NIOSH Response to SC&A Findings on SEC-00225 Blockson Chemical Company Residual Contamination Period

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Finding 1: ***The approach used to assign external exposures to workers at Blockson, though reasonable, is not consistent with the method used to assign external exposures at Simonds Saw and Steel, nor is it consistent with reported working hours characterized in claimant CATI reports.***

NIOSH response: NIOSH agrees with SC&A that the external doses during the Blockson residual contamination period are reasonable and we also acknowledge that the methods used to assign external exposures at Simonds were different. The differences in methods between the two sites are a result of differences in available data, site processing history, and the relative extent of contamination at the two sites.

Since there are notable differences between the two sites and available data, there is no way to provide a quantitative comparison to the methods used to estimate doses at Blockson and Simonds. However, some notable differences were pointed out. SC&A noted that NIOSH used an 80 µR/hr value and 2,500 hours exposure time to estimate doses at Simonds and applied it as a constant, noting the dose rate was higher than the 95th percentile 75 µR/hr value. That compares to a lognormal distribution based on 2,000 hours for Blockson. The Blockson TBD provides a distribution of annual dose, but the values were not based on a true statistical distribution of the dose rate data. It was an assumed distribution taken from bounding dose rate assumptions (median dose assumed a worker was exposed to one specific area for 2,000 hours, while the 95th percentile assumed a worker was exposed to the highest observed dose). These assumptions provided a favorable, yet plausible dose for Blockson.

The 80 µR/hr dose rate used for Simonds TBD Revision 2 was retained from Revision 1 after consideration of comments from SC&A and review of the available data. The 80 µR/hr dose rate, taken from a 1957 survey, was retained rather than using a slightly lower value estimated from consideration of a broader set of data. NIOSH increased the exposure time to 2,500 hours for Simonds to allow for comments on overtime work. Based on the extent of areal elevated dose rates in the general area of the rolling mill at Simonds it was considered plausible some workers could have been exposed at that rate for a significant portion of the work day. Blockson's dose rate patterns in the building were much different; there was no overall elevated general area dose rate, only a few spots and small areas with elevated radiation. The 2,000-hour assumption with the applied dose uncertainty sufficiently allows for overtime work.

Finding 2: ***The Blockson TBD (DCAS-TKBS-0002, Revision 04) should address the potential exposures associated with the phosphogypsum stacks, including the relatively small volume of scale and sediment containing elevated levels of Ra-226 that are often present in phosphogypsum stacks.***

During the residual contamination period, some Blockson workers could have been exposed to elevated dose rates at the phosphogypsum stacks for short periods of time

from scale residues that originated in the AWE contract period. NIOSH considers those doses to be bounded by the assumptions made in the Building 55 dose model, which provided for a bounding rate for the entire site. The Building 55 dose model provides a median dose of 0.060 R/year with a geometric standard deviation of 3.2. The 95th percentile of that distribution in 0.406 R /year. The distribution should account for infrequent exposure at a higher rate, although it should also be noted that SC&A's report assessed the typical dose rates from phosphogypsum stacks, noting they were lower than the Blockson TBD values for Building 55. Based on studies of historical exposures at phosphate plants (as discussed in the TBD and in the SC&A review) the dose estimates in the TBD for Building 55 is sufficient to bound dose.

Finding 3: ***Beta dose associated with residual contamination in Building 55 should be included in the site profile.***

NIOSH response: NIOSH agrees that beta doses are a consideration; however, we believe that the bounding photon dose rates in the TBD sufficiently account for both photon dose and beta dose. As discussed in the SC&A report, the TBD provides an annual photon dose of 0.060 R/year, assigned as the median of a lognormal distribution having a geometric standard deviation of 3.2. The TBD did not provide beta dose during the residual period.

Based on their estimates of beta dose, SC&A suggested adding 24 mrad per year beta dose for skin. NIOSH agrees that the value suggested by SC&A is reasonable and that a specific beta dose is appropriate. However, NIOSH does not agree that the dose provided in the TBD should be increased. If a revision is made to the TBD to more accurately model external dose, the dose conversion factors in TBD-6000 Table 3.10, and the contamination levels in Building 55, should be used to estimate a much lower photon dose (applicable to all organs). Estimates indicate the total dose to all organs would be lower. The current TBD provides a claimant-favorable approach.

NIOSH proposes no changes be made to the TBD because such a change would only marginally *reduce* total dose, although skin dose would not be reduced as much as dose to other tissues.

Finding 4: ***The doses associated with the inhalation of resuspended particulates in the vicinity of the phosphogypsum stack should be explicitly addressed in the site profile.***

NIOSH response: NIOSH considered the potential for intakes at the phosphogypsum stacks. However, the concentration and mix of radionuclides in phosphogypsum stacks indicated that workers in that area would have received a lower dose than the dose estimates provided for Building 55. Note the phosphogypsum from the AEC contract period did not have significant quantities of uranium (since most of it was recovered). NIOSH did not include an evaluation of intakes from the phosphogypsum stacks in the

TBD because it was not needed for dose reconstructions. SC&A confirmed the conclusions made by NIOSH.

Finding 5: ***The radon concentration in the vicinity of the phosphogypsum stacks should remain at the elevated level of 2.1 pCi/L up until 1991, the time when the piles actually became inactive.***

Observation 1: ***Radon exposures to workers in the vicinity of phosphogypsum stacks during the residual period appear to have been substantially overestimated.***

NIOSH response: SC&A's Finding 5 and Observation 1 are related issues that suggest opposing positions. Both comments summarize valid observations from SC&A that need discussion. It appears Finding 5 may be written to indicate that even if the residual radon exposures are overestimated, NIOSH did not provide a valid reason to apply a depletion curve starting in 1960. Although the bounding methods used were explained in the TBD, the complete rationale for the depletion parameters was not fully explained in the TBD. The rationale differs in some respects from the evaluation provided by SC&A.

NIOSH provided an estimate of radon exposures from the phosphogypsum stacks for 1960 (for active stacks). NIOSH also provided an estimate of radon exposures in 1993 (for inactive stacks). NIOSH considers both of those values to include radon that is related to AEC work and radon that is unrelated to AEC work. In Observation 1, SC&A pointed out that the radon emanating from the stacks was significantly overestimated because NIOSH assumed all the radon escaping the pile was from AEC-related waste, when in fact, there was a significant fraction of the radium-bearing waste that was from non-covered commercial operations prior to the start of AEC activities. NIOSH agrees that a substantial quantity of phosphogypsum existed prior to AEC production era (1952-June 1960). There are no data available to estimate quantities on the stacks prior to 1952, but Blockson had been in business for many years prior to the AEC work. The Block brothers assumed ownership of their father's company in the 1930s and renamed it Blockson.

A considerable quantity of phosphogypsum waste was generated from 1952 – June 1960 during the period of AEC work. NIOSH presumes the radon emanating from the stacks in 1960 was coming from the AEC-related waste that would have comprised the uppermost layers of the stack, while the majority of the earlier waste was likely buried or in an inactive area of the stacks, such that most of the radon generated from decay of Ra-226 in 1960 was from the layers recently deposited, with a significant portion of the radon from historical waste decaying into particulate within the stack matrix. Thus, since there is no means to provide an accurate estimate of the fractions of covered and non-covered radon in 1960, the presumption to apply all radon as covered exposure is bounding, but it is not considered a significant overestimate for someone working at the stacks. It is a reasonable bounding assumption.

With Blockson continuing to produce and deposit phosphogypsum on the stacks after June 1960, up to plant closure in 1991, the AEC layer of waste became buried, gradually reducing the diffusion of radon from the AEC layer. Conversely, if the AEC waste was in a location of the stack that became inactive and not covered up by newly generated (non-covered) phosphogypsum, the emanation from the inactive areas would have declined (for the reasons discussed in the TBD and SC&A report). In either case, the AEC era waste was either declining from being located in an inactive area of the stack or declining because it was being covered by significant quantities of commercial waste.

The 1993 radon concentration of 0.42 pCi/L was derived from measured flux values on top of the inactive stacks. NIOSH presumes the majority of the radon emanating from the stacks in 1993 was from commercial operations in the latter years, but there is a potential contribution from 1950s AEC work. NIOSH concluded it cannot distinguish the 0.42 pCi/L being covered exposures or non-covered commercial exposures.

Although NIOSH concluded the fractions of covered radon and non-covered radon cannot be determined in either 1960 or 1993, there is still a basis to assume the emanation of AEC-related radon started declining in 1960.

Regarding Finding 1 that radon depletion should not begin until the stack became inactive, NIOSH agrees that the *total* radon emanation from *active* portions of the stack would not have been declining in 1960, but the portion from the AEC-related waste layer would have declined because lesser quantities of radon gas would have escaped the matrix as more and more material was piled on top of it. Likewise, if the AEC waste comprised the top layer of an inactive portion of the stack, the emanation of the AEC radon started declining due to characteristics of radon emanating from inactive stacks.

Based on this discussion, NIOSH concluded it is appropriate to assume all radon was covered exposures at the beginning of the residual period, then declined gradually. The end point of that decline assumes all radon from an inactive stack could have been from radium originating in the AEC era. Given the relatively low 0.42 pCi/L value, NIOSH considers the estimate sufficiently accurate.