MEMO

TO: Mound Work Group

FROM: Joseph Fitzgerald, SC&A

DATE: June 1, 2012

SUBJECT: Reply to NIOSH Comments on SC&A's Thorium Report of May 2, 2012

On May 2, 2012, SC&A provided the Mound Work Group with a report titled, *SC&A's Evaluation of NIOSH's April 2012 Mound Laboratory Th-232 White Paper*. On May 29, 2012, NIOSH forwarded the following responses to the comments expressed by SC&A in this white paper. NIOSH's report is provided below, and SC&A replies to the NIOSH responses are provided in blue text.

NIOSH Responses to SCA's Thorium Report of May 8, 2012
May 29, 2012

SC&A comment 1:
Was access to, and working with, the thorium-containing materials controlled by physical barriers and/or procedural requirements?

NIOSH response 1:
The redrumming effort occurred in a remote part of the site (near the future location of Building 21 – the thorium sludge storage building), geographically removed from other site activities. Former workers have anecdotally told NIOSH that controls (exclusion zones, health physics monitoring, respiratory protection, etc.) were established and that the workers involved were on a routine urinalysis program (which is supported by the urinalysis records). Therefore, it is highly unlikely that a worker would have visited this work location without being on at least gross alpha urinalysis.

SC&A's reply 1:
This issue comes down to accepting that oversight and control was adequate and in place.

SC&A comment 2:
Were only persons directly involved with handling the material allowed in the area, or could there have been other personnel, such as craft workers, maintenance workers, grounds keeper, etc., that may have worked around the material, but were not considered part of the thorium-handling crew? Exposures could have occurred not only during the periods the material was being handled, but also during dormant periods when no specific activity was taking place, and

no health physics oversight was in place; thorium bioassays would not have been available for these types of workers under those circumstances.

NIOSH response 2:
Craft and maintenance workers were in fact the personnel performing this project. It involved Hyster operators and laborers, as well as health physics monitors. It is unlikely that exposures occurred during the "dormant" periods. The drums were stored outside in a geographically remote part of the site removed from other site activities. Redrumming occurred in the warm weather months, and ceased in the winter months. While it would not be physically impossible for some worker to visit this remote location in the dead of winter when no activity was being performed, reasons for doing so are not obvious. Furthermore, the material was contained in drums. While it is true that some drums began rusting, hence the need for redrumming, the airborne exposure potential from material so stored would have been minimal unless the material was disturbed (*e.g.* redrumming).

SC&A's reply 2:
Again, this issue comes down to accepting that oversight and control was adequate and in place.

SC&A comment 3:
What situation or procedure triggered the need to obtain urine samples and have them analyzed for thorium and the results recorded?

NIOSH response 3:
As with other radionuclides at Mound, work with ^{232}Th triggered collection of urine samples. Workers involved in this activity were on a routine urinalysis program.

SC&A's reply 3:
This issue comes down to accepting that administrative requirements were carried out.

SC&A comment 4:
Was a list of personnel working with or around thorium-containing materials maintained? Relying on recorded thorium bioassays and/or applying a coworker model can only be used if it can reasonably be assured that the potentially thorium-exposed workers were bioassayed or identifiable for coworker dose application, unless the coworker dose is applied to all unmonitored workers.

NIOSH response 4:
NIOSH is aware of no list of workers on the thorium redrumming project beyond what can be assembled from the bioassay records. Also see NIOSH response 5.

SC&A's reply 4:
Again, this issue comes down to accepting that oversight and control was adequate and in place.

SC&A comment 5:
ORAUT-TKBS-0016-5 states:

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> *Primary ^{230}Th bioassay records consisted of a logbook, and apparently duplicate records in a brown notebook. Count data were typically recorded on Form O-318 followed by an "I" or "Io." Secondary ^{230}Th results started as weekly reports on March 17, 1958. Weekly reports included Name, Isotope, and Result. Prior to 1958, secondary ^{230}Th results were reported on Form O-634 including Name, Badge Number, Date, Type of Analysis, Isotope, and Result. However, some secondary documents have problems with reporting units. Some results are reported to be cph* [counts per hour] *per 24-hour sample when primary records indicate that they are actually cpm* [counts per minute] *per aliquot. The ORAU database should therefore be considered a secondary record extracted from primary records.*

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> *Thorium-232 records are diverse due to programs conducted for many years. Primary ^{232}Th bioassay data were entered into a small brown spiral notebook marked "Radium-Thorium" and "Radium-Thorium Separation from 8/15/1955 to 2/2/1959 (Meyer 1992). Additional primary 232Th bioassay data were recorded in a large hardcover record book. However, the first 38 pages from this record book were removed from 7/6/59 to 1/9/61, 7/13/64 to 11/15/64 and 5/30/65 to 6/6/65. These record books apparently do not contain true primary data, but calculated results such as cpm excreted per day. Secondary records in weekly reports contained ^{232}Th results as cpm/24-hr samples beginning March 17, 1958. In August 1959, secondary results were reported on form O-756. The ORAU database is a record of secondary ^{232}Th bioassay data extracted from other primary records (ORAU 2003e).* [Emphasis added.]

From this information, it is not apparent that the dose reconstructor has access to copies of all the original data sheets, or where they are located. SC&A's scan of some of the DOE files located several of these forms with thorium bioassay data recorded. However, there does not appear to be much assurance that all the primary data are available to the dose reconstructor.

NIOSH response 5:

The quote from ORAUT-TKBS-0016-5 page 30 is not relevant as it deals with ionium (^{230}Th), while the subject of NIOSH's paper was reconstruction of dose from ^{232}Th. The record books in question are available in the SRDB. SC&A has seen for themselves that thorium bioassay results are included in the DOE files. It is not possible to prove a negative *i.e.* NIOSH cannot prove that there are no records beyond those captured in the SRDB and claimant files. However, it is worth considering that the majority (if not the entirety) of the thorium redrumming effort occurred in or before 1959. There is already a SEC class at Mound including all workers for this time period. The effect of disregarding the thorium bioassay records would be to deny the thorium doses calculated from these data from workers who don't qualify for the existing SEC. This is not claimant favorable, and since we demonstrated that thorium doses can be reconstructed in our *Retrospective Dose Reconstruction for Thorium-232 Activities at the Mound Laboratory*, (April, 2012) in NIOSH's judgment disregarding this data is not scientifically justified.

SC&A's reply 5:
SC&A agrees that the use of the available thorium bioassay records (complete or not) during the 1949–1959 SEC period is appropriate. However, the 1959–1980 SEC period requires at least one tritium bioassay to be considered for the SEC; therefore, adequate thorium bioassay records may be important for workers not qualifying under the latter SEC.

SC&A comment 6:
In addition to the drummed material from United Lead Corporation (ULC), Mound also received thorium-containing materials from the St. Louis Airport, according to page 15 of ORAUT-TKBS-0016-2 (ORAUT 2004):

> *SW building was used in the Cotter Concentrate (St. Louis Airport Cake) starting in the early 1970s and terminated late in that decade. Pilot plant operations in SW were to recover Th-230 and Pa-231.*

The Cotter concentrate contained 99.9 g/drum of Th-232 and 11.1 g/drum of Th-230, according to page 16.

NIOSH response 6:
The Cotter concentrate material actually came from the Cotter Corporation in Canon City, Colorado. The Cotter Concentrate program has been extensively discussed in *NIOSH Evaluation of Data Adequacy and Completeness Issues at the Mound Laboratory* (August 2011) [see NIOSH Responses 6, 9, 52, and 56 in that document].

SC&A's reply 6:
This item was listed because it illustrates that Th-232 was present in sources other than the redrumming operations of the 1950s. Regardless of where the thorium-containing materials came from (or when workers were exposed), the issue of the workers being adequately bioassayed and the results available is still of concern, as has been discussed in the previous issues.

SC&A comment 7:
Additionally, thorium was used in other areas at Mound as stated on page 12 of ORAUT-TKBS-0016:

> *Thorium-232 was often substituted for ^{238}Pu compounds for modeling purposes in research and development, because this isotope was less expensive and less hazardous, and had physical characteristics similar to ^{238}Pu. It is possible, therefore, to find ^{232}Th compounds identical to the ^{238}Pu compounds.*

These were not included in the paper that SC&A could find, and most likely not in the cleanup date of September 1975 as stated on page 20 of the paper. Although the drummed material from ULC most likely presented the greatest exposure potential, the issue of thorium exposure/monitoring did not go completely away in mid-1975. These other sources of thorium, and thorium contamination present during decontamination and decommissioning (D&D), are sources that could also result in personnel exposures and require bioassay data for DR.

NIOSH response 7:

Just as was the case for thorium at Rocky Flats, where thorium was used as a stand-in for plutonium, the exposure potential from these applications would be minimal. While NIOSH never asserted, "the issue of thorium exposure/monitoring did not go completely away in mid-1975", we agree with SC&A's assessment that the monazite sludge redrumming program would have been the activity performed at Mound with the highest thorium-232 internal dose potential.

However, as extensively discussed in *NIOSH Evaluation of Data Adequacy and Completeness Issues at the Mound Laboratory* (August, 2011) [see especially NIOSH Response 63], the gross alpha procedure used at Mound was capable of isolating actinium, neptunium, americium, curium, and thorium. As described in NIOSH's *Retrospective Dose Reconstruction for Thorium-232 Activities at the Mound Laboratory*, (April, 2012), nuclide specific procedures could be (and were) performed to determine which of these nuclides were present. But in the absence of nuclide-specific results, the results of gross alpha urinalyses can be conservatively attributed to whichever of these nuclides is plausibly present, and gives the highest organ-specific dose for the dose reconstruction being performed. This is the way NIOSH handles gross alpha urinalysis results at every other facility, and the procedures used at Mound will be no different. In any case, the twenty dose-reconstructions performed in NIOSH's *Retrospective Dose Reconstruction for Thorium-232 Activities at the Mound Laboratory*, (April, 2012) indicate that doses calculated by assuming the activity in the sample came from thorium-232 would be comparable to those calculated by assuming plutonium-238.

SC&A's reply 7:

SC&A agrees that the use of the current dose reconstruction (DR) protocol when only gross alpha data is available is claimant favorable. As previously discussed, the issue comes down to determining if all workers potentially exposed to thorium were adequately bioassayed.

SC&A's Summary:

SC&A finds that if the workers exposed to Th-232 were adequately bioassayed (during all periods Th-232 exposure was present at Mound), then DR methods are available to perform claimant-favorable intakes and assign resulting doses. However, this requires that it be assumed that procedures and controls were in place, implemented, and enforced, for adequate bioassays records to be available for DR; to date, SC&A has found no solid indications this was, or was not, the case for Mound.