MEMO

DATE: October 16, 2015

TO: KCP Work Group

FROM: Ron Buchanan, SC&A

SUBJECT: Evaluation of NIOSH's Mg-Th, Tritium, and Ni-63 Example Dose Reconstruction

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During the July 17, 2015, Kansas City Plant (KCP) Work Group (WG) meeting, NIOSH was instructed to demonstrate the feasibility of performing dose reconstruction (DR) using the methods recommended in NIOSH's white papers (NIOSH 2015a, and NIOSH 2015b). NIOSH provided a sample DR on September 16, 2015 (NIOSH 2015c, referred to in this report as the example DR). The example DR consisted of a hypothetical worker at the KCP during the period that Mg-Th, tritium, and Ni-63 operations were conducted (1959–1977) with five different cancers. SC&A was tasked with reviewing the example DR to ensure that the methods used were reasonable and applicable to claimant cases.

The example DR covered the following potential radionuclide intakes:

- Mg-Th operations, August 23, 1961–March 31, 1963, and August 28, 1970–December 31, 1977.
- Manufacturing of switch plates containing tritium, 1963–1968.
- Manufacturing of tritium monitors, 1959–1975.
- Manufacturing Ni-63 check sources for tritium monitors.

SC&A's evaluation of the feasibility of DR and NIOSH's methods for each of these operations is outlined below.

Mg-Th operations (pages 3–5 of the example DR)
During the period August 23, 1961–March 31, 1963, and August 28, 1970–December 31, 1977, a potentially exposed worker's intakes were based on the KCP engineering control limit of 3E-11 μCi/ml (alpha) air concentration. This equates to 1.6E5 dpm/y potential alpha intake. This intake was divided between the three alpha emitters (Th-232, Th-228, and Ra-224) and applied to their decay products (Ra-228 and Ac-228). The ingested intakes were determined using OCAS-TIB-009. The resulting intakes were entered into the chronic annual dose workbook (CADW) for the appropriate time periods and the resulting doses to the organ of interest determined. The results of the solubility type that produced the greatest organ dose were then assigned appropriately in the accompanying Interactive RadioEpidemiological Program (IREP) Input tables and used in determining the probability of causation (POC) for each of the five types of cancer; as listed on page 9 of the example DR. The total dose ranged from 3.6 rem to the skin to 1,264 rem to the bone surface.

Manufacturing of switch plates containing tritium (pages 5–6 of the example DR)
During the period 1963–1968, recorded tritium contamination levels of the switch plates resulted in a 95th percentile level of 16,900 dpm/100cm^2. Assuming two sides to the plate, 100% absorption of the contaminant through the skin, 3 plates per day, and 250 days/year, this resulted in 2.54E7 dpm/y, which equals 4.23E5 Bq/y. At 4.19E-9 rem/Bq, this results in 1.77 mrem/year to each of the organs. This dose was assigned appropriately in the accompanying IREP Input tables and used in determining the POC for each of the five cancer types, as listed on page 9 of the example DR. The total dose was 0.011 rem to each of the organs.

Manufacturing of tritium monitors (pages 7–8 of the example DR)
During the period 1959–1975, KCP received tritium solutions that they transferred from large containers to smaller 400 ml bottles, resulting in 100 μCi (3.7E6 Bq) of tritiated water per bottle. NIOSH assuming that an entire 400-ml container was spilled each year, with 100% absorption by the worker. At 1.8E-9 rem/Bq, this resulted in 6.66 mrem/year to the worker. This dose was assigned appropriately in the accompanying IREP Input tables and used in determining the POC for each of the five cancer types; as listed on page 9 of the example DR. The total dose was 0.113 rem to each of the organs.

Manufacturing Ni-63 check sources for tritium monitors (pages 8–9 of the example DR)
The KCP manufactured 1-inch square check sources on aluminum plates containing Ni-63 by chemical plating. This process could release Ni-63 into the air and create a potential intake. Pages 18 and 19 of NIOSH 2015b provide the details of deriving the potential air concentration; which was 8.49E-11 μCi/ml in the room. The derived air concentration (DAC) for Ni-63 (which results in 5 rem/y of dose over a 2,000-hour period) is 1.02E-6 μCi/ml. Assuming that each year 100 plates, at 1 hour per plate, were manufactured by the same worker, the resulting dose would be 2.12E-2 mrem/y. This would be below the dose assignment level of 1 mrem.

Conclusions
SC&A found that doses could be assigned for the Mg-Th operations, tritium handling, and Ni-63 plating operations at the KCP with claimant-favorable assumptions; as demonstrated in NIOSH's example DR.

References

NIOSH 2015a. *Internal Exposures to Thorium and its Progeny at the Kansas City Plant During Mg-Th Machining*, National Institute for Occupational Safety and Health, Division of Compensation Analysis and Support, Cincinnati, Ohio, January, 2015.

NIOSH 2015b. *Tritium and Nickle-63 at the Kansas City Plant, Rev 01*, National Institute for Occupational Safety and Health, Division of Compensation Analysis and Support, Cincinnati, Ohio, May 7, 2015.

NIOSH 2015c. *Example Dose Reconstruction for the Kansas City Plant*, National Institute for Occupational Safety and Health, Division of Compensation Analysis and Support, Cincinnati, Ohio, September 16, 2015.

OCAS-TIB-009. 2004. *Estimation of Ingestion Intakes*, Rev 0, National Institute for Occupational Safety and Health, Office of Compensation Analysis and Support, Cincinnati, Ohio. April 13, 2004.