C-AD
Radiation
Safety
Committee

Issued: October 16, 2001

Amended Minutes of the RSC Meeting of Sept. 19, 2001

Polarized Protons to RHIC

Present: J.W. Glenn, E.T. Lessard, A. Stevens, J. Alessi, W. MacKay, I.-H. Chiang, L. Ahrens, and D. Beavis

Purpose: The committee reviewed the proposal to use the A20 current transformer in the AGS to prevent high intensity polarized proton beams to RHIC.

The committee had recommended (minutes of April 2,2001) that well controlled and documented hardware be used to prevent polarized proton faults, which could produce levels above 100 mrem in an hour.

C.J. Gardner provided a memo stating that the maximum theoretical limit of accelerated polarized protons in the Booster (AGS) is 100% of the linac beam. The linac has an upper limit of $5.6*10^{12}$ protons per linac pulse (see file attachment). This limit is approximately 100 times the highest beam intensity achieved last year. Improvements in the source are expected to allow a substantial increase. Additionally, there was a limit to the allowed pulse width last year. The committee will use $5.6*10^{12}$ protons per linac pulse as the maximum beam limit but expects that a credible limit be substantially below this number.

Routine operation of RHIC is expected with one linac pulse to be accelerated and filled into RHIC. The intensity of each pulse is $2*10^{11}$ protons. Each RHIC ring is expected to be filled with a maximum of 120 bunches. An incorrect cycle can be loaded into the machines allowing for the AGS to accelerate 6 linac pulses per cycle. A routine operating cycle is 3.6 seconds. A maximum fault under routine conditions (without mitigating controls) would be $5.6*10^{10}$ protons per second. A maximum fault under extraordinary circumstances (6 pulses/cycle and $5.6*10^{12}$ p/pulse) would be $9.33*10^{12}$ protons per second.

To prevent large intensities of polarized protons to RHIC the A20 current transformer will be used (see attachment 2). The committee approved the use of the device with the following requirements:

1) An engineering review will be conducted and a summary submitted to the RSC chair. The review should determine the accuracy and linearity of the device. It should identify potential failures. The device will be classified as A3. Procedures should be written to prevent inadvertent changes to the functioning of the device. The device should have a keep-alive signal. The accuracy of the trip limit should be 20-30 percent. **(CK-polarized protons-RHIC-fy2002-259)**
2) The device will interface to the beam inhibit system and also the LTB beam stops if the 8 and 20 degree bends are on in the AtR beam line. Both the keep-alive and max. beam intensity limits will be used. **(CK-polarized protons-RHIC-FY2002-260)**
3) Operations procedures will be modified to require the device to be tested before each fill to RHIC. This requirement can be relaxed if it is a problem to implement. **(CK-polarized protons-RHIC-FY2002-261)**
4) The upper limit for beam intensity will be $6*10^{11}$ protons per AGS cycle. **(CK-polarized protons-RHIC-fy2002-262)**

The committee as previously accepted a value of 1.5 microrem per 10^{10} protons for losses under Thompson road (also for faults under Railroad Ave. of the RHIC berm). Table I gives a list of potential doses and dose rates for various fault scenarios at injection energy. Faults levels at RHIC full energy are a factor of 7 higher, although limited to one store.

Table I

scenario	Protons lost	duration	Dose (mrem)
I	$2*10^{11}$	3.6 seconds	0.03
II	$2*10^{11}*120$	432 sec.	3.6
III	$6*10^{11}*1000$	1 hour	90
IV	$5.6*10^{12}*1000$	1 hour	840
V	$5.6*10^{12}*6*1000$	1 hour	5040

Comments on the fault scenarios:

I) a single routine bunch lost.
II) An entire routine fill for a ring lost
III) An entire hour of maximum allowed intensity lost
IV) An entire hour at an maximum theoretical intensity with a normal machine cycle
V) IV but with a the wrong cycle i.e. a 6 bunches per cycle in the AGS

The A20 current transformer will prevent faults that could range from 100 mrem in an hour to 5000 mrem in an hour. Losses are presently monitored and prevented from exceeding 5 mrem in an hour for controlled area by C-A TPL 01-20. The early portions of the injection arcs (near Thompson Road) are monitored by interlocking chipmunks. These chipmunks are not sensitive to the entire arcs but are placed at locations where maximal faults are most likely to be achievable. A non-interlocking chipmunk monitors Railroad Ave. over the RHIC berm and alarms if undesirable levels are detected.

It was proposed that the A20 transformer be used only in the beam inhibit system. There was some discussion that the potential escalation was so unlikely that it might be sufficient to use only in the beam inhibit system. The committee recommends it be in the interlocks to protect against any inadvertent configuration control issues since the A20 transformer has other uses. This will make operational testing of the device before each fill more difficult.

Many of the extreme faults conditions require multiple errors to occur. The committee judges these to be highly unlikely and the A20 transformer to be more than sufficient to protect against these unlikely escalation scenarios.

The maximum possible levels for Au faults may be just above the 100 mrem in an hour limit. For the present, the committee judges that it is not necessary to use the A20 transformer for Au.

The need for the A20 transformer for other ions will be reviewed before they are transported to RHIC. It is expected that they will probably not require the A20 transformer. **(CK-RHIC-IONs-fy2002-263)**

Attachments File copy only:

1) C.J. Gardner memo of Sept. 18, 2001
2) N. Tsoupas memo.