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Memo

Date: *June 2, 2015*

To: *C. Gardner, RSC Booster-file, W. Fischer, P. Cirnigliaro, P. Ingrassia, P. Bergh, and R. Karol*

From: *D. Beavis* DB

Subject: *Radiation at Booster High Radiation Areas*

This memorandum addresses three areas at the Booster that are posted as High Radiation Areas. These areas are:

1. Locked fenced area of the Booster berm above building 914.
2. The area on top of the movable plug door inside building. The seam between the stationary shielding and the movable plug door is the area of concern..
3. The locked fence in front of the movable plug door.

The conclusions of this memorandum are:

1. The locked fenced area over building 914 can be reposted as a Radiation Area.
2. The top of the shielding plug near the seam with the shielding can be posted as a radiation area.
3. The radiation monitor at the plug door, NMO60 should have the interlock level changed to 20 mrem/hr and the Alarm level to 10 mrem/hr.
4. The locked fence in front of the shield plug should remain posted as a High Radiation Area.

Fenced Area

The portion of Building 914 that encloses the Booster to AGS transfer line has a locked fence that is posted as a High Radiation Area. This is historical from high intensity proton operations. The Area contains two interlock chipmunks, NMO58 and NMO59. An RCT along with the RSC Chairman entered the area during routine operations on May 26, 2015. Five locations were measured at waist height and measurements were below the minimum detectable level of 0.2 mrem/hr with an HPI 1010 integrating for 30 seconds. During this time period the Operations Coordinator ensured that protons transfer occurred at the 3.9 second repetition rate. The transferred proton intensity was about $3.0*10^{11}$ protons per transfer and is shown in Figure I.

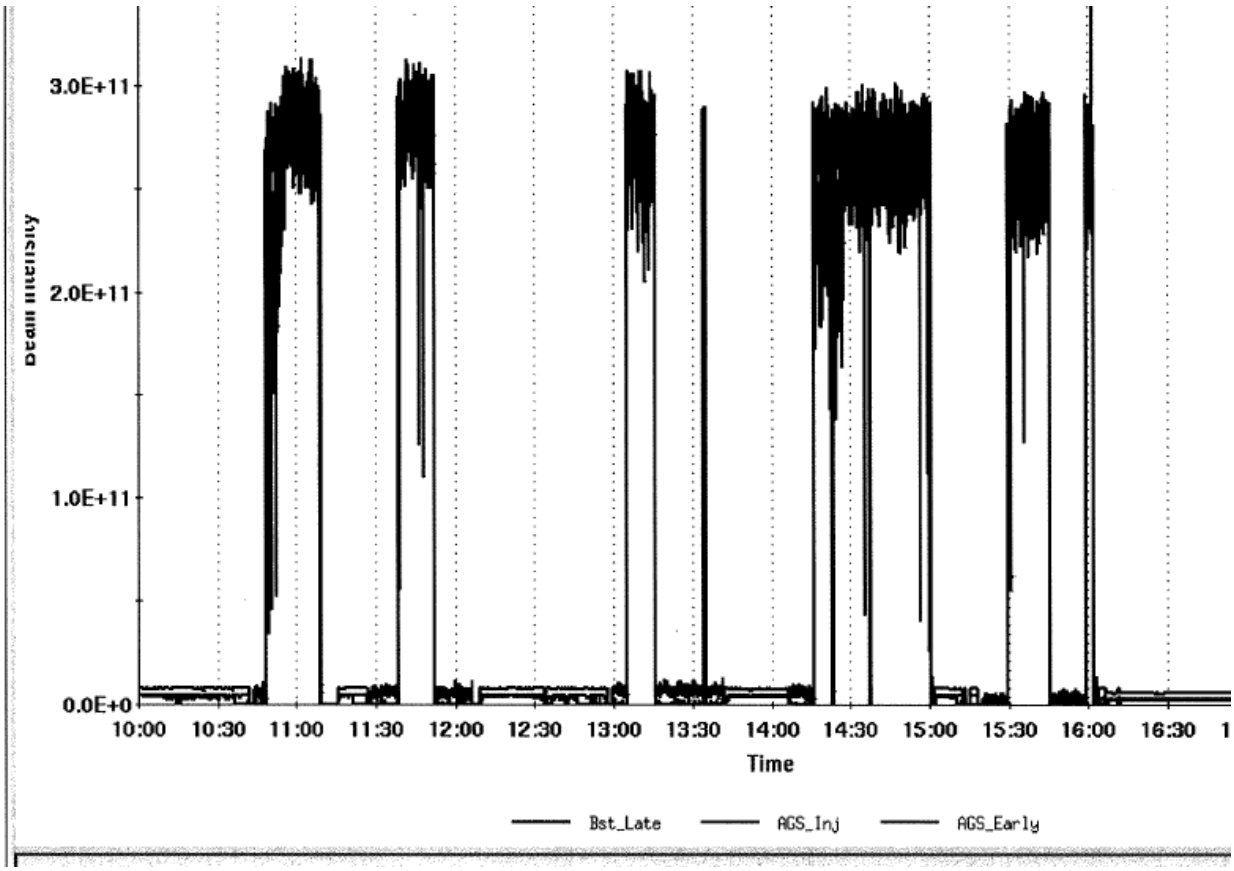

Figure I: Beam intensity in Booster and AGS. Radiation measurements were conducted during the time period about 14:30. The plot colors are not discernable in this black and white reproduction.

The chipmunks in this area have an alarm level of 40 mrem/hr and an interlock level of 50 mrem/hr. These chipmunks limit the dose rate in the fenced area as well as the AGS ring and the C fan-house. The chipmunk viewer outputs are shown in Figure II and Figure III. Both chipmunks were essentially reading background levels. For routine operations with protons the area could be reposted as a Radiation Area. The Booster ASE is $1.1*10^{18}$ GeV in one hour. The radiation measurements were conducted at an intensity that is more than 1000 times lower than the Booster ASE. In recent times the Booster has not operated near the ASE limit but if future operations require large intensity increases the area posting may need to be reconsidered.

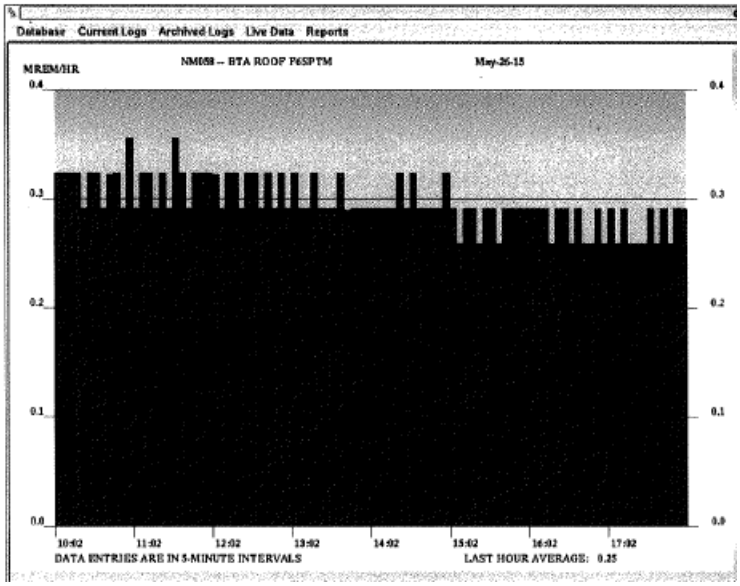

Figure II: Recorded dose rate for NMO58 over F6 septum. Dose rate is essentially at background.

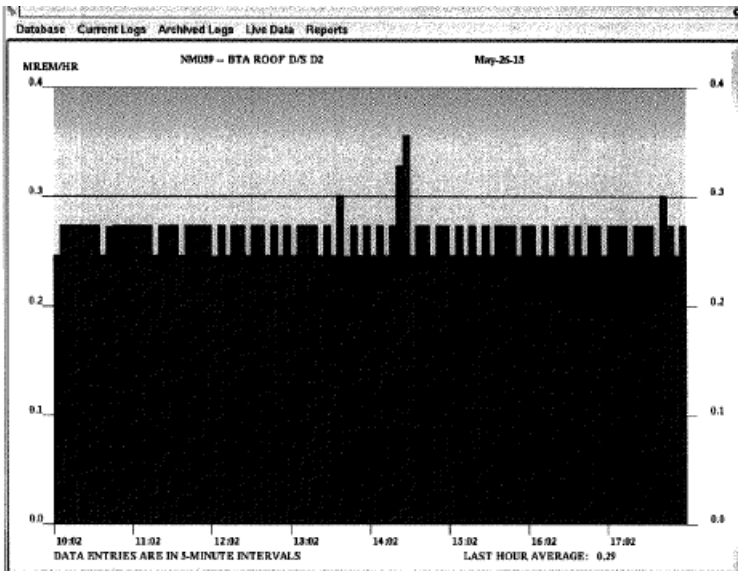

Figure III: Recorded dose rate for NMO59 downstream of D2. Dose rate is essentially at background.

Radiation Dose Rates during Beam Faults

Fault studies 6-11 were examined for beam faults in the Booster that could impact the areas being considered including the AGS ring. The Dose rates at the seam between the plug door and the shielding can be as high as 6500 mrem/hr for a loss of 10^{14}protons/sec. The NMO60 would have a reading of 150 mrem/hr. If the interlock level was lowered to 20 mrem/hr the maximum

dose rate at the seam would be less than 1000 mrem/hr and the floor crack would be less than 125 mrem/hr. Neither of these are whole body doses and the whole body dose rate would be expected to be substantially smaller. It is therefore recommended that the interlock level be lowered to 20 mrem/hr and the alarm level to 10 mrem/hr. The area near the seam could be posted as a Radiation Area. Building 914 is a Controlled Area-TLD required so local posting would be required. Reducing the interlock threshold of this chipmunk will also reduce the potential levels in the fenced area on the berm during beam faults.

The dose rates in the AGS ring can exceed several 100's of mrem/hr for full beam faults in the booster. Most of the beam faults have beam partially in the extraction channel when access is not allowed in the AGS. These were conducted to verify the shield design. Booster Fault study 11 shows that beam faults in booster magnets A2 to A4 will produce radiation levels up to 260 mrem/hr in the AGS ring. NMO59 will limit the dose rate to 9 mrem/hr and the change in NMO60 will limit it to less than 10 mrem/hr. The dose rate in the fenced area (at NMO59) will be 1600 mrem/hr although it will be stopped by the chipmunk interlock. No interlock changes are necessary for these areas.

The gate in front of the movable plug door is posted as a High Radiation Area. This posting is in place as this becomes the entrance to the Booster if the Plug door is open. It is the same posting as the man-door which cannot be used when the plug door is open. It has been desirable to leave the posting in place when the entrance is changed to the Booster tunnel. The RCD facility Representative[1] agrees with this recommendation.

[1] Private communication between P. Bergh and D. Beavis.