



Particle Physics Division

Mechanical Department Engineering Note

Number: MD-ENG-314

Date: January 6, 2011

Project: LAR TPC

Project Internal Reference:

Title: Phase Separator Support

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Key Words: LAr, TPC, Phase Separator, Support

Abstract/Summary:

A phase separator vessel for the LArTPC will be suspended from existing building roof beams in PC4. This note includes calculations that prove that the structural members, chosen in the preliminary design, will safely support the vessel. The Facilities Engineering Services Section (FESS) was consulted concerning the additional load applied to the existing roof beams and approval was given to attach to the building as designed.

One minor change from the preliminary design was required. The threaded rods that attached the vessel to the Top Beam were changed from $\frac{1}{2}$ inch diameter to $\frac{3}{4}$ inch diameter as shown in this note.

Applicable Codes: *Manual of Steel Construction, Allowable Stress Design, Ninth Edition*, American Institute of Steel Construction, Chicago, Illinois 1989.

VESSEL HEIGHT $\approx 500 \#$

ROD SUPPORT:

LOAD/ROD = $500/2 = 250 \#$

CHECK $1/2" \phi$ ROD 316 STAINLESS $F_y = 35 \text{ KSI}$

AREA = $\pi d^2/4 = \pi (0.5)^2/4$
 $= 0.1963 \text{ IN}^2$

$f_t = 250/0.1963$
 $= 1273 \text{ PSI}$

$F_t = 0.6 F_y = 0.6 (35)$
 $= 21 \text{ KSI}$
 $= 21,000 \text{ PSI}$

 $> 1273 \text{ PSI}$
OK10% VERT. LOAD = HORIZ. LOAD
 $10\% (250) = 25 \#$

$M = (36.22 - (4.16 + 4.06/2))(25) = 751 \#-IN$

$s = \pi d^3/32 = \pi (0.5)^3/32 = 0.012 \text{ IN}^3$
 $f_b = 751/0.012 = 62,583 \text{ PSI NG}$

TRY $3/4" \phi$ ROD $s = \pi (0.75)^3/32 = 0.0414$

$f_b = 751/0.0414 = 18,132 \text{ PSI OK}$

USE $3/4" \phi$ ROD

TOP BEAM W4X13 (WEAK AXIS)

SPAN = 28"

$M = P L = 250 (5.25) = 1313 \#-IN$

$f_b = 1313/1.90 = 691 \text{ PSI}$

$F_b = 0.75 F_y = 0.75 (36) = 27.0 \text{ KSI}$
 $= 27,000 \text{ PSI} > 691 \text{ OK}$

$R = 500/2 = 250 \#$

CHECK CONNECTION:

NUMBER OF BOLTS/CONNECTION = 4

BOLT SIZE = $1/2" \phi$

LOAD/BOLT = $250/4 = 62.5 \#$

ASSUME GRADE 2 BOLTS (A307)

A_{BOLT} = $\pi (0.5)^2/4 = 0.1963$

ALLOW. SHEAR = $0.1963 (10 \text{ K}) = 1.9 \text{ K} = 1900 \#$

 $> 62.5 \# \text{ OK}$

VERTICAL COLUMN W4X13:

$l = 25" \quad K = 2.0$

$Kl = 25 (2.0) = 50" = 4.17'$

FROM P3-33 AISC MANUAL:

ALLOW. LOAD @ $Kl = 5' = 67 \text{ K} = 67,000 \#$
 $> 250 \# \text{ OK}$

CHECK STABILITY ($P_H = 25 \#$)

$M = 25" (25 \#) = 625 \#-IN$

$L_c = 4.3" > 25"$

$F_b = 0.66 F_y = 0.66 (36) = 24 \text{ KSI} = 24,000 \text{ PSI}$

FLARE LAP

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$$f_b = 625/1.90 = 329 \text{ psi} < 24,000 \text{ psi} \quad \underline{\text{OK}}$$

ANGLE BRACKET:

$$\text{TENSION LOAD} = 625/4.06 = 154 \#$$

$$\text{ALLOWABLE TENSION} = F_b = 20 \text{ ksi (TAB. 1-2 p 4-3}$$

$$20(0.1963) = 3.9 \text{ k/BOLT (AISC)}$$

$$= 3900 \#/\text{BOLT} > 154 \# / 2 = 77 \#/\text{BOLT}$$

LONG H 4x13 BEAM:

$$L = 107.5 \text{ ft} \quad P = 250 \#$$

$$M = PL/4 = 250(107.5)/4 = 6719 \# \cdot \text{ft}$$

$$f_b = 6719/5.46 = 1231 \text{ psi}$$

$$F_b = 0.60 F_y = 0.60(36) = 21.6 \text{ ksi} = 21,600 \text{ psi} > 1231 \text{ psi} \quad \underline{\text{OK}}$$

$$\text{SHEAR} = (250/2)/3.83 = 33 \text{ psi}$$

$$F_v = 0.40(F_y) = 0.40(36) = 14.4 \text{ ksi} = 14,400 \text{ psi} < 33 \text{ psi} \quad \underline{\text{OK}}$$

PHASE SEPARATOR SUPPORT

