C-AD
Radiation
Safety
Committee

Issued: October 19, 2001

Minutes of Radiation Safety Committee of October 5, 2001

Light Ions Beams from the Tandem to Booster

Present: A. Stevens, A. Etkin, D. Beavis, L. Ahrens, P. Kelley, J. Alessi, C. Carlson, P. Thieberger, N. Williams, R. Karol, E.T. Lessard, H. Kahnhauser, and J.W. Glenn

E.T. Lessard presented an overview of the radiation issues related to light ions in the transfer line (see attachment 1). The material is available on the web and will be presented to the lab safety committee. A list of actions items was proposed for the committee's consideration. The committee recommends that these items become check-off list items and closed before routine deuteron operations. A sub-committee will review any items that require an equivalent substitution for completion.

The list is:

1. Install a harp and Chipmunk radiation monitors to limit beam intensity. Average deuteron currents above 100 nA must be prevented by redundant radiation monitors (Chipmunks) placed at a harp, which will be a fixed fractional beam-loss point. The harp transparency should be about 85%, which results in 15 mrem/h at 1-meter lateral to a 100 nA deuteron beam. Chipmunk radiation monitors should be nominally set to trip the deuteron beam off if levels exceed about 25 mrem/h at this fixed fractional beam-loss point. (J. Alessi, prior to operations with deuteron beam in the TTB) If a harp is used an operations procedure must have a periodic check for broken wires. The intensity monitors will alarm for 20 nano-amps of deuterons and interlock at 200 nano-amps. Optics at this location that could defeat the intensity limit should be considered. An alternate method to limit the intensity will be reviewed by a sub-committee if the harp does not work. **(CK-Tandem-deuterons-fy2002-264)**

2. Augment the present relay-based access controls system with a dual set of door interlocks in the TVDG, and input the signal from two interlocking and alarming Chipmunk radiation monitors that detect radiation from the harp cited in Action 1. A second set of switches (or two sets of switches) shall be added on outside gates; that is, dual interlocks in the TVDG shall be on the mechanical equipment room, control room, Target Room 4, TTB gate, downstairs electrical equipment room and downstairs mechanical equipment room gates. This is a simple loop (or two simple loops if we don't want to use existing TVDG ACS) with all gates in series. Requirements for this system shall follow established Collider-Accelerator Department guidelines for limiting and controlling personnel access to beam enclosures, and for controlling possible prompt radiation concerns in adjacent areas. The redundant string should be able to be manually disabled, via procedure, when running heavy ions. It is suggested that the mechanical switching and procedure be made as simple as possible. (N. Williams, prior to operations with deuteron beam in the TTB) **(CK-Tandem-deuterons-fy2002-265)**

3. Write a procedure for TVDG operator response to the harp/chipmunk intensity-monitor alarms and interlocks. It shall contain formal reporting requirements. Operators shall be trained to respond to the problem immediately based on alarms or the resultant radiation-monitor interlock that turns the beam off. Operators shall be trained to investigate these events according to written procedures, correct the problem if appropriate, record the event for management review or discontinue operations if appropriate. Given the anticipated duration of these events, a few seconds or less, and the frequency of these events, several times during an annual running period, the on-site and off-site radiation

impact shall be essentially nil if the operators perform their job according to procedure. (C. Carlson, prior to deuteron operations in TTB) **(CK-Tandem-deuterons-fy2002-266)**

4. Write procedures for operation of the Tandem with low-mass ions and account for the administrative limit on the terminal voltage to 6 MV or less, and the limit on intensity to 200 nA dc average current or less. Procedures shall allow low-mass ions from MP6 only, unless RSC approval to run from MP7 is obtained. Other administrative issues to be covered by written procedures and/or the RSC check off list shall include (C. Carlson, prior to deuteron operations in TTB):
   - Redundant interlock string is to be switched in.
   - Bypass line dipole fields are to be limited.
   - Harp that monitors beam intensity is to be locked in the inserted position, and Chipmunk interlocks switched in.
   - Target room beam plugs must be put in.
     (CK-Tandem-deuterons-fy2002-267)

5. Write or amend procedure for entry into an accelerator tank after having run with deuterons to include a check for contamination by the RCTs. An RCT will check for contamination following deuteron beam running when the accelerator tank is opened for entry. (C. Schaefer and C. Carlson, Prior to deuteron operations in TTB) **(CK-Tandem-deuterons-fy2002-268)**

6. Write an ALARA procedure to minimize the use of Faraday cups in TTB when running deuterons since Faraday cups create a point source albeit briefly. (C. Carlson, prior to deuteron operations in TTB) **(CK-Tandem-deuterons-fy2002-269)**

7. Install a shielding plug. In reviewing radiation shielding associated with deuteron running, it was determined that a shielding plug was needed at the beam opening to Target Room 1 to prevent inadvertent beam from entering that area. (J. Alessi, prior to deuteron operations in TTB) **(CK-Tandem-deuterons-fy2002-270)**

8. Perform a fault study to see if shielding at the northwest corner of the Tandem Control Room is sufficient for proton and deuteron running at full energy and current. In order to maintain ALARA, either shielding can be added to this location, or a Chipmunk can be added in the Tandem Control Room as an area-radiation monitor during proton or deuteron running. At least part of the Tandem Control Room may be allowed to become a Controlled Area. (D. Beavis and J. Alessi, prior to deuteron operations in TTB) **(CK-Tandem-deuterons-fy2002-271)**

9. Perform a survey of earth shield areas along the TTB beam line. Check for any low spots west of Rutherford Ave. for thickness less than 3 feet. (D. Beavis) **(CK-Tandem-deuterons-fy2002-272)**

10. For earth shield along the TTB beam line found to be less than 3 feet, increase to 3 feet thickness or more. (C. Pearson, prior to deuteron operations in TTB) **(CK-Tandem-deuterons-fy2002-273)** Where the berm is improved the committee strongly suggests increase the thickness to 3.5 feet. The additional 0.5 feet provides a dose reduction factor of 2.65.

11. Add two new beam stops at the low energy end of MP6 and two at the low energy end of MP7. These beam stops shall be the critical devices that will inhibit the beam should door interlocks or radiation levels trigger an interlock. (J. Alessi and N. Williams, prior to deuteron operations in TTB) **(CK-Tandem-deuterons-fy2002-274)** This item is essentially item 236 in the database. They will be closed as one item.

12. Add current limiting hardware to limit the beam steered to the TTB. The limit on deuteron beam energy at 12 MeV shall be maintained by limiting the field in bypass dipoles that direct the beam out of MP6 and around the back of MP7 prior to steering into TTB. Radiation Safety Committee approved units that limit current shall be placed on two magnets. These magnets shall limit deuterons leaving MP6 and entering TTB to less than 12.5 MeV. An "equivalent" method shall be used to limit deuteron energy if beam has to be delivered from MP7. (J. Alessi and N.

Williams, prior to deuteron operations in TTB) **(CK-Tandem-deuterons-fy2002-275)** This is item 241 in the database and will be closed together.

13. Wiring diagrams and functional tests of the changes to the TVDG and TTB ACS shall be approved by the RSC. (D. Beavis, prior to deuteron operations in TTB) **(CK-Tandem-deuterons-fy2002-276)**

14. All new ACS wiring and testing shall be completed and documented by qualified technicians and engineers in the Collider-Accelerator Access Controls Group. Changes to the system shall be controlled according to requirements in the BNL SBMS, Collider-Accelerator Department Quality Assurance Procedures and the Collider-Accelerator Department's OPM. The ACS shall be a QA1 system, and all drawings and components shall be configuration controlled. (N. Williams, prior to deuteron operations in TTB) **(CK-Tandem-deuterons-fy2002-277)**

15. Longer-term goals for the integration of the full Tandem ACS into the Access Controls Group shall be set. **(CK-Tandem-deuterons-fy2002-278)**

16. RSC Chair and/or ESHQ Associate Chair to sign off on shield prints. **(CK-Tandem-deuterons-fy2002-279)**

    A. Stevens presented an overview of the loss scenario, soil activation, component activation, and fault study results and comparison to calculations (see attachment 2 and 3). The loss scenario is considered conservative. The estimate for 3 feet of soil is 34 micro-rem/hr and 14 mrem/yr for deuterons in the transfer line for a worst-case point. The proposed limit to the beam current is 200 nano-amps D.C. equivalent of deuterons. The fault studies confirm the calculations (guestimates- see attachment 4). A 12 MeV deuteron beam of 200 nano-amps striking an iron target creates 3.3 mrem/hr on the surface of the berm that is 3 feet thick. A Ta target creates levels about a factor of 5 lower and this ratio is in good agreement with the model calculations. The committee was satisfied with all the calculations and estimates presented.

A summary of 106 MeV oxygen fault studies conducted in 1991 was presented by C. Carlson (see attachment 5). These fault studies examined many weak areas such as vents and power supply buildings along the transfer line. An apparent discrepancy between the present berm thickness and one these numbers was noticed. After the meeting it was determined that this apparent discrepancy was due to the fact that certain areas were improved after the oxygen fault study in 1991. Specifically soil was added to section N and shielding was added in the building 908. Oxygen fault studies will be conducted to verify these existing numbers**(ck-tandem-deuterons-fy2002-280)**. Two of the locations will be the same as conducted with the deuteron beam enabling oxygen numbers to be used to scale potential deuteron faults at the various special locations. There was a concern that the angular distribution for neutrons from deuterons may be substantially different from oxygen. This could cause a difference in the entrance dose to a labyrinth. It is recommended that a labyrinth or escape hatch be check with deuterons and compared to oxygen **(ck-tandem-deuterons-fy2002-281)**.

The potential dose rates from the TTB beam stops into the HEBT tunnel needs to be examined. Personnel are allowed in the HEBT tunnel with beam on the TTB beam stops. **(ck-tandem-deuterons-fy2002-282)**

This review has not considered the issue of transporting radioactive beams such as tritium.

The committee recommended that the last sentence of section 3.1 of the proposed ASE (see attachment 6) for TTB and TVGD be removed or modified.

Attachments (file copy only):
1. E.T. Lessard presentation material. (also see USI ,unresolved safety issue, web)
2.A. J. Stevens presentation material.
3.Loss scenario from USI document on web.
4.Summary of deuteron fault study; C. Carlson and A.J. Stevens 10/02/01.
5. C. Carlson presentation material.
6.Proposed ASE for TVDG and TTB