Fermilab

Particle Physics Division
Mechanical Department Engineering Note

Number: MD-ENG- 113 Date: 08/25/06

Project Internal Reference: E954

Project: SCIBOONE

Title: MRD

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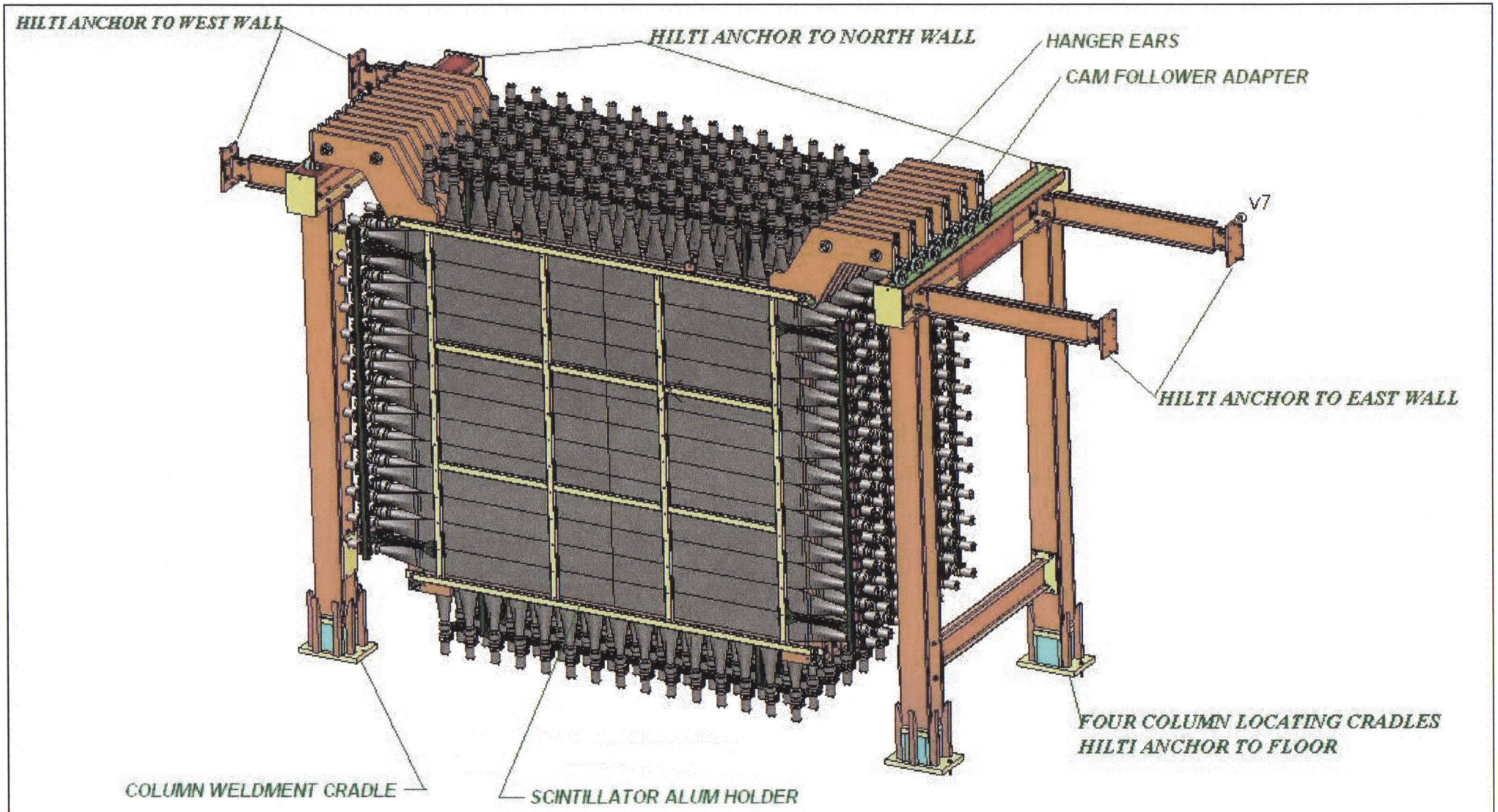
Reviewer(s): Tony Throp 9-21-06

Summary:

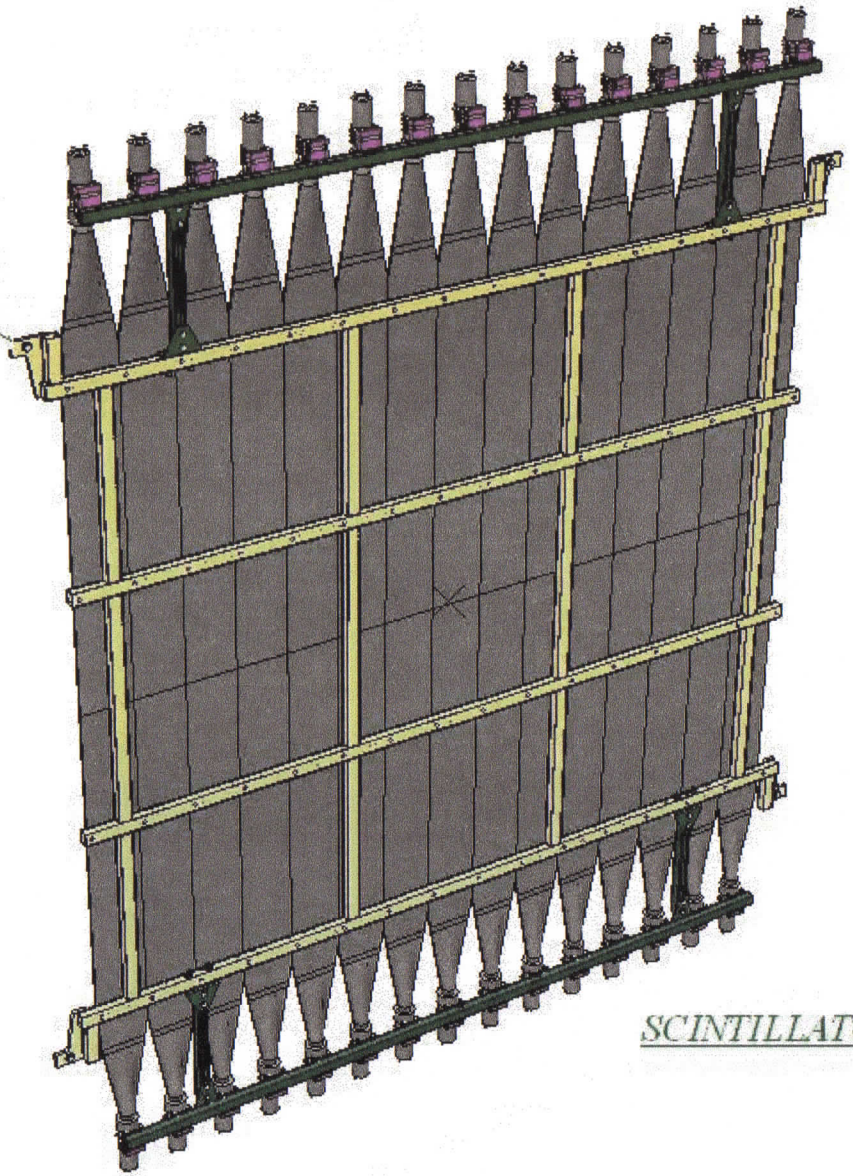
1) Scintillators will fasten to an aluminum frame.
   See attachment #1, 1a, 2 and 3
2) Each aluminum frame with scintillators will fasten to a
   2" x 9' x 10' steel plate to make a plane.
   Six vertical planes with fifteen scintillators each.
   Five horizontal planes with thirteen scintillators each.
   One horizontal and one vertical plane with thirteen
   and fifteen scintillators respectively. See attachments
   # 4, 5 and 6.
3) Each plane is to roll along the beam line (Z direction) independent
   from each other. This is to facilitate replacement of individual
   scintillators. See attachments # 7
4) The twelve planes which constitute the MRD plane assembly are
   to be fasten as close as possible to each other with tie-rods.
   See attachment # 8.
5) A stand constructed of ASTM A36 steel will support the plane
   assembly which weight approximately ~~50.4~~ 53.2 ton.
   See Attachments # 9, 10, 11 and 12.
6) SEE ATTACHMENT #13 FOR SCINS PICK FEA.



MRD BEAM-ON ASSEMBLY

ATTACHMENT #1

SCINTILLATOR VERTICAL ALUM HOLDER
SHOWN IN YELLOW
SEE ATTACHMENT #2 & 3

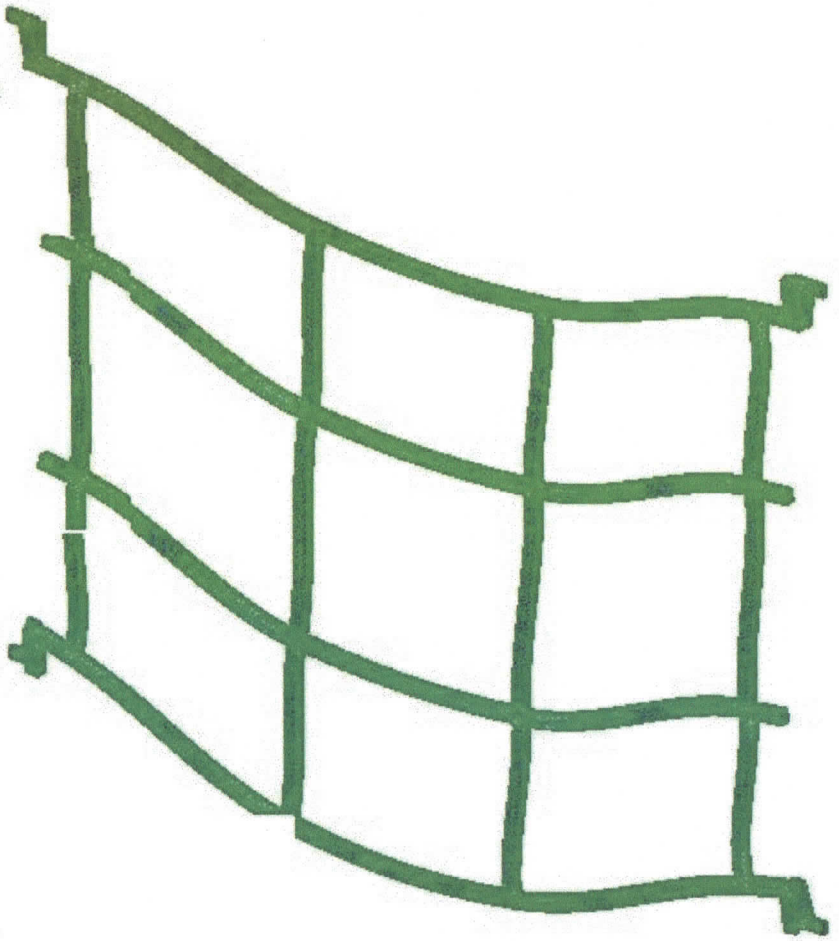


SCINTILLATOR VERTICAL ASSEMBLY

ATTACHMENT 1A

I-DEAS 12 NX Series m1: I-DEAS Visualizer

Display 1
180 LB EVENLY DISTRIBUTED VERTICALLY
B.C. 1,STRESS_2,LOAD SET 1
C:\PPD_IDM_PPD90896\EMV_SCIBOONE_MRD_FEA_08-17-06.mf1
STRESS Von Mises Averaged Top shell
Min: 3.03E-01 lbf/in^2 Max: 1.85E+03 lbf/in^2
B.C. 1,DISPLACEMENT_1,LOAD SET 1
C:\PPD_IDM_PPD90896\EMV_SCIBOONE_MRD_FEA_08-17-06.mf1
DISPLACEMENT XYZ Magnitude
Min: 0.00E+00 in Max: 2.96E-02 in
Part Coordinate System



lbf/in^2
1.85E+03
1.75E+03
1.66E+03
1.57E+03
1.48E+03
1.38E+03
1.29E+03
1.20E+03
1.11E+03
1.02E+03
9.23E+02
8.31E+02
7.39E+02
6.46E+02
5.54E+02
4.62E+02
3.70E+02
2.77E+02
1.85E+02
9.26E+01
3.03E-01

SCINT ALUM HOLDER VERTICAL POSITION

FULLY RESTRAINED ALL FOUR CORNERS

180 LBS EVENLY DISTRIBUTED ON FAR SURFACES

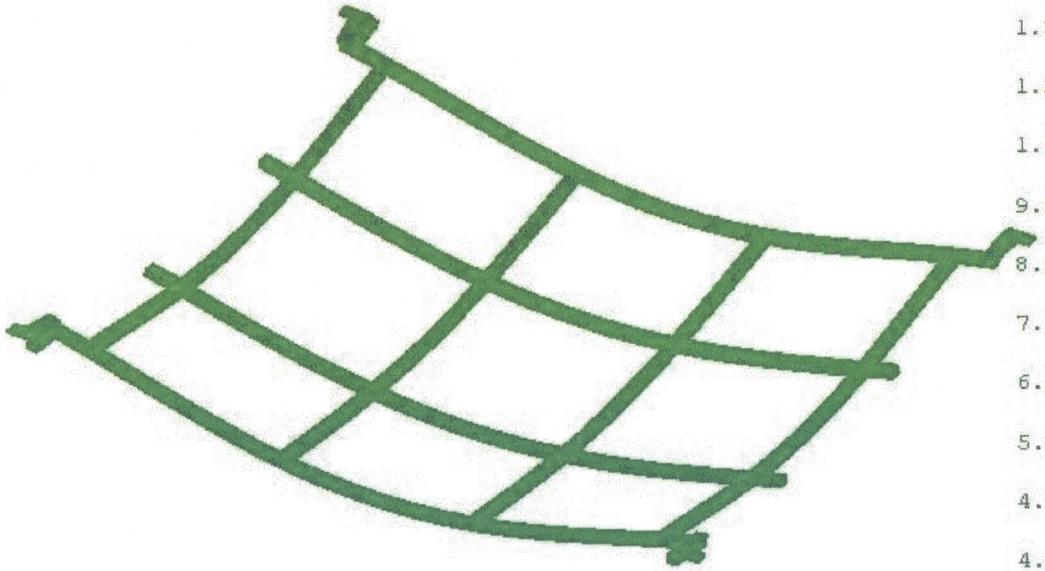
MATERIAL: ALUM 6061-T6 RECT TUBE 1.5x2x.125 WALL
YIELD STRESS = 35000 PSI

ATTACHMENT #2

I-DEAS 12 NX Series m1: I-DEAS Visualizer

Display 1
180_LB_EVENLY_DISTRIBUTED
B.C. 1,STRESS_2,LOAD SET 1
C:\PPD_IDM_PPD90896\EMV_SCIBOONE_MRD_FEA_08-17-06.mf1
STRESS Von Mises Averaged Top shell
Min: 5.40E-01 lbf/in^2 Max: 2.00E+04 lbf/in^2
B.C. 1,DISPLACEMENT_1,LOAD SET 1
C:\PPD_IDM_PPD90896\EMV_SCIBOONE_MRD_FEA_08-17-06.mf1
DISPLACEMENT XYZ Magnitude
Min: 0.00E+00 in Max: 3.59E-01 in
Part Coordinate System

WHEN ROTATING FROM HORIZONTAL TO VERTICAL A STRONG BACK SHOULD BE USED TO ALLEVIATE THE POSSIBILTY OF CRAZING THE SCINTILLATOR PADDLE



lbf/in^2
2.00E+04
1.90E+04
1.80E+04
1.70E+04
1.60E+04
1.50E+04
1.40E+04
1.30E+04
1.20E+04
1.10E+04
9.99E+03
8.99E+03
7.99E+03
6.99E+03
5.99E+03
4.99E+03
4.00E+03
3.00E+03
2.00E+03
9.99E+02
5.40E-01

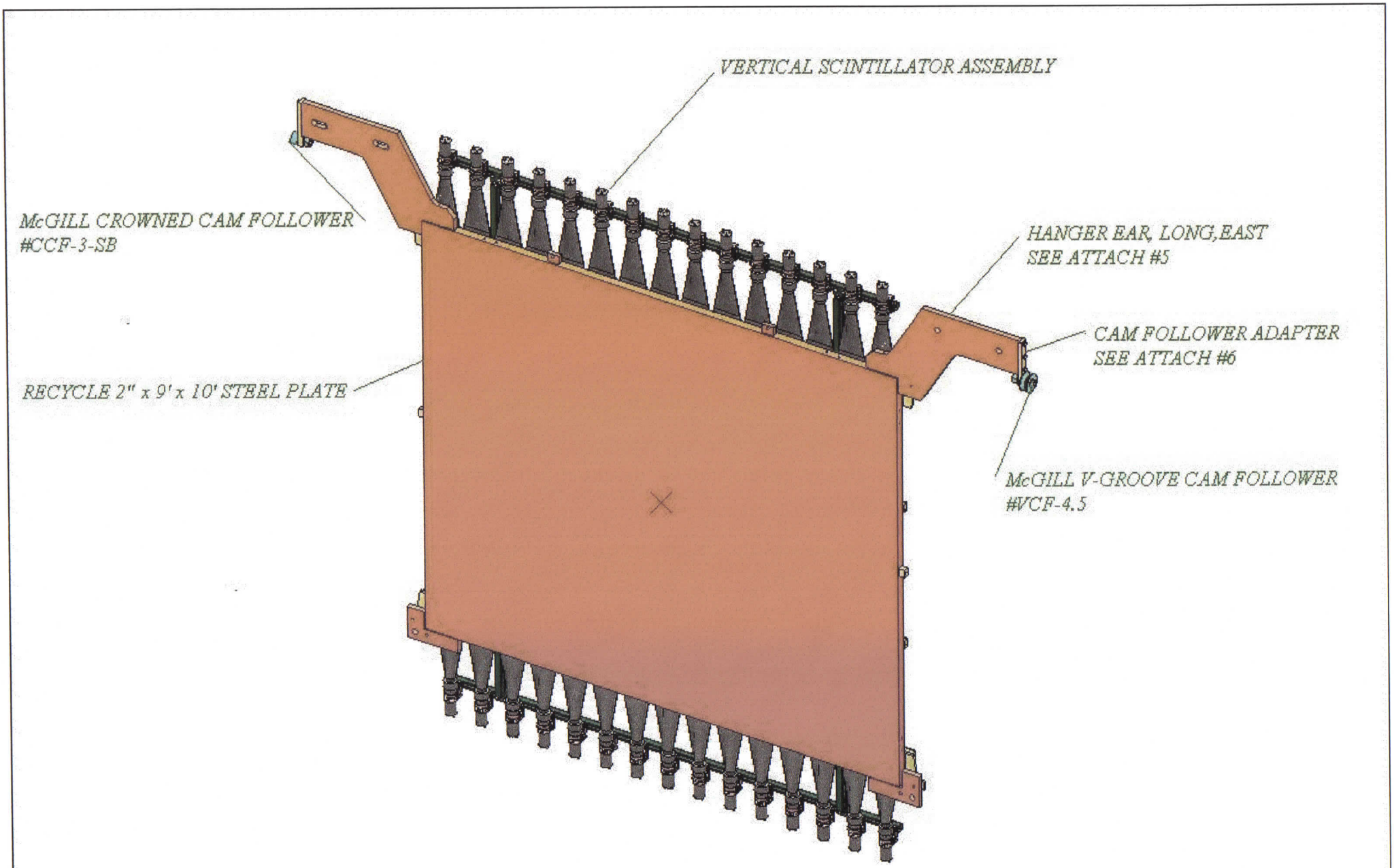
SCINT ALUM HOLDER HORIZ POSITION

TWO CORNERS RESTRAINT IN XYZ
TWO CORNERS RESTRAINT IN Y

180 LBS EVENLY DISTRIBUTED

MATERIAL: ALUMINUM 6060-T6 RECT TUBE 1.5 x 2 x .125 WALL
YIELD STESS=35000 PSI

ATTACHMENT #3

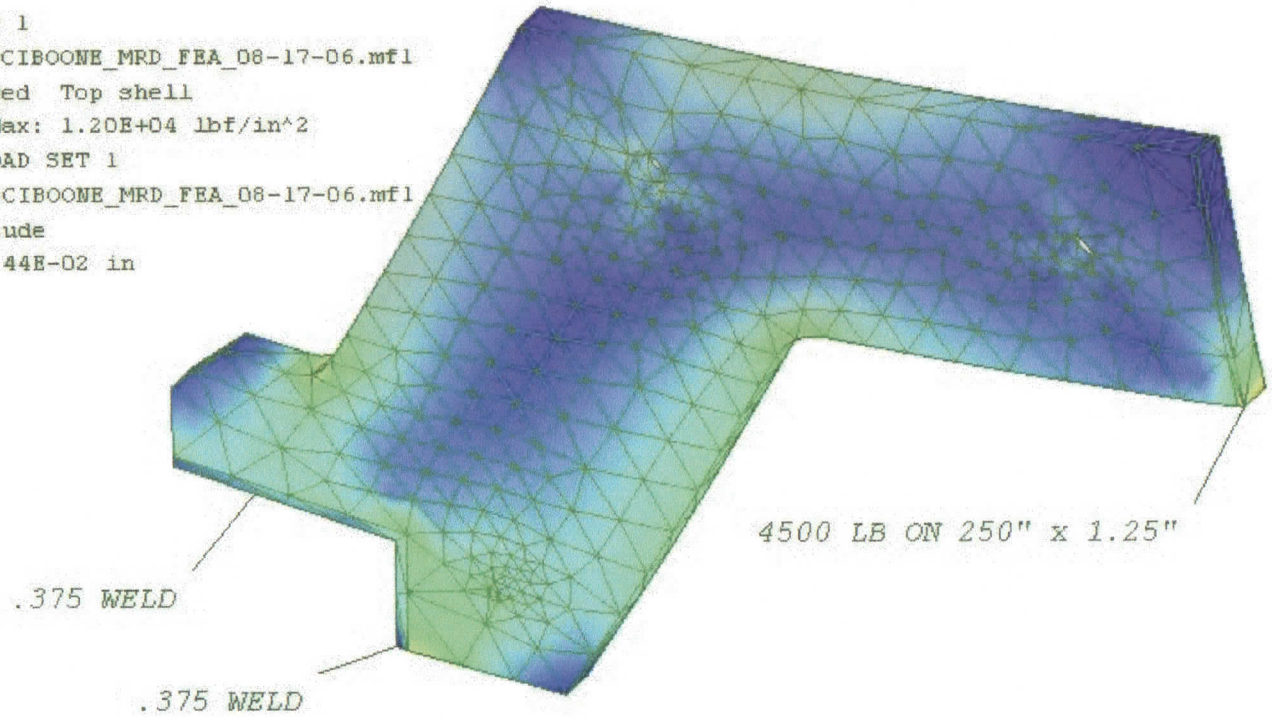


MRD VERTICAL PLANE ASSY

ATTACHMENT #4

I-DEAS 12 NX Series m1: I-DEAS Visualizer

Display 1
4500 LB LOAD
B.C. 1,STRESS_2,LOAD SET 1
C:\PPD_IDM_PPD90896\EMV_SCIBOONE_MRD_FEA_08-17-06.mf1
STRESS Von Mises Averaged Top shell
Min: 2.16E-04 lbf/in^2 Max: 1.20E+04 lbf/in^2
B.C. 1,DISPLACEMENT_1,LOAD SET 1
C:\PPD_IDM_PPD90896\EMV_SCIBOONE_MRD_FEA_08-17-06.mf1
DISPLACEMENT XYZ Magnitude
Min: 0.00E+00 in Max: 2.44E-02 in
Part Coordinate System



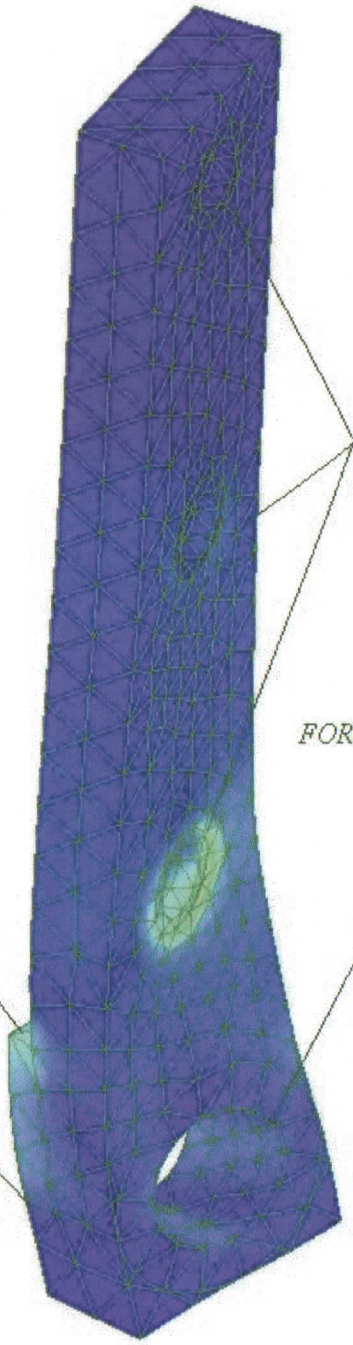
lbf/in^2
1.20E+04
1.14E+04
1.08E+04
1.02E+04
9.57E+03
8.97E+03
8.38E+03
7.78E+03
7.18E+03
6.58E+03
5.98E+03
5.38E+03
4.79E+03
4.19E+03
3.59E+03
2.99E+03
2.39E+03
1.79E+03
1.20E+03
5.98E+02
2.16E-04

HANGER EAR EAST LONG
MATERIAL: STEEL ASTM A36
YIELD STRESS = 36000 PSI

ATTACHMENT #5

I-DEAS 12 NX Series m1: I-DEAS Visualizer

Display 1
SLIDING_LOAD_AT_4_DEG_.05x4500=225LB
B.C. 1,STRESS_2,LOAD SET 1
C:\PPD_IDM_PPD90896\EMV_SCIBOONE_MRD_FEA_08-17-06.mf1
STRESS Von Mises Averaged Top shell
Min: 4.97E-01 lbf/in^2 Max: 1.55E+04 lbf/in^2
B.C. 1,DISPLACEMENT_1,LOAD SET 1
C:\PPD_IDM_PPD90896\EMV_SCIBOONE_MRD_FEA_08-17-06.mf1
DISPLACEMENT XYZ Magnitude
Min: 0.00E+00 in Max: 9.80E-04 in
Part Coordinate System



lbf/in^2
1.55E+04
1.47E+04
1.39E+04
1.31E+04
1.24E+04
1.16E+04
1.08E+04
1.01E+04
9.28E+03
8.50E+03
7.73E+03
6.96E+03
6.18E+03
5.41E+03
4.64E+03
3.87E+03
3.09E+03
2.32E+03
1.55E+03
7.74E+02
4.97E-01

BOLTED SURFACES
XYZ RESTRAINTS

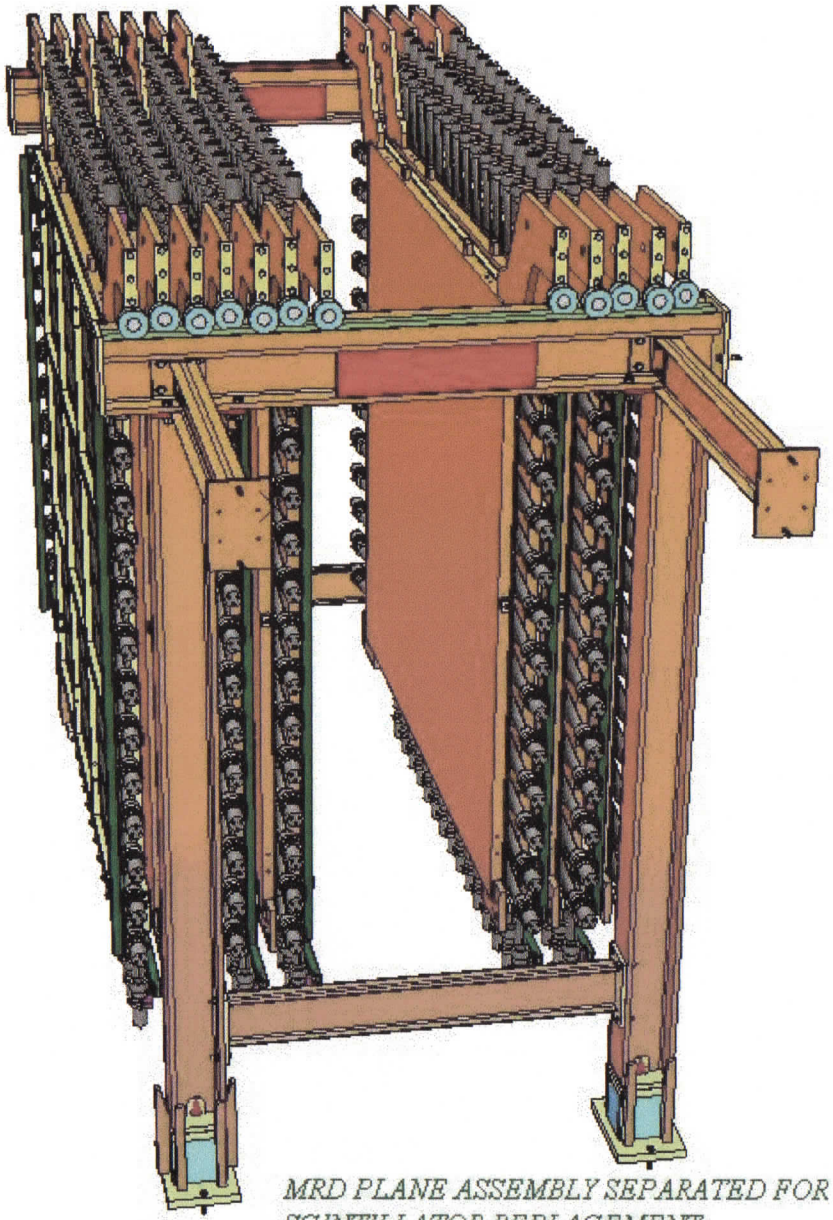
Y RESTRAINT

FORCE ALONG -Z-.05X4500=225 LBS

FORCE ALONG X=SIN4DEG x 225=16 LB

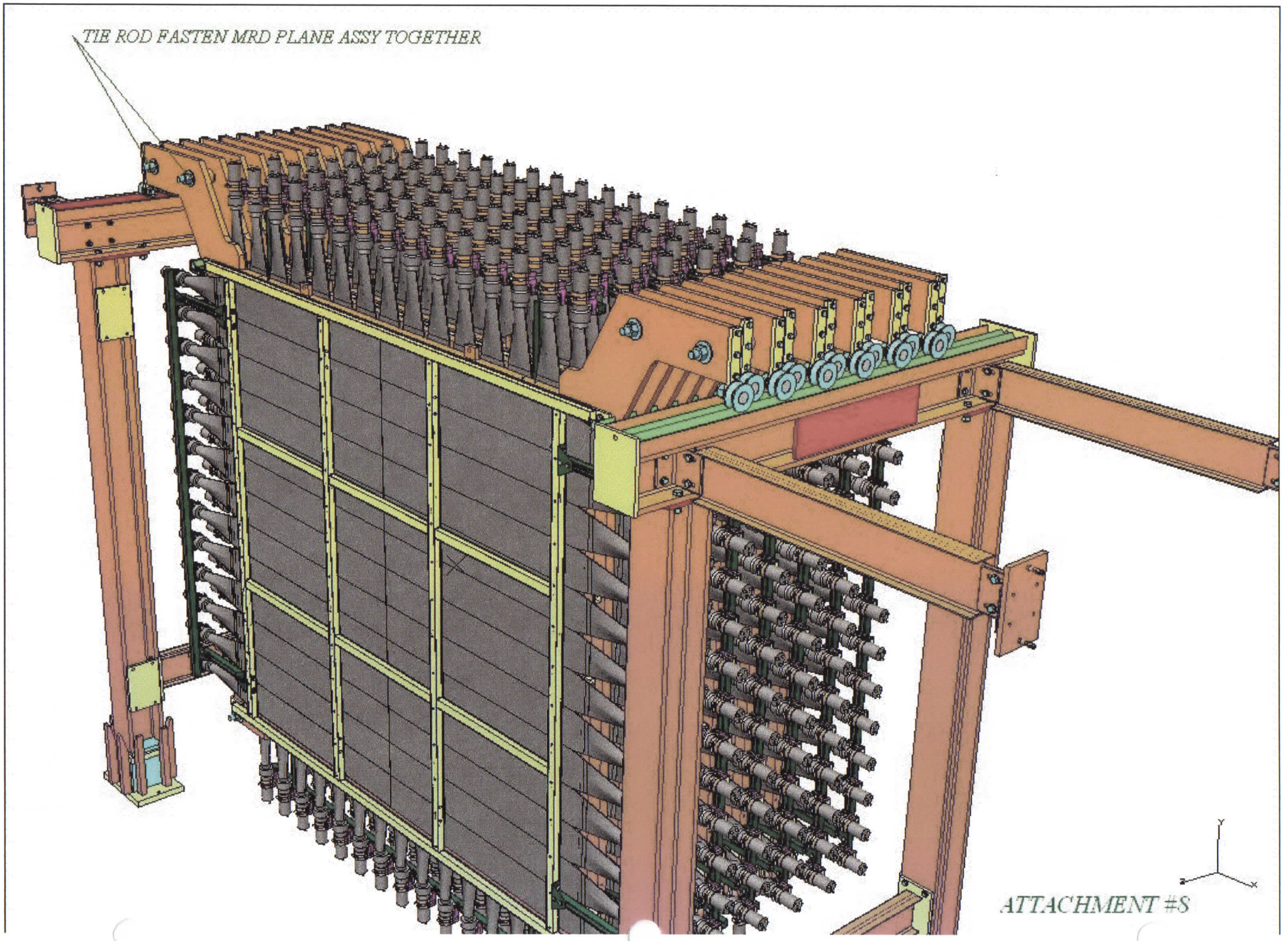
CAM FOLLOWER ADAPTER
MATERIAL: STEEL ASTM A36
YIELD STRESS = 36000 PSI

ATTACHMENT #6



MRD PLANE ASSEMBLY SEPARATED FOR SCINTILLATOR REPLACEMENT

ATTACHMENT #7



ATTACHMENT #S

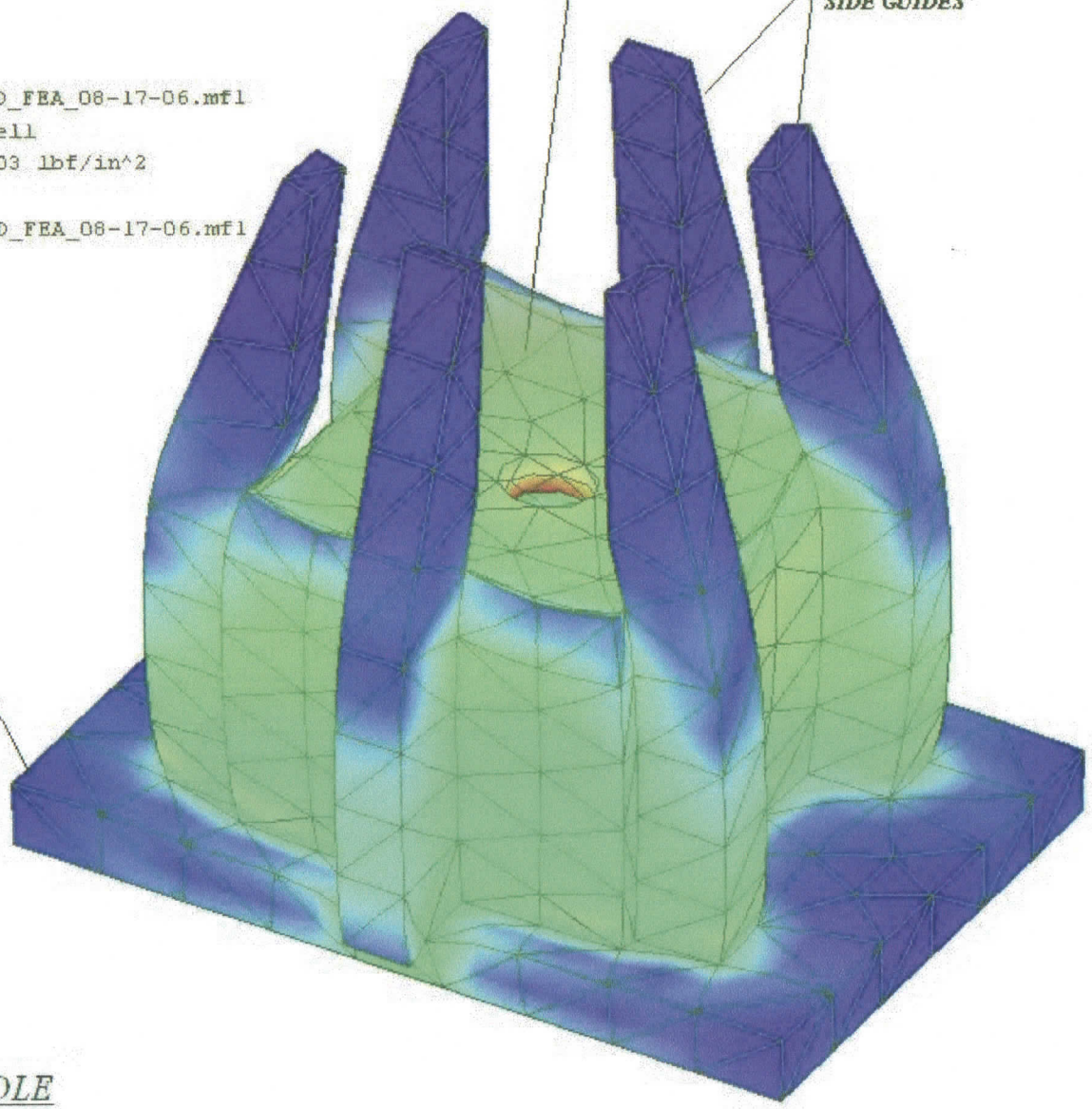
I-DEAS 12 NX Series m1: I-DEAS Visualizer

Display 1
27_TON_LOAD
B.C. 1,STRESS_2,LOAD SET 1
C:\PPD_IDM_PPD90896\EMV_SCIBOONE_MRD_FEA_08-17-06.mf1
STRESS Von Mises Averaged Top shell
Min: 5.43E-03 lbf/in^2 Max: 1.05E+03 lbf/in^2
B.C. 1,DISPLACEMENT_1,LOAD SET 1
C:\PPD_IDM_PPD90896\EMV_SCIBOONE_MRD_FEA_08-17-06.mf1
DISPLACEMENT XYZ Magnitude
Min: 0.00E+00 in Max: 2.36E-04 in
Part Coordinate System

27 TON (54000 #) APPLIED VERTICALLY ON A 8.5" x 8.5" TOP SUFACE

1.5 x 2" x 16.25 SIDE GUIDES

1.5" x 12" x 18" PLATE RESTS ON CONCRETE FLOOR



lbf/in^2
1.05E+03
9.99E+02
9.46E+02
8.94E+02
8.41E+02
7.88E+02
7.36E+02
6.83E+02
6.31E+02
5.78E+02
5.26E+02
4.73E+02
4.21E+02
3.68E+02
3.15E+02
2.63E+02
2.10E+02
1.58E+02
1.05E+02
5.26E+01
5.43E-03

Y
Z
X

COLUMN WELDMENT CRADLE

MATERIAL: STEEL ASTM A36
YIELD STRESS = 36000 PSI

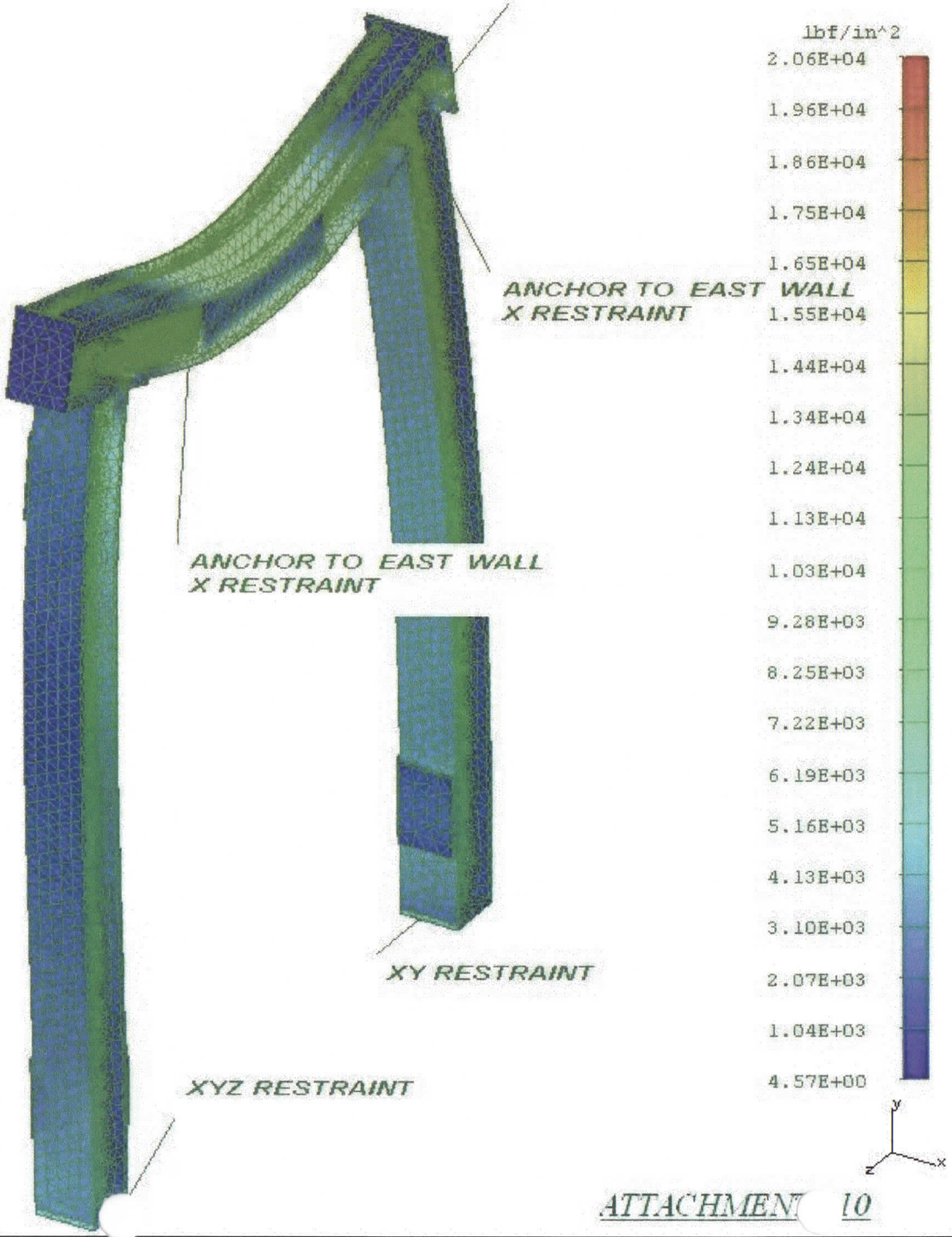
ATTACHMENT 9

I-DEAS 12 NX Series m1: I-DEAS Visualizer

Display 1
27_TON_CENTER_LOAD
B.C. 1,STRESS_2,LOAD SET 1
C:\PPD_IDM_PPD90896\EMV_SCIBOONE_MRD_FEA_08-17-06.mf1
STRESS Von Mises Averaged Top shell
Min: 4.57E+00 lbf/in^2 Max: 2.06E+04 lbf/in^2
B.C. 1,DISPLACEMENT_1,LOAD SET 1
C:\PPD_IDM_PPD90896\EMV_SCIBOONE_MRD_FEA_08-17-06.mf1
DISPLACEMENT XYZ Magnitude
Min: 0.00E+00 in Max: 7.28E-02 in
Part Coordinate System

27 TON DISTRIBUTED ON 30 INCHES LOCATED ON MID-SPAN OF HORIZONTALLY BEAM

MATERIAL: W8x67 ASTM A36 STEEL
YIELD STRESS = 36000 PSI



ATTACHMENT 10

I-DEAS 12 NX Series m1: I-DEAS Visualizer

Display 1
8-RESTRAINTS_SUDDEN_STOP
B.C. 1,STRESS_3,LOAD SET 1
C:\PPD_IDM_PPD90896\EMV_SCIBOONE_MRD_FEA_08-17-06.mf1
STRESS Von Mises Averaged Top shell
Beam stress: Von Mises , maximum point
Min: 5.65E-12 lbf/in^2 Max: 1.38E+04 lbf/in^2
Part Coordinate System

APPLIED LOADS

Y DIRECTION = 50.4 TON SCINT. WT. (APPLIED @ MID SPAN OF HORIZ BEAM)

Y DIRECTION @ C.G = 3.2 TON DUE TO SUPPORT STAND WT.

X DIRECTON = Ma = Wa/g = 50.4 x 10 x 5280 / 32.16 x 60 x 60 = 23 TON (ACCEL @ 10 MPH AND SUDDEN STOP)

X DIRECTION @ C.G. = 3.2 x 10 x 5280/32.16 x 60 x 60 = 1.46 TON (TRANSLATIONAL ACCEL. OF SUPPORT STAND @ 10 MPH AND SUDDEN STOP)

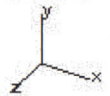
lbf/in^2
1.38E+04
1.31E+04
1.24E+04
1.17E+04
1.10E+04
1.04E+04
9.66E+03
8.97E+03
8.28E+03
7.59E+03
6.90E+03
6.21E+03
5.52E+03
4.83E+03
4.14E+03
3.45E+03
2.76E+03
2.07E+03
1.38E+03
6.90E+02
5.65E-12

EIGHT TIE-DOWNS FOR TRANSPORT EACH APPLIES XYZ RESTRAINTS

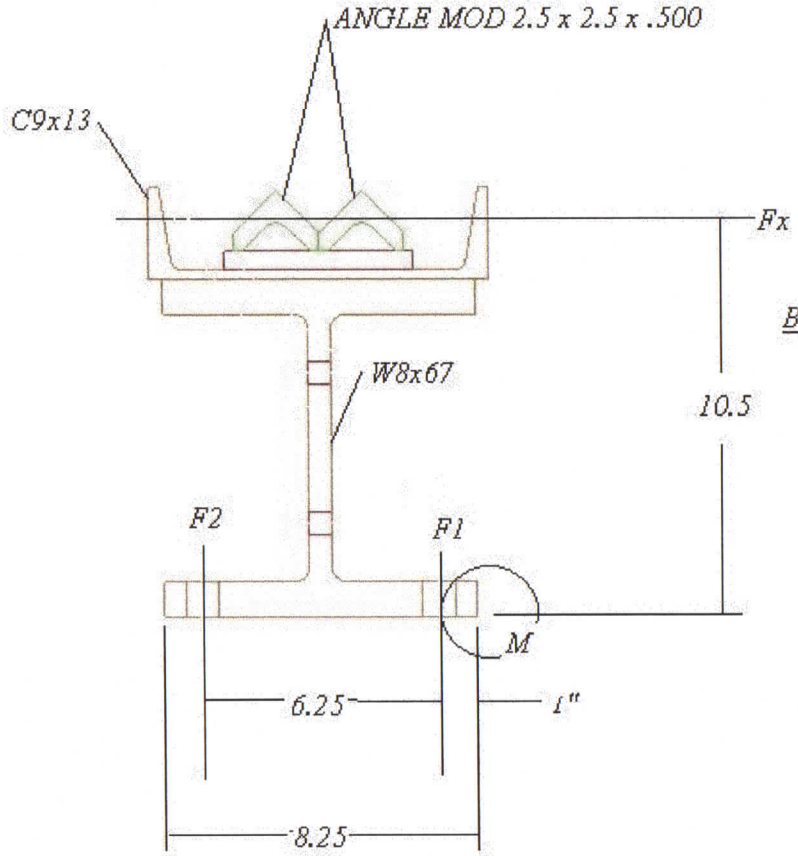
EACH LEG IS RESTAINED IN Y DIRECTON

MRD ASSEMBLY IN TRANSPORT MODE

ASSUMES MRD IS SOLIDLY ANCHOR TO HORIZONTAL BEAM



ATTACHMENT 11



BOLT CONNECTIONS BETWEEN HORIZONTAL BEAM AND COLUMNS

Assuming 10 mph in x direction, and scintillator weight of 50.4 tons
then Fx = Ma = Wa/g = 50.4 x 2000 x 10 5280 /2 x 32.16 x 60 x 60 =46000 #

moment @ M = 10.5 x 46000 = 483000 in-lb

but M is also = F1 + 7.25F2 where F1 = F2/7.25

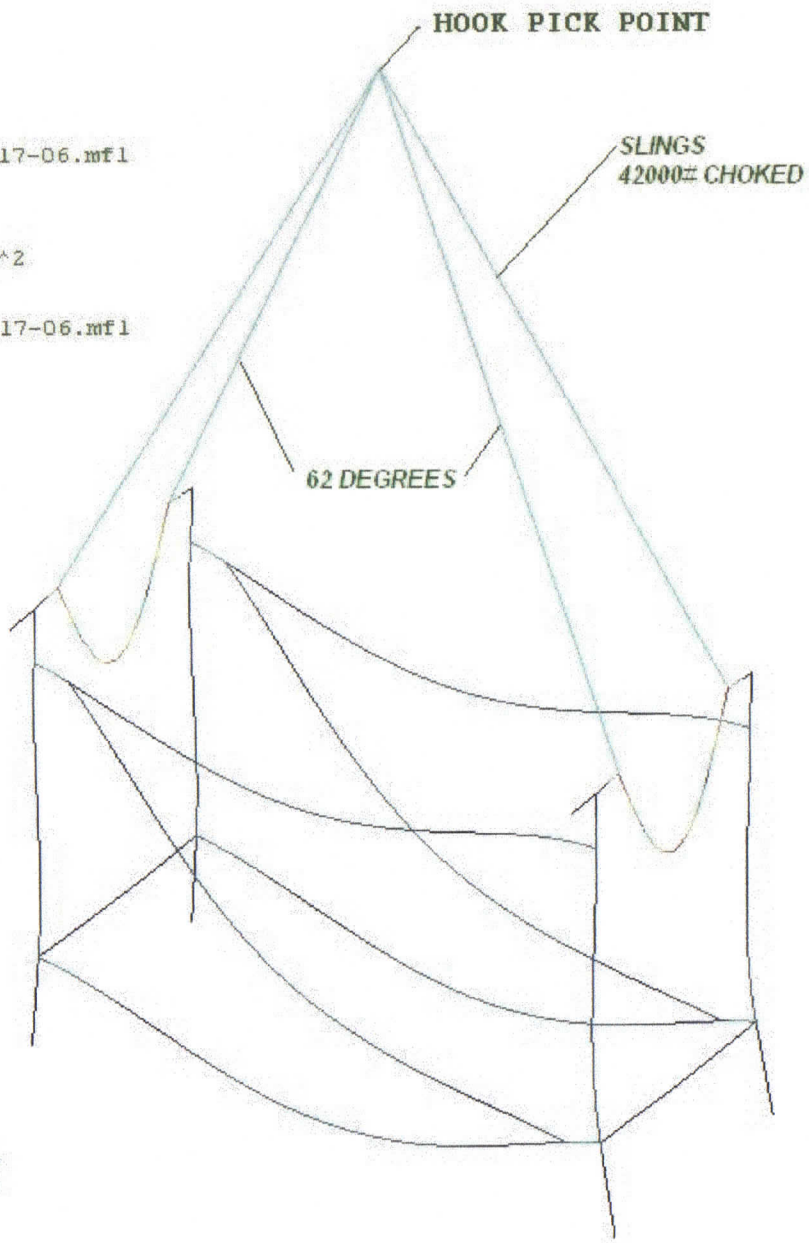
then M = F2/7.25 + 7.25F2
7.25M = F2 + 7.25 x 7.25F2
7.25M = 53.563F2
F2 = 7.25 X 483000/53.563
= 65400 #

Since F2 is held by four grade eight 3/4-10 bolts and nuts (allowable 24000#/bolt) each bolt carries 654000/4 = 16350 #

ATTACHMENT #12

I-DEAS 12 NX Series m1: I-DEAS Visualizer

Display 1
SLING_PICK_62_DEGREES
B.C. 1,STRESS_3,LOAD SET 1
C:\PPD_IDM_PPD90896\EMV_SCIBOONE_MRD_FEA_08-17-06.mf1
STRESS Von Mises Averaged Top shell
Beam stress: Von Mises , maximum point
Min: 4.90E-14 lbf/in^2 Max: 1.90E+03 lbf/in^2
B.C. 1,DISPLACEMENT_1,LOAD SET 1
C:\PPD_IDM_PPD90896\EMV_SCIBOONE_MRD_FEA_08-17-06.mf1
DISPLACEMENT XYZ Magnitude
Min: 0.00E+00 in Max: 7.89E-03 in
Part Coordinate System



lbf/in^2
1.90E+03
1.80E+03
1.71E+03
1.61E+03
1.52E+03
1.42E+03
1.33E+03
1.23E+03
1.14E+03
1.04E+03
9.48E+02
8.53E+02
7.59E+02
6.64E+02
5.69E+02
4.74E+02
3.79E+02
2.84E+02
1.90E+02
9.48E+01
4.90E-14

MRD LOAD = 53.2 TON
SUPT STAND = 3.8 TON (GRAVITY)

MRD 62 DEG SLING PICK

ATTACHMENT #13