Subject: CeCPoP Radiological Issues


This is part of the on-going review of CeCPoP. The focus for this meeting was the means to stay in the abort gap, the limit on beam power, and the high power beam dump.

Low Beam Power and the Abort Gap

I. Pinayev used a Powerpoint presentation\(^1\) to go over the salient features of the logic to ensure that there is low power beam. A controls expert has noted that the V294 units are very reliable. The V294 will prevent laser pulses for 990 milli-seconds and allows the Pockel cell to be open for approximately 30 milliseconds. The Pockel has an attenuation of 1000. Some laser light will leak through but will be stopped by a 30 milli-second failsafe mechanical shutter. Mechanical shutters with closing times of a few milli-seconds can be purchased but the committee did not see a need for this complication. Unlike a gate delay generator the V294 would require the internal board to be removed and the gate array reprogrammed to change the allowed timing. This board will be under the control of the controls group. The committee approved the planned means to keep the beam power low.

I. Pinayev also reviewed how the BPMs would be used in a scope to examine that the electron beam was well timed in the abort gap. It was noted that the RF timing is very stable so once this is initially examined for a store the location of the electron beam in the abort gap will be stable. The signals are available on the net and can be observed from MCR. The committee approved the means to maintain the electron beam in the abort gap.

Losses and High Power Beam Dump

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\(^1\) I. Pinayev, “Assuring Low Power Beam”[PDF]
D. Beavis presented the general approach to the shielding and controls for the CeC area. Calculations have been conducted in a conservative manner. The plan will be to examine any issues at low power and correct shielding as need so that the CeC PoP can operate at full power.

The table of dose rates and doses for routine losses and full beam faults was presented. The dose rates outside the bulk shielding are small. The dose in a beam fault assumed that the beam fault was limited in time to 12 minutes. A full beam fault would provide a dose of 0.5 mrem at the truck door. The roof could have a fault dose of 140 mrem but is inside a locked area and personnel are excluded. The electron beam fault doses are much smaller than expected for a RHIC beam fault. The frequency of electron beam faults should be determined from operations and reviewed for ALARA issues. The table of expected dose rates (dose) is reproduced here:

<table>
<thead>
<tr>
<th></th>
<th>Routine dose rate mrad/hr, mrem/hr</th>
<th>Fault dose rate mrad/hr, mrem/hr</th>
<th>Fault dose mrad, mrem</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transport-sidewall</strong></td>
<td>0.023, 0.0005</td>
<td>1.6, 0.034</td>
<td>0.3, 0.007</td>
</tr>
<tr>
<td><strong>Transport-roof</strong></td>
<td>9, 0.7</td>
<td>634, 45</td>
<td>130, 9</td>
</tr>
<tr>
<td><strong>Transport-truck door</strong></td>
<td>0.034, 0.002⁴</td>
<td>2.3, 0.16</td>
<td>.5, 0.03</td>
</tr>
<tr>
<td><strong>Beam dump-roof</strong></td>
<td>170, 13</td>
<td>170, 13</td>
<td>na</td>
</tr>
<tr>
<td><strong>Beam dump-berm</strong></td>
<td>0.09, .0005</td>
<td>0.09, .0005</td>
<td>na</td>
</tr>
</tbody>
</table>

In this table the photon dose is listed as mrad and the neutron dose as mrem. It was noted that the dose from the beam dump does not include the shielding that is expected to be added around the beam dump. The shield around the beam dump has numerous constraints which are now being examined. It is expected that the shielding place around the beam dump will reduce radiation issues well below any concern.

The site boundary is closer than the nearest BNL facility. The expected yearly dose to the site boundary is reported as 0.1 mrad/yr from photons but does not include attenuation in the air or the local shield around the beam dump. The neutron dose from the beam dump is estimated to be 0.014 mrem/yr. The 0.1 mrad/yr is below 5 mrad/yr for C_AD facilities to the site boundary. The nearest on-site will be much lower and has a limit of 25 mrem/yr.

The beam dump design was described for the water cooled copper beam dump. The main issue of the copper beam dump is that the residual activity after several days of full power operations would create dose rates up to 650 rads/hr at a foot. There are plans to build an Al beam dump which would have about 50 times lower residual activity. After the meeting it was discussed that due to limited resources that are being used by multiple projects that it would be best if the CeC beam

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2 D. Beavis, “CeC Open Issues” [PDF]
3 A math error was detected in the dump to roof dose and corrected. This correspondingly reduce the skyshine dose.
4 Updated
5 The 2% components for aluminum alloy 6061 have been assumed to produce the activity as if was all copper. The actual composition is 0.3% Cu, 0.6% Si, 1.0% Mg, and 0.2% Cr.
dump shield could be designed so that the change to Al does not need to occur this year. The design team is presently working on this option. In addition, there are plans to place electronics below the beam dump and there is a camera for the beam profile monitor upstream of the beam dump. The shield design will take these issues into account.

The other radiological issues examined from the copper beam dump have been evaluated with no shield present. The shielding would reduce all the following quantities substantially. The results of the analysis for hours of full power operations are:

- **Ozone:** After hours of operations the air around the dump would be at 3.4 times the Threshold Level Value (TLV) for eight hours of exposure. This is a conservative calculation with no ventilation included and less than the full IR volume. Ozone exposures are expected to be well below the 12 DAC-hours per week given in the RadCon manual.

- **Soil Activation:** The thresholds for tritium are too high for substantial tritium to be produced. The tritium threshold from oxygen is 25.0 MeV for photo-production. The thresholds for tritium photo-production from silicon are 27.5 MeV $^{28}$Si, 24.6 MeV $^{29}$Si, and 22.2 MeV for $^{30}$Si. Tritium production is not expected to be significant.

- **Water Activation:** The only activation product in water with a threshold low enough for production is $^{15}$O which has a threshold of 15.67 MeV. The saturated $^{15}$O activity was estimated in the first seven cooling channel to be 0.06 Ci. If concentrated in single location this could produce approximately 50 mrem/hr at a foot. There are at least 250 feet of four inch diameter water pipes for the water system. The supply and return are in close proximity so this provides a dose rate from $^{15}$O of 0.03 mrem/hr-ft. Converting to an infinitely long line source yields a dose rate of 0.1 mrem/hr at a foot. The demineralization tanks are C-AD property and are regenerated on site. The water system is on a tickler system to check for the water activity.

- **Hydrogen generation:** Hydrogen gas can be generated in the cooling water due to ionization. 8500 watts of ionization would lead to 9.18 liters of hydrogen per hour. It will be assumed that 1% of the ionization occurs in the water paths leading to 0.1 liter of hydrogen per hour.

The committee recommends:

- Document the final dump analysis before operations above 1 Watt are allowed. (CK-CeCPoP-March 15, 2016-Beavis&Karol-1012)
- Document the shield design for the water cooled beam dump. (CK-CeCPoP-March 15, 2016-Beavis&Phillips-1013)
- Surveys of the beam dump and the water pipes will be conducted. (CK-CeCPoP-March 15, 2016-Bergh&Pinayev-1014)
- A removable soil sample will be placed on the tunnel wall in line with the beam direction. (CK-CeCPoP-March 15, 2016-M. Van Essendelft&Pinayev-1015)
- The complete calculations for the hydrogen and check that the release is conducted in a safe manner. The release should consider a small amount of $^{15}$O in the release of gases. (CK-CeCPoP-March 15, 2016-Beavis&Scaduto-1016)

Other Misc. item
• Calculate the dose out penetrations for 25 MeV electron beam where access to the port is possible. (CK-CeCPoP-March 15, 2016-Beavis&Karol-1017)
• Place a chipmunk in the tunnel at the boundary barrier near alcove B for warning personnel of potential elevated radiation. If possible add to the alarm system. (CK-CeCPoP-March 15, 2016-Citro&Beavis-1018)

CC:
Present
RSC
RSC Minutes File
A. Drees
M. Van Essendelft
J. Scaduto
J. Citro