Status of Operations Involving Thorium and Americium at Area IV SSFL During the Remediation Period (1988 - Present)

White Paper

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BACKGROUND

In May, 2017, NIOSH issued an evaluation report for petition SEC-00235 for Area IV of the Santa Susana Field Laboratory (SSFL) from August 1, 1991 to June 30, 1993 (NIOSH, 2017). NIOSH found that there was no dose reconstruction infeasibility for the evaluated period and did not recommend that a class be added to the SEC. During the ABRWH work group discussion on this evaluation on December 04, 2017, the work group pointed out the lack of discussion on the thorium and americium source term after the end of the operational period in 1988 (Transcript, 2017). The previous SEC evaluation (SEC-00234) for Area IV of the SSFL was added to the SEC because NIOSH found an infeasibility to reconstruct internal doses from thorium and americium radionuclides (NIOSH, 2016). The recommended period of the SEC class for SEC-00234 was 1965 through 1988. The work group has requested that NIOSH provide more detail and relevant references on the nature of the source term for thorium and americium after 1988 at Area IV SSFL. The following is a more detailed workup of the operations and facilities that were identified as having handled Am and Th at Area IV, and what their status was in the post-1988 period.

STATUS OF THORIUM AND AMERICIUM SOURCE TERMS AT AREA IV SSFL AFTER 1988

All reactor facilities ended operations by 1980, and all nuclear support operations were terminated by 1988, with the exception of operations that supported closure and cleanup activities (hence the DOE determined end of the EEOICPA operational period). Figure 1 provides a timeline of reactor operations at Area IV SSFL. Americium at Area IV was produced as a transuranic element in the reactor cores during reactor operation. It was also present in form of sealed sources. Thorium was a component of the reactor fuel for two reactors, the Advanced Epithermal Thorium Reactor (AETR) and Core II of the Sodium Reactor Experiment (SRE). Transuranic and activation radionuclide contamination from the fuel within the reactors could have contributed to radiological exposures at the reactor buildings in Area IV. The majority of the transuranic activity would have been from plutonium-238, plutonium-239, plutonium-240, plutonium-241, americium-241, and curium-244. Research activities on the spent fuel, including decladding operations in hot cells, could have potentially been a path of exposure for employees. Workers who subsequently performed decommissioning and decontamination (D&D) procedures on the hot cells could potentially be exposed to residual amounts of these radionuclides. Based on a review of available health physics documentation during the remediation period (Moore, 1992; Quarterly Reviews, 1991-1993), the major transuranic radionuclide of concern was Pu-239, which was present in small residual amounts at the Hot Lab facility. During the D&D period, radiological surveillance documents report the major radionuclides of concern at Area IV SSFL to be fission products (Cs-137 and Sr-90) and the activation products Co-60 (Documented Communication 2017a; Documented Communication 2017b; Moore, 1992).

The main facilities involved in thorium operations were the SRE complex and the AETR, along with their reactor and fuel handling support facilities. The main facilities that had potential americium exposure were reactor facilities where irradiated fuel was handled (there was no fuel reprocessing at Area IV, SSFL, but there was some fuel decladding and other experimental

handling and analyses of irradiated fuel). Fuel decladding operations were done in the Hot Lab (Building 20).

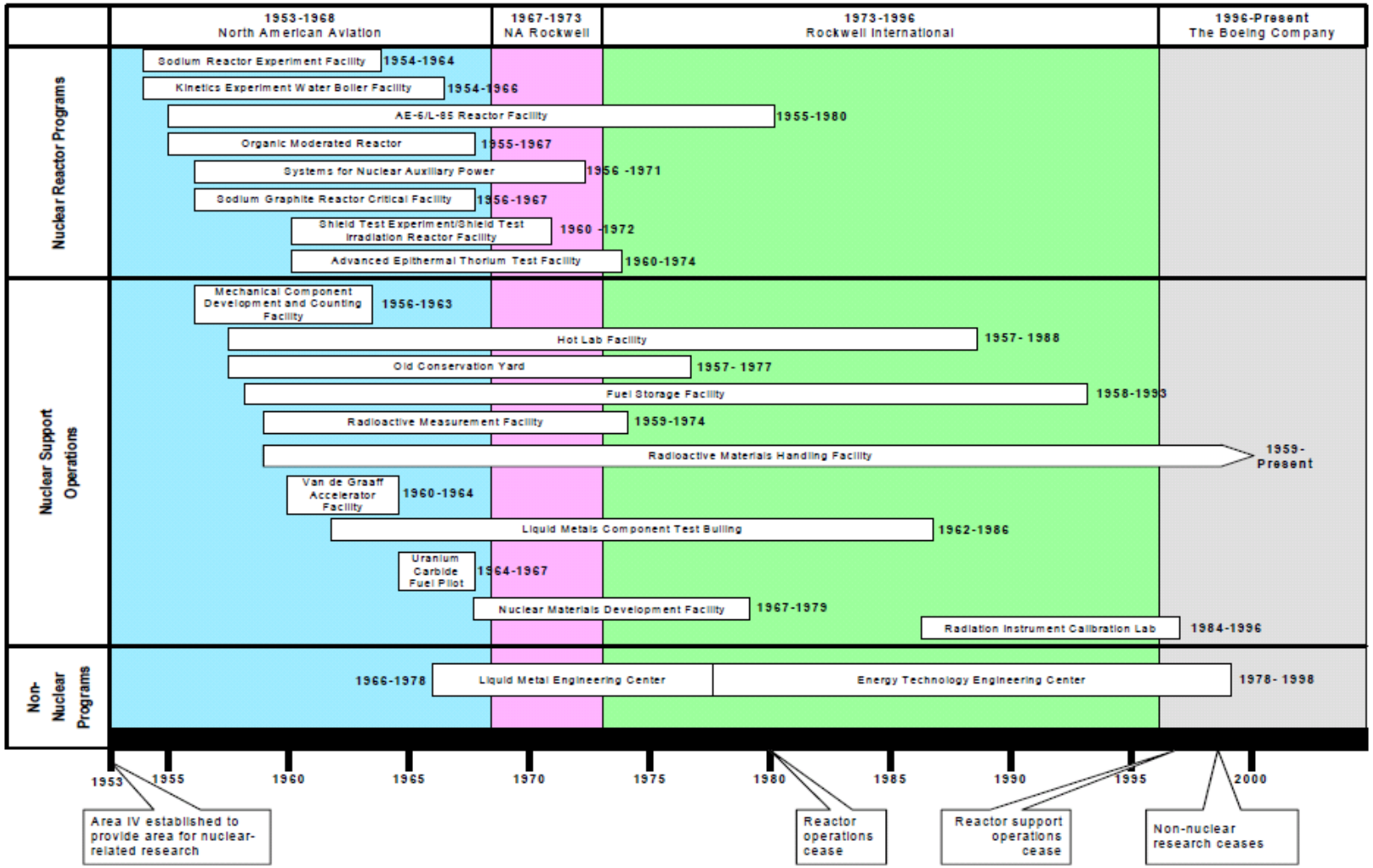

Figure 1. Facility Operations Timeline, Area IV SSFL (Sapere and Boeing, 2005)

The SRE was a sodium cooled, graphite moderated, thermal reactor that used uranium-thorium metal alloy fuel in its Core II, that was in operation between 1960 and 1964 (Ureda, 1975). The fuel for Core II was assembled by loading the fuel slugs into metal tubes in the Engineering Test Building (Building 4003) to create the fuel rods (meaning the actual fuel slugs were not produced on-site) (Rucker, 2009). The Core II fuel consisted of Th-232 and enriched uranium (EU) alloy. The fuel from Core II was stored in the fuel storage vault at the Radioactive Materials Disposal Facility (RMDF) after it was removed from the SRE in 1964 (Dennison, 1977).

In 1974, the SRE Core II fuel was disassembled at the Hot Lab so that the fuel could be shipped off-site to the Savannah River Site where it would be reprocessed. The fuel disassembly at the Hot Lab consisted of the removal of the fuel from storage casks, removing the fuel from the cladding material and removing the sodium-potassium (NaK) around the fuel slugs. Cladding and wires and washing solvent were disposed as high level waste. The slugs were further cleaned with a hot alcohol bath and then packaged into a SRE shipping can, which was welded shut and leak tested before being transferred to the RMDF for storage and, eventually, shipping. Documentation indicates that approximately 1,972 kg of thorium were shipped to Savannah River as declad fuel over nine shipments (Dennison, 1977). The last shipment of Core II left Area IV at 2-19-1977. There is no documentation that indicated that any of the fuel slugs were damaged or ruptured during disassembly of Core II, but there was a potential of some contamination of the inside of the hot cells where the Core II fuel was handled. The documentation of the fuel handling indicates that the hot cell was cleaned up after Core II was processed (Dennison, 1977). The packaged fuel was stored in a sealed container at the RMDF until shipment in 1977. Based on this information, it is unlikely that there was a significant internal exposure potential from Th at the RMDF during the post-1988 period, which is over a decade after the Th containing canisters were removed. Annual reports and quarterly surveillance reports for the D&D of the Hot Lab are available (Annual Reports, 1992-1994, Quarterly Reviews 1991-1993), but there are no indications of thorium contamination being encountered.

The SRE Core II fuel was assembled in the Engineering test building before 1960. Later on, this building was used for analysis of SNAP fuel burn up analyses and evaluation of irradiation experiments. Some research on reprocessing of used nuclear fuel was done in the Hot Cave of the Engineering Test Building. These research-related experiments used quantities of up to 1 kg of uranium and thorium (Oldenkamp, 1990) and up to 100 g quantities of highly irradiated materials. The remediation of this building ended in 1975, after the Hot Cave was dismantled and the main process infrastructure was removed (fume hoods, rad waste sinks, drain lines etc.). Some drain line contamination was found later and removed. Suspected contaminated sewer lines were removed in 1982. The building was released for unrestricted use in 1985 (Sapere and Boeing, 2005) and was used for non-radioactive storage after that. The building was demolished in 1999. There seems no likely exposure scenario to thorium or americium from the Engineering Test Building after 1988.

The AETR (Building 4100) which operated from 1960–1974, also used thorium-containing fuel. The AETR's first nine core configurations (through 1965) contained various amounts of U-233 and Th-232, and were driven by 93% enriched uranium fuel. For both the SRE and AETR, the thorium isotopes present in the fuel would have consisted mainly of Th-232 and its decay progeny, Th-228, in partial equilibrium. Eggen and Morewitz, 1959, indicate that the AETR fuel was fabricated at the fuel fabrication area in the AETR lab, which had an 1100 square feet area for that purpose. The work was done in a series of glove boxes. The thorium fertile material was in the form of 2 by 2 inch metal plates of varying thicknesses. The AETR reactor program was terminated in 1974 and the NRC released the building for unrestricted use in 1980. After that, it housed other operations, including a Computer Aided Tomography facility and a radioactive sample counting lab (Sapere and Boeing, 2005). There seems no plausible exposure to thorium after the building was released for unrestricted use.

The Transuranic Management by Pyropartitioning-Separation (TRUMP-S) program, a joint project between the United States and Japan, intended to use small quantities of plutonium, neptunium, and americium. The materials for the TRUMP-S testing included 4 g of americium, which was stored in the Fuel Storage Facility, Building 4064. The project was transferred to the University of Missouri Research Reactor sometime after 1990. There is no evidence that the program work was ever started and there was no use of the materials other than storage at Area IV SSFL. The Fuel Storage Facility was only used for storage of non-irradiated reactor fuels, but all fissionable material was removed by the mid-1980s and was used for storage of miscellaneous materials afterwards. There is no indication of a release of materials from the TRUMP-S program (Sapere and Boeing, 2005).

The SSFL incident report data base was reviewed for incidents involving americium or thorium. There are some indications of incident reports that list americium among other contaminants before 1988. Incidents, 1970, page 184, has a listing of Pu and Am particle contamination of T055 glovebox maintenance that resulted in some airborne in June, 1979. Incidents, 1980, page 154, lists personal contamination of Am-241 in 1986, resulting from a smoke detector source. There are no listings of incidents involving thorium or americium during the post -1988 period, but not all incidents list the nuclide of concern (SSFL 2007, Incidents 1980; Incidents 1990).

Facilities with potential for thorium and americium residual contamination after 1988 were the Hot Lab and the RMDF. Some residual material containing thorium and americium could be present at the Hot Lab, based on the operations outlined above for SRE core II and other fuel handling operations. During the post-1988 period, the hot lab was being decommissioned and decontaminated. A review of the incident report data base indicates a number of small scale incidents in the hot lab in the post-1988 period, resulting from D&D operations. None if the incident reports list thorium or americium as a radionuclide of concern. The RMDF (Buildings 4021/4022) consists of several buildings that were used for processing radioactive wastes from on-site processes for packaging and disposal. During operation, the facility was guarded and fenced to prevent unauthorized access. It was used for storage of wastes through the decontamination period. The materials handled had changed from reactor fuels and supporting materials to storage of wastes from the decommissioning operations. There is no indication that

the remaining wastes contained significant levels of thorium or americium, because all fuel materials had been removed from the site. A review of activity reports on D&D operations for the Hot Lab and a review of quarterly surveillance reports for the Hot Lab and the RMDF during the 1991-1993 period do not contain any reference to thorium. There is no evidence that there was a significant exposure potential to americium or thorium radionuclides at the Hot Lab or the RMDF during the post-1988 period.

CONCLUSION

The major sources of radioactivity at the SSFL came from the reactor facilities, the nuclear fuel manufacturing operations and the operations in the Hot Lab. By the end of the operational period, all of the highly radioactive fuel had been removed from the site. Thus, two of the most important types of radioactivity, the fission products and the transuranics in the reactor fuel had all been removed from SSFL by 1988. A detailed review of the operational facilities during the remediation period for Area IV SSFL does not indicate a sustained radiation exposure potential similar to the operational period. The remaining radionuclides of concern at Area IV in 1992 were Cs-137, Sr-90, Co-60 and Pu-239. Only Cs-137 and Sr-90 were present in sufficient quantity to be readily dispersed for inhalation by workers, and Cs-137 was considered the most important radionuclide of concern during this period in operational history (Moore, 1992). Although the D&D of remaining facilities may result in unpredictable exposures to residual contamination, it is believed that the facility had at that point a state-of-the-art radiation protection program that was capable of detecting relevant radionuclides, and that those data are available for dose reconstruction under EEOICPA. NIOSH, therefore, does not believe that the exposure potential outlined in the SEC-00234 evaluation report continued into the remediation period (post-1988).

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