TO: Advisory Board on Radiation and Worker Health Work Group on TBD-6000
FROM: Robert Anigstein and John Mauro, SC&A
SUBJECT: Alternative Calculations of Resuspension at GSI
DATE: October 22, 2013

Alternative Calculations of Resuspension at GSI

1 Background

As stated in our earlier memo (Anigstein and Mauro 2013), we believe that inhaled activities of uranium during the residual period should be based on a resuspension factor (RF) of $10^{-5}m^{-1}$, rather than the RF of 10^{-6} m^{-1} used by NIOSH. In the course of a discussion of this issue during the October 11, 2013, teleconference meeting of the Work Group on TBD-6000, one of us (RA) cited two alternative methods of calculating airborne uranium dust concentration at the time of the 1993 FUSRAP cleanup of the Old Betatron Building that produced comparable results. The work group asked SC&A to document its findings.

2 Methodology of Alternative Methods

Our proposed method starts with the surface contamination of 1.34×10^5 dpm/m^2 during the period of AEC operations, as cited by Allen (2013). The FUSRAP cleanup of the Old Betatron Building took place in June 1993, at the end of the 27th year of the residual period. According to Sharfi (2012), "If no data are available for airborne radioactivity levels during the residual period, a source term depletion factor of 0.00067 d^{-1} . . . can be used in conjunction with the available operational period data." Sharfi (2012, Table 4-2) recommends that the airborne activity concentration should be reduced by a factor of 1.73×10^{-3} during the 27th year. Applying this factor in the present case, and assuming our proposed RF of $10^{-5}m^{-1}$, yields an airborne uranium activity of 1.34×10^5 dpm/m^2 $\times$ $10^{-5}m^{-1}$ $\times$ $1.73 \times 10^{-3} = 2.32 \times 10^{-3}$ dpm/m^3.

Our alternative method is based on the results of the survey of the Old Betatron Building performed by the Oak Ridge National Laboratory (ORNL), starting on June 7, 1993, as reported by Murray and Brown (1994, Table 4). The authors list the α-radiation levels at 31 random locations on the first floor of this building. These random samples constitute the best available data for estimating the average contamination level on the floor of the shooting room of the Old Betatron Building.

Figure 1 shows the locations of the measurements reported by Murray and Brown (1994), superimposed on a map of the first floor of the Old Betatron Building. The blue squares denote the random locations. In addition, the ORNL team scanned the entire floor using large-area floor monitors and G-M pancake probes. Red squares indicate locations that showed elevated ß/γ activities. Since they represent biased samples, the activities at these locations were not used in the present calculations, but are shown to indicate the localized distribution of these "hot spots." At 13 of the 25 random locations, the α-radiation levels were <MDA. Since Murray and Brown state that the MDA = 50 dpm/100 cm^2, we set readings of "<MDA" to one-half that value—

25 dpm/100 cm^2, as shown in Table 1 of the present memo. The average of the 31 readings is equal to 26.2 dpm/100 cm^2 or 2.62×10^3 dpm/m^2.

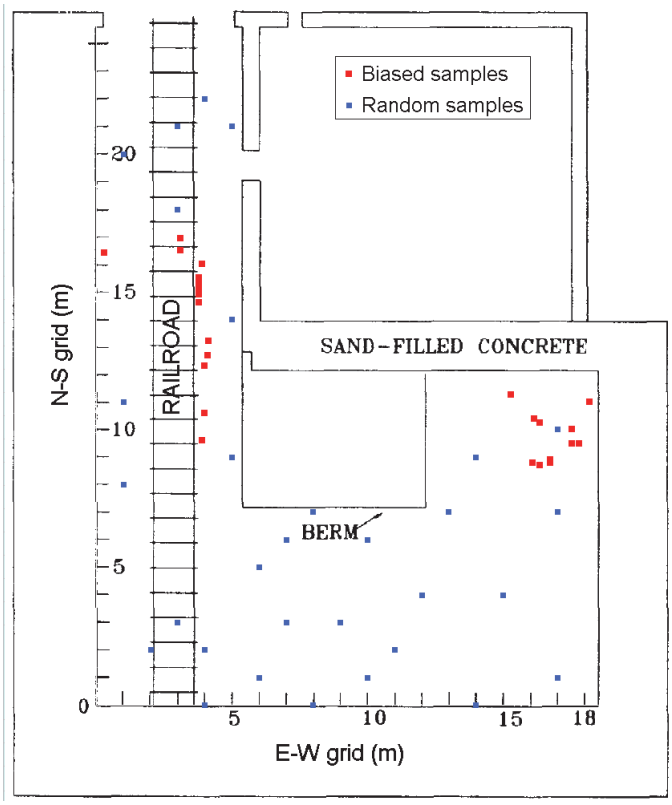

Figure 1. Locations of α-Activity Measurements in Old Betatron Building

Reviewing some of the resuspension factors cited by Sharfi (2012), we note that a factor of 10^{-6} m^{-1} is appropriate for a decommissioned facility in which surfaces were cleaned or washed, no fresh radioactive material had accumulated, and a facility in was a quiescent state. These conditions would apply to the Old Betatron Building at the time of the FUSRAP cleanup. Applying this RF to the average surface contamination level on the first floor of the Old Betatron Building results in an airborne activity concentration of 2.62×10^{-3} dpm/m^3, which is remarkably close to the value of 2.32×10^{-3} dpm/m^3 obtained by using the NIOSH approach but with an RF of 10^{-5}.

3 Conclusion

We observe that the depletion factors cited by Sharfi (2012, Table 4-2) reflect both a decrease in the surface contamination level due to removal and a decrease in the RF, a result of the surficial contamination becoming less available for resuspension. We thus conclude that the estimated airborne activity concentrations in 1993, calculated from the FUSRAP survey measurements and an RF of 10^{-6} m^{-1}, validate the proposed methodology of using the surficial activity concentration calculated by NIOSH for the operational period, coupled with the depletion rate recommended by Sharfi (2012) and a constant RF of $10^{-5}m^{-1}$.

Table 1. Alpha Activity Concentrations on Floor of Old Betatron Building

Sample location		Alpha (dpm/100 cm^2)	
North	East	Reported	Assumed[a]
0	4	<MDA	25
0	8	<MDA	25
0	14	<MDA	25
1	6	<MDA	25
1	10	<MDA	25
1	17	<MDA	25
2	2	<MDA	25
2	4	<MDA	25
2	11	21	21
3	3	<MDA	25
3	7	35	35
3	9	<MDA	25
4	12	<MDA	25
4	15	<MDA	25
5	6	<MDA	25
6	7	<MDA	25
6	10	<MDA	25
7	8	<MDA	25
7	13	35	35
7	17	<MDA	25
8	1	<MDA	25
9	5	<MDA	25
9	14	<MDA	25
10	17	42	42
11	1	<MDA	25
14	5	28	28
18	3	<MDA	25
20	1	<MDA	25
21	3	<MDA	25
21	5	<MDA	25
22	4	<MDA	25
Average			26.2

Source: Murray and Brown (1994, Table 4)

[a] Assuming "<MDA" = 25 dpm/100 cm^2

References

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