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Radiation stops in the SEB extension

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EP & S DIVISION TECHNICAL NOTE

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RADIATION STOPS IN THE SEB EXTENSION

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The extension of the SEB into the new East Experimental Building addition will require a 6-inch penetration, at 0^{o} to F10 through the shielding between the AGS ring and primary beam cave #1, the radiation shield for Target Station A. A similar penetration will be required between primary beam cave #1 and primary beam cave #2, cf.Figure. Relevant shielding of these penetrations must be provided.

A. Access to Primary Beam Cave #1

Personnel access to Target Station A must be provided when the SEB is off, but the AGS is operating for other facilities. We intend to provide a radiation shield for the 6" opening against the possibility of accidental beam loss at F-10, sending excess radiation into primary cave #1. Considering the solid angle subtended by the 6" aperture at 1400-inches from F-10, and assuming a catastrophic loss of 10^{13} protons in a point interaction at F10, and allowing a factor of 10^{-2} in intensity due to absorption in a 4-foot steel plug, the dose at the downstream end of the aperture is of the order of 10^{-1} mrad for one pulse. In considering the significance of this level, it should be noted that this radiation is collimated within the beam pipe by some 12-feet of steel and concrete. The beam pipe is continuous in the cave, so the actual levels experienced by personnel working in the cave would be significantly lower than these.

It is assumed that radiation monitoring devices will be provided in the cave capable of turning off the circulating beam in the event that such catastrophic losses raise the radiation levels in Cave #1 above tolerable levels. Response time should be of the order of one pulse. The calculations above indicate that this response time is adequate for personnel safety.

B. Access to Primary Beam Cave #2

A potentially more serious problem is that of access to primary beam cave #2 when the SEB is being extracted onto Target Station A or into the T channel in primary cave #1. There is a possibility of the switchyard dipoles, SD1, SD2 losing current, sending the primary beam down the R-pipe to primary cave #2. The interlock conditions for entrance to primary cave #2 are that Radiation Plugs #1 and #2 must be closed and that a radiation monitor be provided in primary cave #2 capable of shutting off the extracted beam in one pulse. To evaluate the personnel hazard under these conditions we assume 10^{13} protons incident on Radiation Plug #1 with a 1-in.^{2} cross section. We further assume that both plugs are 4-foot stainless steel plugs with an 8-in. by 8-in. cross section. The factors affecting the resultant radiation levels in primary cave #2 are the attenuation of the beam due to the nuclear cascade in the two plugs plus the dilution of the beam by multiple scattering in plug #1 and subsequent diffustion in the 2000-in. drift space to plug #2. The resultant intensity in primary cave #2 is given by:

$$I = I_o \text{ X DF x } Att_2 \text{ x Aperture \#2 x } Att_2$$

Where: DF = the dilution factor due to multiple scattering in plug #1.

Att_i = the attenuation in plug #i (4.54 attenuation lengths beyond the transition region).

Aperture #2 = 6-inches in diameter

$$I = 10^{13} \times \frac{\pi}{(9.5)^2\,\pi} \times 9\pi \times 1.07 \times 10^{-2} \times 1.07 \times 10^{-2}$$

$$\approx 3.6 \times 10^8 \text{ particles/pulse}$$

The resultant dose is given by:

$$\text{Dose} = 3.6 \times 10^8 \text{ particles} \times \frac{1}{9\pi(\text{in}^2)} \times \frac{1 \text{ in.}^2}{(2.54)^2 \text{ cm}^2}$$

$$\approx \frac{2 \times 10^6 \text{ particles/cm}^2}{3 \times 10^7 \text{ particles/cm}^2\text{/Rad}} \times 1 \times \frac{1}{3}$$

using a quality factor of 1 for minimally ionizing particles and an organ factor of $\frac{1}{3}$ for the worst case of the eye.

DE $\approx$ 20 mrem/pulse for minimium ionizing

$\approx$ 38 mrem/pulse for neutrons using a quality factor of 3.5

$$DE_{total} \approx 60 \text{ mrem/pulse}$$

Again, this is well-collimated inside the pipe. Dummy pipe or fencing of some sort should be provided in primary beam cave #2 at 0° downstream of the switching dipole for target station C to keep personnel from being in the direct beam in case of the accidental failure of SD1, SD2.

Attachm/t

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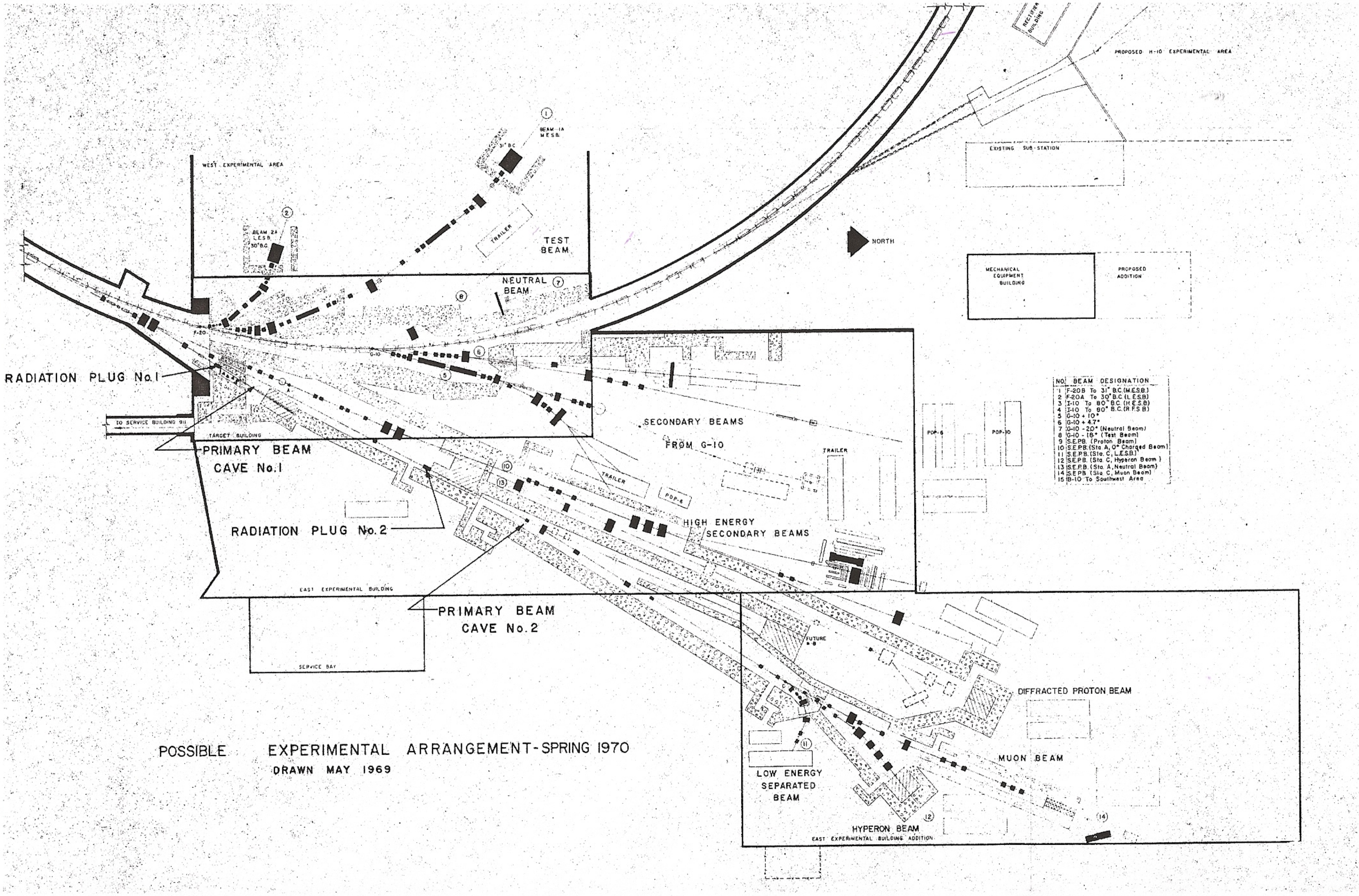

NO.	BEAM DESIGNATION
1	F-20B To 31" B.C.(M.E.S.B.)
2	F-20A To 30" B.C.(L.E.S.B.)
3	I-10 To 80" B.C. (H.E.S.B.)
4	I-10 To 80" B.C. (R.F.S.B.)
5	G-10 + 10°
6	G-10 + 4.7°
7	G-10 - 20° (Neutral Beam)
8	G-10 - 18° (Test Beam)
9	S.E.P.B. (Proton Beam)
10	S.E.P.B. (Sta. A, 0° Charged Beam)
11	S.E.P.B. (Sta. C, L.E.S.B.)
12	S.E.P.B. (Sta. C, Hyperon Beam)
13	S.E.P.B. (Sta. A, Neutral Beam)
14	S.E.P.B. (Sta. C, Muon Beam)
15	B-10 To Southwest Area

POSSIBLE EXPERIMENTAL ARRANGEMENT-SPRING 1970
DRAWN MAY 1969