153.32           133.15            455.03

-----------------------------------------------------------------
AX=  10.00 SZ=     9.00 SY=     7.33 JW=    20.83 CH=    1.50 CV=    1.00
-----------------------------------------------------------------

   69       STA                1              3/16                498.29
             1                 153.32           133.15            455.04

   69       END                1              3/16                425.89
             1                 153.32           127.21            376.42

-----------------------------------------------------------------
AX=  10.00 SZ=     9.00 SY=     7.33 JW=    20.83 CH=    1.50 CV=    1.00
-----------------------------------------------------------------

   70       STA                1              3/16                420.54
             1                 156.26           103.65            376.42

   70       END                1              3/16                432.88
             1                 156.26           106.56            389.37

-----------------------------------------------------------------
AX=  10.00 SZ=     9.00 SY=     7.33 JW=    20.83 CH=    1.50 CV=    1.00
-----------------------------------------------------------------
```

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                          STAAD-III WELD DESIGN
                          *********************

ALL UNITS ARE - INCH POUN

MEMBER    LOCATION/      WELD TYPE/       WELD SIZE/        COMB STRESS/
          LOADING        HOR STRESS      VERT STRESS         DIR STRESS
====================================================================


   71       STA                1               3/16               231.01
             1                   0.00               6.81          230.91

   71       END                1               3/16               334.91
             1                   0.00               0.00          334.91

-------------------------------------------------------------------
AX=  10.00 SZ=     9.00 SY=     7.33 JW=    20.83 CH=    1.50 CV=    1.00
-------------------------------------------------------------------

   72       STA                1               3/16               334.91
             1                   0.00               0.00          334.91

   72       END                1               3/16               231.01
             1                   0.00               6.81          230.91

-------------------------------------------------------------------
AX=  10.00 SZ=     9.00 SY=     7.33 JW=    20.83 CH=    1.50 CV=    1.00
-------------------------------------------------------------------

   73       STA                1               3/16               432.88
             1               156.26             106.56            389.37

   73       END                1               3/16               420.54
             1               156.26             103.65            376.42

-------------------------------------------------------------------
AX=  10.00 SZ=     9.00 SY=     7.33 JW=    20.83 CH=    1.50 CV=    1.00
-------------------------------------------------------------------

   74       STA                1               3/16               425.90
             1               153.32             127.21            376.43

   74       END                1               3/16               498.30
             1               153.32             133.16            455.05

-------------------------------------------------------------------
AX=  10.00 SZ=     9.00 SY=     7.33 JW=    20.83 CH=    1.50 CV=    1.00
-------------------------------------------------------------------

   76       STA                1               3/16              1481.95
             1                86.41             134.58           1473.30

   76       END                1               3/16               498.83
             1                86.41              97.15            481.59
```

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                          STAAD-III WELD DESIGN
                          *********************

ALL UNITS ARE - INCH POUN

MEMBER    LOCATION/     WELD TYPE/        WELD SIZE/         COMB STRESS/
          LOADING       HOR STRESS       VERT STRESS          DIR STRESS
===========================================================================

---------------------------------------------------------------------------
AX=   8.00 SZ=    5.33 SY=    5.33 JW=   10.67 CH=   1.00 CV=   1.00
---------------------------------------------------------------------------

   77        STA              1               3/16               1481.95
              1                86.41           134.58            1473.30

   77        END              1               3/16                498.83
              1                86.41            97.15             481.59

---------------------------------------------------------------------------
AX=   8.00 SZ=    5.33 SY=    5.33 JW=   10.67 CH=   1.00 CV=   1.00
---------------------------------------------------------------------------

   88        STA              1               3/16               1481.95
              1                86.41           134.58            1473.29

   88        END              1               3/16                498.83
              1                86.41            97.15             481.59

---------------------------------------------------------------------------
AX=   8.00 SZ=    5.33 SY=    5.33 JW=   10.67 CH=   1.00 CV=   1.00
---------------------------------------------------------------------------

   89        STA              1               3/16               1481.95
              1                86.41           134.58            1473.30

   89        END              1               3/16                498.83
              1                86.41            97.15             481.59

---------------------------------------------------------------------------
AX=   8.00 SZ=    5.33 SY=    5.33 JW=   10.67 CH=   1.00 CV=   1.00
---------------------------------------------------------------------------

  100        STA              1               3/16               2911.08
              1                91.93            87.97            2908.30

  100        END              1               3/16               1323.07
              1                91.93            87.97            1316.94

---------------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=   57.17 CH=   1.75 CV=   1.75
---------------------------------------------------------------------------

  101        STA              1               3/16               1166.69
              1                23.49            22.61            1166.23
```

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                    STAAD-III WELD DESIGN
                    *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/     WELD TYPE/      WELD SIZE/       COMB STRESS/
         LOADING       HOR STRESS     VERT STRESS        DIR STRESS
=====================================================================

  101      END             1             3/16                514.34
            1               23.49            22.61           513.30

--------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=   57.17 CH=   1.75 CV=   1.75
--------------------------------------------------------------------

  102      STA             1             3/16                458.20
            1               14.46            14.46           457.75

  102      END             1             3/16                459.75
            1               14.46            14.46           459.29

--------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=   57.17 CH=   1.75 CV=   1.75
--------------------------------------------------------------------

  103      STA             1             3/16               2911.08
            1               91.93            87.96          2908.30

  103      END             1             3/16               1323.07
            1               91.93            87.96          1316.94

--------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=   57.17 CH=   1.75 CV=   1.75
--------------------------------------------------------------------

  104      STA             1             3/16               1166.69
            1               23.49            22.61          1166.23

  104      END             1             3/16                514.34
            1               23.49            22.61           513.30

--------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=   57.17 CH=   1.75 CV=   1.75
--------------------------------------------------------------------

  105      STA             1             3/16                458.22
            1               14.46            14.46           457.76

  105      END             1             3/16                459.76
            1               14.46            14.46           459.31

--------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=   57.17 CH=   1.75 CV=   1.75
--------------------------------------------------------------------
```

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                     STAAD-III WELD DESIGN
                     *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/    WELD TYPE/       WELD SIZE/      COMB STRESS/
         LOADING      HOR STRESS     VERT STRESS        DIR STRESS
===================================================================


  106      STA            1              3/16              2911.08
            1              91.93             87.97         2908.30

  106      END            1              3/16              1323.07
            1              91.93             87.97         1316.94

------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=   57.17 CH=   1.75 CV=   1.75
------------------------------------------------------------------

  107      STA            1              3/16              1166.69
            1              23.49             22.61         1166.23

  107      END            1              3/16               514.34
            1              23.49             22.61          513.30

------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=   57.17 CH=   1.75 CV=   1.75
------------------------------------------------------------------

  108      STA            1              3/16               458.21
            1              14.46             14.46          457.75

  108      END            1              3/16               459.75
            1              14.46             14.46          459.30

------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=   57.17 CH=   1.75 CV=   1.75
------------------------------------------------------------------

  109      STA            1              3/16              2911.08
            1              91.93             87.96         2908.30

  109      END            1              3/16              1323.07
            1              91.93             87.96         1316.94

------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=   57.17 CH=   1.75 CV=   1.75
------------------------------------------------------------------

  110      STA            1              3/16              1166.69
            1              23.49             22.61         1166.23

  110      END            1              3/16               514.34
            1              23.49             22.61          513.30
```

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                              STAAD-III WELD DESIGN
                              *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/     WELD TYPE/       WELD SIZE/        COMB STRESS/
         LOADING       HOR STRESS      VERT STRESS         DIR STRESS
======================================================================


-------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=  57.17 CH=   1.75 CV=   1.75
-------------------------------------------------------------------

  111     STA             1              3/16                 458.21
           1               14.46             14.46            457.76

  111     END             1              3/16                 459.76
           1               14.46             14.46            459.30

-------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=  57.17 CH=   1.75 CV=   1.75
-------------------------------------------------------------------

  116     STA             1              3/16                 696.81
           1               41.67             44.34            694.14

  116     END             1              3/16                 341.89
           1               41.67             39.37            337.05

-------------------------------------------------------------------
AX=   8.00 SZ=    5.33 SY=    5.33 JW=  10.67 CH=   1.00 CV=   1.00
-------------------------------------------------------------------

  117     STA             1              3/16                 535.97
           1               88.97             91.48            520.56

  117     END             1              3/16                 673.19
           1               88.97             86.48            661.66

-------------------------------------------------------------------
AX=   8.00 SZ=    5.33 SY=    5.33 JW=  10.67 CH=   1.00 CV=   1.00
-------------------------------------------------------------------

  118     STA             1              3/16                1274.72
           1                0.00              2.20           1274.72

  118     END             1              3/16                1259.64
           1                0.00              0.00           1259.64

-------------------------------------------------------------------
AX=   8.00 SZ=    5.33 SY=    5.33 JW=  10.67 CH=   1.00 CV=   1.00
-------------------------------------------------------------------

  119     STA             1              3/16                1259.64
           1                0.00              0.00           1259.64
```

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                   STAAD-III WELD DESIGN
                   *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/      WELD TYPE/       WELD SIZE/       COMB STRESS/
         LOADING        HOR STRESS      VERT STRESS        DIR STRESS
===================================================================


  119      END               1              3/16             1274.71
             1                 0.00             2.20         1274.71

------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
------------------------------------------------------------------

  120      STA               1              3/16              673.19
             1                88.97            86.48          661.66

  120      END               1              3/16              535.98
             1                88.97            91.48          520.56

------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
------------------------------------------------------------------

  121      STA               1              3/16              341.89
             1                41.67            39.37          337.05

  121      END               1              3/16              696.81
             1                41.67            44.34          694.15

------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
------------------------------------------------------------------

  122      STA               1              3/16              477.42
             1                12.21            17.73          476.93

  122      END               1              3/16              234.73
             1                12.21            12.03          234.10

------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
------------------------------------------------------------------

  123      STA               1              3/16              415.00
             1                 3.83            10.96          414.84

  123      END               1              3/16              339.61
             1                 3.83             9.44          339.45

------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
------------------------------------------------------------------
```

```
                         STAAD-III WELD DESIGN
                         *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/     WELD TYPE/      WELD SIZE/       COMB STRESS/
         LOADING       HOR STRESS     VERT STRESS        DIR STRESS
===================================================================

  124       STA                1            3/16               339.61
             1                  3.83            9.44           339.46

  124       END                1            3/16               415.01
             1                  3.83           10.96           414.84

------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
------------------------------------------------------------------

  125       STA                1            3/16               234.73
             1                 12.21           12.03           234.11

  125       END                1            3/16               477.42
             1                 12.21           17.73           476.93

------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
------------------------------------------------------------------

  126       STA                1            3/16               696.81
             1                 41.67           44.34           694.15

  126       END                1            3/16               341.89
             1                 41.67           39.37           337.05

------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
------------------------------------------------------------------

  127       STA                1            3/16               535.97
             1                 88.97           91.48           520.56

  127       END                1            3/16               673.19
             1                 88.97           86.48           661.66

------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
------------------------------------------------------------------

  128       STA                1            3/16              1274.74
             1                  0.00            2.20          1274.74

  128       END                1            3/16              1259.62
             1                  0.00            0.00          1259.62
```

```
                         STAAD-III WELD DESIGN
                         *********************

ALL UNITS ARE - INCH POUN

MEMBER    LOCATION/      WELD TYPE/        WELD SIZE/       COMB STRESS/
          LOADING        HOR STRESS       VERT STRESS        DIR STRESS
==========================================================================

---------------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
---------------------------------------------------------------------------

  129       STA               1              3/16              1259.61
             1                  0.00              0.00         1259.61

  129       END               1              3/16              1274.75
             1                  0.00              2.20         1274.75

---------------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
---------------------------------------------------------------------------

  130       STA               1              3/16               673.19
             1                 88.97             86.48          661.66

  130       END               1              3/16               535.98
             1                 88.97             91.48          520.56

---------------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
---------------------------------------------------------------------------

  131       STA               1              3/16               341.89
             1                 41.67             39.37          337.05

  131       END               1              3/16               696.81
             1                 41.67             44.34          694.15

---------------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
---------------------------------------------------------------------------

  132       STA               1              3/16               477.42
             1                 12.21             17.73          476.93

  132       END               1              3/16               234.73
             1                 12.21             12.03          234.10

---------------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
---------------------------------------------------------------------------

  133       STA               1              3/16               415.00
             1                  3.83             10.96          414.84
```

```
                      STAAD-III WELD DESIGN
                      *********************

ALL UNITS ARE - INCH POUN

MEMBER    LOCATION/      WELD TYPE/       WELD SIZE/        COMB STRESS/
           LOADING       HOR STRESS      VERT STRESS         DIR STRESS
=======================================================================

  133       END             1               3/16              339.61
             1                3.83              9.44          339.45

----------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=   1.00
----------------------------------------------------------------------

  134       STA             1               3/16              339.61
             1                3.83              9.44          339.46

  134       END             1               3/16              415.01
             1                3.83             10.96          414.84

----------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=   1.00
----------------------------------------------------------------------

  135       STA             1               3/16              234.73
             1               12.21             12.03          234.11

  135       END             1               3/16              477.42
             1               12.21             17.73          476.93

----------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=   1.00
----------------------------------------------------------------------

  136       STA             1               3/16              957.71
             1               23.28             32.11          956.89

  136       END             1               3/16             1028.36
             1               23.28             34.88         1027.50

----------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=   1.00
----------------------------------------------------------------------

  137       STA             1               3/16              957.71
             1               23.28             32.11          956.89

  137       END             1               3/16             1028.36
             1               23.28             34.88         1027.50

----------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=   1.00
----------------------------------------------------------------------
```

```
                          STAAD-III WELD DESIGN
                          *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/        WELD TYPE/        WELD SIZE/      COMB STRESS/
         LOADING          HOR STRESS       VERT STRESS       DIR STRESS
=====================================================================

  138       STA               1               3/16              650.66
             1                 19.87              31.05         649.61

  138       END               1               3/16              938.56
             1                 19.87              34.80         937.70

-------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
-------------------------------------------------------------------

  139       STA               1               3/16              650.66
             1                 19.87              31.05         649.61

  139       END               1               3/16              938.56
             1                 19.87              34.80         937.71

-------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
-------------------------------------------------------------------

  140       STA               1               3/16              957.71
             1                 23.28              32.11         956.89

  140       END               1               3/16             1028.36
             1                 23.28              34.88        1027.50

-------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
-------------------------------------------------------------------

  141       STA               1               3/16              957.71
             1                 23.28              32.11         956.89

  141       END               1               3/16             1028.36
             1                 23.28              34.88        1027.50

-------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
-------------------------------------------------------------------

  142       STA               1               3/16              650.66
             1                 19.87              31.05         649.61

  142       END               1               3/16              938.56
             1                 19.87              34.80         937.71
```

```
                      STAAD-III WELD DESIGN
                      *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/     WELD TYPE/      WELD SIZE/       COMB STRESS/
         LOADING       HOR STRESS     VERT STRESS        DIR STRESS
====================================================================

--------------------------------------------------------------------
AX=   8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
--------------------------------------------------------------------

  143       STA            1             3/16               650.66
             1              19.87           31.05           649.61

  143       END            1             3/16               938.56
             1              19.87           34.80           937.71

--------------------------------------------------------------------
AX=   8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
--------------------------------------------------------------------

  144       STA            1             3/16              1326.66
             1              48.32           44.48          1325.04

  144       END            1             3/16               575.75
             1              48.32           44.48           571.99

--------------------------------------------------------------------
AX=   8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
--------------------------------------------------------------------

  145       STA            1             3/16              1326.66
             1              48.32           44.48          1325.04

  145       END            1             3/16               575.75
             1              48.32           44.48           571.99

--------------------------------------------------------------------
AX=   8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
--------------------------------------------------------------------

  146       STA            1             3/16               566.33
             1               0.00            4.76           566.31

  146       END            1             3/16               359.78
             1               0.00            4.76           359.75

--------------------------------------------------------------------
AX=   8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
--------------------------------------------------------------------

  147       STA            1             3/16              1326.67
             1              48.32           44.48          1325.04
```

```
                         STAAD-III WELD DESIGN
                         *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/     WELD TYPE/      WELD SIZE/       COMB STRESS/
         LOADING       HOR STRESS     VERT STRESS        DIR STRESS
==================================================================

  147      END             1             3/16                575.75
            1              48.32            44.48            571.99

------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
------------------------------------------------------------------

  148      STA             1             3/16               1326.66
            1              48.32            44.48           1325.04

  148      END             1             3/16                575.75
            1              48.32            44.48            571.99

------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
------------------------------------------------------------------

  149      STA             1             3/16                566.33
            1               0.00             4.76            566.31

  149      END             1             3/16                359.78
            1               0.00             4.76            359.74

------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
------------------------------------------------------------------

  150      STA             1             3/16                346.54
            1              55.75            53.92            337.75

  150      END             1             3/16                205.03
            1              55.75            58.59            188.41

------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
------------------------------------------------------------------

  151      STA             1             3/16                346.55
            1              55.75            53.92            337.76

  151      END             1             3/16                205.03
            1              55.75            58.59            188.41

------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
------------------------------------------------------------------
```

```
                         STAAD-III WELD DESIGN
                         *********************

ALL UNITS ARE - INCH POUN

MEMBER    LOCATION/       WELD TYPE/         WELD SIZE/        COMB STRESS/
          LOADING         HOR STRESS       VERT STRESS           DIR STRESS
=======================================================================

  152        STA               1                3/16                196.32
              1                 16.44               17.55           194.85

  152        END               1                3/16                220.34
              1                 16.44               21.90           218.63

---------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
---------------------------------------------------------------------

  153        STA               1                3/16                196.33
              1                 16.44               17.55           194.85

  153        END               1                3/16                220.34
              1                 16.44               21.90           218.63

---------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
---------------------------------------------------------------------

  154        STA               1                3/16                346.54
              1                 55.75               53.92           337.75

  154        END               1                3/16                205.03
              1                 55.75               58.59           188.41

---------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
---------------------------------------------------------------------

  155        STA               1                3/16                346.55
              1                 55.75               53.92           337.76

  155        END               1                3/16                205.03
              1                 55.75               58.59           188.41

---------------------------------------------------------------------
AX=    8.00 SZ=     5.33 SY=     5.33 JW=    10.67 CH=    1.00 CV=    1.00
---------------------------------------------------------------------

  156        STA               1                3/16                196.33
              1                 16.44               17.55           194.85

  156        END               1                3/16                220.34
              1                 16.44               21.90           218.63
```

```
                         STAAD-III WELD DESIGN
                         *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/      WELD TYPE/       WELD SIZE/       COMB STRESS/
         LOADING        HOR STRESS      VERT STRESS        DIR STRESS
======================================================================


-------------------------------------------------------------------
AX=   8.00 SZ=    5.33 SY=    5.33 JW=   10.67 CH=   1.00 CV=   1.00
-------------------------------------------------------------------

  157      STA              1              3/16              196.33
            1                16.44            17.55          194.85

  157      END              1              3/16              220.34
            1                16.44            21.90          218.64

-------------------------------------------------------------------
AX=   8.00 SZ=    5.33 SY=    5.33 JW=   10.67 CH=   1.00 CV=   1.00
-------------------------------------------------------------------


****************** END OF TABULATED WELD DESIGN *****************

110. STEEL TAKE OFF
```

```
STEEL TAKE-OFF
--------------

PROFILE                 LENGTH(INCH)       WEIGHT(POUN)

ST   TUB 60303             1338.00           1188.974
ST   TUB 30203              302.00            140.164
ST   TUB 20203             2668.99            959.262
ST   TUB 35353              360.00            243.493
                                        ----------------
                                 TOTAL =     2531.89

 TOTAL VOLUME OF PRISMATIC SECTIONS =       329.78 CUBIC INCH

************ END OF DATA FROM INTERNAL STORAGE ************

111. FINISH

          *************** END OF STAAD-III ***************

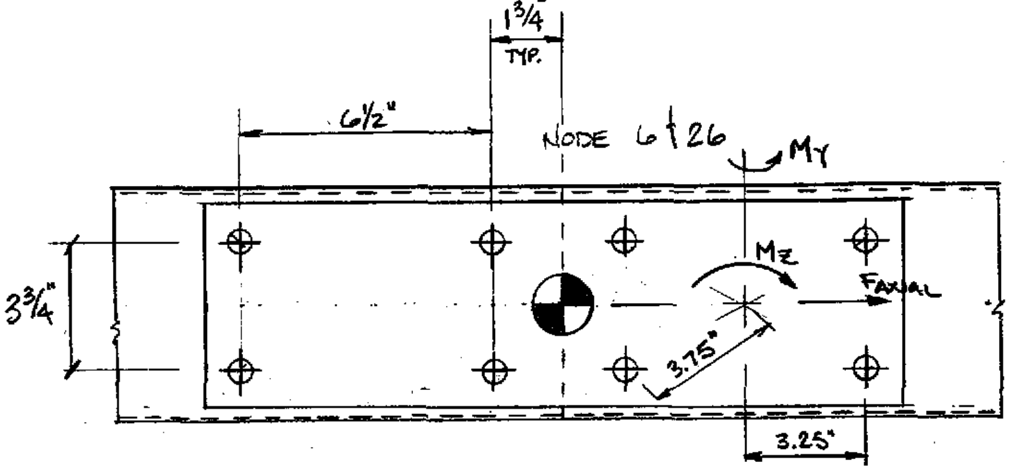
            **** DATE= SEP 25,1996   TIME=  8:38:38 ****

     ************************************************************
     *         For questions on  STAAD-III,   contact:          *
     *               Research Engineers, Inc at                 *
     *        Ph: (714) 974-2500   Fax:  (714) 921-2543         *
     ************************************************************
```

THRU BOLTED

MOMENT CONNECTION

@ TS 6x3x3/16 (2 PCS)



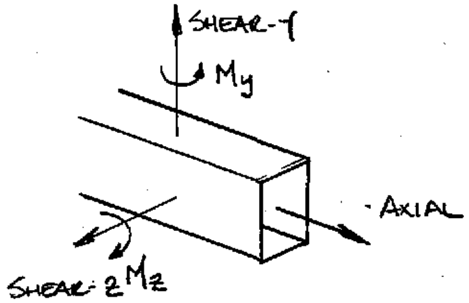
MEMBER 5 JT 6 (BSCLNRM 3)

AXIAL	833. lbs.	TORSION	0.
SHEAR-Y	0.	MOM-Y	258 in-lbs.
SHEAR-Z	0.	MOM-Z	4915 in-lbs.

BOLTS 1/2"φ HEX HEAD (A-307)
$A_K = .126 in^2$ $A_{TENS.} = .142 in^2$

$F_V = 0.17 F_U$
$F_U = 58$ KSI $\therefore F_V = .17(58 KSI)$
$= 9.86$ KSI
$V_{ALL} = 9.86 KSI (.126 in^2)$
$= 1.242 K \approx 1242$ lbs/BOLT
(SINGLE SHEAR)

$F_t = .33 F_U = 19.14$ KSI
$T_{ALL} = 19.14 KSI (.142 in^2) = 2718$ lbs/BOLT



CONSERVATIVELY; (ASSUMING SINGLE SHEAR)

SHEAR FORCE PER BOLT

$$V = \overset{AXIAL}{\frac{833 \text{ lbs}}{4 \text{ BOLTS}}} + \overset{MZ}{\frac{4915 \text{ lbs-in}}{4 \text{ BOLTS } (3.75 \text{ in})}} = 536 \text{ lbs/BOLT (DOUBLE SHEAR)}$$

$$= 268 \text{ lbs/BOLT (SINGLE SHEAR)}$$

TENSION FORCE PER BOLT

$$T = \overset{MY}{\frac{258 \text{ in-lbs}}{2 \text{ BOLTS } (3.25 \text{ in})}} = 40 \text{ lbs/BOLT}$$

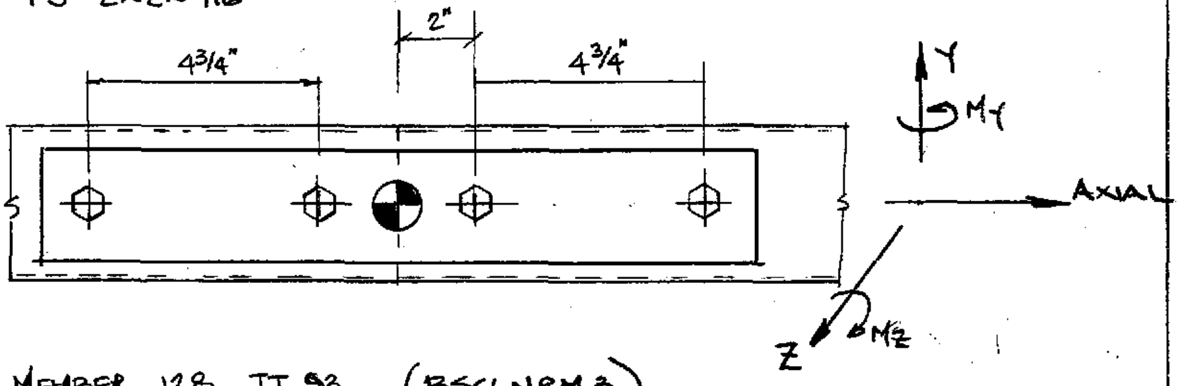
USE: 1/2"φ A-307 HEX HEAD

THRU-BOLTED

MOMENT CONNECTIONS (CON'T)

AT JTS 93 & 83

@ TS 2x2x3/16



MEMBER 128 JT 93 (BSCLNRM3)

AXIAL = 857. lbs. TORSION = 0.
SHEAR-Y = 0. M_y = 571. IN-lbs.
SHEAR-Z = 0. M_z = 117. IN-lbs.

BOLTS 3/8" φ

$A_K = .068 \text{ in}^2$ $A_{TENSILE} = .078 \text{ in}^2$

$F_V = 0.17 F_U = .17(58 \text{ KSI}) = 9.86 \text{ KSI}$

$V_{ALL} = 9.86 \text{ KSI}(.068 \text{ in}^2) = 670 \text{ lbs/BOLT}$ (SINGLE SHEAR)

$F_t = .33 F_U = .33(58 \text{ KSI}) = 19.14 \text{ KSI}$

$T_{ALL} = 19.14 \text{ KSI}(.078 \text{ in}^2) = 1493. \text{ lbs/BOLT}$

CONSERVATIVELY;

SHEAR FORCE PER BOLT

$$V = \frac{857 \text{ lbs}}{2 \text{ BOLTS}} + \frac{117 \text{ in-lbs}}{2 \text{ BOLTS}(2 \text{ in})} = 457.75 \text{ lbs/BOLT}$$

TENSION FORCE PER BOLT

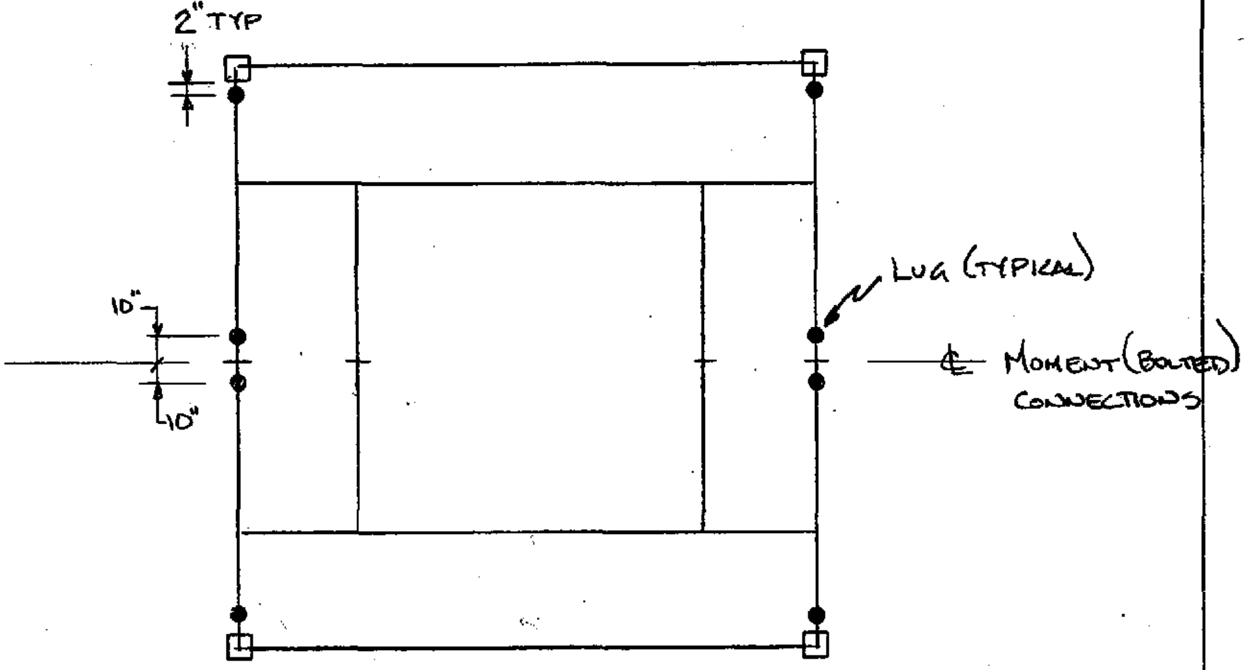
$$T = \frac{571 \text{ in-lbs}}{2 \text{ BOLTS}(2 \text{ in})} = 142.75 \text{ \#/BOLT}$$

THE ABOVE SHEAR & TENSION ASSUMES single shear ACTUAL SHEAR IS DOUBLE (i.e. half), therefore quite conservative, additionally only two bolts are assumed to take all the shear & Tension when in fact there are 4 bolts.

USE: 3/8" φ A-307 BOLTS

LIFTING LUG

LOCATION OF LIFTING LUGS

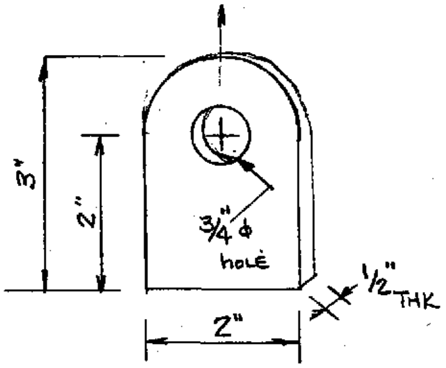


ASSUME WGHT OF STRUCTURE + EQUIPMENT MOUNTED
(AIR CIRCULATORS + PUMPS)

= 8000 lbs.

NOTE: CRANE IS A 5 TON CAPACITY CRANE

$$\frac{8000 \text{ lbs}}{8 \text{ LUGS}} = 1000 \text{ lbs/LUG}$$



$$\text{SHEAR} = \frac{P}{A} = \frac{1000 \text{ lbs}}{(5/8")(1/2")} = 3200 \text{ lb/in}^2$$

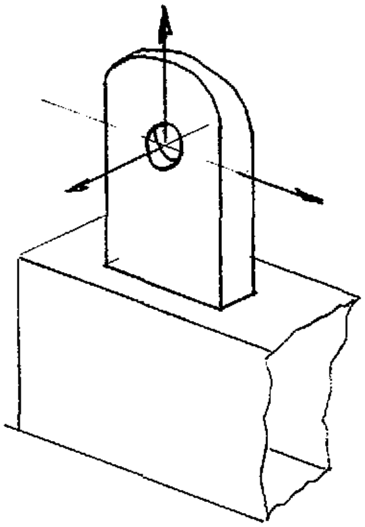
$$F_{V_{ALL}} = .4(36000\#/\text{in}^2) = 14400 \text{ lb/in}^2$$

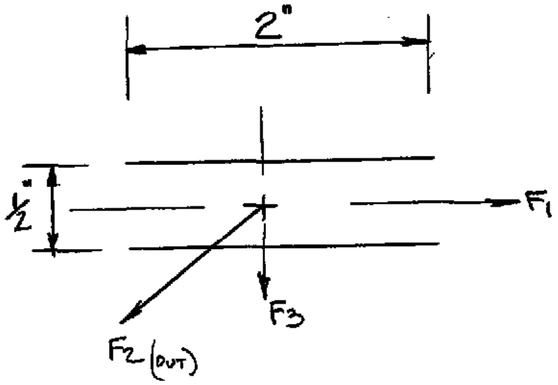
$$3200\#/\text{in}^2 < 14400\#/\text{in}^2$$

filename: BSC CLEAN RM

HORIZONTAL FILLET WELDS PARALLEL TO F1 AXIS

Between part LIFTING LUG AND TS 6X3





LOAD INPUT (LBS., INCH-LBS.)

F1	F2	F3	M1	M2	M3
	1000.00				

GEOMETRIC DIMENSIONS

a	b	WELD STRESS (PSI)
0.500	3.000	21000

SECTION PROPERTIES

A	Sw1	Sw3	J	C1	C3
6.000	1.500	3.000	4.875	0.250	1.500

MAXIMUM WELD LOAD (f) - #/INCH

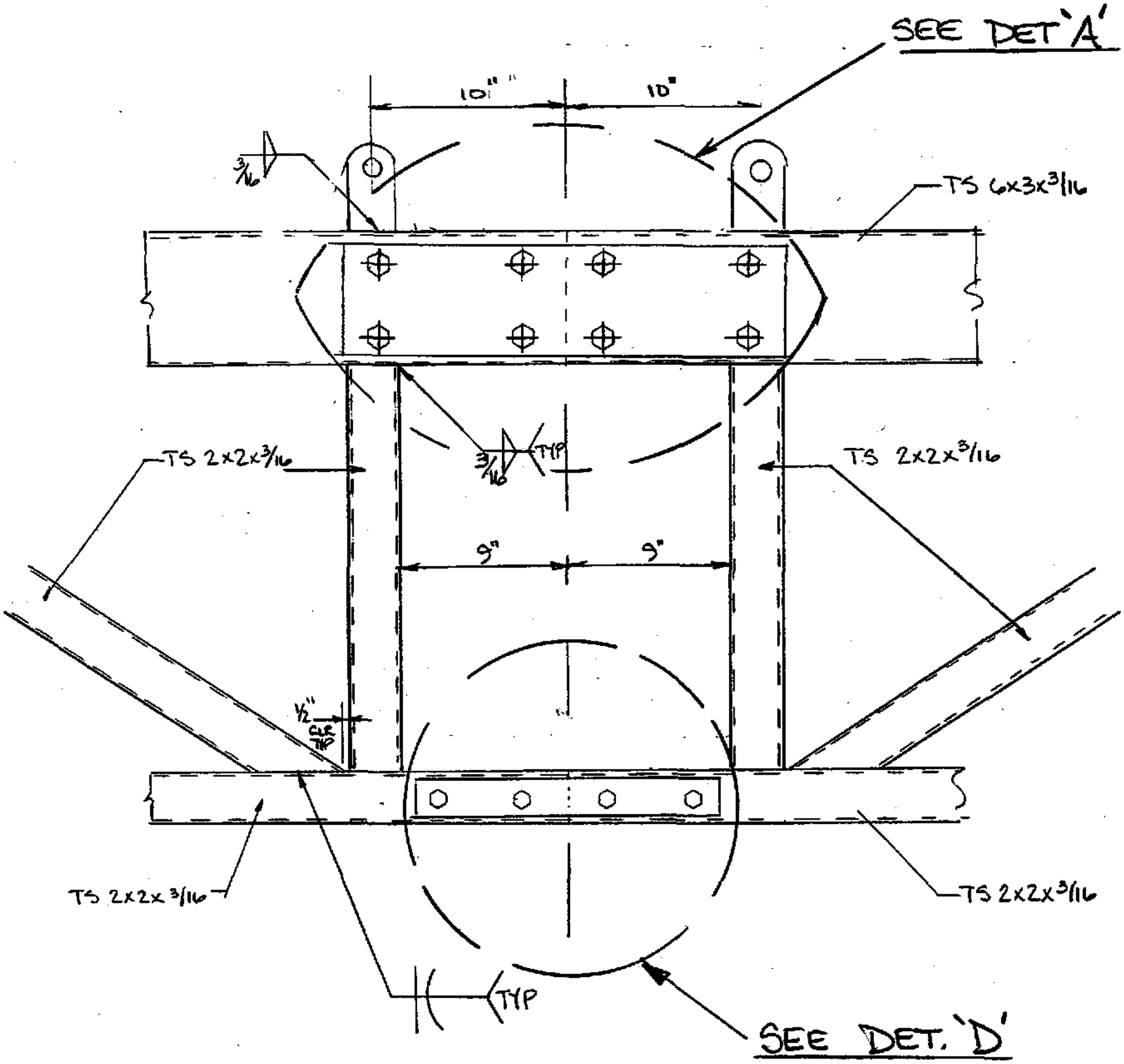
f
167

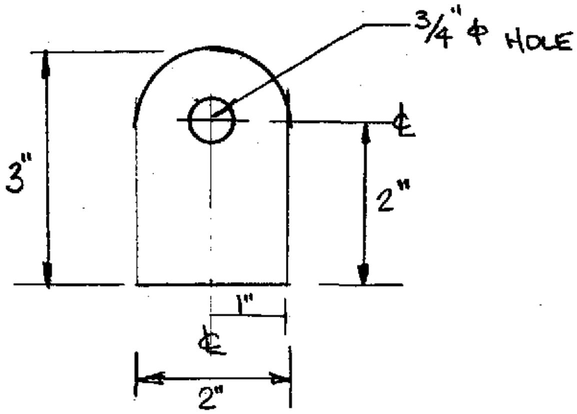
REQUIRED FILLET WELD SIZE (INCHES)

w
0.011

USE 3/16" FILLET 2" LONG (NEAR SIDE/FAR SIDE)

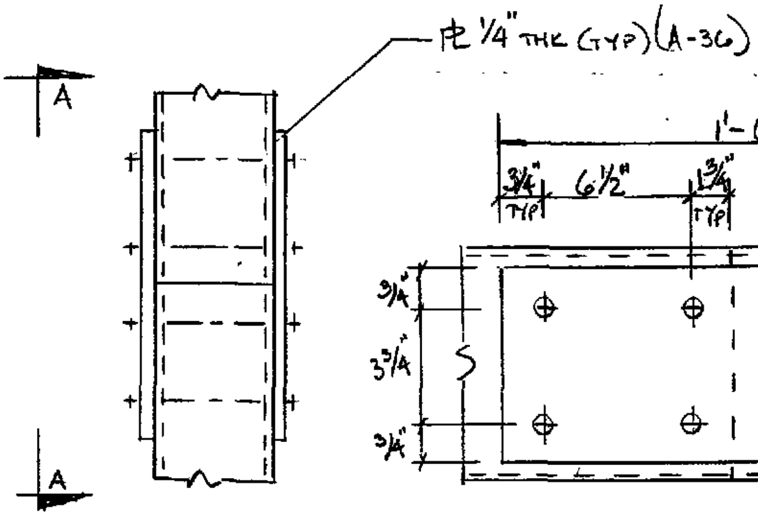
DETAIL DESIGN SKETCH





LIFTING LUG DETAIL

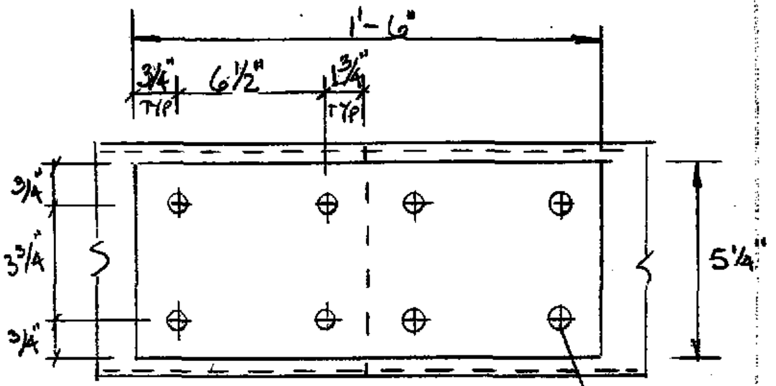
DETAIL DESIGN SKETCH



DET. 'A'

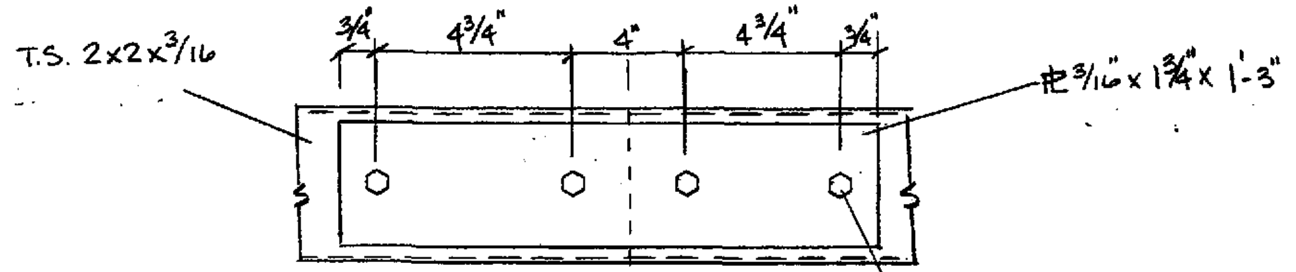
(SPLICE CONNECTION DETAIL)

TYP 2 PLCS.



DET. 'A'

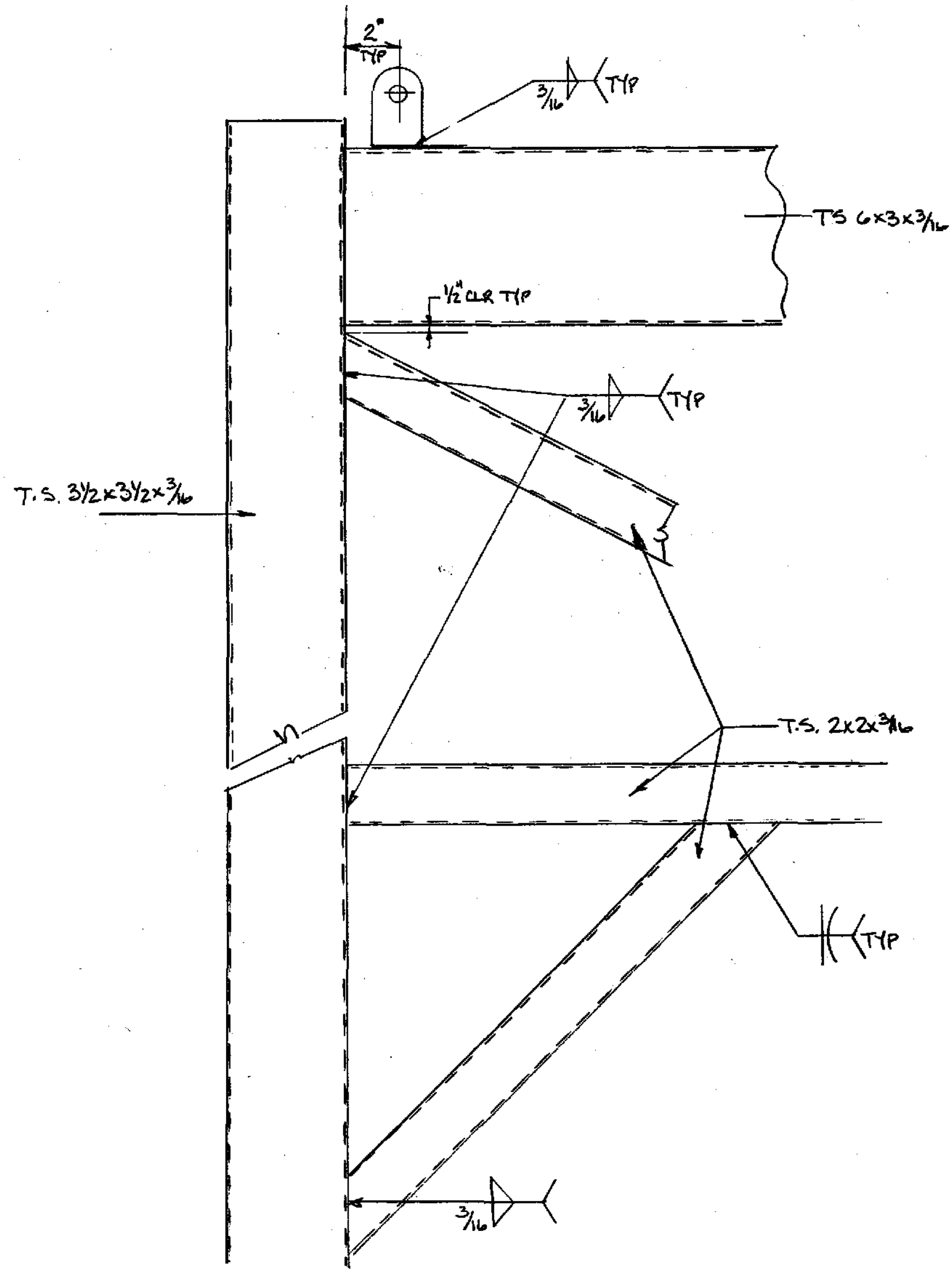
SECTION A-A



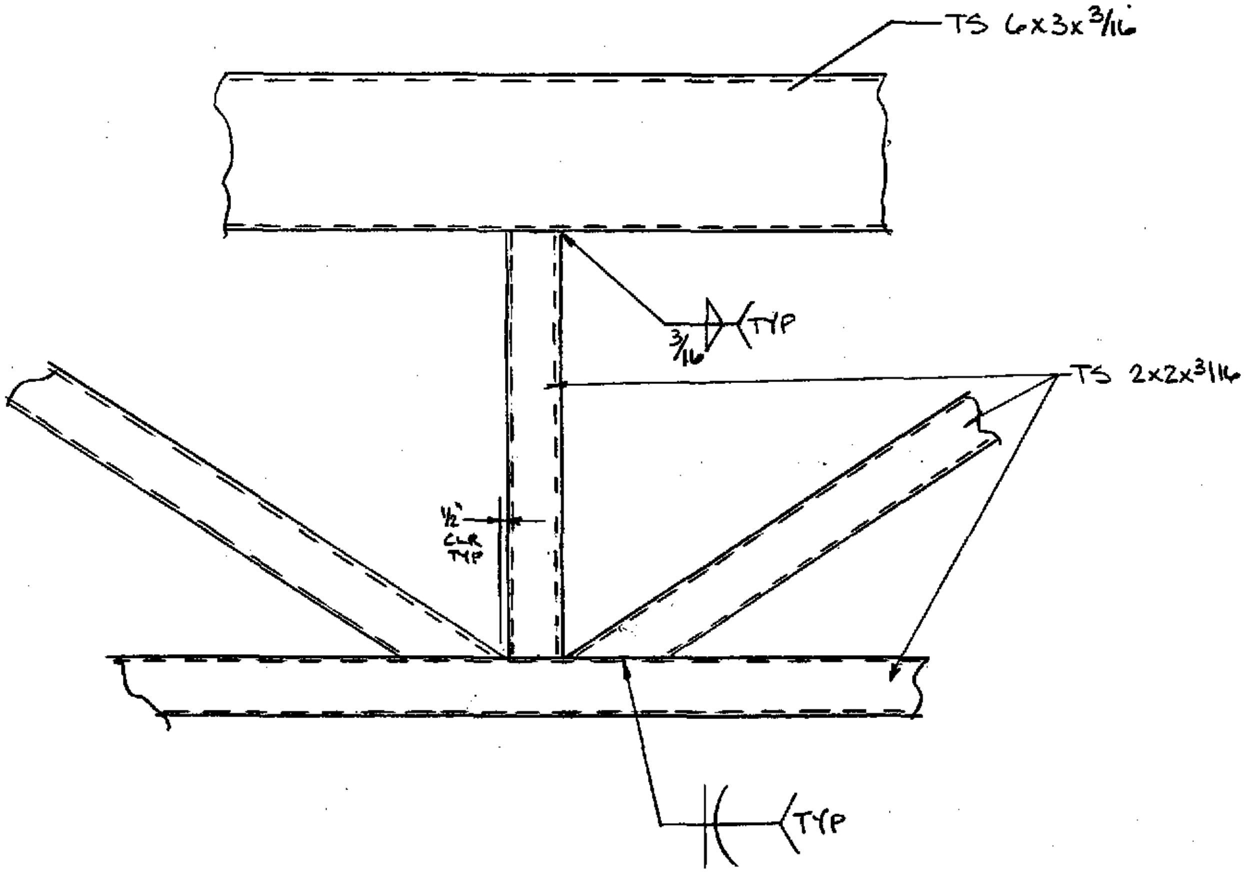
DET. 'D'

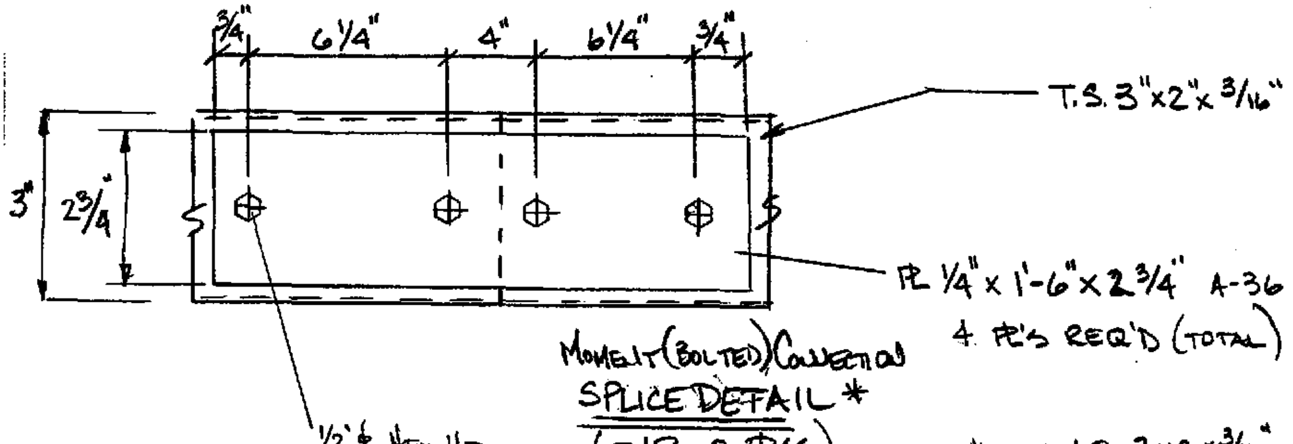
(TYP 2 PLCS)

DETAIL DESIGN SKETCH



DETAIL DESIGN SKETCH

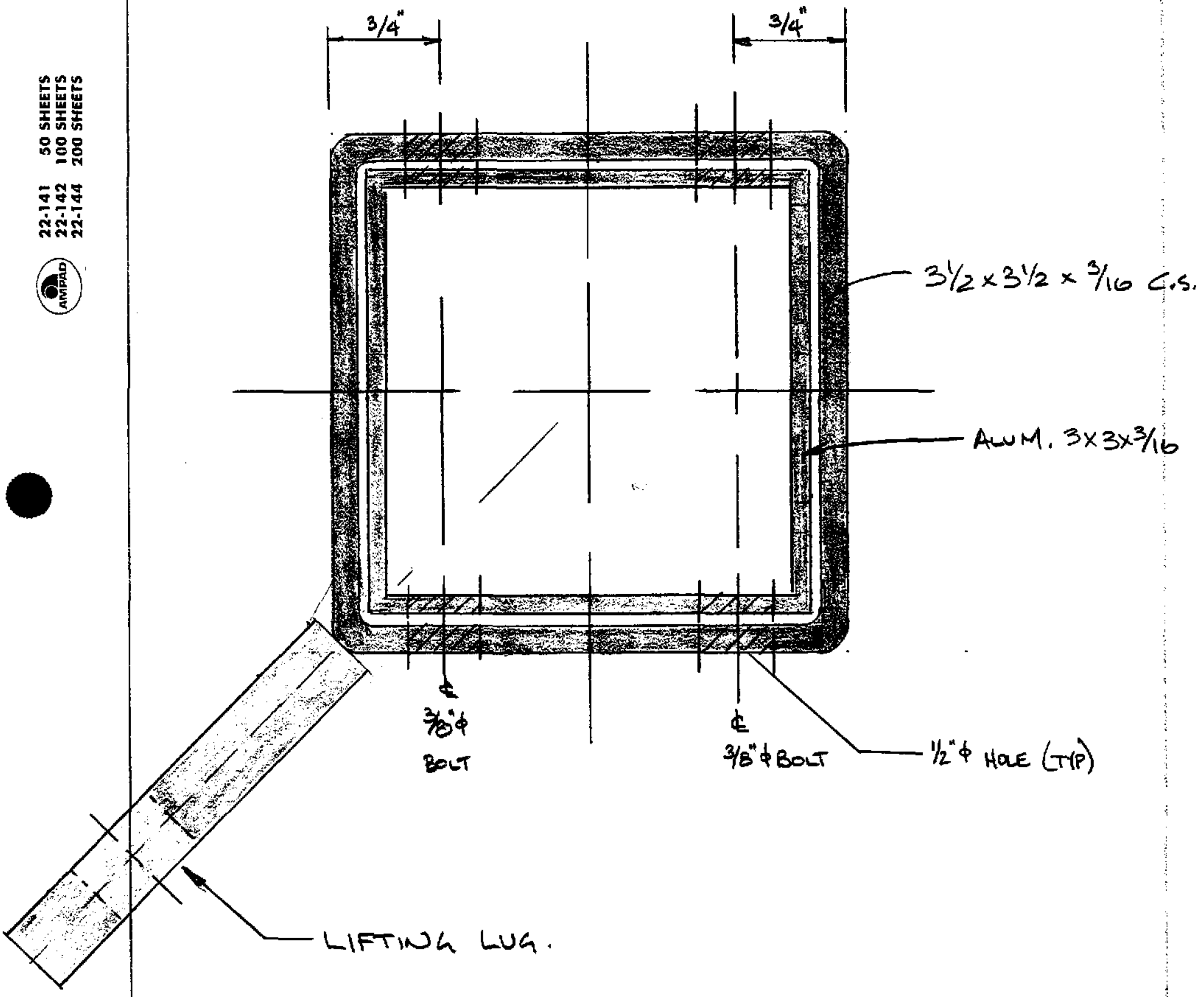




MOMENT (BOLTED) CONNECTION
SPLICE DETAIL *
(TYP 2 PLCS)

* ONLY @ 3x2x3/16" T.S.

DETAIL DESIGN SKETCH



PROCESS SYSTEMS INTERNATIONAL, INC.
WESTBOROUGH, MA

ENGINEERING CALCULATIONS

NO: V049-1-113
PAGE 1 OF 72

REV.	DEO #	DATE	BY:	CHECK
0	349	10.7.96	WDB	RDC

TITLE:

HAM Portable Clean Room

BY: W. Bilynsky
DEPT.: 744

PROJECT: LIGO Vacuum Equipment

PROJECT NO: V59049

PURPOSE:

Design mobile (portable) Clean Room for the Horizontal Access Module (HAM). The frame design must be able to withstand the installed weight of the air circulators and various pumps and must also be fairly lightweight to allow unconstrained mobility. Additionally, the HAM clean room frame will have adjustable (telescoping) legs for fitup and alignment.

METHOD:

Support frame is designed to AISC standards using classical hand calculations and STAAD-III computer program (release 21).

ASSUMPTIONS:

See calculation

INPUTS:

2. Design load = 10.0 lbs/ft^2
3. Non-standard AISC Structural Members (see calculation)

REFERENCES:

1. STAAD-III , Research Engineers, Release 21
2. AISC - ASD 9th edition
3. Doc. No. V049-1-066 LIGO Vacuum Equipment Structural Design Criteria
4. Aluminum Construction Manual, Section 3, Engineering data for aluminum structures.

CALCULATIONS:

CONCLUSIONS:

The requirements of the AISC Codes and Standards and the Ligo Vacuum Equipment Structural Design Criteria are met.

NOTES: STAAD-III Computer File: HAMCLNRM.*

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Member Properties 4

HAM Clean Room

- STAAD Model 5
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Final Design Drawing 72

REVISION HISTORY

Rev. 0	Original Issue October 7, 1996

DESIGN LOADING CONDITION

2'-0" x 4'-0" PANELS WILL PROVIDE SUPPORT FOR PUMPS, AIR CIRCULATORS, DUCT WORK LIGHTING ETC.

ASSUME 50#/PANEL

$$2'\text{-}0" \times 4'\text{-}0" = 8 \, FT^2$$

$$\frac{50 \text{ lbs}}{8 \, FT^2} = 6.25 \text{ lbs}/FT^2 = 0.043 \frac{\text{lbs}}{IN^2}$$

ASSUME ADDITIONAL WEIGHT OF LIVE LOADS FROM MAINTENANCE OPERATORS. ∴ USE $0.10 \frac{lb}{IN^2}$

> DESIGN LOAD = 10 psf

MEMBER PROPERTIES

- ALL MEMBERS ARE STANDARD AISC STEEL SECTIONS THE EXCEPTIONS ARE THE RETRACTABLE LEGS AND THE TEE SECTIONS WHICH MAKE UP THE PANEL SECTIONS THESE ARE ALUMINUM AND REQUIRE PRISMATIC PROPERTIES FOR PROPER MODELLING.

- ALUMINUM LEGS 3" x 3" x 1/8" REF. ALUMINUM CONSTRUCTION MANUAL

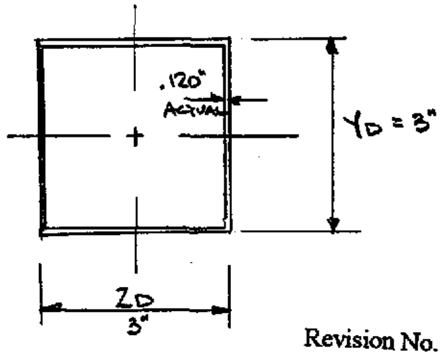
$A_x = 1.382 \text{ in}^2$

$I_Y = 1.914 \text{ in}^4$

$I_Z = 1.914 \text{ in}^4$

$Y_D = 3.0 \text{ in}$

$Z_D = 3.0 \text{ in}.$



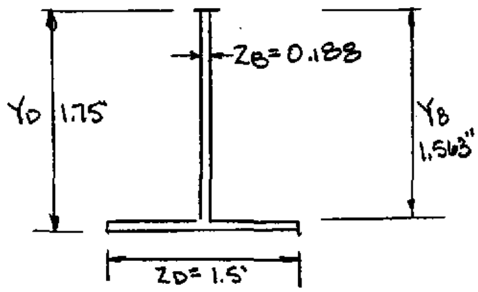
- ALUMINUM TEE

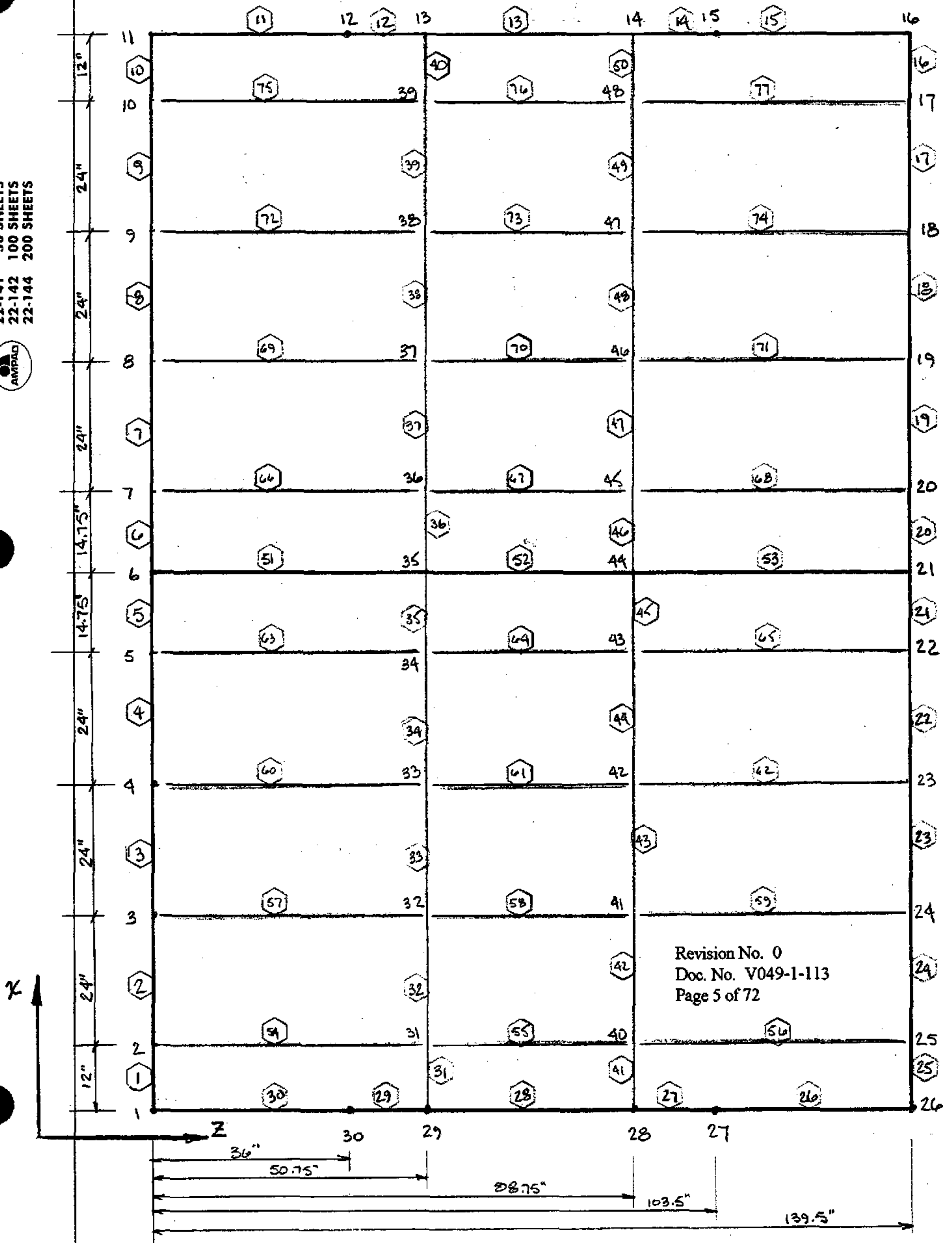
$Y_D = 1.75 \text{ in}$

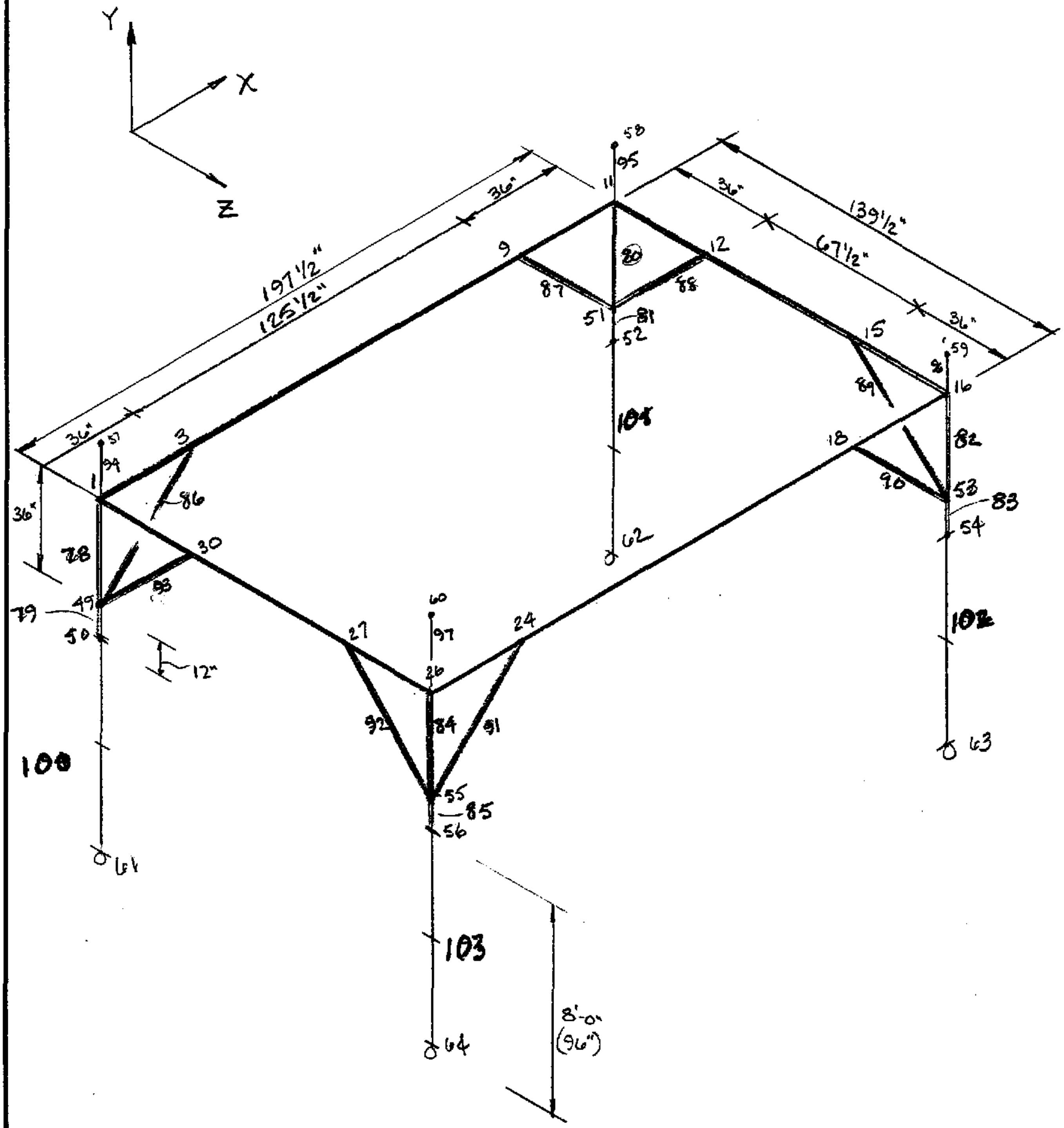
$Z_D = 1.50 \text{ in}$

$Y_B = 1.563 \text{ in}$

$Z_B = 0.188 \text{ in}$




X
Z
11
12
13
14
15
16
10
9
8
7
6
5
4
3
2
1
30
29
28
27
26
17
18
19
20
21
22
23
24
25
12"
24"
24"
24"
14.75"
14.75"
24"
24"
24"
12"
36"
50.75"
88.75"
103.5"
139.5"



REV	BY	DATE	CHECKED	DATE

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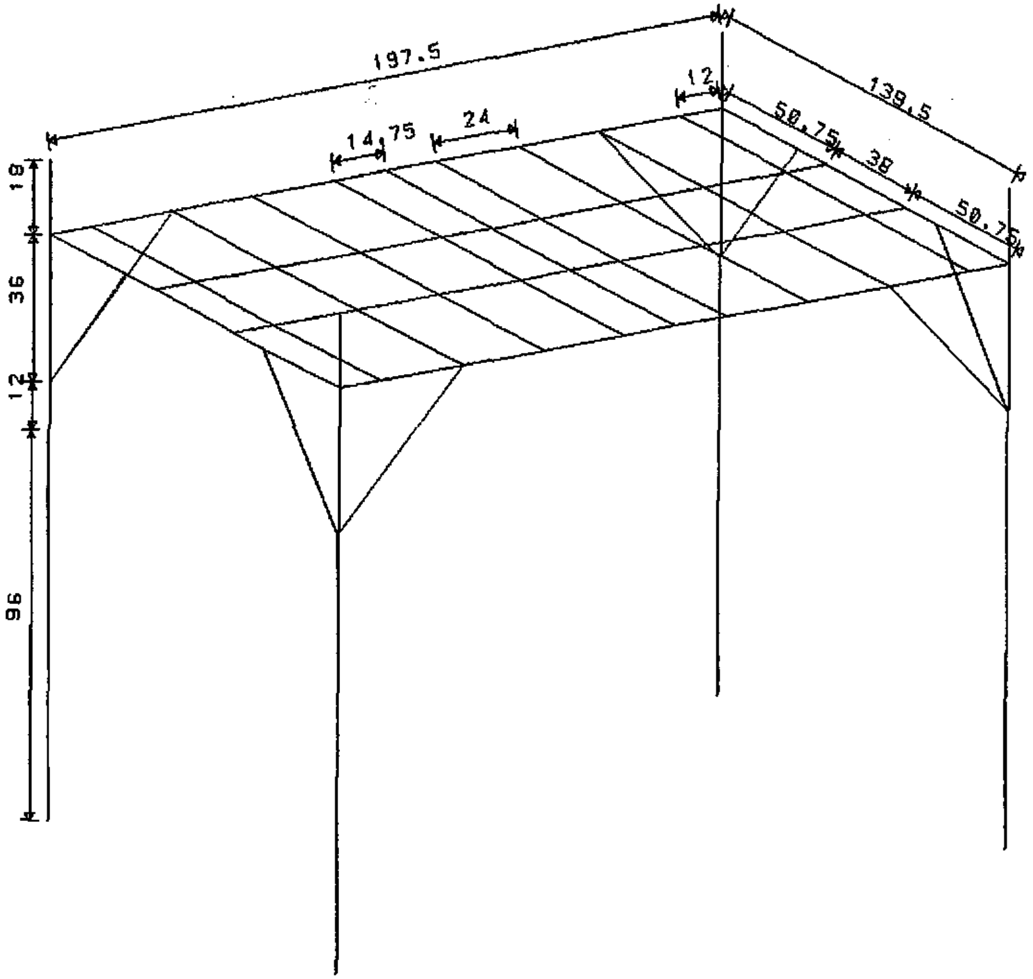
OF

1

MN/ELEM

STRUCTURE DATA

TYPE = SPACE
NJ = 64
NM = 101
NE = 0
NS = 4
NL = 1
XMAX= 197.5
YMAX= 162.0
ZMAX= 139.5



J=64,M=101

UNIT INC POU

USER ID:PROCESS SYSTEMS INTERNATIONAL IN

STAAD POST-PLOT (REV: 21.0)

TITLE: HAM PORTABLE CLEANROOM

DATE: OCT 7, 1996

```
               ****************************************************
               *                                                  *
               *           S T A A D - III                        *
               *           Revision 21.0                          *
               *           Proprietary Program of                 *
               *           Research Engineers, Inc.               *
               *           Date=    OCT  4, 1996                  *
               *           Time=    15:53:41                      *
               *                                                  *
               *      USER ID: PROCESS SYSTEMS INTERNATIONAL IN   *
               ****************************************************

    1. STAAD SPACE HAM PORTABLE CLEANROOM
    2. INPUT WIDTH 72
    3. UNIT INCHES POUND
    4. JOINT COORDINATES
    5. 1 0. 0. 0.; 2 12. 0. 0.; 3 36. 0. 0.; 4 60. 0. 0.; 5 84. 0. 0.
    6. 6 98.75 0. 0.; 7 113.5 0. 0.; 8 137.5 0. 0.; 9 161.5 0. 0.
    7. 10 185.5 0. 0.; 11 197.5 0. 0.; 12 197.5 0. 36.; 13 197.5 0. 50.75
    8. 14 197.5 0. 88.75; 15 197.5 0. 103.5; 16 197.5 0. 139.5
    9. 17 185.5 0. 139.5; 18 161.5 0. 139.5; 19 137.5 0. 139.5
   10. 20 113.5 0. 139.5; 21 98.75 0. 139.5; 22 84. 0. 139.5; 23 60. 0. 139.5
   11. 24 36. 0. 139.5; 25 12. 0. 139.5; 26 0. 0. 139.5; 27 0. 0. 103.5
   12. 28 0. 0. 88.75; 29 0. 0. 50.75; 30 0. 0. 36.; 31 12. 0. 50.75
   13. 32 36. 0. 50.75; 33 60. 0. 50.75; 34 84. 0. 50.75; 35 98.75 0. 50.75
   14. 36 113.5 0. 50.75; 37 137.5 0. 50.75; 38 161.5 0. 50.75
   15. 39 185.5 0. 50.75; 40 12. 0. 88.75; 41 36. 0. 88.75; 42 60. 0. 88.75
   16. 43 84. 0. 88.75; 44 98.75 0. 88.75; 45 113.5 0. 88.75; 46 137.5 0. 88.75
   17. 47 161.5 0. 88.75; 48 185.5 0. 88.75; 49 0. -36. 0.; 50 0. -48. 0.
   18. 51 197.5 -36. 0.; 52 197.5 -48. 0.; 53 197.5 -36. 139.5
   19. 54 197.5 -48. 139.5; 55 0. -36. 139.5; 56 0. -48. 139.5; 57 0. 18. 0.
   20. 58 197.5 18. 0.; 59 197.5 18. 139.5; 60 0. 18. 139.5; 61 0. -144. 0.
   21. 62 197.5 -144. 0.; 63 197.5 -144. 139.5; 64 0. -144. 139.5
   22. MEMBER INCIDENCES
   23. 1 1 2; 2 2 3; 3 3 4; 4 4 5; 5 5 6; 6 6 7; 7 7 8; 8 8 9; 9 9 10; 10 10 11
   24. 11 11 12; 12 12 13; 13 13 14; 14 14 15; 15 15 16; 16 16 17; 17 17 18
   25. 18 18 19; 19 19 20; 20 20 21; 21 21 22; 22 22 23; 23 23 24; 24 24 25
   26. 25 25 26; 26 26 27; 27 27 28; 28 28 29; 29 29 30; 30 30 1; 31 29 31
   27. 32 31 32; 33 32 33; 34 33 34; 35 34 35; 36 35 36; 37 36 37; 38 37 38
   28. 39 38 39; 40 39 13; 41 28 40; 42 40 41; 43 41 42; 44 42 43; 45 43 44
   29. 46 44 45; 47 45 46; 48 46 47; 49 47 48; 50 48 14; 51 6 35; 52 35 44
   30. 53 44 21; 54 2 31; 55 31 40; 56 40 25; 57 3 32; 58 32 41; 59 41 24
   31. 60 4 33; 61 33 42; 62 42 23; 63 5 34; 64 34 43; 65 43 22; 66 7 36
   32. 67 36 45; 68 45 20; 69 8 37; 70 37 46; 71 46 19; 72 9 38; 73 38 47
   33. 74 47 18; 75 10 39; 76 39 48; 77 48 17; 78 1 49; 79 49 50; 80 11 51
   34. 81 51 52; 82 16 53; 83 53 54; 84 26 55; 85 55 56; 86 3 49; 87 9 51
   35. 88 12 51; 89 15 53; 90 18 53; 91 24 55; 92 27 55; 93 30 49; 94 1 57
   36. 95 11 58; 96 16 59; 97 26 60; 100 50 61; 101 52 62; 102 54 63; 103 56 64
   37. MEMBER PROPERTY AMER
   38. 1 TO 30 TABLE ST TUB60303
   39. 31 TO 53 TABLE ST TUB40203
   40. 54 TO 77 PRI YD 1.75 ZD 1.5 YB 1.563 ZB 0.188
   41. ***  ALUMINUM TEES
```

```
   42. 78 TO 85 94 TO 97 TABLE ST TUB35353
   43. 86 TO 93 TABLE ST TUB20203
   44. 100 TO 103 PRI AX 1.382 IY 1.914 IZ 1.914 YD 3. ZD 3.
   45. ***  ALUMINUM TUBE (3" X 3" X 1/8")
   46. CONSTANTS
   47. E STEEL MEMB 1 TO 53 78 TO 97
   48. E ALUMINUM MEMB 54 TO 77 100 TO 103
   49. POISSON STEEL MEMB 1 TO 53 78 TO 97
   50. POISSON ALUMINUM MEMB 54 TO 77 100 TO 103
   51. DENSITY STEEL MEMB 1 TO 53 78 TO 97
   52. DENSITY ALUMINUM MEMB 54 TO 77 100 TO 103
   53. BETA 180. MEMB 54 TO 77
   54. SUPPORTS
   55. 61 FIXED BUT FX MZ
   56. 62 FIXED BUT FX FZ MX MZ
   57. 63 FIXED BUT FX MZ
   58. 64 FIXED BUT FX FZ
   59. LOAD 1
   60. SELFWEIGHT Y -1.
   61. AREA LOAD
   62. 1 TO 77 ALOAD -0.1
   63. PERFORM ANALYSIS


          P R O B L E M   S T A T I S T I C S
          -----------------------------------

    NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =    64/  101/    4
    ORIGINAL/FINAL BAND-WIDTH =    56/     7
    TOTAL PRIMARY LOAD CASES  =     1, TOTAL DEGREES OF FREEDOM =   370
    SIZE OF STIFFNESS MATRIX =   17760 DOUBLE PREC. WORDS
    REQRD/AVAIL. DISK SPACE =  12.24/  943.7 MB,  EXMEM = 14.83 MB

 ++ PROCESSING ELEMENT STIFFNESS MATRIX.              15:53:43
 ++ PROCESSING GLOBAL STIFFNESS MATRIX.               15:53:43
 ++ PROCESSING TRIANGULAR FACTORIZATION.              15:53:44

  ***WARNING - IMPROPER LOAD WILL CAUSE INSTABILITY AT JOINT   63   *
    DIRECTION = FX  PROBABLE CAUSE MODELING PROBLEM    0.622E-11
 ++ CALCULATING JOINT DISPLACEMENTS.                  15:53:44
 ++ CALCULATING MEMBER  FORCES.                       15:53:44


   64. PRINT MATERIAL PROPERTIES ALL
```

* Program recovered from instability

```
MATERIAL PROPERTIES.
--------------------
ALL UNITS ARE - POUN INCH

MEMBER           E             G              DEN          ALPHA

    1       29000000.0    11153846.0     0.28299999   0.00000000
    2       29000000.0    11153846.0     0.28299999   0.00000000
    3       29000000.0    11153846.0     0.28299999   0.00000000
    4       29000000.0    11153846.0     0.28299999   0.00000000
    5       29000000.0    11153846.0     0.28299999   0.00000000
    6       29000000.0    11153846.0     0.28299999   0.00000000
    7       29000000.0    11153846.0     0.28299999   0.00000000
    8       29000000.0    11153846.0     0.28299999   0.00000000
    9       29000000.0    11153846.0     0.28299999   0.00000000
   10       29000000.0    11153846.0     0.28299999   0.00000000
   11       29000000.0    11153846.0     0.28299999   0.00000000
   12       29000000.0    11153846.0     0.28299999   0.00000000
   13       29000000.0    11153846.0     0.28299999   0.00000000
   14       29000000.0    11153846.0     0.28299999   0.00000000
   15       29000000.0    11153846.0     0.28299999   0.00000000
   16       29000000.0    11153846.0     0.28299999   0.00000000
   17       29000000.0    11153846.0     0.28299999   0.00000000
   18       29000000.0    11153846.0     0.28299999   0.00000000
   19       29000000.0    11153846.0     0.28299999   0.00000000
   20       29000000.0    11153846.0     0.28299999   0.00000000
   21       29000000.0    11153846.0     0.28299999   0.00000000
   22       29000000.0    11153846.0     0.28299999   0.00000000
   23       29000000.0    11153846.0     0.28299999   0.00000000
   24       29000000.0    11153846.0     0.28299999   0.00000000
   25       29000000.0    11153846.0     0.28299999   0.00000000
   26       29000000.0    11153846.0     0.28299999   0.00000000
   27       29000000.0    11153846.0     0.28299999   0.00000000
   28       29000000.0    11153846.0     0.28299999   0.00000000
   29       29000000.0    11153846.0     0.28299999   0.00000000
   30       29000000.0    11153846.0     0.28299999   0.00000000
   31       29000000.0    11153846.0     0.28299999   0.00000000
   32       29000000.0    11153846.0     0.28299999   0.00000000
   33       29000000.0    11153846.0     0.28299999   0.00000000
   34       29000000.0    11153846.0     0.28299999   0.00000000
   35       29000000.0    11153846.0     0.28299999   0.00000000
   36       29000000.0    11153846.0     0.28299999   0.00000000
   37       29000000.0    11153846.0     0.28299999   0.00000000
   38       29000000.0    11153846.0     0.28299999   0.00000000
   39       29000000.0    11153846.0     0.28299999   0.00000000
   40       29000000.0    11153846.0     0.28299999   0.00000000
   41       29000000.0    11153846.0     0.28299999   0.00000000
   42       29000000.0    11153846.0     0.28299999   0.00000000
   43       29000000.0    11153846.0     0.28299999   0.00000000
   44       29000000.0    11153846.0     0.28299999   0.00000000
   45       29000000.0    11153846.0     0.28299999   0.00000000
   46       29000000.0    11153846.0     0.28299999   0.00000000
```

```
MATERIAL PROPERTIES.
--------------------
ALL UNITS ARE - POUN INCH

MEMBER          E             G            DEN          ALPHA

  47      29000000.0    11153846.0    0.28299999   0.00000000
  48      29000000.0    11153846.0    0.28299999   0.00000000
  49      29000000.0    11153846.0    0.28299999   0.00000000
  50      29000000.0    11153846.0    0.28299999   0.00000000
  51      29000000.0    11153846.0    0.28299999   0.00000000
  52      29000000.0    11153846.0    0.28299999   0.00000000
  53      29000000.0    11153846.0    0.28299999   0.00000000
  54       9999999.0     3999999.8    0.09548600   0.00000000
  55       9999999.0     3999999.8    0.09548600   0.00000000
  56       9999999.0     3999999.8    0.09548600   0.00000000
  57       9999999.0     3999999.8    0.09548600   0.00000000
  58       9999999.0     3999999.8    0.09548600   0.00000000
  59       9999999.0     3999999.8    0.09548600   0.00000000
  60       9999999.0     3999999.8    0.09548600   0.00000000
  61       9999999.0     3999999.8    0.09548600   0.00000000
  62       9999999.0     3999999.8    0.09548600   0.00000000
  63       9999999.0     3999999.8    0.09548600   0.00000000
  64       9999999.0     3999999.8    0.09548600   0.00000000
  65       9999999.0     3999999.8    0.09548600   0.00000000
  66       9999999.0     3999999.8    0.09548600   0.00000000
  67       9999999.0     3999999.8    0.09548600   0.00000000
  68       9999999.0     3999999.8    0.09548600   0.00000000
  69       9999999.0     3999999.8    0.09548600   0.00000000
  70       9999999.0     3999999.8    0.09548600   0.00000000
  71       9999999.0     3999999.8    0.09548600   0.00000000
  72       9999999.0     3999999.8    0.09548600   0.00000000
  73       9999999.0     3999999.8    0.09548600   0.00000000
  74       9999999.0     3999999.8    0.09548600   0.00000000
  75       9999999.0     3999999.8    0.09548600   0.00000000
  76       9999999.0     3999999.8    0.09548600   0.00000000
  77       9999999.0     3999999.8    0.09548600   0.00000000
  78      29000000.0    11153846.0    0.28299999   0.00000000
  79      29000000.0    11153846.0    0.28299999   0.00000000
  80      29000000.0    11153846.0    0.28299999   0.00000000
  81      29000000.0    11153846.0    0.28299999   0.00000000
  82      29000000.0    11153846.0    0.28299999   0.00000000
  83      29000000.0    11153846.0    0.28299999   0.00000000
  84      29000000.0    11153846.0    0.28299999   0.00000000
  85      29000000.0    11153846.0    0.28299999   0.00000000
  86      29000000.0    11153846.0    0.28299999   0.00000000
  87      29000000.0    11153846.0    0.28299999   0.00000000
  88      29000000.0    11153846.0    0.28299999   0.00000000
  89      29000000.0    11153846.0    0.28299999   0.00000000
  90      29000000.0    11153846.0    0.28299999   0.00000000
  91      29000000.0    11153846.0    0.28299999   0.00000000
  92      29000000.0    11153846.0    0.28299999   0.00000000
```

```
MATERIAL PROPERTIES.
--------------------
ALL UNITS ARE - POUN INCH

MEMBER           E           G          DEN         ALPHA

  93      29000000.0  11153846.0   0.28299999  0.00000000
  94      29000000.0  11153846.0   0.28299999  0.00000000
  95      29000000.0  11153846.0   0.28299999  0.00000000
  96      29000000.0  11153846.0   0.28299999  0.00000000
  97      29000000.0  11153846.0   0.28299999  0.00000000
 100       9999999.0   3999999.8   0.09548600  0.00000000
 101       9999999.0   3999999.8   0.09548600  0.00000000
 102       9999999.0   3999999.8   0.09548600  0.00000000
 103       9999999.0   3999999.8   0.09548600  0.00000000

************ END OF DATA FROM INTERNAL STORAGE ************

 65. PRINT MEMBER INFORMATION ALL
```

MEMBER INFORMATION

MEMBER	START JOINT	END JOINT	LENGTH (INCH)	BETA (DEG)	RELEASES
1	1	2	12.000	0.00	
2	2	3	24.000	0.00	
3	3	4	24.000	0.00	
4	4	5	24.000	0.00	
5	5	6	14.750	0.00	
6	6	7	14.750	0.00	
7	7	8	24.000	0.00	
8	8	9	24.000	0.00	
9	9	10	24.000	0.00	
10	10	11	12.000	0.00	
11	11	12	36.000	0.00	
12	12	13	14.750	0.00	
13	13	14	38.000	0.00	
14	14	15	14.750	0.00	
15	15	16	36.000	0.00	
16	16	17	12.000	0.00	
17	17	18	24.000	0.00	
18	18	19	24.000	0.00	
19	19	20	24.000	0.00	
20	20	21	14.750	0.00	
21	21	22	14.750	0.00	
22	22	23	24.000	0.00	
23	23	24	24.000	0.00	
24	24	25	24.000	0.00	
25	25	26	12.000	0.00	
26	26	27	36.000	0.00	
27	27	28	14.750	0.00	
28	28	29	38.000	0.00	
29	29	30	14.750	0.00	
30	30	1	36.000	0.00	
31	29	31	12.000	0.00	
32	31	32	24.000	0.00	
33	32	33	24.000	0.00	
34	33	34	24.000	0.00	
35	34	35	14.750	0.00	
36	35	36	14.750	0.00	
37	36	37	24.000	0.00	
38	37	38	24.000	0.00	
39	38	39	24.000	0.00	
40	39	13	12.000	0.00	
41	28	40	12.000	0.00	
42	40	41	24.000	0.00	
43	41	42	24.000	0.00	
44	42	43	24.000	0.00	
45	43	44	14.750	0.00	
46	44	45	14.750	0.00	

```
MEMBER INFORMATION
------------------

MEMBER     START    END          LENGTH     BETA
           JOINT    JOINT        (INCH)     (DEG)       RELEASES

  47        45       46          24.000      0.00
  48        46       47          24.000      0.00
  49        47       48          24.000      0.00
  50        48       14          12.000      0.00
  51         6       35          50.750      0.00
  52        35       44          38.000      0.00
  53        44       21          50.750      0.00
  54         2       31          50.750    180.00
  55        31       40          38.000    180.00
  56        40       25          50.750    180.00
  57         3       32          50.750    180.00
  58        32       41          38.000    180.00
  59        41       24          50.750    180.00
  60         4       33          50.750    180.00
  61        33       42          38.000    180.00
  62        42       23          50.750    180.00
  63         5       34          50.750    180.00
  64        34       43          38.000    180.00
  65        43       22          50.750    180.00
  66         7       36          50.750    180.00
  67        36       45          38.000    180.00
  68        45       20          50.750    180.00
  69         8       37          50.750    180.00
  70        37       46          38.000    180.00
  71        46       19          50.750    180.00
  72         9       38          50.750    180.00
  73        38       47          38.000    180.00
  74        47       18          50.750    180.00
  75        10       39          50.750    180.00
  76        39       48          38.000    180.00
  77        48       17          50.750    180.00
  78         1       49          36.000      0.00
  79        49       50          12.000      0.00
  80        11       51          36.000      0.00
  81        51       52          12.000      0.00
  82        16       53          36.000      0.00
  83        53       54          12.000      0.00
  84        26       55          36.000      0.00
  85        55       56          12.000      0.00
  86         3       49          50.912      0.00
  87         9       51          50.912      0.00
  88        12       51          50.912      0.00
  89        15       53          50.912      0.00
  90        18       53          50.912      0.00
  91        24       55          50.912      0.00
  92        27       55          50.912      0.00
```

```
MEMBER INFORMATION
------------------

MEMBER    START   END          LENGTH     BETA
          JOINT   JOINT        (INCH)     (DEG)      RELEASES

  93        30     49          50.912     0.00
  94         1     57          18.000     0.00
  95        11     58          18.000     0.00
  96        16     59          18.000     0.00
  97        26     60          18.000     0.00
 100        50     61          96.000     0.00
 101        52     62          96.000     0.00
 102        54     63          96.000     0.00
 103        56     64          96.000     0.00

************ END OF DATA FROM INTERNAL STORAGE ************

 66. PRINT JOINT COORDINATES ALL
```

```
JOINT COORDINATES
-----------------
COORDINATES ARE INCH UNIT

JOINT              X              Y              Z

   1           0.000          0.000          0.000
   2          12.000          0.000          0.000
   3          36.000          0.000          0.000
   4          60.000          0.000          0.000
   5          84.000          0.000          0.000
   6          98.750          0.000          0.000
   7         113.500          0.000          0.000
   8         137.500          0.000          0.000
   9         161.500          0.000          0.000
  10         185.500          0.000          0.000
  11         197.500          0.000          0.000
  12         197.500          0.000         36.000
  13         197.500          0.000         50.750
  14         197.500          0.000         88.750
  15         197.500          0.000        103.500
  16         197.500          0.000        139.500
  17         185.500          0.000        139.500
  18         161.500          0.000        139.500
  19         137.500          0.000        139.500
  20         113.500          0.000        139.500
  21          98.750          0.000        139.500
  22          84.000          0.000        139.500
  23          60.000          0.000        139.500
  24          36.000          0.000        139.500
  25          12.000          0.000        139.500
  26           0.000          0.000        139.500
  27           0.000          0.000        103.500
  28           0.000          0.000         88.750
  29           0.000          0.000         50.750
  30           0.000          0.000         36.000
  31          12.000          0.000         50.750
  32          36.000          0.000         50.750
  33          60.000          0.000         50.750
  34          84.000          0.000         50.750
  35          98.750          0.000         50.750
  36         113.500          0.000         50.750
  37         137.500          0.000         50.750
  38         161.500          0.000         50.750
  39         185.500          0.000         50.750
  40          12.000          0.000         88.750
  41          36.000          0.000         88.750
  42          60.000          0.000         88.750
  43          84.000          0.000         88.750
  44          98.750          0.000         88.750
  45         113.500          0.000         88.750
  46         137.500          0.000         88.750
  47         161.500          0.000         88.750
```

```
JOINT COORDINATES
-----------------
COORDINATES ARE INCH UNIT

JOINT            X               Y               Z

  48          185.500          0.000          88.750
  49            0.000        -36.000           0.000
  50            0.000        -48.000           0.000
  51          197.500        -36.000           0.000
  52          197.500        -48.000           0.000
  53          197.500        -36.000         139.500
  54          197.500        -48.000         139.500
  55            0.000        -36.000         139.500
  56            0.000        -48.000         139.500
  57            0.000         18.000           0.000
  58          197.500         18.000           0.000
  59          197.500         18.000         139.500
  60            0.000         18.000         139.500
  61            0.000       -144.000           0.000
  62          197.500       -144.000           0.000
  63          197.500       -144.000         139.500
  64            0.000       -144.000         139.500


************ END OF DATA FROM INTERNAL STORAGE ************


 67. PRINT SUPPORT INFORMATION ALL


SUPPORT INFORMATION (1=FIXED, 0=RELEASED)
-------------------
UNITS FOR SPRING CONSTANTS ARE POUN INCH DEGREES

JOINT   FORCE-X/   FORCE-Y/   FORCE-Z/   MOM-X/   MOM-Y/   MOM-Z/
          KFX        KFY        KFZ       KMX      KMY      KMZ

  61       0           1          1         1        1        0
              0.0         0.0        0.0      0.0      0.0      0.0
  62       0           1          0         0        1        0
              0.0         0.0        0.0      0.0      0.0      0.0
  63       0           1          1         1        1        0
              0.0         0.0        0.0      0.0      0.0      0.0
  64       0           1          0         1        1        1
              0.0         0.0        0.0      0.0      0.0      0.0
```

```
************ END OF DATA FROM INTERNAL STORAGE ************

68. PRINT ANALYSIS RESULTS
```

```
 JOINT DISPLACEMENT (INCH RADIANS)    STRUCTURE TYPE = SPACE
 ------------------

JOINT  LOAD   X-TRANS   Y-TRANS   Z-TRANS   X-ROTAN   Y-ROTAN   Z-ROTAN

    1    1   -0.91001  -0.00785   0.16347   0.00254   0.00162  -0.00505
    2    1   -0.91002  -0.06838   0.14397   0.00276   0.00163  -0.00496
    3    1   -0.91005  -0.18074   0.10441   0.00313   0.00168  -0.00425
    4    1   -0.91005  -0.26800   0.06411   0.00352   0.00168  -0.00292
    5    1   -0.91005  -0.31834   0.02388   0.00381   0.00167  -0.00120
    6    1   -0.91005  -0.32740  -0.00074   0.00393   0.00167   0.00000
    7    1   -0.91004  -0.31835  -0.02537   0.00382   0.00167   0.00120
    8    1   -0.91004  -0.26802  -0.06564   0.00355   0.00168   0.00292
    9    1   -0.91004  -0.18073  -0.10563   0.00317   0.00165   0.00425
   10    1   -0.91007  -0.06830  -0.14533   0.00280   0.00164   0.00496
   11    1   -0.91008  -0.00773  -0.16492   0.00257   0.00161   0.00505
   12    1   -0.85187  -0.09178  -0.16496   0.00181   0.00165   0.00565
   13    1   -0.82748  -0.11346  -0.16496   0.00107   0.00165   0.00599
   14    1   -0.76520  -0.11301  -0.16495  -0.00109   0.00163   0.00598
   15    1   -0.74135  -0.09120  -0.16495  -0.00181   0.00161   0.00565
   16    1   -0.68262  -0.00784  -0.16497  -0.00256   0.00162   0.00501
   17    1   -0.68261  -0.06793  -0.14546  -0.00278   0.00163   0.00492
   18    1   -0.68258  -0.17940  -0.10589  -0.00315   0.00168   0.00421
   19    1   -0.68258  -0.26584  -0.06559  -0.00355   0.00168   0.00289
   20    1   -0.68258  -0.31553  -0.02535  -0.00384   0.00167   0.00118
   21    1   -0.68258  -0.32432  -0.00073  -0.00396   0.00167  -0.00001
   22    1   -0.68258  -0.31515   0.02390  -0.00384   0.00167  -0.00120
   23    1   -0.68258  -0.26500   0.06417  -0.00356   0.00168  -0.00290
   24    1   -0.68259  -0.17852   0.10414  -0.00317   0.00165  -0.00420
   25    1   -0.68257  -0.06757   0.14383  -0.00278   0.00164  -0.00490
   26    1   -0.68256  -0.00777   0.16342  -0.00255   0.00161  -0.00500
   27    1   -0.74079  -0.09105   0.16346  -0.00179   0.00166  -0.00562
   28    1   -0.76518  -0.11259   0.16346  -0.00106   0.00165  -0.00597
   29    1   -0.82746  -0.11226   0.16345   0.00108   0.00163  -0.00600
   30    1   -0.85131  -0.09063   0.16345   0.00179   0.00161  -0.00567
   31    1   -0.82746  -0.18551   0.14388   0.00108   0.00164  -0.00610
   32    1   -0.82746  -0.32463   0.10430   0.00116   0.00166  -0.00525
   33    1   -0.82746  -0.43055   0.06413   0.00131   0.00168  -0.00345
   34    1   -0.82746  -0.48743   0.02385   0.00154   0.00167  -0.00128
   35    1   -0.82747  -0.49665  -0.00074   0.00171   0.00165  -0.00001
   36    1   -0.82747  -0.48763  -0.02533   0.00153   0.00168   0.00127
   37    1   -0.82747  -0.43107  -0.06562   0.00131   0.00168   0.00343
   38    1   -0.82747  -0.32545  -0.10571   0.00115   0.00166   0.00524
   39    1   -0.82748  -0.18659  -0.14531   0.00107   0.00164   0.00609
   40    1   -0.76518  -0.18557   0.14382  -0.00107   0.00164  -0.00608
   41    1   -0.76519  -0.32424   0.10423  -0.00117   0.00166  -0.00524
   42    1   -0.76519  -0.42984   0.06414  -0.00134   0.00168  -0.00344
   43    1   -0.76519  -0.48654   0.02386  -0.00158   0.00168  -0.00128
   44    1   -0.76519  -0.49573  -0.00074  -0.00176   0.00165  -0.00001
   45    1   -0.76520  -0.48672  -0.02532  -0.00158   0.00167   0.00126
   46    1   -0.76520  -0.43027  -0.06561  -0.00135   0.00168   0.00343
   47    1   -0.76520  -0.32480  -0.10578  -0.00118   0.00166   0.00524
   48    1   -0.76520  -0.18609  -0.14538  -0.00109   0.00164   0.00609
```

```
 JOINT DISPLACEMENT (INCH RADIANS)    STRUCTURE TYPE = SPACE
 ------------------

JOINT  LOAD   X-TRANS   Y-TRANS   Z-TRANS   X-ROTAN   Y-ROTAN   Z-ROTAN

   49    1   -1.08372  -0.00730   0.08003   0.00217   0.00147  -0.00476
   50    1   -1.14087  -0.00712   0.05463   0.00207   0.00138  -0.00476
   51    1   -0.73623  -0.00717  -0.24979   0.00230   0.00148   0.00475
   52    1   -0.67919  -0.00699  -0.27735   0.00230   0.00139   0.00475
   53    1   -0.51023  -0.00729  -0.08095  -0.00218   0.00147   0.00472
   54    1   -0.45354  -0.00711  -0.05536  -0.00208   0.00138   0.00472
   55    1   -0.85403  -0.00722   0.24747  -0.00224   0.00147  -0.00463
   56    1   -0.90902  -0.00705   0.27414  -0.00220   0.00139  -0.00454
   57    1   -0.81910  -0.00785   0.20918   0.00254   0.00162  -0.00505
   58    1   -1.00105  -0.00773  -0.11860   0.00257   0.00161   0.00505
   59    1   -0.77288  -0.00784  -0.21099  -0.00256   0.00162   0.00501
   60    1   -0.59265  -0.00777   0.11745  -0.00255   0.00161  -0.00500
   61    1   -1.59801   0.00000   0.00000   0.00000   0.00000  -0.00476
   62    1   -0.22285   0.00000  -0.49783   0.00230   0.00000   0.00475
   63    1    0.00000   0.00000   0.00000   0.00000   0.00000   0.00472
   64    1   -1.12686   0.00000   0.37980   0.00000   0.00000   0.00000
```

```
  SUPPORT REACTIONS -UNIT POUN INCH    STRUCTURE TYPE = SPACE
  -----------------

 JOINT  LOAD   FORCE-X   FORCE-Y   FORCE-Z     MOM-X     MOM-Y     MOM Z

   61     1       0.00   1031.83     11.55    141.92   -568.89      0.00
   62     1       0.00   1013.21      0.00      0.00   -572.50      0.00
   63     1       0.00   1030.42    -11.55   -138.88   -568.63      0.00
   64     1       0.00   1020.96      0.00    438.87   -571.42    904.84
```

```
  MEMBER END FORCES    STRUCTURE TYPE = SPACE
  -----------------
  ALL UNITS ARE -- POUN INCH

 MEMBER  LOAD  JT     AXIAL    SHEAR-Y   SHEAR-Z    TORSION      MOM-Y      MOM-Z


      1     1   1    102.52    560.28     -3.74   -2444.31     -79.31     272.76
                2   -102.52   -549.61      3.74    2444.31     124.16    6386.57

      2     1   2    102.21    499.50    -13.70   -2024.74    -124.48   -6387.16
                3   -102.21   -478.17     13.70    2024.74     453.24   18119.21

      3     1   3     -3.48    336.83     -0.01   -2197.78       8.72  -19014.54
                4      3.48   -315.50      0.01    2197.78      -8.58   26842.41

      4     1   4     -3.23    247.02      2.56   -1587.92       5.36  -26842.72
                5      3.23   -225.69     -2.56    1587.92     -66.84   32515.27

      5     1   5     -3.15    169.88     -0.48   -1104.75      63.95  -32515.54
                6      3.15   -156.78      0.48    1104.75     -56.86   34924.72

      6     1   6     -9.05   -156.29      0.90    1014.99     -89.82  -34929.59
                7      9.05    169.40     -0.90   -1014.99      76.56   32527.97

      7     1   7     -9.01   -225.19      5.92    1497.59     -79.54  -32527.80
                8      9.01    246.52     -5.92   -1497.59     -62.47   26867.36

      8     1   8     -8.80   -314.96      8.66    2105.97      59.35  -26867.34
                9      8.80    336.29     -8.66   -2105.97    -267.27   19052.19

      9     1   9     99.05   -478.77     18.06    2059.69    -193.80  -18145.39
               10    -99.05    500.09    -18.06   -2059.69    -239.75    6399.06

     10     1  10     97.55   -550.28     19.82    2479.28     238.76   -6398.76
               11    -97.55    560.95    -19.82   -2479.28    -476.60    -268.63

     11     1  11    102.29    504.33    -18.95   -2209.24     178.92     -37.57
               12   -102.29   -450.74     18.95    2209.24     503.27   17228.99

     12     1  12      0.62    379.49      9.05   -2998.41       2.33  -18078.96
               13     -0.62   -357.53     -9.05    2998.41    -135.86   23514.55

     13     1  13    -10.68     18.18      2.34      13.47      37.00  -23524.60
               14     10.68     38.39     -2.34     -13.47    -125.86   23140.61

     14     1  14    -10.92   -377.44     -2.94    3010.89     162.53  -23116.13
               15     10.92    399.40      2.94   -3010.89    -119.21   17386.94

     15     1  15     43.47   -418.63     17.06    2335.76    -351.06  -16495.53
               16    -43.47    472.23    -17.06   -2335.76    -263.06     460.05
```

```
 MEMBER END FORCES    STRUCTURE TYPE = SPACE
 -----------------
 ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


  16     1    16    103.37    557.67    -3.98  -2460.62    -75.32     223.87
              17   -103.37   -547.01     3.98   2460.62    123.08    6404.18

  17     1    17    103.05    496.86   -13.83  -2040.56   -123.36   -6404.81
              18   -103.05   -475.53    13.83   2040.56    455.22   18073.40

  18     1    18     -2.91    333.55    -0.02  -2217.74     10.23  -18968.12
              19      2.91   -312.22     0.02   2217.74     -9.83   26717.31

  19     1    19     -2.92    243.70     2.53  -1606.22      6.63  -26717.39
              20      2.92   -222.37    -2.53   1606.22    -67.32   32310.16

  20     1    20     -4.20    166.57    -0.54  -1121.46     64.47  -32309.82
              21      4.20   -153.46     0.54   1121.46    -56.54   34670.12

  21     1    21     -8.26   -161.42     0.84   1079.86    -87.71  -34675.22
              22      8.26    174.53    -0.84  -1079.86     75.26   32197.91

  22     1    22     -8.94   -230.38     5.89   1564.91    -78.21  -32197.92
              23      8.94    251.70    -5.89  -1564.91    -63.04   26413.06

  23     1    23     -8.72   -320.27     8.65   2176.85     59.99  -26413.26
              24      8.72    341.60    -8.65  -2176.85   -267.68   18470.63

  24     1    24     69.04   -450.78    17.78   2123.20   -190.78  -17537.01
              25    -69.04    472.10   -17.78  -2123.20   -235.91    6462.45

  25     1    25     68.65   -522.30    19.76   2543.24    235.03   -6461.73
              26    -68.65    532.96   -19.76  -2543.24   -472.15     130.20

  26     1    26     88.35    490.70   -18.37  -2318.73    168.25    -236.10
              27    -88.35   -437.11    18.37   2318.73    493.22   16936.65

  27     1    27      1.31    381.85     8.94  -3127.83      5.28  -17799.41
              28     -1.31   -359.90    -8.94   3127.83   -137.06   23269.86

  28     1    28    -10.57     20.48     2.44    -82.77     35.54  -23307.66
              29     10.57     36.08    -2.44     82.77   -128.19   23011.23

  29     1    29    -10.65   -375.64    -2.93   2940.96    163.12  -23006.02
              30     10.65    397.59     2.93  -2940.96   -119.79   17303.43

  30     1    30     42.98   -416.58    16.60   2279.34   -341.36  -16416.41
               1    -42.98    470.17   -16.60  -2279.34   -256.39     455.05

  31     1    29      5.88    339.58    -0.22     -5.15    -35.04    3023.79
              31     -5.88   -332.72     0.22      5.15     37.69    1009.93
```

```
 MEMBER END FORCES    STRUCTURE TYPE = SPACE
 -----------------
 ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


    32     1   31      5.54    253.47     -0.23   -141.94    -38.02   -1009.34
               32     -5.54   -239.75      0.23    141.94     43.51    6928.03

    33     1   32      5.72    136.34      1.91   -273.65    -48.06   -6927.47
               33     -5.72   -122.62     -1.91    273.65      2.14   10035.15

    34     1   33      5.22     19.95      1.29   -393.74     -8.67  -10034.78
               34     -5.22     -6.23     -1.29    393.74    -22.22   10348.90

    35     1   34      5.11    -76.95      5.60   -513.52     16.28  -10349.03
               35     -5.11     85.39     -5.60    513.52    -98.81    9151.67

    36     1   35      7.09     85.57      5.67    515.17   -101.81   -9147.10
               36     -7.09    -77.14     -5.67   -515.17     18.22   10347.23

    37     1   36      6.66     -6.03      1.82    395.75    -24.30  -10347.33
               37     -6.66     19.75     -1.82   -395.75    -19.38   10037.97

    38     1   37      6.64   -122.46      0.99    276.37     12.99  -10038.14
               38     -6.64    136.18     -0.99   -276.37    -36.72    6934.47

    39     1   38      6.74   -239.65      0.27    145.34     32.91   -6934.87
               39     -6.74    253.37     -0.27   -145.34    -39.46    1018.75

    40     1   39      7.33   -332.49    -11.45     10.01     38.75   -1019.21
               13     -7.33    339.35     11.45    -10.01     98.68   -3011.76

    41     1   28      6.20    339.42    -11.69     37.73    101.42    3045.02
               40     -6.20   -332.56     11.69    -37.73     38.78     986.78

    42     1   40      6.60    253.38      0.26    172.32    -39.39    -986.26
               41     -6.60   -239.66     -0.26   -172.32     33.24    6902.70

    43     1   41      6.26    136.23      0.99    299.75    -36.96   -6902.09
               42     -6.26   -122.51     -0.99   -299.75     13.26   10007.03

    44     1   42      6.73     19.80      1.82    414.89    -19.57  -10006.65
               43     -6.73     -6.08     -1.82   -414.89    -24.08   10317.29

    45     1   43      6.33    -77.09      5.59    531.72     18.06  -10317.12
               44     -6.33     85.52     -5.59   -531.72   -100.55    9117.79

    46     1   44      4.95     85.98      5.52   -525.47    -98.06   -9123.12
               45     -4.95    -77.54     -5.52    525.47     16.58   10329.13

    47     1   45      5.27     -5.63      1.29   -407.52    -22.50  -10329.25
               46     -5.27     19.35     -1.29    407.52     -8.36   10029.40
```

```
 MEMBER END FORCES    STRUCTURE TYPE = SPACE
 -----------------
 ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


    48    1   46      5.41   -122.07     1.92   -289.99      1.84  -10029.66
              47     -5.41    135.79    -1.92    289.99    -47.85    6935.35

    49    1   47      5.42   -239.23    -0.21   -160.37     43.29   -6935.86
              48     -5.42    252.95     0.21    160.37    -38.13    1029.60

    50    1   48      5.63   -332.20    -0.09    -24.39     37.75   -1030.13
              14     -5.63    339.06     0.09     24.39    -36.72   -2997.38

    51    1    6     -1.38    313.13    -5.38      4.91    146.68    2119.76
              35      1.38   -209.27     5.38     -4.91    126.21   11136.15

    52    1   35     -1.45     38.30    -3.92      0.10     74.40  -10107.46
              44      1.45     39.47     3.92     -0.10     74.72   10085.21

    53    1   44     -1.38   -211.00    -5.28      5.42    123.90  -11142.45
              21      1.38    314.87     5.28     -5.42    144.26   -2201.33

    54    1    2      9.96    -50.14     0.02      0.57     -0.34    -419.57
              31     -9.96    -43.99    -0.02     -0.57     -0.48     263.51

    55    1   31      9.98    -35.24    -0.01     -0.01      0.15    -126.71
              40     -9.98    -35.24     0.01      0.01      0.12     126.68

    56    1   40     -1.96    -43.94     0.03     -0.59     -0.73    -261.27
              25      1.96    -50.20    -0.03      0.59     -0.86     420.04

    57    1    3     12.44    -67.77     0.11      0.50     -2.95    -599.68
              32    -12.44    -56.82    -0.11     -0.50     -2.59     321.75

    58    1   32     10.30    -46.60     0.10     -0.01     -1.96    -190.05
              41    -10.30    -46.69    -0.10      0.01     -1.90     191.77

    59    1   41      9.56    -56.75     0.07     -0.51     -1.81    -319.19
              24     -9.56    -67.83    -0.07      0.51     -1.53     600.43

    60    1    4     -2.56    -68.49     0.13      0.26     -3.22    -609.86
              33      2.56    -56.09    -0.13     -0.26     -3.23     295.28

    61    1   33     -1.94    -46.58     0.17     -0.01     -3.30    -175.19
              42      1.94    -46.70    -0.17      0.01     -3.25     177.49

    62    1   42     -2.77    -56.00     0.12     -0.27     -3.07    -292.63
              23      2.77    -68.58    -0.12      0.27     -3.05     611.95

    63    1    5      3.04    -55.76     0.11      0.04     -2.88    -483.17
              34     -3.04    -45.35    -0.11     -0.04     -2.93     219.12
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 MEMBER END FORCES    STRUCTURE TYPE = SPACE
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 ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


    64    1   34     -1.27    -37.81     0.16      0.00     -3.02     -99.34
              43      1.27    -37.90    -0.16      0.00     -3.05     100.94

    65    1   43     -5.04    -45.29     0.12     -0.04     -2.97    -217.77
              22      5.04    -55.82    -0.12      0.04     -2.96     485.05

    66    1    7     -5.02    -55.75     0.12     -0.03     -3.00    -482.58
              36      5.02    -45.36    -0.12      0.03     -3.02     219.00

    67    1   36     -1.17    -37.83     0.16      0.00     -3.05     -99.57
              45      1.17    -37.88    -0.16      0.00     -3.03     100.56

    68    1   45      3.06    -45.31     0.11      0.04     -2.89    -218.52
              20     -3.06    -55.80    -0.11     -0.04     -2.84     484.75

    69    1    8     -2.74    -68.47     0.12     -0.26     -3.11    -608.39
              37      2.74    -56.11    -0.12      0.26     -3.13     294.87

    70    1   37     -1.91    -46.61     0.17      0.00     -3.27    -175.50
              46      1.91    -46.68    -0.17      0.00     -3.32     176.77

    71    1   46     -2.55    -56.04     0.13      0.27     -3.21    -294.30
              19      2.55    -68.54    -0.13     -0.27     -3.20     611.52

    72    1    9      9.67    -67.74     0.07     -0.49     -1.60    -597.39
              38     -9.67    -56.84    -0.07      0.49     -1.88     320.94

    73    1   38     10.38    -46.61     0.10      0.00     -1.93    -189.91
              47    -10.38    -46.67    -0.10      0.00     -1.99     191.13

    74    1   47     12.52    -56.77     0.11      0.51     -2.57    -320.75
              18    -12.52    -67.81    -0.11     -0.51     -2.94     600.98

    75    1   10     -1.74    -50.20     0.03     -0.56     -0.92    -419.58
              39      1.74    -43.94    -0.03      0.56     -0.79     260.69

    76    1   39      9.99    -35.20    -0.01      0.00      0.08    -125.36
              48     -9.99    -35.28     0.01      0.00      0.11     126.82

    77    1   48      9.86    -43.97     0.02      0.58     -0.47    -262.80
              17     -9.86    -50.17    -0.02     -0.58     -0.32     420.07

    78    1    1   1042.63    -86.30   -39.23   -335.66   1989.25   -2552.52
              49  -1066.98     86.30    39.23    335.66   -576.81    -554.24

    79    1   49   1011.06     -0.05   -11.55   -568.89   1105.66      -0.58
              50  -1019.18      0.05    11.55    568.89   -967.09      -0.57
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 MEMBER END FORCES    STRUCTURE TYPE = SPACE
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 ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT     AXIAL    SHEAR-Y   SHEAR-Z    TORSION      MOM-Y      MOM-Z


   80    1    11   1077.46     79.88    -82.50    -297.62    2441.70    2477.90
              51  -1101.81    -79.88     82.50     297.62     528.34     397.85

   81    1    51    992.40     -0.01      0.00    -572.50      -0.01      -0.10
              52  -1000.51      0.01      0.00     572.50      -0.02      -0.01

   82    1    16   1042.09     86.44     39.50    -338.48   -2000.56    2559.78
              53  -1066.44    -86.44    -39.50     338.48     578.40     552.04

   83    1    53   1009.63     -0.05     11.55    -568.63   -1108.71      -0.30
              54  -1017.74      0.05    -11.55     568.63     970.07      -0.36

   84    1    26   1035.85    -50.45     68.44    -303.85   -2307.26   -2188.68
              55  -1060.20     50.45    -68.44     303.85    -156.74     372.46

   85    1    55   1000.19      0.03     -0.01    -571.42    -438.80    -904.38
              56  -1008.30     -0.03      0.01     571.42     438.91     904.94

   86    1     3   -126.90    -22.82     26.14    -217.66    -875.14    -894.81
              49    113.97     35.76    -26.14     217.66    -455.52    -596.36

   87    1     9   -129.08    -23.44    -19.07     130.27     780.03    -906.36
              51    116.14     36.38     19.07    -130.27     190.88    -616.26

   88    1    12   -122.20    -21.44     27.99    -200.51    -915.54    -849.95
              51    109.26     34.38    -27.99     200.51    -509.38    -571.19

   89    1    15    -51.98    -24.79    -19.99     144.75     810.04    -891.37
              53     39.04     37.73     19.99    -144.75     207.80    -700.00

   90    1    18   -127.75    -22.81     26.33    -219.02    -881.46    -894.11
              53    114.81     35.75    -26.33     219.02    -459.00    -596.63

   91    1    24    -84.18    -25.71    -18.69     139.38     785.63    -933.01
              55     71.24     38.65     18.69    -139.38     166.07    -705.54

   92    1    27   -100.68    -22.54     27.28    -219.49    -924.75    -862.68
              55     87.74     35.48    -27.28     219.49    -464.36    -614.47

   93    1    30    -51.48    -24.64    -19.55     141.82     793.83    -886.98
              49     38.55     37.58     19.55    -141.82     201.50    -697.04

   94    1     1     12.19      0.04      0.00       0.01      -0.02       0.43
              57     -0.01     -0.04      0.00      -0.01       0.01       0.45

   95    1    11     12.17     -0.02      0.00      -0.01       0.02      -0.17
              58      0.00      0.02      0.00       0.01       0.03      -0.17
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MEMBER END FORCES    STRUCTURE TYPE = SPACE
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ALL UNITS ARE -- POUN INCH

MEMBER  LOAD  JT      AXIAL    SHEAR-Y   SHEAR-Z    TORSION      MOM-Y       MOM-Z


   96     1   16      12.18       0.01      0.00       0.00      -0.02        0.09
              59       0.00      -0.01      0.00       0.00      -0.01        0.10

   97     1   26      12.18       0.00      0.00      -0.01       0.00        0.13
              60      -0.01       0.00      0.00       0.01       0.00        0.14

  100     1   50    1019.17       0.00    -11.55    -568.89     967.05        0.00
              61   -1031.83       0.00     11.55     568.89     141.92        0.00

  101     1   52    1000.55       0.00      0.00    -572.50       0.00        0.00
              62   -1013.21       0.00      0.00     572.50       0.00        0.00

  102     1   54    1017.75       0.00     11.55    -568.63    -970.09        0.03
              63   -1030.42       0.00    -11.55     568.63    -138.88        0.00

  103     1   56    1008.30       0.00      0.00    -571.42    -438.87     -904.85
              64   -1020.96       0.00      0.00     571.42     438.87      904.84


************** END OF LATEST ANALYSIS RESULT **************

  69. PRINT MEMBER STRESSES ALL
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 MEMBER STRESSES
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 ALL UNITS ARE POUN/SQ INCH

MEMB    LD   SECT     AXIAL     BEND-Y      BEND-Z    COMBINED   SHEAR-Y   SHEAR-Z


    1    1    .0     32.6 C      24.8        57.2      114.7     249.0       5.0
              1.00   32.6 C      38.8      1339.8     1411.3     244.3       5.0

    2    1    .0     32.6 C      38.9      1340.0     1411.4     222.0      18.3
              1.00   32.6 C     141.6      3801.2     3975.4     212.5      18.3

    3    1    .0      1.1 T       2.7      3989.1     3992.9     149.7       0.0
              1.00    1.1 T       2.7      5631.3     5635.1     140.2       0.0

    4    1    .0      1.0 T       1.7      5631.3     5634.0     109.8       3.4
              1.00    1.0 T      20.9      6821.4     6843.3     100.3       3.4

    5    1    .0      1.0 T      20.0      6821.4     6842.4      75.5       0.6
              1.00    1.0 T      17.8      7326.9     7345.6      69.7       0.6

    6    1    .0      2.9 T      28.1      7327.9     7358.8      69.5       1.2
              1.00    2.9 T      23.9      6824.1     6850.9      75.3       1.2

    7    1    .0      2.9 T      24.9      6824.0     6851.7     100.1       7.9
              1.00    2.9 T      19.5      5636.5     5658.9     109.6       7.9

    8    1    .0      2.8 T      18.5      5636.5     5657.9     140.0      11.6
              1.00    2.8 T      83.5      3997.0     4083.3     149.5      11.6

    9    1    .0     31.5 C      60.6      3806.7     3898.8     212.8      24.1
              1.00   31.5 C      74.9      1342.5     1448.9     222.3      24.1

   10    1    .0     31.1 C      74.6      1342.4     1448.1     244.6      26.4
              1.00   31.1 C     148.9        56.4      236.4     249.3      26.4

   11    1    .0     32.6 C      55.9         7.9       96.4     224.1      25.3
              1.00   32.6 C     157.3      3614.5     3804.3     200.3      25.3

   12    1    .0      0.2 C       0.7      3792.8     3793.7     168.7      12.1
              1.00    0.2 C      42.5      4933.1     4975.8     158.9      12.1

   13    1    .0      3.4 T      11.6      4935.2     4950.2       8.1       3.1
              1.00    3.4 T      39.3      4854.7     4897.4      17.1       3.1

   14    1    .0      3.5 T      50.8      4849.5     4903.8     167.8       3.9
              1.00    3.5 T      37.3      3647.6     3688.3     177.5       3.9

   15    1    .0     13.8 C     109.7      3460.6     3584.1     186.1      22.7
              1.00   13.8 C      82.2        96.5      192.6     209.9      22.7

   16    1    .0     32.9 C      23.5        47.0      103.4     247.9       5.3
              1.00   32.9 C      38.5      1343.5     1414.9     243.1       5.3

   17    1    .0     32.8 C      38.6      1343.7     1415.0     220.8      18.4
              1.00   32.8 C     142.3      3791.6     3966.7     211.3      18.4
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 MEMBER STRESSES
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 ALL UNITS ARE POUN/SQ INCH

MEMB   LD  SECT     AXIAL     BEND-Y      BEND-Z    COMBINED   SHEAR-Y   SHEAR-Z


   18     1    .0       0.9 T        3.2      3979.3      3983.5     148.2        0.0
             1.00       0.9 T        3.1      5605.0      5609.0     138.8        0.0

   19     1    .0       0.9 T        2.1      5605.0      5608.1     108.3        3.4
             1.00       0.9 T       21.0      6778.4      6800.3      98.8        3.4

   20     1    .0       1.3 T       20.1      6778.3      6799.8      74.0        0.7
             1.00       1.3 T       17.7      7273.5      7292.5      68.2        0.7

   21     1    .0       2.6 T       27.4      7274.5      7304.6      71.7        1.1
             1.00       2.6 T       23.5      6754.8      6781.0      77.6        1.1

   22     1    .0       2.8 T       24.4      6754.8      6782.1     102.4        7.8
             1.00       2.8 T       19.7      5541.2      5563.7     111.9        7.8

   23     1    .0       2.8 T       18.7      5541.2      5562.8     142.3       11.5
             1.00       2.8 T       83.6      3875.0      3961.4     151.8       11.5

   24     1    .0      22.0 C       59.6      3679.1      3760.7     200.3       23.7
             1.00      22.0 C       73.7      1355.8      1451.5     209.8       23.7

   25     1    .0      21.9 C       73.4      1355.6      1450.9     232.1       26.3
             1.00      21.9 C      147.5        27.3       196.7     236.9       26.3

   26     1    .0      28.1 C       52.6        49.5       130.2     218.1       24.5
             1.00      28.1 C      154.1      3553.1      3735.4     194.3       24.5

   27     1    .0       0.4 C        1.7      3734.1      3736.2     169.7       11.9
             1.00       0.4 C       42.8      4881.8      4925.0     160.0       11.9

   28     1    .0       3.4 T       11.1      4889.7      4904.2       9.1        3.3
             1.00       3.4 T       40.1      4827.5      4871.0      16.0        3.3

   29     1    .0       3.4 T       51.0      4826.4      4880.8     167.0        3.9
             1.00       3.4 T       37.4      3630.1      3670.9     176.7        3.9

   30     1    .0      13.7 C      106.7      3444.0      3564.4     185.1       22.1
             1.00      13.7 C       80.1        95.5       189.3     209.0       22.1

   31     1    .0       2.9 C       27.0      1550.7      1580.5     226.4        0.4
             1.00       2.9 C       29.0       517.9       549.8     221.8        0.4

   32     1    .0       2.7 C       29.2       517.6       549.6     169.0        0.5
             1.00       2.7 C       33.5      3552.8      3589.0     159.8        0.5

   33     1    .0       2.8 C       37.0      3552.5      3592.4      90.9        3.8
             1.00       2.8 C        1.6      5146.2      5150.7      81.7        3.8

   34     1    .0       2.6 C        6.7      5146.0      5155.3      13.3        2.6
             1.00       2.6 C       17.1      5307.1      5326.8       4.2        2.6
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MEMBER STRESSES
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ALL UNITS ARE POUN/SQ INCH

MEMB   LD   SECT     AXIAL      BEND-Y      BEND-Z     COMBINED   SHEAR-Y   SHEAR-Z


  35    1    .0      2.5 C       12.5      5307.2      5322.2      51.3      11.2
            1.00     2.5 C       76.0      4693.2      4771.7      56.9      11.2

  36    1    .0      3.5 C       78.3      4690.8      4772.6      57.0      11.3
            1.00     3.5 C       14.0      5306.3      5323.8      51.4      11.3

  37    1    .0      3.3 C       18.7      5306.3      5328.3       4.0       3.6
            1.00     3.3 C       14.9      5147.7      5165.9      13.2       3.6

  38    1    .0      3.3 C       10.0      5147.8      5161.0      81.6       2.0
            1.00     3.3 C       28.2      3556.1      3587.7      90.8       2.0

  39    1    .0      3.3 C       25.3      3556.3      3585.0     159.8       0.5
            1.00     3.3 C       30.4       522.4       556.1     168.9       0.5

  40    1    .0      3.6 C       29.8       522.7       556.1     221.7      22.9
            1.00     3.6 C       75.9      1544.5      1624.0     226.2      22.9

  41    1    .0      3.1 C       78.0      1561.6      1642.6     226.3      23.4
            1.00     3.1 C       29.8       506.0       538.9     221.7      23.4

  42    1    .0      3.3 C       30.3       505.8       539.3     168.9       0.5
            1.00     3.3 C       25.6      3539.8      3568.7     159.8       0.5

  43    1    .0      3.1 C       28.4      3539.5      3571.1      90.8       2.0
            1.00     3.1 C       10.2      5131.8      5145.1      81.7       2.0

  44    1    .0      3.3 C       15.1      5131.6      5150.0      13.2       3.6
            1.00     3.3 C       18.5      5290.9      5312.8       4.1       3.6

  45    1    .0      3.1 C       13.9      5290.8      5307.9      51.4      11.2
            1.00     3.1 C       77.3      4675.8      4756.3      57.0      11.2

  46    1    .0      2.5 C       75.4      4678.5      4756.4      57.3      11.0
            1.00     2.5 C       12.8      5297.0      5312.2      51.7      11.0

  47    1    .0      2.6 C       17.3      5297.1      5317.0       3.8       2.6
            1.00     2.6 C        6.4      5143.3      5152.3      12.9       2.6

  48    1    .0      2.7 C        1.4      5143.4      5147.5      81.4       3.8
            1.00     2.7 C       36.8      3556.6      3596.1      90.5       3.8

  49    1    .0      2.7 C       33.3      3556.8      3592.8     159.5       0.4
            1.00     2.7 C       29.3       528.0       560.0     168.6       0.4

  50    1    .0      2.8 C       29.0       528.3       560.1     221.5       0.2
            1.00     2.8 C       28.2      1537.1      1568.2     226.0       0.2

  51    1    .0      0.7 T      112.8      1087.1      1200.6     208.8      10.8
            1.00     0.7 T       97.1      5710.8      5808.6     139.5      10.8
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MEMBER STRESSES
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ALL UNITS ARE POUN/SQ INCH

MEMB   LD   SECT     AXIAL     BEND-Y      BEND-Z    COMBINED   SHEAR-Y   SHEAR-Z


  52    1    .0       0.7 T      57.2      5183.3     5241.3      25.5       7.8
            1.00      0.7 T      57.5      5171.9     5230.1      26.3       7.8

  53    1    .0       0.7 T      95.3      5714.1     5810.1     140.7      10.6
            1.00      0.7 T     111.0      1128.9     1240.5     209.9      10.6

  54    1    .0      17.4 C       4.8      2974.5     2996.6     152.4       0.1
            1.00     17.4 C       6.8      1868.1     1892.2     133.7       0.1

  55    1    .0      17.4 C       2.0       898.3      917.7     107.1       0.0
            1.00     17.4 C       1.7       898.1      917.2     107.1       0.0

  56    1    .0       3.4 T      10.3      1852.2     1866.0     133.6       0.1
            1.00      3.4 T      12.1      2977.9     2993.3     152.6       0.1

  57    1    .0      21.7 C      41.4      4251.4     4314.4     206.0       0.4
            1.00     21.7 C      36.3      2281.1     2339.0     172.7       0.4

  58    1    .0      17.9 C      27.5      1347.4     1392.8     141.6       0.4
            1.00     17.9 C      26.7      1359.5     1404.1     141.9       0.4

  59    1    .0      16.7 C      25.4      2262.9     2304.9     172.5       0.2
            1.00     16.7 C      21.5      4256.7     4294.8     206.2       0.2

  60    1    .0       4.5 T      45.2      4323.6     4373.3     208.2       0.5
            1.00      4.5 T      45.4      2093.4     2143.2     170.5       0.5

  61    1    .0       3.4 T      46.3      1242.0     1291.7     141.6       0.6
            1.00      3.4 T      45.5      1258.3     1307.2     142.0       0.6

  62    1    .0       4.8 T      43.0      2074.6     2122.5     170.2       0.4
            1.00      4.8 T      42.7      4338.4     4385.9     208.5       0.4

  63    1    .0       5.3 C      40.3      3425.4     3471.1     169.5       0.4
            1.00      5.3 C      41.0      1553.5     1599.8     137.9       0.4

  64    1    .0       2.2 T      42.4       704.2      748.8     114.9       0.6
            1.00      2.2 T      42.7       715.6      760.6     115.2       0.6

  65    1    .0       8.8 T      41.7      1543.9     1594.4     137.7       0.4
            1.00      8.8 T      41.5      3438.7     3488.9     169.7       0.4

  66    1    .0       8.7 T      42.1      3421.2     3472.1     169.5       0.4
            1.00      8.7 T      42.4      1552.6     1603.8     137.9       0.4

  67    1    .0       2.0 T      42.8       705.9      750.8     115.0       0.6
            1.00      2.0 T      42.5       712.9      757.4     115.1       0.6

  68    1    .0       5.3 C      40.5      1549.2     1595.1     137.7       0.4
            1.00      5.3 C      39.8      3436.6     3481.8     169.6       0.4
```

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 MEMBER STRESSES
 ---------------
 ALL UNITS ARE POUN/SQ INCH

MEMB   LD  SECT     AXIAL     BEND-Y      BEND-Z    COMBINED  SHEAR-Y  SHEAR-Z


   69    1    .0       4.8 T      43.6     4313.1     4361.5     208.1      0.4
            1.00       4.8 T      43.9     2090.5     2139.1     170.6      0.4

   70    1    .0       3.3 T      45.8     1244.2     1293.3     141.7      0.6
            1.00       3.3 T      46.6     1253.2     1303.1     141.9      0.6

   71    1    .0       4.4 T      45.0     2086.4     2135.9     170.3      0.5
            1.00       4.4 T      44.9     4335.3     4384.6     208.3      0.5

   72    1    .0      16.8 C      22.4     4235.2     4274.4     205.9      0.2
            1.00      16.8 C      26.3     2275.3     2318.4     172.8      0.2

   73    1    .0      18.1 C      27.1     1346.4     1391.6     141.7      0.4
            1.00      18.1 C      28.0     1355.0     1401.1     141.9      0.4

   74    1    .0      21.8 C      36.1     2274.0     2331.9     172.6      0.4
            1.00      21.8 C      41.2     4260.6     4323.6     206.1      0.4

   75    1    .0       3.0 T      12.8     2974.6     2990.5     152.6      0.1
            1.00       3.0 T      11.2     1848.1     1862.3     133.5      0.1

   76    1    .0      17.4 C       1.2      888.7      907.3     107.0      0.0
            1.00      17.4 C       1.5      899.1      918.0     107.2      0.0

   77    1    .0      17.2 C       6.6     1863.1     1886.8     133.6      0.1
            1.00      17.2 C       4.5     2978.0     2999.8     152.5      0.1

   78    1    .0     436.2 C     809.6     1038.8     2284.6      65.8     29.9
            1.00     446.4 C     234.7      225.6      906.7      65.8     29.9

   79    1    .0     423.0 C     450.0        0.2      873.3       0.0      8.8
            1.00     426.4 C     393.6        0.2      820.2       0.0      8.8

   80    1    .0     450.8 C     993.7     1008.4     2453.0      60.9     62.9
            1.00     461.0 C     215.0      161.9      837.9      60.9     62.9

   81    1    .0     415.2 C       0.0        0.0      415.3       0.0      0.0
            1.00     418.6 C       0.0        0.0      418.6       0.0      0.0

   82    1    .0     436.0 C     814.2     1041.8     2292.0      65.9     30.1
            1.00     446.2 C     235.4      224.7      906.3      65.9     30.1

   83    1    .0     422.4 C     451.2        0.1      873.8       0.0      8.8
            1.00     425.8 C     394.8        0.1      820.8       0.0      8.8

   84    1    .0     433.4 C     939.0      890.7     2263.2      38.4     52.1
            1.00     443.6 C      63.8      151.6      659.0      38.4     52.1

   85    1    .0     418.5 C     178.6      368.1      965.1       0.0      0.0
            1.00     421.9 C     178.6      368.3      968.8       0.0      0.0
```

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MEMBER STRESSES
---------------
ALL UNITS ARE POUN/SQ INCH

MEMB   LD   SECT     AXIAL     BEND-Y      BEND-Z    COMBINED   SHEAR-Y   SHEAR-Z


  86    1    .0      99.9 T    1250.2      1278.3     2628.4      30.4      34.8
            1.00     89.7 T     650.7       851.9     1592.4      47.7      34.8

  87    1    .0     101.6 T    1114.3      1294.8     2510.8      31.3      25.4
            1.00     91.5 T     272.7       880.4     1244.5      48.5      25.4

  88    1    .0      96.2 T    1307.9      1214.2     2618.3      28.6      37.3
            1.00     86.0 T     727.7       816.0     1629.7      45.8      37.3

  89    1    .0      40.9 T    1157.2      1273.4     2471.5      33.1      26.7
            1.00     30.7 T     296.9      1000.0     1327.6      50.3      26.7

  90    1    .0     100.6 T    1259.2      1277.3     2637.1      30.4      35.1
            1.00     90.4 T     655.7       852.3     1598.4      47.7      35.1

  91    1    .0      66.3 T    1122.3      1332.9     2521.5      34.3      24.9
            1.00     56.1 T     237.2      1007.9     1301.2      51.5      24.9

  92    1    .0      79.3 T    1321.1      1232.4     2632.7      30.1      36.4
            1.00     69.1 T     663.4       877.8     1610.3      47.3      36.4

  93    1    .0      40.5 T    1134.0      1267.1     2441.7      32.9      26.1
            1.00     30.4 T     287.9       995.8     1314.0      50.1      26.1

  94    1    .0       5.1 C       0.0         0.2        5.3       0.0       0.0
            1.00      0.0 C       0.0         0.2        0.2       0.0       0.0

  95    1    .0       5.1 C       0.0         0.1        5.2       0.0       0.0
            1.00      0.0 C       0.0         0.1        0.1       0.0       0.0

  96    1    .0       5.1 C       0.0         0.0        5.1       0.0       0.0
            1.00      0.0 C       0.0         0.0        0.0       0.0       0.0

  97    1    .0       5.1 C       0.0         0.1        5.1       0.0       0.0
            1.00      0.0 C       0.0         0.1        0.1       0.0       0.0

 100    1    .0     737.5 C     757.9         0.0     1495.3       0.0       8.4
            1.00    746.6 C     111.2         0.0      857.8       0.0       8.4

 101    1    .0     724.0 C       0.0         0.0      724.0       0.0       0.0
            1.00    733.2 C       0.0         0.0      733.2       0.0       0.0

 102    1    .0     736.4 C     760.3         0.0     1496.7       0.0       8.4
            1.00    745.6 C     108.8         0.0      854.4       0.0       8.4

 103    1    .0     729.6 C     343.9       709.1     1782.7       0.0       0.0
            1.00    738.8 C     343.9       709.1     1791.8       0.0       0.0
```

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*************** END OF LATEST ANALYSIS RESULT ***************

70. PARAMETER
71. CODE AISC
72. FYLD 42000. MEMB 1 TO 53 78 TO 97
73. FYLD 21999.994 MEMB 54 TO 77 100 TO 103
74. WMIN 0.188 ALL
75. DFF 0.063 ALL
76. LY 197.5 MEMB 1 TO 10 16 TO 25
77. LZ 197.5 MEMB 1 TO 10 16 TO 25
78. LY 139.5 MEMB 11 TO 15 26 TO 30 51 TO 53
79. LZ 139.5 MEMB 11 TO 15 26 TO 30 51 TO 53
80. UNL 96. MEMB 100 TO 103
81. KY 1. MEMB 100 TO 103
82. KZ 1. MEMB 100 TO 103
83. CB 1. ALL
84. MAIN 0. ALL
85. TRACK 1. ALL
86. RATIO 1. ALL
87. WELD 1. ALL
88. LOAD LIST ALL
89. CHECK CODE ALL
```

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                    STAAD-III CODE CHECKING - (AISC)
                    ***********************

ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE          RESULT/   CRITICAL COND/      RATIO/     LOADING/
                               FX             MY             MZ     LOCATION
=======================================================================


     1  ST   TUB 60303      PASS     AISC- H1-3          0.060          1
                       102.52 C       124.16        6386.57        12.00
|-----------------------------------------------------------------------|
| MEM=     1, UNIT KIP-INCH,  L=  12.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
     2  ST   TUB 60303      PASS     AISC- H1-3          0.162          1
                       102.21 C       453.24       18119.21        24.00
|-----------------------------------------------------------------------|
| MEM=     2, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
     3  ST   TUB 60303      PASS     AISC- H2-1          0.224          1
                         3.48 T        -8.58       26842.41        24.00
|-----------------------------------------------------------------------|
| MEM=     3, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
     4  ST   TUB 60303      PASS     AISC- H2-1          0.272          1
                         3.23 T       -66.84       32515.27        24.00
|-----------------------------------------------------------------------|
| MEM=     4, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
     5  ST   TUB 60303      PASS     AISC- H2-1          0.291          1
                         3.15 T       -56.86       34924.72        14.75
|-----------------------------------------------------------------------|
| MEM=     5, UNIT KIP-INCH,  L=  14.8  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
     6  ST   TUB 60303      PASS     AISC- H2-1          0.292          1
                         9.05 T       -89.82      -34929.59         0.00
|-----------------------------------------------------------------------|
| MEM=     6, UNIT KIP-INCH,  L=  14.8  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE          RESULT/   CRITICAL COND/     RATIO/     LOADING/
                            FX            MY              MZ       LOCATION
=======================================================================

     7  ST  TUB 60303       PASS     AISC- H2-1          0.272         1
                          9.01 T        -79.54      -32527.80       0.00

|-----------------------------------------------------------------------|
| MEM=     7, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
     8  ST  TUB 60303       PASS     AISC- H2-1          0.225         1
                          8.80 T         59.35      -26867.34       0.00

|-----------------------------------------------------------------------|
| MEM=     8, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
     9  ST  TUB 60303       PASS     AISC- H1-3          0.159         1
                         99.05 C       -193.80      -18145.39       0.00

|-----------------------------------------------------------------------|
| MEM=     9, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
    10  ST  TUB 60303       PASS     AISC- H1-3          0.062         1
                         97.55 C        238.76       -6398.76       0.00

|-----------------------------------------------------------------------|
| MEM=    10, UNIT KIP-INCH,  L=  12.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
    11  ST  TUB 60303       PASS     AISC- H1-3          0.152         1
                        102.29 C        503.27       17228.99      36.00

|-----------------------------------------------------------------------|
| MEM=    11, UNIT KIP-INCH,  L=  36.0  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 112.8  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 11.68  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
    12  ST  TUB 60303       PASS     AISC- H1-3          0.197         1
                          0.62         -135.86       23514.55      14.75

|-----------------------------------------------------------------------|
| MEM=    12, UNIT KIP-INCH,  L=  14.8  AX=  3.14  SZ=    4.8  SY=   3.2 |
| KL/R-Y= 112.8  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 11.68  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
    13  ST  TUB 60303       PASS     AISC- H2-1          0.196         1
                         10.68 T         37.00      -23524.60       0.00
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER      TABLE          RESULT/   CRITICAL COND/     RATIO/      LOADING/
                             FX            MY             MZ        LOCATION
=======================================================================


 |-----------------------------------------------------------------------|
 | MEM=     13, UNIT KIP-INCH,  L=  38.0  AX=  3.14  SZ=    4.8  SY=    3.2 |
 | KL/R-Y= 112.8  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
 | FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 11.68  FT= 25.20  FV= 16.80  |
 |-----------------------------------------------------------------------|
    14  ST  TUB 60303      PASS      AISC- H2-1         0.195          1
                        10.92 T        162.53      -23116.13        0.00
 |-----------------------------------------------------------------------|
 | MEM=     14, UNIT KIP-INCH,  L=  14.8  AX=  3.14  SZ=    4.8  SY=    3.2 |
 | KL/R-Y= 112.8  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
 | FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 11.68  FT= 25.20  FV= 16.80  |
 |-----------------------------------------------------------------------|
    15  ST  TUB 60303      PASS      AISC- H1-3         0.143          1
                        43.47 C       -351.06      -16495.53        0.00
 |-----------------------------------------------------------------------|
 | MEM=     15, UNIT KIP-INCH,  L=  36.0  AX=  3.14  SZ=    4.8  SY=    3.2 |
 | KL/R-Y= 112.8  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
 | FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 11.68  FT= 25.20  FV= 16.80  |
 |-----------------------------------------------------------------------|
    16  ST  TUB 60303      PASS      AISC- H1-3         0.060          1
                       103.37 C        123.08        6404.18       12.00
 |-----------------------------------------------------------------------|
 | MEM=     16, UNIT KIP-INCH,  L=  12.0  AX=  3.14  SZ=    4.8  SY=    3.2 |
 | KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
 | FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80  |
 |-----------------------------------------------------------------------|
    17  ST  TUB 60303      PASS      AISC- H1-3         0.162          1
                       103.05 C        455.22       18073.40       24.00
 |-----------------------------------------------------------------------|
 | MEM=     17, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=    3.2 |
 | KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
 | FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80  |
 |-----------------------------------------------------------------------|
    18  ST  TUB 60303      PASS      AISC- H2-1         0.223          1
                         2.91 T         -9.83       26717.31       24.00
 |-----------------------------------------------------------------------|
 | MEM=     18, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=    3.2 |
 | KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
 | FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80  |
 |-----------------------------------------------------------------------|
    19  ST  TUB 60303      PASS      AISC- H2-1         0.270          1
                         2.92 T        -67.32       32310.16       24.00
 |-----------------------------------------------------------------------|
 | MEM=     19, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=    4.8  SY=    3.2 |
 | KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
 | FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80  |
 |-----------------------------------------------------------------------|
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER      TABLE          RESULT/   CRITICAL COND/     RATIO/      LOADING/
                              FX            MY             MZ        LOCATION
=======================================================================

    20   ST  TUB 60303        PASS      AISC- H2-1         0.289          1
                            4.20 T         -56.54      34670.12       14.75
|-----------------------------------------------------------------------|
| MEM=    20, UNIT KIP-INCH,  L=  14.8  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
    21   ST  TUB 60303        PASS      AISC- H2-1         0.290          1
                            8.26 T         -87.71     -34675.22        0.00
|-----------------------------------------------------------------------|
| MEM=    21, UNIT KIP-INCH,  L=  14.8  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
    22   ST  TUB 60303        PASS      AISC- H2-1         0.269          1
                            8.94 T         -78.21     -32197.92        0.00
|-----------------------------------------------------------------------|
| MEM=    22, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
    23   ST  TUB 60303        PASS      AISC- H2-1         0.221          1
                            8.72 T          59.99     -26413.26        0.00
|-----------------------------------------------------------------------|
| MEM=    23, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
    24   ST  TUB 60303        PASS      AISC- H1-3         0.152          1
                           69.04 C        -190.78     -17537.01        0.00
|-----------------------------------------------------------------------|
| MEM=    24, UNIT KIP-INCH,  L=  24.0  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
    25   ST  TUB 60303        PASS      AISC- H1-3         0.060          1
                           68.65 C         235.03      -6461.73        0.00
|-----------------------------------------------------------------------|
| MEM=    25, UNIT KIP-INCH,  L=  12.0  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 159.7  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  5.85  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
    26   ST  TUB 60303        PASS      AISC- H1-3         0.150          1
                           88.35 C         493.22      16936.65       36.00
```

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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE          RESULT/   CRITICAL COND/     RATIO/     LOADING/
                            FX            MY             MZ       LOCATION
=======================================================================

|-----------------------------------------------------------------------|
| MEM=    26, UNIT KIP-INCH,  L=  36.0  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 112.8  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 11.68  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
   27   ST  TUB 60303      PASS     AISC- H1-3         0.195        1
                         1.31 C      -137.06      23269.86       14.75
|-----------------------------------------------------------------------|
| MEM=    27, UNIT KIP-INCH,  L=  14.8  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 112.8  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 11.68  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
   28   ST  TUB 60303      PASS     AISC- H2-1         0.195        1
                        10.57 T        35.54     -23307.66        0.00
|-----------------------------------------------------------------------|
| MEM=    28, UNIT KIP-INCH,  L=  38.0  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 112.8  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 11.68  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
   29   ST  TUB 60303      PASS     AISC- H2-1         0.194        1
                        10.65 T       163.12     -23006.02        0.00
|-----------------------------------------------------------------------|
| MEM=    29, UNIT KIP-INCH,  L=  14.8  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 112.8  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 11.68  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
   30   ST  TUB 60303      PASS     AISC- H1-3         0.142        1
                        42.98 C      -341.36     -16416.41        0.00
|-----------------------------------------------------------------------|
| MEM=    30, UNIT KIP-INCH,  L=  36.0  AX=  3.14  SZ=   4.8  SY=   3.2 |
| KL/R-Y= 112.8  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 11.68  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
   31   ST  TUB 40203      PASS     AISC- H1-3         0.063        1
                         5.88 C       -35.04       3023.79        0.00
|-----------------------------------------------------------------------|
| MEM=    31, UNIT KIP-INCH,  L=  12.0  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  15.0  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 24.29  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
   32   ST  TUB 40203      PASS     AISC- H1-3         0.142        1
                         5.54 C        43.51       6928.03       24.00
|-----------------------------------------------------------------------|
| MEM=    32, UNIT KIP-INCH,  L=  24.0  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  29.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 23.07  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE          RESULT/   CRITICAL COND/     RATIO/     LOADING/
                            FX            MY             MZ       LOCATION
=======================================================================

   33  ST  TUB 40203       PASS     AISC- H1-3         0.204         1
                          5.72 C        2.14        10035.15       24.00
|-----------------------------------------------------------------------|
| MEM=    33, UNIT KIP-INCH,  L=  24.0  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  29.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 23.07  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
   34  ST  TUB 40203       PASS     AISC- H1-3         0.211         1
                          5.22 C      -22.22        10348.90       24.00

|-----------------------------------------------------------------------|
| MEM=    34, UNIT KIP-INCH,  L=  24.0  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  29.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 23.07  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
   35  ST  TUB 40203       PASS     AISC- H1-3         0.211         1
                          5.11 C       16.28       -10349.03        0.00

|-----------------------------------------------------------------------|
| MEM=    35, UNIT KIP-INCH,  L=  14.8  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  18.4  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 24.04  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
   36  ST  TUB 40203       PASS     AISC- H1-3         0.211         1
                          7.09 C       18.22        10347.23       14.75

|-----------------------------------------------------------------------|
| MEM=    36, UNIT KIP-INCH,  L=  14.8  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  18.4  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 24.04  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
   37  ST  TUB 40203       PASS     AISC- H1-3         0.211         1
                          6.66 C      -24.30       -10347.33        0.00

|-----------------------------------------------------------------------|
| MEM=    37, UNIT KIP-INCH,  L=  24.0  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  29.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 23.07  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
   38  ST  TUB 40203       PASS     AISC- H1-3         0.205         1
                          6.64 C       12.99       -10038.14        0.00

|-----------------------------------------------------------------------|
| MEM=    38, UNIT KIP-INCH,  L=  24.0  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  29.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 23.07  FT= 25.20  FV= 16.80   |
|-----------------------------------------------------------------------|
   39  ST  TUB 40203       PASS     AISC- H1-3         0.142         1
                          6.74 C       32.91        -6934.87        0.00
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE          RESULT/   CRITICAL COND/     RATIO/     LOADING/
                            FX            MY              MZ       LOCATION
=======================================================================


|--------------------------------------------------------------------------|
| MEM=    39, UNIT KIP-INCH,  L=  24.0  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  29.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 23.07  FT= 25.20  FV= 16.80   |
|--------------------------------------------------------------------------|
    40   ST  TUB 40203       PASS      AISC- H1-3         0.064          1
                          7.33 C        98.68       -3011.76       12.00
|--------------------------------------------------------------------------|
| MEM=    40, UNIT KIP-INCH,  L=  12.0  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  15.0  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 24.29  FT= 25.20  FV= 16.80   |
|--------------------------------------------------------------------------|
    41   ST  TUB 40203       PASS      AISC- H1-3         0.065          1
                          6.20 C       101.42        3045.02        0.00
|--------------------------------------------------------------------------|
| MEM=    41, UNIT KIP-INCH,  L=  12.0  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  15.0  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 24.29  FT= 25.20  FV= 16.80   |
|--------------------------------------------------------------------------|
    42   ST  TUB 40203       PASS      AISC- H1-3         0.142          1
                          6.60 C        33.24        6902.70       24.00
|--------------------------------------------------------------------------|
| MEM=    42, UNIT KIP-INCH,  L=  24.0  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  29.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 23.07  FT= 25.20  FV= 16.80   |
|--------------------------------------------------------------------------|
    43   ST  TUB 40203       PASS      AISC- H1-3         0.204          1
                          6.26 C        13.26       10007.03       24.00
|--------------------------------------------------------------------------|
| MEM=    43, UNIT KIP-INCH,  L=  24.0  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  29.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 23.07  FT= 25.20  FV= 16.80   |
|--------------------------------------------------------------------------|
    44   ST  TUB 40203       PASS      AISC- H1-3         0.211          1
                          6.73 C       -24.08       10317.29       24.00
|--------------------------------------------------------------------------|
| MEM=    44, UNIT KIP-INCH,  L=  24.0  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  29.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 23.07  FT= 25.20  FV= 16.80   |
|--------------------------------------------------------------------------|
    45   ST  TUB 40203       PASS      AISC- H1-3         0.211          1
                          6.33 C        18.06      -10317.12        0.00
|--------------------------------------------------------------------------|
| MEM=    45, UNIT KIP-INCH,  L=  14.8  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  18.4  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 24.04  FT= 25.20  FV= 16.80   |
|--------------------------------------------------------------------------|
```

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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE          RESULT/   CRITICAL COND/     RATIO/      LOADING/
                           FX            MY             MZ         LOCATION
=======================================================================

   46  ST  TUB 40203       PASS      AISC- H1-3         0.211          1
                          4.95 C         16.58      10329.13        14.75

|-----------------------------------------------------------------------|
| MEM=    46, UNIT KIP-INCH,  L=  14.8  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  18.4  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 24.04  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
   47  ST  TUB 40203       PASS      AISC- H1-3         0.211          1
                          5.27 C        -22.50     -10329.25         0.00

|-----------------------------------------------------------------------|
| MEM=    47, UNIT KIP-INCH,  L=  24.0  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  29.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 23.07  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
   48  ST  TUB 40203       PASS      AISC- H1-3         0.204          1
                          5.41 C          1.84     -10029.66         0.00

|-----------------------------------------------------------------------|
| MEM=    48, UNIT KIP-INCH,  L=  24.0  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  29.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 23.07  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
   49  ST  TUB 40203       PASS      AISC- H1-3         0.143          1
                          5.42 C         43.29      -6935.86         0.00

|-----------------------------------------------------------------------|
| MEM=    49, UNIT KIP-INCH,  L=  24.0  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  29.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 23.07  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
   50  ST  TUB 40203       PASS      AISC- H1-3         0.062          1
                          5.63 C        -36.72      -2997.38        12.00

|-----------------------------------------------------------------------|
| MEM=    50, UNIT KIP-INCH,  L=  12.0  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y=  15.0  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 24.29  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
   51  ST  TUB 40203       PASS      AISC- H2-1         0.231          1
                          1.38 T        126.21      11136.15        50.75

|-----------------------------------------------------------------------|
| MEM=    51, UNIT KIP-INCH,  L=  50.8  AX=  2.02  SZ=   2.0  SY=   1.3 |
| KL/R-Y= 173.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  4.94  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
   52  ST  TUB 40203       PASS      AISC- H2-1         0.208          1
                          1.45 T         74.40     -10107.46         0.00
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE        RESULT/   CRITICAL COND/     RATIO/     LOADING/
                          FX            MY             MZ       LOCATION
=======================================================================

 |-----------------------------------------------------------------------|
 | MEM=     52, UNIT KIP-INCH,  L=  38.0  AX=  2.02  SZ=    2.0  SY=    1.3 |
 | KL/R-Y= 173.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
 | FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  4.94  FT= 25.20  FV= 16.80  |
 |-----------------------------------------------------------------------|
     53   ST  TUB 40203      PASS     AISC- H2-1         0.231         1
                          1.38 T      123.90      -11142.45        0.00
 |-----------------------------------------------------------------------|
 | MEM=     53, UNIT KIP-INCH,  L=  50.8  AX=  2.02  SZ=    2.0  SY=    1.3 |
 | KL/R-Y= 173.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
 | FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA=  4.94  FT= 25.20  FV= 16.80  |
 |-----------------------------------------------------------------------|
     54        PRI SMAT      PASS     AISC- H1-3         0.235         1
                          9.96 C       -0.34        -419.57        0.00
 |-----------------------------------------------------------------------|
 | MEM=     54, UNIT KIP-INCH,  L=  50.8  AX=  0.57  SZ=    0.1  SY=    0.1 |
 | KL/R-Y= 166.3  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
 | FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  1.86  FT= 13.20  FV=  8.80  |
 |-----------------------------------------------------------------------|
     55        PRI SMAT      PASS     AISC- H1-3         0.073         1
                          9.98 C        0.15        -126.71        0.00
 |-----------------------------------------------------------------------|
 | MEM=     55, UNIT KIP-INCH,  L=  38.0  AX=  0.57  SZ=    0.1  SY=    0.1 |
 | KL/R-Y= 124.6  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
 | FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.32  FT= 13.20  FV=  8.80  |
 |-----------------------------------------------------------------------|
     56        PRI SMAT      PASS     AISC- H2-1         0.227         1
                          1.96 T       -0.86         420.04       50.75
 |-----------------------------------------------------------------------|
 | MEM=     56, UNIT KIP-INCH,  L=  50.8  AX=  0.57  SZ=    0.1  SY=    0.1 |
 | KL/R-Y= 166.3  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
 | FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  1.86  FT= 13.20  FV=  8.80  |
 |-----------------------------------------------------------------------|
     57        PRI SMAT      PASS     AISC- H1-3         0.337         1
                         12.44 C       -2.95        -599.68        0.00
 |-----------------------------------------------------------------------|
 | MEM=     57, UNIT KIP-INCH,  L=  50.8  AX=  0.57  SZ=    0.1  SY=    0.1 |
 | KL/R-Y= 166.3  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
 | FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  1.86  FT= 13.20  FV=  8.80  |
 |-----------------------------------------------------------------------|
     58        PRI SMAT      PASS     AISC- H1-3         0.110         1
                         10.30 C       -1.90         191.77       38.00
 |-----------------------------------------------------------------------|
 | MEM=     58, UNIT KIP-INCH,  L=  38.0  AX=  0.57  SZ=    0.1  SY=    0.1 |
 | KL/R-Y= 124.6  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
 | FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.32  FT= 13.20  FV=  8.80  |
 |-----------------------------------------------------------------------|
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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE        RESULT/   CRITICAL COND/     RATIO/     LOADING/
                          FX            MY            MZ        LOCATION
=======================================================================

  59      PRI SMAT       PASS     AISC- H1-3         0.333          1
                        9.56 C        -1.53        600.43        50.75

|-----------------------------------------------------------------------|
| MEM=    59, UNIT KIP-INCH,  L=  50.8  AX=  0.57  SZ=   0.1  SY=   0.1 |
| KL/R-Y= 166.3  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  1.86  FT= 13.20  FV=  8.80  |
|-----------------------------------------------------------------------|
  60      PRI SMAT       PASS     AISC- H2-1         0.331          1
                        2.56 T        -3.22       -609.86         0.00

|-----------------------------------------------------------------------|
| MEM=    60, UNIT KIP-INCH,  L=  50.8  AX=  0.57  SZ=   0.1  SY=   0.1 |
| KL/R-Y= 166.3  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  1.86  FT= 13.20  FV=  8.80  |
|-----------------------------------------------------------------------|
  61      PRI SMAT       PASS     AISC- H2-1         0.099          1
                        1.94 T        -3.25        177.49        38.00

|-----------------------------------------------------------------------|
| MEM=    61, UNIT KIP-INCH,  L=  38.0  AX=  0.57  SZ=   0.1  SY=   0.1 |
| KL/R-Y= 124.6  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.32  FT= 13.20  FV=  8.80  |
|-----------------------------------------------------------------------|
  62      PRI SMAT       PASS     AISC- H2-1         0.332          1
                        2.77 T        -3.05        611.95        50.75

|-----------------------------------------------------------------------|
| MEM=    62, UNIT KIP-INCH,  L=  50.8  AX=  0.57  SZ=   0.1  SY=   0.1 |
| KL/R-Y= 166.3  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  1.86  FT= 13.20  FV=  8.80  |
|-----------------------------------------------------------------------|
  63      PRI SMAT       PASS     AISC- H1-3         0.265          1
                        3.04 C        -2.88       -483.17         0.00

|-----------------------------------------------------------------------|
| MEM=    63, UNIT KIP-INCH,  L=  50.8  AX=  0.57  SZ=   0.1  SY=   0.1 |
| KL/R-Y= 166.3  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  1.86  FT= 13.20  FV=  8.80  |
|-----------------------------------------------------------------------|
  64      PRI SMAT       PASS     AISC- H2-1         0.057          1
                        1.27 T        -3.05        100.94        38.00

|-----------------------------------------------------------------------|
| MEM=    64, UNIT KIP-INCH,  L=  38.0  AX=  0.57  SZ=   0.1  SY=   0.1 |
| KL/R-Y= 124.6  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.32  FT= 13.20  FV=  8.80  |
|-----------------------------------------------------------------------|
  65      PRI SMAT       PASS     AISC- H2-1         0.264          1
                        5.04 T        -2.96        485.05        50.75
```

```
ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE         RESULT/   CRITICAL COND/     RATIO/     LOADING/
                           FX            MY             MZ       LOCATION
=======================================================================


|-----------------------------------------------------------------------|
| MEM=    65, UNIT KIP-INCH,  L=  50.8  AX=  0.57  SZ=    0.1  SY=   0.1 |
| KL/R-Y= 166.3  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  1.86  FT= 13.20  FV=  8.80  |
|-----------------------------------------------------------------------|
    66       PRI SMAT        PASS     AISC- H2-1         0.262        1
                           5.02 T         -3.00       -482.58       0.00
|-----------------------------------------------------------------------|
| MEM=    66, UNIT KIP-INCH,  L=  50.8  AX=  0.57  SZ=    0.1  SY=   0.1 |
| KL/R-Y= 166.3  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  1.86  FT= 13.20  FV=  8.80  |
|-----------------------------------------------------------------------|
    67       PRI SMAT        PASS     AISC- H2-1         0.057        1
                           1.17 T         -3.03        100.56      38.00
|-----------------------------------------------------------------------|
| MEM=    67, UNIT KIP-INCH,  L=  38.0  AX=  0.57  SZ=    0.1  SY=   0.1 |
| KL/R-Y= 124.6  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.32  FT= 13.20  FV=  8.80  |
|-----------------------------------------------------------------------|
    68       PRI SMAT        PASS     AISC- H1-3         0.266        1
                           3.06 C         -2.84        484.75      50.75
|-----------------------------------------------------------------------|
| MEM=    68, UNIT KIP-INCH,  L=  50.8  AX=  0.57  SZ=    0.1  SY=   0.1 |
| KL/R-Y= 166.3  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  1.86  FT= 13.20  FV=  8.80  |
|-----------------------------------------------------------------------|
    69       PRI SMAT        PASS     AISC- H2-1         0.330        1
                           2.74 T         -3.11       -608.39       0.00
|-----------------------------------------------------------------------|
| MEM=    69, UNIT KIP-INCH,  L=  50.8  AX=  0.57  SZ=    0.1  SY=   0.1 |
| KL/R-Y= 166.3  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  1.86  FT= 13.20  FV=  8.80  |
|-----------------------------------------------------------------------|
    70       PRI SMAT        PASS     AISC- H2-1         0.098        1
                           1.91 T         -3.32        176.77      38.00
|-----------------------------------------------------------------------|
| MEM=    70, UNIT KIP-INCH,  L=  38.0  AX=  0.57  SZ=    0.1  SY=   0.1 |
| KL/R-Y= 124.6  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.32  FT= 13.20  FV=  8.80  |
|-----------------------------------------------------------------------|
    71       PRI SMAT        PASS     AISC- H2-1         0.332        1
                           2.55 T         -3.20        611.52      50.75
|-----------------------------------------------------------------------|
| MEM=    71, UNIT KIP-INCH,  L=  50.8  AX=  0.57  SZ=    0.1  SY=   0.1 |
| KL/R-Y= 166.3  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  1.86  FT= 13.20  FV=  8.80  |
|-----------------------------------------------------------------------|
```

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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE        RESULT/   CRITICAL COND/     RATIO/     LOADING/
                          FX            MY             MZ       LOCATION
=======================================================================

   72      PRI SMAT       PASS     AISC- H1-3        0.332          1
                        9.67 C         -1.60       -597.39        0.00

|-----------------------------------------------------------------------|
| MEM=    72, UNIT KIP-INCH,  L=  50.8  AX=  0.57  SZ=    0.1  SY=   0.1 |
| KL/R-Y= 166.3  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  1.86  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
   73      PRI SMAT       PASS     AISC- H1-3        0.110          1
                       10.38 C         -1.99        191.13       38.00

|-----------------------------------------------------------------------|
| MEM=    73, UNIT KIP-INCH,  L=  38.0  AX=  0.57  SZ=    0.1  SY=   0.1 |
| KL/R-Y= 124.6  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.32  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
   74      PRI SMAT       PASS     AISC- H1-3        0.338          1
                       12.52 C         -2.94        600.98       50.75

|-----------------------------------------------------------------------|
| MEM=    74, UNIT KIP-INCH,  L=  50.8  AX=  0.57  SZ=    0.1  SY=   0.1 |
| KL/R-Y= 166.3  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  1.86  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
   75      PRI SMAT       PASS     AISC- H2-1        0.226          1
                        1.74 T         -0.92       -419.58        0.00

|-----------------------------------------------------------------------|
| MEM=    75, UNIT KIP-INCH,  L=  50.8  AX=  0.57  SZ=    0.1  SY=   0.1 |
| KL/R-Y= 166.3  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  1.86  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
   76      PRI SMAT       PASS     AISC- H1-3        0.073          1
                        9.99 C          0.11        126.82       38.00

|-----------------------------------------------------------------------|
| MEM=    76, UNIT KIP-INCH,  L=  38.0  AX=  0.57  SZ=    0.1  SY=   0.1 |
| KL/R-Y= 124.6  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  3.32  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
   77      PRI SMAT       PASS     AISC- H1-3        0.235          1
                        9.86 C         -0.32        420.07       50.75

|-----------------------------------------------------------------------|
| MEM=    77, UNIT KIP-INCH,  L=  50.8  AX=  0.57  SZ=    0.1  SY=   0.1 |
| KL/R-Y= 166.3  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  1.86  FT= 13.20  FV=  8.80   |
|-----------------------------------------------------------------------|
   78  ST  TUB 35353      PASS     AISC- H1-3        0.092          1
                     1042.63 C       1989.25      -2552.52        0.00
```

```
ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE          RESULT/   CRITICAL COND/     RATIO/     LOADING/
                            FX            MY             MZ       LOCATION
=======================================================================


|-----------------------------------------------------------------------|
| MEM=    78, UNIT KIP-INCH,  L=  36.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=  26.8  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 23.34  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
    79  ST  TUB 35353       PASS      AISC- H1-3          0.035         1
                       1011.06 C      1105.66           -0.58        0.00
|-----------------------------------------------------------------------|
| MEM=    79, UNIT KIP-INCH,  L=  12.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=   8.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 24.70  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
    80  ST  TUB 35353       PASS      AISC- H1-3          0.099         1
                       1077.46 C      2441.70         2477.90        0.00
|-----------------------------------------------------------------------|
| MEM=    80, UNIT KIP-INCH,  L=  36.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=  26.8  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 23.34  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
    81  ST  TUB 35353       PASS      AISC- H1-3          0.017         1
                       1000.51 C        -0.02           -0.01       12.00
|-----------------------------------------------------------------------|
| MEM=    81, UNIT KIP-INCH,  L=  12.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=   8.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 24.70  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
    82  ST  TUB 35353       PASS      AISC- H1-3          0.092         1
                       1042.09 C     -2000.56         2559.78        0.00
|-----------------------------------------------------------------------|
| MEM=    82, UNIT KIP-INCH,  L=  36.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=  26.8  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 23.34  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
    83  ST  TUB 35353       PASS      AISC- H1-3          0.035         1
                       1009.63 C     -1108.71           -0.30        0.00
|-----------------------------------------------------------------------|
| MEM=    83, UNIT KIP-INCH,  L=  12.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=   8.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 24.70  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
    84  ST  TUB 35353       PASS      AISC- H1-3          0.091         1
                       1035.85 C     -2307.26        -2188.68        0.00
|-----------------------------------------------------------------------|
| MEM=    84, UNIT KIP-INCH,  L=  36.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=  26.8  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 23.34  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
```

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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE        RESULT/   CRITICAL COND/     RATIO/     LOADING/
                           FX           MY             MZ       LOCATION
=======================================================================

   85   ST   TUB 35353      PASS     AISC- H1-3          0.039         1
                     1008.30 C        438.91         904.94        12.00

|-----------------------------------------------------------------------|
| MEM=    85, UNIT KIP-INCH,  L=  12.0  AX=  2.39  SZ=   2.5  SY=   2.5 |
| KL/R-Y=   8.9  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 24.70  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
   86   ST   TUB 20203      PASS     AISC- H2-1          0.104         1
                      126.90 T       -875.14        -894.81         0.00

|-----------------------------------------------------------------------|
| MEM=    86, UNIT KIP-INCH,  L=  50.9  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  68.6  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 18.67  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
   87   ST   TUB 20203      PASS     AISC- H2-1          0.100         1
                      129.08 T        780.03        -906.36         0.00

|-----------------------------------------------------------------------|
| MEM=    87, UNIT KIP-INCH,  L=  50.9  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  68.6  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 18.67  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
   88   ST   TUB 20203      PASS     AISC- H2-1          0.104         1
                      122.20 T       -915.54        -849.95         0.00

|-----------------------------------------------------------------------|
| MEM=    88, UNIT KIP-INCH,  L=  50.9  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  68.6  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 18.67  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
   89   ST   TUB 20203      PASS     AISC- H2-1          0.098         1
                       51.98 T        810.04        -891.37         0.00

|-----------------------------------------------------------------------|
| MEM=    89, UNIT KIP-INCH,  L=  50.9  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  68.6  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 18.67  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
   90   ST   TUB 20203      PASS     AISC- H2-1          0.105         1
                      127.75 T       -881.46        -894.11         0.00

|-----------------------------------------------------------------------|
| MEM=    90, UNIT KIP-INCH,  L=  50.9  AX=  1.27  SZ=   0.7  SY=   0.7 |
| KL/R-Y=  68.6  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 18.67  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
   91   ST   TUB 20203      PASS     AISC- H2-1          0.100         1
                       84.18 T        785.63        -933.01         0.00
```

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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE         RESULT/   CRITICAL COND/     RATIO/     LOADING/
                           FX            MY             MZ       LOCATION
=======================================================================


|-----------------------------------------------------------------------|
| MEM=    91, UNIT KIP-INCH,  L=  50.9  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y=  68.6  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 18.67  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
    92  ST  TUB 20203      PASS     AISC- H2-1         0.104         1
                    100.68 T        -924.75         -862.68        0.00
|-----------------------------------------------------------------------|
| MEM=    92, UNIT KIP-INCH,  L=  50.9  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y=  68.6  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 18.67  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
    93  ST  TUB 20203      PASS     AISC- H2-1         0.097         1
                     51.48 T         793.83         -886.98        0.00
|-----------------------------------------------------------------------|
| MEM=    93, UNIT KIP-INCH,  L=  50.9  AX=  1.27  SZ=    0.7  SY=    0.7 |
| KL/R-Y=  68.6  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 18.67  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
    94  ST  TUB 35353      PASS     AISC- H1-3         0.000         1
                     12.19 C          -0.02            0.43        0.00
|-----------------------------------------------------------------------|
| MEM=    94, UNIT KIP-INCH,  L=  18.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=  13.4  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 24.40  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
    95  ST  TUB 35353      PASS     AISC- H1-3         0.000         1
                     12.17 C           0.02           -0.17        0.00
|-----------------------------------------------------------------------|
| MEM=    95, UNIT KIP-INCH,  L=  18.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=  13.4  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 24.40  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
    96  ST  TUB 35353      PASS     AISC- H1-3         0.000         1
                     12.18 C          -0.02            0.09        0.00
|-----------------------------------------------------------------------|
| MEM=    96, UNIT KIP-INCH,  L=  18.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=  13.4  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 24.40  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
    97  ST  TUB 35353      PASS     AISC- H1-3         0.000         1
                     12.18 C           0.00            0.13        0.00
|-----------------------------------------------------------------------|
| MEM=    97, UNIT KIP-INCH,  L=  18.0  AX=  2.39  SZ=    2.5  SY=    2.5 |
| KL/R-Y=  13.4  CB=  1.00  YLD= 42.00  ALLOWABLE STRESSES:  FCZ= 25.20 |
| FTZ= 25.20  FCY= 25.20  FTY= 25.20  FA= 24.40  FT= 25.20  FV= 16.80  |
|-----------------------------------------------------------------------|
```

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ALL UNITS ARE - POUN INCH (UNLESS OTHERWISE NOTED)

MEMBER     TABLE         RESULT/   CRITICAL COND/     RATIO/     LOADING/
                            FX           MY             MZ       LOCATION
=======================================================================

  100       PRI SMAT        PASS     AISC- H1-3         0.159         1
                       1019.17 C      967.05            0.00        0.00

|-----------------------------------------------------------------------|
| MEM=   100, UNIT KIP-INCH,  L=  96.0  AX=  1.38  SZ=    1.3  SY=    1.3 |
| KL/R-Y=  81.6  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  7.25  FT= 13.20  FV=  8.80  |
|-----------------------------------------------------------------------|
  101       PRI SMAT        PASS     AISC- H1-3         0.101         1
                       1013.21 C        0.00            0.00       96.00

|-----------------------------------------------------------------------|
| MEM=   101, UNIT KIP-INCH,  L=  96.0  AX=  1.38  SZ=    1.3  SY=    1.3 |
| KL/R-Y=  81.6  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  7.25  FT= 13.20  FV=  8.80  |
|-----------------------------------------------------------------------|
  102       PRI SMAT        PASS     AISC- H1-3         0.159         1
                       1017.75 C     -970.09            0.03        0.00

|-----------------------------------------------------------------------|
| MEM=   102, UNIT KIP-INCH,  L=  96.0  AX=  1.38  SZ=    1.3  SY=    1.3 |
| KL/R-Y=  81.6  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  7.25  FT= 13.20  FV=  8.80  |
|-----------------------------------------------------------------------|
  103       PRI SMAT        PASS     AISC- H1-3         0.182         1
                       1020.96 C      438.87          904.84       96.00

|-----------------------------------------------------------------------|
| MEM=   103, UNIT KIP-INCH,  L=  96.0  AX=  1.38  SZ=    1.3  SY=    1.3 |
| KL/R-Y=  81.6  CB=  1.00  YLD= 22.00  ALLOWABLE STRESSES:  FCZ= 13.20 |
| FTZ= 14.52  FCY= 13.20  FTY= 14.52  FA=  7.25  FT= 13.20  FV=  8.80  |
|-----------------------------------------------------------------------|
  90. SELECT WELD ALL
```

```
                     STAAD-III WELD DESIGN
                     *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/     WELD TYPE/       WELD SIZE/      COMB STRESS/
         LOADING       HOR STRESS      VERT STRESS       DIR STRESS
====================================================================

    1      STA            1               3/16              470.13
            1             322.99            326.95             99.01

    1      END            1               3/16             1281.67
            1             322.99            323.79           1197.30

-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=   3.00 CV=   1.50
-------------------------------------------------------------------

    2      STA            1               3/16             1259.43
            1             270.69            281.32           1197.39

    2      END            1               3/16             3388.63
            1             270.69            275.00           3366.58

-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=   3.00 CV=   1.50
-------------------------------------------------------------------

    3      STA            1               3/16             3404.75
            1             289.42            244.51           3383.61

    3      END            1               3/16             4789.88
            1             289.42            238.19           4775.19

-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=   3.00 CV=   1.50
-------------------------------------------------------------------

    4      STA            1               3/16             4782.27
            1             209.87            177.75           4774.35

    4      END            1               3/16             5804.75
            1             209.87            171.43           5798.42

-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=   3.00 CV=   1.50
-------------------------------------------------------------------

    5      STA            1               3/16             5800.85
            1             145.62            123.08           5797.72

    5      END            1               3/16             6227.06
            1             145.62            119.19           6224.21
```

```
                      STAAD-III WELD DESIGN
                      *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/      WELD TYPE/       WELD SIZE/       COMB STRESS/
         LOADING        HOR STRESS      VERT STRESS        DIR STRESS
======================================================================

---------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
---------------------------------------------------------------------

    6      STA              1              3/16              6237.66
             1              133.93           113.14          6235.20

    6      END              1              3/16              5807.60
             1              133.93           117.02          5804.88

---------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
---------------------------------------------------------------------

    7      STA              1              3/16              5811.35
             1              198.97           165.33          5805.59

    7      END              1              3/16              4802.15
             1              198.97           171.65          4794.96

---------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
---------------------------------------------------------------------

    8      STA              1              3/16              4807.86
             1              279.90           231.99          4794.10

    8      END              1              3/16              3477.03
             1              279.90           238.31          3457.54

---------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
---------------------------------------------------------------------

    9      STA              1              3/16              3327.56
             1              276.59           277.47          3304.41

    9      END              1              3/16              1290.21
             1              276.59           283.79          1227.85

---------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
---------------------------------------------------------------------

   10      STA              1              3/16              1312.52
             1              332.36           326.29          1227.10
```

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                         STAAD-III WELD DESIGN
                         *********************

ALL UNITS ARE - INCH POUN

MEMBER    LOCATION/     WELD TYPE/      WELD SIZE/       COMB STRESS/
          LOADING       HOR STRESS      VERT STRESS        DIR STRESS
======================================================================

  10        END            1              3/16               508.02
             1             332.36           329.45           197.70

---------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=   1.50
---------------------------------------------------------------------

  11        STA            1              3/16               426.26
             1             296.54           294.90            82.43

  11        END            1              3/16              3246.69
             1             296.54           279.02          3221.06

---------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=   1.50
---------------------------------------------------------------------

  12        STA            1              3/16              3254.09
             1             397.53           309.87          3214.81

  12        END            1              3/16              4244.61
             1             397.53           303.36          4215.05

---------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=   1.50
---------------------------------------------------------------------

  13        STA            1              3/16              4194.72
             1               2.47             6.27          4194.71

  13        END            1              3/16              4149.03
             1               2.47            12.26          4149.01

---------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=   1.50
---------------------------------------------------------------------

  14        STA            1              3/16              4184.52
             1             397.37           310.08          4154.05

  14        END            1              3/16              3165.56
             1             397.37           316.59          3124.52

---------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=   1.50
---------------------------------------------------------------------
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                         STAAD-III WELD DESIGN
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ALL UNITS ARE - INCH POUN

MEMBER     LOCATION/       WELD TYPE/       WELD SIZE/        COMB STRESS/
           LOADING         HOR STRESS      VERT STRESS         DIR STRESS
======================================================================


  15         STA                1                3/16               3063.26
              1                 312.64             277.83           3034.58

  15         END                1                3/16                458.35
              1                 312.64             293.71            161.47

---------------------------------------------------------------------
AX=   18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
---------------------------------------------------------------------

  16         STA                1                3/16                469.98
              1                 325.21             327.25             89.56

  16         END                1                3/16               1285.22
              1                 325.21             324.09           1200.41

---------------------------------------------------------------------
AX=   18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
---------------------------------------------------------------------

  17         STA                1                3/16               1262.90
              1                 272.81             281.57           1200.50

  17         END                1                3/16               3381.48
              1                 272.81             275.25           3359.19

---------------------------------------------------------------------
AX=   18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
---------------------------------------------------------------------

  18         STA                1                3/16               3397.02
              1                 292.05             244.85           3375.57

  18         END                1                3/16               4768.04
              1                 292.05             238.53           4753.10

---------------------------------------------------------------------
AX=   18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
---------------------------------------------------------------------

  19         STA                1                3/16               4760.38
              1                 212.27             177.97           4752.31

  19         END                1                3/16               5768.45
              1                 212.27             171.65           5761.99
```

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                      STAAD-III WELD DESIGN
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ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/     WELD TYPE/      WELD SIZE/      COMB STRESS/
         LOADING       HOR STRESS     VERT STRESS       DIR STRESS
===================================================================


-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------

  20       STA             1              3/16             5764.80
            1            147.84             123.19           5761.58

  20       END             1              3/16             6182.10
            1            147.84             119.31           6179.18

-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------

  21       STA             1              3/16             6191.99
            1            142.45             118.93           6189.21

  21       END             1              3/16             5748.71
            1            142.45             122.81           5745.63

-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------

  22       STA             1              3/16             5752.89
            1            207.82             171.30           5746.59

  22       END             1              3/16             4722.23
            1            207.82             177.62           4714.31

-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------

  23       STA             1              3/16             4728.38
            1            289.23             238.23           4713.51

  23       END             1              3/16             3375.55
            1            289.23             244.55           3354.23

-------------------------------------------------------------------
AX=  18.00 SZ=    30.00 SY=    21.00 JW=  121.50 CH=    3.00 CV=    1.50
-------------------------------------------------------------------

  24       STA             1              3/16             3210.96
            1            284.87             273.36           3186.60
```

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                       STAAD-III WELD DESIGN
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ALL UNITS ARE - INCH POUN

MEMBER    LOCATION/       WELD TYPE/         WELD SIZE/       COMB STRESS/
          LOADING         HOR STRESS       VERT STRESS        DIR STRESS
=====================================================================

  24        END              1                3/16              1292.45
             1               284.87             279.68          1229.25

--------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------

  25        STA              1                3/16              1315.24
             1               340.77             322.21          1228.78

  25        END              1                3/16               498.69
             1               340.77             325.37           163.40

--------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------

  26        STA              1                3/16               444.67
             1               310.79             298.07           110.88

  26        END              1                3/16              3190.14
             1               310.79             282.19          3162.40

--------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------

  27        STA              1                3/16              3209.00
             1               414.54             319.09          3166.07

  27        END              1                3/16              4204.24
             1               414.54             312.58          4172.06

--------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------

  28        STA              1                3/16              4155.78
             1                11.62              11.52          4155.74

  28        END              1                3/16              4126.62
             1                11.62              16.14          4126.57

--------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
--------------------------------------------------------------------
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                         STAAD-III WELD DESIGN
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ALL UNITS ARE - INCH POUN

MEMBER     LOCATION/        WELD TYPE/          WELD SIZE/          COMB STRESS/
           LOADING          HOR STRESS         VERT STRESS           DIR STRESS
=====================================================================================


   29         STA                1                  3/16                 4163.90
               1                 388.15               304.94             4134.54

   29         END                1                  3/16                 3149.31
               1                 388.15               311.45             3109.74

-----------------------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
-----------------------------------------------------------------------------------

   30         STA                1                  3/16                 3045.59
               1                 305.08               273.51             3017.90

   30         END                1                  3/16                  449.47
               1                 305.08               289.39              158.75

-----------------------------------------------------------------------------------
AX=  18.00 SZ=   30.00 SY=   21.00 JW=  121.50 CH=   3.00 CV=   1.50
-----------------------------------------------------------------------------------

   31         STA                1                  3/16                 1241.46
               1                   1.62               151.69             1232.16

   31         END                1                  3/16                  453.20
               1                   1.62               148.64              428.13

-----------------------------------------------------------------------------------
AX=  12.00 SZ=   13.33 SY=    9.33 JW=   36.00 CH=   2.00 CV=   1.00
-----------------------------------------------------------------------------------

   32         STA                1                  3/16                  450.30
               1                  42.16               133.68              427.92

   32         END                1                  3/16                 2801.76
               1                  42.16               127.58             2798.53

-----------------------------------------------------------------------------------
AX=  12.00 SZ=   13.33 SY=    9.33 JW=   36.00 CH=   2.00 CV=   1.00
-----------------------------------------------------------------------------------

   33         STA                1                  3/16                 2804.02
               1                  81.93               101.14             2800.99

   33         END                1                  3/16                 4019.78
               1                  81.93                95.04             4017.82
```

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                         STAAD-III WELD DESIGN
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ALL UNITS ARE - INCH POUN

MEMBER    LOCATION/       WELD TYPE/        WELD SIZE/        COMB STRESS/
          LOADING         HOR STRESS       VERT STRESS         DIR STRESS
===========================================================================

---------------------------------------------------------------------------
AX=   12.00 SZ=    13.33 SY=     9.33 JW=    36.00 CH=    2.00 CV=    1.00
---------------------------------------------------------------------------

   34       STA               1               3/16               4023.46
              1               117.24             67.20           4021.19

   34       END               1               3/16               4156.68
              1               117.24             61.10           4154.58

---------------------------------------------------------------------------
AX=   12.00 SZ=    13.33 SY=     9.33 JW=    36.00 CH=    2.00 CV=    1.00
---------------------------------------------------------------------------

   35       STA               1               3/16               4155.53
              1               154.64            110.28           4151.19

   35       END               1               3/16               3724.36
              1               154.64            114.03           3719.40

---------------------------------------------------------------------------
AX=   12.00 SZ=    13.33 SY=     9.33 JW=    36.00 CH=    2.00 CV=    1.00
---------------------------------------------------------------------------

   36       STA               1               3/16               3725.16
              1               155.16            114.35           3720.17

   36       END               1               3/16               4156.82
              1               155.16            110.61           4152.45

---------------------------------------------------------------------------
AX=   12.00 SZ=    13.33 SY=     9.33 JW=    36.00 CH=    2.00 CV=    1.00
---------------------------------------------------------------------------

   37       STA               1               3/16               4157.91
              1               118.07             61.31           4155.78

   37       END               1               3/16               4031.52
              1               118.07             67.41           4029.22

---------------------------------------------------------------------------
AX=   12.00 SZ=    13.33 SY=     9.33 JW=    36.00 CH=    2.00 CV=    1.00
---------------------------------------------------------------------------

   38       STA               1               3/16               4027.60
              1                82.33             95.37           4025.63
```

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                     STAAD-III WELD DESIGN
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ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/     WELD TYPE/      WELD SIZE/       COMB STRESS/
         LOADING       HOR STRESS     VERT STRESS        DIR STRESS
=====================================================================

  38       END            1              3/16              2800.77
            1              82.33          101.47            2797.72

---------------------------------------------------------------------
AX=  12.00 SZ=    13.33 SY=     9.33 JW=   36.00 CH=   2.00 CV=   1.00
---------------------------------------------------------------------

  39       STA            1              3/16              2799.01
            1              43.19          128.04            2795.75

  39       END            1              3/16               455.40
            1              43.19          134.14             433.04

---------------------------------------------------------------------
AX=  12.00 SZ=    13.33 SY=     9.33 JW=   36.00 CH=   2.00 CV=   1.00
---------------------------------------------------------------------

  40       STA            1              3/16               458.15
            1               8.06          149.26             433.08

  40       END            1              3/16              1273.51
            1               8.06          152.30            1264.34

---------------------------------------------------------------------
AX=  12.00 SZ=    13.33 SY=     9.33 JW=   36.00 CH=   2.00 CV=   1.00
---------------------------------------------------------------------

  41       STA            1              3/16              1288.36
            1              16.37          156.44            1278.72

  41       END            1              3/16               447.08
            1              16.37          153.39             419.63

---------------------------------------------------------------------
AX=  12.00 SZ=    13.33 SY=     9.33 JW=   36.00 CH=   2.00 CV=   1.00
---------------------------------------------------------------------

  42       STA            1              3/16               445.04
            1              51.17          138.14             419.95

  42       END            1              3/16              2786.61
            1              51.17          132.04            2783.01

---------------------------------------------------------------------
AX=  12.00 SZ=    13.33 SY=     9.33 JW=   36.00 CH=   2.00 CV=   1.00
---------------------------------------------------------------------
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                      STAAD-III WELD DESIGN
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ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/      WELD TYPE/        WELD SIZE/        COMB STRESS/
         LOADING        HOR STRESS        VERT STRESS        DIR STRESS
=======================================================================

  43       STA              1                3/16              2788.14
            1                89.25             104.95          2784.74

  43       END              1                3/16              4015.38
            1                89.25              98.86          4013.17

----------------------------------------------------------------------
AX=  12.00 SZ=   13.33 SY=    9.33 JW=   36.00 CH=   2.00 CV=   1.00
----------------------------------------------------------------------

  44       STA              1                3/16              4019.35
            1               123.74              70.27          4016.83

  44       END              1                3/16              4146.01
            1               123.74              64.17          4143.66

----------------------------------------------------------------------
AX=  12.00 SZ=   13.33 SY=    9.33 JW=   36.00 CH=   2.00 CV=   1.00
----------------------------------------------------------------------

  45       STA              1                3/16              4144.62
            1               160.03             113.04          4139.98

  45       END              1                3/16              3712.68
            1               160.03             116.78          3707.39

----------------------------------------------------------------------
AX=  12.00 SZ=   13.33 SY=    9.33 JW=   36.00 CH=   2.00 CV=   1.00
----------------------------------------------------------------------

  46       STA              1                3/16              3712.67
            1               158.15             116.06          3707.48

  46       END              1                3/16              4147.87
            1               158.15             112.31          4143.33

----------------------------------------------------------------------
AX=  12.00 SZ=   13.33 SY=    9.33 JW=   36.00 CH=   2.00 CV=   1.00
----------------------------------------------------------------------

  47       STA              1                3/16              4149.15
            1               121.32              62.88          4146.90

  47       END              1                3/16              4021.30
            1               121.32              68.97          4018.88
```

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                     STAAD-III WELD DESIGN
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ALL UNITS ARE - INCH POUN

MEMBER    LOCATION/      WELD TYPE/       WELD SIZE/        COMB STRESS/
          LOADING        HOR STRESS      VERT STRESS         DIR STRESS
=======================================================================


----------------------------------------------------------------------
AX=  12.00 SZ=    13.33 SY=     9.33 JW=   36.00 CH=   2.00 CV=   1.00
----------------------------------------------------------------------

   48       STA              1               3/16               4017.43
             1                86.77             97.21           4015.32

   48       END              1               3/16               2807.13
             1                86.77            103.31           2803.89

----------------------------------------------------------------------
AX=  12.00 SZ=    13.33 SY=     9.33 JW=   36.00 CH=   2.00 CV=   1.00
----------------------------------------------------------------------

   49       STA              1               3/16               2804.91
             1                47.61            130.08           2801.49

   49       END              1               3/16                459.28
             1                47.61            136.18            436.04

----------------------------------------------------------------------
AX=  12.00 SZ=    13.33 SY=     9.33 JW=   36.00 CH=   2.00 CV=   1.00
----------------------------------------------------------------------

   50       STA              1               3/16                461.67
             1                 7.26            151.26            436.13

   50       END              1               3/16               1232.16
             1                 7.26            154.31           1222.44

----------------------------------------------------------------------
AX=  12.00 SZ=    13.33 SY=     9.33 JW=   36.00 CH=   2.00 CV=   1.00
----------------------------------------------------------------------

   51       STA              1               3/16                942.78
             1                 3.85            139.90            932.34

   51       END              1               3/16               4528.17
             1                 3.85             93.74           4527.20

----------------------------------------------------------------------
AX=  12.00 SZ=    13.33 SY=     9.33 JW=   36.00 CH=   2.00 CV=   1.00
----------------------------------------------------------------------

   52       STA              1               3/16               4086.18
             1                 1.77             17.04           4086.15
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                        STAAD-III WELD DESIGN
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ALL UNITS ARE - INCH POUN

MEMBER    LOCATION/       WELD TYPE/        WELD SIZE/        COMB STRESS/
          LOADING         HOR STRESS       VERT STRESS         DIR STRESS
=======================================================================

  52        END               1               3/16              4077.46
             1                  1.77            17.56           4077.42

-----------------------------------------------------------------------
AX=  12.00 SZ=   13.33 SY=    9.33 JW=   36.00 CH=   2.00 CV=   1.00
-----------------------------------------------------------------------

  53        STA               1               3/16              4529.38
             1                  3.95            94.58           4528.39

  53        END               1               3/16               973.81
             1                  3.95           140.74            963.58

-----------------------------------------------------------------------
AX=  12.00 SZ=   13.33 SY=    9.33 JW=   36.00 CH=   2.00 CV=   1.00
-----------------------------------------------------------------------

  78        STA               1               3/16              1883.56
             1                 69.75            87.68           1880.22

  78        END               1               3/16               783.84
             1                 69.75            87.68            775.79

-----------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=   57.17 CH=   1.75 CV=   1.75
-----------------------------------------------------------------------

  79        STA               1               3/16               758.41
             1                 97.28            92.90            746.39

  79        END               1               3/16               716.96
             1                 97.28            92.90            704.23

-----------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=   57.17 CH=   1.75 CV=   1.75
-----------------------------------------------------------------------

  80        STA               1               3/16              2019.99
             1                 80.02            79.02           2016.86

  80        END               1               3/16               730.87
             1                 80.02            79.02            722.17

-----------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=   57.17 CH=   1.75 CV=   1.75
-----------------------------------------------------------------------
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                         STAAD-III WELD DESIGN
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ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/    WELD TYPE/     WELD SIZE/     COMB STRESS/
         LOADING      HOR STRESS     VERT STRESS     DIR STRESS
===================================================================

   81      STA           1             3/16             400.53
            1             93.47           93.47         378.09

   81      END           1             3/16             403.43
            1             93.47           93.47         381.16

------------------------------------------------------------------
AX=  14.00 SZ=    16.33 SY=    16.33 JW=    57.17 CH=    1.75 CV=    1.75
------------------------------------------------------------------

   82      STA           1             3/16            1889.44
            1             70.31           88.19        1886.07

   82      END           1             3/16             783.54
            1             70.31           88.19         775.38

------------------------------------------------------------------
AX=  14.00 SZ=    16.33 SY=    16.33 JW=    57.17 CH=    1.75 CV=    1.75
------------------------------------------------------------------

   83      STA           1             3/16             758.76
            1             97.24           92.86         746.75

   83      END           1             3/16             717.30
            1             97.24           92.86         704.59

------------------------------------------------------------------
AX=  14.00 SZ=    16.33 SY=    16.33 JW=    57.17 CH=    1.75 CV=    1.75
------------------------------------------------------------------

   84      STA           1             3/16            1865.48
            1             75.68           68.83        1862.67

   84      END           1             3/16             585.69
            1             75.68           68.83         576.69

------------------------------------------------------------------
AX=  14.00 SZ=    16.33 SY=    16.33 JW=    57.17 CH=    1.75 CV=    1.75
------------------------------------------------------------------

   85      STA           1             3/16             830.17
            1             93.30           93.30         819.61

   85      END           1             3/16             833.43
            1             93.30           93.30         822.92
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                         STAAD-III WELD DESIGN
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ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/     WELD TYPE/      WELD SIZE/       COMB STRESS/
         LOADING       HOR STRESS      VERT STRESS        DIR STRESS
=====================================================================

---------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=   57.17 CH=   1.75 CV=   1.75
---------------------------------------------------------------------

   86       STA             1              3/16             1862.98
             1              126.25           124.04         1854.55

   86       END             1              3/16             1142.63
             1              126.25           132.67         1127.86

---------------------------------------------------------------------
AX=   8.00 SZ=    5.33 SY=    5.33 JW=   10.67 CH=   1.00 CV=   1.00
---------------------------------------------------------------------

   87       STA             1              3/16             1775.99
             1               77.85            80.76         1772.44

   87       END             1              3/16              892.48
             1               77.85            89.38          884.57

---------------------------------------------------------------------
AX=   8.00 SZ=    5.33 SY=    5.33 JW=   10.67 CH=   1.00 CV=   1.00
---------------------------------------------------------------------

   88       STA             1              3/16             1854.32
             1              118.91           114.55         1846.95

   88       END             1              3/16             1166.06
             1              118.91           123.18         1153.42

---------------------------------------------------------------------
AX=   8.00 SZ=    5.33 SY=    5.33 JW=   10.67 CH=   1.00 CV=   1.00
---------------------------------------------------------------------

   89       STA             1              3/16             1740.45
             1               85.70            88.90         1736.07

   89       END             1              3/16              942.81
             1               85.70            97.53          933.83

---------------------------------------------------------------------
AX=   8.00 SZ=    5.33 SY=    5.33 JW=   10.67 CH=   1.00 CV=   1.00
---------------------------------------------------------------------

   90       STA             1              3/16             1869.23
             1              127.06           124.72         1860.73
```

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                      STAAD-III WELD DESIGN
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ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/      WELD TYPE/       WELD SIZE/        COMB STRESS/
         LOADING        HOR STRESS      VERT STRESS         DIR STRESS
=======================================================================

  90       END             1               3/16               1147.05
            1              127.06            133.34           1132.17

--------------------------------------------------------------------
AX=   8.00 SZ=    5.33 SY=    5.33 JW=   10.67 CH=   1.00 CV=   1.00
--------------------------------------------------------------------

  91       STA             1               3/16               1778.79
            1               82.15             86.83           1774.76

  91       END             1               3/16                927.69
            1               82.15             95.46            919.10

--------------------------------------------------------------------
AX=   8.00 SZ=    5.33 SY=    5.33 JW=   10.67 CH=   1.00 CV=   1.00
--------------------------------------------------------------------

  92       STA             1               3/16               1863.14
            1              127.94            124.78           1854.55

  92       END             1               3/16               1152.25
            1              127.94            133.40           1137.32

--------------------------------------------------------------------
AX=   8.00 SZ=    5.33 SY=    5.33 JW=   10.67 CH=   1.00 CV=   1.00
--------------------------------------------------------------------

  93       STA             1               3/16               1719.41
            1               83.94             87.34           1715.14

  93       END             1               3/16                932.99
            1               83.94             95.96            924.24

--------------------------------------------------------------------
AX=   8.00 SZ=    5.33 SY=    5.33 JW=   10.67 CH=   1.00 CV=   1.00
--------------------------------------------------------------------

  94       STA             1               3/16                  4.79
            1                0.00              0.02              4.79

  94       END             1               3/16                  0.16
            1                0.00              0.02              0.15

--------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=   57.17 CH=   1.75 CV=   1.75
--------------------------------------------------------------------
```

```
                        STAAD-III WELD DESIGN
                        *********************

ALL UNITS ARE - INCH POUN

MEMBER   LOCATION/     WELD TYPE/      WELD SIZE/      COMB STRESS/
         LOADING       HOR STRESS     VERT STRESS       DIR STRESS
====================================================================

  95       STA              1            3/16                 4.70
            1                 0.00           0.01              4.70

  95       END              1            3/16                 0.07
            1                 0.00           0.01              0.06

-------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=   57.17 CH=   1.75 CV=   1.75
-------------------------------------------------------------------

  96       STA              1            3/16                 4.67
            1                 0.00           0.00              4.67

  96       END              1            3/16                 0.04
            1                 0.00           0.00              0.04

-------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=   57.17 CH=   1.75 CV=   1.75
-------------------------------------------------------------------

  97       STA              1            3/16                 4.68
            1                 0.00           0.00              4.68

  97       END              1            3/16                 0.05
            1                 0.00           0.00              0.05

-------------------------------------------------------------------
AX=  14.00 SZ=   16.33 SY=   16.33 JW=   57.17 CH=   1.75 CV=   1.75
-------------------------------------------------------------------


****************** END OF TABULATED WELD DESIGN ******************


 91. STEEL TAKE OFF
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STEEL TAKE-OFF
--------------

PROFILE                    LENGTH(INCH)      WEIGHT(POUN)

ST   TUB 60303                 674.00           598.930
ST   TUB 40203                 534.50           305.552
ST   TUB 35353                 264.00           178.562
ST   TUB 20203                 407.29           146.385
                                          ----------------
                                  TOTAL =        1229.43

 TOTAL VOLUME OF PRISMATIC SECTIONS =        395.32 CUBIC INCH

************ END OF DATA FROM INTERNAL STORAGE ************

 92. FINISH

          *************** END OF STAAD-III ***************

            **** DATE= OCT  4,1996   TIME= 15:53:49 ****

      *****************************************************
      *        For questions on  STAAD-III,   contact:    *
      *              Research Engineers, Inc at           *
      *       Ph: (714) 974-2500   Fax:  (714) 921-2543   *
      *****************************************************
```

LIFTING LUGS

TOTAL WGHT = 1229.43 lbs = STEEL

395.32 in^3 ALUMINUM

$(395.32\ in^3)(.098\ \#/in^3) = 38.74$ lbs.

TOTAL WEIGHT OF STRUCTURE

1229.43 lbs
38.74 lbs
1268.2 lbs.

WEIGHT OF PUMPS & AIR CIRCULATORS

SAY 50 lbs / PANEL x 12 PANELS = 600 lbs.

WEIGHT OF LIGHT FIXTURES

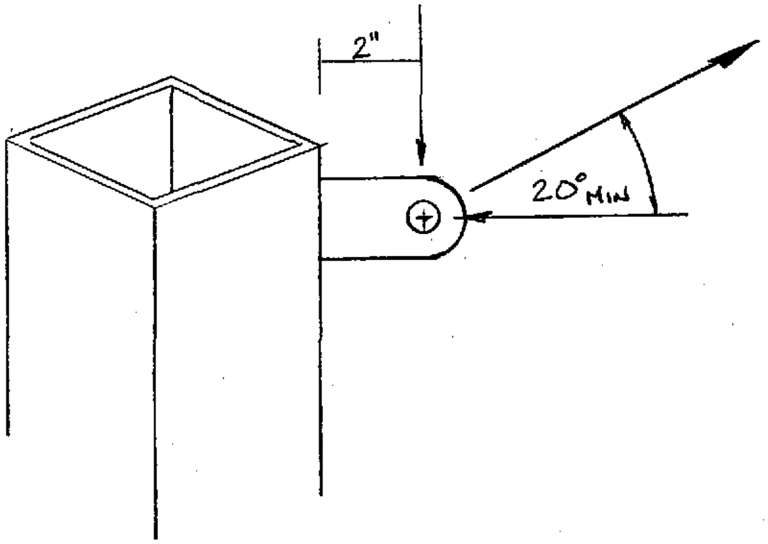
SAY 6 PANELS @ 20 lbs/PANEL = 120 lbs.

SUBTOTAL = 1268. lbs
600 lbs
120 lbs.
1988 lbs.

SAY 2500 lbs TOTAL WEIGHT
OF HAM CLNROOM.

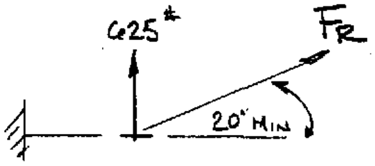
EVALUATE LUGS.

LUGS ARE USED FOR LIFTING HAM CLEANROOM
- SINGLE HOOK USED TO



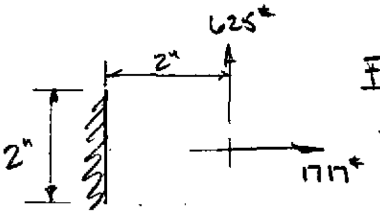
DEADWEIGHT OF HAM CLEANROOM $\hat{=}$ 2500 lbs

$$\frac{2500 \text{ lbs}}{4 \text{ Lugs}} = 625 \text{ lbs/LUG}$$



RESULTANT FORCE = 1827 lbs.
w/ 20° MIN OFFSET

∴ WORST CONDITION PER LUG IS 1827 lbs RESULTANT FORCE



FORCES @ LUG WELD

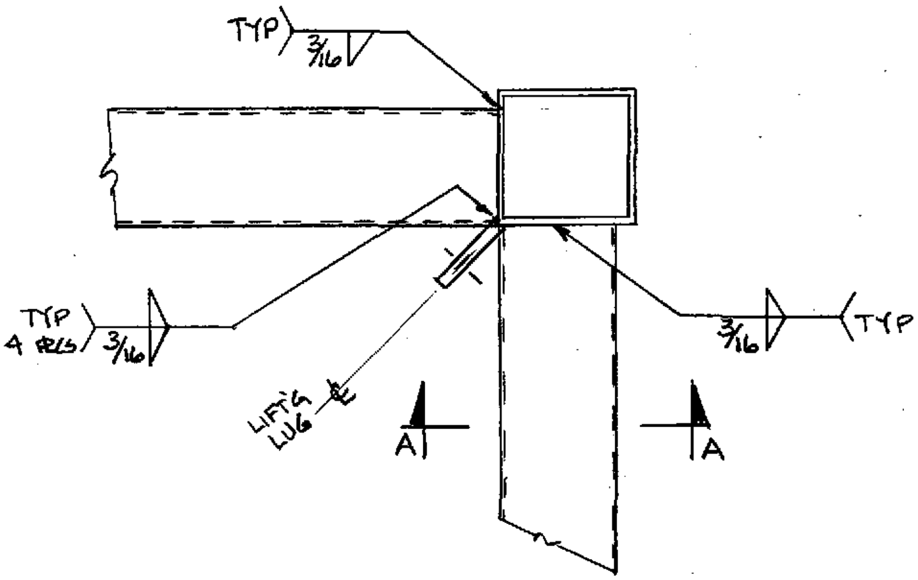
$$\text{TENSION} = 1717 \text{ lbs} + \frac{625 \text{ lbs } (2\text{in})}{2"} = 2342 \text{ lbs.}$$

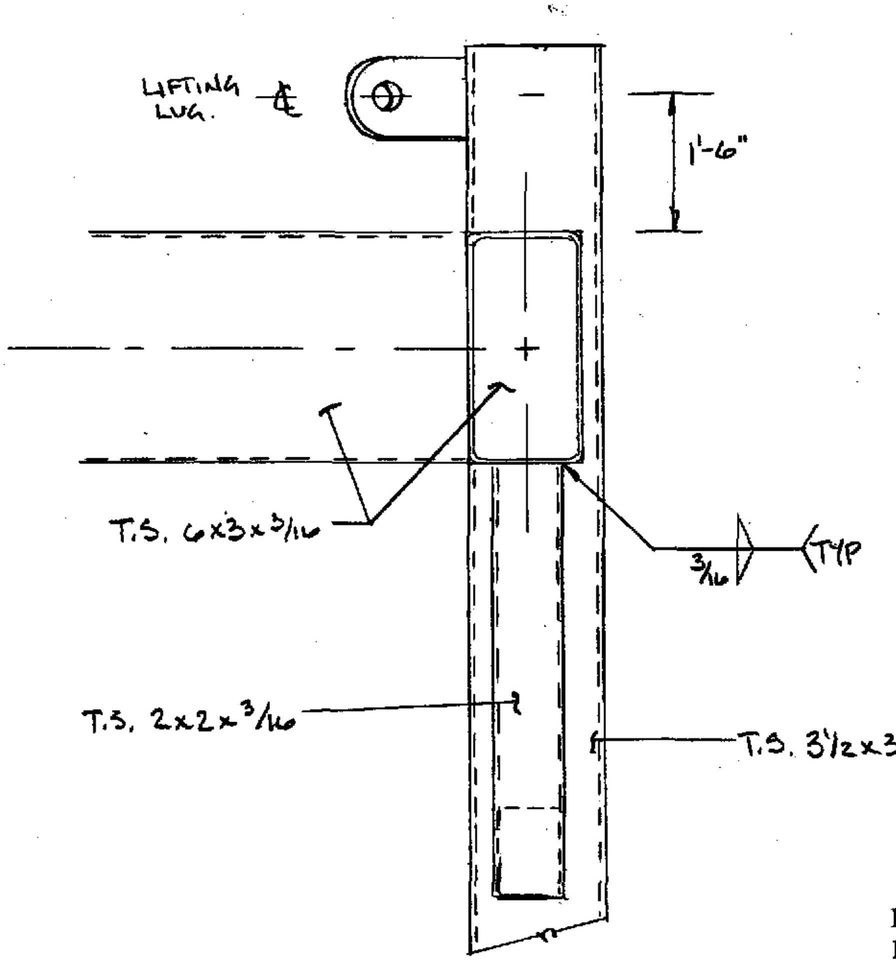
$$\text{SHEAR} = 625 \text{ lbs}$$

$$F_{WL_{TOTAL}} = \left[(2342 \text{ lbs})^2 + (625 \text{ lbs})^2\right]^{1/2} = 2424 \text{ lbs.}$$

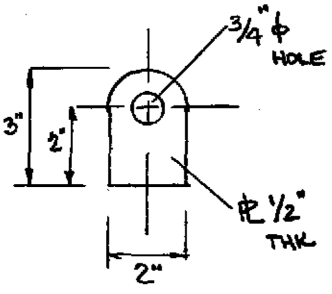
$$F_{ALLOW} = 3/16" \, (2\text{in})(2)(.707)(18000\text{psi}) = 9545 \text{ lbs.} \; \therefore$$

2 sided 3/16" fillet weld is ADEQUATE.



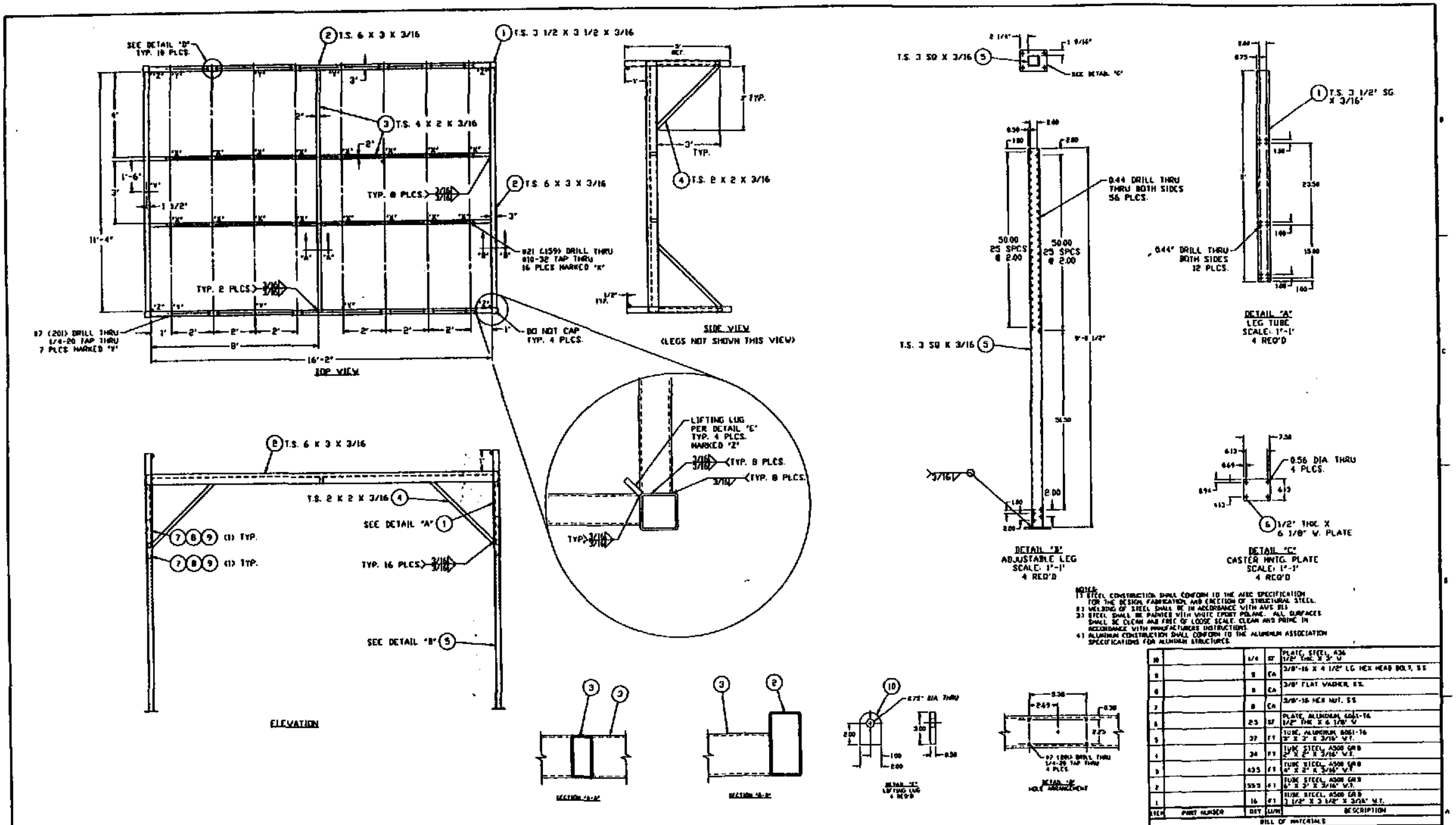


SECTION A-A



LUG DETAIL

71



NOTES:
1) STEEL CONSTRUCTION SHALL CONFORM TO THE AISC SPECIFICATION FOR THE DESIGN, FABRICATION AND ERECTION OF STRUCTURAL STEEL.
2) WELDING OF STEEL SHALL BE IN ACCORDANCE WITH AWS D1.1
3) STEEL SHALL BE PAINTED WITH WHITE EPOXY POLANE. ALL SURFACES SHALL BE CLEAN AND FREE OF LOOSE SCALE. CLEAN AND PRIME IN ACCORDANCE WITH MANUFACTURERS INSTRUCTIONS.
4) ALUMINUM CONSTRUCTION SHALL CONFORM TO THE ALUMINUM ASSOCIATION SPECIFICATIONS FOR ALUMINUM STRUCTURES.

ITEM	PART NUMBER	QTY	U/M	DESCRIPTION
10		1/4	SF	PLATE, STEEL, A36 1/2" THK. X 3" W
9		8	EA	3/8"-16 X 4 1/2" LG. HEX HEAD BOLT, SS
8		8	EA	3/8" FLAT WASHER, SS.
7		8	EA	3/8"-16 HEX NUT, SS
6		2.5	SF	PLATE, ALUMINUM, 6061-T6 1/2" THK. X 6 1/8" W
5		37	FT	TUBE, ALUMINUM, 6061-T6 3" X 3" X 3/16" W.T.
4		34	FT	TUBE, STEEL, A500 GR B 2" X 2" X 3/16" W.T.
3		43.5	FT	TUBE, STEEL, A500 GR B 4" X 2" X 3/16" W.T.
2		55.5	FT	TUBE, STEEL, A500 GR B 6" X 3" X 3/16" W.T.
1		16	FT	TUBE, STEEL, A500 GR B 3 1/2" X 3 1/2" X 3/16" W.T.

BILL OF MATERIALS

PROCESS SYSTEMS INTERNATIONAL, INC.

CLEAN ROOM STRUCTURE WELDMENT
HORIZONTAL ACCESS MODULE

LIGO VACUUM EQUIPMENT

CAD FILE	SIZE	DWG NO	REV
V0494137	D	V049-4-137	0
SCALE 1"=2'		SHEET 1 OF 1	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

DO NOT SCALE THIS DRAWING

USED ON

NEXT ASSY:

REV | DESCRIPTION | CHKD | DRWN | DATE | ECO

ISSUE DESCRIPTION

DWG NO. | DESCRIPTION | DWG NO | DESCRIPTION

REFERENCE DRAWINGS

PROPRIETARY AND CONFIDENTIAL

Revision No. 0
Doc. No. V049-1-113
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