

Nuclear Latency (NL) Dataset
Country Coding Sheets

SWEDEN

COW COUNTRY CODE: 380

List of Country's Enrichment and Reprocessing (ENR) Facilities

1. Stockholm Extraction Laboratory
2. Studsvik Research Center

Note: Sweden had a centrifuge research program in the 1960s and 1970s. Bjorn Bonnevier at the Royal Institute of Technology in Stockholm used a rotating plasma to separate isotopes of light elements.¹ We did not find any clear evidence, however, indicating that Sweden used centrifuges to enrich *uranium*. Yet the technology developed in Sweden certainly could have been used for that purpose.

Detailed Facility-Specific Information and Sources

1. Stockholm Extraction Laboratory

- a. *ENR type (diffusion, centrifuge, EMIS, chemical and ion exchange, aerodynamic isotope separation, reprocessing).*

Spent fuel reprocessing.

- b. *Facility size (laboratory, pilot, commercial).*

Laboratory.

- c. *Is the facility under construction or in operation? If under construction, list the construction years. If in operation, list the years of operation.*

Swedish interest in plutonium separation began around 1946.² It operated an extraction laboratory in Stockholm in the 1950s. We estimate that this facility began operations in 1954. Jonter (2003) states that Sweden produced 600 grams of plutonium in 1955. The country moved work on reprocessing to the Studsvik Research Center around 1960.

- d. *Was the facility developed covertly? If so, identify years that facility was covert.*

Yes, the facility and the entire nuclear complex was covert.

¹ Bonnevier, Bjorn. 1970. "Experimental Evidence of Element and Isotope Separation in a Rotating Plasma," *Plasma Physics* 13: 763-774.

² The 1946 date is only an approximation based on when Swedish interest in separation began.

- e. *Was the facility placed under IAEA safeguards? If so, identify the years that the facility was safeguarded.*

No.

- f. *Was the facility placed under regional safeguards? If so, identify the years that the facility was under regional safeguards.*

No.

- g. *Did the facility have a military purpose?*

Yes, there is evidence that Sweden's plutonium program was geared, in part, towards producing fissile material for nuclear weapons.

- h. *Was the facility multinational? If so, identify the other countries that were involved.*

No.

- i. *Was the facility built with foreign assistance? If so, list the supplier(s) and what they provided.*

There is no evidence of foreign assistance for the construction of this plant. Sweden did engage in close cooperation with several European states beginning in the 1950s, including Norway and Belgium.

- j. *Sources:*

Arnett, Eric. 1998. "Norms and Nuclear Proliferation: Sweden's Lessons for Assessing Iran." *The Nonproliferation Review*. 5(2): 32-43.

Cole, Paul. 1997. "Atomic Bombast: Nuclear Weapon Decision-Making in Sweden, 1946-72." *The Washington Quarterly*. 20(2): 233-251.

Cole, Paul M. 1994. "Sweden Without the Bomb: The Conduct of a Nuclear-Capable Nation Without Nuclear Weapons." RAND Corporation.

Fehrm, Martin 1985. "Sweden." In *Non-Proliferation: The Why and the Wherefore*. Joseph Goldblat, Ed. Philadelphia, PA: Taylor and Francis. 213-20.

Goldenberg et al. 1985. "An End-Use Oriented Global Energy Strategy." *Annual Review of Energy*. 10: 613-88.

Hultgren, A. and C-G Osterlund. 1990. *Reprocessing in Sweden: History and Perspective*. Statens Karnbransle Namnd, SKN Report 38.

- Johansson, Thomas B. 1986. "Sweden's Abortive Nuclear Weapons Project." *Bulletin of the Atomic Scientist*. 42(3): 31-34.
- Jonter, Thomas. 2003. "Impact of Historical Developments of a State's National Nuclear Non-Proliferation Policy on Additional Protocol Implementation." SKI Report 2003: 18.
- Jonter, Thomas. 2010. "The Swedish Plans to Acquire Nuclear Weapons, 1945-1968: An Analysis of the Technical Preparations." *Science & Global Security*. 18: 61-85.
- Larsson, Christer. 1985. "The History of a Swedish Atomic Bomb 1945-1972." *Ny Teknik*. 17-20.
- Lundby, John Erling. 1994. "Decommissioning of a Uranium Reprocessing Pilot Plant." *Tema Nord*. 594.
- Rydbert, Jan. 1955. "Fr ºagor av betydelse f¸or isolering av plutonium f¸or atombomber; f¸orslag till arbetsprogram." FOA Archive, H 4140.
- Zentner, M.D., G.L. Coles, and R.J. Talbert. 2005. "Nuclear Proliferation Technology Trends Analysis." Pacific Northwest National Laboratory. Report 14480, 91.

2. Studsvik Research Center

- a. *ENR type (diffusion, centrifuge, EMIS, chemical and ion exchange, aerodynamic isotope separation, reprocessing).*

Spent fuel reprocessing.

- b. *Facility size (laboratory, pilot, commercial).*

Laboratory.

- c. *Is the facility under construction or in operation? If under construction, list the construction years. If in operation, list the years of operation.*

The laboratory opened around 1960. Sweden planned to build a larger pilot plant at this site, but those plans never materialized (neither did plans to build a pilot plant at Sannas). Work on nuclear weapons halted as of 1968 when Sweden signed the NPT. However, multiple sources, including Zentner et al., list 1972 as the end date for Sweden's ENR pursuits.

- d. *Was the facility developed covertly? If so, identify years that facility was covert.*

Yes, the facility and the entire nuclear complex was covert.

- e. *Was the facility placed under IAEA safeguards? If so, identify the years that the facility was safeguarded.*

No, Sweden signed the NPT in 1972 at the same time they ended their program. Sweden signed a limited safeguard agreement in 1975 (INFCIRC/234) but the facility was no longer operating at this time. Sweden did not sign comprehensive safeguards until 1995 and additional protocols until 2004.

- f. *Was the facility placed under regional safeguards? If so, identify the years that the facility was under regional safeguards.*

No, there was a bilateral agreement with the US, but the Swedish military was convinced they could produce plutonium without American involvement.

- g. *Did the facility have a military purpose?*

Yes, the facility was created to produce military grade plutonium. There is little evidence to suggest that Sweden ever produced sufficient material for a weapon. However, most experts state that they had the technical capability to produce a nuclear weapon but not the political will. According to the RAND study, developing nuclear technology was taken as a matter of national pride within the military.

Sweden pursued an inconsistent security policy regime during the period, going through several distinct phases of nuclear weapon development posturing. One Swedish plan from the period outlined constructing 20 weapons a year, which would have required a commercial facility to be constructed. Theoretical exploration of plutonium and uranium weapons began in 1947-48.

The Swedish military sought to produce 20 kg of plutonium per year from several reactors, primarily the Markiven reactor. However, problems with scaling and the lack of political will eventually caused the program to be terminated. According to Christer Larson small amounts of plutonium were imported from the UK (1957) and France (1960). The UK provided approximately 10 grams of weapons grade material (Johansson 1986). Johansson (1986, 32) argues that the reprocessing facility was not constructed, though the parliament did secretly pass legislation for the construction of a small-scale separation facility in Ursvik, just outside Stockholm.

The military wanted the work to progress to the point where it was a ‘turn key away’ from production. In the words of former Swedish Supreme Commander Stig Synnergren in 1985 “Our objective was to make all military preparations so that the shortest time possible we could start the industrial manufacture of nuclear weapons in Sweden. The task of Atomenergi was, roughly, to adapt the civilian program accordingly” (RAND, 34).

- h. *Was the facility multinational? If so, identify the other countries that were involved.*

No, this particular complex was secretive. There were other portions of the nuclear complex that were multinational. The reactor used to produce the plutonium received fuel from France and heavy water from Norway. Additional, small quantities of weapons grade plutonium were received from the UK in 1957 and France in 1960.

- i. *Was the facility built with foreign assistance? If so, list the supplier(s) and what they provided.*

No evidence of foreign nuclear assistance found. From the beginning of its nuclear program, Sweden placed a premium on indigenous development, choosing technologies and methods that would allow for the autonomous development of a weapons program. In the early 1950s Swedish scientists at AB Atomenergi developed equipment for reprocessing and began working on a pilot plant for reprocessing. A plan was in place for a larger reprocessing plant at Studvisk before the 1958 agreement with Norway made reprocessing possible at Kjeller. Apparently the Swedish military (perhaps independently from the government) signed the contract with AM Atomenergi for the construction and operation of the Studvisk reprocessing plant.

- j. *Sources:*

Arnett, Eric. 1998. "Norms and Nuclear Proliferation: Sweden's Lessons for Assessing Iran." *The Nonproliferation Review*. 5(2): 32-43.

Cole, Paul. 1997. "Atomic Bombast: Nuclear Weapon Decision-Making in Sweden, 1946-72." *The Washington Quarterly*. 20(2): 233-251.

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Jonter, Thomas. 2003. "Impact of Historical Developments of a State's National Nuclear Non-Proliferation Policy on Additional Protocol Implementation." SKI Report 2003: 18.

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- Lundby, John Erling. 1994. "Decommissioning of a Uranium Reprocessing Pilot Plant." *Tema Nord*. 594.
- Rydbert, Jan. 1955. "Fr ¨ogor av betydelse f¸or isolering av plutonium f¸or atombomber; f¸orslag till arbetsprogram." FOA Archive, H 4140.
- Zentner, M.D., G.L. Coles, and R.J. Talbert. 2005. "Nuclear Proliferation Technology Trends Analysis." Pacific Northwest National Laboratory. Report 14480, 91.