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Radiation

Safety Minutes of RSC Subcommittee of March 17, 2009

Committee

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Minutes of an RSC Subcommittee Meeting of March 17, 2009

Subject: The SRF gun Blockhouse

Present: D. Beavis, R. Karol, E. Lessard, A. Etkin, A. Burrill, and J. Kewisch

A review of the shielding and interlocks requirements for a small block house to conduct tests on superconducting RF electron guns was conducted. The blockhouse construction is nearly complete and was based on initial discussions between D. Beavis, A. Burrill, and J. Kewisch. A more formal review of the shielding and an initial assessment of the interlocks was started at this meeting. A plan view of the SRF in the blockhouse is shown in Figure 1. An elevation view is shown in figure 2. The blockhouse has an internal working area of about 100 ft^2 and has a single labyrinth for entrance/exit. There are several ports in the block house for utilities and an ODH exhaust fan.

Sources

The blockhouse is being constructed in building 912 near the ERL area. The shielding must reduce the generated x-rays to sufficiently low levels for the surrounding area. The sources of x-rays are field emissions from the cavity and the electron beam that will be energized and then stopped in a Faraday cup.

Andrew B. has provided numbers[1] for x-ray generation from the cavity for field emissions at Thomas Jefferson Laboratory. The maximum measured value was 45 mrem/hr. The distance was 8 feet with 1 inch of stainless steel was between the source and detector. The distance scaling provides for a dose rate of 2.9 rem/hr at a foot. Correcting for the stainless steel at 1 MeV the dose rate is about 9 rem/hr. The x-ray spectrum is most likely lower in energy, which means the dose rate is higher than estimated at 1 MeV for the steel attenuation. The dominate x-ray source for the blockhouse will be the 1 MeV electron beam striking the Faraday cup as discussed below.

A conservative dose rate for an electron beam striking a thick target is given by figure 3.5 of reference 2. The power supply has a maximum power of 150 Watts. At 1 MeV this would correspond to 4520 rads/hr at a foot. The gun is expected to provide a beam with about 10 Watts of power, which would correspond to 300 rads/hr at a foot. Either beam current generates enough radiation to require dual interlocks. The need to have a single layer of interlocks if the

photocathode was not driven did not seem to warrant additional work to justify such as mode. Therefore the area will require redundant interlocks.

Interlocks

The SRF gun area will be swept by the team developing the SRF. It was decide that a reset station inside was warranted since their attention may be focused on other activities. There appears to be no need for a crash cord or button since the area is small. The distance to the exit door is 40 feet along a simple egress path. Exiting the gate if it has been reset will crash the interlocks. **(Ck-SRF-fy09-594)**

An audiovisual warning will be required with at least 30 seconds of warning to alert personnel if the system has been made beam operational. **(Ck-SRF-fy09-595)**

The intent is to operate the cavity with a beam to understand and improve the performance of the electron gun. A request has been submitted to operate the gun as a Radiation Generating Device (RGD) and not an accelerator. An exemption from the accelerator order has been requested. If the exemption is approved then the SRF will be required to be registered as an RGD. **(Ck-SRF-fy09-596)**

There does not appear to be a need for a controlled access mode. The control of access can be managed by keys rather than badges if desired. Building 912 is posted as a radiation area in this region. **(CK-SRF-fy09-597)**

The interlocks may need to incorporate oxygen level detection, warning and activation of fans so that the area can be a class 0 ODH area. The safety section will determine the final ODH requirements.

The critical devices were briefly discussed. Two shutoff devices are required. The primary candidate is to shutoff the A.C. power to the power supply for the cavity with contactors. Turing off the laser that drives the photocathode is another possibility. Review and acceptance of the critical devices will need to be conducted. **(Ck-SRF-fy09-598)**

Shielding

The side walls of the shielding are 4 feet thick and composed of light concrete. The TVL of light concrete at 1 MeV is 40 gm/cm^2. The 48 inch thick light concrete is 7.2 TVL's. The TVLs are broad beam values so they will provide a conservative estimate for the point source. The minimum distance to the outside through the side wall shielding from either the Faraday cup of the bending magnet is 6.9 feet. The estimated dose rate for 10 Watts of electrons on a target is less than 0.0005 mrem/hr. The four feet shielding blocks were chosen for mechanical stability of the walls and it was readily available.

The shielding is a single layered wall with vertical cracks. Initial inspection indicates that care has been taken to keep the cracks small. The area around the blockhouse should be roped off for

initial commissioning and surveys to check the shielding design including the cracks. **(Ck-SRF-fy09-599)**

The roof is 28 inches thick. The minimum distance from a source through the roof is 4.7 feet. Ten Watts of beam is expected to generate a dose rate of less than 2.5 mrem/hr. Chipmunks are not required for the facility.

X-rays from the source require 2 bounces to exit the labyrinth. A simple estimation using refection coefficients suggests that the dose rate for a 10 Watt electron beam will be less than 1 mrem/hr out the labyrinth door.

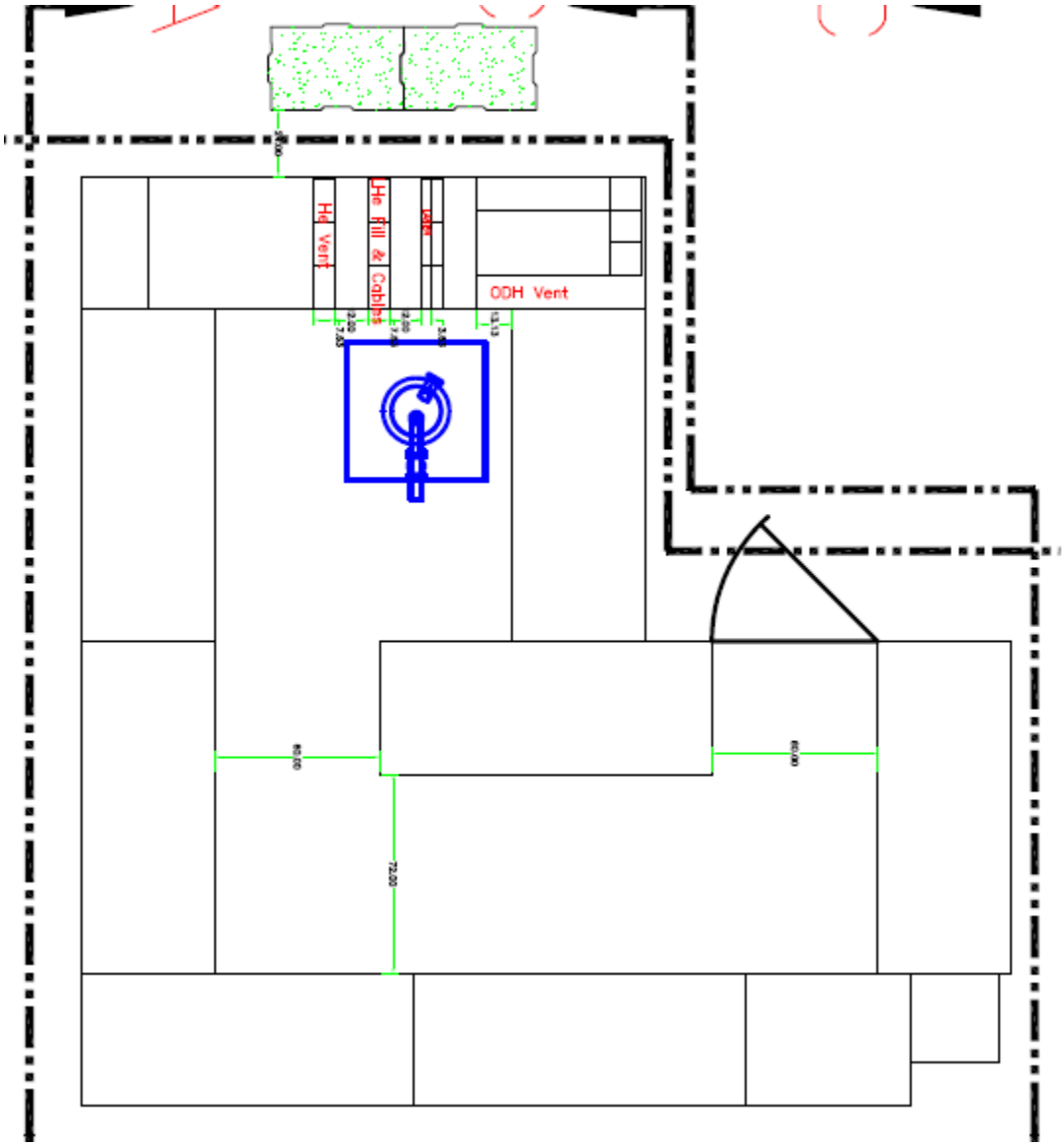

Figure 1: Plan view of the block house.

Figure 1 shows the service ports for the gun have shielding placed on the outside two feet away from the port exit. Although not shown in figure 1, the exhaust port also has a similar arrangement. There will be barriers to prevent access to the ports. **(Ck-SRF-fy09-600)**

Using Figure 2.26 of reference 3 the dose rate for 10 Watts of electrons can be estimated out the ports. The service ports are expected to have 190 mrem/hr at the exit of the ports. This area is excluded of personnel by the shield block two feet away and the side barriers. The radiation surveys will determine if the geometry of the barriers and external shielding are appropriate. The dose rate out the exhaust vent could be 120 mrem./hr at exit of the port. The same comments hold as for the service ports. **(Ck-SRF-fy2009-601)**

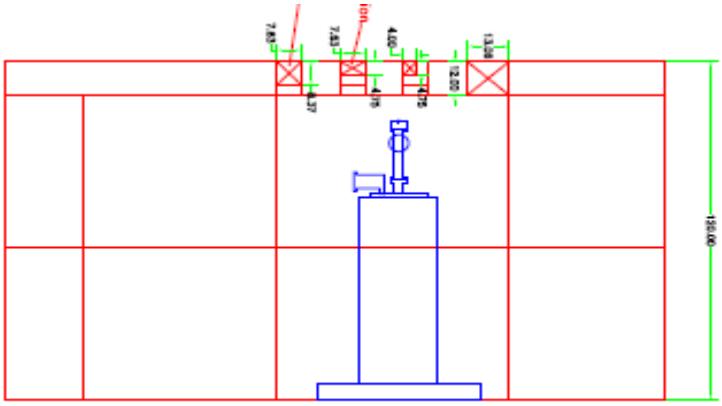

Figure 2: Elevation view of the SRF in Blockhouse.

The final posting of adjacent areas will be established by RCD after the commissioning tests and surveys. **(Ck-SRF-fy09-602)**

An appropriate set of procedures is required for operating including the sweep procedure. **(Ck-SRF-fy09-603)**

References

1. A. Burrill to D. Beavis, private communication, May 2008.
2. NCRP Report no. 144, Radiation Protection for Particle Accelerator Facilities, NCRP, 2003.
3. A.H. Sullivan, A Guide to Radiation and radioactivity Levels near High Energy Particle Accelerators, Nuclear technology Publishing, 1992.

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