LIFTING DEVICE

DEVICE NAME: E-8 HYPERON MAGNET COIL LIFTING FIXTURE

ENGINEERING NOTE NUMBER: 70

DRAWING NUMBER: 3832.233-ME-268107

APPLICABLE STANDARD: ASME B30.20-1993

AISC 9th EDITION ASD

RATED LOAD: 8000 POUNDS

TEST LOAD: 9400

TEST LOAD PERCENT: 117.5%

LAST LOAD TEST DATE: 28 APRIL '95

COLOR: YELLOW

STRESS CALCULATIONS:

Done by: DAVE PUSHKA

Date: 10 JANUARY 1995

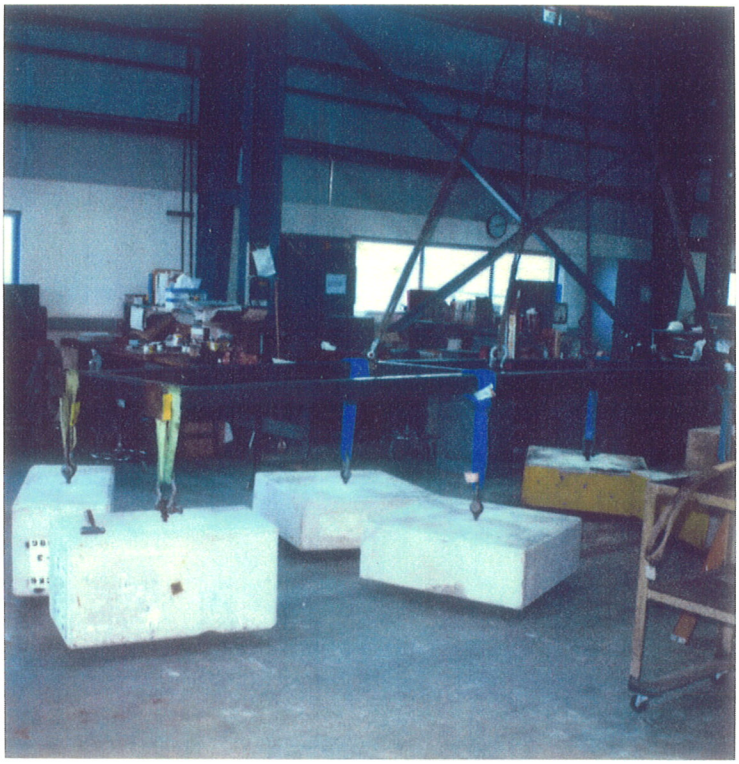
Reviewed by: ANG LEE

Date: JANUARY 1995

REMARKS: THIS FIXTURE IS DESIGNED TO LIFT A PAIR OF RACE TRACK COILS AND SHOULD NOT BE USED FOR OTHER APPLICATIONS WITHOUT AN ENGINEERING ANALYSIS.

IDENTIFICATION:

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



MECHANICAL SUPPORT DEPARTMENT
ENGINEERING NOTE

NUMBER: MSD EN-2.3.3 - KTeV
(WBS number items 2.3.3)

DATE: 10 January 1995

TITLE: Design Note for the Lifting Fixture used to install the Coils for the E-8 Hyperon Magnet

AUTHOR(s): Dave Pushka

REVIEWER: [signature] January 1995

KEY WORDS: Lifting Fixture, E-8 magnet coils, Hyperon Magnet coils

ABSTRACT/SUMMARY:

This design note contains the calculations required to size member used for the lifting fixture. Allowable stresses are based on those calculated from AISC 9th edition and from ASME B30.20 'Under-the-Hook Lifting Fixtures'. The most conservative of the two values calculated from each Code was used.

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NAME: DAVE PUSHKA

DATE	REVISION DATE
12/23/04	

E-8 MAG. COILS - ≈ 21'-0 LONG (YOKE IS 18'-0 LG)

36" I.D.

48.75" O.D.

6 3/8" WIDE × 16.5" TALL CROSS SECTION

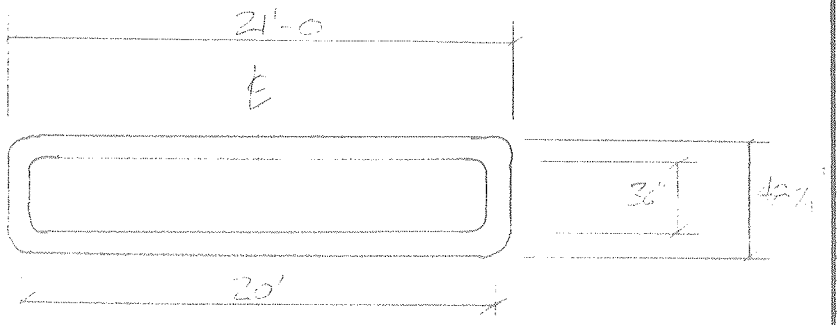
ASSUME SOLID ALUMINUM

TOTAL WT. = $\frac{(6.375 \times 16.5)}{144} \times 2 \times (21' + 4') \times 170\ \#/FT^3 = 6208\ \#$

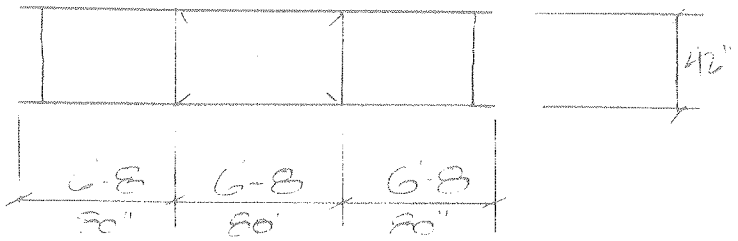
DESIGN FIXTURE TO LIFT BOTH COILS TOGETHER -

DESIGN FOR 3K LOAD & OMIT FIXTURE WT. SINCE FIXTURE WT SHOULD BE LESS THAN 1500 #

COIL PLAN VIEW



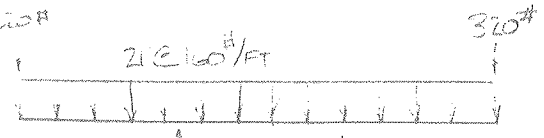
LIFTING FIXTURE PLAN



COIL PERIMETER = 80'

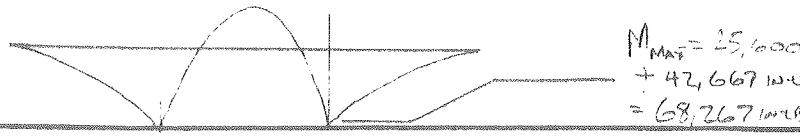
$\frac{3K}{80} = 160\ \#/FT.$

LOADING



SHEAR

MOMENT



$M_{MAX} = 25,600 + 42,667$ IN-LB $= 68,267$ IN-LB

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M_{MAX} = 68,267 IN-LBS

ASSUME AN ALLOWABLE BENDING STRESS OF $0.6F_y = 21.6$ KSI

$$S = \frac{M}{F_a} = \frac{68267 \text{ IN. LBS}}{21{,}600 \text{ LBS/IN}^2} = 3.16 \text{ IN}^3$$

A 4x4x1/4 □ STEEL TUBE HAS $S_x = 4.11 \text{ IN}^3$ BUT $F_y = 46$ KSI

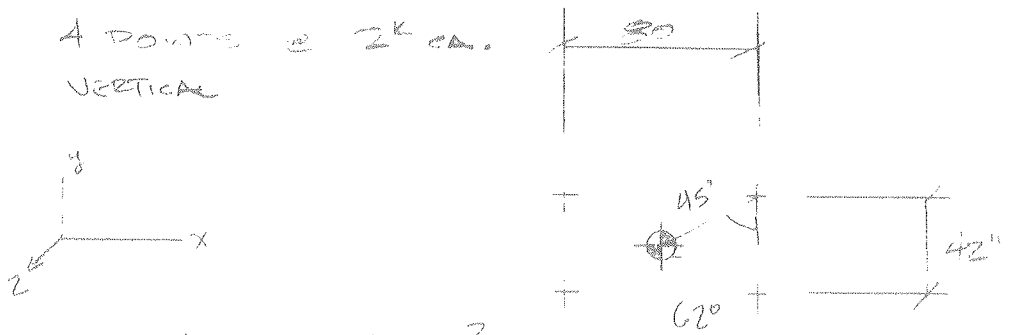
$$\therefore S_{REQ} = \frac{68{,}267}{(0.6)(46)} = 2.47 \text{ IN}^3$$ — 3x3x1/4 HAS $S_x = 2.10$

∴ 4x4x1/4 IS A MINIMUM STARTING SIZE.

CONSIDER LOADS DUE TO SLINGS —

4 POINTS @ 2K EA.

VERTICAL



y = 21", x = 40", z = ?

TRY 4'-0 SLINGS. $(y^2 + x^2 + z^2)^{1/2} = 48"$. z = 16" ∴ TOO SHORT

" 6'-0 SLINGS ∴ z = 56", ∠ = 51° ∴ POSSIBLY OK

CHECK LOAD $T = \frac{2{,}000 \#}{\sin 51°} = 2568 \#$ < 8400# CAPACITY

∴ USE OF 6'-0 SLINGS IS OKAY

COMPRESSION LOADS IN FIXTURE:

$F_x = ((2568)\cos 51°)(\sin 62°) = 1427 \#$

$F_z = ((2568)\cos 51°)(\cos 62°) = 759 \#$

CONFIRM LOADS: $(2000^2 + 1427^2 + 759^2)^{1/2} = 2571 \#$ ∴ OK

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FERMILAB

ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE
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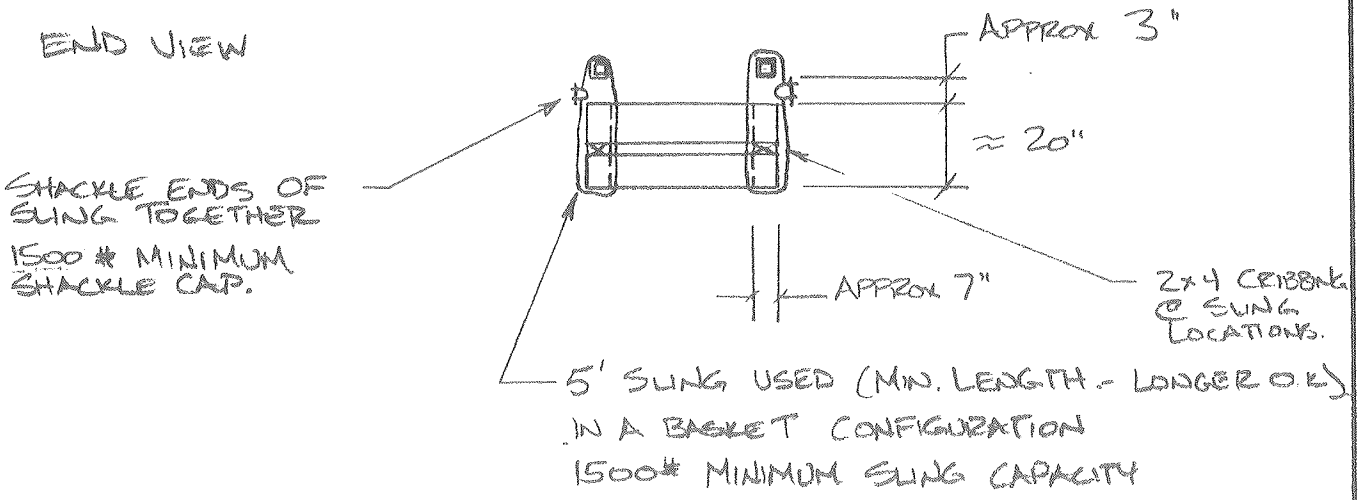
SUBJECT: E-8 HYPERON MAGNET COIL LIFTING FIXTURE

NAME: DAVE POEHLAU

DATE: 12/29/94

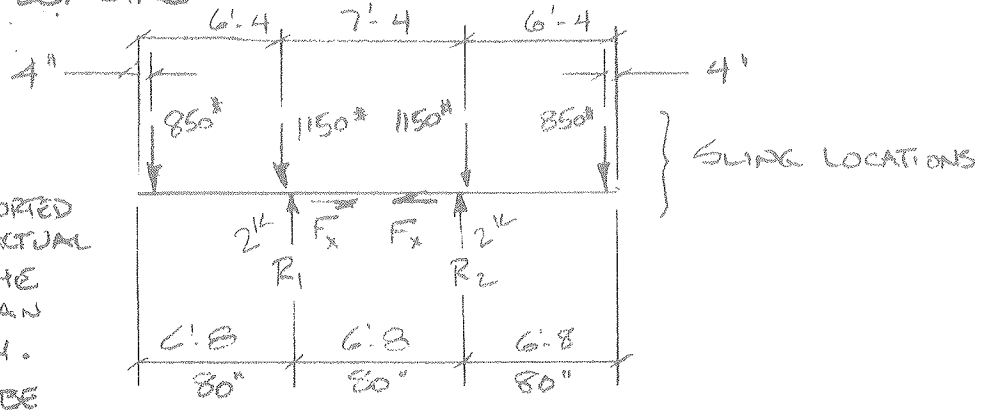
REVISION DATE:

END VIEW



USE FOUR SLINGS EACH SIDE.

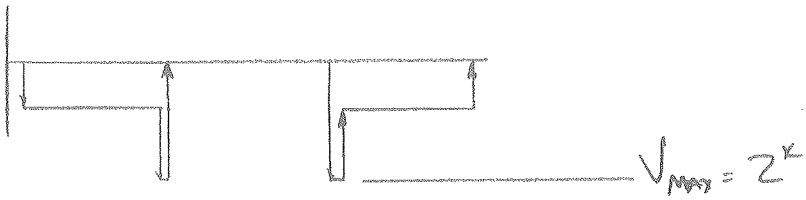
ACTUAL BEAM LOADING —



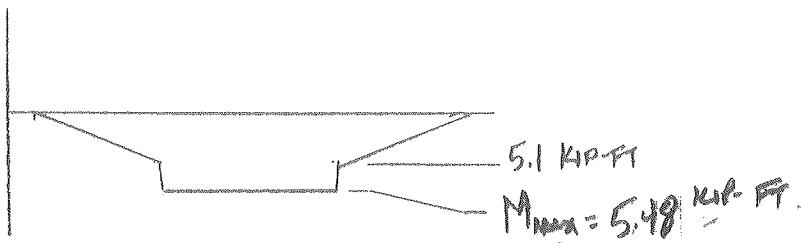
THE 850# LOAD HAS BEEN ESTIMATED BY APPROXIMATING THE LENGHT OF COIL SUPPORTED BY THIS SUPT. THE ACTUAL LOAD DEPENDS ON THE COIL STIFFNESS, AN UNKNOWN QUANTITY.

I BELIEVE THIS TO BE A REALISTIC APPROXIMATION AND UNWORTHY OF A DETAILED ANALYSIS SINCE THE ASSUMED LOADS EXCEED THE ACTUAL [illegible] BY ABOUT 28%

SHEAR



MOMENT



SUBJECT: E-8 HYPERON MAG. COIL LIFTING FIXTURE.

NAME: DAVE POSHKA

DATE: 1/9/95 | REVISION DATE:

FINAL DESIGN CALCS – MAIN SIDE BEAMS.

$M_{MAX} = 5.5$ KIP-FT

$F_{A_t} = \frac{F_y}{3}$ (PER ASME/ANSI B20.20-1985)

USE SQUARE STRUCTURAL TUBING, $F_y = 46$ ksi

$\therefore F_A = \frac{46}{3} = 15.3$ ksi

FOR LUGS, USE PLAIN C.S., $F_y = 30$ ksi

$\therefore F_A = \frac{30}{3} = 10$ ksi

$\sigma = \frac{M}{S} \rightarrow S_{REQ'D} = \frac{M_{MAX}}{F_A} = \frac{(5.5 \text{ KIP-FT})(12^{IN}/_{FT})}{15.3 \text{ ksi}} = 4.31 \text{ IN}^3$

TRY $4 \times 4 \times 5/16 \rightarrow S = 4.79$ $\quad F_b = \frac{M}{S} = \frac{(5.5)(12)}{4.79} = 13.7$

$F_{AXIAL} = 1427\#$ (SEE PAGE 2), $A = 4.36 \text{ IN}^2 \rightarrow F_{AXIAL} = \frac{1427}{4.36} = 327$ PSI

$F_{TOTAL} = (13.7 \text{ ksi} + 327 \text{ psi}) = 14{,}105$ PSI

$14{,}105 < 15.3$ ksi $(F_A) \therefore 4 \times 4 \times 5/16$ IS O.K. PER B20.20 FOR USE AS THE LONG BEAMS. NOTE SINCE ASME/ANSI B20.20 DOESN'T ADDRESS BUCKLING – USE AISC TO CHECK THIS. SEE AISC CHAPTERS E, F IN THE 9TH ED.

SUBJECT: E.S HYPERION MAG COIL LIFTING FIXTURE

NAME: DAVE POSHKA

DATE: 1/9/95 | REVISION DATE:

CHAPTER E - $KL/r = \frac{(20)(20')(12''/ft)}{1.48} = 324$

$$C_c = \sqrt{\frac{2\pi^2 E}{F_y}} = \sqrt{\frac{2\pi^2(29{,}000)}{46}} = 111.5$$

$$KL/r > C_c \therefore F_a = \frac{12\pi^2 E}{23(KL/r)^2} = 1.42 \text{ ksi}$$

ACTUAL AXIAL COMPRESSION = 327 psi < 1.42 ksi ∴ OK
- BUT NEED TO CHECK CHAPTER H.

FROM CHAPTER F, BEAM & FLEX. MEMBERS, THE ALLOWABLE STRESS ON BOX SECTIONS IN BENDING IS AT LEAST (FOR NON-COMPACT SECTIONS) $F_b = 0.6 F_y$. THEREFORE, THE MORE STRINGENT ASME/ANSI B20.20 GOVERNS.

FROM CHAPTER H, COMBINED STRESSES

$$\frac{f_a}{F_a} + \frac{C_{mx} f_{bx}}{\left(1 - \frac{f_a}{F'_{ex}}\right) F_{bx}} + \frac{C_{my} f_{by}}{\left(1 - \frac{f_a}{F'_{ey}}\right) F_{by}} \leq 0$$

$F'_{ex} \to \infty$

$$\frac{327}{1420} + 0 + \frac{(0.85)(13.7)}{\left(1 - \frac{.327}{\frac{12\pi^2 E}{23(KL/r)^2}}\right)(.6)(46)} = 0.23 + .54 = .78 < 1.0 \quad \therefore \text{OK}$$

AND $$\frac{f_a}{.6F_y} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}} \leq 1.0$$

$\frac{f_{bx}}{F_{bx}} \to 0$

$$\frac{.327}{(.6)46} + \frac{13.7}{(.6)46} = 0.012 + 0.49 = 0.50 < 1.0 \therefore \text{OK}$$

∴ THIS MEMBER SIZE IS OKAY PER NSC.

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FERMILAB
ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE
RDIMSDMEG	KTeV	2.3.3	6

SUBJECT: E-8 HYPERON MAGNET COIL LIFTING FIXTURE

NAME: DAVE PUSHKA

DATE: 1/10/95

REVISION DATE:

FINAL DESIGN CALCS - CROSS BEAMS.

SINCE THE LOAD ON THE 2 CROSS BEAMS @ THE LUGS IS 759# (AXIAL) AND THE SIDE BEAMS HAVE A 1427# AXIAL LOAD AND A BENDING MOMENT, USE OF THE SAME SIZE MEMBER WILL SUFFICE.

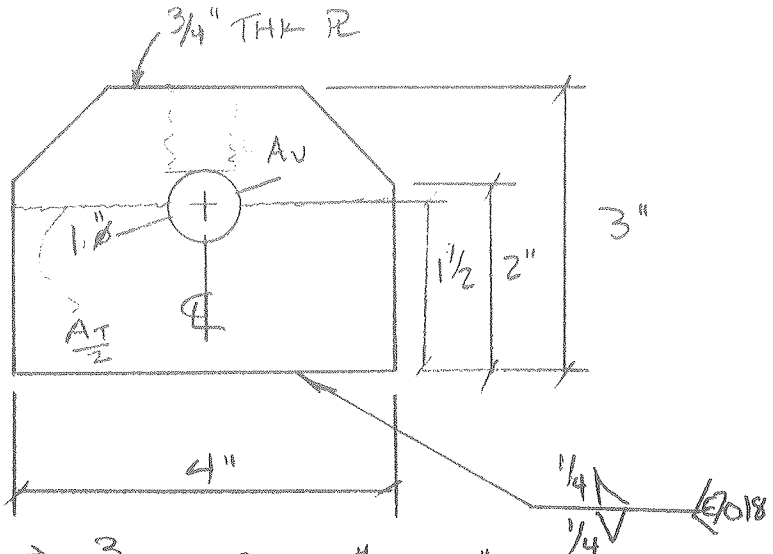
∴ USE 4 x 4 x 5/16 □ STRUCTURAL TUBE.

FINAL DESIGN CALCS - LIFTING LUGS

TENSILE ON LUGS IS 2571# EA → DESIGN FOR 3 KIPS. IF F_a = 10 KSI & F_v = 10 KSI

THE $A_T = \frac{3^K}{10\ KSI} = 0.3\ IN^2$ & $A_v = \frac{3^K}{10\ KSI} = 0.3\ IN^2$

LUG SKETCH:



$A_T = (4-1)(3/4") = 2.25\ IN^2$

$2.25\ IN^2 >> .3\ IN^2$

$A_v = (3 - 1\frac{1}{2} - \frac{1}{2})(.75)(2)$

$= 1.5\ IN^2 >> .3\ IN^2$

WELD $P = 0.928\ ^K/_{16^{th}/IN} \rightarrow \frac{3}{.928} = 3.23\ 16^{ths}$ @ 1"

∴ USE 1/4" FILLET BOTH SIDES, $P_{MAX} = 30^K >> 3^K$ ∴ OK

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ENGINEERING NOTE

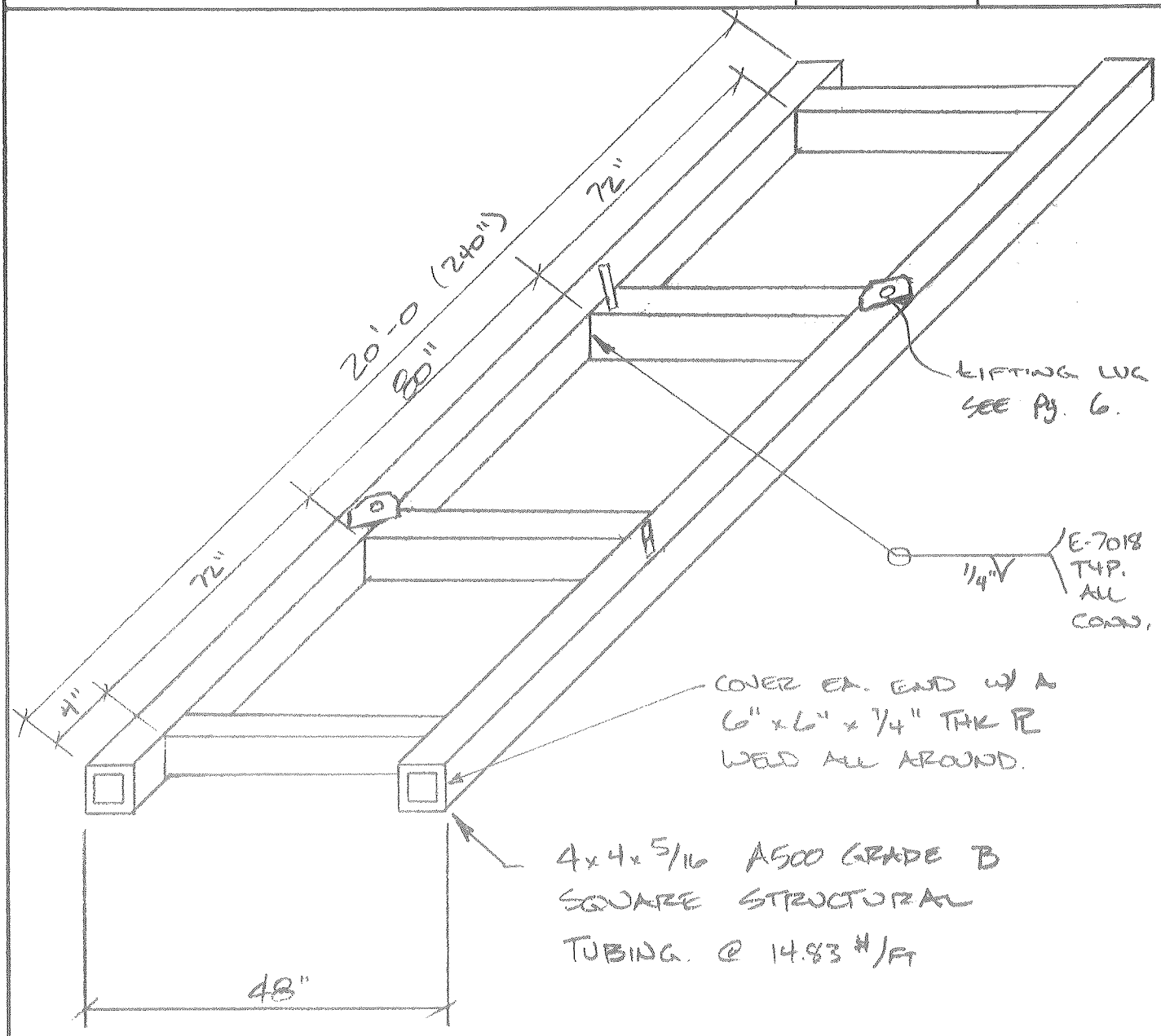
SECTION	PROJECT	SERIAL-CATEGORY	PAGE
RD/MSD/MSL	KTEV	2.3.3.	7

SUBJECT: E8 MAGNET COIL LIFTING FIXTURE.

NAME: DAVE POSHKA

DATE: 10 JAN '95

REVISION DATE:



TOTAL WT = 790 #

SAY 800 #

DESIGNED FOR 8^K - COILS ARE 6.2^K ∴ TOTAL LOAD = 7^K

7^K < 8^K ∴ OK

FERMILAB

ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE
RD/MED/MSG	KTeV	2.3.3	8

SUBJECT: E-8 MAGNET COIL LIFT FIXTURE TEST SET-UP.

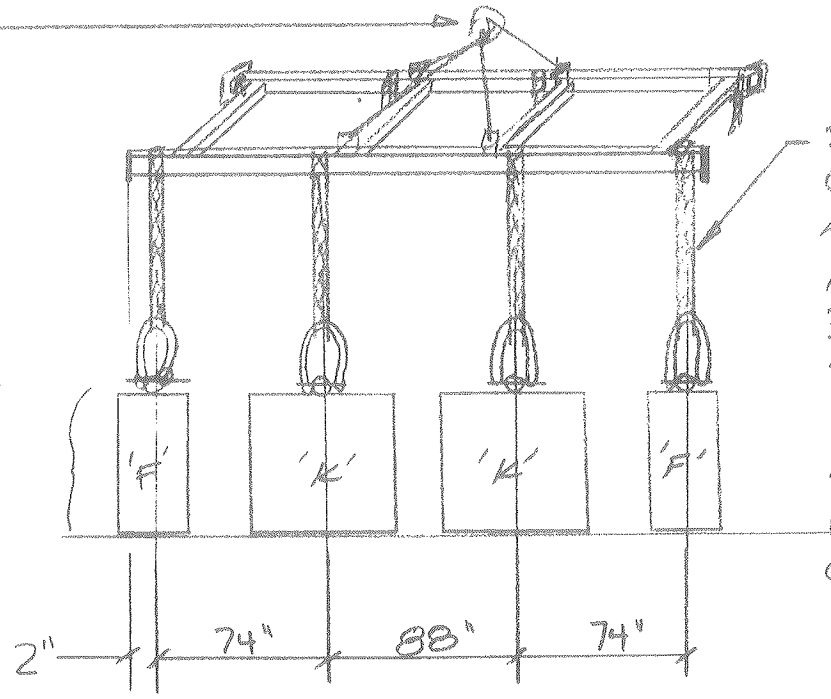
NAME: D. PUSHKA

DATE: 15 MAR '95

REVISION DATE:

DESIGN →		650#	1150#	1150#	850#
TEST (IDEAL)		1062#	1437#	1437#	1062#
TEST (ACTUAL)	1000# 'F' BLOCK	1350# 'K' BLOCK	1350# 'K' BLOCK	1000# 'F' BLOCK
ACTUAL %	17%	17%	17%	17%

USE MIN 6'-0 SLINGS (QTY = 4) TO ATTACH TO CRANE HOOK.



PASS SLING OVER THE 4"x4" TUBE AND CONNECT BOTH ENDS TO SHACKLE. CONNECT SHACKLE TO LIFTING EYE OF BLOCKS.

2 'F' BLKS & 2 'K' BLOCKS ON REAR LONG SECTION NOT SHOWN FOR CLARITY. MUST BE THERE FOR TEST.