SNS BEAM CONTAINMENT WORKSHOP MINUTES
(Workshop held at ORNL Jan. 28, 1998)

[Changes from draft version shown highlighted.]

1. ATTENDEES

Jose Alonso	ORNL
Ron Battle	ORNL
Kent Crawford	ANL
Bill DeVan	ORNL
Mike Harrington	ORNL
Andy Jason	LANL
Jeff Johnson	ORNL
Rod Keller	LBNL
Frank Kornegay	ORNL
Tom McManamy	ORNL
Alex Ratti	LBNL
Ken Reece	BNL
Jim Schubert	ORNL
Andy Soukas	BNL
Paul Wright	ORNL

2. FRONT END TUNING

It does appear that neutrons could be generated by the front end. The point at which beam energy will be high enough to generate neutrons is somewhere along the RFQ. LBNL is investigating at this time.

Rod Keller reviewed potential beam cut-off mechanisms relevant to the different safety systems:

<table>
<tr><th>Cut-off Mechanism:</th><th>Time Response:</th><th>Comments:</th></tr>
<tr><td>Ion source chopper</td><td>2 μsec</td><td>Not fail safe. The ion source chopper will not be used for forming pulses, but could still be used as a cut-off mechanism.</td></tr>
<tr><td>Ion source high voltage power supply
(-65kV)</td><td>2 sec</td><td>Failsafe. Beam will be cut off before the voltage completely decays (perhaps <|-45| kV), which helps the time response some.</td></tr>
<tr><td>RFQ RF power</td><td>5 μsec</td><td>Fail safe.</td></tr>
<tr><td>Beam stop at end of MEBT</td><td>10 sec.</td><td>Make fail safe. The time response shown is very conservative.</td></tr>
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The time required to resume operations after a safety-system-initiated cut-off was discussed. The consensus was that this will not be a big issue due to required operating procedures. The longest recovery time identified was for the RFQ RF power. It will take ~2 min. to resume operations after RF power is restored. (Active temperature regulation will be provided to help yield this relatively-fast recovery time). Recovery from a source high-voltage power supply shut-off is expected to take around 30 sec.

The question was raised: "What is the minimum acceptable current after cut-off?" Some cut-off mechanisms may not completely extinguish the beam. Fast shut-off mechanisms would also serve to extinguish beam (but we probably can't take credit for this since they are not part of a safety system).

Personnel access in the vicinity of the front end was discussed. Jose reminded the group that a labyrinth was required at the low-energy end of the linac tunnel to mitigate backstreaming. Now it looks like some additional shielding could be required around part of the RFQ and all of the MEBT. Figure 1 attached shows one proposal for front end shield changes.

The issue of personnel access to the linac tunnel during front-end tuning was discussed. Prior to the workshop it was thought that (a) inserting the end-of-MEBT beam stop and (b) turning off DTL rf power would be sufficient to protect personnel in the linac tunnel during front-end tuning. The consensus now is that turning off the DTL rf is not sufficient. No other potential beam confinement mechanisms were identified. There is not room in the front end for a second beam stop. There may be a beam stop in the CCDTL, but this is too far downstream to protect personnel in the linac tunnel. So, the consensus was that it will not be safe to be in the linac tunnel during front-end tuning. It was decided to now have two front-end operating modes:

- Source conditioning. Personnel access will be unrestricted during source conditioning. [Possible exceptions: There will be a high-voltage cage. Whether or not it encompasses the front end is TBD. Also there may be some local access restrictions due to the potential for x-rays]. The RFQ will serve as the only beam containment mechanism for this mode of operation. (Since the beam reaches energy levels capable of generating neutrons somewhere in the RFQ, beam containment mechanisms downstream of the RFQ aren't adequate. All potential beam containment mechanisms upstream of the RFQ are required for conditioning. Consequently, shut-off of RFQ RF power appears to be the only option available).

- Front end tuning. Personnel will be excluded from the linac tunnel during front-end tuning. Beam containment devices used will be the same as for linac tuning. [Since the review, Jose Alonso has suggested that radiation levels might be acceptable beyond some distance downstream of the front end. For example, a gate placed across the tunnel in the vicinity of the CCDTL/CCL boundary might be sufficient to exclude personnel from radiation areas. If this were true then we would want to revert to the original beam containment devices, i.e. the end-of-MEBT beam stop and shut-off of DTL RF power.]

LINAC COMMISSIONING AND TUNING

Andy Jason reviewed plans for commissioning the linac. Beam containment during commissioning was discussed. When using a diagnostic commissioning plate (DCP), burn-through of shielding is not a credible accident due to the certain loss of beamline vacuum.

Jeff Johnson will calculate shielding requirements for linac commissioning.

Neutron monitors will be required on the downstream side of the shield wall.

Ken Reece reviewed plans for beam containment during linac tuning. The plan is to (a) inhibit the achromat 7.5^{o} dipole magnet power supply and (b) inhibit the achromat 82.5^{o} dipole magnet power supply. Beam containment configurations like this have been approved and are in use at BNL.

Ken feels it would be very difficult to implement a beam stop in the achromat that would provide adequate protection due to the high energy and small profile of the beam.

The consensus was that the plan to use two different sets of magnets as the beam containment critical devices was OK. (Andy Jason objected to not having a beam stop).

The consensus was that it would be prudent to remove a section of the HEBT beamline prior to CCL commissioning. This would provide added assurance beam would be contained during testing. Ken Reece warned that this could raise questions with regulators. Jose noted that since risks are higher during construction and testing, taking extra measures can be justified.

Andy Soukas noted a scheduling problem. The schedule logic assumes that there will be personnel access to most of the achromat area during CCL commissioning. This is an invalid assumption. Current plans are to put a shield labyrinth in the upstream end of the achromat section. The plan also includes a gate near the downstream end of the achromat section to restrict personnel access to the HEBT. Jeff Johnson has calculated that 8-10 feet of steel and concrete are required even if personnel are as far away as the gate. [A full-power beam was assumed for this calculation. If a safety system limited beam current, then shielding could be reduced.]

It was noted that the RTBT beam stop/diffuser in not currently in the BNL baseline budget for the Ring. It needs to be added.

RING TUNING

Ken Reece reviewed plans for beam containment during ring tuning. The plan is to (a) inhibit the extraction dump bending magnet, and (b) insert beam stop in RTBT.

Downgrading the beam stop to a beam diffuser was discussed. If we relied solely on inhibiting the bending magnet to make sure beam was never was sent down the RTBT during tuning, then the beam stop could be downgraded to a diffuser. That is, it would serve more as a shield than as a beam stop. The consensus was to leave it as a beam stop.

Tom McManamy noted that access to the remote handling cell in the target building is required during ring commissioning. This means shielding will have to be provided at the end of the RTBT. Jose Alonso noted that a shield wall is needed anyway to mitigate backstreaming of neutrons from the target. A likely scenario is that an ~8 ft. thick wall of stackable block will be required at the end of the RTBT to fulfill both of these functions.

NEUTRON PRODUCTION

Ron Battle described plans for protecting against a loss-of-mercury-shielding accident. Part of the plan involves shutting off beam when increased levels of radiation are detected downstream of the target. The rad monitor will have to look for neutrons and not gamma. The question was raised "How do you pick a setpoint without actually trying it out?" Ken Reece expressed concern over using a rad-monitor as part of an active shutdown.

Kent Crawford reviewed plans for instrument personnel protection. Prior to the workshop, plans for beam containment were (a) close neutron shutter and (b) design experiments so it is not physically possible for experimenters to put their body in the path of the beam. However now it looks like it will be difficult to design some instruments so it is impossible to get into the beam. Other options for neutron beam containment were discussed. It is not practical to provide a second shutter. Radiation monitoring will provide defense-in-depth. The consensus was that it would be OK for the neutron shutter to be the sole beam containment critical device. Redundant, highly-reliable means of monitoring shutter position must be provided.