D ZERO FORWARD MUON TRACKING UPGRADE

B LAYER MDT OCTANT SUPPORT ANALYSIS

ENGINEERING NOTE

3823.130-EN542

WRITTEN BY:
TONY LEVAND 10/17/2000

CHECKED BY:

Tampin DATE: 10-30-00

FERMILAB
ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE
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SUBJECT: B LAYER MDT SUPPORTS

NAME: Tony Levand

DATE: 7/31/00

REVISION DATE:

OCTANT WEIGHTS

OCTANT 0-3, 1-2

Area = $\frac{200.83 + 56.93}{2} \times 147.24 = 18.98 \text{ in}^2 \times 10^3$

Frames + skins = $\left[2(.04 \times 2.2) + .1 \times 2\right] 18.98 \times 10^3 \times .11 = 785$ lbs

MDT = .038 lb/in

= $.038\left[\frac{200.83 + 56.93}{2} \times 44 \times 3\right] = 642$ lbs

ELECTRONICS, MISC COVERS 200 lbs

TOTAL: MDT 0-3 1627 lbs

OCTANT 4-7

Area = $18.98 - 1.436 = 17.54 \text{ in}^2 \times 10^3$

weight = $\left[785 + 642\right] \times \frac{17.54}{18.98} + 200 = 1519$ lbs

OCTANT 5-6

Area = $102.37 \times \frac{153.96 + 56.93}{2} = 10.85 \text{ in}^2 \times 10^3$

weight = $(785 + 642)\,\frac{10.85}{18.78} + 150 = 965$ lbs

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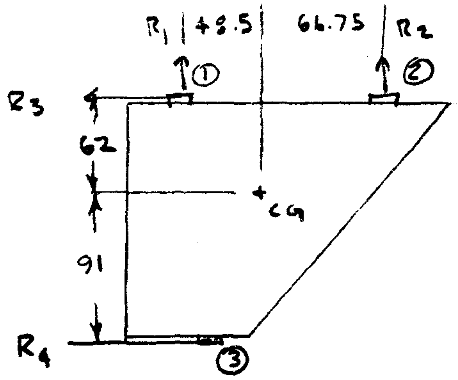
SUBJECT: B LAYER MDT SUPPORTS

NAME: Tony Levard

DATE: 7/31/00

REVISION DATE:

SUPPORT LOADS:



OCTANTS 1,2

$W = 1627$ lbs

$R_1 = 1627 \times \frac{66.75}{115.3} = 942$ lbs

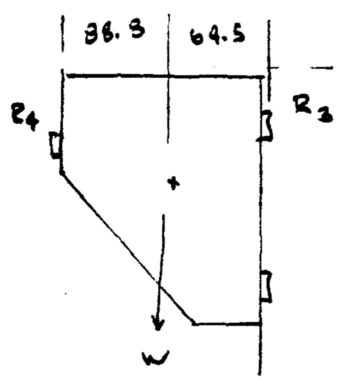
$R_2 = 1627 - 742 = 685$ lbs

OCTANTS 0,3

$R_3 = 1627 \times \frac{91}{153}$ 968 lbs

$R_4 = 1627 - 968 = 659$ lbs

OCTANTS 4-7



$W = 1519$ lbs

$R_3 = 1519 \times \frac{88.8}{153} = 880$ lbs

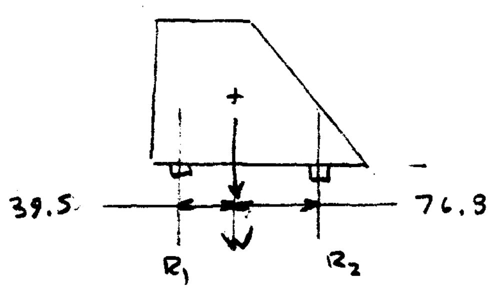
$R_4 = 1519 - 880 = 640$ lbs

OCTANTS 5-6

$W = 965$ lbs

$R_1 = 965 \times \frac{76.8}{116.3} = 637$ lbs

$R_2 = 965 - 637 = 328$ lbs



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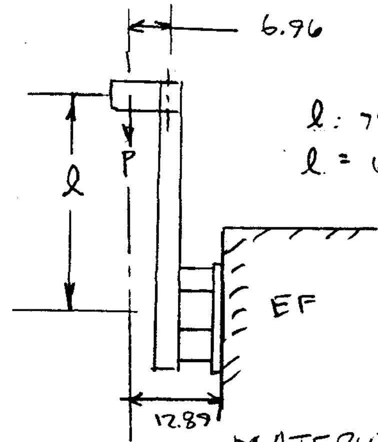
SUBJECT: B LAYER SUPPORTS		NAME: TONY LEVAND	DATE: 10/3/00	REVISION DATE

OCTANTS 1 & 2 SUPPORTS
DWG 386953, 966, 950



ℓ : 75.78 + 1.31 − 6.72 − $\frac{5.73}{2}$

ℓ = 67"

MATERIAL: ~~ASTM A-500~~

F_{ty} = 42 KSI

FLAGPOLE:

P = 942 lbs

4 x 4 x .188 TUBE

$I = 6.59\ in^4$ $\quad A = 2.77\ in^2$

$P_{cr} = c\dfrac{\pi^2 EI}{L^2}$, $c = .25$

$$P_{cr} = \frac{.25 \times \pi^2 \times 30\times10^6 \times 6.59}{67^2} = 108 \text{ Kips} - \text{stable}$$

BEAM-COLUMN

Ref: Roark 6th ed p 167 case 3a, a = 0

$$M_b = \frac{M_o}{\cos(k\ell)}$$

$M_o = 942 \times 6.96 = 6.6$ kip-in

$$k = \sqrt{\frac{P}{EI}} =$$

$$K_1 = \left(\frac{942}{30\times10^6 \times 6.59}\right)^{1/2} = 2.18\times10^{-3}$$

$$M_b = \frac{6.96}{\cos(2.18\times10^{-3} \times 67)} = 7.04 \text{ in kip}$$

$$f_b = \frac{7.04 \times 2}{6.59} = 2.1 \text{ KSI} \qquad f_c = \frac{942}{}$$

$$f_b + f_c = 2.1 + \frac{942}{2.77} = 2.4 \text{ KSI} < 14 \text{ KSI}$$

FERMILAB ENGINEERING NOTE	SECTION	PROJECT	SERIAL-CATEGORY	PAGE 4

SUBJECT	NAME Tony Levand
B LAYER PIXEL Z SUPPORTS	DATE 10/17/00 — REVISION DATE

THESE SUPPORTS HOLD THE B LAYER PIXEL PLANE IN PLANE. THE LOADS ARE ON THE ORDER OF 100 - 200 lbs

COLUMN STABILITY

$$P_{cr} = \frac{\pi^2 EI}{L^2}$$

$$\cancel{P_{cr} = \frac{\pi^2 \times 30\times10^6 \times .017}{23.66^2}}$$

$P_{cr} =$ 2.8 KIP >> 200 lbs

MATERIAL ALLOWABLES:
ASTM A-500 Grd C
$F_{ty} = 40$ KSI
$F_1 = 15$ KSI

1/2" SCH 40 PIPE

$$I = \frac{\pi\left(.840^4 - (.840 - .213)^4\right)}{64}$$

$I = .017 \text{ in}^4$

ROD END

3/8 MALE ROD END

ALLOWABLE = $\frac{4916}{5}$ = 983 lbs > 200 lbs

Quick Disconnect:

3/8 $P_{allow} = \frac{1000}{5}$ = 200 lbs = 200 lbs rated load
RATED LOAD

HANDLING LOAD:

$$M = \frac{200 \times 23.66}{4} = 1183 \text{ in lbs}$$

$$f_b = \frac{1183 \times \frac{.840}{2}}{.017} = 29 \text{ KSI} < 46 \text{ KSI YIELD}$$

FERMILAB
ENGINEERING NOTE

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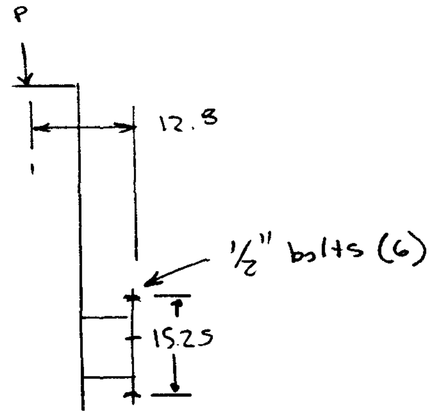
SUBJECT	NAME	REVISION DATE
B LAYER MDT SUPPORTS	Tony Levand	
	DATE 7/31/00	

OCTANTS 1,2 SUPPORT



$M = 742 \times 12.8 = 12 \times 10^3$ in.lbs

FASTENER LOADS:

$$P_t = \frac{12 \times 10^3}{15.25 \times 2} = 396 \text{ lbs}$$

$$\cancel{f_t = \frac{396}{.1419} = 2.7 \text{ KSI}} \quad , \cancel{\text{tens}}$$

$$f_s = \frac{742}{6 \times .1419} = .1.1 \text{ KSI} \quad \text{- low}$$

SUBJECT: B LAYER MOT SUPPORTS

NAME: Tony Levand

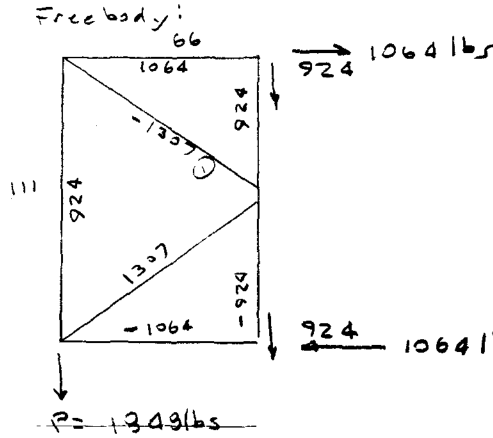
DATE: 7/31/00 | REVISION DATE

SUPPORT WELDMENT 0, 3, 4, 7 OUTBOARD DWG 386961, 951

$P_{03} = R_3 = 963$ lbs

$P_{47} = R_3 = 930$ lbs

Freebody:



STABILITY OF DIAGONAL MEMBER:

$P_{cr} = \frac{\pi^2 EI}{L^2} = \frac{\pi^2 \times 30\times10^6 \times 2.5^{①}}{71^2} = 146$ KIP (stable)

① 4×3×.125 ▯ $I = \frac{3^3\times4 - 2.75^3\times3.75}{12} = 2.5\,in^4$

FASTENER LOADS:

SHEAR, VERTICAL

$S_v = \frac{924}{6} = 154$ lbs

$S_h = \frac{1064}{6} = 177$ lbs

total $\left[154^2 + 177^2\right]^{1/2} = 234$ lbs

$f_s = \frac{234}{.147} = 1.6$ KSI (low)

MATERIAL ALLOWABLE:

ASTM A-500 STEEL

$F_{ty} = 42$ KSI

$F_a = \frac{F_{ty}}{3} = 14$ KSI

WELDS TO EF IRON:

$f_s = \frac{\left(1064^2 + 924^2\right)^{1/2}}{10\times2\times\frac{.375}{\sqrt{2}}} = 265$ PSI

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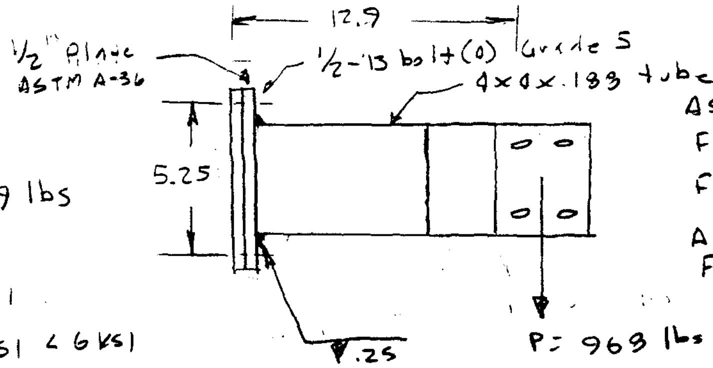
SUBJECT	NAME
B LAYER MOT SUPPORTS	Tony Leveand
	DATE 7/31/00 — REVISION DATE

OCTANT 2-3 INBOARD MOUNT DWG 336960, 964, 965, 971, 954, 963



ASTM A-500
$F_{ty} = 42$ KSI
$F_t = \frac{42}{3} = 14$ KSI
A-36
$F_s = 6$ KSI

Fasteners:

$P_t = \frac{968 \times 12.9}{2 \times 5.25} = 1189$ lbs

should be 2 bolts →

$f_t = \frac{1189}{.1419} = 8.4$ KSI

$f_s = \frac{968}{4 \times .1419} = 1.7$ KSI < 6 KSI

FASTENER ALLOWABLE $= \frac{90}{3}$ KSI $\times .1419 = 4.2$ KIP

WELD:

Assume weld on top & bottom only

$f_s = \frac{968 \times 12.3}{4 \times 4 \times \frac{.25}{\sqrt{2}}} = 4.2$ KSI < 6 KSI

OCTANT 6-7 INBOARD MOUNT:

THE MOUNT ATTACHMENT IS THE SAME AS 2-3 INBD
THE LOAD IS 830 lbs.

OCTANT 5-6 UPPER MOUNT

LOAD = 637 lbs

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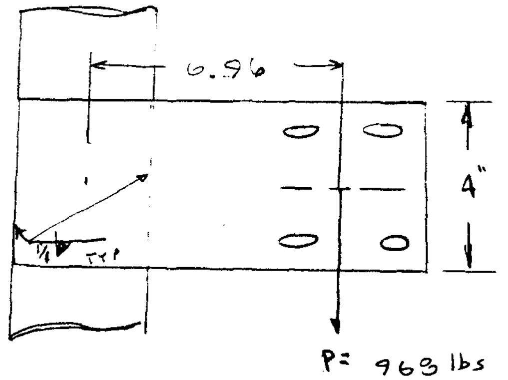
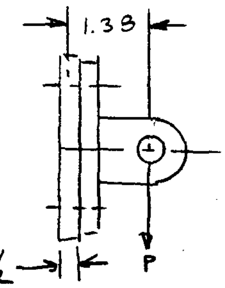
B LAYER MUT SUPPORTS	Tony Levand	7/31/00	

SLOTTED PLATE





$M = 963 \times 6.96 = 6.6$ in kip

$f_b = \frac{6.6 \cancel{5} \times 6.3}{4^2 \times .5} = \frac{4.95}{\cancel{4.7}}$ KSI (< 12 KSI)

Torsion:

$f_s = \frac{T}{k\ a^2 b}$

$k_3 = .3$

$f_s = \frac{963 \times 1.38}{.3 \times .5^2 \times 4} = .4.45$ KSI < 6 KSI

ASTM A-36 steel

$F_n = \frac{F_{ty}}{3} = 12$ KSI

$F_s = \frac{12}{2} = 6$ KSI

Deflection:

$\delta = \frac{TL^2}{JG} = \frac{963 \times 1.38 \times 6.5^2}{(.3 \times .5^3 \times 4)\ 12 \times 10^6}$ .031 in

Weld:

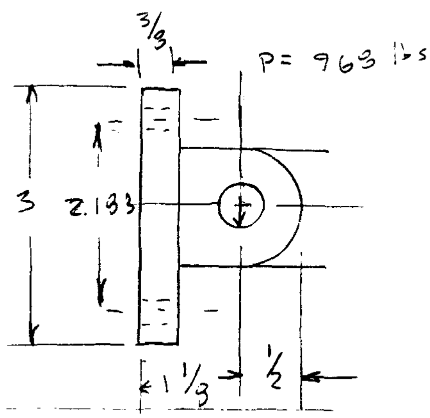
$f_s = \frac{963 \times 4.5 \times 6}{4^2 \times \frac{.25}{\sqrt{2}}} = 9.2$ KSI < 12 KSI

combine bending and torsion:
maximum occur at different locations, thus not combined ?

shear stress

$f_v = \frac{968}{4 \times 0.5} = 484$ psi

CLEVIS BRACKET, McMaster # 6211K57



MATERIAL ALLOWABLE:

DUCTILE IRON CASTING

$F_{ty} = 40$ KSI ①

$F_b = \frac{40}{3} = 13.3$ KSI

NOTE:

THIS CLEVIS IS USED ON AIR CYLINDERS $P_{max} = 250$ PSI

$2\frac{1}{2}\phi$ BORE =

$P_{allow} =$ 1227 lbs Rated load

BENDING:

$M = 968 \times .75 = 726$ in lbs

$f_b = \frac{726 \times 6}{2 \times .5 \times 1^2} = 4.3$ KSI < 13.3 KSI

$f_s = \frac{926}{1} = 926$ PSI $\ll 7$ KSI

FASTENERS:

$P_s = \frac{968}{4} = 242$ lbs

$P_t = \frac{968 \times 1.13}{2.183 \times 2} = 243$ lbs

5/16 - 13

$f_s = \frac{242}{.0524} = 4.6$ KSI $\ll 45$ KSI

$f_t = \frac{243}{.0524} = 4.7$ KSI $\ll 90$ KSI

① Appendix A Ductile Iron Data

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SUBJECT: BLAKE MOT SUPPORTS

NAME: Tony Leonard

DATE: 7/31/00

REVISION DATE:

CLEVIS BRACKET (cont.)

eccentric lug analysis:

$P_{ty} = K_{ty} A_{Br} F_{ty}$ (1)

$A_{avg} = .25$

$A_{Br} = .25 \times 1 = .25$

$\frac{A_v}{A_{br}} = 1.0$, $K_{ty} = 1.0$

$P_{ty} = 1.0 \times .25 \times 40 = 10$ kip

Allowable load $= \frac{10}{3} = 3.3$ kip > 968 lbs

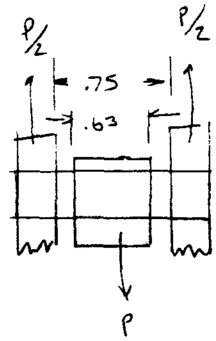
PIN SHEAR: *

Grade 5 bolt, $F_{ty} = 90$ KSI

$F_{s} = \frac{F_{ty}}{3} = 30$ KSI

$f_s = \frac{968}{2 \times .1419} = 3.4$ KSI

PIN BENDING:



$M = \frac{968}{2} \times .25 = 121$ in lbs

1/2" bolt

$J = 1.6 \times 10^{-3}$ in

$f_b = \frac{121 \times .25}{1.6 \times 10^{-3}} = 18$ KSI < 30 KSI

* Pin area is calculated for a 1/2" bolt. The clevis pin is supplied with the bracket.

(1) Bruhn, Analysis & Design of Flight Vehicle Structures, p D1.8

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SUBJECT: BLAYER MOT SUPPORTS

NAME: Tony Levand

DATE: 7/31/00

REVISION DATE:

ROD END

Mc Master # 6064K16 1/2" MALE

LOAD RATING = 8338 LBS

$$\text{Allowable load} = \frac{8333}{5} = 1668 > 968 \text{ lbs}$$

TURNBUCKLE:

1/2 x 6 MATERIAL C-1035 STEEL, FORGED PER ~~ASTM E1165-92~~

WORKING LOAD LIMIT = 2200 lbs < 968 LBS

PIN SHEAR:

1/2 Ø PIN DOUBLE SHEAR:

$$f_s = \frac{968}{2 \times .1419} = 3.4 \text{ KSI}$$

FERMILAB ENGINEERING NOTE

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SUBJECT: B LAYER MDT SUPPORTS

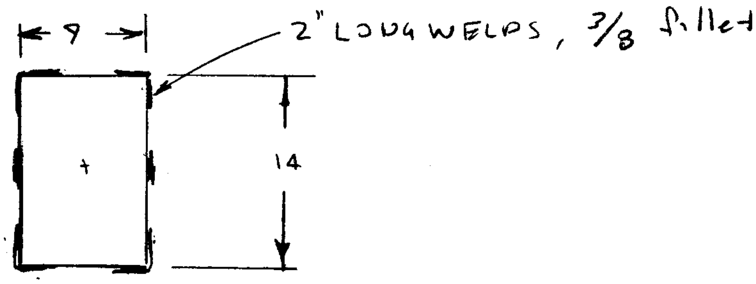
NAME: Tony Lesand

DATE: 10/3/00

REVISION DATE:

WELDS TO EF IRON

OCTANTS 1 & 2



$P = 942 \text{ lbs}$

$M = 942 \times 12.9 = 12.1 \text{ kip in}$

$$f_s = \frac{942}{10 \times 2 \times \frac{.375}{\sqrt{2}}} = 177 \text{ PSI}$$

$$\Sigma A d^2 = \left(\frac{.375 \times 2}{\sqrt{2}}\right)\left[6^2 \times 4 + 7^2 \times 4\right] = 180 \text{ in}^4$$

$$f_t = \frac{12.1 \times 7}{180} \quad 471 \text{ PSI}$$

$$f_s + f_t = 177 + 471 = 650 \text{ PSI}$$

OCTANTS 0,3 & 4,7

$$f_s = \frac{\left[924^2 + 1064^2\right]^{1/2}}{10 \times 2 \times \frac{.375}{\sqrt{2}}} = 265 \text{ PSI}$$

$$f_s + f_t = 265 + 471 = 737 \text{ PSI}$$

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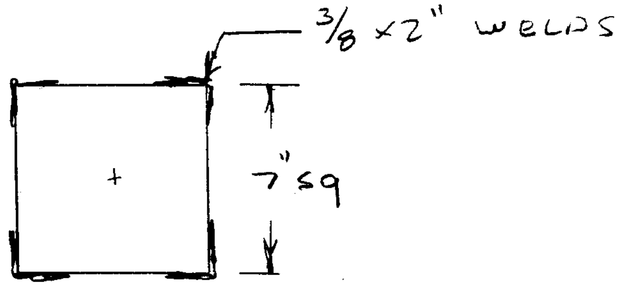
SUBJECT	NAME	REVISION DATE
B LAYER MDT SUPPORTS	Tony Leveand	
	DATE 10/3/00	

WELDS TO EF IRON

OCTANT 0,3 INBD



$P = 968$ lbs

$M = 968 \times 12.9 = \quad 12.5$ Kip in

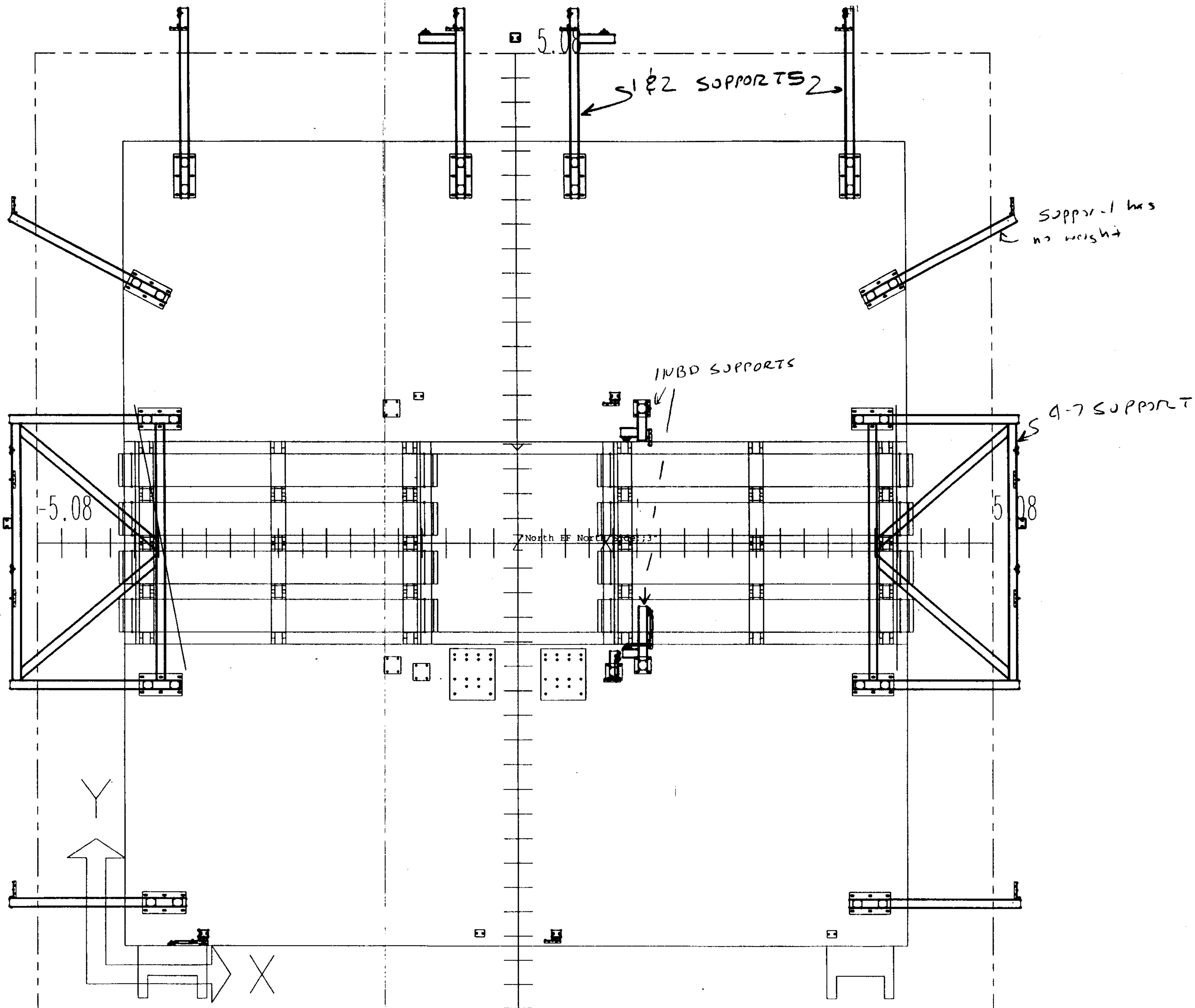
$$\Sigma A d^2 = \frac{.375 \times 2}{\sqrt{2}} \left[3.5^2 \times 4 + 2.5^2 \times 4 \right] = 39.2$$

$$f_s = \frac{968}{8 \times 2 \times \frac{.375}{\sqrt{2}}} = 223 \text{ PSI}$$

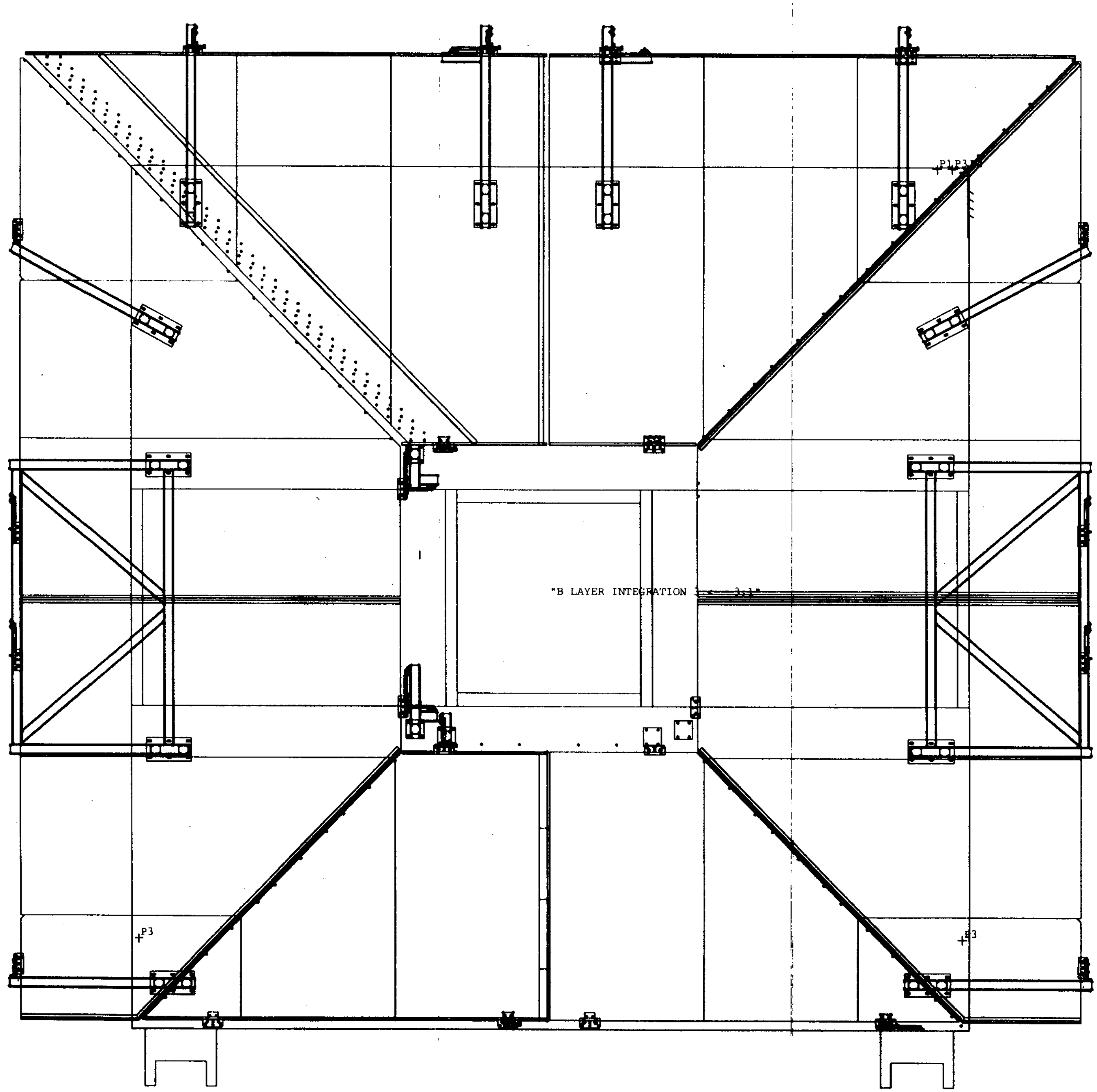
$$f_t = \frac{968 \times 12.1 \times 3.5}{39.2} = 1043 \text{ PSI}$$

$$f_s + f_t = 1043 + 223 = \underline{1274 \text{ PSI}}$$

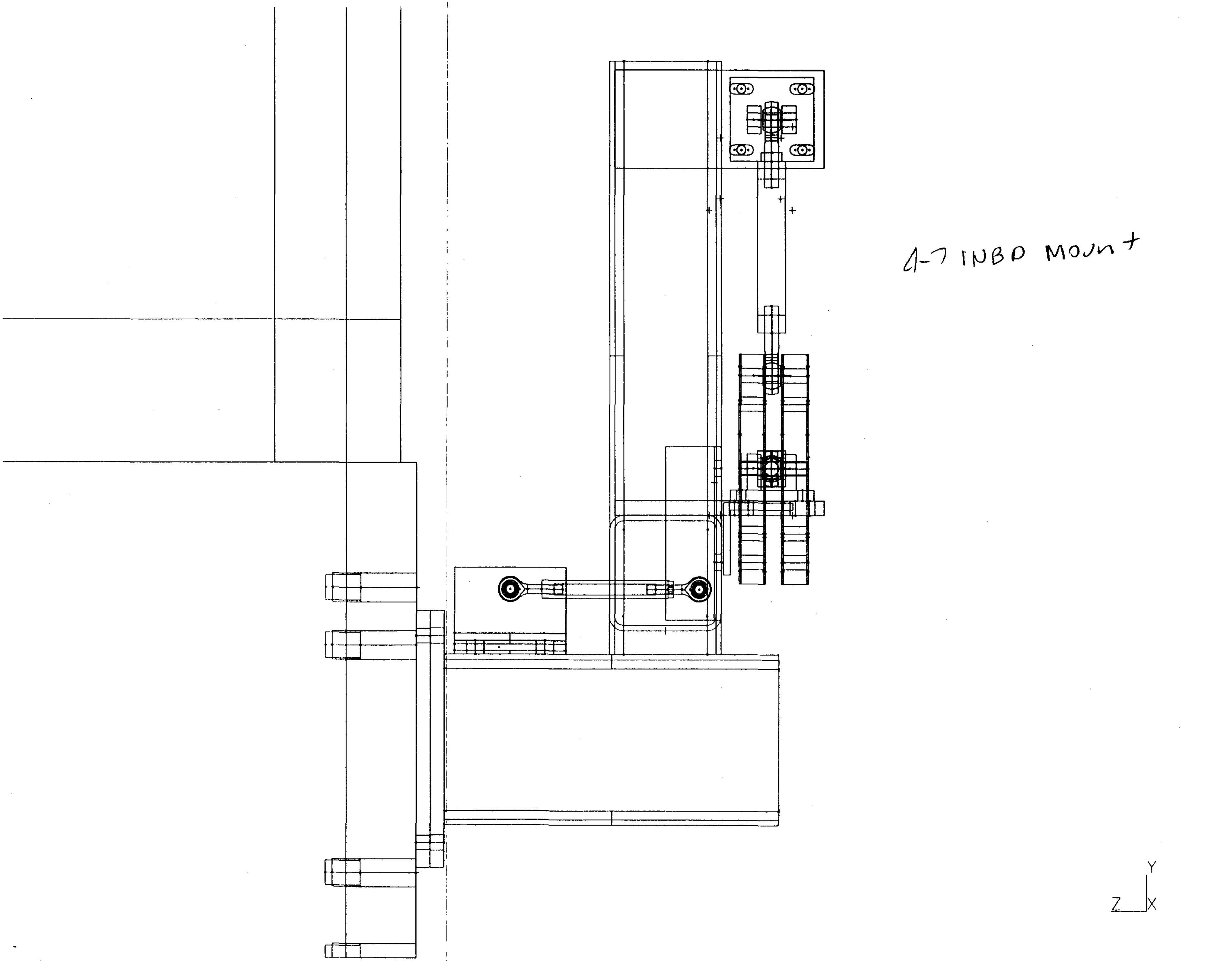
TYPICAL STRESS IN A LAYER MOUNTS ~ 3 KSI



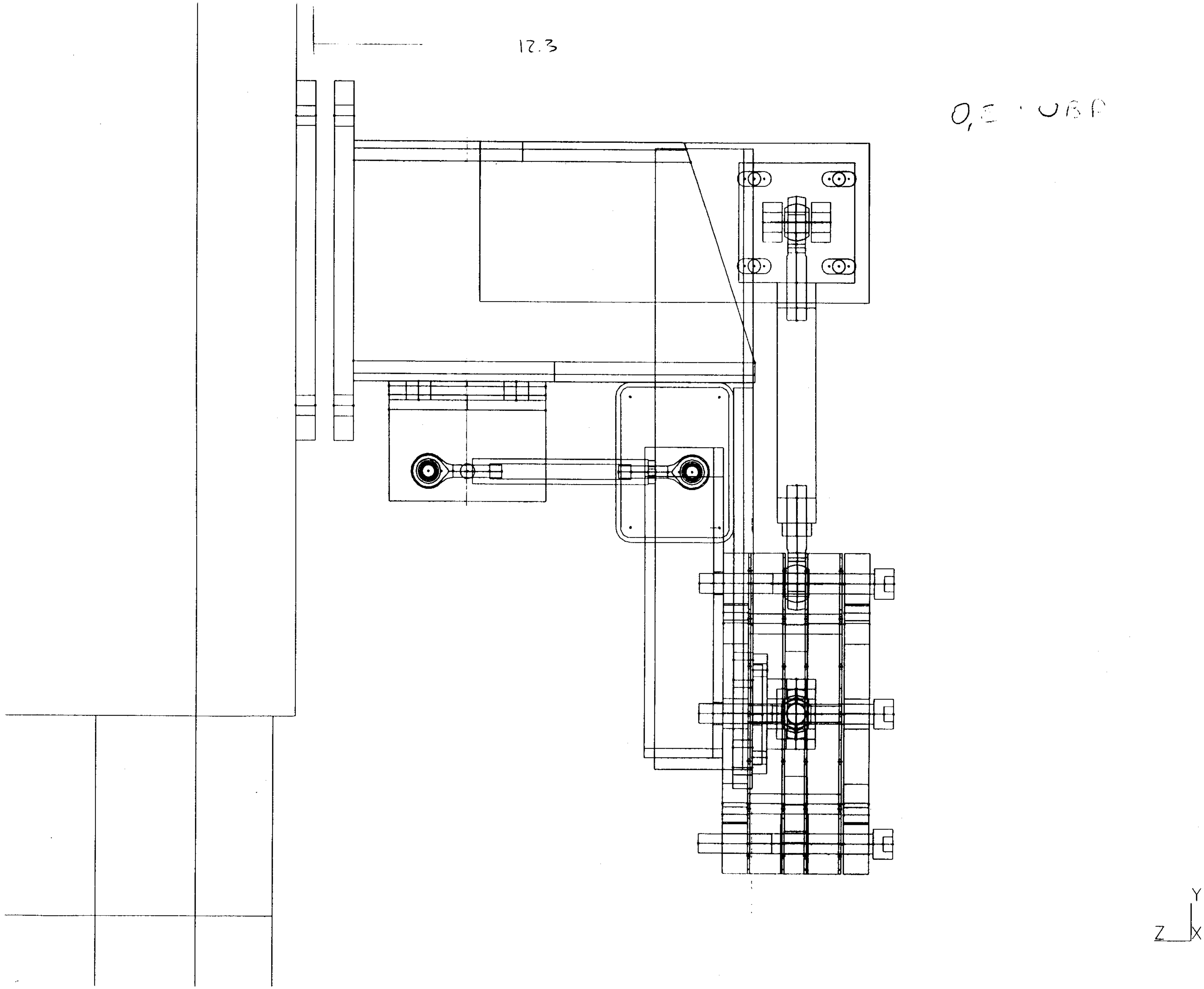
Plotted evand on 03-Oct-00 , File: b.pff



Plotted by levand on 26-Oct-00 , File: MDT.pff

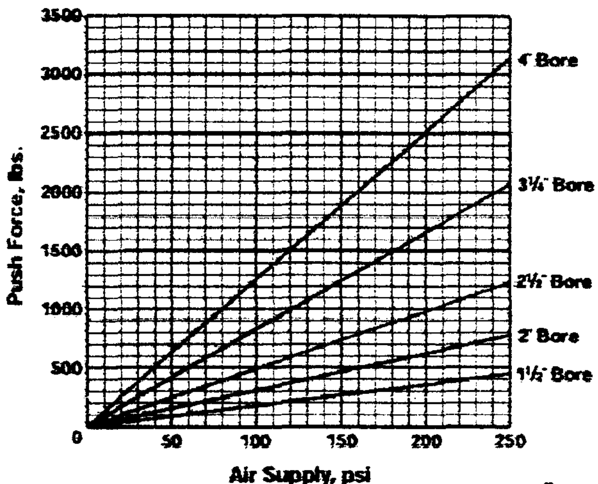


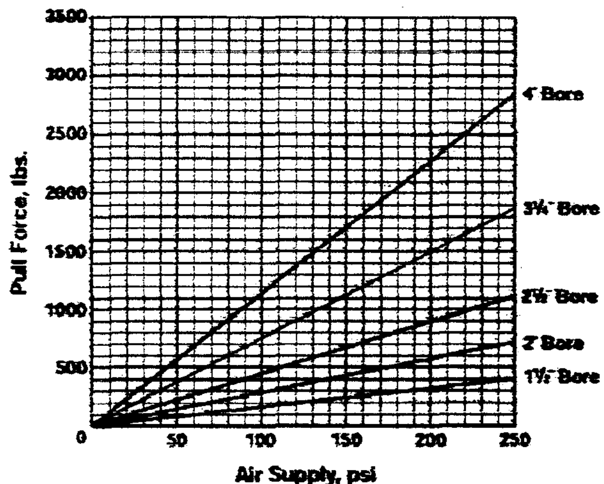
Plo(y levand on 01-Aug-00 , File: bmount.pff



Plott by levand on 01-Aug-00 , File: bmount.pff

Performance Data



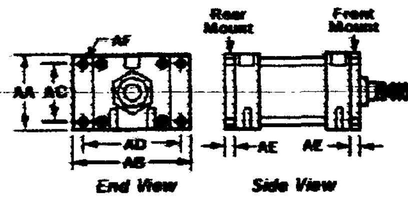


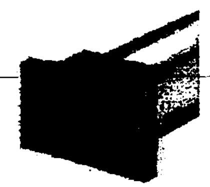
Attachments

Front or Rear Flange

Use this flange on either the front or rear of your cylinder.

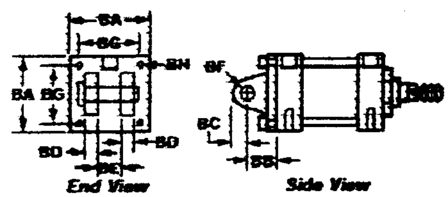
Fits Bore Size	AA	AB	AC	AD	AE	Dia., AF	
1 1/2"	2"	3 3/8"	1 5/16"	2 3/8"	3/8"	5/16"	6211K1
2"	2 1/2"	4 1/8"	1 27/32"	3 3/8"	3/8"	3/8"	6211K2
2 1/2"	3"	4 5/8"	2 3/16"	3 7/8"	3/8"	3/8"	6211K3
3 1/4"	3 3/4"	5 1/2"	2 3/4"	4 11/16"	5/8"	7/16"	6211K4
4"	4 1/2"	6 1/4"	3 21/64"	5 7/16"	5/8"	7/16"	6211K5





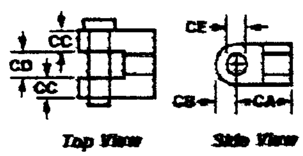
Clevis Bracket with Pin

Fits Bore Size	BA	BB	BC	BD	BE	Dia., BF	BG	BH	
1 1/2"	2"	1 1/8"	1/2"	1/2"	3/4"	1/2"	1 11/16"	17/64"	6211K55
2"	2 1/2"	1 1/8"	1/2"	1/2"	3/4"	1/2"	1 27/32"	21/64"	6211K56
2 1/2"	3"	1 1/8"	1/2"	1/2"	3/4"	1/2"	2 3/16"	21/64"	6211K57
3 1/4"	3 3/4"	1 7/8"	3/4"	5/8"	1 1/4"	3/4"	2 3/4"	25/64"	6211K58
4"	3 3/4"	1 7/8"	3/4"	5/8"	1 1/4"	3/4"	3 21/64"	25/64"	6211K59



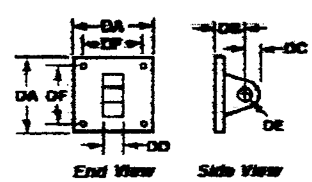
Rod Clevis with Pin

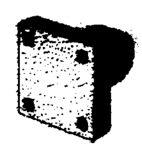
Fits Bore Sizes	CA	CB	CC	CD	Dia., CE	
1 1/2"-2 1/2"	1 1/2"	1/2"	1/2"	3/4"	1/2"	6211K65
3 1/4"-4"	2 3/8"	3/4"	5/8"	1 1/4"	3/4"	6211K66



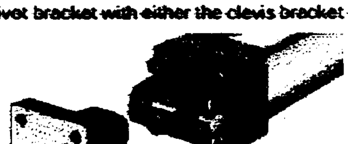
Pivot Bracket

Fits Bore Size	DA	DB	DC	DD	Dia., DE	DF	
1 1/2"	2"	1 1/8"	1/2"	3/4"	1/2"	1 7/16"	6211K6
2"	2 1/2"	1 1/8"	1/2"	3/4"	1/2"	1 27/32"	6211K7
2 1/2"	3"	1 1/8"	1/2"	3/4"	1/2"	2 3/16"	6211K8
3 1/4"	3 3/4"	1 7/8"	3/4"	1 1/4"	3/4"	2 3/4"	6211K9
4"	3 3/4"	1 7/8"	3/4"	1 1/4"	3/4"	3 21/64"	6211K11

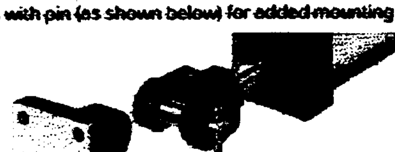




Use the pivot bracket with either the clevis bracket with pin or the rod clevis with pin (as shown below) for added mounting versatility.



Pivot Bracket and Clevis Bracket with Pin

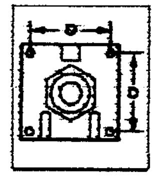


Pivot Bracket and Rod Clevis with Pin

More About Drop-In Tie Rod Air Cylinders

NFPA—The National Fluid Power Association sets industry standards for a wide variety of pneumatic and hydraulic products. For air cylinders, those standards specify bore size and mounting configuration.

When you're replacing a cylinder, how do you know if it's an NFPA cylinder? For some cylinders, it's easy—they're marked "NFPA." Others aren't marked, so you'll have to look at the cylinder's end cap. Measure the center-to-center distance between the tie rods (shown as dimension "D" on the schematic at right), then refer to specifications below. A 1⁷⁄₁₆" "D" dimension, for example, tells you that you have an NFPA cylinder; the same is true for a 1²⁷⁄₃₂" "D" dimension, a 2³⁄₁₆" "D" dimension, and so on. Some NFPA cylinders have tie rods with countersunk mounting holes on each end and other NFPA cylinders have tie rods with nuts on each end. In either case, the "D" dimension is the same.

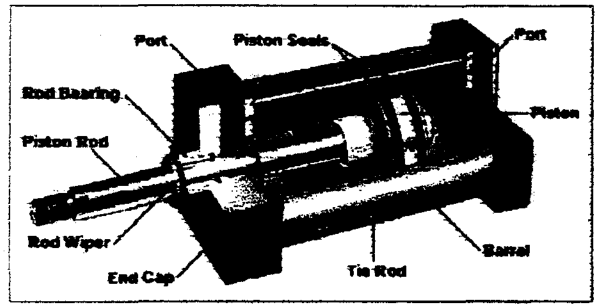


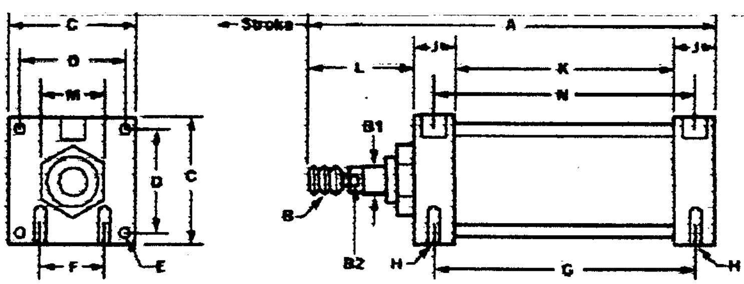
Tie Rod Body Design—Our NFPA tie rod cylinders have external high-tensile steel threaded tie rods that hold the cylinder together, but also allow for easy disassembly and repair. Simply unthread the tie rods and remove the end caps for access to the cylinder internals.

End caps contain the air ports and are machined to accept mounting attachments. End caps also have NFPA tapped holes for mounting the cylinder without attachments. The end caps are machined from solid 6061-T6511 black anodized aluminum bar stock.

Designed for smooth operation and long life, the cylinder barrel is anodized aluminum, hard-coated to Rockwell 60C with a fine finish. The piston is solid high-alloy aluminum with two wear-compensating Buna-N seals and a high-tensile ground and polished chrome-plated steel piston rod. Rod is threaded for connecting to whatever you want to push or pull.

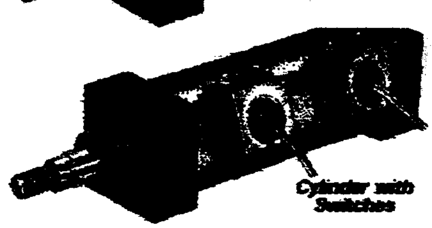
The Teflon-impregnated anodized-aluminum rod bearing provides rod stability and allows the cylinder to handle side loads. Cylinders have a Teflon rod wiper to help prevent dirt and debris from entering the cylinder.





End View *Side View*

Cylinder



Cylinder with Switches

Bore Size	Port Size, NPT Female	Overall Retract. Lg. (A)	Rod Thread (B)	Rod Dia. (B1)	Wd. Across Flats (B2)	End Cap Wd. (C)	Tie Rod, Center to Center (D)	Size of Mounting Holes (E)	Mounting Holes, Center to Center (F)	(G)	Size of Mounting Holes (H)	End Cap Thick. (J)	Barrel Lg. (K)	(L)	Nut Size (M)	Port, Center to Center (N)
1½"	¼"	5⅝"+ Stroke Lg.	7/16"-20	⅝"	½"	2"	1 7/16"	¼"-28	⅝"	2¾"+ Stroke Lg.	¼"-20	1"	1⅝"+ Stroke Lg.	2⅜"	1⅜"	2¾"+ Stroke Lg.
2"	¼"	5⅝"+ Stroke Lg.	7/16"-20	⅝"	½"	2½"	1 27/32"	5/16"-24	⅞"	2¾"+ Stroke Lg.	5/16"-18	1"	1⅝"+ Stroke Lg.	2⅜"	1⅜"	2¾"+ Stroke Lg.
2½"	¼"	5¾"+ Stroke Lg.	7/16"-20	⅝"	½"	3"	2 3/16"	5/16"-24	1¼"	2¾"+ Stroke Lg.	⅜"-16	1"	1⅝"+ Stroke Lg.	2⅜"	1⅜"	2¾"+ Stroke Lg.
3¼"	½"	6⅝"+ Stroke Lg.	¾"-16	1"	⅞"	3¾"	2¾"	⅜"-24	1½"	2⅝"+ Stroke Lg.	½"-13	1¼"	1⅝"+ Stroke Lg.	3"	1¾"	2¾"+ Stroke Lg.
4"	½"	6⅝"+ Stroke Lg.	¾"-16	1"	⅞"	4½"	3 21/64"	⅜"-24	2 1/16"	2⅝"+ Stroke Lg.	½"-13	1¼"	1¼"+ Stroke Lg.	3"	1¾"	2¾"+ Stroke Lg.

Cylinders

Bore Size	1" to 4" Stroke Lg.	4.1" to 8" Stroke Lg.	8.1" to 12" Stroke Lg.
1½"	6211K31	6211K41	6211K81
2"	6211K32	6211K42	6211K82
2½"	6211K33	6211K43	6211K83
3¼"	6211K34	6211K44	6211K84
4"	6211K35	6211K45	6211K85

Cylinders with Switches

Bore Size	1" to 4" Stroke Lg.	4.1" to 8" Stroke Lg.	8.1" to 12" Stroke Lg.
1½"	62175K31	62175K41	62175K81
2"	62175K32	62175K42	62175K82
2½"	62175K33	62175K43	62175K83
3¼"	62175K34	62175K44	62175K84
4"	62175K35	62175K45	62175K85

Appendix A

DUCTILE IRON DATA

FOR DESIGN ENGINEERS

ENGINEERING DATA

TENSILE PROPERTIES

Yield Strength

The yield strength, or proof stress is the stress at which a material begins to exhibit significant plastic deformation. The sharp transition from elastic to plastic behaviour exhibited by annealed and normalized steels (Figure 3.3) gives a simple and unambiguous definition of yield strength. For Ductile Iron the offset method is used in which the yield strength is measured at a specified deviation from the linear relationship between stress and strain. This deviation, usually 0.2 %, is included in the definition of yield strength or proof stress in international specifications (see Section XII) and is often incorporated in the yield strength terminology, e.g. "0.2 % yield strength". Yield strengths for Ductile Iron typically range from 40,000 psi (275 MPa) for ferritic grades to over 90,000 psi (620 MPa) for martensitic grades.

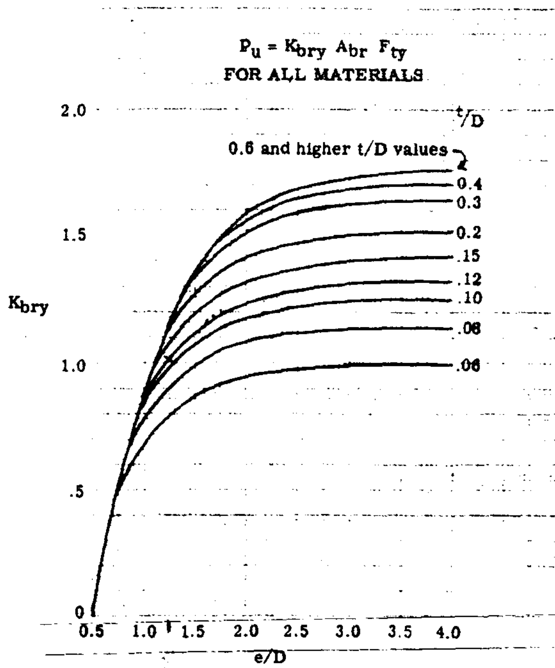


Fig. D1.14 (Ref. 5)
Values of Shear-Bearing Factors of Lugs

Bolt or Pin Bending.

The subject of bolt bending strength is treated in Art. D1.14.

D1.12 Lug Strength Analysis Under Transverse Loading.

Cases arise where the lug of a fitting unit is subjected to only a transverse load. Melcon and Hobbit in (Ref. 4) express the ultimate transverse or failing load by a single equation:-

$$P_{tu} = K_{tu} A_{br} F_{tu} \quad \text{-------------(10)}$$

Similarly the yield strength of lug is,

$$P_{ty} = K_{ty} A_{br} F_{ty} \quad \text{-------------(11)}$$

The efficiency failing and yield co-efficients K_{tu} and K_{ty} are given by the curves in Fig. D1.15. The curve nomenclature for the curves in Fig. D1.15 is given in Table D1.4. In using Fig. D1.15, a value called A_{av} is needed, the value of which is shown in the equation shown on Fig. D1.15

D1.13 Lug Strength Analysis Under Oblique Loads.

Fitting lugs are often subjected to oblique loads. Ref. 4 gives the following approach to this loading case.

Resolve the applied load into axial and transverse components. Then use the following interaction equation;-

$$R_a^{1.6} + R_{tr}^{1.6} = 1 \quad \text{-------------(12)}$$

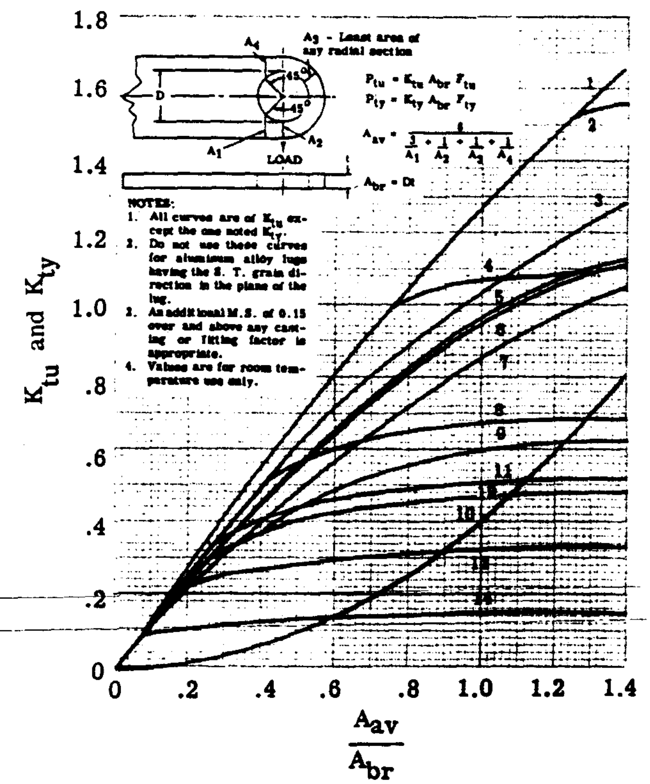


Fig. D1.15 Lug Design Data
Tension Efficiency Factors for Transversely Loaded Lugs (Ref. 3, 4)
(See Table D1.4 for Curve Nomenclature)

Table D1.4
(To be Used with Fig. D1.15)
Curve Nomenclature for Transverse Loading

Curve 1	4130 and 8630 Steel thru 125 KSI H. T.
Curve 2	4130 and 8630 Steel 150 KSI H. T.
Curve 3	K_{ty} for All Aluminum and Steel Alloys
Curve 4	4130 and 8630 Steel 180 KSI H. T.
Curve 5	356-T6 and AZ91C-T6 Sand Castings
Curve 6	2024-T3 and 2024-T4 Plate ≤ 0.5 in.
Curve 7	220-T4 Sand Casting
Curve 8	2014-T6 and 7075-T6 Plate ≤ 0.5 in.
Curve 9	2024-T3 and 2024-T4 Plate > 0.5 in. also 2024-T4 Bar
Curve 10	Approximate Cantilever Strength for All Aluminum and Steel Alloys. If K_{tu} is Below this Curve a Separate Calculation as a Cantilever Beam is Warranted.
Curve 11	2014-T6 and 7075-T6 Plate > 0.5 in. ≤ 1.0 in. 7075-T6 Extrusions 2014-T6 Hand Forged Billet ≤ 36 in.[a] 2014-T6 and 7075-T6 Die Forgings
Curve 12	2024-T6 Plate, 2024-T4 & 2024-T42 Extrusions
Curve 13	2014-T6 and 7075-T6 Plate > 1 in.
Curve 14	2014-T6 Hand Forged Billet > 36 in.[a]

or margin of safety is,

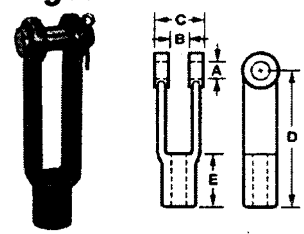
$$M.S. = \frac{1}{(R_a^{1.6} + R_{tr}^{1.6})^{0.625}} - 1 \quad \text{----(13)}$$

where, R_a = axial component of applied ultimate load divided by the smaller of the

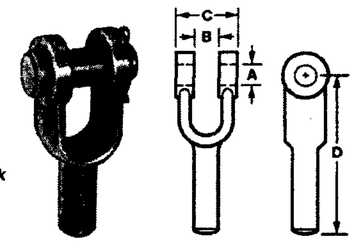
Linkages & Ball Joint Bearings

Yoke End Linkages

Threaded



Blank



These forged-steel yokes are great for near 360 °pivot-point linkages of shafts, rods, and other assemblies. Also known as clevis ends, they're furnished with clevis and cotter pins (except where noted).

Threaded yokes have female right-hand threads on the shank that let you adjust the overall length of the linkage. They're typically screwed onto the threaded end of a rod, pipe, tube, or cable linkage and secured with a clevis pin. Machined to Society of Automotive Engineers (SAE) standards.

Threaded Yokes

Shank Thread Size	(A)	(B)	(C)	(D)	(E)		Each
#10-32	3/16"	3/16"	7/16"	1 9/16"	—	6071K11	$4.76
1/4"-28	1/4"	9/32"	5/8"	2"	3/4"	6071K12	3.59
5/16"-24	5/16"	11/32"	3/4"	2 1/4"	13/16"	6071K13	3.59
3/8"-24	3/8"	7/16"	7/8"	2 1/2"	7/8"	6071K14	5.23
3/8"-24	1/2"	9/16"	1 1/8"	3"	—	6071K16	7.77
7/16"-20	7/16"	1/2"	1"	2 7/8"	1"	6071K31•	5.87
1/2"-13	1/2"	9/16"	1 1/8"	3"	1 1/8"	6071K32•	6.12
1/2"-20	1/2"	9/16"	1 1/8"	3"	1 1/8"	6071K26	7.77
1/2"-20	1/2"	1 5/32"	1 29/32"	3"	—	6071K19	11.59
1/2"-20	1/2"	9/16"	1 1/8"	4 3/16"	—	6071K17	8.41
5/8"-11	5/8"	11/16"	1 3/8"	4 15/16"	1 1/4"	6071K33•	7.84
5/8"-18	5/8"	11/16"	1 3/8"	4 15/16"	1 1/4"	6071K21	12.09
3/4"-10	5/8"	11/16"	1 1/2"	4"	1 1/4"	6071K34•	13.31
3/4"-10	3/4"	13/16"	1 5/8"	6 1/16"	1 1/2"	6071K35•	13.31
3/4"-16	3/4"	13/16"	1 5/8"	6 1/16"	1 1/2"	6071K22	21.46

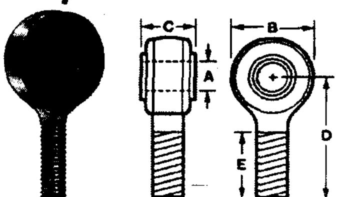
Blank yokes have a solid unfinished stem that you can thread, weld, or form for a custom fit. They're typically welded to a shaft or inside a tube ID.

Blank Yokes

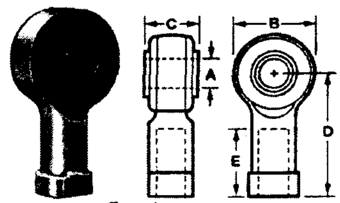
Shank Dia.	(A)	(B)	(C)	(D)		Each
5/16"	5/16"	11/32"	3/4"	2"	6414K12	$3.12
3/8"	3/8"	7/16"	7/8"	2 1/8"	6414K13	3.56
3/8"	3/8"	7/16"	7/8"	7"	6414K21•	5.08
7/16"	7/16"	1/2"	1"	2 7/8"	6414K15	4.91
1/2"	1/2"	9/16"	1 1/8"	2 1/2"	6414K14	4.66
1/2"	1/2"	9/16"	1 1/8"	6 1/2"	6414K23•	3.98
5/8"	5/8"	11/16"	1 3/8"	2 7/8"	6414K17	7.14
5/8"	5/8"	11/16"	1 3/8"	4 3/4"	6414K24•	8.23
3/4"	3/4"	13/16"	1 5/8"	3 5/8"	6414K18	9.93
3/4"	3/4"	13/16"	1 5/8"	8 1/4"	6414K25•	12.16
1"	1"	1 1/16"	2 1/8"	6"	6414K26•	13.03

• Clevis and cotter pin are not included. Please see 98306A on page 2884 for clevis pins ("C" in table above is the clevis spindle diameter); 98338A on page 2888 for cotter pins ("D" in table above is the minimum grip length).

Neoprene-Isolated Rod Ends



Male



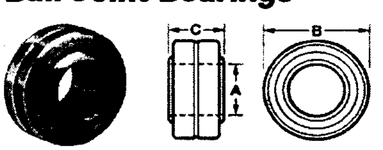
Female

No metal-on-metal sliding surfaces—the oil-resistant neoprene insert in each of these rod ends helps eliminate noise, vibration, and the risk of brinnelling (scribing a wear pattern in the metal). Ideal for use in suspensions and linkages.

Each rod end consists of a plated steel housing and a neoprene insert (the neoprene insert is bonded to a nylon sleeve and has an inner steel mounting sleeve). **To Order:** Please specify right- or left-hand threads.

Shank Thread Size	(A)	(B)	(C)	Load Cap., lbs.	Male (D)	Male (E)		Male Each	Female (D)	Female (E)		Female Each
1/4"-28	0.25"	0.94"	0.50"	60	1.56"	1.00"	6088K11	$21.73	1.56"	1.00"	6088K21	$21.73
3/8"-24	0.38"	1.25"	0.75"	140	1.94"	1.12"	6088K13	23.15	1.94"	1.12"	6088K22	23.15
1/2"-20	0.50"	1.31"	0.98"	270	2.12"	1.19"	6088K15	26.46	2.12"	1.19"	6088K23	26.46

Ball Joint Bearings



Make your own custom ball joints with these bearings. Mount them inside a hole drilled in a rod end blank (sold separately on page 899). They're also ideal for use in areas where shanks won't fit.

Bearings with ***steel housing and ball*** have oil holes and grooves on the ID and OD of the race for easy lubrication. Bearings with ***steel housing and ball with Teflon lining*** offer lubrication-free operation. Bearings with ***stainless steel housing and steel ball with Teflon lining*** have a Type 17-4PH stainless steel housing for good corrosion resistance and offer lubrication-free operation.

(A)	(B)	(C)	Max. Misalignment	Steel Housing and Ball: Load Cap., lbs.		Each	Steel Housing and Ball with Teflon Lining: Load Cap., lbs.		Each	Stainless Steel Housing and Steel Ball w/Teflon Lining: Load Cap., lbs.		Each
3/16"	9/16"	9/32"	11 °	3,250	63195K61	$6.02	3,250	63195K11	$8.85	3,975	63215K31	$16.29
1/4"	21/32"	11/32"	13.5 °	4,950	63195K63	5.90	4,950	63195K12	8.24	6,040	63215K32	15.88
5/16"	3/4"	3/8"	12 °	6,475	63195K65	6.27	6,475	63195K13	8.61	8,750	63215K33	16.81
3/8"	13/16"	13/32"	10 °	8,400	63195K67	6.32	8,400	63195K14	8.66	10,540	63215K34	17.71
7/16"	29/32"	7/16"	8 °	9,453	63195K69	8.46	9,453	63195K15	10.78	13,200	63215K35 ♦	20.31
1/2"	1"	1/2"	9.5 °	13,250	63195K71	6.51	13,250	63195K16	8.85	17,900	63215K36	21.52
9/16"	1 3/32"	9/16"	9.5 °	16,630	63195K73	6.90	16,630	63195K17	10.27	—	—	—
5/8"	1 3/16"	5/8"	8.5 °	21,280	63195K75	6.88	21,280	63195K18	9.24	30,500	63215K38	22.88
3/4"	1 7/16"	3/4"	9 °	31,920	63195K77	10.12	31,920	63195K19	12.41	46,400	63215K39	29.38
7/8"	1 9/16"	7/8"	9.5 °	41,960	63195K79	13.63	41,960	63195K21	15.83	62,200	63215K41	39.19
1"	1 3/4"	1"	10 °	55,200	63195K81	17.15	55,200	63195K22	19.29	82,200	63215K42	51.33

♦ Maximum misalignment is 9.5 °

CHICAGO HARDWARE and FIXTURE COMPANY

Chicago Drop Forged Steel Turnbuckles

request more info

(C-1035 Steel)

Available with hot galvanized or self-colored finish. Jaw types supplied with round pins and cotter keys unless nuts and bolts are specified. Locking nuts are also available. To ascertain extended length add amount of take-up to length in closed position.

Turnbuckles meet ASTM F1145-92 Specification

Diameter and Take-Up Inches	Overall Lengths - Inches *Closed Position				Estimated Weight Per 100 in Lbs.			
	Eye & Eye	Hook & Eye	Hook & Hook	Jaw & Eye	Jaw & Jaw	Eye & Eye, Hook & Eye or Hook & Hook	Jay & Eye	Jaw & Jaw
1/4 x 4	8	8 1/4	8 1/2	8 1/4	8 1/2	30	34	38
5/16 x 4 1/2	9	9 1/4	9 1/2	9 1/8	9 1/4	47	48	50
3/8 x 6	11 1/2	11 3/4	12	11 1/2	11 1/2	82	88	89
1/2 x 6	13	13 5/8	14 1/4	13 1/4	13 1/2	155	156	160
1/2 x 9	16	16 3/8	17 1/4	16 1/4	16 1/2	183	185	188
1/2 x 12	19	19 5/8	20 1/4	19 1/4	19 1/2	213	232	235
5/8 x 6	13 1/2	14 1/8	14 3/4	14 5/8	15 3/4	245	258	275
5/8 x 9	17	17 3/8	17 3/4	17 7/8	18 3/4	316	324	331
~~5/8 x 12~~	~~20 1/2~~	~~20 5/8~~	~~20 3/4~~	~~21 1/8~~	~~21 3/4~~	~~350~~	~~360~~	~~386~~
5/8 x 18	26 1/2	26 5/8	26 3/4	27 1/8	27 3/4	562	575	588
3/4 x 6	14 3/4	15 3/4	16 3/4	15 5/8	16 1/2	377	388	417
3/4 x 9	18	18 7/8	19 3/4	18 3/4	19 1/2	477	485	492
3/4 x 12	21 3/4	22 1/8	22 3/4	22	22 1/2	544	569	575
3/4 18	27 3/4	28 1/8	28 3/4	28	28 1/2	675	712	743
7/8 x 6	18	18 1/2	19	19	19 1/2	550	600	630
7/8 x 12	22 1/2	23 1/8	23 3/4	23 1/2	24 1/2	750	820	860
7/8 x 18	28 1/2	29 1/8	29 3/4	29 1/2	30 1/2	1110	1179	1219
1 x 6	17	19 1/2	20	19 1/8	21 3/16	784	863	925
1 x 12	25	25 1/4	25 1/2	25 1/4	25 1/2	1050	1155	1205
1 x 18	31	31 1/4	31 1/2	32 1/4	31 1/2	1310	1415	1466

Diameter and Take-Up Inches	Overall Lengths - Inches		Estimated Weight Per 100 in Lbs.	
	Bodies with Stubs *Closed	Bodies Only	Bodies with Stubs	Bodies Only
1/4 x 4	10	4 13/16	25	16
5/16 x 4 1/2	11	5 9/16	43	24
3/8 x 6	16	7 1/8	83	39
1/2 x 6	16	7 1/2	138	60
1/2 x 9	19	10 1/2	175	83
1/2 x 12	22	13 1/2	206	103
5/8 x 6	16	7 7/8	212	94
5/8 x 9	19	10 7/8	279	135
5/8 x 12	22	13 7/8	325	175
5/8 x 18	28	20 1/4	535	325
3/4 x 6	17	8 1/4	325	134
3/4 x 9	20	11 1/4	404	189
3/4 x 12	23	14 1/4	490	239
3/4 x 18	29	20 1/4	625	325
7/8 x 6	18	8 5/8	481	205
7/8 x 12	24	14 5/8	650	300
7/8 x 18	30	20 5/8	1009	575
1 x 6	19	9	656	275
1 x 12	25	15	925	425
1 x 18	31	21	1186	575
1 1/8 x 6	19	9	700	225
1 1/8 x 12	25	15	1081	441
1 1/4 x 6	20	9 3/4	1100	450
1 3/8 x 6	20 1/2	9 3/4	1200	425
1 1/2 x 6	20 1/2	10 3/8	1706	661

Chicago Forged Turnbuckle Fittings

Maximum load ratings are based on a straight vertical lift in a gradually increasing manner. Any deviations as angular lifts, shock loads, modification of the basic part, etc., will result in drastically reduced maximum loads.

Specifications

Eye Dimensions - Strength

Diameter	ID Eye	OD Eye	Thickness of Eye	Max. Load Lbs.
1/4	1/2	1	7/32	500
5/16	5/8	1 1/4	9/32	800
3/8	3/4	1 1/2	11/32	1,200
1/2	1	2	7/16	2,200
5/8	1 1/4	2 5/16	17/32	3,500
3/4	1 1/2	2 3/4	5/8	5,200
7/8	1 3/4	3 1/4	3/4	7,000
1	2	3 3/4	7/8	10,000

Hook Dimensions - Strength

Diameter	Inside ID	Throat Opening	Thickness of Hook	Max Load Lbs.
1/4	5/16	9/32	7/32	400
5/16	1/2	1/2	5/16	700
3/8	1/2	1/2	3/8	900
1/2	7/8	13/16	17/32	1,300
5/8	29/32	27/32	5/8	2,200
3/4	1 1/8	29/32	11/16	2,700
7/8	1 3/16	1 1/16	13/16	3,200
1	1 3/8	1 1/4	7/8	4,200

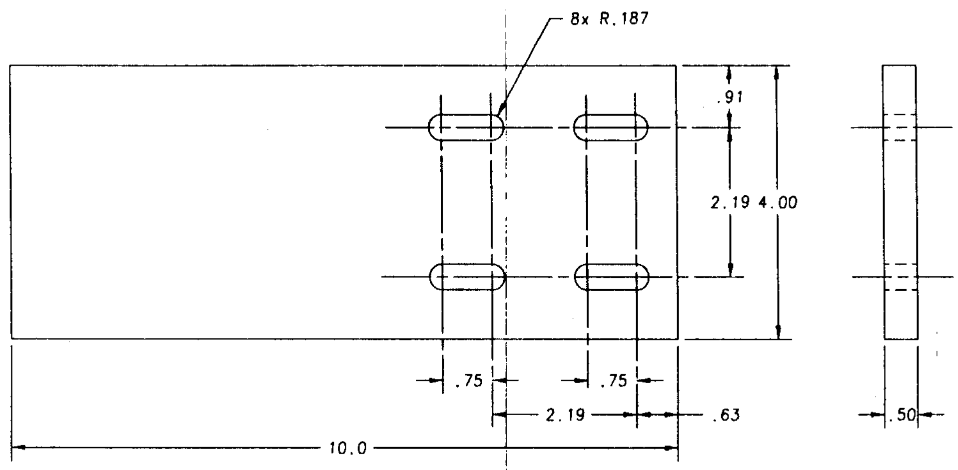
Jaw Dimensions - Strength

Diameter	Jaw Thickness	Hole Center to Jawend	Hole Center to Shank	Inside Jaw Width	OD Jaweye	ID Jaweye	Pin Diameter	Max Load Lbs.
1/4	7/32	5/16	25/32	5/8	5/8	9/32	1/4	500
5/16	1/4	5/16	7/8	5/8	5/8	9/32	1/4	800
3/8	9/32	13/32	1	13/16	13/16	11/32	5/16	1,200
1/2	5/16	1/2	1 9/32	1	1	15/32	7/16	2,200
5/8	3/8	21/32	1 21/32	1 5/16	1 5/16	35/64	1/2	3,500
3/4	1/2	13/16	1 27/32	1 5/8	1 5/8	43/64	5/8	5,200
7/8	9/16	29/32	1 31/32	1 7/8	1 7/8	25/32	3/4	7,000
1	11/16	1 1/16	2 13/32	2	15/16	15/16	7/8	10,000

Chicago Hardware & Fixture Co.
9100 Park Lane
Franklin Park, IL 60131
(847)455-6609; Fax: (847)455-0012

request more info

REV	DESCRIPTION	DRAWN / APPROVED	DATE / DATE



UNLESS OTHERWISE SPECIFIED	ORIGINATOR	TONY LEVAND	08/16/00
DECIMAL TOLERANCES:	DRAWN	K.POTTER	08/16/00
.X=±.1 .XX=±.03 .XXX=±.005	CHECKED	TONY LEVAND	08/28/00
ANGULAR TOLERANCE: ±1°	APPROVED	TONY LEVAND	08/28/00
1) BREAK ALL SHARP EDGES .015 MAX. 2) DO NOT SCALE DRAWING.	USED ON		
3) DIMENSIONS BASED UPON ANSI Y14.5M-1982 4) MAX. ALL MACH. SURFACES 125√	MATERIAL ASTM A-36 H.R.S. OR C-1018 C.F. FLAT		

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

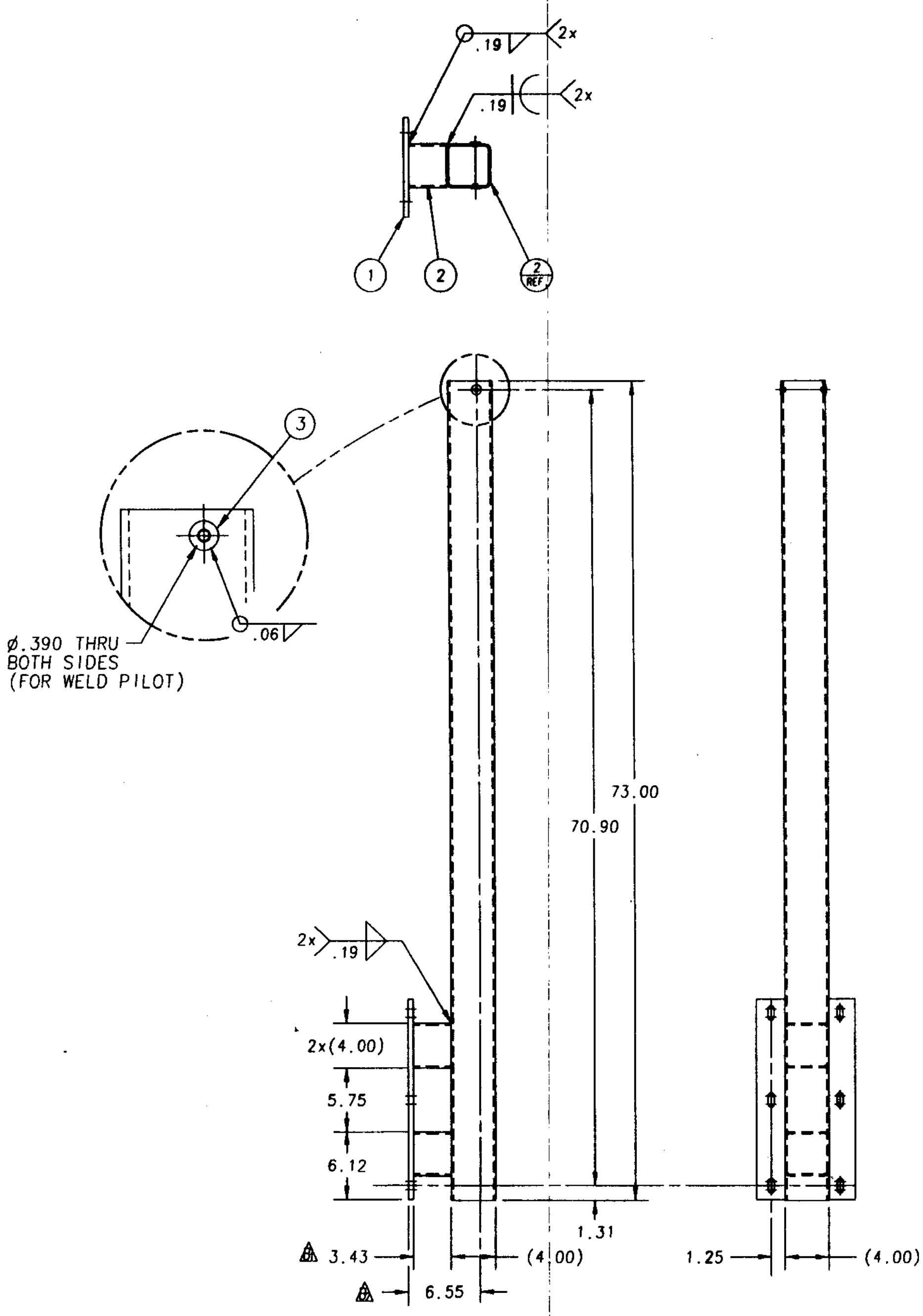
PPD/MECHANICAL SUPPORT
B LAYER MDT OCTANT SUPPORT
ATTATCHMENT PLATE

SCALE	DRAWING NUMBER	SHEET	REV
.75	3823.130-MC-386948	1 OF 1	

CREATED WITH : MS2.1 GROUP: DOMS

Plotted b .nd on 01-Sep-2000 , File: 38694801 .pff

REV	DESCRIPTION	DRAWN / APPROVED	DATE
A	WAS #MC-386948	K.POTTER	09/07/00
		TONY LEVAND	09/07/00
B	B1 WAS 3.25, B2 WAS 6.25	K.POTTER	09/13/00
		TONY LEVAND	09/13/00



NOTES:

- ALL WELDS TO CONFORM TO A.W.S. D1.1-2000 (STANDARD FOR WELDING PROCEDURE AND PERFORMANCE QUALIFICATIONS)
- APPROMATE WEIGHT= 90 POUNDS

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.
3	COMM./STK.	Ø.50-13 UNC-2B HEX STEEL WELD NUT (*McMASTER-CARR #90596A030 OR EQUAL)	2
2	COMM./STK.	4.0x4.0x.19 A500 GR.B STRUCTURAL STL.TUBE	7'±
1	MC-386949	MOUNTING PLATE	1

PARTS LIST

UNLESS OTHERWISE SPECIFIED			
DECIMAL TOLERANCES: .X=±.1 .XX=±.03 .XXX=±.005	ORIGINATOR	TONY LEVAND	08/16/00
ANGULAR TOLERANCE: ±1°	DRAWN	K.POTTER	08/16/00
1) BREAK ALL SHARP EDGES .015 MAX.	CHECKED	TONY LEVAND	08/28/00
2) DO NOT SCALE DRAWING.	APPROVED	TONY LEVAND	08/28/00
3) DIMENSIONS BASED UPON ANSI Y14.5M-1982	USED ON		
4) MAX. ALL MACH. SURFACES 125	MATERIAL	SEE PARTS LIST	

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

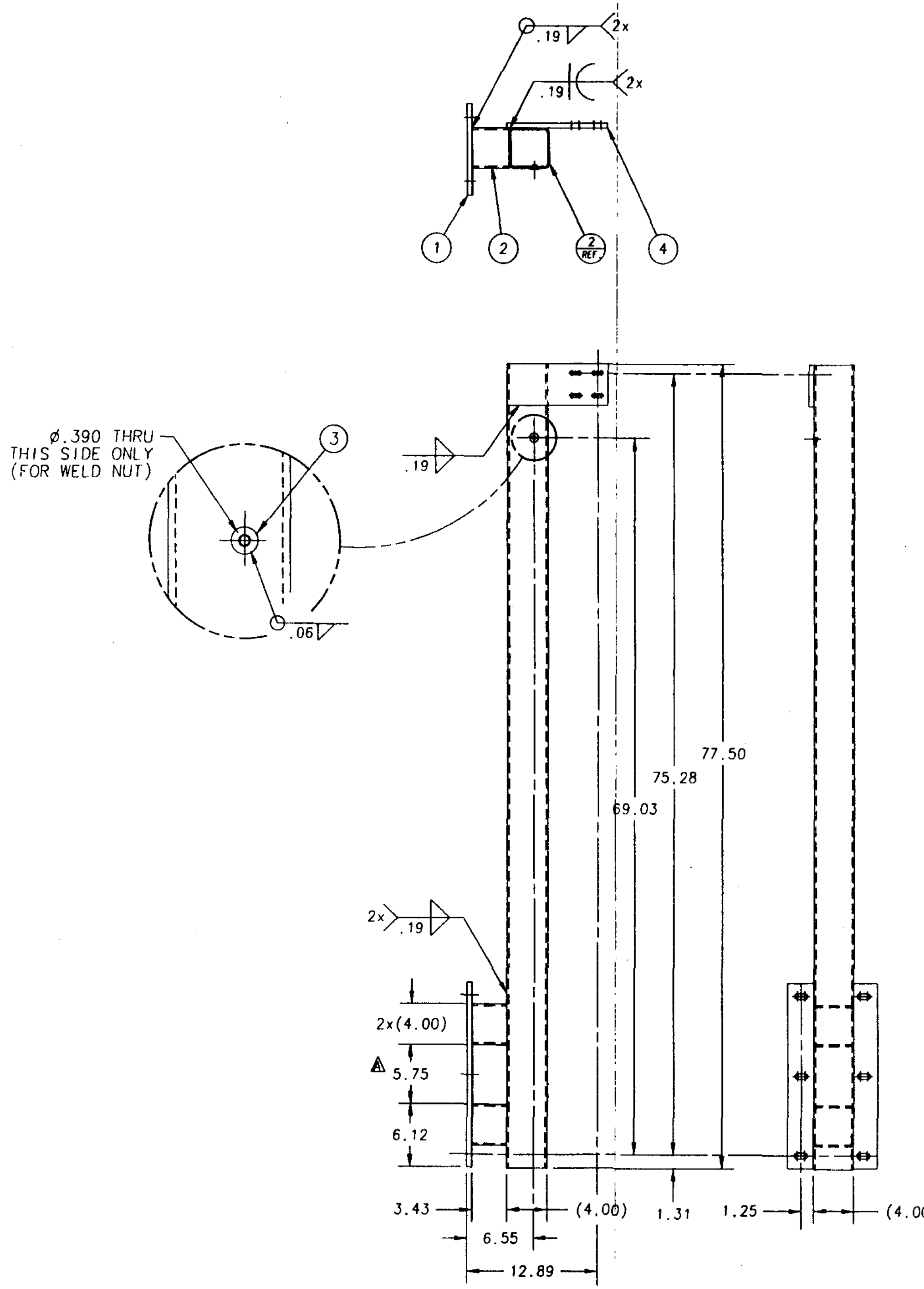
PPD/MECHANICAL SUPPORT
B LAYER MDT OCTANT SUPPORT
SUB-FRAME WELDMENT

SCALE	DRAWING NUMBER	SHEET	REV
.09	3823.130-MC-386952	1 OF 1	B

CREATED WITH : MS2.1 GROUP: DOMS

Plotted (and on 18-Sep-2000 , File: 38695201_B.pff

REV	DESCRIPTION	DRAWN / APPROVED	DATE / DATE
A	COMM./STK. WAS #MC-386948. 5.75 WAS 7.12	K.POTTER TONY LEVAND	09/07/00 09/07/00



NOTES:

- ALL WELDS TO CONFORM TO A.W.S. D1.1-2000 (STANDARD FOR WELDING PROCEDURE AND PERFORMANCE QUALIFICATIONS)
- APPROMATE WEIGHT= 100 POUNDS

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.
4	COMM./STK.	ATTATCHMENT PLATE	1
3	MC-386948	Ø.50-13 UNC-2B HEX STEEL WELD NUT ("McMASTER-CARR #90596A030 OR EQUAL)	1
2	COMM./STK.	4.0x4.0x.19 A500 GR.B STRUCTURAL STL.TUBE	8'
1	MC-386974	MOUNTING PLATE	1

PARTS LIST

UNLESS OTHERWISE SPECIFIED	ORIGINATOR	TONY LEVAND	08/16/00
DECIMAL TOLERANCES: .X=±.1 .XX=±.03 .XXX=±.005	DRAWN	K.POTTER	08/16/00
ANGULAR TOLERANCE: ±1°	CHECKED	TONY LEVAND	08/28/00
1) BREAK ALL SHARP EDGES .015 MAX	APPROVED	TONY LEVAND	08/28/00
2) DO NOT SCALE DRAWING.	USED ON		
3) DIMENSIONS BASED UPON ANSI Y14.5M-1982			
4) MAX. ALL MACH. SURFACES 125	MATERIAL	SEE PARTS LIST	

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

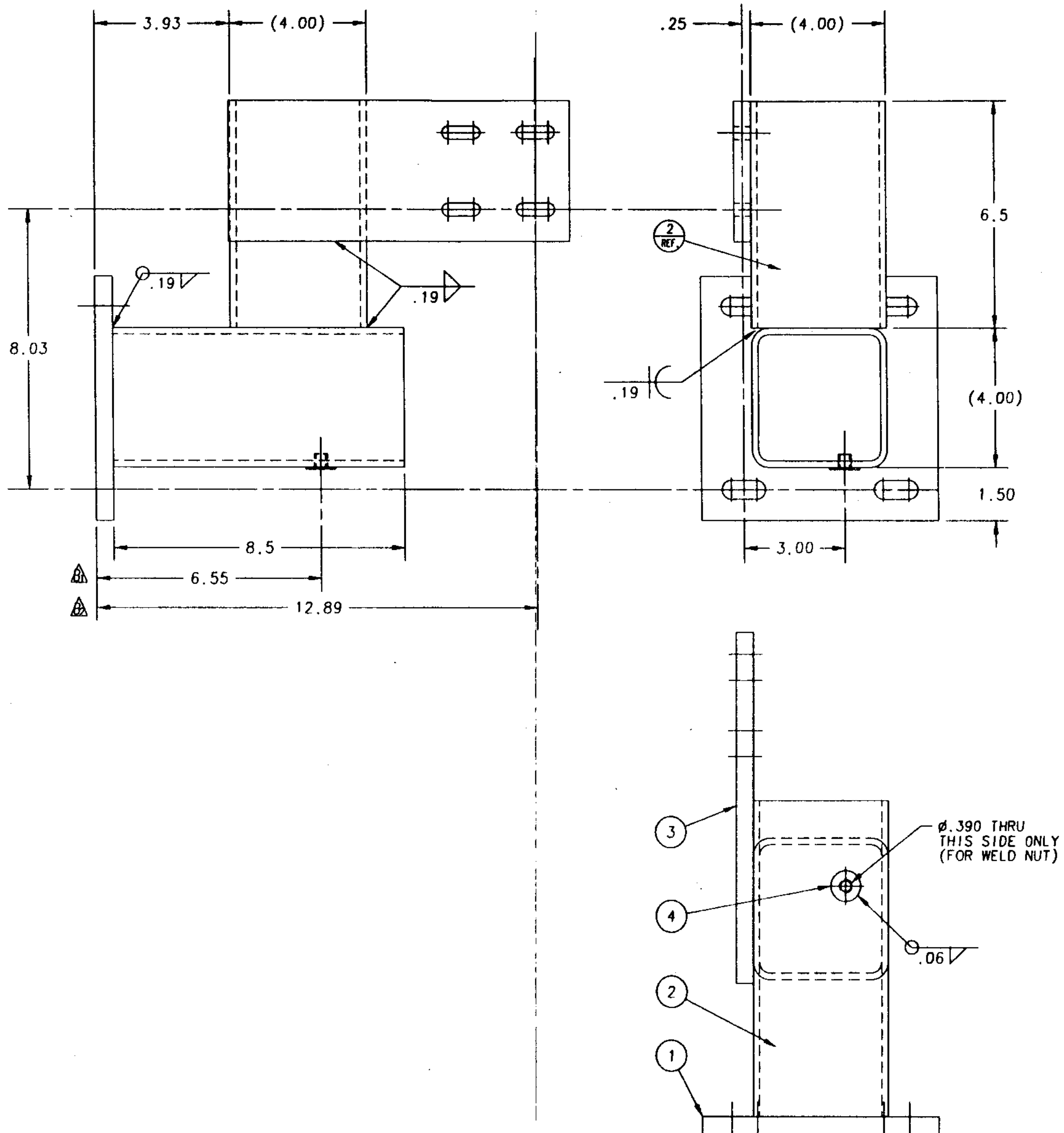
PPD/MECHANICAL SUPPORT
B LAYER MDT OCTANT SUPPORT
SUB-FRAME WELDMENT

SCALE	DRAWING NUMBER	SHEET	REV
.09	3823.130-MC-386953	1 OF 1	A

CREATED WITH : MS2.1 GROUP: DOMS

Plotted and on 14-Sep-2000 , File: 38695301_A.pff

REV	DESCRIPTION	DRAWN / APPROVED	DATE / DATE
A	WAS #MC-386948	K.POTTER / TONY LEVAND	09/07/00 / 09/07/00
B	B1 WAS 7.08. B2 WAS 11.14	K.POTTER / TONY LEVAND	09/13/00 / 09/13/00



NOTES:

- ALL WELDS TO CONFORM TO A.W.S. D1.1-2000 (STANDARD FOR WELDING PROCEDURE AND PERFORMANCE QUALIFICATIONS)
- APPROMATE WEIGHT= 35 POUNDS
- THIS DRAWING IS A LEFT HAND VERSION OF #MC-3B6965

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.
4	COMM./STK.	ATTATCHMENT PLATE	1
3	MC-386948	ø.313-18 UNC-2B HEX STEEL WELD NUT (*McMASTER-CARR #90596A030 OR EQUAL)	1
2	COMM./STK.	4.0x4.0x.19 A500 GR.B STRUCTURAL STL.TUBE	1.5'
1	MC-386955	MOUNTING PLATE	1

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DECIMAL TOLERANCES:
.X=±.1 .XX=±.03 .XXX=±.005
ANGULAR TOLERANCE: ±1°

1) BREAK ALL SHARP EDGES .015 MAX.
2) DO NOT SCALE DRAWING.
3) DIMENSIONS BASED UPON ANSI Y14.5M-1982
4) MAX. ALL MACH. SURFACES 125

ORIGINATOR	TONY LEVAND	08/16/00
DRAWN	K.POTTER	08/16/00
CHECKED	TONY LEVAND	08/28/00
APPROVED	TONY LEVAND	08/28/00

USED ON

MATERIAL: SEE PARTS LIST

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

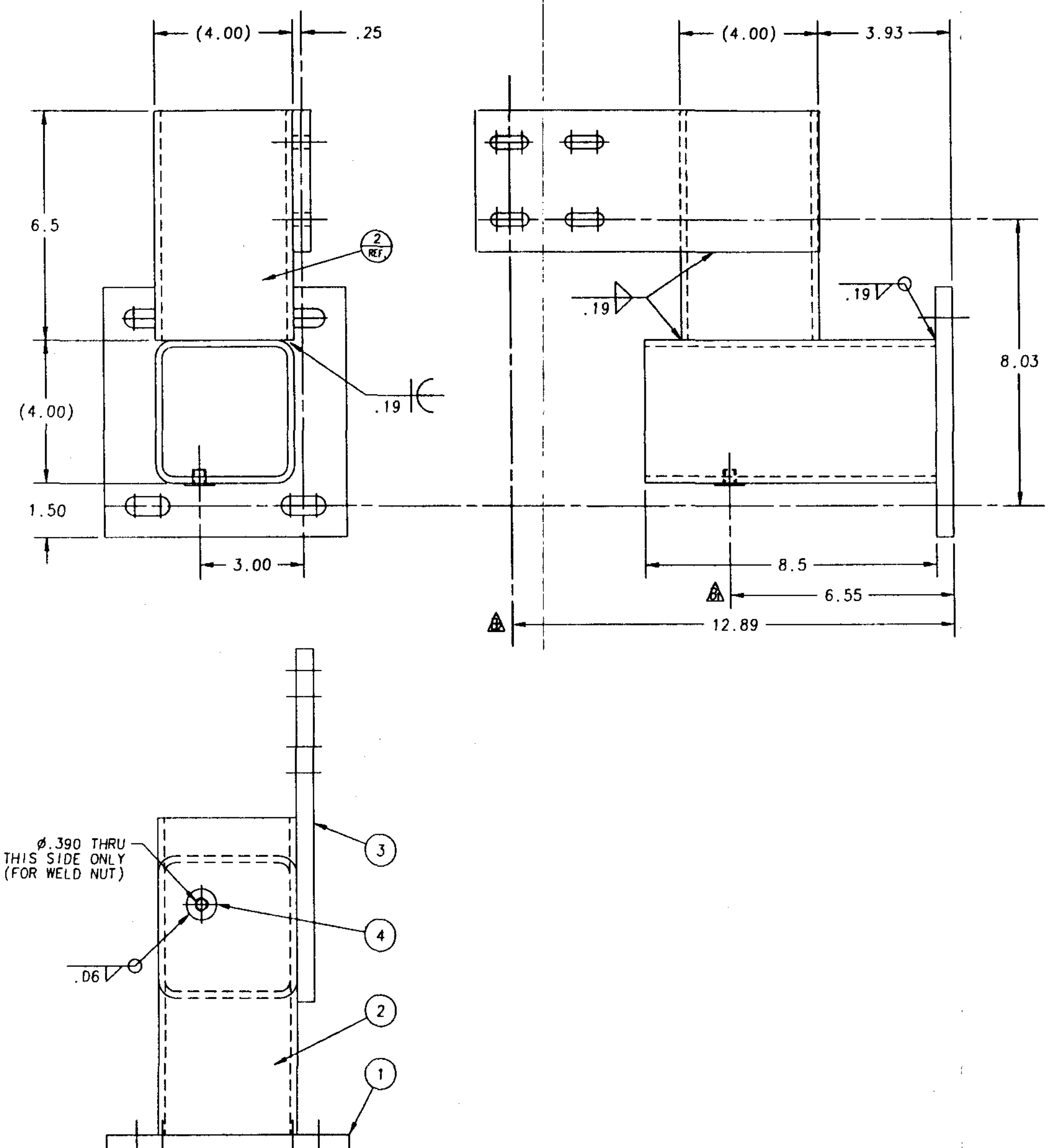
PPD/MECHANICAL SUPPORT
B LAYER MDT OCTANT SUPPORT
SUB-FRAME WELDMENT

SCALE	DRAWING NUMBER	SHEET	REV
.4	3823.130-MC-386971	1 OF 1	B

CREATED WITH: MS2.1 GROUP: DOMS

Plotted by ... vond on 18-Sep-2000, File: 38697101_B.pff

REV	DESCRIPTION	DRAWN / APPROVED	DATE
A	WAS #MC-386948	K.POTTER	09/07/00
		TONY LEVAND	09/07/00
B	B1 WAS 7.06, B2 WAS 11.14	K.POTTER	09/13/00
		TONY LEVAND	09/13/00



NOTES:

- ALL WELDS TO CONFORM TO A.W.S. D1.1-2000 (STANDARD FOR WELDING PROCEDURE AND PERFORMANCE QUALIFICATIONS)
- APPROMATE WEIGHT= 35 POUNDS
- THIS DRAWING IS A RIGHT HAND VERSION OF #MC-386971

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY
4	COMM./STK.	ATTATCHMENT PLATE	1
3	MC-386948	Ø.313-18 UNC-2B HEX STEEL WELD NUT (*McMASTER-CARR #90596A030 OR EQUAL)	1
2	COMM./STK.	4.0x4.0x.19 A500 GR.B STRUCTURAL STL.TUBE	1.5'
1	MC-386955	MOUNTING PLATE	1

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DECIMAL TOLERANCES:
.X=±.1 .XX=±.03 .XXX=±.005
ANGULAR TOLERANCE: ±1°

1) BREAK ALL SHARP EDGES .015 MAX.
2) DO NOT SCALE DRAWING.
3) DIMENSIONS BASED UPON ANSI Y14.5M-1982
4) MAX. ALL MACH. SURFACES 125

ORIGINATOR	TONY LEVAND	08/16/00
DRAWN	K.POTTER	08/16/00
CHECKED	TONY LEVAND	08/28/00
APPROVED	TONY LEVAND	08/28/00

USED ON

MATERIAL: SEE PARTS LIST

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

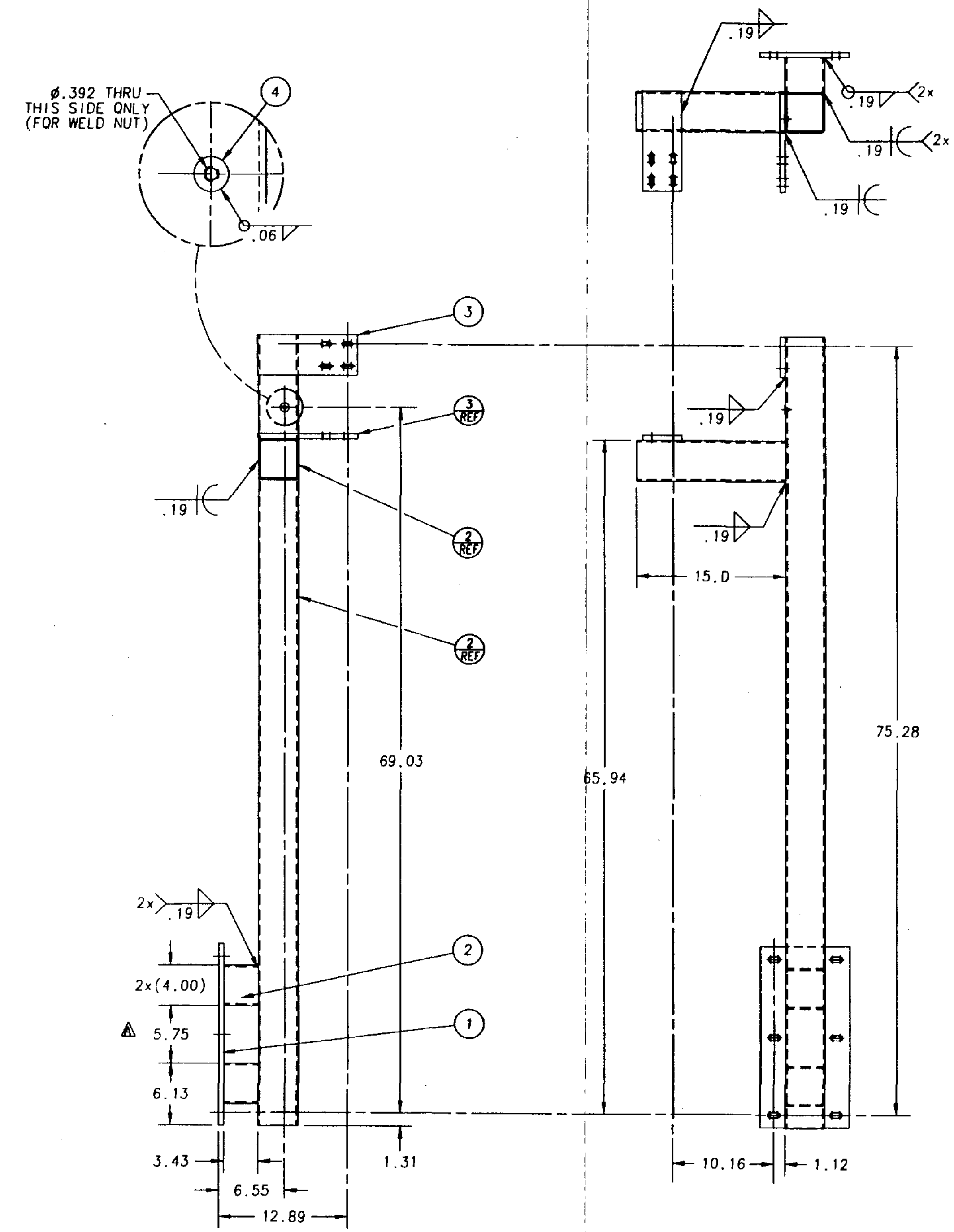
PPD/MECHANICAL SUPPORT
B LAYER MDT OCTANT SUPPORT
SUB-FRAME WELDMENT

SCALE	DRAWING NUMBER	SHEET	REV
.4	3823.130-MC-386965	1 OF 1	B

CREATED WITH : MS2.1 GROUP: DOMS

Plotted ...vand on 18-Sep-2000 , File: 38696501_B.pff

REV	DESCRIPTION	DRAWN / APPROVED	DATE
A	COMM./STK. WAS #MC-386948, 5.75 WAS 7.12	K.POTTER TONY LEVAND	09/07/00 09/07/00



NOTES:

- ALL WELDS TO CONFORM TO A.W.S. D1.1-2000 (STANDARD FOR WELDING PROCEDURE AND PERFORMANCE QUALIFICATIONS)
- APPROMATE WEIGHT= 120 POUNDS

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY
4	COMM./STK.	ø.313-18 UNC-2B HEX STEEL WELD NUT ("McMASTER-CARR #90596A030 OR EQUAL)	1
3	MC-386948	ATTATCHMENT PLATE	2
2	COMM./STK.	4.0x4.0x.19 A500 GR.B STRUCTURAL STL.TUBE	8.5
1	MC-386974	MOUNTING PLATE	1

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DECIMAL TOLERANCES:
.X=±.1 .XX=±.03 .XXX=±.005
ANGULAR TOLERANCE: ±1°

1) BREAK ALL SHARP EDGES .015 MAX.
2) DO NOT SCALE DRAWING.
3) DIMENSIONS BASED UPON ANSI Y14.5M-1982
4) MAX. ALL MACH. SURFACES 125

ORIGINATOR	TONY LEVAND	08/16/00
DRAWN	K.POTTER	08/16/00
CHECKED	TONY LEVAND	08/28/00
APPROVED	TONY LEVAND	08/28/00

USED ON

MATERIAL: SEE PARTS LIST

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

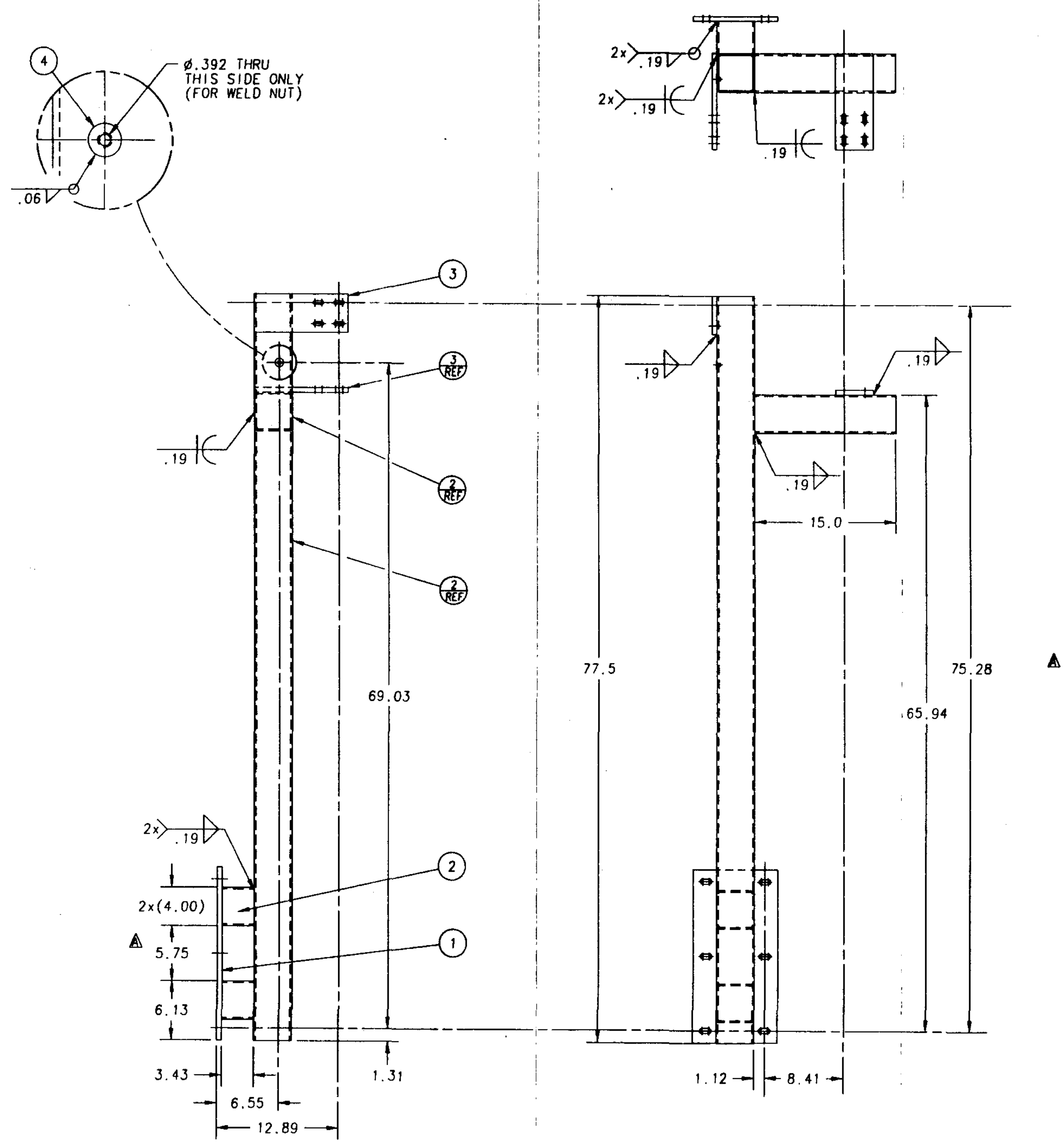
PPD/MECHANICAL SUPPORT
B LAYER MDT OCTANT SUPPORT
SUB-FRAME WELDMENT

SCALE	DRAWING NUMBER	SHEET	REV
.09	3823.130-MC-386950	1 OF 1	A

CREATED WITH : MS2.1 GROUP: DDMS

Plotted /and on 14-Sep-2000 , File: 38695001_A.pff

REV	DESCRIPTION	DRAWN / APPROVED	DATE
A	COMM./STK. WAS #MC-386948. 5.75 WAS 7.12	K.POTTER / TONY LEVAND	09/07/00 / 09/07/00



NOTES:

- ALL WELDS TO CONFORM TO A.W.S. D1.1-2000 (STANDARD FOR WELDING PROCEDURE AND PERFORMANCE QUALIFICATIONS)
- APPROMATE WEIGHT= 120 POUNDS

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY
4	COMM./STK.	Ø.313-18 UNC-2B HEX STEEL WELD NUT ("McMASTER-CARR #90596A030 OR EQUAL)	1
3	MC-386948	ATTATCHMENT PLATE	2
2	COMM./STK.	4.0x4.0x.19 A500 GR.B STRUCTURAL STL.TUBE	8.5
1	MC-386974	MOUNTING PLATE	1

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DECIMAL TOLERANCES: .X=±.1 XX=±.03 .XXX=±.005
ANGULAR TOLERANCE: ±1°
1) BREAK ALL SHARP EDGES .015 MAX.
2) DO NOT SCALE DRAWING.
3) DIMENSIONS BASED UPON ANSI Y14.5M-1982
4) MAX. ALL MACH. SURFACES 125

ORIGINATOR	TONY LEVAND	08/16/00
DRAWN	K.POTTER	08/16/00
CHECKED	TONY LEVAND	08/28/00
APPROVED	TONY LEVAND	08/28/00

USED ON

MATERIAL: SEE PARTS LIST

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

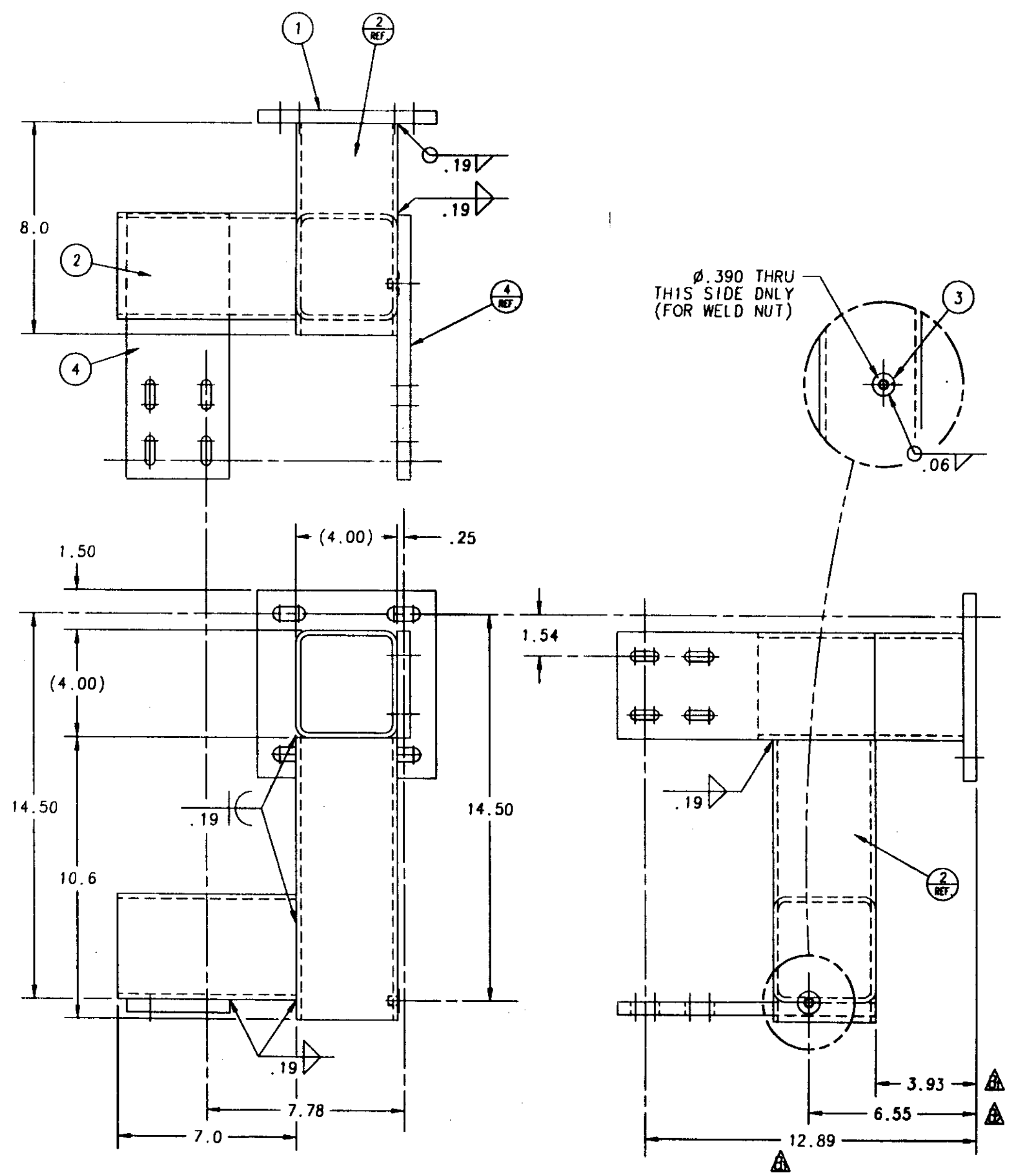
PPD/MECHANICAL SUPPORT
B LAYER MDT OCTANT SUPPORT
SUB-FRAME WELDMENT

SCALE	DRAWING NUMBER	SHEET	REV
.09	3823.130-MC-386966	1 OF 1	A

CREATED WITH : MS2.1 GROUP: DOMS

Plotted vand on 14-Sep-2000 , File: 38696601_A.pff

REV	DESCRIPTION	DRAWN / APPROVED	DATE
A	WAS #MC-386948	K.POTTER	09/07/00
		TONY LEVAND	09/07/00
B	B1 WAS 4.43, B2 WAS 7.05 B3 WAS 11.21	K.POTTER	09/13/00
		TONY LEVAND	09/13/00



NOTES:

- ALL WELDS TO CONFORM TO A.W.S. D1.1-2000 (STANDARD FOR WELDING PROCEDURE AND PERFORMANCE QUALIFICATIONS)
- APPROMATE WEIGHT= 50 POUNDS
- THIS DRAWING IS A RIGHT HAND VERSION OF #MC-386964

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.
4	COMM./STK.	ATTATCHMENT PLATE	2
3	MC-386948	Ø.313-18 UNC-2B HEX STEEL WELD NUT ("McMASTER-CARR #90596A030 OR EQUAL)	1
2	COMM./STK.	4.0x4.0x.19 A500 GR.B STRUCTURAL STL.TUBE	2.5'
1	MC-386955	MOUNTING PLATE	1

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DECIMAL TOLERANCES:
.X=±.1 .XX=±.03 .XXX=±.005
ANGULAR TOLERANCE: ±1°

1) BREAK ALL SHARP EDGES .015 MAX.
2) DO NOT SCALE DRAWING.
3) DIMENSIONS BASED UPON ANSI Y14.5M-1982
4) MAX. ALL MACH. SURFACES 125

ORIGINATOR	TONY LEVAND	08/16/00
DRAWN	K.POTTER	08/16/00
CHECKED	TONY LEVAND	08/28/00
APPROVED	TONY LEVAND	08/28/00
USED ON		
MATERIAL	SEE PARTS LIST	

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

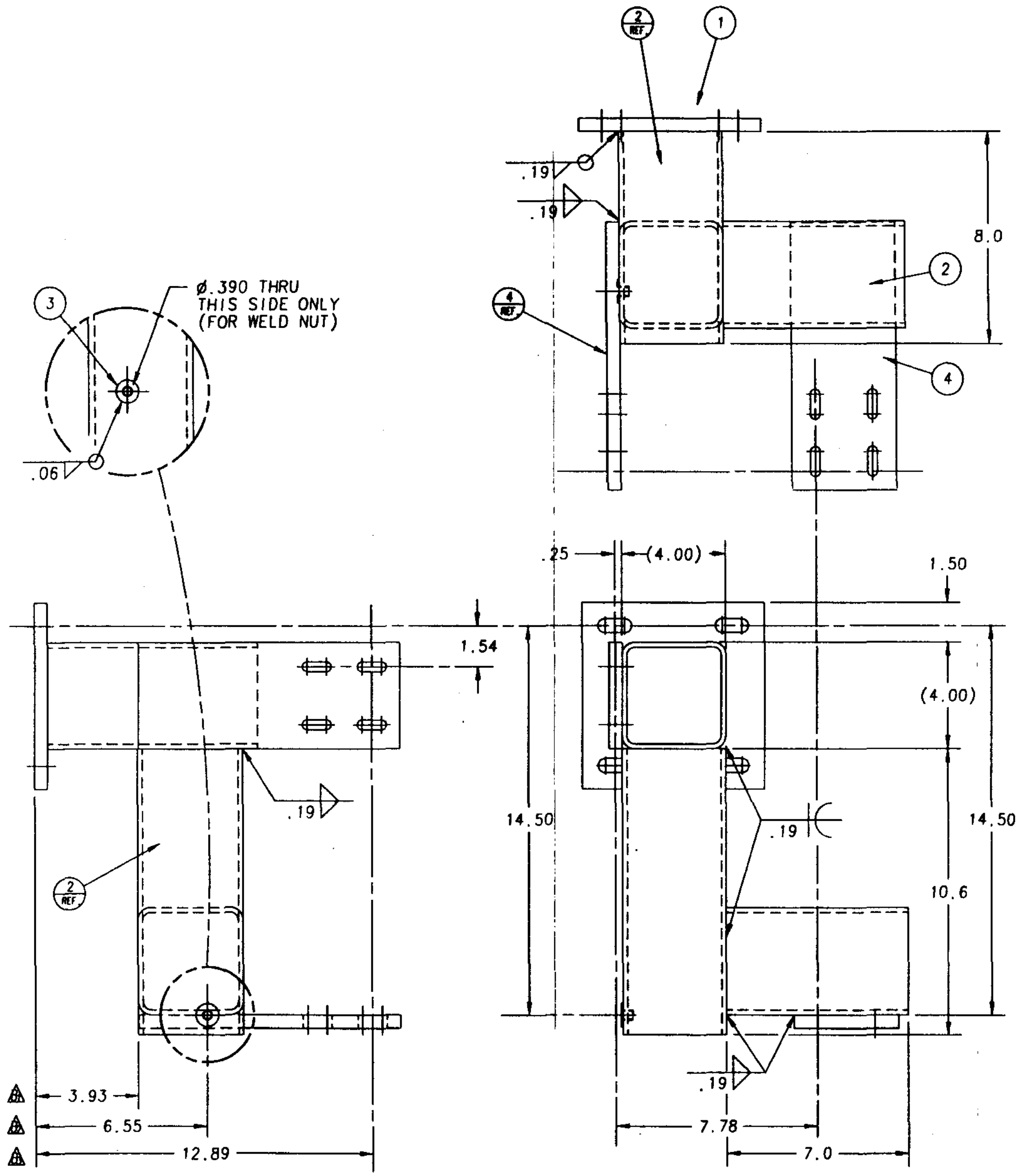
PPD/MECHANICAL SUPPORT
B LAYER MDT OCTANT SUPPORT
SUB-FRAME WELDMENT

SCALE	DRAWING NUMBER	SHEET	REV
.09	3823.130-MC-386960	1 OF 1	B

CREATED WITH : MS2.1 GROUP: DOMS

Plotted by levand on 18-Sep-2000 , File: 38696001_B.pff

REV	DESCRIPTION	DRAWN / APPROVED	DATE
A	WAS #MC-386948	K.POTTER	09/07/00
		TONY LEVAND	09/07/00
B	B1 WAS 4.43, B2 WAS 6.55, B3 WAS 11.21	K.POTTER	09/13/00
		TONY LEVAND	09/13/00



NOTES:

- ALL WELDS TO CONFORM TO A.W.S. D1.1-2000 (STANDARD FOR WELDING PROCEDURE AND PERFORMANCE QUALIFICATIONS)
- APPROMATE WEIGHT= 50 POUNDS
- THIS DRAWING IS A LEFT HAND VERSION OF #MC-386960

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY
4	COMM./STK.	ATTATCHMENT PLATE	2
3	MC-386948	Ø.313-18 UNC-28 HEX STEEL WELD NUT (*McMASTER-CARR #90596A030 OR EQUAL)	1
2	COMM./STK.	4.0x4.0x.19 A500 GR.B STRUCTURAL STL.TUBE	2.5'
1	MC-386955	MOUNTING PLATE	1

PARTS LIST

UNLESS OTHERWISE SPECIFIED			
DECIMAL TOLERANCES: .X=±.1 .XX=±.03 .XXX=±.005	ORIGINATOR	TONY LEVAND	08/16/00
ANGULAR TOLERANCE: ±1°	DRAWN	K.POTTER	08/16/00
1) BREAK ALL SHARP EDGES .015 MAX.	CHECKED	TONY LEVAND	08/28/00
2) DO NOT SCALE DRAWING.	APPROVED	TONY LEVAND	08/28/00
3) DIMENSIONS BASED UPON ANSI Y14.5M-1982	USED ON		
4) MAX. ALL MACH. SURFACES 125√	MATERIAL	SEE PARTS LIST	

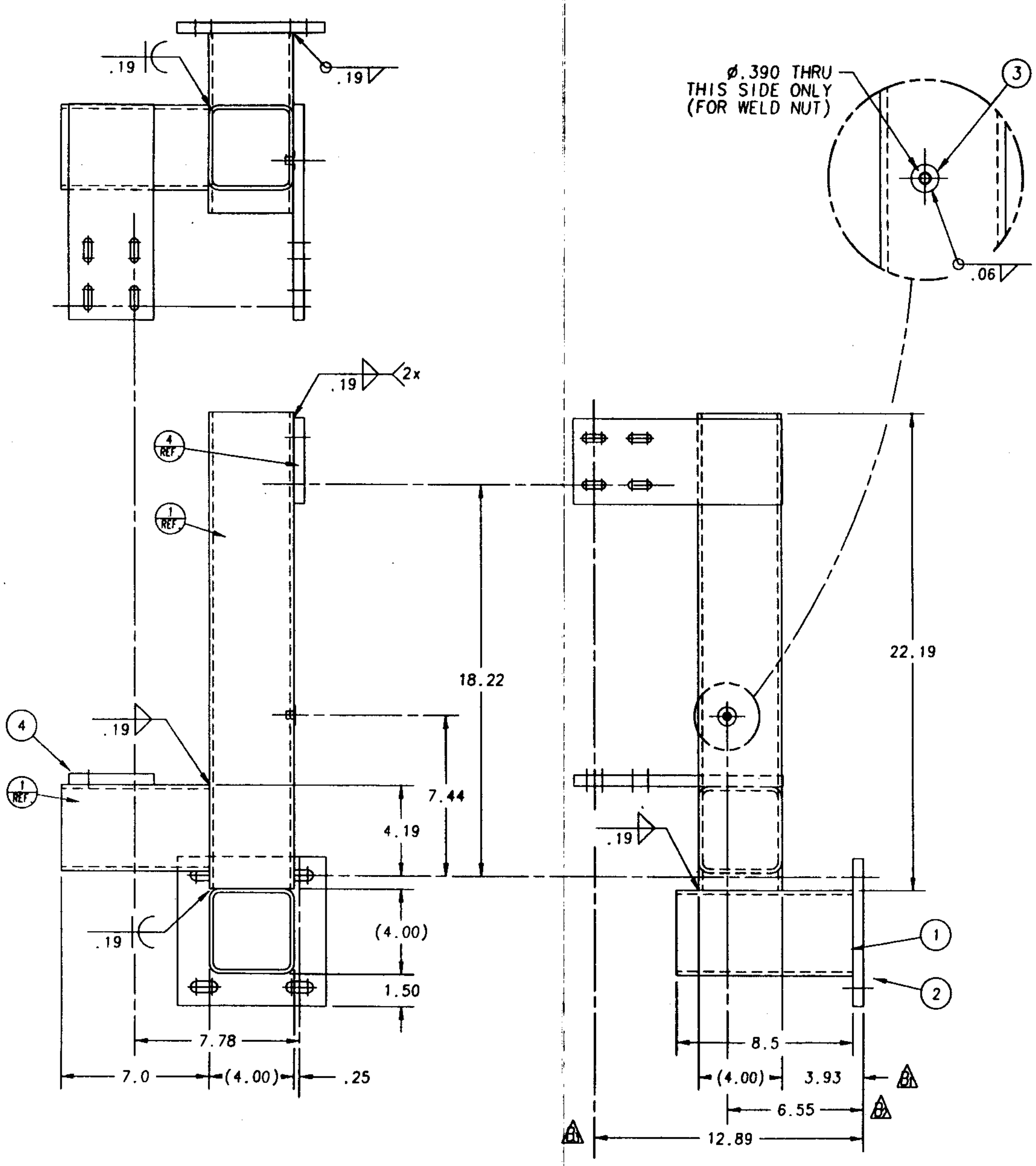
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

PPD/MECHANICAL SUPPORT
B LAYER MDT OCTANT SUPPORT
SUB-FRAME WELDMENT

SCALE	DRAWING NUMBER	SHEET	REV
.09	3823.130-MC-386964	1 OF 1	B

CREATED WITH : MS2.1 GROUP: DDMS

Plotted ... ond on 18-Sep-2000 , File: 38696401_B.pff



REV	DESCRIPTION	DRAWN / APPROVED	DATE
A	WAS #MC-386948	K.POTTER	09/07/00
		TONY LEVAND	09/07/00
B	B1 WAS 4.44, B2 WAS 7.07, B3 WAS 11.14	K.POTTER	09/13/00
		TONY LEVAND	09/13/00

NOTES:

- ALL WELDS TO CONFORM TO A.W.S. D1.1-2000 (STANDARD FOR WELDING PROCEDURE AND PERFORMANCE QUALIFICATIONS)
- APPROMATE WEIGHT= 60 POUNDS
- THIS DRAWING IS A RIGHT HAND VERSION OF #MC-386963

PARTS LIST

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY
4	COMM./STK.	ATTATCHMENT PLATE	2
3	MC-386948	ø.50-13 UNC-2B HEX STEEL WELD NUT ("McMASTER-CARR #90596A030 OR EQUAL)	1
2	COMM./STK.	4.0x4.0x.19 A500 GR.B STRUCTURAL STL.TUBE	3.5'
1	MC-386955	MOUNTING PLATE	1

UNLESS OTHERWISE SPECIFIED
DECIMAL TOLERANCES:
.X=±.1 .XX=±.03 .XXX=±.005
ANGULAR TOLERANCE: ±1°

1) BREAK ALL SHARP EDGES .015 MAX.
2) DO NOT SCALE DRAWING.
3) DIMENSIONS BASED UPON ANSI Y14.5M-1982
4) MAX. ALL MACH. SURFACES 125

ORIGINATOR	TONY LEVAND	08/16/00
DRAWN	K.POTTER	08/16/00
CHECKED	TONY LEVAND	08/28/00
APPROVED	TONY LEVAND	08/28/00

USED ON

MATERIAL: SEE PARTS LIST

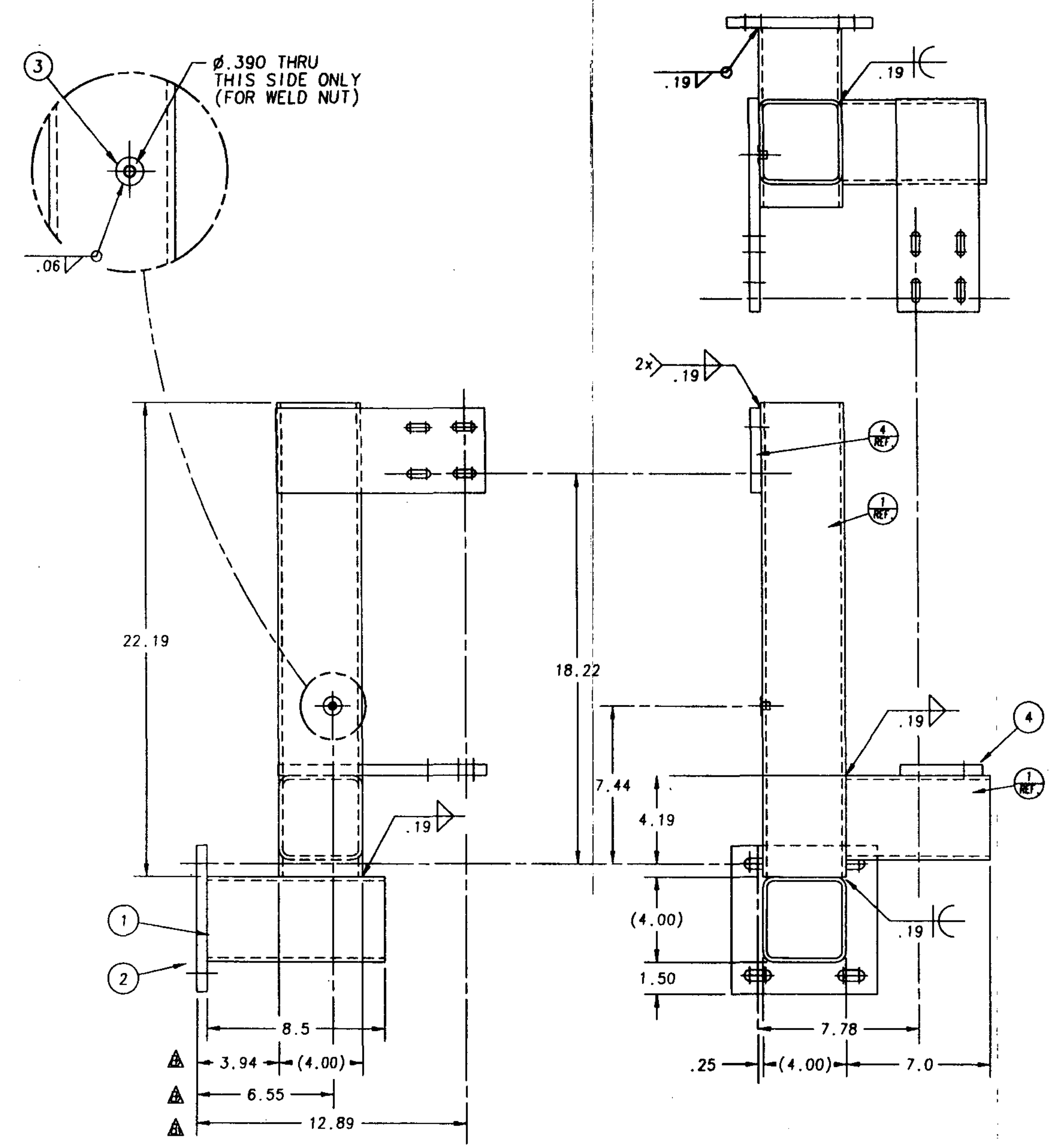
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

PPD/MECHANICAL SUPPORT
B LAYER MDT OCTANT SUPPORT
SUB-FRAME WELDMENT

SCALE	DRAWING NUMBER	SHEET	REV
.09	3823.130-MC-386954	1 OF 1	B

CREATED WITH : MS2.1 GROUP: DOMS

Plotted ... nd on 18-Sep-2000 , File: 38695401_B.pff



REV	DESCRIPTION	DRAWN / APPROVED	DATE / DATE
A	WAS #MC-386948	K.POTTER TONY LEVAND	09/07/00 09/07/00
B	A1 WAS 2.93, A2 WAS 6.07, A3 WAS 11.14	K.POTTER TONY LEVAND	09/13/00 09/13/00

NOTES:

- ALL WELDS TO CONFORM TO A.W.S. D1.1-2000 (STANDARD FOR WELDING PROCEDURE AND PERFORMANCE QUALIFICATIONS)
- APPROMATE WEIGHT= 60 POUNDS
- THIS DRAWING IS A LEFT HAND VERSION OF #MC-386954

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY
4	COMM./STK.	ATTATCHMENT PLATE	2
3	MC-386948	ø.50-13 UNC-2B HEX STEEL WELD NUT ("McMASTER-CARR #90596A030 OR EQUAL)	1
2	COMM./STK.	4.0x4.0x.19 A500 GR.B STRUCTURAL STL.TUBE	3.5'
1	MC-386955	MOUNTING PLATE	1

PARTS LIST

UNLESS OTHERWISE SPECIFIED			
DECIMAL TOLERANCES: .X=±.1 XX=±.03 .XXX=±.005	ORIGINATOR	TONY LEVAND	08/16/00
ANGULAR TOLERANCE: ±1°	DRAWN	K.POTTER	08/16/00
1) BREAK ALL SHARP EDGES .015 MAX.	CHECKED	TONY LEVAND	08/28/00
2) DO NOT SCALE DRAWING.	APPROVED	TONY LEVAND	08/28/00
3) DIMENSIONS BASED UPON ANSI Y14.5M-1982	USED ON		
4) MAX. ALL MACH. SURFACES 125	MATERIAL: SEE PARTS LIST		

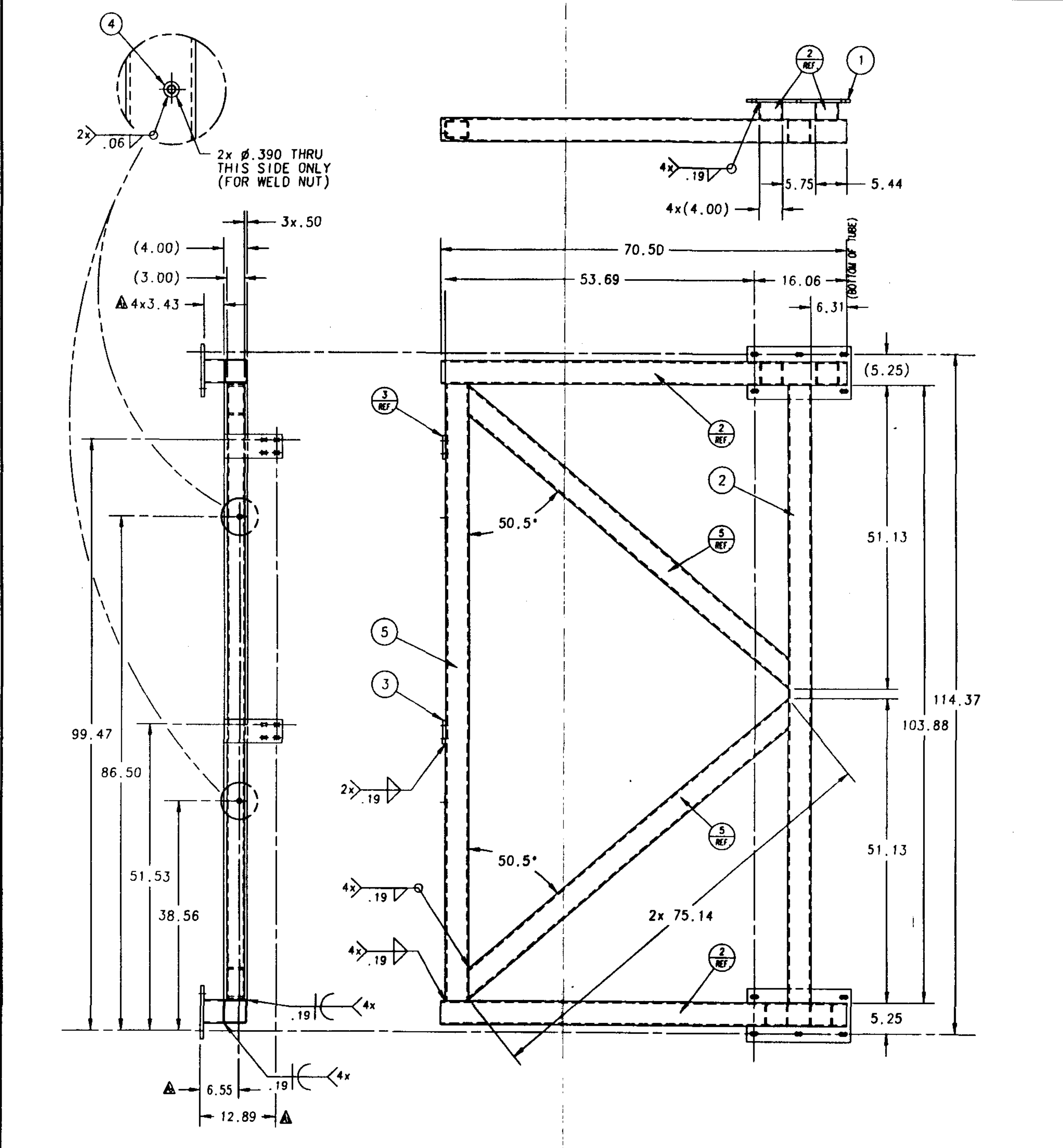
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

PPD/MECHANICAL SUPPORT
B LAYER MDT OCTANT SUPPORT
SUB-FRAME WELDMENT

SCALE	DRAWING NUMBER	SHEET	REV
.09	3823.130-MC-386963	1 OF 1	B
CREATED WITH : MS2.1	GROUP: DOMS		

Plotted [illegible] and on 18-Sep-2000 , File: 38696301_B.pff

REV	DESCRIPTION	DRAWN / APPROVED	DATE / DATE
A	A1 WAS 2.93, A2 WAS 6.06, A3 WAS 10.20	K.POTTER / TONY LEVAND	09/13/00 / 09/13/00



NOTES:

- ALL WELDS TO CONFORM TO A.W.S. D1.1-2000 (STANDARD FOR WELDING PROCEDURE AND PERFORMANCE QUALIFICATIONS)
- APPROMATE WEIGHT- 470 POUNDS
- THIS DRAWING IS A LEFT HAND VERSION OF #MC-386951

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY
5	COMM./STK.	3.0x4.0x.19 A500 GR.B STRUCTURAL STL.TUBE	21.5'
4	COMM./STK.	ø.313-18 UNC-2B HEX STEEL WELD NUT ("McMASTER-CARR #90596A030 OR EQUAL)	2
3	MC-386948	ATTACHMENT PLATE	2
2	COMM./STK.	4.0x4.0x.19 A500 GR.B STRUCTURAL STL.TUBE	21.5'
1	MC-386949	MOUNTING PLATE	2

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DECIMAL TOLERANCES:
.X=±.1 .XX=±.03 .XXX=±.005
ANGULAR TOLERANCE: ±1°

1) BREAK ALL SHARP EDGES .015 MAX.
2) DO NOT SCALE DRAWING.
3) DIMENSIONS BASED UPON ANSI Y14.5M-1982
4) MAX. ALL MACH. SURFACES 125

ORIGINATOR	TONY LEVAND	08/16/00
DRAWN	K.POTTER	08/16/00
CHECKED	TONY LEVAND	08/28/00
APPROVED	TONY LEVAND	

USED ON

MATERIAL: SEE PARTS LIST

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

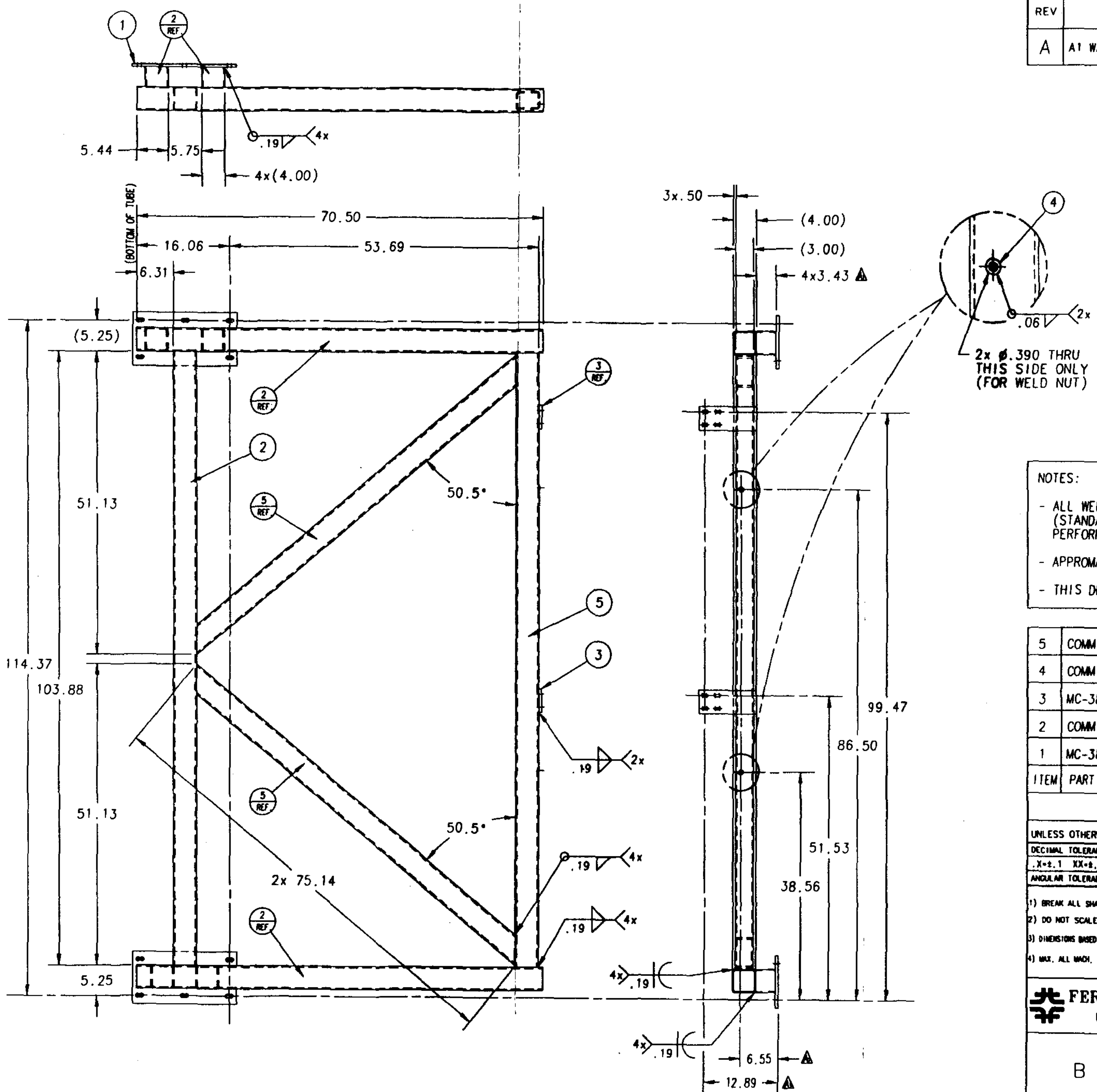
PPD/MECHANICAL SUPPORT
B LAYER MDT OCTANT SUPPORT
SUB-FRAME WELDMENT

SCALE	DRAWING NUMBER	SHEET	REV
.09	3823.130-MC-386961	1 OF 1	A

CREATED WITH : MS2.1 GROUP: DDMS

Plotted by ... on 18-Sep-2000 , File: 38696101_A.pff

REV	DESCRIPTION	DRAWN / APPROVED	DATE
A	A1 WAS 2.93, A2 WAS 6.03, A3 WAS 10.20	K.POTTER	09/13/00
		TONY LEVANO	09/13/00



NOTES:

- ALL WELDS TO CONFORM TO A.W.S. D1.1-2000 (STANDARD FOR WELDING PROCEDURE AND PERFORMANCE QUALIFICATIONS)
- APPROMATE WEIGHT= 470 POUNDS
- THIS DRAWING IS A RIGHT HAND VERSION OF #MC-386961

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.
5	COMM./STK.	3.0x4.0x.19 A500 GR.B STRUCTURAL STL.TUBE	21.5'
4	COMM./STK.	ø.313-18 UNC-2B HEX STEEL WELD NUT ("McMASTER-CARR #90596A030 OR EQUAL)	2
3	MC-386948	ATTACHMENT PLATE	2
2	COMM./STK.	4.0x4.0x.19 A500 GR.B STRUCTURAL STL.TUBE	21.5'
1	MC-386949	MOUNTING PLATE	2

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DECIMAL TOLERANCES:
.X=±.1 .XX=±.03 .XXX=±.005
ANGULAR TOLERANCE: ±1°

1) BREAK ALL SHARP EDGES .015 MAX.
2) DO NOT SCALE DRAWING.
3) DIMENSIONS BASED UPON ANSI Y14.5M-1982
4) MAX. ALL MACH. SURFACES 125

ORIGINATOR	TONY LEVANO	08/16/00
DRAWN	K.POTTER	08/16/00
CHECKED	TONY LEVANO	08/28/00
APPROVED	TONY LEVANO	08/28/00

USED ON

MATERIAL: SEE PARTS LIST

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

PPD/MECHANICAL SUPPORT
B LAYER MDT OCTANT SUPPORT
SUB-FRAME WELDMENT

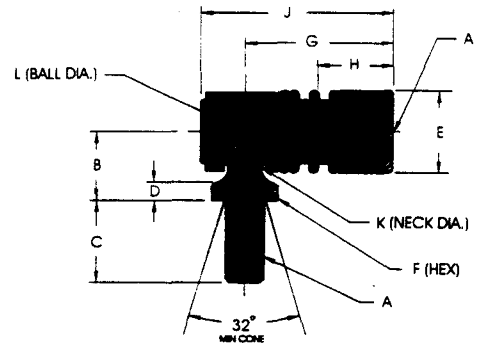
SCALE	DRAWING NUMBER	SHEET	REV
.09	3823.130-MC-386951	1 OF 1	A

CREATED WITH : MS2.1 GROUP: DOMS

Plotted ('and on 18-Sep-2000 . File: 38695101_A.pff

SS Series

Quick Disconnect



Dimensions in inches

<u>**Description and Specifications**</u>

Type SS ball joints are high strength, quick disconnect assemblies with good wear characteristics.

Patented design features "key hole" retaining sleeve which insures that the assembly can only be put together with the sleeve positively aligned with the ball cavity. When the spring is released, alignment is automatic, thereby eliminating any possibility of partial closure.

Materials of Construction

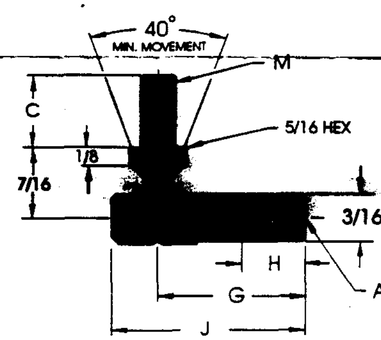
Body and ball stud are of low carbon steel. Ball studs are surface hardened for wear resistance. All components except the stainless steel spring are plated and yellow dichromate treated for corrosion resistance.

Lubrication

Ball cavity is packed with high wear lubricant.

P Series

Disconnect



Dimensions in inches

[illegible]	7/16	7/8	[illegible]	[illegible]	[illegible]
[illegible]	9/16	7/8	[illegible]	[illegible]	[illegible]
[illegible]	9/16	31/32	[illegible]	[illegible]	[illegible]
P1200 [illegible]	7/16	31/32	17/32	1-1/4	10-32

<u>**Description and Specifications**</u>

Type P Ball Joints are a cost effective design for applications where minimum weight is required. As part of a linkage assembly, length adjustments are simplified because of the disconnect feature.

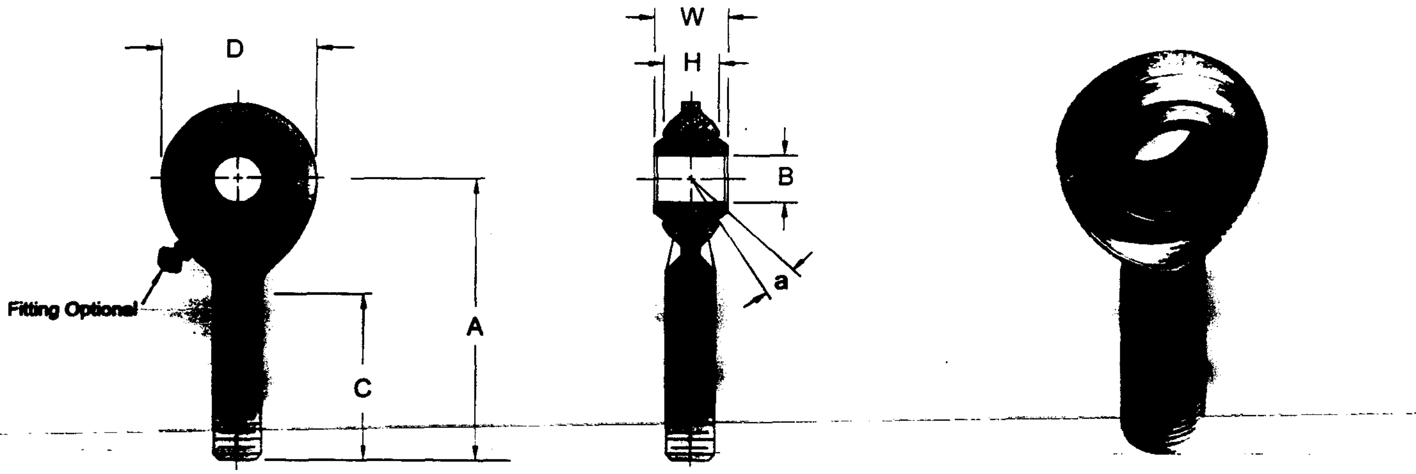
The hardened spring steel retaining clip accepts ball stud member at 19 pounds maximum push-in. load and permits removal of ball stud with 14 pounds minimum pull-out load.

Materials of Construction

Body and ball stud are of low carbon steel. Ball studs are surface hardened for wear resistance. All components except the stainless steel spring are plated and yellow dichromate treated for corrosion resistance.

MSM Series

2-Piece, Metal to Metal



Dimensions in inches

[illegible]	[illegible]	.1900	.312	[illegible]	[illegible]	[illegible]	.437	.750	10-32	[illegible]	1,170	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1/4-28	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1/2-20	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Dimensions in millimeters

[illegible]	[illegible]	[illegible]	7.92	[illegible]	31.75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	6.35	[illegible]	19.05	[illegible]	25.40	1/4-28	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	7.94	11.10	7.92	47.63	22.23	15.88	31.75	5/16-24	17	1,574	32
[illegible]	[illegible]	9.53	12.70	9.12	[illegible]	25.40	18.26	31.75	3/8-24	19	2,230	[illegible]
MSM7	[illegible]	11.11	14.27	10.31	53.98	28.58	20.62	34.93	7/16-20	[illegible]	2,795	[illegible]
MSM8	[illegible]	12.70	15.88	11.50	61.93	33.32	23.80	38.10	1/2-20	17	3,663	109
[illegible]	[illegible]	15.88	19.05	12.29	66.68	38.10	28.58	41.28	5/8-18	22	4,313	163
MSM12	MSML12	19.05	22.23	15.06	73.03	44.45	33.32	44.45	3/4-16	18	6,274	259

Materials

[illegible]
[illegible]
Hard [illegible] Chromate Treated

Notes:

1. For standard zerk lubrication fitting add "Z" to suffix. Example: MSM8Z
2. This series is also available in a studded configuration. (refer to chart in this catalog, page 47) Specify by adding "S" to suffix. Example: MSM8S

* Lubrication fittings are not supplied on these units