NIOSH Response to Sanford Cohen & Associates Review of Battelle -TBD-6000 Appendix BB *(General Steel Industries, Rev. 2)*

Response Paper

National Institute for Occupational Safety and Health

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Background

The Advisory Board's work group on TBD-6000 held numerous meetings to discuss issues identified in Sanford and Cohen's review of Appendix BB to TBD-6000, the site profile for General Steel Industries (GSI). During these discussions, most issues associated with estimating doses at GSI were resolved. On June 6, 2014, NIOSH issued revision 1 of Appendix BB. SC&A reviewed this document and issued a memo on December 10, 2014, that contained 9 findings. On January 8, 2015, NIOSH issued two white papers providing responses to the 9 findings. On January 26, 2015, SC&A issued a new memo responding to the NIOSH white paper. This new memo added one additional finding.

The work group held additional meetings on February 5, 2015, and November 3, 2015, resulting in a resolution to each finding. As a result, revision 2 of Appendix BB was issued on May 26, 2016. On September 6, 2016, SC&A issued a memo discussing their review of revision 2 which concurred that all findings had been resolved with the exception of findings 1 and10. This paper provides the NIOSH response to these two findings.

Finding 1 – Neutron Dose Rates

Appendix BB specifies that neutron doses are assumed to be from exposure in the 0.1-2 MeV energy interval. Based on the distribution of neutron energies in the modeled exposure scenarios, SC&A pointed out that this assumption underestimates the dose. While using the 0.1-2 MeV neutron energy range is a favorable approximation when the dose comes from film badges calculated using a quality factor of 10, NIOSH agrees it is not necessarily a favorable assumption when doses are modeled.

Because the doses are small, we do not believe it is necessary to assign a dose for each of the four neutron energy intervals proposed by SC&A. DCAS will still assign all the neutron dose to one energy range, but the 2 to 20 MeV range will be used to provide a claimant favorable simplification. That requires the revision to one sentence in the paragraph that follows table 9 in Appendix BB. A revised version of Table 1 from SC&A's review is provided below which shows that the use of a default 2 to 20 MeV energy range is a claimant favorable simplification.

Energy range	Lung DCF	Betatron Operator						Layout man	
		Uranium radiography	Uranium handling	Uranium total		Steel radiography		Steel radiography	
		H*(10)	H*(10)	H*(10)	Lung	H*(10)	Lung	H*(10)	Lung
0-10 keV	1.523	0.574	0.003	0.577	0.879	0.160	0.244	0.106	0.162
10–100 keV	0.751	0.100	0.047	0.147	0.111	0.058	0.044	0.084	0.063
0.1–2 MeV	0.579	0.731	0.795	1.526	0.884	0.588	0.340	1.413	0.818
2-20 MeV	1.004	0.063	0.006	0.069	0.069	0.051	0.051	0.234	0.235
Total		1.469	0.851	2.319	1.942	0.857	0.679	1.837	1.278
NIOSH[a]	1.004	1.469	0.851	2.319	2.328	0.857	0.860	1.837	1.844
Δ[b]					-17%		-21%		-31%

[a] Lung dose calculated using lung DCF for 2 – 20 MeV neutrons
[b] Δ = Total ÷ NIOSH - 1

Finding 10 – External Exposure of Betatron Operator

In its review, SC&A indicated the site profile should specify that the maximum dose conversion factor (DCF) from the <30 keV photon range should be used to calculate the betatron operator photon dose.

Use of the maximum DCF as recommended by SC&A did not appear to have any basis at first. After careful review, however, it was realized that the appropriate DCF would be that of a 30 keV mono-energetic photon rather than from the zero to 30 keV range. This is because the mono-energetic DCF for breast was used to derive the 204.5 mrem/week dose rate. The 30 keV mono-energetic photon DCF corresponds with the maximum DCF of the zero to 30 keV range. Since the PA geometry DCF was used in the derivation, the PA geometry, air kerma, 30 kev photon DCFs will be specified in a revision to the appendix.

Using the 30 kev DCF then changes the limiting exposure scenario for the skin of the hands and forearms. Table 9 values for 1964 through 1966 will change to the Betatron Operator values instead of the layout man values.

Changes to be made to Appendix BB

The discussion of the photon DCF mentioned in finding 10 and the neutron DCF mentioned in finding 1 are both contained in the same paragraph following Table 9 of Appendix BB revision 2. The photon DCF is also mentioned on page 15 and in footnotes to Tables 8 and 9 of the Appendix. Therefore, the list of recommended changes to Appendix BB would be:

1. Change the footnote of Table 8 and the text on page 15 from <30 keV to 30 keV.

2. Change the values for the last three years of Table 9, as well as the footnote. Table 9 now reads as follows:

Table 9 – Operator Dose Estimate for the Skin of the Hands and Forearms (H&F)

Year	Gamma Dose (rad/yr) (a)	Neutron Dose (mrem/yr)	Beta Dose (mrad/yr)	Source of Estimate
1952	10.225	108	7312	Betatron Operator
1953	10.225	432	29249	Betatron Operator
1954	10.225	432	29249	Betatron Operator
1955	10.225	432	29249	Betatron Operator
1956	10.225	432	29249	Betatron Operator
1957	10.225	432	29249	Betatron Operator
1958	10.225	419	24810	Betatron Operator
1959	10.225	413	22982	Betatron Operator
1960	10.225	413	22982	Betatron Operator
1961	10.225	423	26115	Betatron Operator
1962	10.225	403	19456	Betatron Operator
1963	10.225	365	6627	Betatron Operator
1964	10.225	356	3591	Betatron Operator
1965	10.225	354	3113	Betatron Operator
1966	5.112	176	1317	Betatron Operator

(a) Gamma doses represent a constant distribution, PA geometry, air kerma, 30 kev photons

3. Change the paragraph following Table 9 to read as follows:

"Except for the triangular distributions described in Table 8, all doses should be assigned as a constant distribution. Gamma doses should be assigned as 30 to 250 keV photons except for the 10.225 and 5.112 rad/yr doses from betatron operations. Those should be used with the 30 keV DCF for air kerma in the PA geometry. The 30 keV DCF is the maximum of the <30 keV range DCFs. Neutron doses should be assigned as 2 to 20 MeV neutrons and beta doses should be assigned as >15 keV electrons."