

Timeline for Cold War-era lithium enrichment at the Oak Ridge Y-12 Plant (1950 to late 1980s)

Peter Lobner, 12 January 2020

1949: Oak Ridge Materials Chemistry Division initiated work in 1949 to find a method to separate lithium isotopes, with the primary goal of producing high purity lithium-7 for use in Aircraft Nuclear Propulsion (ANP) reactors.

1950: Lithium enrichment process development with a focus on tritium production began in 1950 at the Y-12 Plant in Oak Ridge, Tennessee. Three different enrichment processes would be developed with the goal of producing highly-enriched (30 to 95%) lithium-6. All processes used large quantities of mercury. Lithium-6 has a greater affinity for mercury than does lithium-7.

- **ELEX:** Electrical Exchange, used mechanically driven agitators to provide contact between an amalgam phase and lithium hydroxide dissolved in water. A counter-balancing electromotive force (EMF) was used to prevent amalgam decomposition.
- **OREX:** Organic Exchange, in which an organic solution of lithium is exchanged with a solution of lithium in mercury or an amalgam in pulse columns using Propylene-di-amine (PDA) as the organic phase.
- **COLEX:** Column Exchange is an improvement on the ELEX process, in which isotopes of lithium is partially separated when transferring between an aqueous solution of lithium hydroxide and a lithium-mercury amalgam.

ELEX would be the first to deploy. OREX did not demonstrate adequate enrichment performance. COLEX was the most efficient process and became the primary source of enriched lithium-6.

1950 to 1956: ELEX was the first lithium enrichment process to enter service at Y-12.

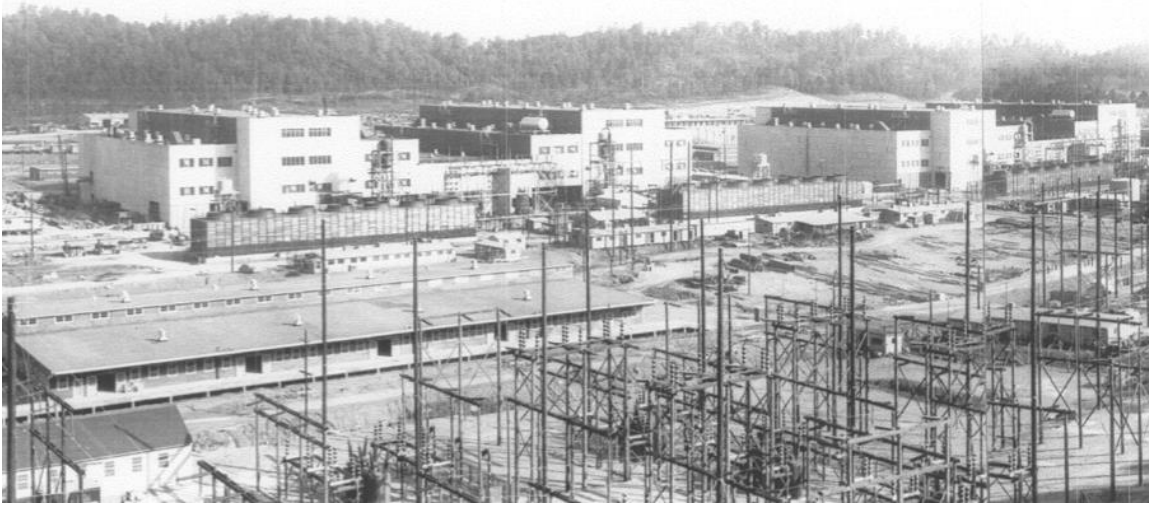
- Work on the small-scale ELEX pilot process line started in 1950 in Y-12 buildings 9733-2 and 9201-2. The pilot line operated until 1951.
- The criteria for the ELEX production plant (also known as Beta-4) was set in December 1951 and the plant was built in 17 months in Building 9204-4. About 1.5 million pounds of mercury were used in the ELEX production plant. The facility began operation on 18 August 1953 and delivered the first enriched lithium product on 24 August 1953.
- The ELEX production plant was shut down on 16 March 1956 and initially was maintained in a standby condition. By December 1956, the mercury had been removed from the ELEX process equipment and transferred to the two COLEX production plants, and the ELEX equipment was removed from Building 9204-4.

1951 to 1954: OREX development and operation at Y-12

- OREX development started in September 1951 with the construction of a small-scale OREX dual-temperature (DT) pilot line in Y-12 Building 9733-1. A March 1952 report stated that the OREX DT pilot line demonstrated feasibility, but numerous issues remained to be resolved. OREX DT was dropped in July 1952.
- OREX development continued in August 1952 with the construction of a small-scale OREX chemical reflux (CR) pilot line in Y-12 Building 9202. The OREX CR pilot line became operational on 28 April 1953 and operated until 8 March 1955, when it was shut down because it failed to achieve the required lithium-6 enrichment.

1952 to 1963: COLEX development and operation at Y-12

- COLEX development started in 1952 with the construction of a small-scale COLEX pilot line in Y-12 Building 9201-2. This line operated until 1955.
- Production scale COLEX facilities operated in Building 9201-4 from 1955 to 1962 and in Building 9201-5 from 1955 to 1959.



Y-12 Buildings 9201-5 and 9201-4, originally built to house the electromagnetic uranium enrichment process during WW II, were later converted to house the COLEX process plant.

Source: Y-12 Plant, photo 6174

1953: ELEX process started delivering enriched lithium-6 product, which was shipped to target manufacturing facilities at Savannah River Plant and Hanford.

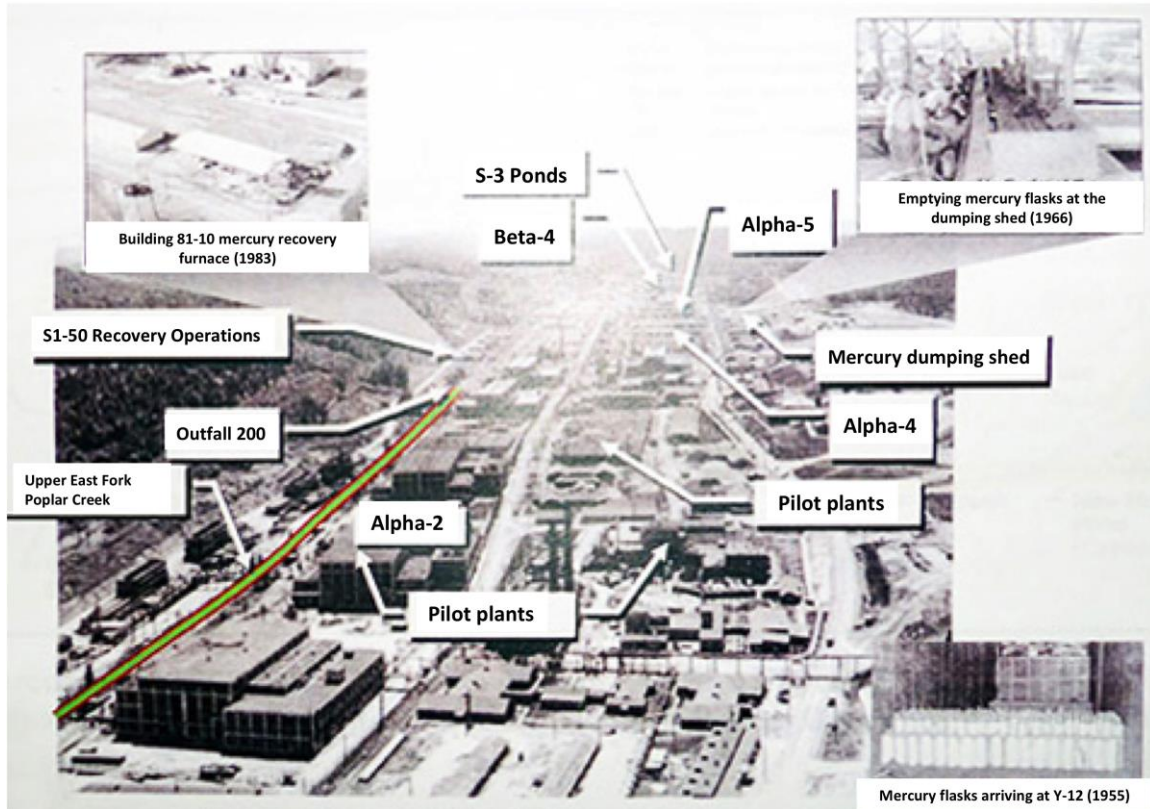
1955: Two large-scale COLEX facilities were completed at Y-12:

- The Alpha-4 COLEX facility started delivering enriched lithium-6 product in January 1955.
- The Alpha-5 COLEX facility became operational later in 1955.

1956: ELEX operations ended.

1957 to 1959: The OREX pilot line dismantled.

1959: The ELEX facility dismantled.



Lithium enrichment facilities at Y-12. Source: DOE

1963:

- Alpha-4 and Alpha-5 COLEX operations ended. Alpha-4 was placed in standby. By then, most of the mercury contamination at Y-12 was the result of eight years of COLEX plant operation.
- A stockpile of enriched lithium-6 had been established at Oak Ridge along with a stockpile of lithium-7.
- A stockpile of unprocessed natural lithium feed material remained at Oak Ridge.
- Production of nuclear and non-nuclear materials associated with NNSA's stockpile stewardship mission continued in the Y-12 lithium production facility in Building 9204-2.

1965 to 1966: The Alpha-5 COLEX facility was dismantled.

1960s: Lithium activities were consolidated in WW II-vintage Building 9204-2 (Beta 2), which originally housed 2nd-stage (Beta) Calutrons for the electromagnetic uranium enrichment process.

Late 1980s: The Alpha-4 COLEX facility was dismantled