



MEMO

TO: Dose Reconstruction Subcommittee
FROM: John Mauro, SC&A
SUBJECT: Comments on SC&A's 'Method B' Blind Dose Reconstruction of Exposure to Radon for a Worker at Allied Chemical and Dye Corporation in North Claymont, Delaware
DATE: May 12, 2015

One of the topics discussed during the meeting of the Dose Reconstruction Subcommittee (DRSC) held on April 14, 2015, was exposure of a worker to radon at Allied Chemical and Dye Corporation in North Claymont, Delaware (Allied). The worker was an energy employee (EE) who worked at Allied from [redact] 1942 to [redact] 1954 and [redact] 1956 to [redact] 1975. This employment period spans the operational period of 1950 through 1969, when Allied was involved in a small-scale pilot operation recovering uranium from a phosphoric acid plant, as well as for most of the residual contamination period of 1970 through 1977. According to the Department of Labor (DOL) records and the Computer-Assisted Telephone Interview (CATI), the EE worked as a [redact] during both employment periods. No employee monitoring records or site survey records were found. The EE was diagnosed with oat cell carcinoma of the lung (ICD-9 Code 162.9) in [redact] 1981.

This blind dose reconstruction (DR) was summarized in SC&A's report, *Comparison of SC&A's Blind Dose Reconstruction to NIOSH's Dose Reconstruction of Case # [redact] from the Allied Chemical Plant and Dye Corporation, North Claymont, Delaware, December 2014*. In that report, SC&A compares the lung doses reconstructed by NIOSH with the lung doses reconstructed by two independent SC&A methods (i.e., 'Method A' and 'Method B'). SC&A performed its DR using information supplied by the Department of Energy (DOE) regarding this site and worker, and any other information SC&A could obtain from the open literature and from the NIOSH Site Research Database (SRDB). However, SC&A did not have access to NIOSH's DR until the comparisons were made in the above referenced report. It is also noteworthy that, for this blind DR, SC&A's 'Method A' (which made use of all of NIOSH's protocols and tools) worked independently and did not communicate with the 'Method B' DR team (which was based on fundamental health physics principles, without necessarily relying on NIOSH guidance or NIOSH contractor workbooks). The following table, excerpted directly from the above-cited report, compares the reconstructed doses/radon progeny exposures performed by NIOSH and SC&A.

Table 3-1. Comparison of Total External and Internal Doses to the Lung

Total Doses	SC&A-Method A (rem)	SC&A-Method B (rem)	NIOSH (rem)
External Lung Doses:			
- Operational Period	1.041	NA	0.381
- Residual Period	0.194	NA	0.103
- Occupational Medical	1.886	NA	1.592
Internal Lung Doses:			
- Operational Period	93.679	NA	15.106
- Residual Period	24.635	NA	0.088
Total Lung Dose	121.435	NA	17.271
Total Radon	0.812 WLM	2.115 WLM	0.214 WLM
POC	85.4%	64.1%	45.90%

NA = Not applicable.

During the DRSC meeting, one of the interesting discussions pertained to comparisons between the radon exposures estimated by SC&A and those estimated by NIOSH. As part of the Subcommittee discussions on this subject, we found that SC&A ‘Method A’ strictly followed NIOSH’s guidance provided in ORAUT-OTIB-0043 for the operations period and ORAUT-OTIB-0070 for the residual period. During the Subcommittee meeting, NIOSH explained that they used fundamentally the same procedures, but divided all values recommended in OTIB-0043 for the operational period by a factor of 10, because they felt that the amount of phosphate processed as part of Allied’s Atomic Weapons Employer (AWE) activities was so small that OTIB-0043, which is intended to be used for DR of large phosphate ore processing plants, would result in a gross overestimate of the doses; hence, the 10-fold reduction factor in the default radiation exposure parameters recommended in OTIB-0043. This is the main reason for the large differences in all exposures between NIOSH’s DR and SC&A’s ‘Method A’ DR.

This memorandum, however, is concerned primarily with SC&A’s ‘Method B’ DR. The author of that DR (John Mauro) decided to perform what is commonly referred to as a minimizing DR, by simply assuming that the workers at Allied during the AWE period were exposed to relatively low concentrations of radon, namely 4 pCi/L for the entire AWE contract period. This resulted in a radon progeny exposure of 2.115 WLM over the course of this worker’s employment at Allied. The intent of this simple calculation was to determine whether this assumed level of exposure was sufficient to result in a probability of causation (POC) of greater than 50%. As it turned out, this first attempt at SC&A ‘Method B’ resulted in a POC of 64.1%, and the ‘Method B’ blind DR was concluded.

During the DRSC meeting, NIOSH and its contractors expressed that they believed that 4 pCi/L was not necessarily a very low radon concentration in light of the data reported in OTIB-0043 for phosphate plants, and the Subcommittee directed SC&A to take a closer look at this assumption, in light of the information provided in OTIB-0043. This memorandum provides the results of SC&A’s follow-up investigations into this matter.

The results of these follow-up investigations are interesting for a number of reasons, creating a conundrum on how to address this particular set of circumstances. SC&A believes that the discussion that follows leads one to conclude that it is difficult to deny this worker compensation under the circumstances encountered at this facility.

OTIB-0043 provides guidance regarding the reconstruction of doses to workers at AWE facilities that processed phosphate rock for the purpose of producing various phosphate products and/or uranium. In the case of Allied Chemical and Dye Company in North Claymont, Delaware, our review of the SRDB (see Appendix 1) reveals that very little uranium was produced, but the reports are silent on the amount of phosphate rock that was processed. We have no information regarding whether Allied produced phosphate commercially during the AWE time period, nor do we have information regarding how much phosphate rock was processed in support of AWE operations. One could back-calculate the amount of phosphate rock that would need to be processed to produce a few pounds of uranium, but that doesn't necessarily mean that value places a plausible upper bound on the amount of phosphate rock that was processed over the AWE time period. Nevertheless, we can agree that the amount of phosphate rock processed at Allied was small relative to the amount of phosphate rock processed at the facilities in Florida, which are used as a starting point for developing surrogate data for Allied.

Based on the above discussion, one could come to the erroneous conclusion that the concentrations of radon in air at the Allied facility were likely a small fraction of the concentrations of radon observed in phosphate processing buildings in Florida. The reason we consider this to be a false conclusion is that the buildings that processed phosphate rock in Florida were open buildings; i.e., they didn't have walls. This issue was discussed beginning on page 60 of the transcript of the June 5, 2008, Blockson Work Group meeting and beginning on page 19 of the January 23, 2009, transcript of the Blockson Work Group meeting. The outcome of these discussions revealed that the radon concentration data summarized in OTIB-0043, which are based on a massive amount of data compiled by the Florida Institute of Phosphate Research (FIPR), cannot be reliably used as a surrogate for enclosed buildings that processed phosphate rock. It is for this reason that FIPR radon concentration data could not be used as a surrogate for DRs for the Blockson Chemical Company, which was a commercial phosphate processing company that also produced uranium in support of the weapons complex. To a large degree, this same issue also applies to Allied.

It is noteworthy that the concentrations of airborne radon reported for phosphate processing facilities in Florida are largely less than 1 pCi/L. These are the concentrations that one would expect outdoors at phosphate facilities, where these slightly elevated levels of outdoor radon (as compared to typical outdoor radon concentrations) are likely due to radon emanation from phosphogypsum stored outdoors. It is therefore apparent to SC&A that OTIB-0043 cannot be applied to closed buildings that processed phosphate rock, such as the Allied building.

Notwithstanding these types of arguments, the radon concentrations used by NIOSH in its DR for this case and those used by SC&A in 'Method B' are not necessarily wrong. The most likely scenario is that the building had some level of radon in it that was from naturally occurring sources and some that was from processing phosphate rock. The Environmental Protection Agency's (EPA's) national radon database reveals that 10.3% of private homes in Claymont,

Delaware, have radon concentrations above 4 pCi/L (i.e., 64 homes out of a total of 621 tested¹). The conundrum regarding this case arises from the following facts:

1. It is quite possible that the airborne concentrations of radon in the Allied building in North Claymont, Delaware, were a few pCi/L, perhaps 4 pCi/L or higher.
2. The amount of naturally occurring radon versus radon generated as a result of phosphate processing is difficult to discern.
3. The radon concentration data provided in OTIB-0043 for buildings processing phosphate cannot be used as a surrogate for Allied, because they are based on open buildings, as reported by the FIPR.
4. It requires only a few pCi/L exposure to radon and its progeny for several years to result in a POC for lung cancer in excess of 50%.

Given this set of circumstances, SC&A believes that it is difficult to deny this claim.

¹ See <http://www.dhss.delaware.gov/dph/hsp/files/hhinsideradonzip.pdf>. This web site provides the results of EPA's national radon testing program.

Appendix 1 Review of Allied Chemical and Dye Company Files in the SRDB

SC&A reviewed all of the records in the NIOSH SRDB pertaining to Allied Chemical Corp. in North Claymont, Delaware. There does not appear to be any information regarding how much phosphoric acid was processed in the plant outside of the Atomic Energy Commission (AEC) operations. The majority of known information on AEC activities at Allied comes from the Formerly Utilized Sites Remedial Action Program (FUSRAP) document published on the site in 1977, which describes the following:

In the early 1950s, Allied Chemical was involved in research and development and small pilot-scale operations on uranium recovery from a phosphoric acid plant at North Claymont. The work, under AEC contracts AT(49-1)-610 and AT(49-6)-913, was performed on a small scale. Former AEC employees estimated that, at most, only a few pounds of uranium concentrate were produced (page 12 of SRDB 13209).

A document titled, “Major activities in atomic energy programs July 1951–Dec 1951” (SRDB 40448, page 16) lists Allied Chemical as a company under AEC contract to carry out “process studies of uranium extraction,” indicating that AEC operations began sometime in 1951. In 1956, AEC began a program to declassify reports and information for plants that had an annual production of 100 tons or less of U₃O₈ and Allied Chemical and Dye in Delaware was included on that list (pages 9–13 of SRDB 123636).

In 1977, interviews were conducted with several former employees. Handwritten notes from these interviews are published in the document, *Report of Findings at Allied Chemical Corporation Site* (SRDB 16503). In an interview dated November 14, 1977, one worker describes the amount of uranium processed at Allied as “less than 2–10 pounds of uranium separated, doesn’t remember a uranium analytical capability with Claymont” (page 7 of SRDB 16503).

The FUSRAP report concluded the following concerning potential contamination at Allied:

Operations at the phosphoric acid plant ceased in the late 1960s and the plant was demolished in the early 1970s. The contractor, Cleveland Wrecking, salvaged reusable building materials and disposed of the remaining rubble in local landfills. The exact location on the site where the AEC work was performed is not known.

DOE (then the Energy Research and Development Administration) Oak Ridge Operations Office contacted Allied on July 18, 1977. A contact report, furnished to DOE Headquarters on December 12, 1977, concluded that the potential for uranium contamination was insignificant. DOE headquarters has approved the operations office recommendation that further investigation to locate and assess the AEC contract work area of the site be terminated. The site has been

eliminated from consideration for inclusion in the Formerly Utilized Sites Remedial Action Program (page 13 in SRDB 13209).

SRDB 123636: Johnson, Jesse C. Authority to declassify documents relating to the raw materials program. Atomic Energy Commission. 1956.

SRDB 13209: FUSRAP Elimination report for Former Allied Chemical Corporation, Chemicals Company (Now General Chemicals Corporation) North Claymont, DE, DOE. 1977.

SRDB 16503: Report of Findings at Allied Chemical Corporation Site. 1977.

SRDB 40448: Major activities in atomic energy programs July 1951–Dec 1951.