LIFTING DEVICE

DEVICE NAME: E-831-HC MODULES SPREADER BARS (2)

ENGINEERING NOTE NUMBER: 61

DRAWING NUMBER: SEE SKETCH ATTACHED

APPLICABLE STANDARD: ANSI/ASME B.30.20-1985

AISC/ASD/9th ed.

RATED LOAD: 13,500 lb (EACH BAR)

TEST LOAD: 20,300 lb

TEST LOAD PERCENT: 150%

LAST LOAD TEST DATE: DECEMBER/16/1993

COLOR:

STRESS CALCULATIONS:

Done by: RAFAEL SILVA

Date: DECEMBER/15/1993

Reviewed by: Zhijing Tang

Date: Jan 12, 1994

REMARKS:

TO BE USED ON E-831, FOR HC MODIFICATION ONLY.
(SEE DRAWING 9220.687-ME-202755)

IDENTIFICATION:

Engineering Note Number & Rated Load Must be Clearly Marked On a Conspicuous Surface.

E - 831 HC MODIFICATION – SPREADER BARS

SPREADER BARS TO BE USED SIMULTANEOUSLY TO LIFT EACH MODULE OF THE HC.

1) WEIGHT

EACH MODULE IS COMPOUNDED OF 5 PLATES (MAX.)

EACH PLATE HAS 82" x 120" x 1 3/4" (NOMINAL) AND IS COMPOUNDED BY 3 PIECES (LARGEST: 82 x 72 x 1 3/4")

DEVIATION OF THICKNESS: RYERSON, p. 455

THICKNESS = 1" TO 2", WIDTH ≤ 96", NOTE 3 ⇒

$Tol = (0.06 \times 1.75)$ → 0.01 ⇒ tol = 0.11".

MAXIMUM THICKNESS = 1.75 + 0.11 = 1.86".

ASSUMING VARIATION OF IN THE OTHER DIMENSIONS, THE MAXIMUM VOLUME PER PLATE IS (RYERSON p.455):

$(83 \times 121 \times 1.86) = 18{,}680\ in^3$ (WITH PLUG IN).

TAKING $d_{STEEL} = 490\ lb/ft^3$ (.2836 lb/in³) (RYERSON, p.476), $18{,}680\ in^3 = 10.81\ ft^3$

THE MAXIMUM WEIGHT PER PLATE IS: 5,298 lb

WEIGHT PER MODULE: 5 x 5,298 = 26,490 lb

CONSIDERING 510 lb OF ATTACHMENTS (~ 2%) ⇒

W = 27,000 lb / MODULE, WHAT IS LESS THEN THE MAXIMUM LOAD FOR THE WBL CRANE. (30,000 lb)

SO, FOR DESIGN PURPOSES, IT WILL BE CONSIDERED

W = 27,000 lb.

2) SPREADER BAR

2.1) MATERIAL:

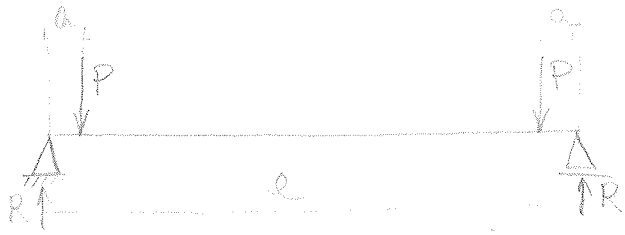
STOCK ITEM 1530-2120

AISI 1018 COLD DRAWN, 1"x1½"x144

5.10 lb/ft, $0.63/in

ACCORDING TO RYERSON CATALOG, p. 432 → $\sigma_y = 54$ ksi

2.2) MODEL



AISC/ASD, 9th ed, p. 2-298, CASE 9,

$M_{MAX} = P \cdot a$; $\Delta_{MAX} = \frac{Pa}{24EI}(3l^2 - 4a^2)$, $S_{MAX} = P$

a OFFSET BETWEEN CENTERLINE OF LINE OF ACTION OF FORCES (P and R)

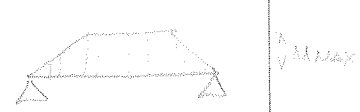
$a_{MAX} \cong 1''$, SO WILL BE ASSUMED $a = 1''$.

$l \cong 84''$.

P WILL BE ASSUMED TO BE THE TEST LOAD, SO $P = 10{,}150$ lb (WEIGHT OF "B" BLOCKS)

CONSIDERING THAT, WE HAVE

$M_{MAX} = 10{,}150 \cdot 1 \Rightarrow M_{MAX} = 10{,}150$ lb-in



$S_{MAX} = 10{,}150$ lb

$E = 2.9 \times 10^7$ psi $\quad I = \frac{bh^3}{12} = \frac{1(1.5)^3}{12} = 0.2813$ in^4

$\Delta_{MAX} = \frac{(10{,}150) \cdot 1}{24 \times (2.9 \times 10^7) \times 0.2813}(3(84)^2 - 4(1)^2) = 1{,}097$ in

2.3) MAXIMUM STRESSES:

BENDING: $\sigma_b = \frac{M}{S}$, $S = \frac{I}{c} = \frac{b h^{\cancel{3}\,2}}{6 \cancel{12} \cdot \frac{\cancel{h}}{\cancel{2}}} = \frac{b h^2}{6}$

$S = \frac{(1) \times (1.5)^2}{6} = 0.375 \ in^3$ $\left(\sigma_b = \frac{P \cdot a}{S}\right)$

$\sigma_b = \frac{10{,}150}{0.375} \Rightarrow \underline{\sigma_b = 27{,}067 \ psi}$

SHEAR: $\sigma_s = \frac{S}{A}$, $A = b \times h = 1 \times 1.5 = 1.5 \ in^2$

$\sigma_s = \frac{10{,}150}{1.5} \Rightarrow \underline{\sigma_s = 6{,}767 \ psi}$

SO THE GOVERNING STRESS IS $\sigma_b = \underline{27{,}067 \ psi}$

2.4) ALLOWABLE STRESS (AISC/ASD, 9th ed.)

2.4.1) WIDTH-THICKNESS RATIO: Tb. B5.1, p. 5-36

$\frac{b}{t} < \frac{K}{\sqrt{F_y}}$

$\left.\begin{array}{l} b = \frac{b_f}{2} \\ t = t_w \end{array}\right\}$ FOR RECTANGULAR SECTIONS $b_f = t_w \Rightarrow \frac{b}{t} = \frac{1}{2}$

$\frac{K}{\sqrt{F_y}} > \frac{1}{2} \Rightarrow$ COMPACT SECTION. THE MINIMUM VALUE OF K IS 65 $\Rightarrow \sqrt{F_y} < \frac{65}{2} \Rightarrow \underline{F_y < 1{,}056 \ ksi}$

$\Rightarrow$ FOR STEEL $\Rightarrow$ ALWAYS (PRATICALLY)

THEN THE SECTION IS COMPACT

2.4.2) CHAPTER F, BEAMS AND OTHER FLEXURAL MEMBERS,

Eq. F1-2, p. 5-45, UNBRACED LENGTH L_b.

$L_c = \frac{76\, b_f}{\sqrt{F_y}} = \frac{76\, 1}{\sqrt{54}} \Rightarrow L_c = 10.34''$ OR

$L_c = \frac{20{,}000}{(d/A_f)F_y} = \frac{20{,}000}{(2/b_f)F_y} = \frac{10{,}000}{54} \Rightarrow L_c = 185.2''$

So $\underline{L_c = 10.34''} < 84''$ (= ℓ).

- TENSION: F1.3, F1-5, p. 5-46, $F_b = 0.6 F_y$.

- COMPRESSION: F1.3, p. 5-47, F1-8

$C_b = 1$

$A_f = b_f \cdot \left(\frac{d}{2}\right) = 1 \cdot \left(\frac{1.5}{2}\right) = 0.75\ in^2$

$\ell = 84''$

$d = 1.5''$

$F_b = \frac{12 \times 10^3\, C_b}{(\ell d/A_f)} < 0.6 F_y$

$F_b = \frac{12 \times 10^3 \cdot 1}{\left(\frac{84 \cdot 1.5}{0.75}\right)} = 71.4 > 0.6 F_y \Rightarrow \underline{F_b = 0.6 F_y}$

F_b tension = F_b compression = $0.6 F_y = 0.6 \cdot 54 \Rightarrow \underline{F_b = 32.4\ ksi}$

2.4.3) ADDITIONAL SAFETY FACTOR.

COMPARING 2.3 AND 2.4.2, THERE IS A ADDITIONAL SAFETY FACTOR OF $\frac{32.4}{27.1} \cong \underline{1.2}$ (ABOVE THE AISC PROVISIONS).

2.5) ANSI/ASME B.30.20-1985 REQUIREMENTS.

ACCORDING TO 1, W = 27,000 lb.

THIS LOAD HAS TO BE TAKEN BY 2 SPREADER BARS

SO: LOAD RATING: 13,500 lb / BAR.

ACCORDING TO 2.2, $\sigma_b = \frac{P \cdot a}{S}$, SO:

$$\sigma_b = \frac{(13{,}500/2) \times 1}{(0.375)} \Rightarrow \underline{\sigma_b = 18 \text{ ksi}}$$

SAFETY FACTOR: $SF = \frac{F_y}{\sigma_b} = \frac{54}{18} \Rightarrow \underline{SF = 3.0}$

TEST LOAD (minimum): $1.25 \times 13{,}500 = \underline{16{,}875 \text{ lb}}$

FINAL LOAD TEST: 20,300 lb $\Rightarrow 1.50 \times 13{,}500 \Rightarrow$

LOAD TEST: 150% RATED LOAD.

3) WELDS OF BAR ENDS

SHIGLEY p. 229, Tb. 5.11.1

BASE THICKNESS $3/4 < t \leq 1\frac{1}{2} \Rightarrow$ WELD = 5/16"

SHIGLEY p. 247, Tb. 5.15.2, $\sigma = 60$ ksi, $s = 5/16" \Rightarrow$ 3.98 kips/in

27,000 lb / 4 POINTS OF SUPPORT $\Rightarrow$ 6,750 lb/POINT.

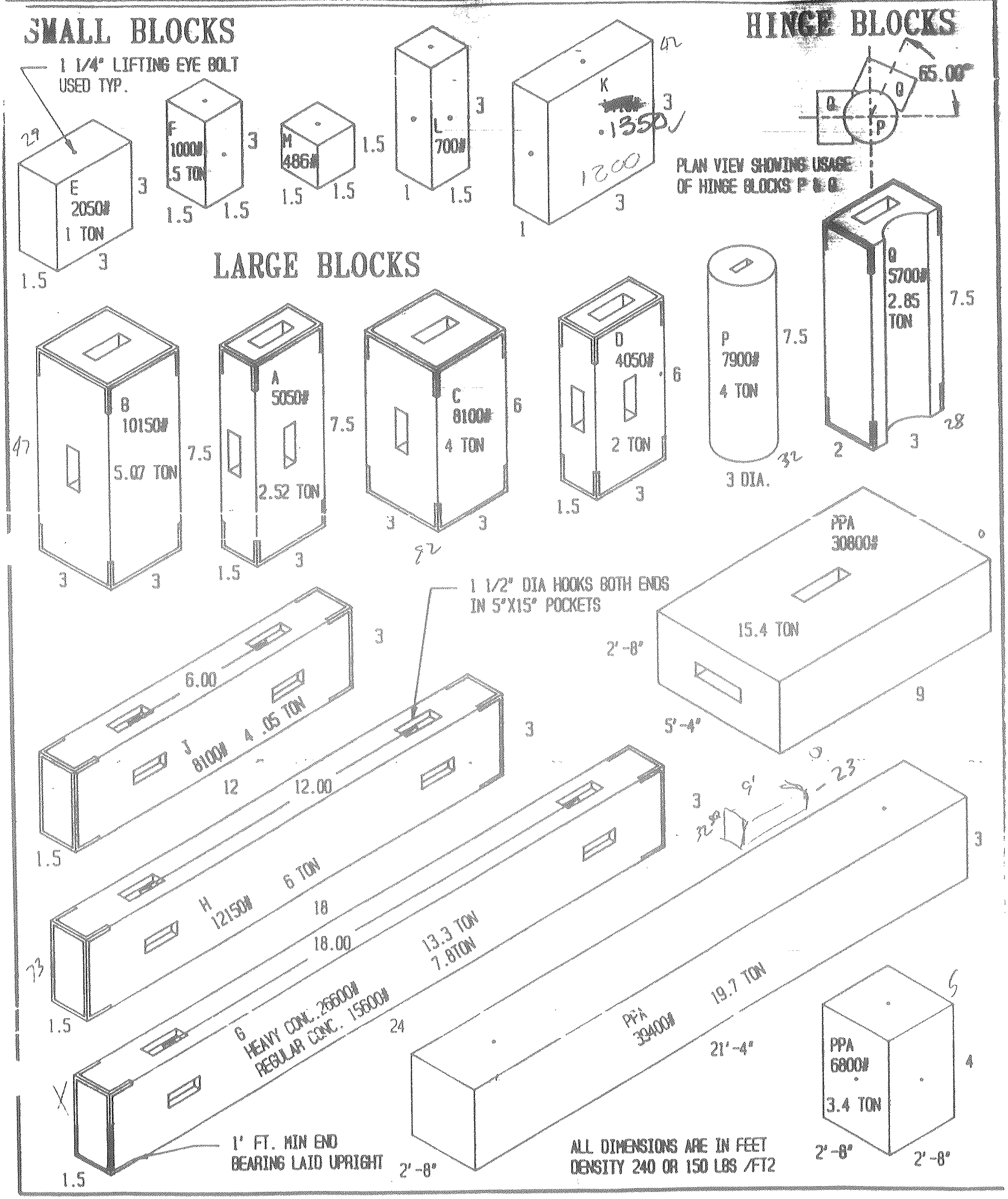
MINIMUM REQUIRED LENGTH: $\frac{6750}{3980} = 1.696$ in

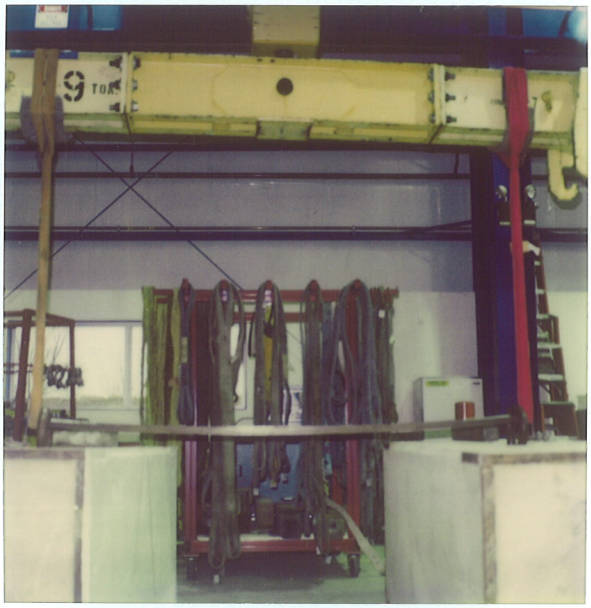
EACH MODULE HAS 10 WELDS 1.75" LONG. (TOTAL LENGTH = 17.5")

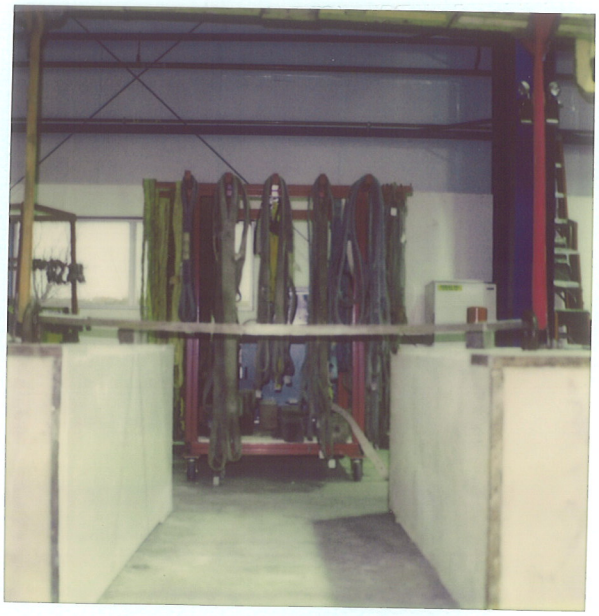
1-10-91

CONCRETE SHIELDING

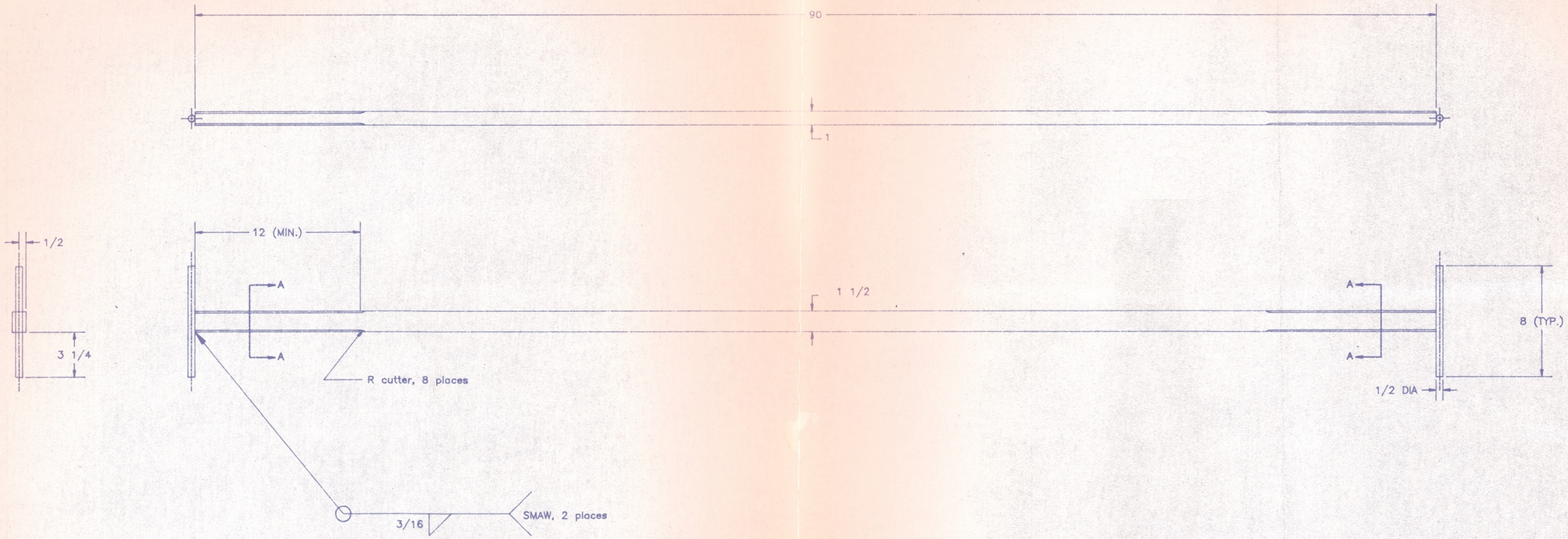
DIMENSIONS & WEIGHTS

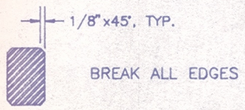






REV.	DESCRIPTION	DRAWN	DATE
		APPD.	DATE





SECTION A–A
SCALE 1:4

QUANTITY: 2

ITEM NO.	PART NO.	DESCRIPTION OR SIZE	QTY. REQ.
2	2	ROUND BAR 1/2 in DIA.	2
1	1	1 x 1 1/2 x 90 CARBON STEEL BAR	1

PARTS LIST

UNLESS OTHERWISE SPECIFIED					
.XX	.XXX	ANGLES	ORIGINATOR	J.RAFAEL SILVA	11/23/93
±.03	±.015	± 1°	DRAWN	J.RAFAEL SILVA	11/23/93
			CHECKED	R. CURRIER	11/23/93
			APPROVED	R. CURRIER	11/23/93

1. BREAK ALL SHARP EDGES .015 MAX.
2. DO NOT SCALE DWG.
3. DIMENSIONING IN ACCORD WITH ANSI Y14.5M–1982 STD'S.
4. ALL DIMENSIONS ARE IN INCHES.

125√ MAX. ALL MACHINED SURFACES

USED ON
E–831 Hadron Calorimeter

MATERIAL–
ASTM A36 CARBON STEEL

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

RD/MECHANICAL SUPPORT DEPARTMENT
E–831 HC / SPREADER BAR

SCALE	DRAWING NUMBER	SHEET NO.	REV.
1:8	SKETCH	1 OF 1	—

NOTE: USE STRAPS AS CLOSE AS POSSIBLE TO THE CALORIMETER