MI-0253

Radiation Dose Rate Measurement at Tevatron Wave Guide Penetrations at FØ Service Building due to 8 GeV Proton Beam Loss

A.F. Leveling

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A. Introduction

Eight Tevatron RF cavity wave guides connect RF power supplies in the FØ service building to the Tevatron RF cavities in the FØ straight section of the Tevatron enclosure. The design of the eight penetrations included radiation shielding both at the tunnel and service building ends. Tevatron RF installation work during commissioning of the Main Injector and Main Ring Remnant precludes installation of the design shielding. The purpose of this measurement is to determine a protection scheme which may be used in lieu of installation of the design shielding. In addition, this is an opportunity to compare the measurement with the calculation used to arrive at the penetration shielding design.

B. Measurement

A Chipmunk (ion chamber) was installed at each of the eight wave guide penetrations in the FØ Service Building. The detectors were connected to the site-wide MUX system and were data-logged in Lumberjack, the Beam Division Control System logger.

A number of attempts were made to establish losses at 8 GeV in the P150 line upstream of the FØ Lambertsons. Losses were deliberately established at 712 which is located within the region beneath the penetrations so that a peak could be observed within the Chipmunk array. The settings used to arrive at this peak are included in Figure 1.

A time line was established to increase intensity sufficiently to ensure reasonable detector response. A total of 3.9E13 protons were delivered to 712 in the P150 line over a one of minute period. The data collected in this measurement is included within the spreadsheet labeled Figure 2. The results normalized to 5.4E15 protons per hour are also displayed in a chart labeled Figure 3.

```
            dej SET              D/A      A/D     Com-U tCOPIES.
TIME        Y=G:RA2232,G:RA2233,G:RA2234,G:RA2235
0              I= 0 ,              0 ,           0 ,          0
900            F= 3 ,              3 ,          3 ,          3
               ........................150.pb/ext


           0
           0
           0
        -.996
           0
          15
           0


         1              .012     Amps ......... .
         1              .007     Amps ........ .
         1              .007     Amps ......... .
         1             -.711     Amps ........ .
         1              .004     Amps .T .
         1              .029     Amps .T .
         1              .001     Amps ......... .


                       -.001     Amps
                       -.008     Amps
                       -.043     Amps
                        .367     Amps
                       -.036     Amps
                       5.114     Amps
                       -.038     Amps
 17.55      .549        .625     Amps D.
   .875      10


                       48.53     SEC
                         0       lE12
                        .001     E12
                       -.01      E12
                       -.004     E12
```
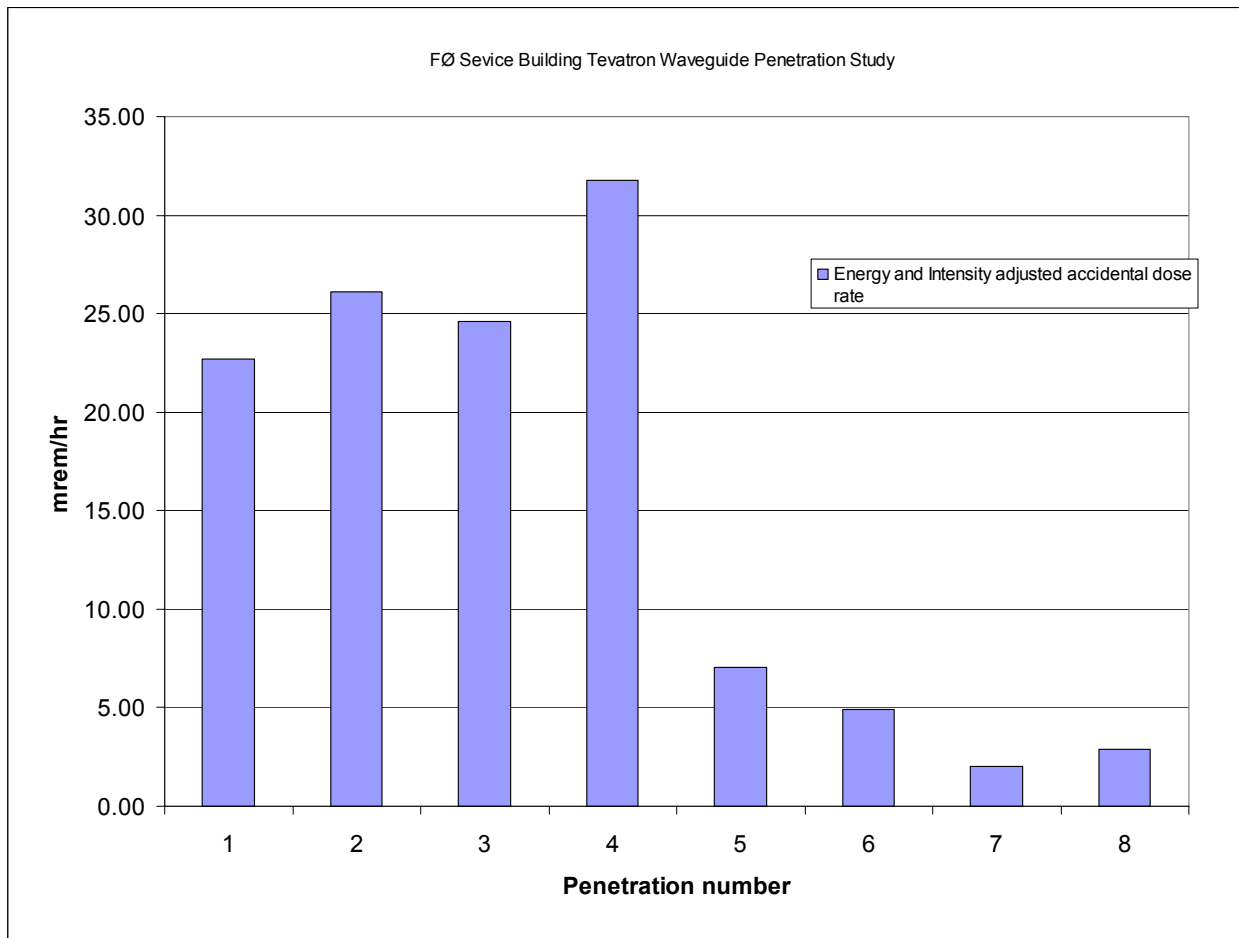
Figure 1

X1	G:RD2228	G:RD2229	G:RD2230	G:RD2231	G:RD2232	G:RD2233	G:RD2234	G:RD2235
Penetration number	1	2	3	4	5	6	7	8
Thu Jan 28 10:40:57	1.65	1.65	1.35	1.95	0.90	0.75	0.90	0.75
Thu Jan 28 10:41:57	0.75	0.90	1.05	0.90	0.60	0.60	0.60	0.75
Minute 1	11.00	11.00	9.00	13.00	6.00	5.00	6.00	5.00
Minute 2	5.00	6.00	7.00	6.00	4.00	4.00	4.00	5.00
Total Gross Counts	16.00	17.00	16.00	19.00	10.00	9.00	10.00	10.00
number of samples	2	2	2	2	2	2	2	2
background average cpm	4.36	4.31	4.05	4.41	3.87	3.71	4.68	4.53
Total Net Counts	7.29	8.38	7.90	10.19	2.27	1.58	0.64	0.93
Beam Intensity for run number of pulses	28	28	28	28	28	28	28	28
Intensity per pulse	1.35E+12	1.35E+12	1.35E+12	1.35E+12	1.35E+12	1.35E+12	1.35E+12	1.35E+12
Total protons in study	3.78E+13	3.78E+13	3.78E+13	3.78E+13	3.78E+13	3.78E+13	3.78E+13	3.78E+13
Desired Intensity (p/h)	5.40E+15	5.40E+15	5.40E+15	5.40E+15	5.40E+15	5.40E+15	5.40E+15	5.40E+15
Counts normalized to desired intensity	1041	1197	1129	1456	324	225	92	133
Adjusted for Energy (8 GeV to 120 GeV)	9087	10445	9849	12703	2826	1967	803	1164
Energy and Intensity adjusted accidental dose rate (mrem/hr)	22.72	26.11	24.62	31.76	7.06	4.92	2.01	2.91

Figure 2

Figure 3

C. Calculation

A calculation was made to determine the dose rates at the end of the FØ penetration due to 8 GeV proton beam loss[1]. The result of this calculation is 7.3 E-16 mrem at the end of the penetration in the FØ service building per 8 GeV proton lost below in the FØ straight section. For a loss of 5.4 E15 protons per hour, this corresponds to a dose rate of 3.9 mrem/hr.

D. Conclusion

A calculation and a measurement have been made for the dose resulting at the FØ penetrations in the FØ service building from an 8 GeV beam loss in the FØ straight section near the entrance of the penetration. The calculation result is 3.9 mrem/hr and the measured result ranges from approximately 2 to 32 mrem/hr.

The calculation depends on empirically derived parameters taken from measurement of significantly larger cross-section labyrinths[2]. The measurement described in this paper is based on an assumed quality factor of 5. The actual dose rate may be a factor of 5 high or a factor of 2 low depending upon the actual quality factor of the field.

The vicinity of the penetrations in the FØ service building has been posted as a radiation area in order to meet the requirements of reference 3.

References

[1]   "FØ Penetrations", A Memorandum from P. Martin to S. Holmes dated 12/29/98 with attached Labyrinth attenuation spreadsheet entitled "Tevatron RF penetrations in the FØ region", dated September 1998

[2]   Radiation Physics Note 118, Approximate Technique for Estimating Labyrinth Attenuation of Accelerator Produced Neutrons, D. Cossairt, September 1995

[3]   Fermilab Radiological Control Manual.