SSC-Note-122
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MEMORANDUM

To: File

From: T.E. Toohig

Subject: Beam Perturbation by a Radiated Field from 35 KV Power Feeders in the SSC Tunnel.

Gerry Tool with Dan Wolfe have looked at the question of beam perturbation from a radiated field from 35 KV electrical feeders in the SSC tunnel. (See the attached figure.) They concluded that at worst the effective field would be of order one Gauss.

Two possibilities were examined, an imbalance among the three phases resulting in a net current, and the residual effect of the separation of the conductors with consequent different distances to the beam. The basic relationship involved is that for a field around a wire.

$$B = \frac{\mu_o}{\pi}\frac{I}{r}$$

For the three-conductor case (three phases)

$$\boxed{B_{tot} = \frac{\mu_o}{\pi}\left(\frac{I_1}{r_1} + \frac{I_2}{r_2} + \frac{I_3}{r_3}\right)}$$

<u>Case 1: Phase imbalance</u>

$$B_{tot} \approx \frac{\mu_o}{\pi} I_{net} \left(\frac{1}{r_{ave.}}\right)$$

Assume: $I_{net} = 75A$, $r_{ave.} = 2' = 61$ cm

$$B_{tot} = \frac{(0.4\pi \text{ G-cm/A})}{\pi} \times \frac{75A}{61 \text{ cm}}$$

$$= 0.5 \text{ Gauss, rms}$$

$$= 0.707 \text{ Gauss, peak}$$

Case 2. Spatial separation of conductors

$$B_{tot} = \frac{\mu_o}{\pi} \left(\frac{I_1}{r_1} + \frac{I_2}{r_2} + \frac{I_3}{r_3}\right)$$

Assume: $I_1 + I_2 + I_3 = 0$ (no imbalance)

$$r_2 = K_2\, r_1, \quad r_3 = K_3\, r_1$$

$$B_{tot} = \frac{\mu_o}{\pi r} \left(I_1 + \frac{I_2}{K_2} + \frac{I_3}{K_3}\right)$$

$$= \left[\frac{\mu_o}{\pi r_1} \quad I_1 + I_2 + I_3 - \left(\frac{K_2 - 1}{K_2}\right) I_2 - \left(\frac{K_3 - 1}{K_3}\right) I_3\right]$$

$$= -\frac{\mu_o}{\pi r_1}\left[\left(\frac{K_2 - 1}{K_2}\right) I_2 + \left(\frac{K_3 - 1}{K_3}\right) I_3\right]$$

Let: $r_1 = 2'$, $r_2 = r_1 (K_2 = 1)$, $r_3 = r_1 + 2" = 26"$ $\left(K_3 = \frac{26}{24} = 1.0833\right)$

$$B_{tot} = \frac{\mu_o}{\pi r_1} \left(7.69 \times 10^{-2} I_3\right)$$

Assume: $I_3 = 750$ A rms, 1100 A peak

$$B_{tot} = \frac{0.4\ \pi}{\pi} \times \frac{81.6A}{61\ cm}$$

$$= 0.53 \text{ gauss}$$

Summing over both cases

$$\boxed{B_{tot} = 0.707 \text{ gauss} + 0.53 \text{ gauss} = 1.2 \text{ gauss}}$$