Attachment G

"Radiation Dose on the 8 GeV Beam-line Berm due to Sight Riser", C. M. Bhat (February 14, 1997)

Radiation Dose on the 8 GeV Beam-line Berm due to Sight Riser

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The survey riser penetrations and their vicinities all along the 8 GeV beam line are one of the potential regions of interest from the radiation safety point of view. In this report we address such locations and their radiation shielding.

The elevation of the berm on the 8 GeV beam line tunnel is about 746 ft with soil equivalent shielding $>$ 24.5 ft. Along the beam line there are four survey riser penetrations which are 12 in dia. Three of these have similar structure. Fig.1 shows a schematic view of one of such survey riser. The one at the intersection of AP2 and 8 GeV beam line tunnels, shown in Fig.2, penetrates through the shielding iron above 8 GeV beam line as well as AP2 beam line tunnels.

To estimate the radiation doses at the berm level we assume the 8 GeV beam loss scenarios explained in the **Main Injector Preliminary Safety Analysis Report**[1] according to which one expects

1.0×10^{19} 8GeV proton losses per year from operational conditions and

5.7×10^{16} 8 GeV protons per accident loss.

Also, we assume that these losses are localized near the penetration. We use computer code CASPEN to estimate the attenuation of radiation dose for straight penetrations and combination of results from CASPEN [2] and EXIT2A [3] at the intersection of AP2 and MI- 8 GeV beam lines.

The estimated radiation doses at the berm level in the vicinity of unfilled survey riser with structure shown in Fig. 1 are listed in Table I. These doses are much larger than allowed limits of 0.025 mrem/hr for operational beam losses and 1 mr per accident [4]. Hence we should fill up the sight risers. (the expected radiation dose with sight risers filled up using poly beads are also given in Table I for comparison).

At the intersection of the AP2 and 8 GeV beam line we have slightly different case. The radiation dose over the berm will be the net effect of dose rate arising from 8 GeV beam loss and AP2 or AP3 beam loss. There are three scenarios of beam losses : a) operational beam loss in the 8 GeV beam line and accidental beam loss in the AP2 tunnel, b) accidental beam loss in the 8 GeV beam line (with no beam in the AP2 beam line) and c) operational beam losses in both the beam lines. We have to address these individually.

In our previous work [5] have shown that the dominant beam in the AP2 beam-line during pbar stacking is pion and the maximum beam loss during accidental condition is estimated to be about **1.2E14 pi(-) @ 8GeV**. (We define a continuous beam loss at a point for one hour as accidental beam loss in this case). The operational and the accidental beam loss cases in the 8 GeV beam-line are similar to one mentioned earlier.

The estimated radiation doses corresponding to the AP2 and 8 GeV intersection region are also listed in the Table I. We find that the contribution from the 8 GeV beam line loss is comparable to the one arising from the AP2 beam line losses. Notice that the AP2 beam line tunnel acting as a void in the straight penetration of survey riser (in contrast to the survey riser shown in the Fig.1) is helping the low energy neutrons to defuse and in reducing radiation dose at the surface. However, even at this location the dose is not below acceptable limits of no occupancy limits.

Recommendations:

To achieve the radiation dose level in accordance with no occupancy limits for both operational as well as accidental beam loss conditions all the sight rises should be filled with soil or polyethylene beads.

Table 1: Radiation levels at the surface in the vicinity of sight risers due to the beam losses in the MI-8 and/or AP2 beam lines during Main Injector era. (The radiation levels estimated for sight risers filled up with poly beads are also listed for comparison).

Location of Survey Riser	Distances in ft	Attenuation in each leg	Radiation Dose at the Surface (mrem/particle)	Dose Rate
Elsewhere in the MI-8GeV Beam-line:	R1=5.6 L1 = 24.5 (W=H=0.886 ft		2.02E-14* 1.4E-18* (with poly beads)	34 mrem/hr 1.2rem/acc. ≪0.025 mrem/hr ≪1 mrem/acc
AP2 and 8 GeV Beam-line Intersection: From AP2 Losses	R = 4.0 L1 = 13.0 (W=H=0.886 ft)		1.6E-13* 5.8E-16* (with poly beads)	19mrem/acc ≪1.0 mrem/acc
From MI 8 GeV Beam loss	R1=5.6 L1 = 4.5 R2 = 8.0 L2 = 13.0	1.68E-5 4.1E-3	3.0E-17@ 3.5E-18 (with poly beads)	0.05 mrem/hr 1.7 mrem/acc. ≪0.025 mrem/hr ≪1 mrem/acc.

* CASPEN, @ Combination of CASPEN and EXIT2A: For L1 we use CASPEN and R2 and L2 we use EXIT2A.

References

1. Fermilab Main Injector Priliminary Safety Analysis Report, 1992

2. A. Van Ginneken, CASPEN code.

3. R. Rameika, EXIT2A code.

4. Fermilab Radiological Control Manual

5. "Radiation Levels in the Intersection Region of the 8 GeV and AP2-Beam-lines due to Beam Losses in the AP2 Beam-line", C.M. Bhat and P.S. Martin, MI-0148, (1995).

8 GeV Beam line Sight Riser

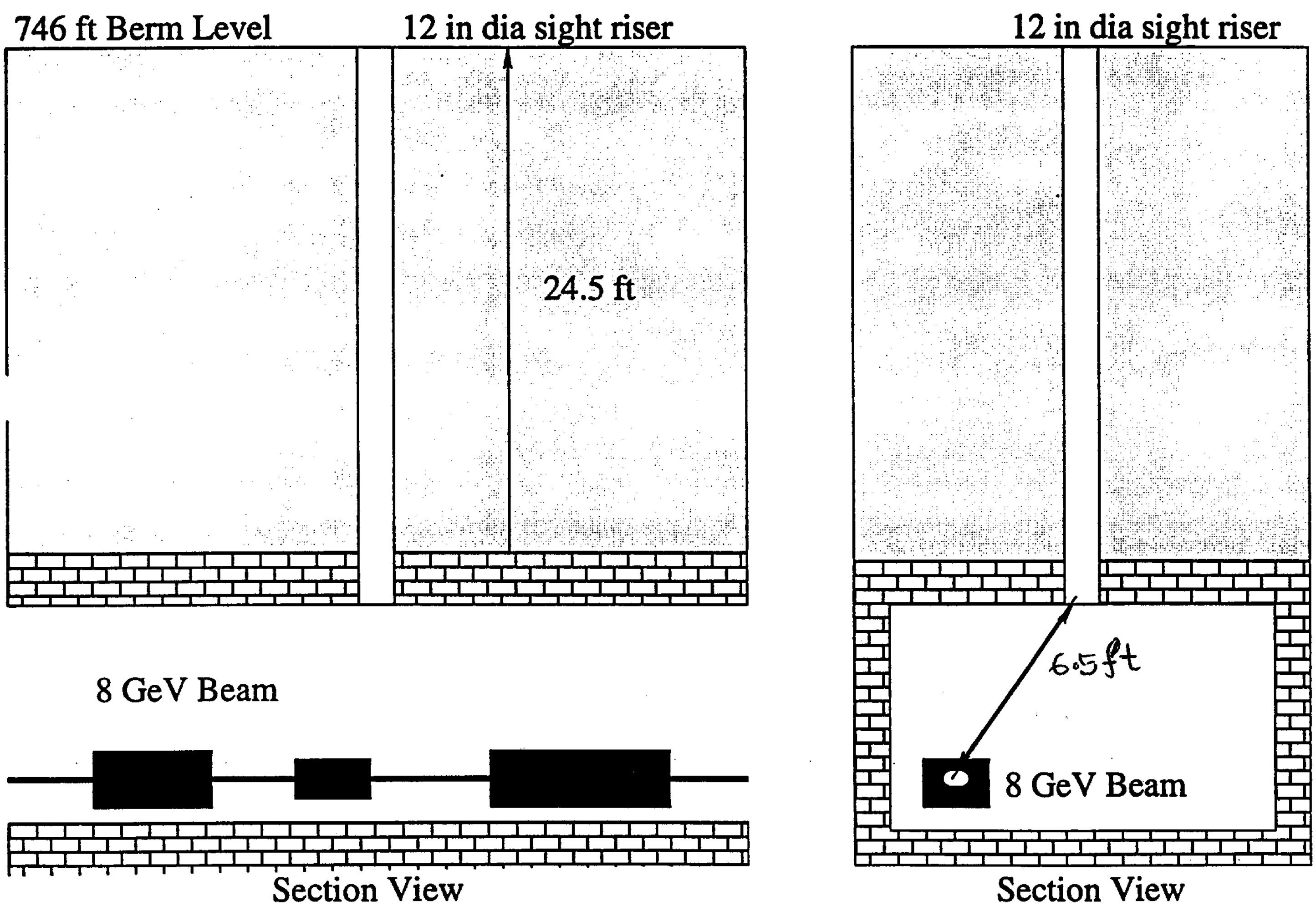

Fig. 1

8 GeV and AP2 Beam line Crossover