

BROOKHAVEN NATIONAL LABORATORY

MAGNET DIVISION NOTES

Author: R. Gupta, S. Kahn and P. A. Thompson

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No: 429-16 (RHIC-MD-140)

Task Force: RHIC

Title: Tie Rods in RHIC 130mm Quadrupole

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Tie Rods in RHIC 130mm Quadrupole

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1. End Forces

- Quench Current 8000 Amp.
- Stored Energy 124 kJ/m.
- End Force 124 kN = 27800 lbs.
- Cross Section Area 4 x 5/8" diameter =1.227"
- Elongation (3.4 meter long, 5/8" diam. rods) = 2.5 mm (0.100").
- Max Load per bolt = 6800 lbs.
- Safe Working Load 1/2" NF thread 9,000 lbs.

CONCLUDE: 5/8" diam rod is marginal? due to elongation under magnetic load.

2. Magnetic Effects

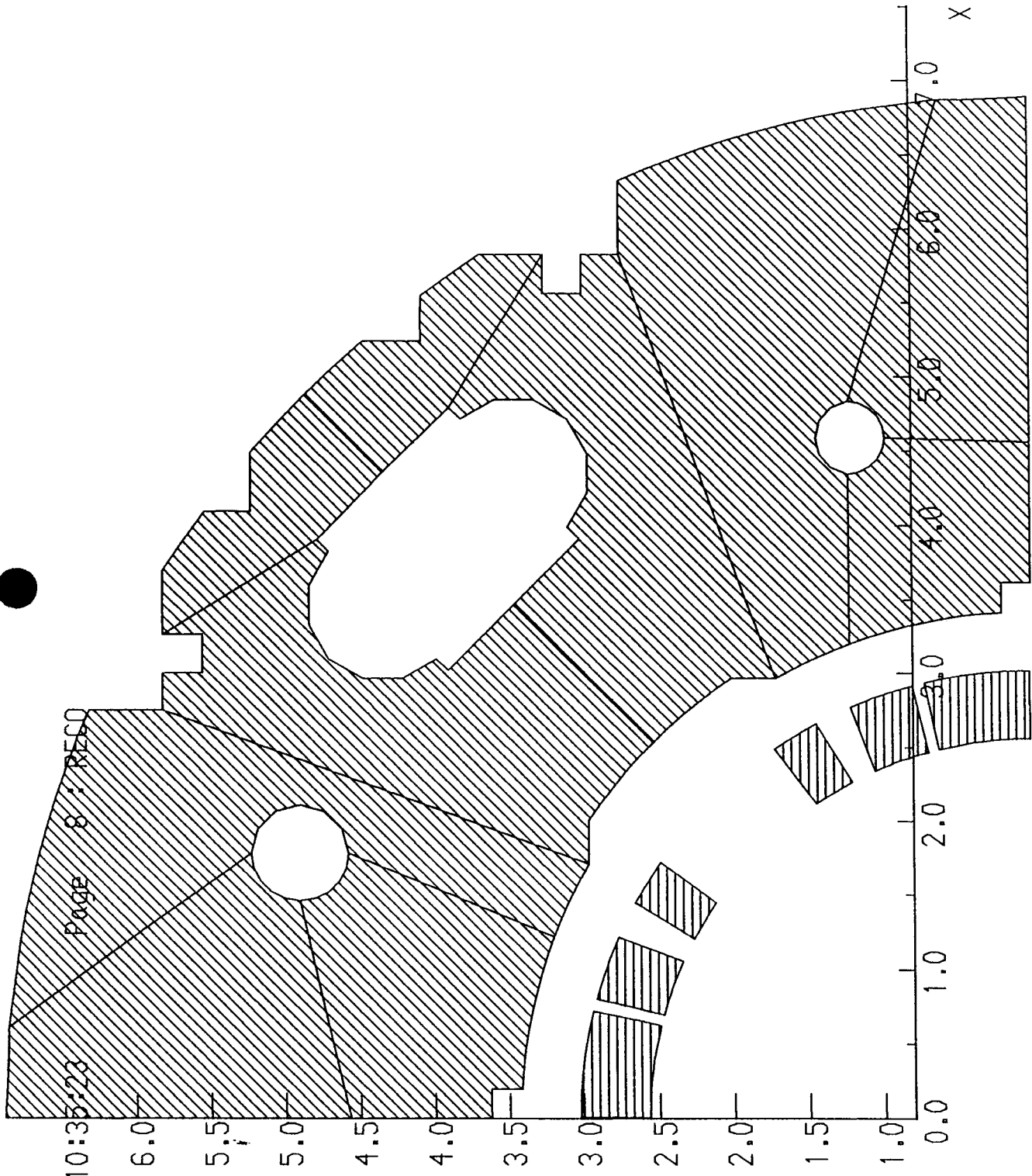
Table 2.1 summarizes the magnetic effects of the tierod. The significant effect of adding a non-magnetic tierod is to introduce a b3 term. This can be partially compensated by changing the shear pin from steel to stainless steel in conformity with the dipole design. Additional compensation is obtained by moving the tierod outward $\sim 0.25''$. This is the configuration designated R=5.2. It is shown in Fig. 2.1 and the details of the holes for the pin and the tierod are given in Table 2.2.

Table 2.1: b3 vs current as function of configuration

| Current(A) | Pin=Fe Tie=Fe | Pin=SS Tie=FE | Pin=Fe Tie=SS | Pin=SS Tie=SS | R=5.2 |
|------------|---------------|---------------|---------------|---------------|--------|
| 1 | -0.003 | -0.007 | | | -0.004 |
| 1000 | -0.001 | -0.006 | 0.004 | 0.000 | -0.003 |
| 2000 | -0.001 | -0.006 | | 0.001 | -0.003 |
| 3000 | -0.003 | -0.011 | 0.012 | 0.004 | -0.003 |
| 4000 | -0.002 | -0.026 | | 0.008 | -0.006 |
| 5000 | -0.006 | -0.066 | 0.137 | 0.074 | -0.012 |
| 6000 | +0.006 | -0.320 | | 0.445 | +0.062 |
| 7000 | +0.006 | -0.750 | 2.241 | 1.426 | +0.082 |
| 8000 | +0.004 | -1.775 | | 2.438 | +0.283 |
| 9000 | +0.004 | -2.476 | 5.013 | 2.363 | +0.178 |

R=5.2 uses SS pins and tie rods with the
tie rods at a radius of 5.2"

Figure 2.1: QRI (130 mm) Quadrupole Cross Section



VF

ELEM=QUAD SYMM=XY SOLN=AT SCALE=1.0 FIEL=MAGN
 Mesh 8592 Elements 58 Regions 2 Symmetry pairs

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Y [INCH]

X

Table 2.2: Tie Rod and Pin Holes

| Element | Diam(inch) | x(inch) | y(inch) |
|---------|------------|---------|---------|
| PIN | 0.50 | 4.59 | 1.22 |
| TieRod | 0.65 | 1.79 | 4.91 |

Pin is assumed to be Stainless Steel

Diameters are hole diameters

x,y are center locations

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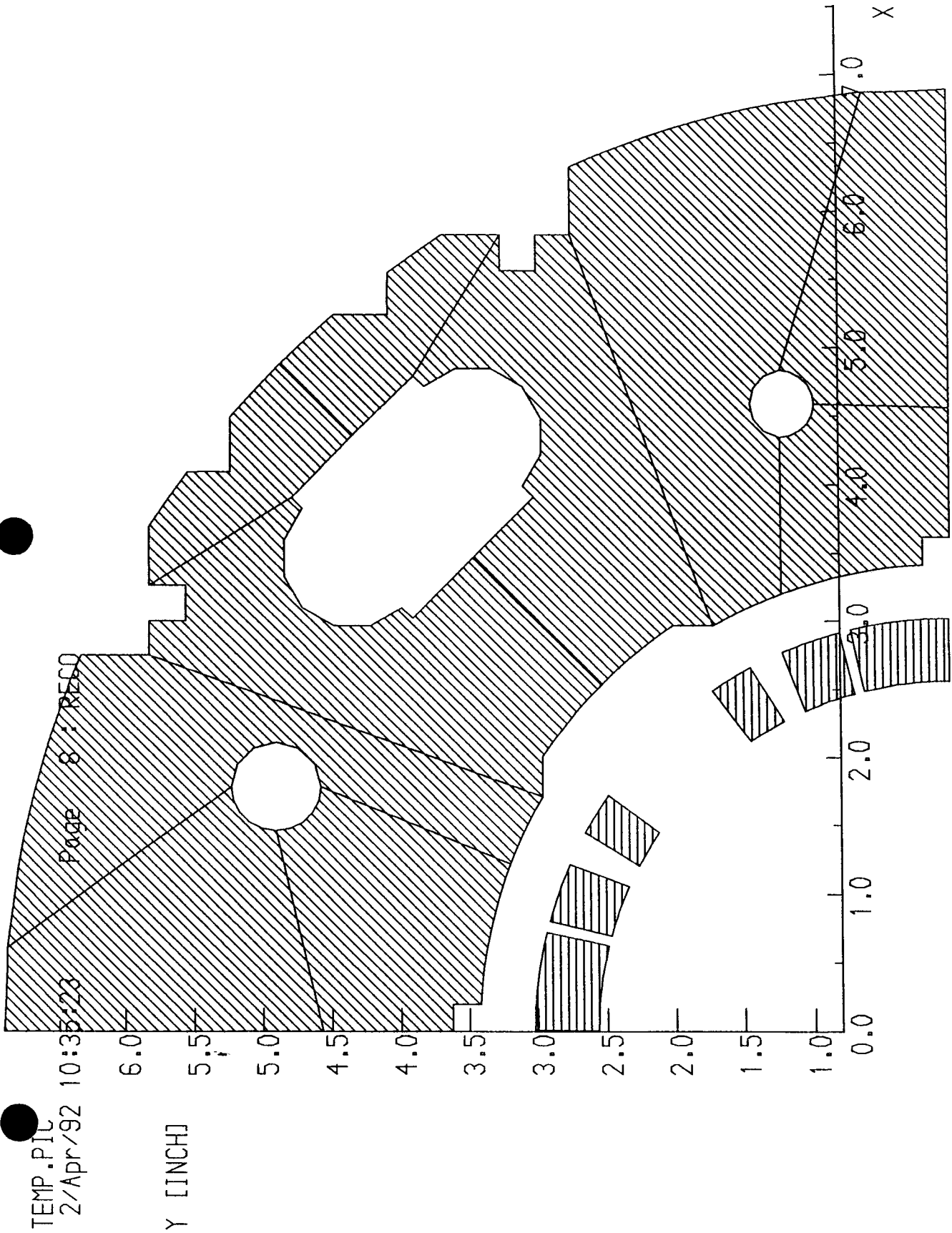
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