Hanford Challenge 219 1st Ave S, Suite 220 Seattle, WA 98104 206.292.2850 hanfordchallenge.org

MEMORANDUM

DATE: 04/2009

FROM: TOM CARPENTER, HANFORD CHALLENGE

RE: HISTORICAL USE OF THORIUM AT HANFORD

This memorandum describes what we know of thorium reprocessing at Hanford from examining past records.

Laboratory testing at Hanford for thorium's potential use in reducing pile reactivity began shortly after Hanford Atomic Products Operations (HAPO) received a small amount of the material in 1945. (HW-31222, 3/26/54) Nonetheless, until 1964 operations were limited to small scale testing. Early that year Hanford's thoria program began in earnest, with the arrival of virgin thorium from the National Lead Company of Ohio, and with the initial test irradiation of six tons of thoria targets in D Reactor. After favorable results, four more tons were tested in F Reactor in September 1964. A core loading at F Reactor containing two tons of thoria followed shortly thereafter. (DUN-1010, 4/14/65)

The thoria program at Hanford began in response to an order placed by the Atomic Energy Commission for the production of U-233 from the irradiation of thorium. Initial orders called for approximately 130 kg of the isotope, and subsequent orders increased that amount. (ibid.) An August 1968 report, for example, notes that "the K reactors are currently involved in producing approximately 460 kg of U-233 for [the AEC]." (DUN-4462, 8/15/68) It is difficult to get more than an impressionistic sense, however, of how much uranium was actually created using thorium. Beyond producing U-233, thorium's other primary application was as fringe shielding to reduce reactor operating temperatures. Insofar as a July 1966 thoria delivery schedule (DUN-1349, 7/21/66) notes that approximately 31 tons would be needed annually in the foreseeable future for shield protection and testing, it seems reasonable to conclude that quantities cited elsewhere in excess of this amount may be assumed to have been directed toward U-233 production.

Thorium use in both test and production missions continued in all five Douglas United Nuclear-operated reactors—B, C, D, KE and KW—through the early 1970s; limited information makes it hard to determine, however, whether thoria was used on a regular basis in F or other reactors. What is clear is that Hanford used significant quantities of the element in the late 1960s. A July 1965 report, for example, notes that "plans to process 150 irradiated tons of thoria are being developed" (RL-SEP-650, 7/26/65), while another report later that year cites General Electric's request to have 100 tons of thorium ready for delivery to Hanford in May 1966. (HAN-92655, 9/28/65) Atlantic-Richfield Hanford Company reported in August 1967 that

it had approximately 200 tons of thorium on-site, in the form of thoria nitrate solutions resulting from the chemical processing of previously irradiated thoria elements in production operations. (DUN-3034, 8/28/67) Another report, from 1968, notes large shipments of thoria received by Douglas United Nuclear's Production Fuels Section. (DUN-4475, 7/12/68)

Every month between July 1968 and August 1969, hundreds of thousands of pounds of virgin thoria powder came to Hanford; the arithmetic mean of shipments received was 600,051 pounds. Documents indicate that Hanford's use of thoria came to an end in the early 1970s. An online history of Hanford, for example, notes that "shortly after [1970]…thorium oxide fuel was ruled out for large scale development at HW." (www.hanford.gov/history/mr0437/mr0437.htm) A thoria delivery schedule from 1968 indicates 170 tons of thoria required for fiscal year 1969, with 24 tons required for each of fiscal years 1971 and 1972, and 20 tons for fiscal year 1973 (DUN-4737, 9/18/68); a subsequent document may refer to these earlier figures, when it notes that "approximately 60 tons of thoria are being diverted to the wafering process and represent essentially all of the material remaining to be irradiated in the current campaign…" (DUN 5841, 5/21/69) Whether delivery schedules approximately matched usage timetables, or preceded them such that the conclusion of fuels processing/production would have been followed by a lagging period of stockpile usage in the 1970s is unknown. Material status reports available for 1977-1978 and for 1984-1985 indicate that Hanford's Nuclear Engineering Development Lab possessed 477 kg and 61 kg of thorium during the ends of those periods, respectively (HEDL-IR-78-33-6-MAR, 3/31/78; HEDL-NM-404-6, 9/30/85); whether there were other stockpiles held elsewhere is open to speculation.

As of April 1966, twenty-five target element failures had occurred. (DUN-1010, 4/15/66) Most, if not all, were caused by water entry through closure welds into the thoria wafers, and monitoring procedures adopted in March and April 1965 greatly decreased the failure rate. Of those failures, 14 resulted in unscheduled reactor shutdown in the C, KE, or KW Reactors. (ibid.)

Finally, **available documents acknowledge the possible fallout of thorium's use. "The handling of thorium," one 1967 report admits, "presents radiological hazards because of gamma emission and the tendency for accumulation of inhaled or ingested thorium in the bones."** (DUN-2409, 4/7/67) Likewise, a 1979 HEDL Radiological Engineering report notes of **a 300 Area (306) Building, involved in the production of thorium target elements: "All sewer lines leading from this building are suspect. The lime pit…contain[s] uranium and thorium sludge. Surface and near surface contamination around this building is to be expected."** (www.hanford.gov/history/300areas/300-1st.htm) Another report admits that **"there is pervasive U, Th, and chemical contamination in the soil beneath and near 321 Building, extending to groundwater."** (www.hanford.gov/history/300area/300-4th.htm) It also notes that, in not only the 321 Building but also the fuel fabrication work at 313 and 314 Buildings, "special precautions for U and Th as radioactive substances were not taken…solutions, scraps, and other substances…were handled and disposed as ordinary process wastes." (ibid.) While not strictly concerned with thorium discharges, Hanford and AEC officials demonstrated concern over levels of contamination in fish tissues in the Columbia in holding discussions aimed at remedial action in 1960. (www.hanford.gov/history/misc/michele.htm)

We consider the thorium issue to be important because of its presence in the river sediment at Hanford.

Endnotes and References:

1. Multiple fires and leaks occurred throughout building history in barrels and waste "load luggers" containing scraps of thorium (http://www.hanford.gov/history/300area/300-1st.htm#300-1-0)

2. Materials handling procedures throughout 1940s and 1950s, especially in fuel fabrication areas, introduced uranium, thorium, and other contaminants to sanitary sewer system (http://www.hanford.gov/history/300area/300-2nd.htm)

3. 321-A was built over 4 original, concrete-encased DuPont waste storage tanks Leaks and spills from and near these tanks over the years produced much Uranium, Thorium, and chemical contamination in the soil under this building. (http://www.hanford.gov/history/300area/300-4th.htm)

4. As in fuel fabrication work in 313 and 314 Buildings, special precautions for Uranium and Thorium as radioactive substances were not taken in 321 Building Solutions, scraps and other substances containing uranium and thorium were handled and disposed as ordinary process wastes. Some uranium and thorium entered the sanitary sewer system from personnel who contacted these substances. All 321 Building liquid wastes (except sanitary) were flushed to the Process Ponds - building was never connected to the Radioactive Liquid Waste Sewer. (http://www.hanford.gov/history/300area/300-4th.htm)

5. There is pervasive uranium, thorium, and chemical contamination in the soil beneath and near 321 Building, extending to groundwater. (http://www.hanford.gov/history/300area/300-4th.htm).

6. By 1960, reactor effluent (wastewater) discharges to the Columbia averaged 14,500 curies per day, after a four-hour decay period in reactor retention basins. Hanford and AEC leaders discussed rising levels of contamination in fish tissues in the river and in shellfish in coastal waters near the river's mouth. (http://www.hanford.gov/history/misc/michele.htm)