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Memo

date: *September 3, 2009*

Updated: *November 20, 2009*

to: *RSC*

from: *D. Beavis*

subject: *Low Energy RHIC Operations: External Dose from the Beam Dumps – Updated*

The external dose from the RHIC primary beam dumps and potential soil activation are discussed for routine operations of low energy RHIC beams.

The radiation analysis for the RHIC beam dumps[1] assumed that the equivalent of $8.9*10^{16}$ 100 GeV protons per year would be sent to each beam dump at RHIC.

The scaling with energy[2] and ions can be used to obtain yearly limits for beam on the deach beam dump. The following table shows the equivalent limits for lower energy operations:

ion	**Yearly limit—equivalent to $8.9*10^{16}$ 100 GeV protons**
Protons at 100	$8.9*10^{16}$
Au at 100 GeV/nucleon	$4.5*10^{14}$
Au at 10.4 GeV/nucleon	$2.76*10^{15}$
Au at 2.5 GeV/nucleon	$8.6*10^{15}$

It would require 36,000 fills at 2.5 GeV with all the beam going into the beam dumps to exceed this limit in one year. There is no credible means for operations to exceed this limit and therefore no controls are required. The yearly external dose on and off site are less than what was considered in the RHIC SAD[3]. Since the potential soil activation scales in the same manner the low energy operations will not violate the protection system for the groundwater that was designed for full energy operations.

The above analysis assumes that the beam strikes the dumps in effectively the same location as high energy operations. If there is a substantial loss of dump shielding due to a change in beam location the loss of shielding will require evaluation for external dose (vertical shielding) and soil activation (horizontal shielding). It was noted during the RSC meeting of Oct. 14 2009 that the intent was to kick the beam to the same position on the beam dump as used for high energy dumping.

Hourly limit for beam into RHIC at full energy is given[4] as $2.85*10^{13}$ protons at 250 GeV/c equivalent. Using the scaling the hourly limits will be satisfied for beams at 10.4 GeV/ nucleon Au if less than 14.5 full ring fills are placed into each dump per hour. The table below gives the limits for several combinations. It is clear that an hourly external dose rate will be satisfied by any credible operations mode. With the present Au fill scheme of four bunches per AGS cycle it would take 413 AGS cycles to achieve this limit into one dump. The AGS can operate at this limit but it is unlikely. If deemed appropriate a simple limit can be placed into an operations or process such as BLAM.

Ion	**Hourly beam limit into each dump**
Protons at 250 GeV	$2.85*10^{13}$
Au at 10.4 GeV/nucleon	$3.5*10^{12}$
Au at 2.5 GeV/nucleon	$1.1*10^{13}$

It should be noted that exceeding the limits given in the tables in this report do not necessarily cause a violation of any compliance issues. Rather, the dose rates and soil activation levels exceed what was considered in the RHIC Project analysis and approving such increases may be possible with more analysis.

This analysis does not address issues of residual activity associated with the beam dump or potential heating effects of the lower beam energy on the beam dump. The energy density on the beam dump should be lower due to the larger beam size than compared to that of high energy. Therefore heating effects were not examined. The residual activity should be examined with surveys conducted during the run and appropriate posting used as needed.

References

1. A.J. Stevens memorandum to D. Paquette, "Radioisotope Production Near RHIC Dumps", March 1, 1996; see RHIC SAD appendix 21, attachment 1.
2. D. Beavis, "Extending Routine Operations of RHIC and AtR to Low Energies", August 28, 2009.
3. RHIC SAD Section 4C.
4. M. Harrison and A.J. Stevens, "Beam loss Scenario in RHIC", AD/RHIC/RD-52, Jan. 1993.

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