MEMO

DATE: April 20, 2015

TO: KCP Work Group

FROM: Joe Fitzgerald, SC&A

SUBJECT: SC&A's Evaluation of NIOSH's January 2015 Response to KCP SEC Matrix Issues 7, 15, 17, 18, and 20

SC&A was tasked by the Kansas City Plant (KCP) Work Group (WG) at its January 20, 2015, meeting with further evaluation of open issues pertaining to NIOSH's Special Exposure Cohort (SEC) evaluation report (SEC-00210) for that site. These included the subject issues, as well as issues 11 (neutron dose) and 13 (Mg-Th alloy), which are being or have been addressed separately.

Following further review of available documents, an onsite data capture with former worker interviews at KCP, and an additional review of classified information at the Department of Energy (DOE), SC&A provides the following assessment of these open issues.

Issue 7 – Radioactive Waste: The WG determined this issue to be "open" pending additional document searches and worker interviews for information regarding KCP radwaste handling in the 1960s, as well as in the 1980s, with specific attention to whether a radwaste handling group existed, or whether project personnel handled radwaste during these time periods (names of contact personnel were identified at the WG meeting; it was also mentioned that personnel handling waste in the 1980s were disqualified because they were illiterate).

SC&A Assessment: Interviews conducted at KCP in March 2015 ([**Worker 5**], [**Worker 1**], and [**Worker 4**]) indicated that unmonitored laborers collected the uranium and Mg-Th cuttings and chips from the lathe machines for placement in 55-gallon drums, which were then transported to the KCP central waste facility. These wastes were coated in lathe oil and were apparently collected from under the machine and from the floor, and loaded into the drums using a "pitchfork" implement. Laborers were neither badged nor bioassayed.[1] It was also noted that while worker movement into and out of these radiological operating areas was restricted by security access badges until the late 1960s-early 1970s, this restriction was relaxed thereafter to anyone with a general "Q" clearance ([**Worker 2**]). While there was clearly an exposure potential, a remaining question is whether it can be considered comparable to the lathe operators, who were monitored. SC&A recommends that NIOSH review the relative exposure potential of the custodial/laborers who routinely collected and drummed contaminated waste, as compared with the operators who conducted the machining of depleted uranium (DU) and Mg-Th, with an objective of informing the WG as to whether these exposures are comparable (or for the former, lower) and can therefore be adequately bounded using available monitoring data.

[1] Albeit, at least one exception was noted; a laborer who had access to a restricted radiological area was badged.

Issue 15 – Thorium oxide operations: SC&A had previously noted for this issue that the NMMSS inventory information for "unalloyed thorium" had not yet been reconciled with onsite records, given the lack of operational information located to date. The current Nuclear Material Management and Safeguard System (NMMSS) database custodian at KCP is relatively new to the position and has been unable to offer any insight. SC&A was charged by the WG with completing its review of Site Research Database (SRDB) records identified by NIOSH from the last data capture, and for both NIOSH and SC&A to continue to look for relevant records while conducting onsite searches at KCP.

SC&A Assessment: SC&A's review of KCP materials inventory data indicates that the listing of "unalloyed" thorium was apparently an artifact of the site's calculation of how much actual "pure" thorium made up the inventory of Mg-Th being processed. This was verified by comparing a sample of historic KCP inventory values from the 1970s, obtained and cleared by KCP, with those in the NMMSS database at DOE headquarters. Recorded values matched from both inventory ledgers. Other than Mg-Th, thorium being used at KCP was historically in gram quantities and of a laboratory scale, was handled under hoods, and did not present an exposure potential. **SC&A recommends that this issue be closed by the WG.**

Issue 17 – D&D activities: The WG tasked SC&A with clarifying a possible path forward on what data or information would inform a NIOSH analysis of whether KCP workers in historic decontamination and decommissioning (D&D) activities would have been either already monitored or whose potential exposure would be bound by proposed NIOSH methods at KCP. NIOSH would then determine its approach and propose same to the WG.

SC&A Assessment: As with Matrix Issue 7 (radioactive waste management), it is clear from the March 2015 onsite interviews with former workers ([**Worker 5**], [**Worker 2**], and ([**Worker 3**]), that at KCP, laborers had a substantial role in cleaning up floors, walls, and equipment, whether on a day-to-day basis, or in periodic room cleanups. A clear distinction was made between "laborers" who handled cleaning duties and various crafts responsible for moving, maintaining, and operating equipment, such as lathes. Some laborers wore external dosimeters (it was said to be mandatory in Mg-Th areas), but none of the former laborers interviewed indicated any routine bioassay. While the "KCP machine repair" was responsible for taking equipment apart, the laborers were responsible for cleaning the internal parts of that equipment ([**Worker 2**], [**Worker 4**], and [**Worker 5**]). It is clear that non-bioassayed laborers had a substantial D&D role at KCP for the periodic room and equipment cleanups that took place at the plant; it is not clear whether their exposure potential was the same as the DU and Mg-Th machinists, themselves.

In terms of a "path-forward," SC&A recommends that NIOSH review the relative exposure potential of the custodial/laborers who routinely cleaned contaminated equipment and areas, as compared with machinists who did the machining of DU and Mg-Th, with an objective of informing the WG as to whether these exposures are comparable (or for the former, lower) and can therefore be adequately bounded using available monitoring data.

Issue 18 – Accidents, Incidents, and Fires in Worker's Record: In its original issue item, SC&A observed that the ER only referenced two radiological incidents of note—the 1987

erbium tritide contamination and the 1989 Pm-147 contamination—and that this did not adequately account for KCP's lengthy operational history. SC&A later noted to the WG that a number of records were found during the October 2014 visit that identified accidents, incidents, and fires at KCP. While weekly activity reports were only located for a narrow range of years (mid-1960s, early 1970s), a folder titled "Radiation Incidents" was found that documents incidents from 1963–1975. None of these incidents were significant in terms of exposure to large numbers of workers and all could be bounded by NIOSH's dose reconstruction approach. At its January 20, 2015, meeting, the WG tasked SC&A (and requested NIOSH) to continue searching for additional incident reporting during its March 2015 KCP site visit.

SC&A Assessment: An additional onsite data capture was conducted at KCP during March 2–5, 2015. Some additional incident-related reports were found, including an unusual occurrence file that provided evaluations of KCP incidents related to lost sealed radioactive sources (e.g., Pm-147 in 1988), radioactive contamination on parts returned to KCP from the field (1989), and low-level contamination on uranium components received from Oak Ridge (1989). Also included was an employee concern package related to potentially unmonitored x-ray exposures in 1989. All of these were evaluated and closed in the documentation reviewed with the exception of the employee concern.[2]

While the three KCP site data captures have realized a more complete compendium of site radiological incidents, it cannot be said to be necessarily complete given what appear to be some gaps in time and a heavy concentration of reporting in the late-1980s. However, none of the incidents reviewed to date indicate exposures that were not adequately addressed by the site or potential exposures or ones that would not be feasible to dose reconstruct.

As a further measure to add to this information, SC&A has scheduled another review of classified documents and notes at the DOE Germantown facility in May 2015, as a means to investigate incidents involving classified operations raised during WG meetings and past interviews. Any relevant findings from this visit will be conveyed to the WG.

Issue 20 – Tritium: The WG requested that NIOSH update its white paper with new information on organic tritium source term, with both NIOSH and SC&A to continue looking for any new documentation regarding tritium operations at KCP during the next site visit.

As indicated at the January 20, 2015, WG meeting, SC&A has reviewed NIOSH's white paper (NIOSH 2015) and found that it had more fully characterized historic tritium operations at KCP. The documents referenced and included in the SRDB represent the extent of what was identified from KCP record holdings during data capture visits in 2014–2015.

[2] SC&A reviewed this concern and found that a radiation survey conducted by KCP found resulting radiation levels to be very low, but not "as-low-as-reasonably-achievable," necessitating actions including repair to x-ray cabinet doors and the purchase of survey instruments to be maintained in the rooms of concern. While workers in the adjacent room were unmonitored, it remains unclear whether this room was an unrestricted area not requiring any badging. While no closure documentation was found, it appears that this concern was investigated by KCP and actions taken.

Essentially, as described in the NIOSH white paper, two discrete operations involving tritium (including one involving Ni-63) were identified: (1) the use of tritiated luminescent paint to fill engraved markings on "Hi-Lo" switch plates during 1963–1968; and (2) manufacturing of tritium monitors during 1959–1975. The Ni-63 operation involved small-scale chemical plating for the Tritium Air Monitor, Bendix/Sandia Model T446.

For the first tritium application ("Hi-Lo" switch plates), NIOSH found KCP workers were applying tritiated phosphors containing 40 mCi of tritium to switch plates to be used in commercial dials. Based on a known volume of switch plates processed in 1965 (based on a 1966 trip report summary) and data collected from 110 contamination swipes taken from 330 switch plates in 1965, an upper 95th percentile distribution value of 16,900 dpm/100 cm^2 is assumed for the bounding contamination level. Assuming three switch plates handled per day, all of the surface contamination transferred to the worker's skin, and all of the transferred skin contamination absorbed, leads to a bounding daily intake of 101,400 dpm (1,690 Bq). This translates to a bounding dose of 3.04E-6 rem/day or 0.7 mrem/year (250 work days).

For the second tritium application, NIOSH and SC&A found evidence that tritium-in-air instruments and tritium-in-urine monitors designed by Sandia were fabricated at KCP from 1959 through the early 1970s. As noted by NIOSH in its white paper, this involved the use of tritiated water as a calibration standard, and plated Ni-63 as a component of one of the tritium-in-air models. From Bendix and Sandia documentation, it was determined that KCP procured tritiated water in unopened bottles from Sandia and installed them in instrument kits beginning in 1959. Starting in 1964, tritiated water was received in gallon bottles and rebottled into smaller 400-ml bottles for use in the kits. With the advent of liquid scintillation methods in the early 1970s, the market for these tritium urinalysis instruments presumably ended and there is no further record of this operation. Assuming that all bottles were handled under a fume hood (as were the initial bottles procured in 1959), NIOSH calculates that a bounding exposure can be based on an assumed 1-ml tritiated water spill occurring for each bottle-filling activity, which, when spread over an assumed 100 cm^2 area of the impervious floor of a fume hood, would lead to a removable hydration layer that would retain 0.1 ml of tritiated water, which equates to 56,000 dpm. Assuming that this contamination is completely transferred to the skin of a KCP laboratory technician and is completely absorbed into the blood stream each day leads to a worker dose of 1.68E-6 rem/day or 0.4 mrem/year (250 work days).

For the Ni-63 plating operation, which was ancillary to the tritium bottling activity, NIOSH judged the potential worker exposure to be negligibly small based on its low-energy beta radiation, the small activity applied to each precipitator plate (about 0.5 uCi), and radiological controls imposed, which included a radiological hazard analysis and procedural precautions (primarily waste management and spill response).

SC&A Assessment: SC&A finds that the lack of specific information regarding exposure source terms, operational conditions, and workplace measurements, coupled with the lack of any bioassay data, over the operational years in question makes it difficult to bound potential worker doses without NIOSH's reliance on these broad assumptions, no matter how logical and scientifically founded. It is also not clear which KCP workers were involved in these operations

and how (or whether), and to whom NIOSH intends to assign doses from potential tritium exposure during the years in question.

Additional data capture and onsite interviews conducted during March 2–5, 2015, coupled with further review of available documentation on the SRDB, have not identified any new or more complete information regarding the two tritium operations in question. SC&A recommends that the WG consider the dose reconstruction bounding approach identified in NIOSH's white paper in the context of the minimal potential exposures involved, the relatively small scope of these operations, and the conservative dose bounding approaches proposed. While some key parameters relevant to dose reconstruction are lacking, the source term involved equates to potential maximum doses at the fractional mrem level. This perspective notwithstanding, NIOSH should inform the WG on whether (and how) it intends to dose reconstruct for these historic tritium exposures, with appropriate sample dose reconstructions.

REFERENCES

[**Worker 1**]. Former KCP worker; interview conducted at KCP on March 3, 2015. SRDB pending.

[**Worker 2**]. Former KCP worker; interview conducted at KCP on March 3, 2015. SRDB pending.

[**Worker 3**]. Former KCP worker; interview conducted at KCP on March 3, 2015. SRDB pending.

[**Worker 4**]. Former KCP worker; interview conducted at KCP on March 3, 2015. SRDB pending.

NIOSH 2015. *Tritium and Ni-63 at the Kansas City Plant*, White Paper, Rev. 0, Robert Morris, Billy P. Smith and Pat McCloskey, National Institute for Occupational Safety and Health, January 13, 2015.

[**Worker 5**]. Former KCP worker; interview conducted at KCP on March 3, 2015. SRDB pending.