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

Remarks added by Bill Higgins are in blue.

Document & Drawing Completeness, Beam Input Parameters, Experimental configurations

1. Figures in SA document are not legible

2. There appears to be no clear summary of conclusions in the 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.

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

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.
FESS has added an indication of the pit fencing to Radiation Safety drawing C-1, which shows fencing around the Mucool and Linac berms.

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.
The "Cossairt Criteria" table comes from Don Cossairt, "Generic Shielding Criteria for Compliance with Chapter 6 of the Fermilab Radiation Guide," memo to John Peoples, December 11, 1990. The Shielding Requirements spreadsheet has been updated to refer to the most recent edition of the FRCM.

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.

8. A comprehensive monitoring plan should be included in the shielding assessment or SAD.

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.

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?
Yes, the assessment uses current FRCM values for dose rate limits in evaluating shielding requirements.

3. It would be very helpful to have an elevation view of the experimental hall so that longitudinal shielding could be displayed graphically.
We are adding Attachment 15, the Radiation Safety drawings for MuCOOL; an elevation view of the experimental hall appears on 9-4-1-35 C-2.

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).

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.
Attachment 7 has seven appendices. Appendix 1 and 2 summarize, respectively, the emittance-mode and the experiment-mode dose rates for labyrinths and penetrations. There is an error in Appendix 2, which contained an incorrect cycle time. The other appendices incorporate standard labyrinth calculations for five of the penetrations.

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.

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.
The Allowed Dose column computes the dose limit in millirem per pulse.

If there is not an interlocked detector:

allowed dose = (hourly dose limit) / (number of pulses per hour)

or

allowed dose = (hourly dose limit) * (accelerator cycle in seconds)/ (3600 seconds per hour)

If an interlocked detector is involved:

allowed dose = (hourly dose limit) / (number of pulses allowed by interlocked detectors per hour)

The reason for this division is that there may be some time delay in the response of interlocks to a fast-cycling machine. (We have set this to 15 pulses because the Linac is capable of 15 Hz operation and interlocked detectors are expected to respond within one second.)

This assumes that, following a trip, the beam is shut off for at least one hour.

As an example, the 20-inch ceiling vent, which is within a fenced area, is category 4, corresponding to a maximum dose of 500 millirem per hour with no interlocked detector. For the emittance mode, the cycle time is 6 seconds, corresponding to 600 pulses per hour. The allowed dose is therefore 500/600 = 0.833 millirem per pulse.

(The penetration we are calling the "20-inch ceiling vent" does not contain a fan.)

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.

6. I suggest adding a table listing all the penetrations together with the calculated dose rates and relevant limits for normal and accident conditions.

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

8. The 1st paragraph under the heading "General" on page 8 seems out of place.

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.

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.

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.

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?

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.

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

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?

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?

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.

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?

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.)

2. What are the thermal limits for the beam stop and emittance beam absorber?

Air Activation
Air activation section is confusing and needs additional details.

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?

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?