Fermilab

Particle Physics Division
Mechanical Department Engineering Note

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

Project Internal Reference: E954

Project: SCIBOONE

Title: MRD

Author(s): E.M. VILLEGAS

Reviewer(s): 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~~ 53.2 ton. See Attachments # 9, 10, 11 and 12.
6) SEE ATTACHMENT #13 FOR SCINT PICK FEA.

Fermilab

Particle Physics Division
Mechanical Department Engineering Note

Number: MD-ENG-113 Date: 08/29/06

Project Internal Reference: E954

Project: SCIBOONE

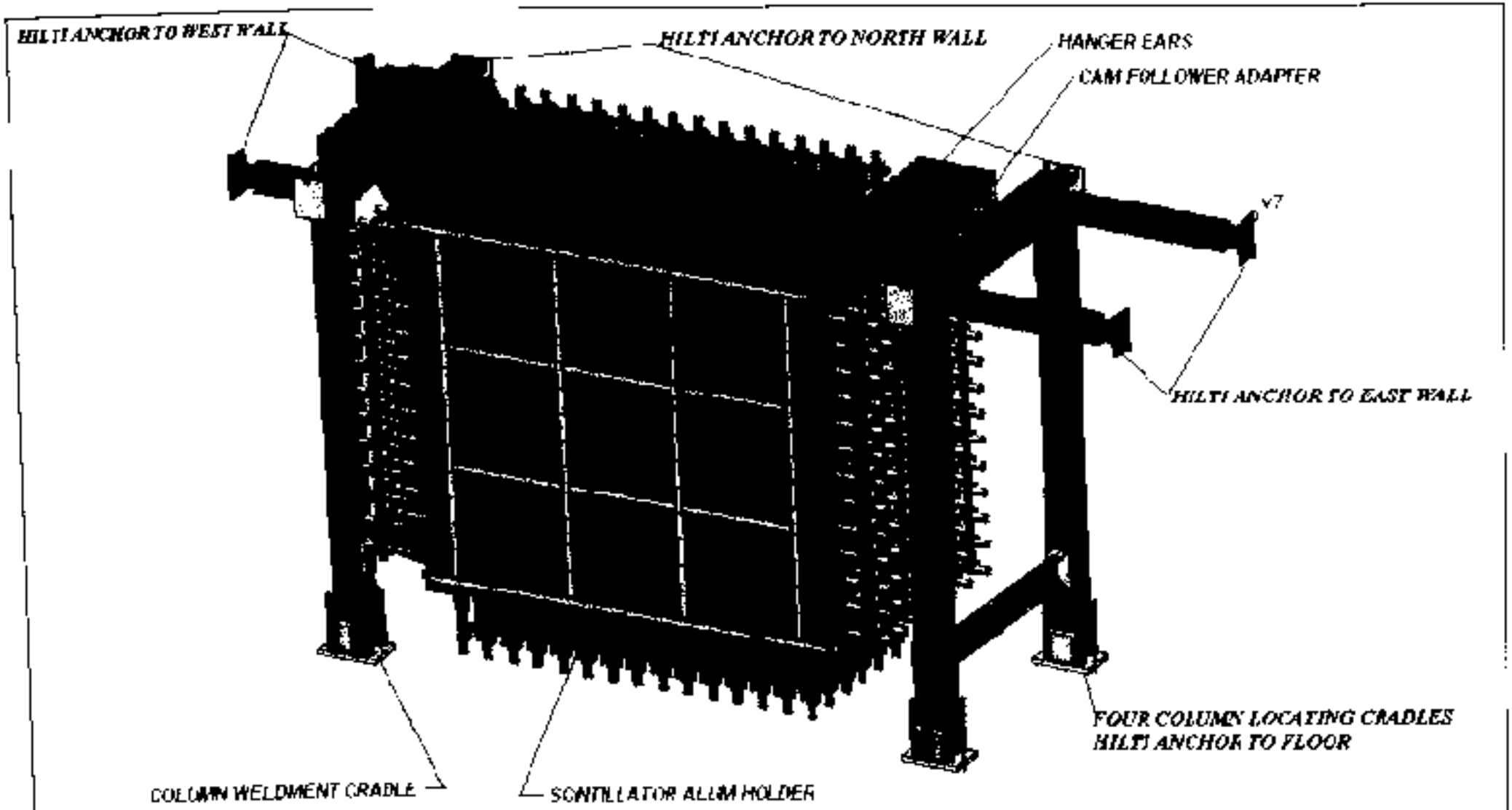
Title: MRD

Author(s): E.M. VILLEGAS

Reviewer(s): ZHIJING TANG 9/21/06

Summary:

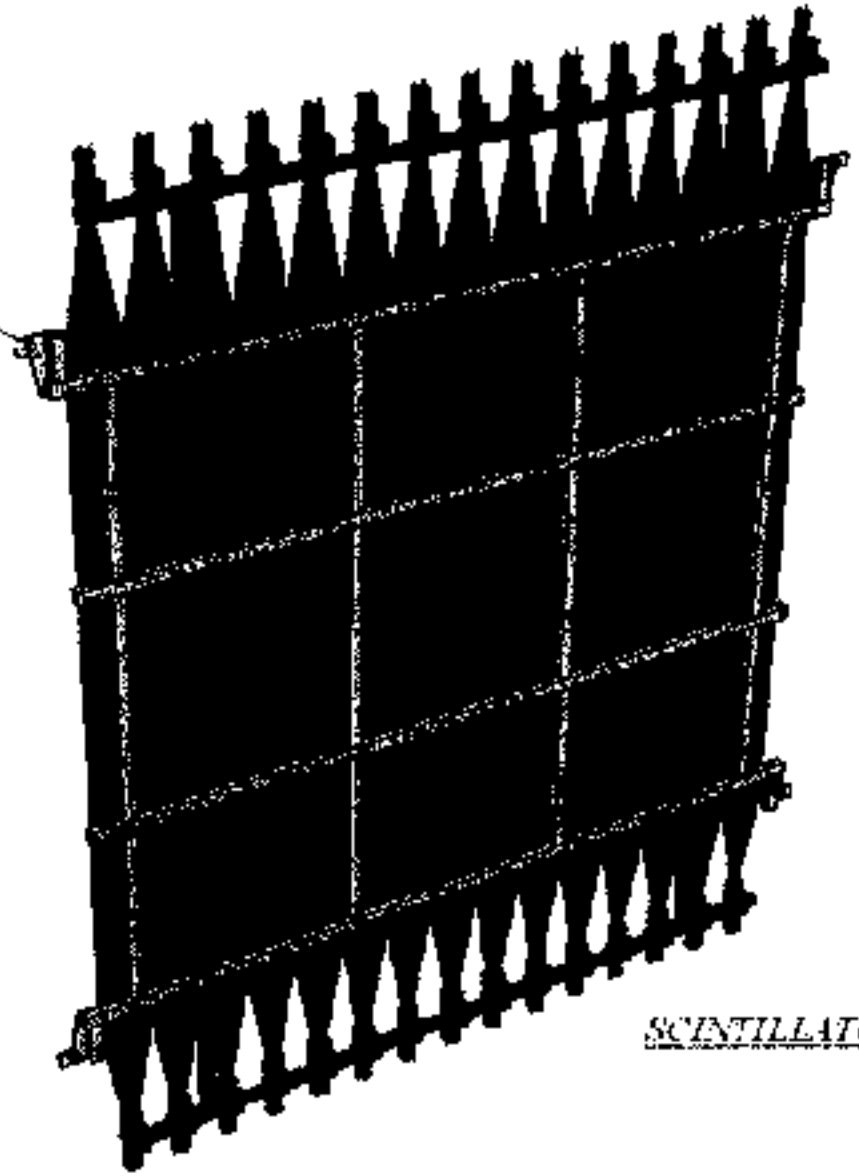
1) Scintillators will fasten to an aluminum frame
   See attachment #1, 1a, 2 and 3
2) Each aluminum frame with scintillators will fasten to a
   2" x 9' x 10' steel plate to make a plane.
   Six vertical planes with fifteen scintillators each
   Five horizontal planes with thirteen scintillators each
   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 53.2 ton.
   See Attachments # 9, 10, 11 and 12.
6) See attachment #13 for sling pick FEA



MRD BEAM-ON ASSEMBLY

ATTACHMENT = 1

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

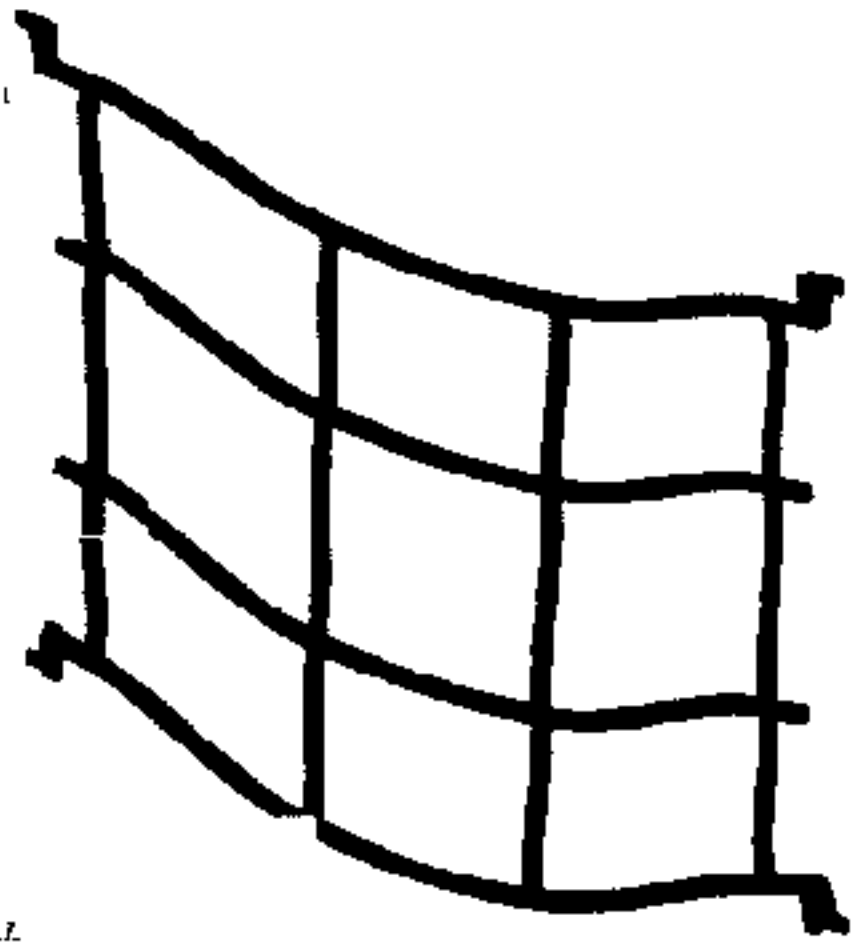


SCINTILLATOR VERTICAL ASSEMBLY

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_SCIBOCNE_MRD_FEA_08-17-06.mf1
STRESS Von Mises Averaged Top shell
Min: 0.03E-01 lbf/in^2 Max: 1.85E+03 lbf/in^2
B.C. 1,DISPLACEMENT_1,LOAD SET 1
C:\PPD IDM_PPD90896\EMV_SCIPOCNE_MRD_FEA_08-17-06.mf1
DISPLACEMENT XYZ Magnitude
Min 0.00E+00 in Max: 2.96E-02 in
Base Coordinate System



lbf/in^2
1.85E+03
1.79E+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
9.29E+02
8.11E+02
7.19E+02
6.46E+02
5.54E+02
4.62E+02
3.70E+02
2.77E+02
1.85E+02
9.24E+01
0.00E+01

SCINT ALUM HOLDER VERTICAL POSITION

FULLY RESTRAINED ALL FOUR CORNERS

180 LBS EVENLY DISTRIBUTED ON FAR SURFACES

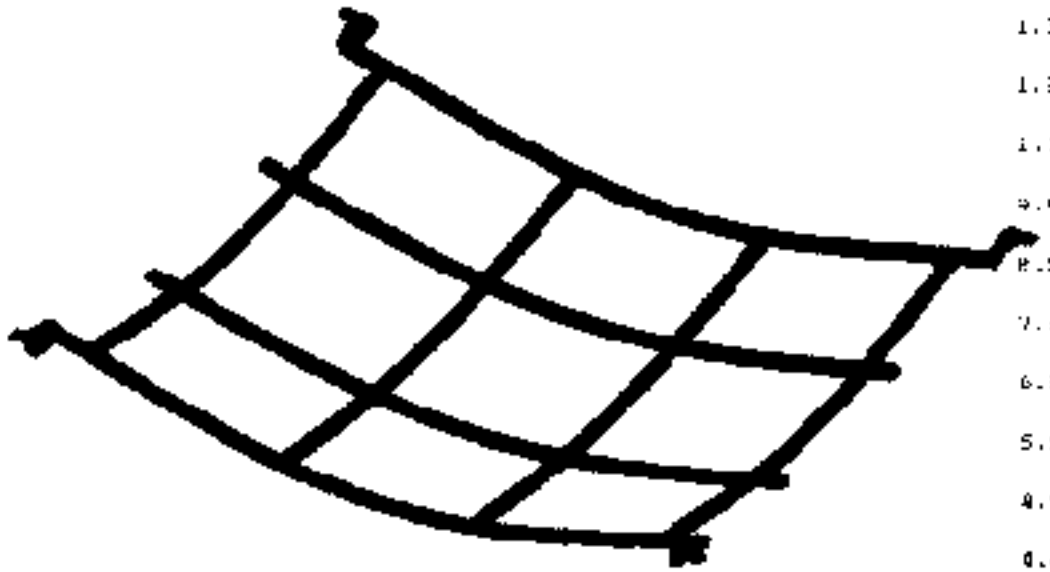
MATERIAL: ALUM 6061-T6 RECT TUBE 1.5x2x.125 WALL
YIELD STRESS = 15000 PSI

ATTACHMENT #2

I DEAS '2 NX Series m1. I DEAS Visualizer

Display 1
180_LB_EVENLY_DISTRIBUTED
B.C. 1,STRESS 2,LOAD SET 1
C:\PPD_IDM_PED90896\ENV_SCIBOONE_MPD_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_PED90896\ENV_SCIBOONE_MPD_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 POSSIBILITY 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
1.00E+03
5.40E-01

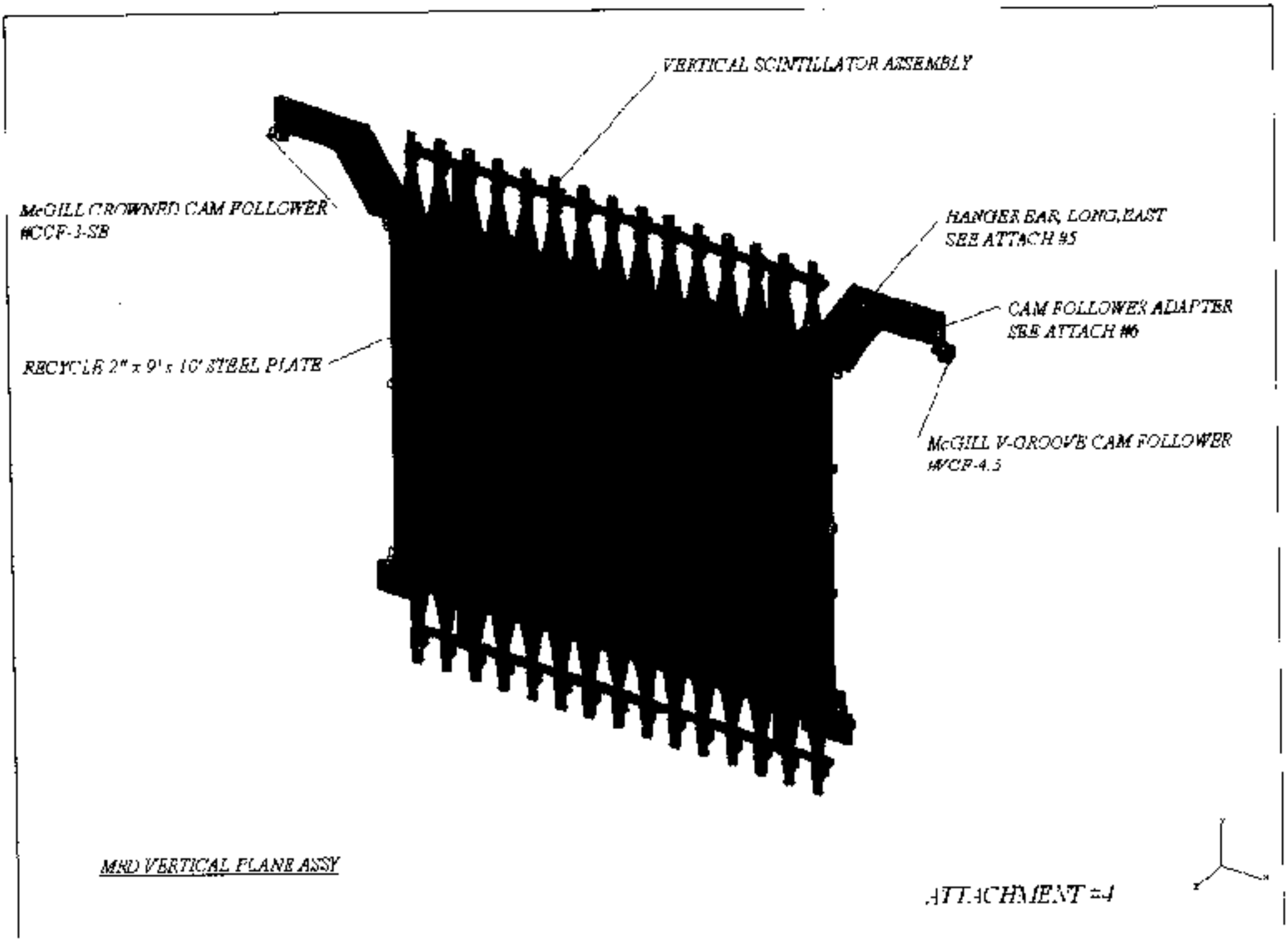
SCINT ALUM HOLDER HORIZ POSITION

TWO CORNERS RESTRAINT IN XYZ
TWO CORNERS RESTRAINT IN Y

180 LBS EVENLY DISTRIBUTED

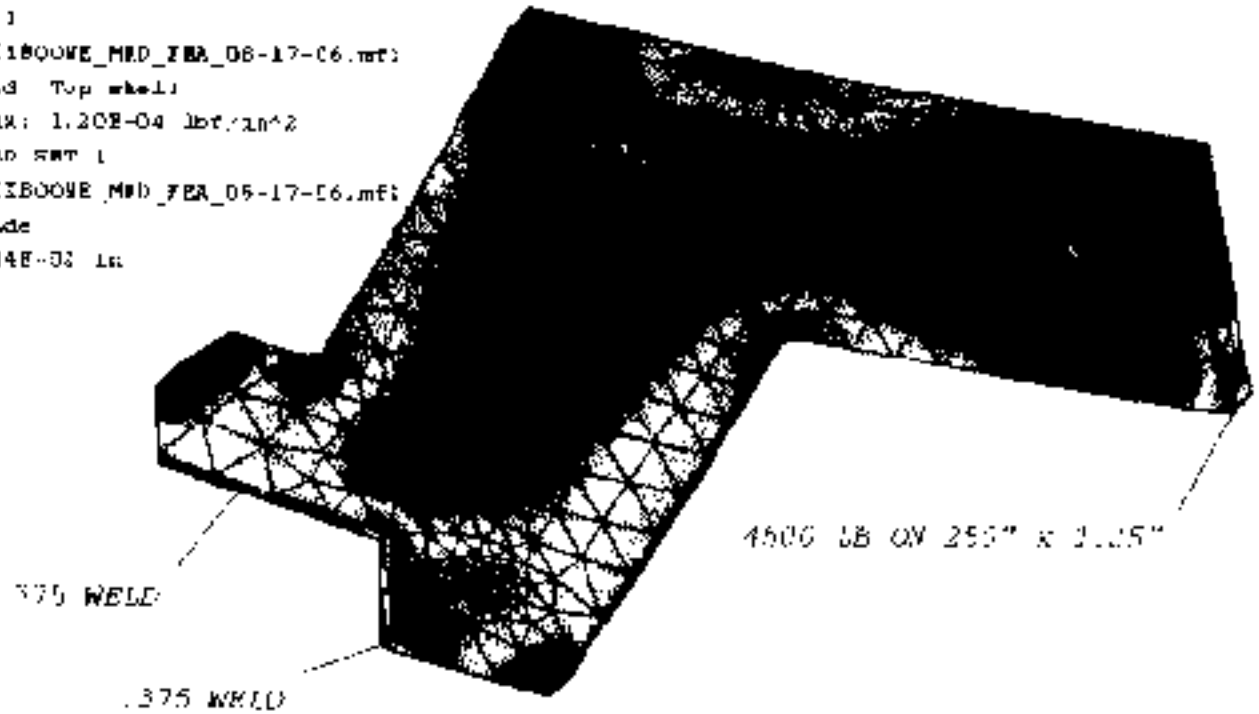
MATERIAL: ALUMINUM 6060-T6 RECT TUBE 1.5 x 1 x .125 WALL
YIELD STRESS=35000 PSI

ATTACHMENT #3


VERTICAL SCINTILLATOR ASSEMBLY
McGILL CROWNED CAM FOLLOWER
#CCF-3-SB
HANGER BAR, LONG,EAST
SEE ATTACH #5
CAM FOLLOWER ADAPTER
SEE ATTACH #6
RECYCLE 2" x 9' x 10' STEEL PLATE
McGILL V-GROOVE CAM FOLLOWER
#VCF-4.5
MRD VERTICAL PLANE ASSY
ATTACHMENT #4

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

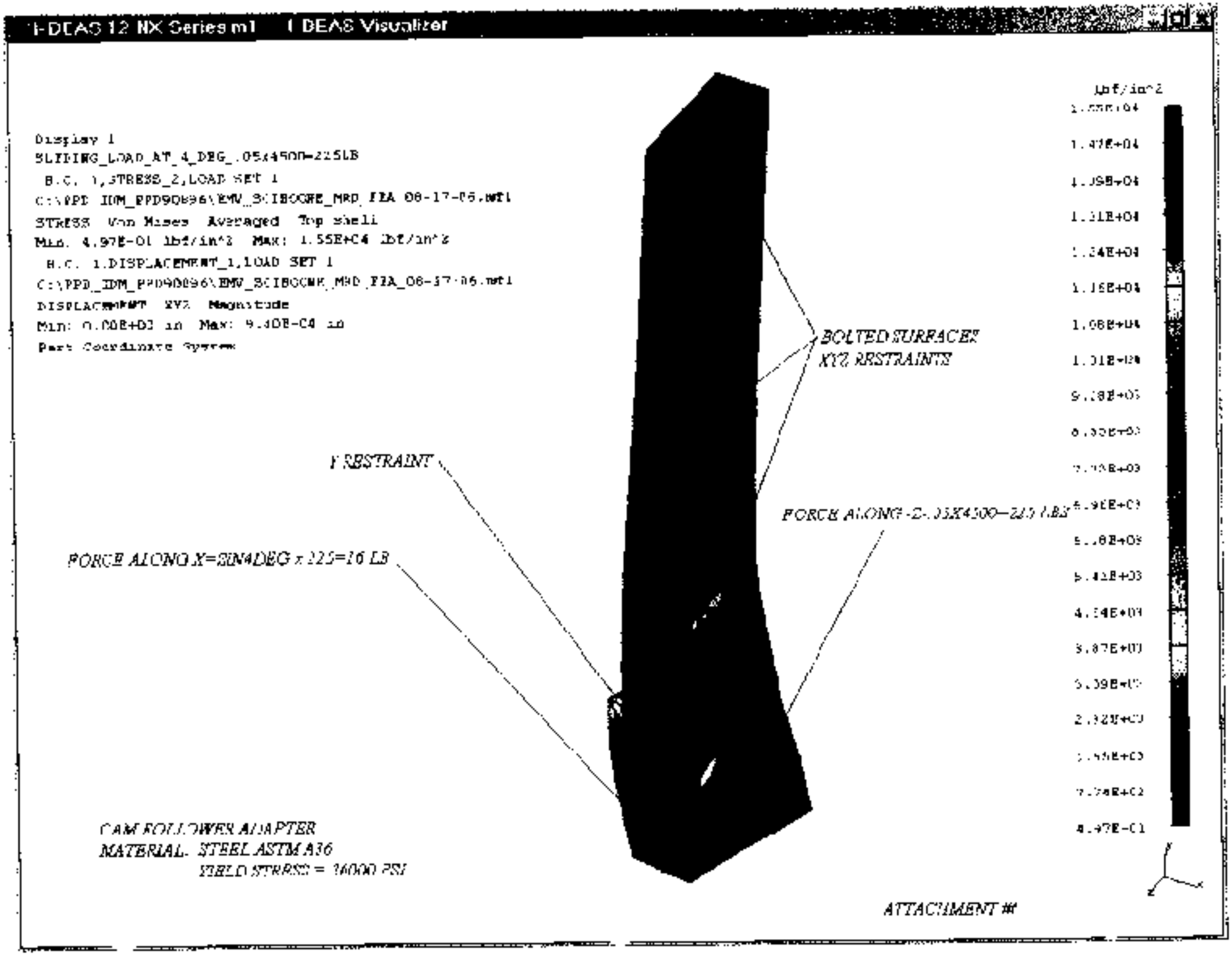
Display 1
4500 LB LOAD
B.C. 1.STRESS_2.LOAD SET 1
C:\PED_IDM_PPD90896\BMV SCIBOOME_MED_FEA_06-17-06.mf1
STRESS Von Mises Averaged Top shell
Min: 2.15E-04 lbf/in^2 Max: 1.20E-04 lbf/in^2
B.C. 1.DISPLACEMENT_1.LOAD SET 1
C:\PED_IDM_PPD90896\BMV_SCIBOOME_MED_FEA_06-17-06.mf1
DISPLACEMENT XYZ Magnitude
Min: 0.00E+00 in Max 2.44E-02 in
Part Coordinate System

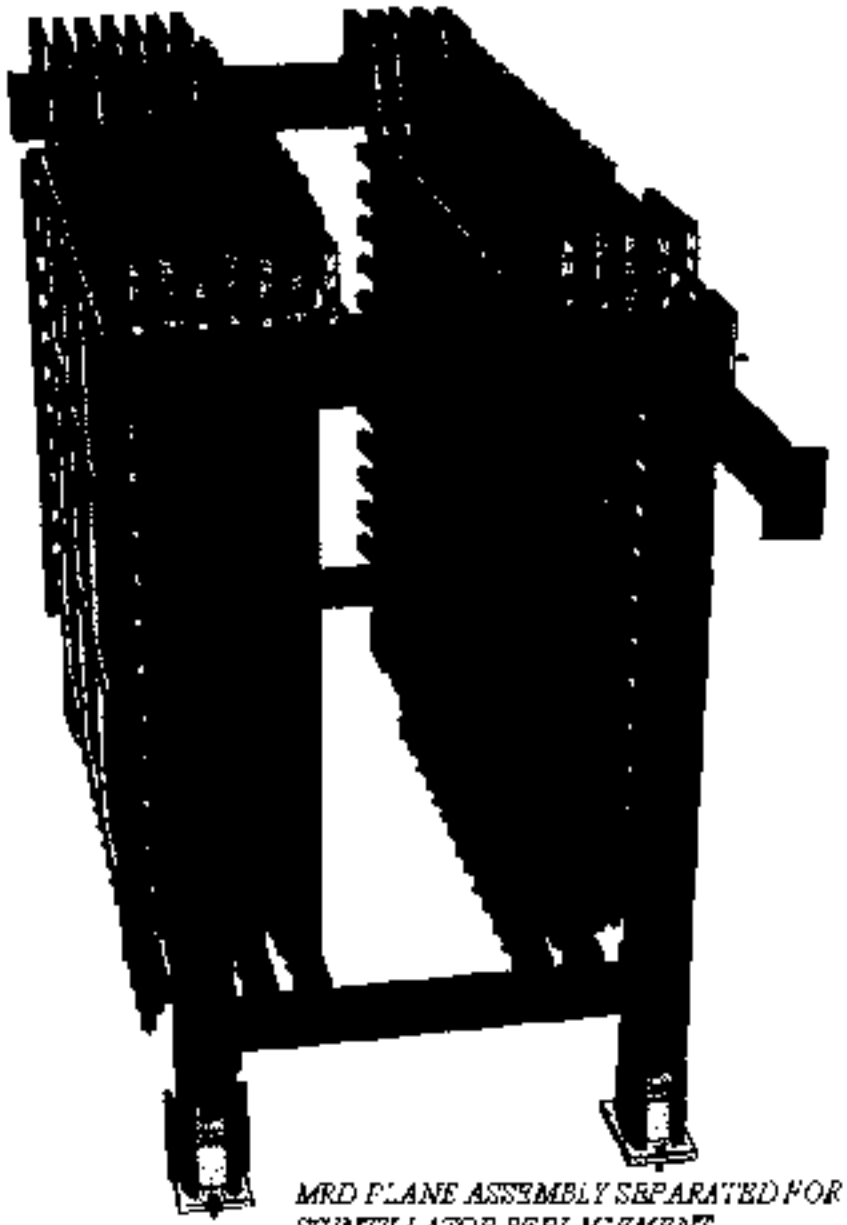


lbf/in^2
1.20E+04
1.14E+04
1.08E+04
1.02E+04
9.57E+03
8.97E+03
8.37E+03
7.77E+03
7.17E+03
6.57E+03
5.97E+03
5.37E+03
4.77E+03
4.17E+03
3.57E+03
2.97E+03
2.37E+03
1.77E+03
1.17E+03
5.76E+02
2.15E-04

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

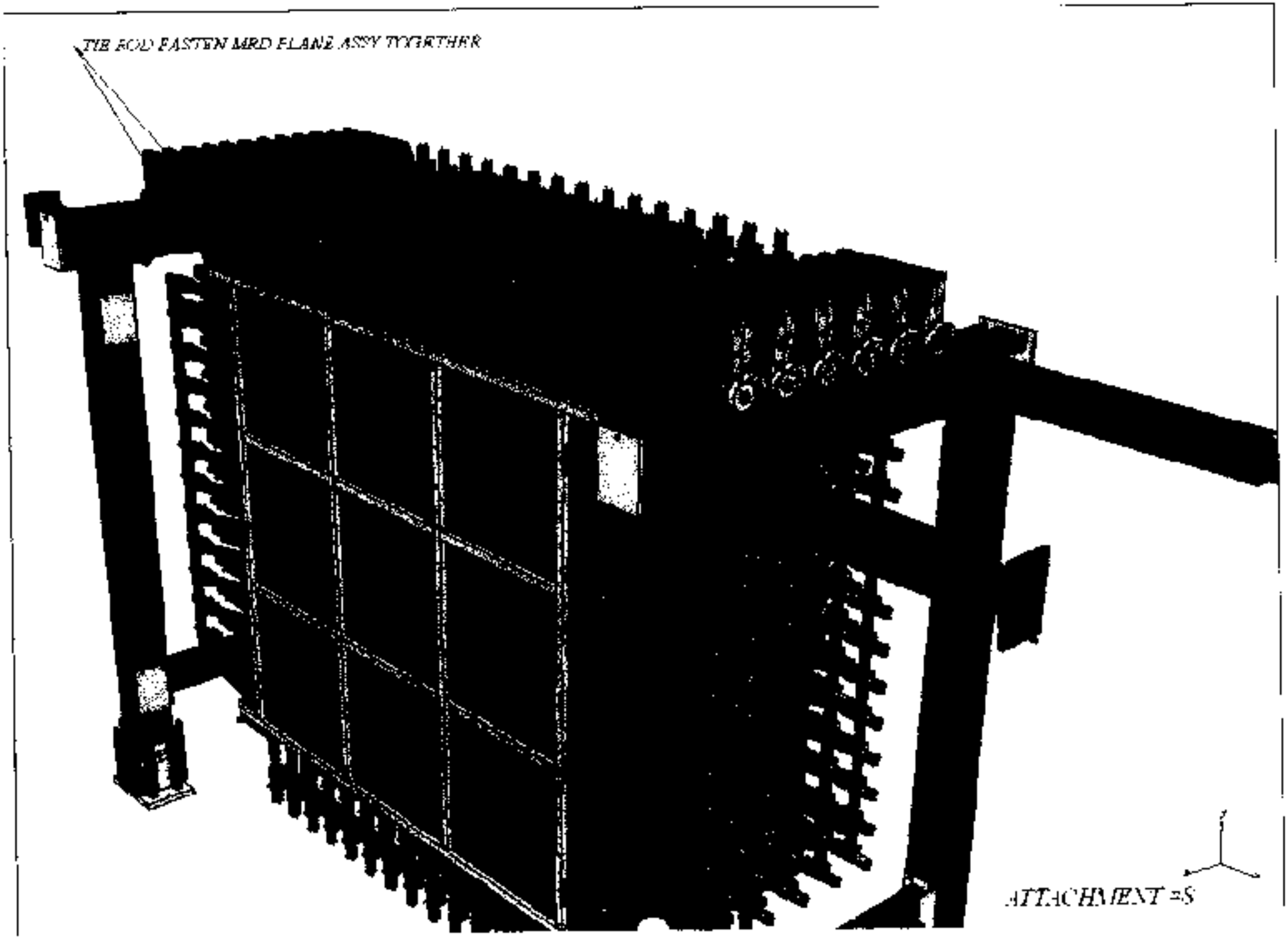
ATTACHMENT #5


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:\PD IDM_PD90896\EMV_SCIBOCME_MRD FEA 08-17-06.mt1
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:\PD_IDM_PD90896\EMV_SCIBOCME_MRD FEA_08-17-06.mt1
DISPLACEMENT XYZ Magnitude
Min: 0.00E+00 in Max: 9.40E-04 in
Part Coordinate System
lbf/in^2
1.47E+04
1.39E+04
1.31E+04
1.23E+04
1.15E+04
1.08E+04
1.01E+04
9.18E+03
8.55E+03
7.93E+03
6.91E+03
5.68E+03
5.42E+03
4.54E+03
3.87E+03
3.39E+03
2.92E+03
2.45E+03
1.98E+03
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 #4



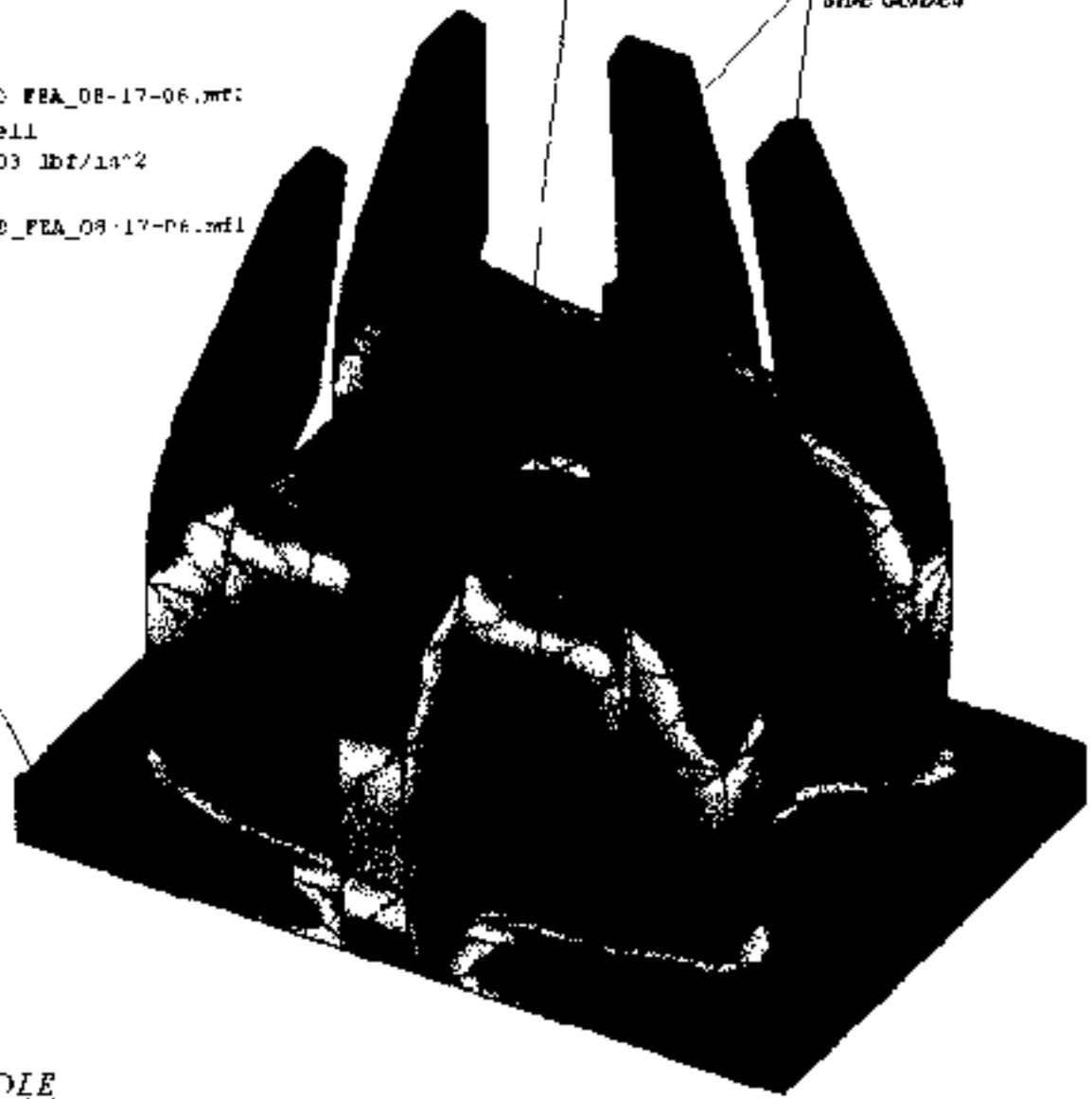
MRD PLANE ASSEMBLY SEPARATED FOR SCINTILLATOR REPLACEMENT

ATTACHMENT #


TIE ROD FASTEN MRD PLANE ASSY TOGETHER
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-01 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



COLUMN WELDMENT CRADLE

MATERIAL: STEEL ASTM A36
YIELD STRESS = 36000 PSI

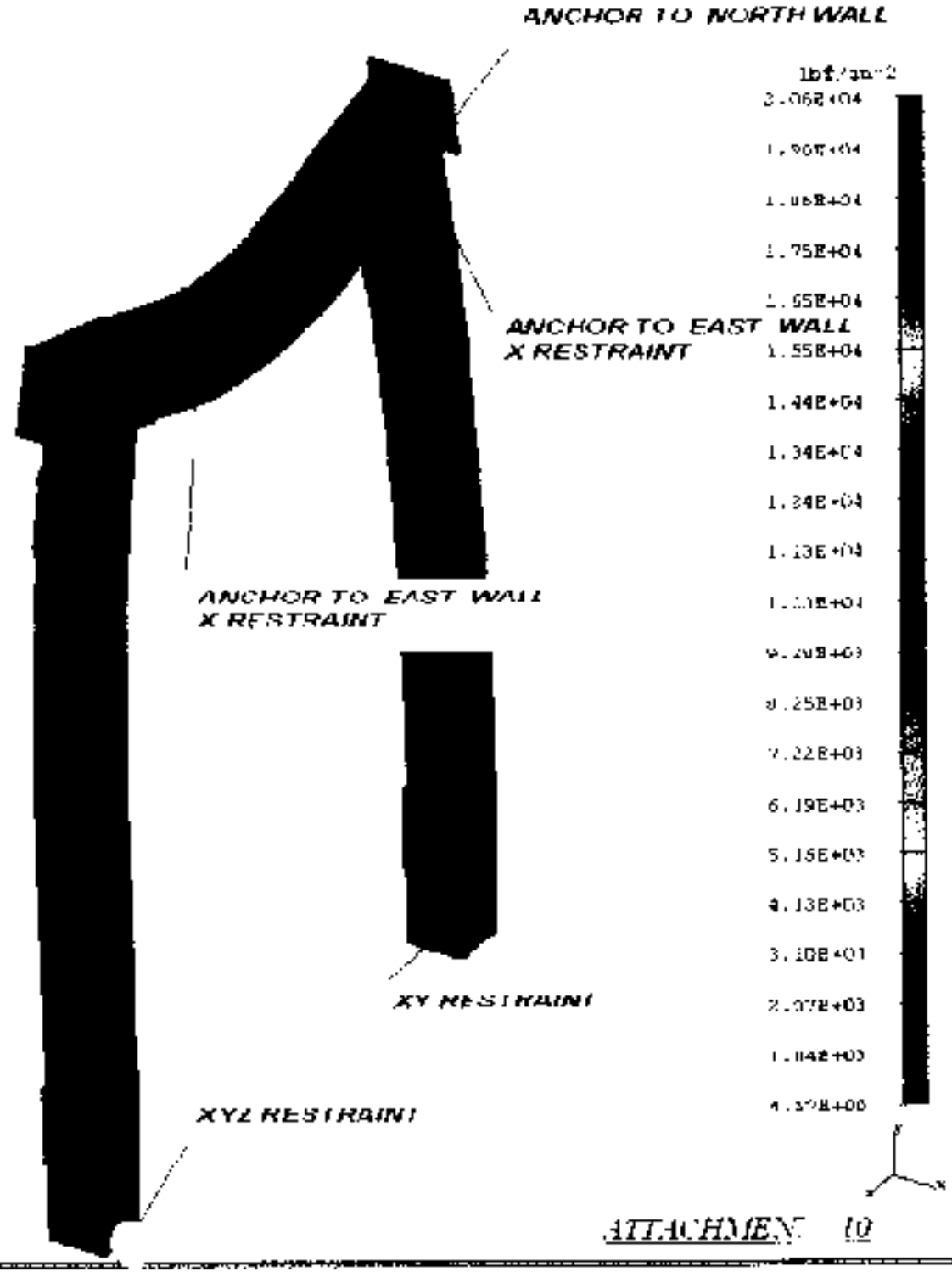
ATTACHMENT 6

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\ENV_SCIBOCWE MPD_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\ENV SCIBOCWE_MPD_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 WRx67 ASTM A36 STEEL
YIELD STRESS = 36000 PSI



ROLLER SUPPORT EAST

ATTACHMENT 10

Display :
6-RESTRAINTS_SUDDEN_STOP
B.C. 1,STRESS_3,LOAD SET 1
C:\PPD IBM PPD90836\EMV_SCIBOONE_MRD_FEA_08-17-06.mf1
STRESS Von Mises Averaged Top shell
Beam stress: Von Mises , maximum point
Min: 5.85E-12 lbf/in^2 Max: 1.38E+04 lbf/in^2
Part Coordinate System

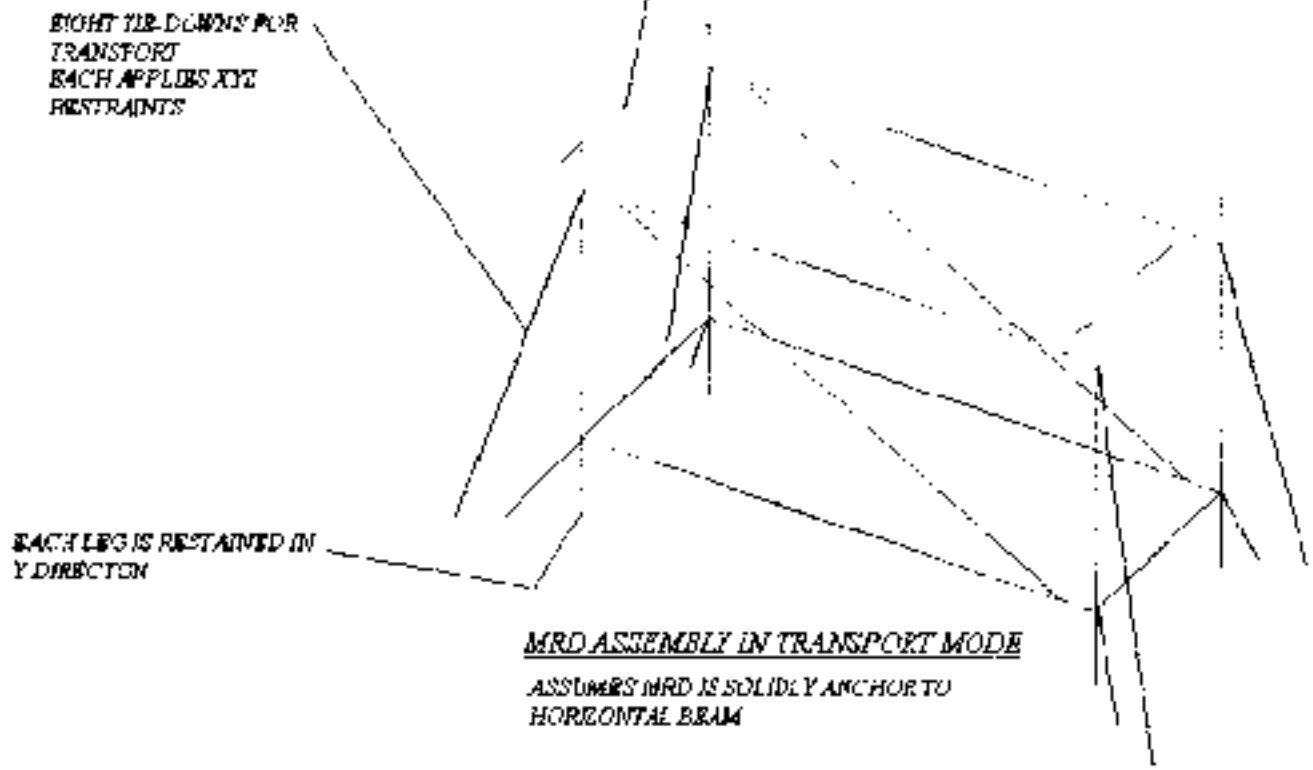
APPLIED LOADS

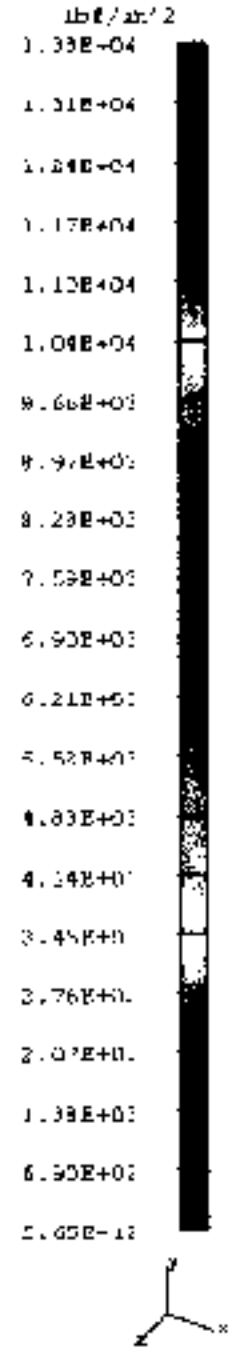
Y DIRECTION = 50.4 TON POINT WT (APPLIED @ MID SPAN OF HORIZ BEAM)

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

X DIRECTION = 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)

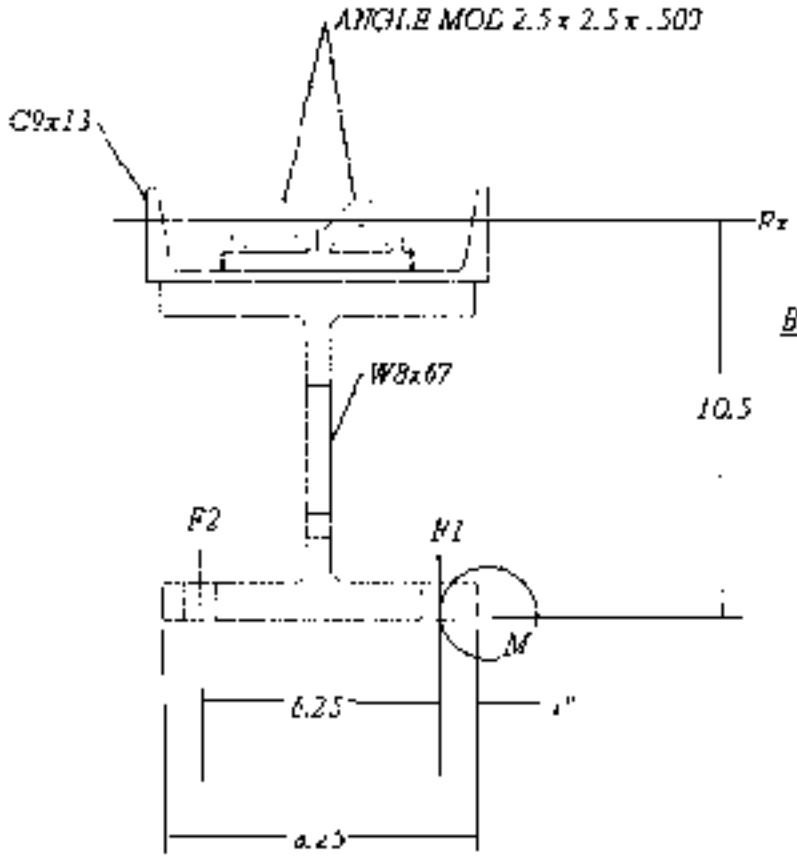




MRD ASSEMBLY IN TRANSPORT MODE

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 $Px = Ma = Wa/g = 50.4 \times 2000 \times 10.5280/2 \times 32.16 \times 60 \times 60 = 46000$ #

moment @ $M = 10.5 \times 46000 = 483000$ in-lb

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

then $M = F2/7.25 + 7.25F2$

$7.25M = F2 + 7.25 \times 7.25F2$

$7.25M = 53.563F2$

$F2 = 7.25 X 483000/53.563$

$= 65460$ #

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

each bolt carries $65400/4 = 16350$ #

ATTACHMENT #12

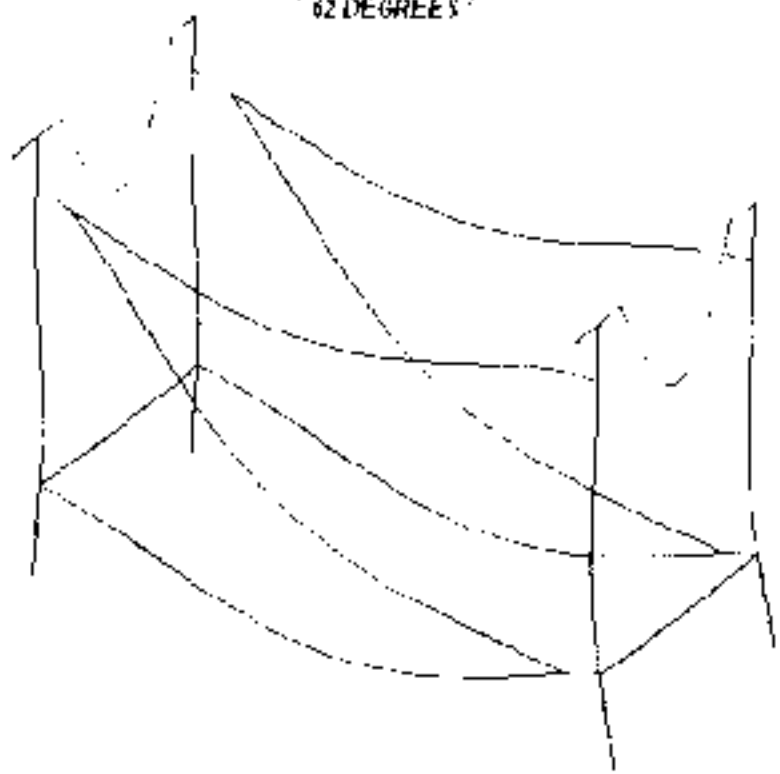
I DEAS 12 NX Series m1 : I DEAS Visualizer

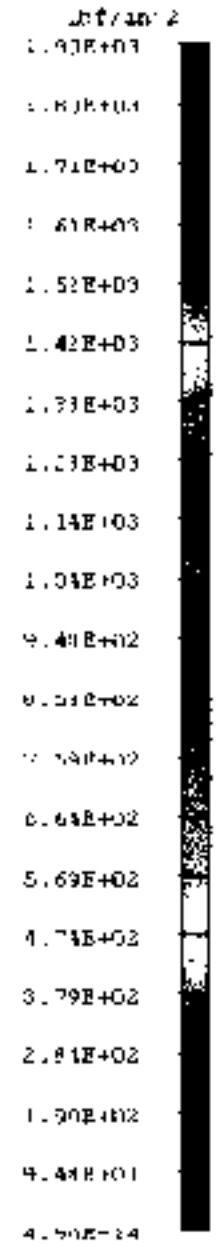
Display .
SLING_PICK_62_DEGREES
B.C. 1,STRESS_3,LOAD SET 1
C:\PED_IDM_PED90696\EMV_SCIBOOWE_MRD_FEA_08-17-06.mf1
STRESS Von Mises Averaged Top shell
Beam stress: Von Mises , maximum point
Min: 4.90E-14 lbf/in^2 Max: 1.90E+03 lbf/in^2
B.C. 1,DISPLACEMENT_.,LOAD SET 1
C:\PED_IDM_PED90696\EMV_SCIBOOWE_MRD_FEA_08-17-06.mf1
DISPLACEMENT XYZ Magnitude
Min: 0.00E+00 in Max 7.89E-03 in
Part Coordinate System

HOOK PICK POINT

SLINGS
420INE CHOKED

62 DEGREES





MRD LOAD - 53.2 TON
SUPT STAND = 3.0 TON (GRAVITY)

MRD 62 DEG SLING PICK

ATTACHMENT #13