WHITE PAPER

Evaluation of Differences in Beta Dose Estimates for GSI

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Background

In August 2013, NIOSH issued a white paper summarizing dose estimates for GSI. On October 6, SC&A issued a response to that white paper that reported a significant difference between NIOSH ansd SC&A in beta dose estimates for Betatron Operators. An agreement had previously been reached that NIOSH would use the SCA model from its original review of the GSI Site Profile, which was issued in April 2008. That model was to be modified using a newer version of MCNPX. This was done for the NIOSH white paper so the differences in the two estimates was reviewed and detailed here.

NIOSH did not have the details of the latest SC&A calculation but was able to reproduce the results (within 10% for most years). The method used to reproduce those results revealed three primary issues contributing to the differences.

1. The uranium working time used in the calculations

Table 1 of the SCA response dated October 6, 2013 lists uranium work hours used by NIOSH and SCA. These hours differ and were used by both organizations in calculating beta dose thus represent some of the difference in the resulting value.

2. Error by NIOSH

In comparing the estimated values, it was determined that NIOSH inadvertently used some dose rate values from the layout worker rather than the betatron operator.

3. 100% occupancy instead of 50% in original model

Although the above two issues would bring the estimates closer in line, they would not result in a dose estimate comparable to the SC&A estimate. However, doubling the dose NIOSH used for exposure to irradiated steel results in a reasonable close match. The original SC&A dose estimate that NIOSH agreed to use had an occupancy factor where the operator was assumed to be within 1 foot of the irradiated

steel 50% of the time (section 2.5 of original SCA review of the Site Profile). It appears that SC&A used 100% occupancy for its current estimate.

4. Additional issues

There are additional differences in the calculations that NIOSH could not account for. Minor differences likely occurred from statistical variability with MCNPX calculations. This does not however, explain all the variations. It is our understanding that the same dose rate from the uranium and from steel is to be used for all years and the year to year dose estimate would vary only by the uranium work hours. Table 3 of the SC&A October 6, 2013 memo indicates the 1961 dose estimate is the highest but Table 1 of the memo indicates 437.5 hours per year is the highest and is to be used for all years prior to 1958. The 437.5 hours is applicable to the 7/1/1961 to 6/30/1962 time frame. The work hours prior to and after that are lower. Therefore the hours used for 1961 cannot be higher than pre-1958 years and should be lower. It is therefore unexplained as to why the 1961 dose estimate is higher than the pre-1958 years. Below are the corrected NIOSH values. These values have been corrected for the error mentioned in item number 2 above.

Table 1

Year	Hours per year	Hands and Forearms (rad/yr)	Other Skin (rad/yr)
10/1/1952 – 1957	337.5	28.5	3.90
1958	337.5	28.5	3.90
1959	337.5	28.5	3.90
1960	337.5	28.5	3.90
1961	387.5	32.0	4.07
1962	281.5	24.5	3.71
1963	76.5	9.9	3.00
1964	28	6.4	2.84

1965	20.5	5.9	2.81
1966	13	2.7	1.39

Below are the NIOSH values using the uranium working time based on SCA table 1 and doubling the steel dose. The SCA values are in parenthesis for comparison. With the exception of the first hand and forearm dose, all values are within 10% of each other.

Table 2

Year	Hours per year	Hands and Forearms NIOSH (SCA)	Other Skin NIOSH (SCA)
10/1/1952 – 1957	437.5	39.4 (33.4)	6.61 (6.27)
1958	366.7	34.5 (32.1)	6.43 (6.22)
1959	337.5	32.4 (30.9)	6.35 (6.18)
1960	337.5	32.4 (30.9)	6.35 (6.18)
1961	387.5	35.9 (34.2)	6.48 (6.30)
1962	281.3	28.5 (27.2)	6.21 (6.04)
1963	76.6	14.2 (13.9)	5.68 (5.56)
1964	28.1	10.8 (10.7)	5.55 (5.45)
1965	20.5	10.3 (10.2)	5.53 (5.43)
1966	12.9	4.9 (4.8)	2.76 (2.71)