Nuclear Latency (NL) Dataset
Country Coding Sheets

GERMANY (WEST GERMANY)
COW COUNTRY CODE: 255

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

1. Enrichment Technology Company Ltd. Zweigniederlassung Deutschland
2. Jet Nozzle Demonstration Plant
3. Karlsruhe Nuclear Research Center, Institute for Nuclear Process Engineering
4. Karlsruhe Reprocessing Plant (WAK)
5. MILLI Reprocessing Test Facility
6. Plutonium Test Extraction Facility (Reprocessing Plant Karlsruhe)
7. Urenco Germany GmbH, Gronau
8. Wackersdorf Reprocessing Plant

Detailed Facility-Specific Information and Sources

1. Enrichment Technology Company Ltd. Zweigniederlassung Deutschland

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

Uranium enrichment, centrifuge.

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.

Construction of the facility began in 1960.[1] The facility has been in operation since 1964.

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

No.

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

[1] 1960 was the year that German scientists were allowed to return from the Soviet Union. A seminal paper on the topic of enrichment was published in 1960 by the returning scientists (Zentner et al. 2005).

Yes, the facility was under IAEA safeguards starting in 1977. Germany signed comprehensive safeguards in 1977 and additional protocols in 2004.

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

Yes, the facility is under Euratom safeguards. The Euratom Treaty entered into force in 1958 (West Germany signed it in 1957) and it covers all civilian nuclear facilities.

g. Did the facility have a military purpose?

No.

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

Yes. As of 2006 ETC is a joint venture between Urenco and Areva.

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

While the plant may have developed indigenously, since 2006 it has been a joint venture between Urenco and Areva.

j. Sources:

Areva. 2006. "Areva and Urenco Announce the Creation of the Joint Venture ETC (Enrichment Technology Company)." http://www.areva.com/EN/news-6408/areva-and-urenco-announce-the-creation-of-the-joint-venture-etc-enrichment-technology-company.html.. Accessed 11/21/2015.

Enrichment Technology Company. "History of Enrichment Technology." http://www.enritec.com/en/about-us/history-of-enrichment-technology/. Accessed 06/15/2015.

Enrichment Technology Company. "Where We are Located." http://www.enritec.com/en/about-us/where-we-are-located/. Accessed 06/15/2015.

International Atomic Energy Agency. "Integrated Nuclear Fuel Cycle Information Systems." https://infcis.iaea.org. Accessed 06/08/2015.

Zentner, M.D., G.L. Coles, and R.J. Talbert. 2005. "Nuclear Proliferation Technology Trends Analysis." Pacific Northwest National Laboratory. Report 14480

2. Jet Nozzle Demonstration Plant

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

Uranium enrichment, jet nozzle.

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

Pilot.

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 facility started operation in 1976 (Zentner et al. 2005, 56). All research was completed by 1980 when the facility was moved to Brazil.

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

No.

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

Yes, the facility was under IAEA safeguards starting in 1977. It is clear the IAEA was present for the dismantling process. Germany signed comprehensive safeguards in 1977 and additional protocols in 2004.

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

Yes, the facility is under Euratom safeguards.

g. Did the facility have a military purpose?

No, the facility was for civilian use.

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.

No.

j. Sources:

Makhijani, Arjun, Lois Chalmers, and Brice Smith. 2004. "Uranium Enrichment: Just Plain Facts to Fuel an Informed Debate on Nuclear Proliferation and Nuclear Power." Institute for Energy and Environmental Research. Nuclear Policy Research Institute.

Szymanski, Piotr. "The Euratom Regional Safeguards System." International Atomic Energy Agency. http://www.iaea.org/newscenter/focus/iaeanwfz/euratom211111.pdf. Accessed 06/15/2015.

Zentner, M.D., G.L. Coles, and R.J. Talbert. 2005. "Nuclear Proliferation Technology Trends Analysis." Pacific Northwest National Laboratory. Report 14480

3. Karlsruhe Nuclear Research Center, Institute for Nuclear Process Engineering

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

Uranium enrichment, aerodynamics.

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

Pilot.[2]

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

Operations at the facility began in 1967. Construction and basic research for jet nozzle enrichment occurred during the 1950's. Construction is coded as beginning in 1960 since Zentner et al. note, "it took seven years to get a laboratory-scale pilot plant in operation." It is not clear whether construction began at this time. All research had been completed by 1989, if not earlier.

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

No, the facility was not covert.

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

Yes, the facility was under IAEA safeguards starting in 1977. It is clear the IAEA was present for the dismantling process. Germany signed comprehensive safeguards in 1977 and additional protocols in 2004.

[2] Zentner et al. say this was a laboratory scale plant but the IAEA states pilot.

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

Yes, the facility is under Euratom Safeguards.

g. Did the facility have a military purpose?

No, the facility was for civilian use.

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.

No evidence of foreign assistance found. The nozzle approach to enrichment seems to be indigenous to the Karsruhe Nuclear Research Center/ Institute of Technology.

j. Sources:

Becker, E.W. 1977. "The Separation Nozzle Process for Uranium Enrichment." *Progress in Nuclear Energy*. 1(1). http://inis.iaea.org/search/search.aspx?orig_q=RN:8347293. Accessed 06/15/2015.

International Atomic Energy Agency. "Integrated Nuclear Fuel Cycle Information Systems." https://infcis.iaea.org. Accessed 06/08/2015.

Lausch, J. et al. "Safeguarding a Vitrification Facility at the Dismantled WAK Pilot Reprocessing Plant." International Atomic Energy Agency. http://www.iaea.org/safeguards/Symposium/2010/Documents/PapersRepository/250.pdf. Accessed 06/15/2015.

Makhijani, Arjun, Lois Chalmers, and Brice Smith. 2004. "Uranium Enrichment: Just Plain Facts to Fuel an Informed Debate on Nuclear Proliferation and Nuclear Power." Institute for Energy and Environmental Research. Nuclear Policy Research Institute.

Szymanski, Piotr. "The Euratom Regional Safeguards System." International Atomic Energy Agency. http://www.iaea.org/newscenter/focus/iaeanwfz/euratom211111.pdf. Accessed 06/15/2015.

Zentner, M.D., G.L. Coles, and R.J. Talbert. 2005. "Nuclear Proliferation Technology Trends Analysis." Pacific Northwest National Laboratory. Report 14480.

4. Karlsruhe Reprocessing Plant (WAK)

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

Spent fuel reprocessing.

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

Pilot.

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

Construction started in 1967.[3] The facility operated from 1971 to 1991.[4]

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

No.

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

Yes, the facility was under IAEA safeguards starting in 1977 and it remained under safeguards as of 2011. It is clear the IAEA was present for the dismantling process.

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

Yes, the facility was eligible for Euratom safeguards as of 1958.

g. Did the facility have a military purpose?

No, the facility was part of the civilian nuclear complex.

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

No, it appears the facility was indigenously developed.

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

No evidence of foreign assistance found.

[3] WAK lists construction start date.
[4] European Nuclear Society lists the end date as 1990 but Zentner et al. (2005) state 1991 and the IAEA INFCIS confirms these dates.

j. Sources:

European Nuclear Society. "Reprocessing Plant Karlsuhe." http://www.euronuclear.org/info/encyclopedia/r/reprocessing-plant-karlsruhe.htm. Accessed 06/15/2015.

Hibbs, Mark. 1990. "Future Uncertain for German Pilot Reprocessing Program." *Nuclear Fuel.* 15(1): 6.

International Atomic Energy Agency. 2011. "Annual Report." http://www.iaea.org/About/Policy/GC/GC56/GC56Documents/English/gc56-2-att1_en.pdf. Accessed 06/15/2015.

International Atomic Energy Agency. "Integrated Nuclear Fuel Cycle Information Systems." https://infcis.iaea.org. Accessed 06/08/2015.

Kalinowski, et al. 2002. "German Plutonium Balance, 1968-1999." *Nonproliferation Review*. Spring 2002.

Lausch, J. et al. "Safeguarding a Vitrification Facility at the Dismantled WAK Pilot Reprocessing Plant." International Atomic Energy Agency. http://www.iaea.org/safeguards/Symposium/2010/Documents/PapersRepository/250.pdf. Accessed 06/15/2015.

Zentner, M.D., G.L. Coles, and R.J. Talbert. 2005. "Nuclear Proliferation Technology Trends Analysis." Pacific Northwest National Laboratory. Report 14480.

5. MILLI Reprocessing Test Facility

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

Spent fuel reprocessing.

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

Pilot.

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

Construction began in 1965 according to an IAEA report.[5] The facility operated from 1971 to 1991.[6]

[5] Wak states late 1960's.

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

No.

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

The facility likely was under safeguards from 1977 to 1991.

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

Yes, the facility is under Euroatom safeguards.

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

No, the facility was commercial.

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

No, the facility was not multinational. However, the decommissioning agreement for the facility was between France and Germany.

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

No.

j. Sources:

Hibbs, Mark. 1991. "Franco-German Back End Accord Won't Save KFK Reprocessing Lab." *Nuclear Fuel.* 16(11): 9.

International Atomic Energy Agency. "Integrated Nuclear Fuel Cycle Information Systems." https://infcis.iaea.org. Accessed 06/08/2015.

Koch, G. 1982. "MILLI II: Conceptual Study of a Pilot Reprocessing Plant for LMFBR Fuel Elements." International Atomic Energy Agency. http://inis.iaea.org/search/search.aspx?orig_q=RN:13695222. Accessed 06/08/2015.

Ochsenfeld, W. and H.J. Bleyl. 1979. "Experiences with the Test Facility MILLI for Reprocessing Nuclear Fuel." *Nuclear Fuel Cycle and Materials*. 33(4).

[6] Mark Hibbs cites the start date as 1970 and the end date as 1990 but the IAEA INFCIS states 1971-1991.

http://inis.iaea.org/search/search.aspx?orig_q=RN:10472590. Accessed 06/15/2015.

6. Plutonium Test Extraction Facility (Reprocessing Plant Karlsruhe)

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

Spent fuel reprocessing.

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

Pilot.

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

Construction of the facility probably began in 1977.[7] The facility operated from 1982 to 1991.[8]

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

No.

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

Yes, the facility was under safeguards from 1980 to 1991 as Germany signed their agreement with the IAEA in 1977.

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

Yes, the facility is under Euratom safeguards.

g. Did the facility have a military purpose?

No.

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

[7] The 1977 date is based on when German legislation required all new nuclear power plants to be associated with increases in separation capacity. In the mid 1970's, it was believed that supplies of LEU for reactors would decrease, spiking the cost of nuclear fuel. Breeder reactors were viewed as a viable alternative (Janberg and von Hipple 2009).
[8] The end operational date is from Zentner et al. (2005) while Hibbs (1990) provides the beginning operational date. The IAEA gives 1980 as the beginning date.

No.

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.

j. Sources:

Hibbs, Mark. 1990. "Future Uncertain for German Pilot Reprocessing Program." *Nuclear Fuel.* 15(1): 6.

International Atomic Energy Agency. "Integrated Nuclear Fuel Cycle Information Systems." https://infcis.iaea.org. Accessed 06/08/2015.

Zentner, M.D., G.L. Coles, and R.J. Talbert. 2005. "Nuclear Proliferation Technology Trends Analysis." Pacific Northwest National Laboratory. Report 14480.

7. Urenco Germany GmbH, Gronau

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

Uranium enrichment, centrifuge.

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

Commercial.

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

Construction of the facility started in 1982[9] when the facility received licenses for ground-breaking. The facility began operation in 1985 and continues to run today.[10]

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

No.

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

[9] The 1983 date is from *Nuclear Fuel* and is confirmed in ORNL (2009).
[10] The facility took until 1998 to reach original design capacity. There are plans for expanded enrichment capabilities at the facility.

Yes, the facility is under IAEA safeguards. Germany signed safeguard agreements with the IAEA in 1977 and safeguard remain in effect as of 2011.

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

Yes, the facility is under Euratom safeguards.

g. Did the facility have a military purpose?

No, the facility was not for military purposes.

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

Yes, the facility is owned and operated by Urenco, which is a multinational corporation involving Germany, the Netherlands, and the United Kingdom. It is considered multinational from 1982 to the present

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

Yes, though the exact technology sharing within the company is unclear. The company draws on each international partner to provide expertise and equipment. Urenco enrichment technology is designed and shared jointly between the UK, Germany, and the Netherlands.

j. Sources:

International Atomic Energy Agency. 2011. "Annual Report." http://www.iaea.org/About/Policy/GC/GC56/GC56Documents/English/gc56-2-att1_en.pdf. Accessed 06/15/2015.

International Atomic Energy Agency. "Integrated Nuclear Fuel Cycle Information Systems." https://infcis.iaea.org. Accessed 06/08/2015.

Jansberg, Klaus, and Frank von Hippel. 2009. "Dry-Cask Storage: How Germany Led the Way." *Bulletin of the Atomic Scientists*. 65(24): 24-32.

Laughter, M.D. 2007. "Profile of World Uranium Enrichment Programs." Oak Ridge National Laboratories. 13.

8. Wackersdorf Reprocessing Plant

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

Spent fuel reprocessing.

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

Commercial.

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

Construction began in 1985 but it was never completed.

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

No.

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

If it had been finished, the plant would have been safeguarded. West Germany had laid the relevant groundwork with the IAEA.

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

If it had been finished, the plant would have been safeguarded.

g. Did the facility have a military purpose?

No.

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

No.

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

No.

j. Sources:

Charles, Dan. 1989. "Exporting Trouble: West Germany's Freewheeling Nuclear Business." *Bulletin of the Atomic Scientists.* April: 21-27.

International Atomic Energy Agency. "Integrated Nuclear Fuel Cycle Information Systems." https://infcis.iaea.org. Accessed 06/08/2015.

MacKenzie, Debora. 1986. “German Fights over the Future of Nuclear Power.” *New Scientist.* May 1986.

Rolandi, G. 1988. “Design Verification for Large Reprocessing Plants,” IAEA report. http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/19/101/19101686.pdf.

Additional Notes: One source lists Germany as constructing a pilot gaseous diffusion facility but we were unable to verify this with a second source. Markhijani et al. (2004) only list the three facilities found in this report. Laughter (2009) only lists Urenco’s facility. Consultation with experts revealed that Germany and Spain were considered part of Eurodif and therefore considered part of production development.