MuCool Shielding Assessment Comments and Questions – Round 1
8/13/10

Document & Drawing Completeness, Beam Input Parameters, Experimental configurations

1. Figures in SA document are not legible
Figures have been inserted as pdf objects

2. There appears to be no clear summary of conclusions in the SA
Mike is writing pending final revision of SA

3. The intended yearly number of protons for which the SA is to apply is not stated; a line in Water Activation calculations section mentions "less than 2E18/year", but the reference number for which the assessment is being done should be stated up front.
Now clearly stated in Assessment Beam Parameters section

4. Hatch Shielding assembly drawing should be shown in some context and should clearly indicate beam location and direction
Done

5. Fence above hatch shield wall is not shown on drawings, nor I think is fence around area of gas shed and the outside pit area.
MuCool Radiation Safety Drawings revised to show fence around pit area

6. On the "Shielding Requirement" spreadsheets: 1) there should be a specific reference where one can find the "Standard Cossairt category table" and a description of how that table is to be interpreted and used, 2) sheets reference 13 yr old version of the RadCon Manual, they should reference current RadCon version.

7. The limitations on what can be in the beam in the experimental hall are unusual. A statement as to what is allowed and not allowed should be very clear so that an additional shielding assessment for each configuration is not necessary. MOUs should not be signed until it is clear that the experimental configuration complies with the shielding assessment. Care should be taken to prevent unauthorized change of configuration.

All experimental configurations will be handled operationally through Beam Permits and Running Conditions. Each experimental configuration will be individually evaluated based on its MOU and ORC, for compliance with the approved shielding assessment criteria.

8. A comprehensive monitoring plan should be included in the shielding assessment or SAD.
Been added to AD routine monitoring program. Routine monitoring or air activation is not anticipated, but will depend on BBM for MTA and will be measured on a yearly basis

Incremental Shielding Assessment

1. The incremental assessment scales the Cossairt shielding requirements from 1000 GeV to 400 MeV. The question of whether the scaling argument is valid over such a broad range is a good one and has apparently been investigated in TM-2248. According to this document, a MARS14 simulation indicates an approximately 3% difference (i.e., 0.6 ft) in compacted dirt shielding thicknesses to reduce dose rate to 5 mrem/hr. A check at other thicknesses and doses indicates a similar difference between the two methods. Until the ES&H Section recommends a different method be used at low energies, scaling the Cossairt requirements seems acceptable. TM-2248 should be included as an appendix to support this.

TM 2248 addresses the scaling of the Cossairt shielding requirements from 1000 GeV to 400 MeV. In this document, a MARS14 simulation produces a difference of only a few percent in the amount of compacted dirt shielding compared to the scaled results. TM2248 is now included as an attachment.

2. Does the incremental assessment include current FRCM values, where appropriate? The dose and dose rate values printed on the spreadsheets appear to be current, but are all cells that perform calculations using current values?

3. It would be very helpful to have an elevation view of the experimental hall so that longitudinal shielding could be displayed graphically.

MuCool Radiation Safety drawings, now attachment 17, see elevation view of experimental hall in drawing 9-4-1-35 C2.

4. Captions for Appendix 8, Figures 4 and 16 are confusing. The Figure 4 caption includes a phrase, "the steel vent for hydrogen is 50 cm in diameter and the vent itself is 21.5 in diameter". I found my English/metric sensibilities strained a bit since "21.5 in" should read "21.5 cm in". Also, the dose equivalent scale in the legends to Figure 16 appears to have the wrong signs (unless the minus signs are too small to be visible or my eyesight is shot).

Captions fixed, pdf did not capture the small minus signs so document posted as original word file.

Labyrinths and Penetrations

1. The labs and pens section is very difficult to review. The relevant information is unnecessarily spread over too many attachments. For instance Attachment 7 itself has 3 attachments that are only 1 page long and two of which appear to be identical.

Fixed- see Bills reponse

2. The authors should use consistent names for the various penetrations. For instance it is difficult to decide how many penetrations there are through the Hatch Shield Wall. The relevant paragraph on p. 7 says there were initially three (2 for RF waveguides and one for cables) and that two more were added for the beam pipe and cabling; i.e. 5 in total.

However, attachment 7 only lists 4 and there are only two shown in the spreadsheet in attachment 7, appendix 1 and 2.
Only RF penetrations are listed now on spreadsheets, tightly packed cabling routes are not considered a penetration. The beampipe connecting the two enclosures is discussed to demonstrate that it is safe to access the experimental hall with Linac operating, but it is not a penetration.

3. The reasoning behind the allowed dose limits column in Appendix 1 of attachment 7. For instance the 20" ceiling fan has an allowed dose of 0.83 mrem/pulses based on 15 pulses per hour allowed by an interlocked detectors. This corresponds to 12.5 mrem/hr. The relevant accident limit for a category 4 area area is listed as 500 mrem in attachment 1B.
Spreadsheets only address accident condition. Limit is assessed for 600 pulses/hr on the emittance beam absorber which is normal operation and therefore the relevant limit is 100 mr/hr. Dose/pulse is 0.1 mrem, hence 60 mr/hr.

5. Some areas are listed as category 4. This implies that there are 4 ft high fences with locked gates. These should be mentioned in the document.
Mentioned but now documented everywhere there is a category 4

6. I suggest adding a table listing all the penetrations together with the calculated dose rates and relevant limits for normal and accident conditions.
Being discussed as an addition to the Summary

7. The text describing each labyrinth and penetration should include a description of the posting/occupancy category of the area that it opens onto.
Done

8. The 1st paragraph under the heading "General" on page 8 seems out of place.
Background and general information considered necessary but not appropriate to individual subsections.

9. The second paragraph states ..
" .. the worst-case loss location and condition were determined for each individual labyrinth and penetration geometry producing the largest prompt dose per pulse achievable at their respective exit." However, nowhere is there a description of how the worst case accident conditions were defined.
Added to SA: A mode-independent approach was taken where the worst-case loss location and condition were determined for each individual labyrinth and penetration geometry – the location that produced the largest prompt dose per pulse at their respective exit. First a location is chosen for proximity and line-of-sight to the entrance of the labyrinth or penetration. Upstream and downstream beam-loss locations were then checked to confirm or adjust this location to obtain the largest possible prompt dose. The highest dose per pulse is then scaled to 600 pulses/hour or 60 pulses/hour to assess the Emittance and Experiment mode, respectively. If the dose rate exceeds or is close to the acceptable limit, then a specific MARS model is invoked.

10. The scaling from baseline to MuCOOL beam conditions is not described and appears to be unity for the emittance mode. The details on how this scaling is done need to be made clear. It is also unclear how the calculations for normal operating modes differ from accident conditions.
To be explained further by Bill in attachments and SA summary table which dominates, normal mode or accident condition.

11. Attachment 7 states that doses from normal operating in experiment mode will depend strongly on the details of the experiment and hence will not be considered. I therefore conclude that the assessment is incomplete with respect to this mode and thus cannot be approved in its current form.
Again, All experimental configurations will be handled operationally through Beam Permits and Running Conditions. Each experimental configuration will be individually evaluated based on its MOU and ORC, for compliance with the approved shielding assessment criteria.

12. Some source terms are based on energy scaling from 1 TeV while others are calculated with MARS. What was the criteria used to decide which direction to take and how much difference did it make?
Either MARS or labyrinth and penetration calculations were used for this assessment (Attachment 7 and 8). When a penetration or labyrinth being assessed was of a "typical" geometry the standard Labs & Pens spreadsheet was used, when the penetration or labyrinth being assessed was atypical, modeling with MARS was performed. This decision as to which method to use was made by the AD/RSO. TM2248 addresses the 2nd question.

13. For below 1 GeV calculations a low energy source term should be used, or shown that scaling down from 1000 GeV results in conservative shielding protection.
Addressed in TM2248

14. Mention of NuMI should be removed from the attachment 7 appendices.
Done

MARS calcs
1. Which data set(s) were used in MARS to make all the calculations? My understanding is that MCNP is required for low energy neutrons?
Yes
Is the polybeads packing fractions is taken into account in MARS shielding calculations?
Yes, Igor has used 50% for the packing fractions, based on the size of the polybeads.

Groundwater & Surface Water
Some typos were cleared up & clarifications made in a new release of att. 13 which Kamran put on the server.

1. H-3 and Na-22 Water Concentration Limits should be cited. They are listed in the FRCM but originate in DOE Order 5400.5 and 40CFR141.

2. Attachment 9, page 2 lists that 2.929E20 protons per year (See Appendix 1) is the rate that will result in surface water activity hitting 100% of the limit. Appendix 1 to attachment 9 does not show a result of 2.929E20 anywhere. It is also a very confusing chart with a lack of details describing the information provided. What purpose does Appendix 1 to attachment 9 really serve?
Bill
3. Attachment 9, page the asks "At what annual rate of total protons does the surface water activity hit 100% of the 2000-pCi annual limit? There are two concerns with this. The first is that the annual limit for H-3 in surface water is 2,000 pCi/ml. The text does not include ml in the denominator when asking the question. Also, why does the question not include the 10 pCi/ml limit for Na-22 in the surface water?
Bill

4. A number of proton delivery limits exist throughout the document without sufficient clarification as to what the limiting factors are for each. This should be tidied up such that the reader is clear as to where each stated limit is derived.
Done – single proton limit from air activation

5. It is unclear as to where the water is finally deposited. The main SA document states "Beneath the experimental hall are drain tiles to collect surface water. Where do those drains lead? Also, it states that the sump pump water is discharged by the way of the Booster sump system. Where does the discharge trench of this system lead?
discharges by way of the Booster sump system into the Booster Pond.

Access & Interlocks (including rate limiter)
No questions yet.

MTA beam stop, emittance absorber, and final absorber
1. How are the beam stop and emittance beam absorber constructed? (Partially covered in attachment 10 section 2.)
New attachment 14

2. What are the thermal limits for the beam stop and emittance beam absorber?
No issues at 600 pulses/hr

Air Activation
Air activation section is confusing and needs additional details.
Revised and a detailed new attachment provided that should address all of the following questions.

1. How was table 2 derived? What methodology was used to determine the number of protons allowed per cfm?

2. Under what operating scenarios does the air activation limits apply?

3. Paragraph 2 appears to be inaccurate. EPA limits are 0.1 mrem and the laboratory limits are 10 mrem?

4. Where does the 100 micro-rem per year MEOI limit come from? We should site the laboratories air emissions permit here if that is where it comes from.

5. Paragraph 2 - At that limit the laboratory doesn't need to provide EPA approved continuous monitoring? At what limit, 0.1 mrem or 10 mrem?

6. What is the significance of 1.48E+9 protons per year in table 2 that is highlighted in blue?

7. Paragraph 3 – How did we get from protons per year to a limit of 30 Ci/year?

8. Document states that "air activity … as a function of air flow rate is given in Table 2"; that is NOT what is given in Table 2

Muon Rates and Residual Dose Rates

1. Ref 2 has >355 pages. The citation needs to be more specific?
Pg. 218-219 added to reference.

2. Was there a MARS calc done for this? Reference? If these results are accurate, this will be the highest planned residual radiation experimental hall. How will experimenters be able to access the hall to maintain their equipment? 24 hrs is not the plateau time for the dose rates The SA does not mention the real operating scenarios for this facility. Other sections discuss between xe18 and xE21 per year. What are the residual does rates if the total beam falls within these amounts. What is the residual dose on the emittance absorber?
MARS calculation is in the SA document itself. For 600 pulses in one hour, the maximum expected residual activation of the emittance absorber is 1-2 rem/hr based on Figure 7 in the SA (since Cu activation is comparable to steel). This and other potential residual activation hazards will be handled operationally as in all other Accelerator Division primary beam enclosures. Residual dose rate on emittance absorber estimated for 600 pulses in an hour is likely to be several factors higher than needed for an emittance measurement.