C-AD

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Radiation

Safety Minutes of Radiation Safety Committee of January 18, 2007

Committee

Subject: Water Pipe over TtB and ERL Items

Present: D. Beavis, E.T. Lessard, C. Carlson, J. Mills, S. Guthrie, A. Raphael, R. Karol, A. Etkin, I.-H. Chiang, W. MacKay, P. Bergh, N. Kling, B. Van Kuik, J.W. Glenn, V. Litvinenko , and L. Ahrens

The committee reviewed two separate issues. The plan to install a domestic water pipe over the top of the TtB tunnel was reviewed. Two issues related to the ERL area design were discussed.

Water Pipe Over TtB

A domestic water pipe is planned to be routed over the top of the TtB tunnel. There is concern for the potential to activate the water in the pipe. Calculations on the expected activity concentrations were provided in two notes (see attachments 1 and 2).

The committee recommended that the pipe be allowed to go over the top of the TtB tunnel. It was recommended, based on ALARA principles, that a minimum of 3 feet of soil remain between the pipe and the tunnel instead of the initially planned 1-foot.

The committee reviewed the methods used to calculate the expected activity concentrations that could be expected in the water pipe for deuteron running. Deuterons beams produce the highest radiation levels of any of the beams that are transported in the Tandem to Booster (TtB) tunnel and therefore represent a worst case. The calculations appear to be conservative. With unrealistic water flow conditions the activity levels are typically 10^{-4} that of the drinking water standard (DWS). With realistic flow conditions most of the activity concentrations are 10^{-5} or lower relative to the DWS.

There was concern expressed about the possible perception of allowing any activity to be created in the water pipe no mater how small. It was noted that the addition of more soil between the pipe and the tunnel would not have a large impact of the cost of the project. Based on this the committee recommended that the design have 3 feet of dirt between the tunnel and the water pipe. Three feet of soil is the required minimum shielding thickness

of the TtB berm for deuterons. This would reduce the activity concentrations by a factor of 25 based on Figure 1. of attachment 1.

These numbers can be placed in perspective to other radiation doses. The average dose on Long Island due to cosmic rays is 24 mrem/yr (Radiological Worker 1 Training Study guide). The drinking water standard is based on 4 mrem/yr if all the water a person consumes comes from the activated water supply. Based on the activity concentrations it would be expected that a person drinking the water could receive 700,000,000 times smaller yearly dose than that from cosmic rays. Put another way, the dose from drinking the water for an entire year would be equivalent to the dose from cosmic rays for $1/10^{th}$ of a second. The committee decided that the potential activity was sufficiently small.

The pipe is a ductile iron pipe with a concrete liner. The question was raised if there was any issue about activity from the water pipe. The concentration of elements in the water includes any elements that were leached from the walls of the water pipe. The concrete has about a 10% fraction of Si. A 10^{-4} concentration of Si in the water could introduce about 10^{-3} pCi of Al-27 into the water with a 2 ft/s flow rate. Any leaching from the wall of the pipe is not expected to be an issue.

The nearest building where water could be extracted from the pipe is about 400 feet away. At a flow rate of 2 ft/s this requires 200 seconds for the water to travel to the nearest extraction point. Short-lived isotopes would have a large reduction in the concentration due to this transit time. The isotope with the highest concentration, N-16, has a half-life of 7.13 seconds. The concentration would be reduced by $4*10^{-9}$ for the transit time.

DOE does not list a drinking water limit for N-16. N-16 does have an air immersion limit of 3.*10**-9 micro-Ci/ml . A crude estimate of the a drinking water limit can be obtained by comparing the air immersion limit of N-16 to an element which has both an air immersion limit and drinking water limit. The air immersion limit for C-11 is 2.*10**-8 micro-Ci/ml and the DWS for C-11 is 400,000 pCi/L. Scaling by the air immersion limit a crude estimate of the drinking water limit for N-16 would be 60,000 pCi/L. The activity concentration was estimated to be 36 pCi/L of more than 1000 times lower. If the decay of the N-16 is taken into account due to the transit time to the nearest extraction point than the activity concentration of N-16 would be 10**-7 pCi/L. The committee did not consider the N-16 to be a concern.

The committee did not see a need to use configuration control on the potential locations of the loss points. It is noted that the calculations were conducted assuming the water pipe is at the peak of the neutron flux distribution relative to a local loss point. In reality the closest point is presently 12 meters away and a reduction of 100 is expected.

ERL Inner Shield Wall

The ERL facility has a four-foot thick light concrete wall. This wall does not provide sufficient shielding for the forward radiation from 25 MeV electron beam losses. Various

schemes have been tried in the past to supplement the outer wall. Attachment 3 discusses a scheme to shadow most of the outer wall by an inner wall of 2 feet of heavy concrete or steel. For a 50 kW beam loss the maximum dose rate outside the shielding is expected to be 15 rem/hr. Normal operations are expected to have values 1000 to 100,000 times lower.

The committee was asked to approve the general approach and not the specific details, which will be reviewed at a later meeting. The committee found the approach was reasonable and although the worst-case levels are higher than desired, the committee expects they are conservative and in reality will be lower. The area will have multiple chipmunks distributed around the facility, which should be able to detect beam faults and prevent exposure above the committee's or BNL's limits.

The machine protection devices are expected to typically turn off the beam when the beam losses are above 5-10 W. It is expected that losses of the scale 50 kW are not practical and the machine would be damaged at much smaller loss rates. The project is encouraged to provide a method and calculations that would support a smaller maximum sustainable beam loss rate.

The shield blocks are planned to be large blocks that require a crane to move. There is one location where space limitations may require lead to be used. It is requested that the inner shadow wall be constructed such that all components are captured in the present shielding removal procedure. Small shielding blocks such as pack blocks should be avoided so that configuration control is not an issue. **(Ck-ERL-FY2007-500).**

ERL 50 kW Wave Guide and Nearby Penetrations

The committee also discussed the penetrations planned for the 50 kW wave-guide, water pipes and cables that are adjacent to the support building. Attachment 4 discusses that assumptions and calculations that were done for these penetrations. The committee found the methods acceptable. A 50 kW beam loss is again assumed and the committee encourages the project to spend the effort to justify a smaller more realistic number.

The support building has predicted maximum levels of 500 mrem/hr from the penetrations. A chipmunk should be sufficient to prevent such faults. The highest estimate dose rate is 28 rem/hr outside the shielding directly outside of the wave-guide penetration. This location is 12 feet above the floor level and is in area that can be fenced off if needed. The 50 kW beam loss is very conservative. Fault studies will need to be conducted to determine the final configuration of this area outside of the penetrations. **(CK-ERL-Fy2007-501)**

The committee requests that the project provides an updated scenario for operations and personnel occupancies by area so that integrated exposure to personnel can be estimated. **(CK-erl-Fy2007-502)**

Attachments (file copy only)

1) D. Beavis, " Estimate of Radioactive Concentrations in a Water Pipe over TtB", Jan. 9, 2007.
2) D. Beavis, " Water Flow and Activity Concentrations in the Water Pipe Over TtB", Jan. 17, 2007.
3) D. Beavis, " The Effectiveness of a Two-Foot Thick Inner Concrete Wall", Dec. 11, 2007.
4) D. Beavis," Estimate of the Radiation Exiting Penetrations for the ERL 50 kW Wave Guide, Cable Buss Block, and Water Pipes", Dec. 6, 2007.

CC:

Present
RSC
RSC Minutes file
RSC tandem file
RSC ERL file