Fermilab

Particle Physics Division

Mechanical Department Engineering Note

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Project: FLARE

Project Internal Reference:

Title: FLARE LArTPC Work Platform

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Reviewer(s): Ingrid Fang 10/7/2010

Key Words: FLARE LAr TPC Tank Work Platform

Abstract/Summary:

The FLARE Purity Test experiment consists of a large stainless steel insulated vessel installed in PC-4. Figure 1 shows the tank in PC-4. The experimenters determined that a work platform was required above this tank for electronics and for access to the top of the tank. This platform had to be positioned between the top of the tank and below the PC-4 roof support beams.

This new platform consists of four wide flange W8 columns, one at each corner of the platform. Each column is bolted to the floor slab with four, 5/8" diameter Hilti Drop-in anchors. The top of the columns are connected by W8 beams that also provide end support for the floor grating and anchorage for the safety railings. At mid-height, a W8 beam spans between the columns on three sides of the platform. These beams shorten the

span of the angle cross bracing, allowing a smaller angle section to be used. A network of intermediate wide flange beams are used to support the floor grating at the top of the platform and are supported by the top beams that span from column to column. Directly above the top access port of the vessel a shop fabricated circular wide flange beam is used to form an opening to access the vessel port and support the edges of the floor grating at this opening. This layout is shown in Figure 3.

Fiberglass grating was chosen for the floor of the platform for two important reasons. First of all, it is easier to cut to size, especially around the circular openings. Secondly, since it is lighter than metal grating with the same span, individual panels will be easier to remove for access to the vessel.

Two small cryogenic vessels with piping are also supported from the top of the platform. The calculations for these supports are shown on pages 14 and 15 of this note.

Access to the platform will be by means of a two level rolling safety ladder system. A twelve foot high safety ladder will be permanently mounted on top of three, three foot high shield blocks that are supported by the floor slab. A three foot high safety ladder will provide access to the top of the shield blocks. This layout can be seen in Figure 2.

Applicable Codes:

Manual of Steel Construction, ASD, Ninth Edition, American Institute of Steel Construction, Inc. 1989

Occupational Safety and Health Standards for Industry, (29 CFR Part 1910), Commerce Clearing House Inc., 1989

LOAD/DEFLECTION TABLES, Strongwell, CHATFIELD DIVISION 1610 Highway 52 South, Chatfield, MN 55923-9799

Hilti North America Product Technical Guide, Hilti U. S., 2001 Edition.

Engineering Manual, Fermilab, 07/09 Edition.

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MAR. 16, 2010

DESIGN LOADS:

FLOOR GRATING = $1\frac{1}{4} \times \frac{3}{16}$ ALUMINUM W/4" CROSS ROD SPACING.
ALLOWABLE LOAD = 247 #/FT² @ 48" SPAN

WEIGHT = 3.1 #/FT² (SAY 5.0 #/FT²)

LIVE LOAD = 100 #/FT²

TOTAL LOAD = 100 + 5 = 105 #/FT²

CIRCULAR BEAM:
(SEE FIGURE 1)

FOR 1/4" CIRCLE:

$$\text{BEAM SPAN} = \pi d/4 = \pi(39.76)/4 = 31.2"$$

BEAM LOADS:

FOR 10 #/FT BEAM WT, BEAM DEAD LOAD =

$$10(31.2)/12 = 26\#$$

GRATING LIVE & DEAD LOAD

$$= 105(24.25^2)/2(144) = 214\#$$

HOLE COVER LIVE & DEAD LOAD

$$= 105(19.9^2)/2(144) = 144\#$$

$$\text{TOTAL LOAD} = 26 + 214 + 144 = 384\#$$

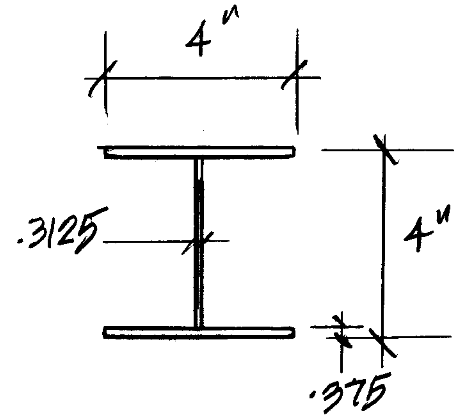
$$\text{BEAM SPAN} = 1/4(\pi d) = 31.2"$$

$$M = 384(31.2)/4 = 2995 \text{ \#-IN}$$

$$\text{TORSIONAL MOMENT} = 384(5.02) = 1928 \text{ \#-IN}$$

TRY BUILT-UP SECTION:

CHECK TO SEE IF SECTION IS COMPACT. USE TABLE B5.1 P. 5-36



FLANGE:

$b/t = 4/.375$
$= 10.7$

$65/\sqrt{F_y} = 65/\sqrt{36}$
$= 10.8$

$b/t < 65/\sqrt{F_y}$ OK

WEB:

$d/t = 4/.3125 = 12.8$

$640/\sqrt{F_y} = 640/\sqrt{36}$
$= 106.7$

$d/t < 640/\sqrt{F_y}$. OK

∴ SECTION IS COMPACT

FIND L_c:

$76 b_f/\sqrt{F_y} = 76(4)/\sqrt{36}$
$= 50.7"$

OR $20{,}000/(d/A_f)(F_y) = 20{,}000/4(.375 \times 4)(\sqrt{36})$
$= 556"$

USE 50.7"

BEAM SPAN = 31.2" < 50.7 ∴ $F_b = 0.66 F_y$
$= 23.8$ KSI

FIND BENDING STRESS

I_x OF COMBINED SECTION:

$I_x = \Sigma(I_o + Ad^2)$
$= (0.018 + 1.5(1.8125)^2)(2) + (0.894 + (1.016(0)^2)$
$= (4.95)(2) + (0.894)$
$= 10.79 \text{ IN}^4$

$f_b = Mc/I = (2995+1928)(2)/10.79$
$= 913 \text{ PSI} < 23,800 \text{ PSI}$ **OK**

CHECK SHEAR:

$R = 384/2 = 192^{\#}$

$f_V = 192/4.016$
$= 48 \text{ PSI}$

ALLOW. SHEAR $= 0.40(36,000 \text{ PSI})$
$= 14,400 \text{ PSI} > 48 \text{ PSI}$ **OK**

LOAD @ EACH OF 4 SUPPORTS:

$(192 \times 2) = 384^{\#}$

BEAM "A" (SEE FIGURE A)

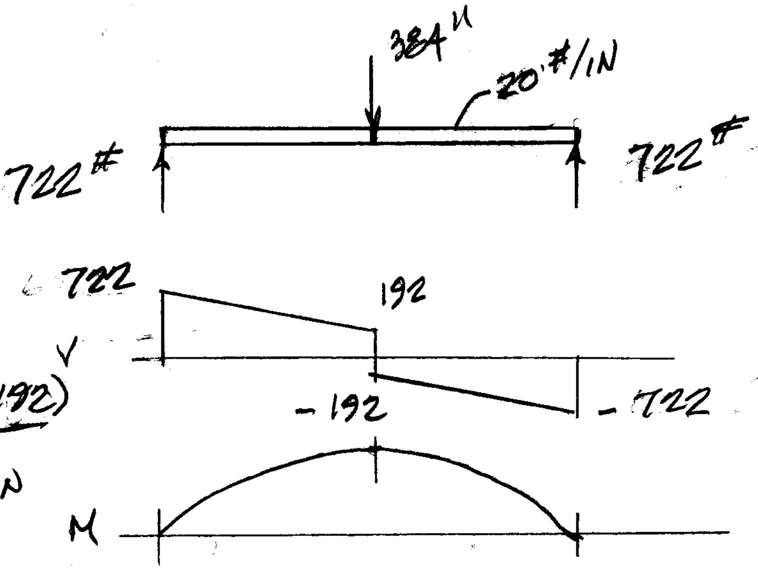
SPAN = 53"

FLOOR LOAD ON BEAM (LONGER SIDE)
$(50/2)\left(\frac{105}{144}\right) = 18.2 \ \#/\text{IN}$

BEAM WT = 24 #/FT
= 2 #/IN

TOTAL UNIFORM LOAD =
$18+2 = 20 \ \#/\text{IN}$

$R_L = R_R = 384/2 + 20(53/2)$
$= 722^{\#}$



$M = \frac{26.5(722+192)}{2}$
$= 12,111 \ \#\text{-IN}$

TRY W8X24 BEAM

$f_b = 12{,}111 / S_x$

$= 12{,}111 / 20.9 = 580$ psi

$L_c = 6.9'$ (P. 2-72 AISC)

$= 82.8'' > 53''$ ∴ $F_b = 0.66 F_y$

$= 0.66(36)$

$= 23.8$ ksi

$= 23{,}800$ PSI

$F_b > f_b$

$23{,}800 > 580$ ok

SHEAR:

$F_V = 0.40 F_y$

$= 0.40(36)$

$= 14.4$ ksi $= 14{,}400$ PSI

$f_V = 722 / 7.08$

$= 102$ psi $< 14{,}400$ PSI ok

USE W8X24

BEAM "B" (SEE FIGURE 4)

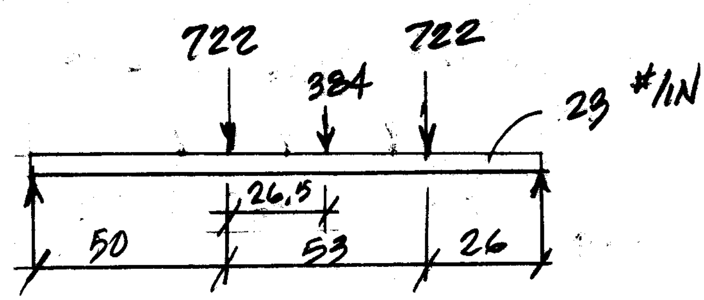
SPAN = 129"

FLOOR LOAD ON BEAM

$57/2 \left(\frac{105}{144}\right) = 21$ #/IN

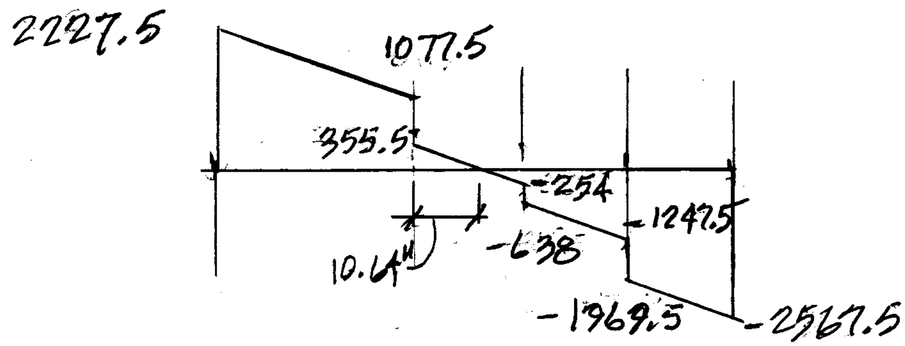
BEAM WT = 2 #/IN

23 #/IN



$R_L = (26(722) + 52.5(384)$
$+ 79(722) + 129(23)(64.5))/129$
$= 2{,}227.5$ #

$R_R = (50(722) + 76.5(384)$
$+ 103(722) + 129(23)(64.5))/129$
$= 2567.5$ #



$M = (50(2227.5+1077.5))/2 + 355.5(26.5)/2$
$= 87329$ #-IN

$f_b = 87329/20.9$
$= 4179$ PSI

$L_b = 129/12 = 10.75'$
$L_c = 6.9'$

$l/r_T = 129/1.76$
$= 73$

CHECK IF $\sqrt{\frac{102\times10^3 C_b}{F_y}} \le l/r_T \le \sqrt{\frac{510\times10^3 C_b}{F_y}}$ (AISC P. 5-47)

$53 \le l/r_T < 119$ (AISC P. 5-120)

$119 > l/r_T > 53 \therefore F_b = \left[\frac{2}{3} - \frac{F_y(l/r_T)^2}{1530\times10^3 C_b}\right]F_y$ (AISC P. 5-47)

$= \left[\frac{2}{3} - \frac{36(73)^2}{1530\times10^3}\right]36$

$= 19.5$ KSI

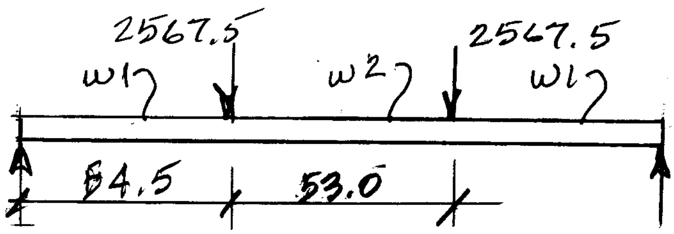
19,500 > 4179 OK

SHEAR:
2567.5/7.08 = 363 PSI < 14,400 PSI OK

USE W8X24

BEAM C (SEE FIGURE 4)

SPAN = 162"



$w_1 = 105/144\,(14/2) + 24/12$

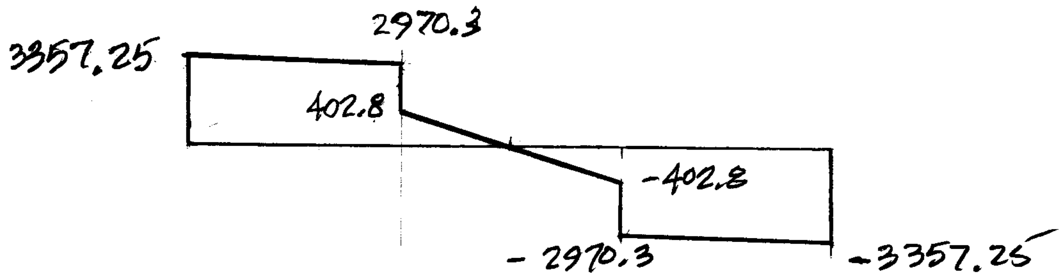
$= 7.1$ #/IN

$w_2 = 105/144\,(50/2) + 24/12$

$= 15.2$ #/IN

$R_L = R_R = \big(7.1(54.5)(54.5/2) + 2567.5(54.5) + 15.2(53)(81.0) + 107.5(2567.5) + 7.1(54.5)(134.75)\big)/162$

$= 3357.25$#



$M_{MAX} = \dfrac{54.5(3357.25 + 2970.3)}{2} + 402.8(53/2)/2$

$= 350{,}189$ #-IN

$f_b = 350{,}189/20.9$

$= 16{,}755$ PSI

$l/r_T = 162/1.76$

$= 92$

$53 < l/r_T < 119$

$$F_b = \left[\tfrac{2}{3} - \frac{F_y (l/r_T)^2}{1530 \times 10^3 C_b} \right] F_y$$

$$= \left[\tfrac{2}{3} - \frac{36(92)^2}{1530 \times 10^3} \right] 36$$

$$= 16.8^{KSI} > 16{,}755^{PSI} \quad \text{OK}$$

SHEAR:

$$f_v = 3357.25/7.08$$

$$= 474 \text{ PSI} < 14{,}400 \text{ PSI} \quad \text{OK}$$

BEAM D (SEE FIGURE 4)

SPAN = 129"

$$w = 105/144\,(56.75/2) + 24/12$$

$$= 21 + 2$$

$$= 23^{\#}/\text{IN}$$

$$M = wl^2/8 = 23(129)^2/8$$

$$= 47\,843^{\#\text{-IN}}$$

$$f_b = 47\,843/20.9$$

$$= 2{,}289 \text{ PSI}$$

$$l/r_T = 129/1.76$$

$$= 73$$

$$F_b = \left[\tfrac{2}{3} - \frac{36(73)^2}{1530 \times 10^3} \right] 36$$

$$= 19.5^{KSI} > 2289 \text{ PSI} \quad \underline{\underline{\text{OK}}}$$

SHEAR:

$$f_v = 23(129/2)/7.08$$

$$= 210 \text{ PSI} < 14{,}400 \text{ PSI} \quad \underline{\underline{\text{OK}}}$$

COLUMNS.

COLUMN VERT. LOAD:

MAXIMUM LOAD:

3357.25 + 1483.5 = 4840.75# VERT.

USE 10% VERT. LOAD = HORIZ. LOAD
= 484# HORIZ.

$h = 196.75''$

FROM P 3-32 AISC FOR W8x24 @ 17'-0 HEIGHT,

$P_{ALLOW} = 66^K$

66,000# > 4840.75# OK

HORIZ. LOAD WILL BE CARRIED BY CROSS BRACING

HORIZONTAL CROSS BRACING:

$P_H = 484\#$ USE 500#

FOR DOUBLE "X"

VERT. DISTANCE = $197/2 = 98.5''$

HORIZ. DISTANCE SHORT SIDE = 126"

LONG SIDE = 162"

$$l = \sqrt{(98.5)^2 + (126)^2} = 160''$$

$$= \sqrt{(98.5)^2 + (162)^2} = 190''$$

FOR 3x3x3/8 L, $Kl/r = (1)\,190/0.913$
= 208 < 300 OK

MAX. AXIAL TENSION LOAD = 500/cos 38.02°
= 635#

NET AREA @ BOLTED CONN.:

$3'' - (3/4 + 1/16) = 2.1875''$

$3/8(2.1875) = 0.820\ IN^2$

$f_t = 635/0.820 = 774\ psi$

$F_{t\,ALLOW} = 0.45(F_y)$ (AISC D3.1 p 5-41)
$= 16.2^{KSI} > 774\ psi$ OK

USE L 3x3x3/8

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MAR. 16, 2010

COLUMN BASE PLATE:

MAX. LOAD = 4841#, USE 5,000#

PLATE SIZE = 12" x 12" x 3/4"

$F_p = 0.35 f'c$ ASSUME $f'c$ = 3,000 PSI

$= 0.35(3000)$

$= 1050$ PSI

$f_p = 5000/12(12)$

$= 34.7$ PSI < 1050 PSI **OK**

$m = (N - d)/2$

$= (12 - 0.95(7.93))$

$= 2.233$

$n = (B - 0.80 b_f)/2$

$= (12 - 0.8(6.495))/2$

$= 3.402$

$t_p = 2m\sqrt{f_p/F_y}$ OR $t_p = n\sqrt{f_p/F_y}$

$= 2(2.233)\sqrt{34.7/36{,}000}$ OR $2(3.402)\sqrt{34.7/36{,}000}$

$= 0.139"$ OR $0.211"$

∴ 3/4" THICK PLATE **OK**

ANCHOR BOLTS:

HORIZONTAL LOAD = 500# FROM 2 DIRECTIONS

ANCHOR SPACING = 9.5"

FOR 5/8"ϕ DROP-IN HILTI ANCHORS

ALLOWABLE SHEAR = 2500# IN 2000 PSI CONC.

(FROM HILTI PRODUCT GUIDE P. 135)

SPACING FACTOR = 1.0 FOR 9" SPACING

∴ ALLOWABLE SHEAR = 4(2500#) = 10 000#

ACTUAL LOAD = 500/0.707

= 707# < 10,000# **OK**

USE 5/8"ϕ HILTI DROP-IN ANCHORS

RAILING:

OSHA LOAD = 200# ANY DIRECTION

TRY 1½"φ SCHED 80 PIPE

$A = 1.07\ IN^2$ $S = .412\ IN^3$ $r = .605\ IN$

VERTICAL RAILING SUPPORT

$MOMENT\ ARM = (42'' + 1.25'') - 1.90/2$
$= 42.3''$

$M = 42.3(200)$
$= 8460\ \#\text{-}IN$

$f_b = M/S = 8460/.412$
$= 20534\ PSI$

$Kl/r = 2(42.3)/.605$
$= 140$

$D = 1.90$ $t = .20$ $F_y = 35\ KSI$

CHECK TO SEE IF PIPE IS COMPACT:

$D/t = 1.90/.20$
$= 9.5$

FROM AISC TAB B5.1 p 5-36:

$3300/F_y = 3300/35$
$= 94 > 9.5$ ∴ PIPE IS COMPACT

FROM AISC SECT F3.1 p 5-48:

$L_c = 1200(b/F_y)$
$= 1200(1.9/35)$
$= 65 > 42.3$ OK

$\therefore F_b = 0.66 F_y = 0.66(35)$
$= 23{,}100\ PSI > 20{,}534$

USE 1½" SCHED 80 PIPE

WELD OF 2"ϕ SCHED. 80 PIPE SUPPORT COLLAR:
TREATING WELD AS A LINE:

$$S_W = \frac{\pi d^2}{4} = \frac{\pi (2.375)^2}{4}$$

$$= 4.43 \text{ IN}^2$$

$$f_W = M/S_W = \frac{8460}{4.43}$$

$$= 1910 \text{ \#/IN}$$

FOR 3/16" WELD:

$$\text{ALLOW. LOAD} = 0.30(.707)(70{,}000)(3/16)$$

$$= 2784 \text{ \#/IN} > 1910 \text{ \#/IN}$$

OK

USE 2"ϕ SCHED. 80 PIPE W/ 3/16" WELD ALL AROUND

CIRCULAR ALUMINUM FLOOR PLATE: (NOTE: SEE PAGE 16 FOR REVISED PLATE LAYOUT CALCS.)
OUTER DIAMETER = 45.5"
MIN. OPENING DIAMETER = 8"
MAX. OPENING DIAMETER = 29.656"

USE "ROARK'S FORMULAS FOR STRESS & STRAIN":
TRY 1/4" THICK PLATE
CASE 22, P. 405 APPLIES:

$a = 22.75"$ $b_{MIN} = 4.0"$ $b_{MAX} = 14.828"$

$$D = Et^3/(12)(1-\nu^2) \quad \nu = 0.35 \text{ FOR 6061-T6}$$

$$= 10(10)^6(0.25)^3/12(1-0.35^2)$$

$$= 14{,}839$$

$$b/a_{MAX} = 14.828/22.75 = 0.65$$

$$b/a_{MIN} = 4.0/22.75 = 0.18$$

FOR $b/a = 0.65$
INTERPOLATE :

b/a	0.5	0.7
K_{yb}	−0.0624	−0.0325
K_{Mtb}	0.2404	0.1469

$0.7 - 0.5 = 0.2$
$0.65 - 0.5 = 0.15$
$0.15/0.20 = 0.75$

FOR K_{yb} :
$-0.0624 - (-0.0325) = 0.0299$
$0.75(0.0299) = 0.0224$
$0.0624 - 0.0224 = 0.0400$

$$y = K_{yb} \frac{qa^4}{D} = 0.0400 \left(\frac{0.73(22.75)^4}{14,839} \right)$$
$= 0.53''$

∴ CENTER SUPPORT WILL BE REQ'D

FOR K_{Mtb}
$0.2404 - 0.1469 = 0.0935$
$0.75(0.0935) = 0.0701$
$0.2404 - 0.0701 = 0.1703$

$M = K_{Mtb}(q)(a)^2 = 0.1703(0.73)(22.75)^2$
$= 64.3$ #-IN

$S = 1(0.25)^2/6 = 0.0104\ IN^3$
$f_b = 64.3/0.0104$
$= 16,172$ psi

FOR $b/a = 0.18$
INTERPOLATE:

b/a	0.1	0.3
K_{yb}	−0.0687	−0.0761
K_{Mtb}	0.3965	0.3272

$0.3 - 0.1 = 0.20$
$0.20 - 0.18 = 0.02$
$0.02/0.20 = 0.10$

FOR K_{yb} $0.0687 - 0.0761 = 0.0074$

$0.10(0.0074) = 0.0007$

$0.0761 - 0.0007 = 0.0753$

$y = K_{yb}\dfrac{qa^4}{D} = 0.0753\left(\dfrac{0.73(22.75)^4}{118,709}\right)$

$= 0.12''\ (0.99'')$

$\ell/240 = \dfrac{2(22.75)}{240} = 0.18'' > 0.12''$ OK

FOR K_{Mtb} $0.3965 - 0.3272 = 0.0693$

$0.10(0.0693) = 0.0069$

$0.3272 + 0.0069 = 0.3341$

$M = 0.3341(0.73)(22.75)^2$

$= 126.2^{\#-IN}$

$f_b = 126.2/0.0104$

$= 12,113$

ALLOWABLE PLATE BENDING (COMPRESSION)

FROM PAGE 40, ALUMINUM SPECIFICATIONS:

$b/t = 1/0.5 = 2 < 6.8$

$\therefore f_b = 21,000$ PSI $> 12,113$ PSI OK

USE 1/4" THICK 6061-T6 ALUMINUM PLATE W/ CENTER SUPPORT STRUT

APPROX. WT. OF PLATE:

1/4" PLATE $= 3.564\ \#/FT^2 = 0.03\ \#/IN^2$

RADIUS OF PLATE $= 22.75''$

$A = \pi(22.75)^2 = 1626\ IN^2$

$1626(0.03) = 49^{\#}$

CRYO PIPING SUPPORT:

LOADS:

	LOAD	ARM
CONDENSER ASSEMBLY	233#	16"
VERTICAL PIPING		
LADDER SIDE	55#	16"
OTHER SIDE	125#	16"
BELOW COND.	50#	16"
HORIZONTAL PIPING	95#	25.75"
	558#	

MOMENT = (558-95)(16) + 95(25.75)
= 9854.25 #-IN

TRY 4X4X1/4 ANGLE ;

$f_a = P/A \pm \frac{Mc}{I}$

$= P/A \pm M/S = \frac{588}{1.94} + \frac{9854.25}{1.05}$

= 9688 psi

FIND Kl/r :

$K = 2.0 \quad l = 48.75 \quad r = 1.25$

$2(48.75)/1.25 = 78$

$C_c = 126.1$

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

$$= \frac{\left[1 - \frac{(78)^2}{2(126.1)^2}\right] 36}{5/3 + \frac{3(78)}{8(126.1)} - \frac{(78)^3}{8(126.1)^3}}$$

= 15.58 KSI = 15,580 psi > 9688 ok

$f_b = 9854.25/1.05 = 9385$ psi

$F_b = 0.60 F_y = 0.60(36) = 21.6^{KSI} = 21600$ psi

FOR 3" PIPE SUPPORT:

$$M = 55(16) + \frac{233}{2}(16) + \frac{50}{2}(16) + \frac{95}{2}(25.75) + 40/2(16) = 4687 \text{ \#-IN}$$

$$f_b = 4687/1.05 = 4464 \text{ PSI}$$

$$P = 55 + 233/2 + 50/2 + \frac{95}{2} + \frac{40}{2} = 264\#$$

$$f_a = 264/1.94 + 4687/1.05 = 4600 \text{ PSI}$$

$$f_a/F_a + f_b/F_b < 1.0$$

$$4600/15580 + 4464/21600 = 0.501 < 1.0 \ \underline{OK}$$

FOR 5" PIPE SUPPORT:

$$M = 125(16) + \frac{233}{2}(16) + \frac{50}{2}(16) \ \frac{95}{2}(25.75) = 3160 \text{ \#-IN}$$

$$f_b = 3160/1.05 = 3010 \text{ PSI}$$

$$P = 125 + \frac{233}{2} + \frac{50}{2} + \frac{95}{2} = 314\#$$

$$f_a = P/A \pm \frac{M}{S} = 314/1.94 + 3010/1.05 = 3029 \text{ PSI}$$

$$3029/15580 + 3010/21600 = 0.333 < 1.0 \ \underline{OK}$$

SINCE LOADS, SUPPORT LENGTHS, AND MOMENTS ARE SMALLER FOR OTHER TWO SUPPORTS, THE RESULTS ABOVE GOVERN. – OK

USE 4x4x1/4" ANGLES

REVISED CIRCULAR ALUMINUM FLOOR PLATE:

PLATE WILL BE SUPPORTED W/ HSS 3×3×1/4 ALUMINUM TUBE, SLIGHTLY OFF CENTER AND EDGE OF KICK PLATE (ALL AROUND)

MAX. PLATE LOAD = 100#/FT^2 LIVE LOAD
5#/FT^2 PLATE DEAD LOAD
105#/FT^2 TOTAL LOAD

105#/FT^2 = 0.73#/IN^2

MAXIMUM PLATE SPAN = 25.5"

$M = 0.73(25.5)^2/8 = 59.3$ #-IN/IN

FOR 1/4" THICK PL $S_x = 1(0.25)^2/6$
$= 0.01$ IN3

$f_b = 59.3/0.01$
$= 5930$ psi

1/4" ALUMINUM DIAMOND TREAD 6061 T6 (RYERSON)
FROM TABLE 3.3.27 ALLOW. BEAM TENSION = 28 KSI
ALLOW. BEAM COMP = 28 KSI
(NOT WELDED)

28 KSI = 28000 PSI > 5930 PSI OK

CHECK 3×3×1/4 TUBE:
LOAD = (0.73(25.5) + 0.73(15.0))/2
= 14.8#/IN

$M = 14.8(40.5)^2/8$
$= 3035$ #-IN

$S_x = \dfrac{3.0^4 - 2.5^4}{6 \times 3.0}$
$= 2.33$ IN3

$f_b = 3035/2.33 = 1302$ psi

ALUMINUM SQUARE TUBE 6063 - T52 (RYERSON)
SINCE MAX. BENDING STRESS IS AT CENTER OF SPAN: $I_y = 3.0^4 - 2.5^4/12 = 3.49$ IN4

$\dfrac{L_b S_c}{I_y} = \dfrac{40.5(2.33)}{3.49} = 27.0 < 204$

$F_b = 9.5$ KSI = 9500 psi > 1302 psi OK

USE 1/4" DIAMOND TREAD W/ HSS 3×3×1/4 SUPPORT TUBE

FIGURE 1

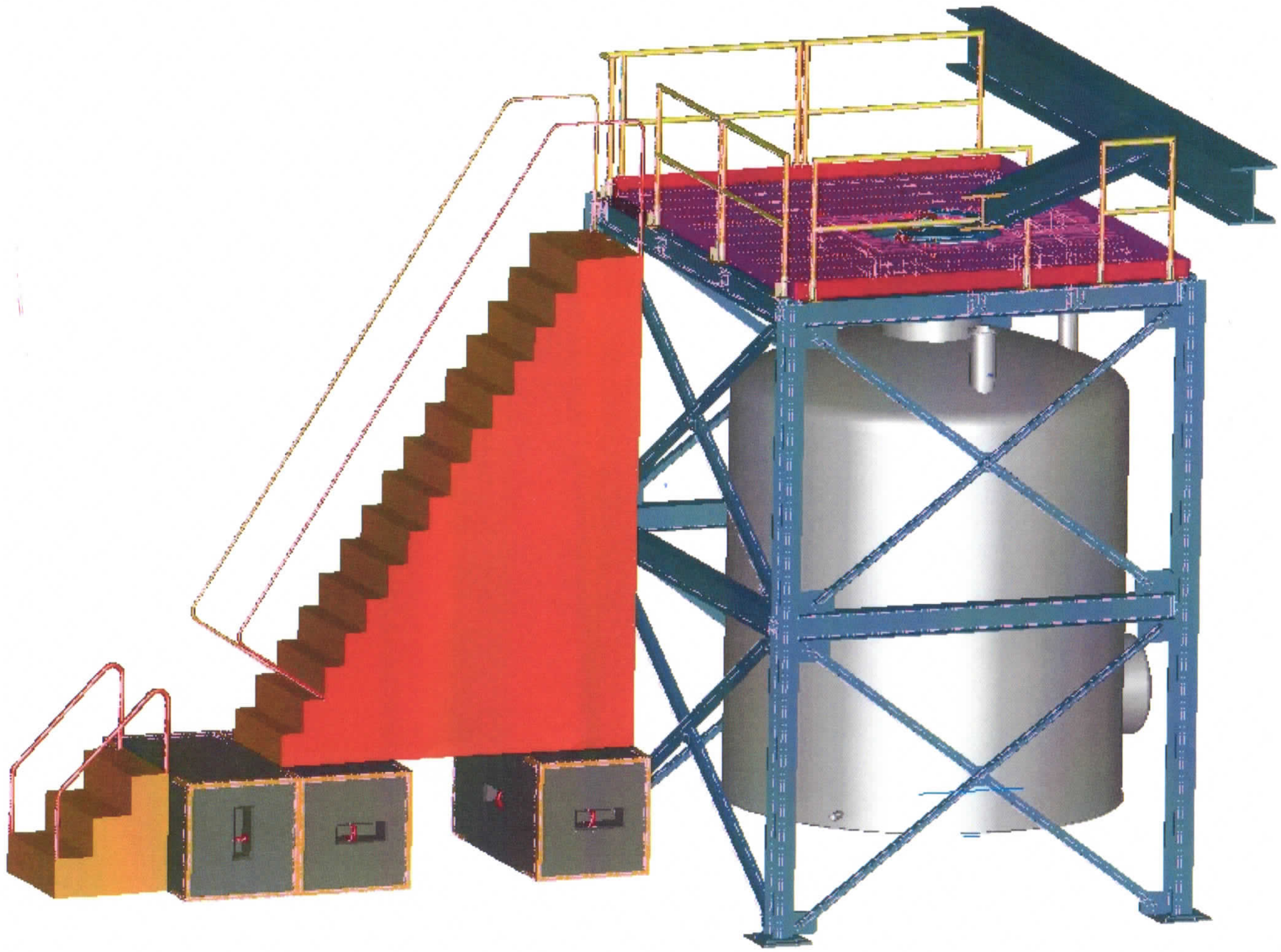


FIGURE 2

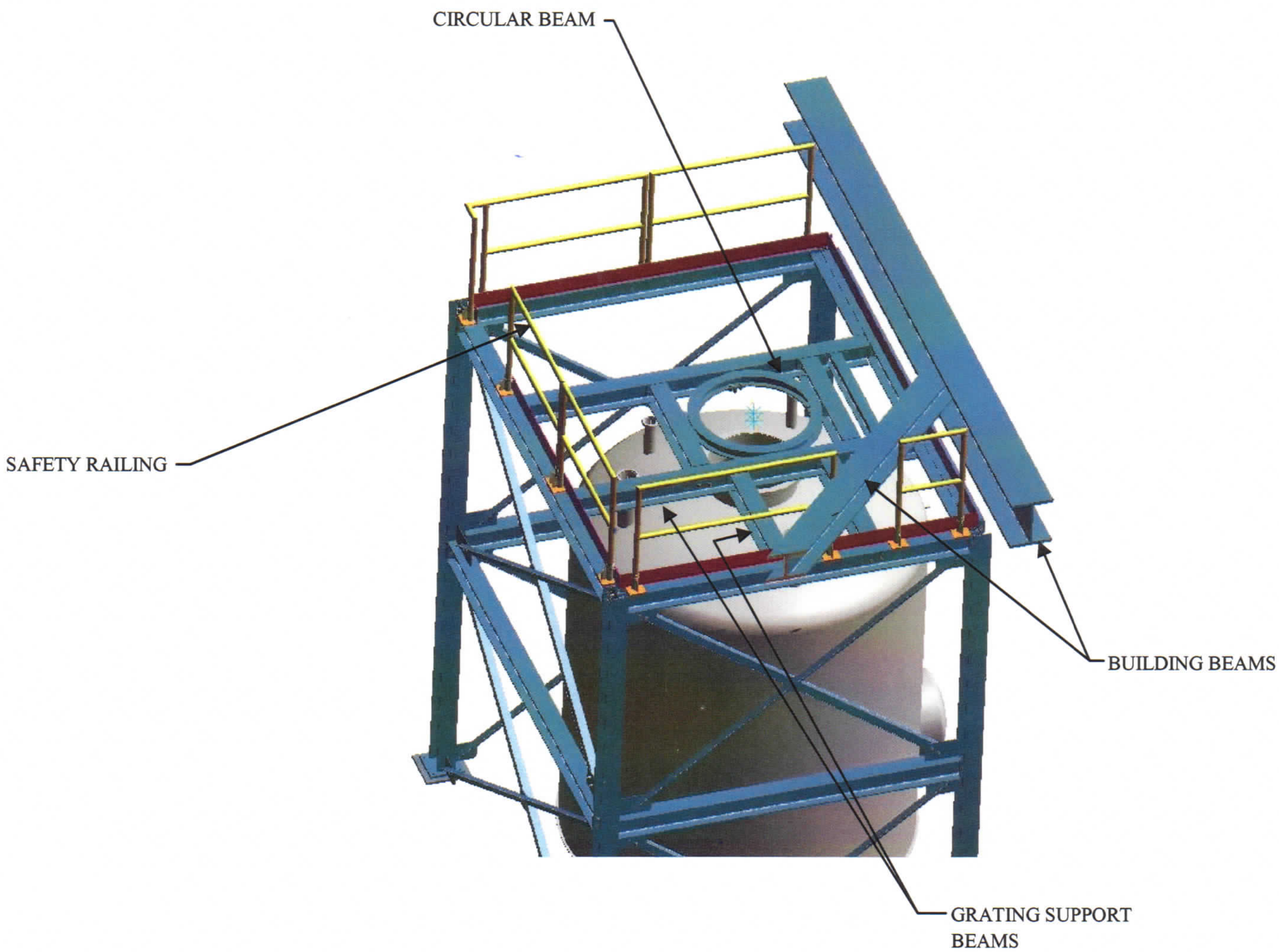

CIRCULAR BEAM
SAFETY RAILING
BUILDING BEAMS
GRATING SUPPORT
BEAMS

FIGURE 3

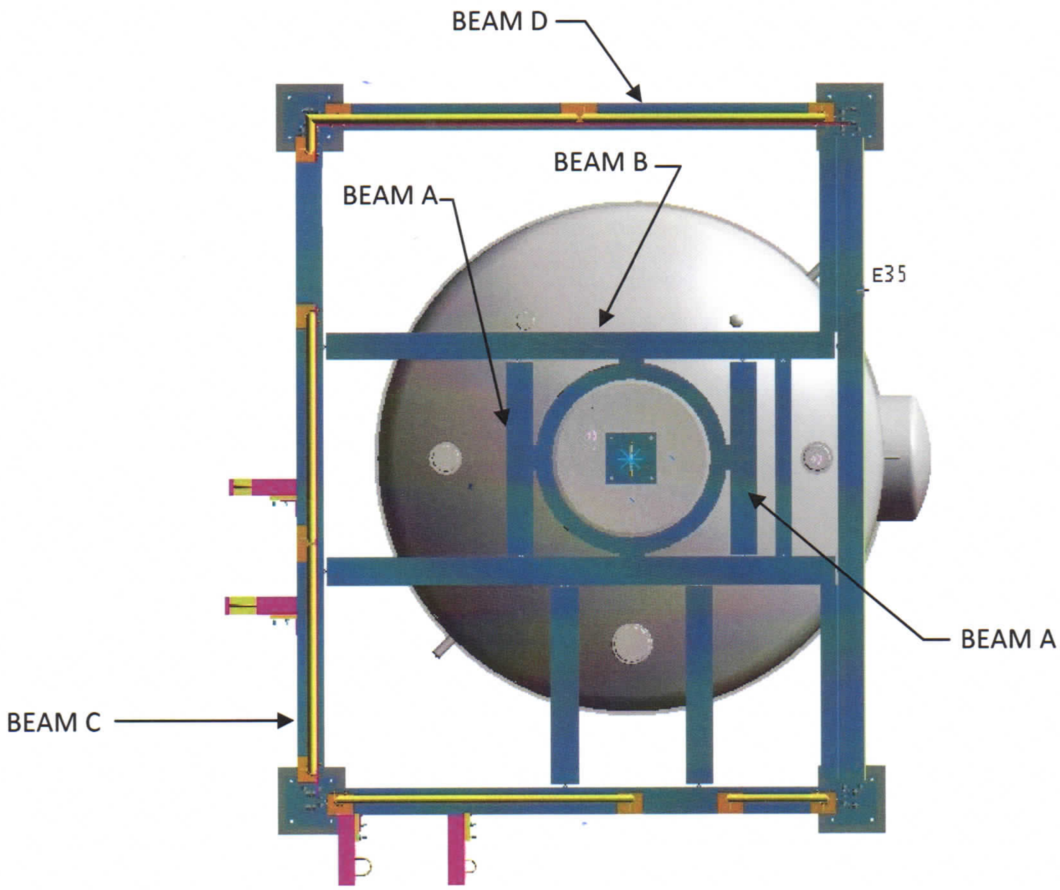
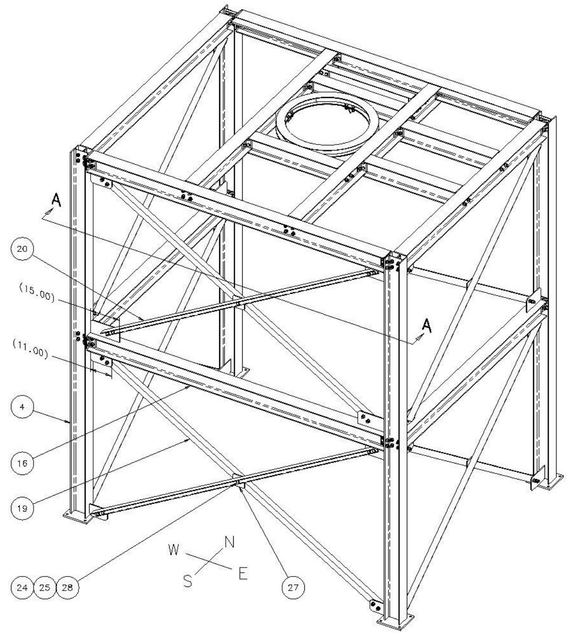
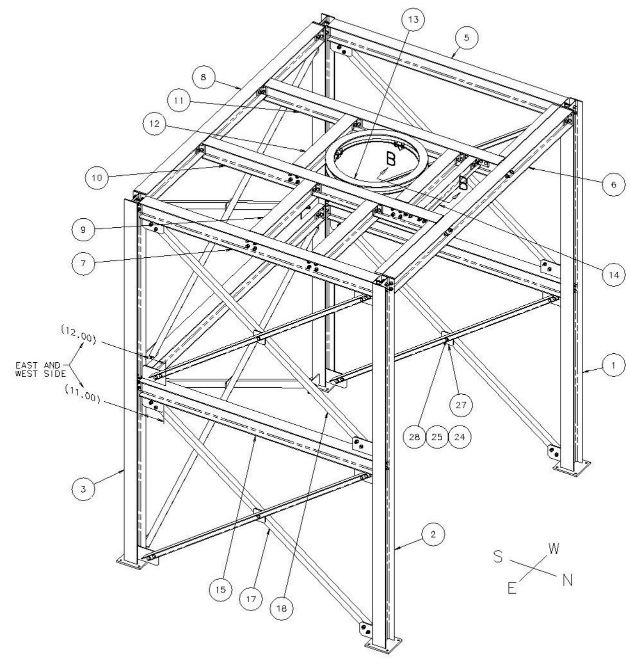
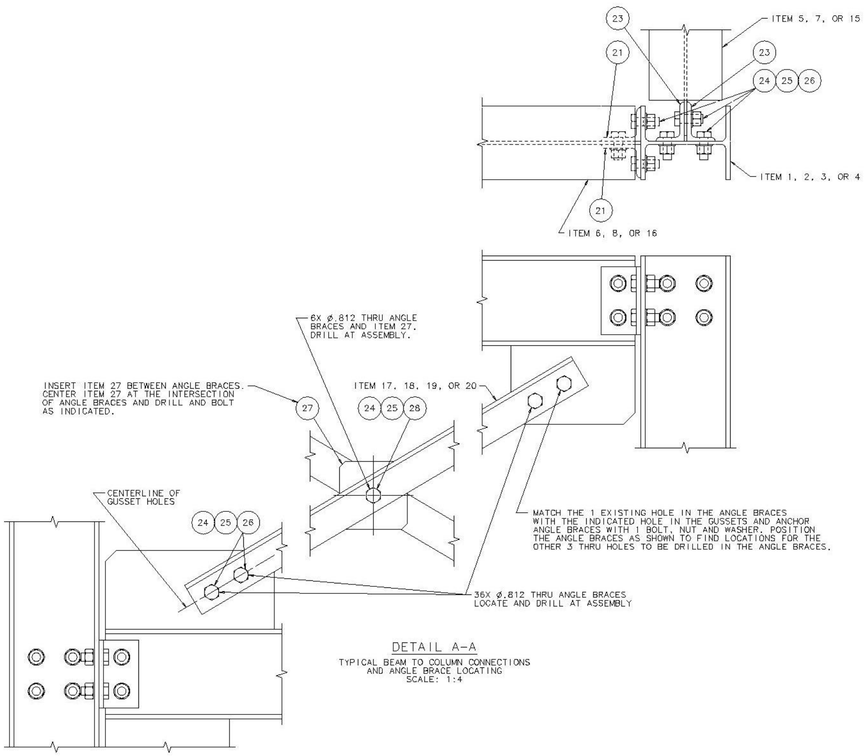


FIGURE 4

REV	DESCRIPTION	DRAWN	DATE
		APPROVED	DATE

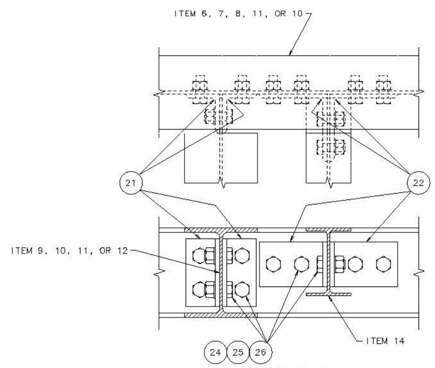






DETAIL A-A

TYPICAL BEAM TO COLUMN CONNECTIONS AND ANGLE BRACE LOCATING
SCALE: 1:4



DETAIL B-B

TYPICAL BEAM TO BEAM CONNECTIONS
SCALE: 1:4

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.
28	COML.	3/4-10 UNC X 2.50 LONG ASTM A325 HEAVY HEX HEAD BOLT - STEEL	6
27	MB-486015	BRACING SPACER PLATE	6
26	COML.	3/4-10 ASTM A563 HEAVY HEX NUT - STEEL	230
25	COML.	3/4 FLAT WASHER - ASTM F436 HARDENED STEEL	230
24	COML.	3/4-10 UNC X 2.00 LONG ASTM A325 HEAVY HEX HEAD BOLT - STEEL	224
23	MB-466892	ANGLE BRACKET 2.5 X 3.5 X 6	16
22	MB-466891	ANGLE BRACKET 6 X 6 X 4	4
21	MB-466893	ANGLE BRACKET 3 X 3.5 X 6	36
20	MC-466916	ANGLE BRACE 3 X 3 X 163" LG.	2
19	MC-466917	ANGLE BRACE, 3 X 3 X 169" LG.	2
18	MC-466914	ANGLE BRACE, 3 X 3 X 139" LG.	4
17	MC-466915	ANGLE BRACE, 3 X 3 X 143.5" LG.	4
16	MD-466903	BRACING BEAM WELDMENT - SOUTH	1
15	MD-466897	BRACING BEAM WELDMENT - E-W	2
14	MD-466895	INNER GRATE SUPPORT BEAM NORTH	1
13	MC-466894	CIRCULAR BEAM WELDMENT	1
12	MC-466909	INNER BEAM WELD. NORTH-SOUTH	2
11	MD-466908	INNER BEAM WELDMENT - WEST	1
10	MD-466907	INNER BEAM WELDMENT -EAST	1
9	MC-466899	INNER GRATE SUPPORT BEAM - EAST	2
8	MD-466901	OUTER BEAM WELDMENT - SOUTH	1
7	MD-466923	OUTER BEAM WELDMENT - EAST	1
6	MD-466900	OUTER BEAM WELDMENT - NORTH	1
5	MD-466896	OUTER BEAM WELDMENT - WEST	1
4	MD-466913	COLUMN & BASE WELDMENT, S.W.	1
3	MD-466912	COLUMN & BASE WELDMENT, S.E.	1
2	MD-466910	COLUMN & BASE WELDMENT, N.E.	1
1	MD-466911	COLUMN & BASE WELDMENT, N.W.	1

PARTS LIST

UNLESS OTHERWISE SPECIFIED			
.XX .XXX ANGLES	DRAWN	J.MULVEY	11-MAY-2010
± .06 ± - ± -	CHECKED	J.RAUCH	09-JUN-2010
	ORIGINATOR	R.J.WOODS	16-MAR-2010
	APPROVED	R.J.WOODS	09-JUN-2010
	USED ON		
	MATERIAL	SEE PARTS LIST ABOVE	

1. BREAK ALL SHARP EDGES - MAX.
2. DO NOT SCALE DRAWING.
3. DIMENSIONS BASED UPON ASME Y14.5M-1994
4. MAX. ALL MACH. SURFACES 250
5. DRAWING UNITS: U.S. INCH

FERMI NATIONAL ACCELERATOR LABORATORY

SCALE 1:10 DRAWING NUMBER

SHEET 1 OF 1 REV

CREATED WITH : Ideas12NXSeries GROUP: PPD/MECHANICAL DEPARTMENT