C-AD

Issued: April 26, 2013

Radiation

Safety Minutes of RSC Subcommittee of April 15 & 17, 2013

Committee

Subject: Review of Increasing the RHIC beam intensity to the equivalent of 3*1013 protons per ring**

Present April 15, 2013: D. Beavis, R. Karol, C. Schaefer, K. Yip, P. Sullivan, L. Ahrens, W. Meng, Y. Makdisi, and C. Theisen

Present April 17, 2013: D. Beavis, E.T. Lessard, C. Schaefer, K. Yip, H. Kahnhauser, Y. Makdisi, J. Sandberg, J.W. Glenn, and A. Etkin

At the conclusion of the meeting on April 17, 2013 the committee recommended that the Department increase the intensity limit to $3*10^{13}$ protons per ring at 255 GeV.

Any necessary procedures must be updated before the increase. The USI determination form should start through the process with a negative finding.

It is noted that many of the referenced calculations are already in the SAD so only the new memo which details the IR shielding and the overall reference memo need to be referenced in the USI for future addition in the SAD. The ASE limit does not need to be changed.

April 15 Summary

A general discussion of the analysis given in the memos[1,2] was presented to the members. After some discussion it was decided that the committee would like a few days to consider the material more carefully. A meeting was scheduled for April 17. Since most of the discussion was repeated in the April 17 meeting it will be provided in the summary of that meeting.

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[1] http://www.c-ad.bnl.gov/esfd/RSC/Memos/RHICPROTON_4_19_13.pdf

[2] http://www.c-ad.bnl.gov/esfd/RSC/Memos/MCI_4_19_13.pdf

April 17 Summary

It is realized that not all members are experienced in doing shielding calculations. The calculations being discussed were conducted for separate areas (Intersection Regions-IRs) either by D. Beavis or K. Yip. The numbers are consistent for the different IRs in the sense that the dose in an MCI is lower than the RHIC Project calculations. Footnote 1 provides generic reasons why this should be expected without having to understand the details of the Monte Carlo programs.

DOE had guidance at the time of the RHIC Project that the neutron dose should be doubled for facilities under design to prepare for an increase in the weighting factors (Quality Factor-QF) for neutrons. The new version of 10CFR835 was published in 2008 with the new weighting factor. FNAL has done an analysis for their hadron facility of the difference between the old dose evaluation and the new dose evaluation due to the actual weighting factor change. On the average the "effective quality factor" was less 1.4. Thus we can expect in general that the RHIC numbers can be decreased by 1.4/2.0 = 0.7. An old limit of $2.4*10^{13}$ protons per ring could therefore be raised to $3.4*10^{13}$ protons per ring for the same potential MCI dose.
H Kahnhauser noted that in evaluating neutron calibration sources on site the average shift in the dose evaluation was typically increased 17% to 20%. The neutron sources represents a different energy domain than the cascade neutrons from proton collisions, but indicates that for a portion of the neutron spectrum would have a reduction factor of 1.2/2 in the RHIC Project numbers.

A factor of 1.84 reduction in the RHIC numbers is expected from the conversion factor used to convert CASIM results to dose. The conversion factor suggested by the CASIM author was used by the RHIC Project but analysis conducted at CERN suggested that it was a factor of 1.84 too large. The RHIC Project decided to choose the more conservative factor. It is expected that the substantial reduction of dose seen in MCNPX and MARS when compared to the RHIC Project numbers is related to the choice of conversion factor used by the RHIC Project.

Combining these two potential reduction factor would suggest that the beam intensity per ring could be increased to $6.3*10^{13}$ protons. The department has requested a temporary increase for this run to $3.0*10^{13}$ and a final increase for next year of $5*10^{13}$ protons per ring.

We note in evaluating the shielding for an MCI we do not use the factors discussed above. The Monte Carlo codes are used to calculate the dose. The factors above provide some understanding as to why the new calculations provide a lower dose per lost proton.

The CASIM code in the forward direction was known to overestimate the forward dose at the time of the RHIC Project. This is referenced in the footnote. The RHIC Project took the conservative approach to use the results and therefore have a conservative design in the forward direction. The new calculations are often more than a factor of ten lower in the forward direction due to this systematic flaw in CASIM.

A Table of some of selected results from the new analysis is compared with the RHIC Project results and given in the Table reproduced from footnote 1 below:

Location	RHIC Project (mrem)	RHIC Upgrade (mrem)	Comment
Berm	114	87	1
STAR Shield Wall	267	130	2
PHENIX Shield Wall	340	11	3
4 O'clock fence (1004B)	85	85	4
4 O' Clock fence at (1004A)	223	10	5
2 O'clock-CeCpop	320	25	6
10 O'clock-berm		130	7
12 O'clock fence	174	7	8

The RHIC Project numbers are for $2.3*10^{13}$ protons per ring and the Upgrade numbers are for $5*10^{13}$ protons per ring. The numbers are substantially lower even with the intensity increase. We can see that the STAR wall is above 100 mrem in an MCI which was the criteria established[3] for reviewing the changes by an RSC subcommittee for areas near the experiments. The RHIC Project criteria for such an area were 500 mrem since it was classed as a high occupancy area that was a Controlled Area. It was noted we can use up to 1000 mrem in an MCI for a Controlled Area. Work controls have been added and all work on the berm is screened as part of the work planning to examine if it will be conducted near weak locations. The IMH/F&O jobs are prescreened to determine if the work is being planned for a location on the RHIC berm. The B1 vents are the only locations that approach 1000 mrem in an MCI.

All IRs and other locations around the RHIC ring have TLDs that are used for monitoring dose. The IRs typically have 8-10 TLDs so that should an MCI occur we could reconstruct the dose at the facility. In addition most of the IR shield walls have chipmunks that would record the dose so that a quick estimate of the dose could be determined before the TLDs are processed. Should an MCI event occur most likely the machine would shutdown while an occurrence investigation is started. MCI in some locations would not exceed unplanned dose limits, which if exceeded would classify the event as reportable. Depending where the event occurred, the actual expected dose, and if the analysis reasonably described the event, the machine would likely begin operations within a few weeks.

Monitor TLDs have been place for the beam dumps and collimators to register skyshine. These TLDs are much closer to the sources than the site boundary so that as intensity increases we should be able to estimate the dose at the site boundary. All these TLDs are changed quarterly. The environmental site TLDs are a different type of TLD then the ones we for quarterly monitoring.

[3] http://www.c-ad.bnl.gov/esfd/RSC/Minutes/8_25_09Minutes.pdf

A software monitor program has been started to tally the amount of protons into the collimators. Although not an MCI issue, the increase in protons per fill means that one achieves more total protons for a fixed number of fills. In addition, there is an effort to move all potential losses to the collimators. Monitoring the total number of protons into the collimators will enable us to examine if any limits are being approached.

The shielding at all IRs was inspected by D. Beavis prior to the start of the run and during the run to look for trouble spots that may not be well determined from the shielding prints. None were found.

It was noted that some locations can have the potential dose to personnel reduced by adding fences or internal shadow shields. If shields where placed between the ring magnets and the B1 and B2 ventilation shafts the dose could be reduced by a factor of 2-4 outside on the berm near the shaft depending on the amount of shielding. Fences were considered last year for the ventilation shafts and would cost approximately $150,000. To reduce the potential dose at IR shield walls could cost $50,000-$100,000 (a guesstimate) per shield wall since even though the dose is close to 100 mrem the mechanically stability requirements to stack shielding up to 14 feet high requires substantial shielding. It also requires additional rigging work each time an IR is opened for summer work. There was not a lot of interest expressed in adding shielding or fences based on the infrequent occurrence of an MCI and the limited dose.

The committee was comfortable with the increase to $3*10^{13}$ protons per ring and will wait for the final IR report to review the final increase to $5*10^{13}$ protons per ring.

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A. Drees