C-AD

Radiation Safety Committee

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Minutes of Radiation Safety Sub-Committee of May 27, 2004

Energy Recovery Linac Experiment in Building 912

Present: L. Ahrens, D. Beavis, I. Ben-Zvi, P. Bergh, I.-H. Chiang, A. Etkin, J.W. Glenn, E. Lessard, V.Litvinenko, and K. Yip,

V. Litvinenko presented an overview of the facility and it's operation (see attachment 1).

The potential sources of radiation are the super-conducting RF electron Gun, the super-conducting RF cavities for the energy recovery linac (erl), and beam losses.

The electron gun will have an energy limit of 5 MeV. The maximum-average power of this beam is 1 MW. It is not expected that the entire beam at full current can be lost for an extended period, however no limitation was presented so it will be assumed that the entire 1 MW 5 MeV beam can be lost at fixed locations. The entire beam will be transported to the beam dump. No design for the beam dump or the potential radiation was presented.

(CK-erl-fy2005-383) Review the beam dump design to withstand the 1 MW electron beam, the associated shielding, and any potential residual activity issues.

Routine losses of the 5 MeV beam are expected to be low. In normal operations the losses of the 5 MeV beam will be dominated by the collimator. One micro-amp of beam is anticipated to be lost on the collimator. Thick target curves from NRCP Report No. 51 predict that the 1 MW of 5 MeV electrons can produce $7*10^6$ rads/hr at a meter. A few micro-amps lost on the collimator would produce approximately 50 rad/hr at a meter from the collimator inside the shielded area. The collimator is located in the transport between the gun and the first chicane. No design of this collimator was presented.

(Ck-erl-fy2005-384) Review the collimator design for the 5 MeV beam, establish loss limits, operational controls, cooling systems if used, and potential residual activity issues.

The 5 MeV beam is not intended to be transported into the 50 MeV transport after the first bend after the recovery linac. Interlocks will require design and review to prevent the transport of the 5 MeV beam past this magnet. **(CK-erl-fy2005-385)**

Project personnel stated that it would be desirable if the interlock systems prevented losses of the 5 MeV beam at ¼-1 kW. A calculation needs to be done to see if the shielding is sufficient for this size of local loss. **(Ck-erl-fy2005-386)**

There are expected to be special modes of operations for tuning the 5 MeV beam in the early stages of the experiment. This includes placing flags into the beam for tuning. The procedures and limits for these special operating modes will require review. **(Ck-erl-fy2005-387)**

Many losses/faults will be terminated by machine protection devices. The committee is not taking credit for these in the design of interlock requirements. The machine protection systems should greatly benefit the ALARA aspects of the experiment.

The machine is not expected to achieve an energy above 40 MeV, but to allow for improvements the project has requested that the review be conducted with an upper limit of 50 MeV.

The 50 MeV beam is separated from the 5 MeV beam in the chiances before and after the energy recovery linac. The maximum sustainable loss of the 50 MeV beam is 50 kW, which is the limitation of the power supply for the linac. It is

expected that the typically losses will be 1-2 micro-amps. The project stated that a limit of 100W for 50 MeV beam losses would be acceptable.

Kin Yip presented a calculation (see attachment 2), which showed that a localized 2 micro-amp beam loss at 50 MeV on the beam pipe would produce 2 mrem/hr outside the adjacent four-foot thick light concrete shielding. If the loss occurs at several locations the dose outside the shielding will be lower. The 50kW of maximum sustainable loss would generate 1.0 rads/hr outside the shielding. A method to prevent large radiation levels outside the shielding must be designed and reviewed **(Ck-erl-fy2005-388**). It is expected that this will be accomplished by an appropriate distribution of chipmunks.

It was noted that the dose potential in the forward direction may be 20-50 times higher than that of 90 degrees levels. This must be examined since it may represent a more stringent condition on the shielding design. **(Ck-erl-fy2005-389)**

The calculation conducted on a 50 MeV electrons scraping the beam pipe showed that the dose inside the shielding due to neutrons was a 1000 times lower than the photon dose. This appeared to be contrary to previous calculations (for example see attachment 3) and other numbers available in NCRP reports, which had the ratio of 10-to-1. After the meeting K. Yip conducted a series of calculations (see attachment 4) that demonstrated that MCNPX gave good agreement with these sources for thick targets (which is what they were for). For scraping on the beam pipe the neutron flux generated drops substantially below the photon dose. A determination needs to be made as to what represents the largest source for photons and neutrons. (Ck-erl-fy2005-390)

The attenuation of the neutrons in the shield needs to be verified **(Ck-erl-fy2005-391)**.

A list of penetrations needs to be generated. The attenuation of the neutron and photon dose through the penetrations needs to be reviewed. **(Ck-erl-fy2005-392)**

The trench that transverses the shielded area must have a buss block placed in it or have the attenuation calculated and a man barrier placed on the outside. **(Ck-erl-fy2005-393)**

The klystron PS needs to be reviewed for the potential to generate radiation. **(Ck-erl-fy2005-394)**

It is expected that the power supplies for the RF cavities will be used as critical devices similar to the e-cooler experiment in building 939. In addition, the laser shutter will act as a reach-back device. The interlocks and radiation detection system will be reviewed at a later date. **(Ck-erl-fy2005-395)**

The shield wall is a single layer. A specification for the size of cracks should be developed **(Ck-erl-fy2005-396).** The dose potential through these cracks should not substantially higher than the wall. The estimates conducted for the RHIC shield wall may be useful for this.

An estimate must be made of the potential dose to personnel in the experimental counting house and other areas of occupancy. **(Ck-erl-fy2005-397)**

The shield design was not approved pending resolution of several of the open issues. It is expected that another meeting will occur in a few weeks.

Attachments (file copy only):

1) V. Litvinenko, Energy Recovery Linac in Building 912, May 6, 2004.
2) K. Yip, Radiation estimates related to the energy recovery linac facility in building 912, May 25, 2004.
3) See for example A.J. Stevens, Preliminary analysis of Radiological Hazards associated with the electron test facility at RHIC, March 27, 2002.
4) K. Yip, e-mail May 28, 2004.

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