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ENGINEERING NOTE

AUTHOR	DEPARTMENT	LOCATION	DATE
P. PURGALIS	MECHANICAL	BERKELEY	1-20-81

PROGRAM - PROJECT - JOB
 PEP-4 P. Purgalis

MAGNET COLE 2-13-81

TITLE
 POLE BASE TO MAGNET LEG ATTACHMENT BOLTS

CALCULATIONS ARE SHOWN FOR THE POLE BASE TO MAGNET LEG ATTACHMENT BOLTS.

THE 1 3/4 - 5 UNC BOLTS HAVE TO BE TORQUED TO 1200 FT-LB TO GIVE SUFFICIENT PRELOAD SO THAT THE POLE BASE WILL NOT LIFT OFF THE MAGNET LEGS WHEN THE TR IS PRESSURIZED TO 150 PSIG

REFERENCE DRAWINGS

<u>DESCRIPTION</u>	<u>DRAWING No.</u>
MAGNET LEG ASSY	19C2346
POLE BASE AND POLE TIP ASSY SOUTH	19C2866
" " " " " NORTH	19C2776
POLE BASE PART 1 SOUTH	19C1546
" " " " NORTH	19C0696

CALCULATIONS

WHEN TRC IS PRESSURIZED TO 150 PSIG THE TOTAL FORCE ACTING ON THE POLE TIP ASSY

$$W = P \frac{\pi D^2}{4} = \frac{150 \text{ PSI} \pi (90^2)}{4} = 954,300 \text{ LB}$$

WHERE 90 IN IS THE O.D. OF THE SEAL RING GROOVE

ENGINEERING NOTE

P40200

M5679

4 of 5

AUTHOR

DEPARTMENT

LOCATION

DATE

P. Purgalis

Mechanical

Berkeley

1/20/81

COMBINING DIRECT TENSION & BENDING

$$\text{BOLT STRESS} = 21.04 + 1.5 = 22.5 \text{ ksi}$$

$$\text{BOLT YIELD} = 153 \text{ ksi} \quad \leftarrow \text{F.S.} = 6.8$$

O.K.

REQUIRED PRELOAD SO POLE BASE WILL NOT LIFT
OF LEGS WHEN TPC IS PRESSURIZED

FROM SHIGLEY "MECHANICAL ENGINEERING DESIGN" 3RD ED
MCGRAW HILL PP 241

$$\text{PRELOAD } F_p = \frac{K_m P}{K_b + K_m}$$

P = EXTERNAL FORCE ON BOLT

K_m = POLE BASE STIFFNESS

$$K_m = \frac{\pi [(3 \times 1.75)^2 - 1.75^2] 30 \times 10^6}{4 (11.38)} = 5.07 \times 10^7 \frac{\text{LB}}{\text{IN}}$$

$$= \frac{AE}{L} = \frac{\pi D^2 E}{4L}$$

$$K_b = \frac{\pi (1.75)^2 30 \times 10^6}{4 (11.38)} = 6.3 \times 10^6 \frac{\text{LB}}{\text{IN}}$$

K_b = BOLT STIFFNESS

$$= \frac{\pi d^4 E}{4L}$$

$$P = \frac{954 \text{ K}}{24 \text{ BOLTS}} = 39.8 \text{ K}$$

$$D = 3d$$

$$\frac{K_m P}{K_b + K_m} = \frac{5.07 \times 10^7 39.8 \text{ K}}{(6.3 \times 10^6 + 5.07 \times 10^7)} = .89 (39.8) = 35.4 \text{ K}$$

USE 40 K FOR PRELOAD

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$$\begin{aligned} \text{RESULTANT BOLT LOAD} &= \frac{K_b P}{K_b + K_m} + F_i \\ &= \frac{6.3 \times 10^6 \cdot 39.8^k}{(6.3 \times 10^6 + 5.07 \times 10^7)} + 40^k = \underline{44.4^k} \end{aligned}$$

TORQUE REQUIRED TO GET 40^k PRELOAD

$$T = .2DP$$

$$T = .2(1.75) 40000 \text{ LB} = 14,000 \text{ IN-LB}$$

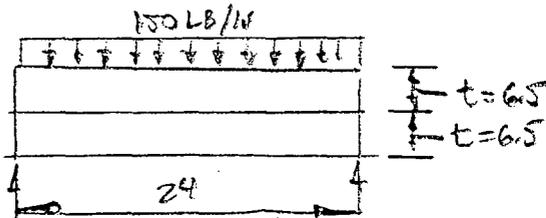
$$\text{OR } \boxed{1200 \text{ FT-LB}}$$

IF BOLTS ARE NOT TORQUED THEY WILL ELONGATE
AND THE POLE BASE WILL SEPARATE FROM THE
MAGNET LEGS

CHECK ELONGATION $\Delta L = \epsilon L = \frac{\sigma}{E} L = \frac{21,040 \text{ PSI}}{30 \times 10^6 \text{ PSI}} \times 11.38 \text{ IN} = .008 \text{ IN}$

THERE ARE SHIMS AROUND EACH BOLT HOLE. THE SHIM
THICKNESSES ARE DIFFERENT WITH MAX BEING ABOUT .125 IN

CHECK DEFLECTION OF POLE BASE WHEN MAGNET IS
TURNED ON. MAGNET FORCE $\cong 150 \text{ PSI}$



$$\text{FOR } t = 6.5 \text{ IN}$$

$$I = \frac{bh^3}{12} = \frac{1(6.5)^3}{12}$$

$$= 22.9 \text{ IN}^4$$

$$\Delta_{\text{max}} = \frac{5W L^4}{384 EI}$$

$$= \frac{5(150 \text{ LB/IN})(24 \text{ IN})^4}{384(30 \times 10^6 \frac{\text{LB}}{\text{IN}^2}) 22.9 \text{ IN}^4} = \underline{.00094 \text{ IN}}$$

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LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720