

Nuclear Latency (NL) Dataset  
Country Coding Sheets

**FRANCE**

**COW COUNTRY CODE: 220**

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

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*Note:* France does not draw a clear distinction between “civilian” and “military” nuclear facilities, like other nuclear weapons states (e.g., the United States). We assume that all plants are at least partially military in nature during the period in which France produced fissile material for nuclear weapons (until 1991 for plutonium and until 1996 for HEU) unless there is clear evidence that a facility served commercial purposes only.

Detailed Facility-Specific Information and Sources

**1. Le Bouchet – Lab-Scale Reprocessing Facility**

- 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.*

This facility began separating small amounts of plutonium in 1949. It is not clear when plutonium separation ended; we use 1951, the year in which the French authorized the construction of a pilot reprocessing plant at Fontenay.

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

The French CEA (atomic energy commission) publicly announced that small amounts of plutonium had been reprocessed.

- 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?*

When the CEA was established in 1945, its mandate included pursuing research and technology for use in “the national defense,” among other areas (Donnay and Kuster 1995, 436). We therefore code this plant as serving a military purpose. It is important to note, however, that many nuclear plants in France serve both civilian and military ends; there is rarely clear separation between the two, unlike in the United States.

- 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.

j. *Sources:*

Donnay, Albert and Martin Kuster. 1995. "France" in *Nuclear Wastelands: A Global Guide to Nuclear Weapons Production and Its Health and Environmental Effects*. Edited by Arjun Makhijani, Howard Hu, and Katherine Yi. Cambridge, MA: MIT Press. 463.

CIA, "The French Nuclear Weapons Program," *Scientific Intelligence Report*, March 27, 1964:  
[http://www.foia.cia.gov/sites/default/files/document\\_conversions/89801/DOC\\_0001465904.pdf](http://www.foia.cia.gov/sites/default/files/document_conversions/89801/DOC_0001465904.pdf)

**2. Areva NC La Hague – UP2 – 400 (renamed HAO facility in 1976)**

- 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 started in 1961. The facility operated from 1967 to 2004.<sup>1</sup>

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

There is no evidence to suggest that the facility was developed covertly.

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

The facility appears on the IAEA's list of French plants that are eligible for safeguards.

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

All *civilian* nuclear plants in France are under Euratom safeguards. This facility was therefore under regional safeguards after 1969, when the facility transitioned from military to civilian control.

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<sup>1</sup> The NFCIS website states 1966 as the operational start date and 2004 as the end date. The 1961 and 1967 dates are from Areva's website. Zentner et al. list 1976, but this likely refers to when the facility was renamed.

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

Yes, it appears that for approximately three years (1966-1969) the facility could have been used for military plutonium separation.

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

No. The facility had international customers but that is not sufficient for multinational status.

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 UP-2 facility was constructed through the CEA. From 1972-1976 the CEA made improvements on the facility and associated equipment. Areva built the facility and Cogema, a French-owned subsidiary of Areva operated the complex.

j. *Sources:*

Areva. 2011. "Overview of Areva's Nuclear Fuel Recycling Activities." Presentation to the Blue Ribbon Commission on America's Nuclear Future. La Hague Facilities Visit 20-21 February 2011.  
[http://cybercemetery.unt.edu/archive/brc/20120621064111/http://brc.gov/sites/default/files/meetings/presentations/brc\\_pres\\_feb\\_2011-final\\_release.pdf](http://cybercemetery.unt.edu/archive/brc/20120621064111/http://brc.gov/sites/default/files/meetings/presentations/brc_pres_feb_2011-final_release.pdf). Accessed 06/11/2015.

Areva. "History." <http://www.Areva.com/EN/operations-1183/key-dates-for-Areva-s-la-hague-site.html>. Accessed 06/11/2015.

Burnie, Shaun. 2007. "French Nuclear Reprocessing: Failure at Home, Coup d'Etat in the United States."  
<https://www.citizen.org/documents/Burnie%20paper%20on%20French%20reprocessing.pdf>. Accessed 06/11/2015. 2.

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

International Atomic Energy Agency. 2008. "Spent Fuel Reprocessing Options" IAEA-TECDOC-1587. [http://www-pub.iaea.org/MTCD/publications/PDF/te\\_1587\\_web.pdf](http://www-pub.iaea.org/MTCD/publications/PDF/te_1587_web.pdf). Accessed 06/11/2015.

Lyman, E. 2010. "Resolving a Safeguards Paradox," IAEA-CN-184/324.  
<https://www.iaea.org/safeguards/symposium/2010/Documents/PapersRepository/3244938985649764720068.pdf>

Organization for Economic Cooperation and Development. “French National Report.” [https://www.oecd-nea.org/science/nsc2008/7\\_France.pdf](https://www.oecd-nea.org/science/nsc2008/7_France.pdf). Accessed 06/11/2015. 7.

Pradoura, F. 2009. “Setting up a Decontamination and Dismantling (D&D) Scenario Methodology and Tools Developed.” WM 2009 Conference. <http://www.wmsym.org/archives/2009/pdfs/9194.pdf>. Accessed 06/11/2015.

US CIA. 1984. “French Nuclear Reactor Fuel Reprocessing Program. CIA Declassified Intelligence Report. [http://next-up.org/pdf/CIA\\_French\\_Nuclear\\_Reactor\\_Fuel\\_Reprocessing\\_Program.pdf](http://next-up.org/pdf/CIA_French_Nuclear_Reactor_Fuel_Reprocessing_Program.pdf). Accessed 06/11/2015. 5.

—. “ASN has Reclassified to Level 2 the Incident Which Occurred on 19 November 2009 in the Irradiated Fuel Reprocessing Plant (UP2 400) on the Site at La Hague.” Autorite De Surete Nucleaire. <http://www.french-nuclear-safety.fr/index.php/English-version/News-releases/2010/Internal-contamination-of-an-employee-from-a-subcontracting-company-AREVA-NC>.

### 3. NC La Hague – UP2 – 800

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 of the facility started in 1982.<sup>2</sup> The facility has been in operation since 1994.<sup>3</sup>

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

No, the facility was publicly announced.

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

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<sup>2</sup> MacLachlan (1982) states that construction had started by November 1982.

<sup>3</sup> Davis (2008) and Areva (2011) provide 1994 as the facility operations start date. INFCIS has the operational start date as 1996. Zentner et al. list 1990.

The facility appears on the IAEA's list of French plants that are eligible for safeguards.

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

All *civilian* nuclear plants in France are under Euratom safeguards.

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

No, the facility is for commercial reprocessing. France stopped producing plutonium for nuclear weapons in the early 1990s.

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

No, the facility was largely indigenous.

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

No, EDF reportedly built the plant. Foreign origin fuel was processed here, though Areva was apparently responsible for the construction of all of the Hague sites. The facility was paid for through Cogema contracts with German, Swiss, Belgium, Dutch, and Japanese utility companies.

- j. *Sources:*

Areva. 2011. "Overview of Areva's Nuclear Fuel Recycling Activities." Presentation to the Blue Ribbon Commission on America's Nuclear Future. La Hague Facilities Visit 20-21 February 2011.  
[http://cybercemetery.unt.edu/archive/brc/20120621064111/http://brc.gov/sites/default/files/meetings/presentations/brc\\_pres\\_feb\\_2011-final\\_release.pdf](http://cybercemetery.unt.edu/archive/brc/20120621064111/http://brc.gov/sites/default/files/meetings/presentations/brc_pres_feb_2011-final_release.pdf). Accessed 06/11/2015.

Burnie, Shaun. 2007. "French Nuclear Reprocessing: Failure at Home, Coup d'Etat in the United States."  
<https://www.citizen.org/documents/Burnie%20paper%20on%20French%20reprocessing.pdf>. Accessed 06/11/2015. 2.

Croff, A.G. R.G. Wymer, L.L. Tavlarides, J.H. Flack, H.G. Larson. 2008. "Background, Status, and Issues Related to the Regulation of Advanced Spent Nuclear Fuel Recycle Facilities." ACNW&M White Paper (NUREG-1909).  
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- Davis, Mary Bryd. 2009. "The La Hague Reprocessing Plant: Basic Facts." EcoPerspectives: A Project of Earth Island Institute.
- European Nuclear Society. "Reprocessing Plants, World Wide." <http://www.euronuclear.org/info/encyclopedia/r/reprocessing-plants-ww.htm>. Accessed 06/11/2015.
- International Atomic Energy Agency. 2011. "Annual Report." [http://www.iaea.org/About/Policy/GC/GC56/GC56Documents/English/gc56-2-att1\\_en.pdf](http://www.iaea.org/About/Policy/GC/GC56/GC56Documents/English/gc56-2-att1_en.pdf). Accessed 06/10/2015.
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- Lyman, E. 2010. "Resolving a Safeguards Paradox," IAEA-CN-184/324. <https://www.iaea.org/safeguards/symposium/2010/Documents/PapersRepository/3244938985649764720068.pdf>
- MacLachlan, Ann. 1982. "Cogema Says La Hague is on its 1990 Target for 1,600 Tonnes of Reprocessing Capacity." *Nuclear Fuel*. 7(23): 3.
- MacLachlan, Ann. 1983. "La Hague Expansion a Certainty Despite Ruminations over Spent Fuel Policy." *Nucleonics Weeks*. 24(3): 1.
- Organization for Economic Cooperation and Development. "French National Report." [https://www.oecd-nea.org/science/nsc2008/7\\_France.pdf](https://www.oecd-nea.org/science/nsc2008/7_France.pdf). Accessed 06/11/2015. 7.
- US CIA. 1984. "French Nuclear Reactor Fuel Reprocessing Program. CIA Declassified Intelligence Report. [http://next-up.org/pdf/CIA\\_French\\_Nuclear\\_Reactor\\_Fuel\\_Reprocessing\\_Program.pdf](http://next-up.org/pdf/CIA_French_Nuclear_Reactor_Fuel_Reprocessing_Program.pdf). Accessed 06/11/2015. 5.

#### **4. Areva NC La Hague – UP3**

- 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 of the facility began in 1982.<sup>4</sup> UP3 began operating in 1990<sup>5</sup> and continues to this day.

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

No, the facility was publicly announced.

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

The facility appears on the IAEA's list of French plants that are eligible for safeguards.

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

All *civilian* nuclear plants in France are under Euratom safeguards.

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

No, the facility is appears to be exclusively civilian. France stopped producing plutonium for nuclear weapons around the time that the plant started operating.

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

No, the facility was indigenously developed.

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

No, the UP-3 was commissioned to process foreign fuels, but there is no indication of foreign nuclear assistance to the plant. Areva was apparently responsible for construction of all of the Hague sites. The facility was "pre-financed by reprocessing contracts that foreign operators of nuclear reactors had made with Cogema" (Davis 2009, 3).

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<sup>4</sup> MacLachlan (1982) states that construction started by November 1982.

<sup>5</sup> The IAEA's NFCIS and Davis (2009) reports lists 1990 as the start date while Schneider and Marignac (2008) list 1989 as the start date for reprocessing. Davis also lists the facility entering into industrial service in 1990. Zentner et al. list 1994.

j. Sources:

Burnie, Shaun. 2007. "French Nuclear Reprocessing: Failure at Home, Coup d'Etat in the United States."

<https://www.citizen.org/documents/Burnie%20paper%20on%20French%20reprocessing.pdf>. Accessed 06/11/2015. 2.

Davis, Mary Bryd. 2009. "The La Hague Reprocessing Plant: Basic Facts." EcoPerspectives: A Project of Earth Island Institute.

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

Lyman, E. 2010. "Resolving a Safeguards Paradox," IAEA-CN-184/324.

<https://www.iaea.org/safeguards/symposium/2010/Documents/PapersRepository/3244938985649764720068.pdf>

MacLachlan, Ann. 1982. "Cogema Says La Hague is on its 1990 Target for 1,600 Tonnes of Reprocessing Capacity." *Nuclear Fuel*. 7(23): 3.

MacLachlan, Ann. 1983. "La Hague Expansion a Certainty Despite Ruminations over Spent Fuel Policy." *Nucleonics Weeks*. 24(3): 1.

Organization for Economic Cooperation and Development. "French National Report." [https://www.oecd-nea.org/science/nsc2008/7\\_France.pdf](https://www.oecd-nea.org/science/nsc2008/7_France.pdf). Accessed 06/11/2015. 7.

Schneider, Mycle and Yves Marignac. 2008. "Spent Fuel Reprocessing in France." International Panel on Fissile Materials.

US CIA. 1984. "French Nuclear Reactor Fuel Reprocessing Program. CIA Declassified Intelligence Report. [http://next-up.org/pdf/CIA\\_French\\_Nuclear\\_Reactor\\_Fuel\\_Reprocessing\\_Program.pdf](http://next-up.org/pdf/CIA_French_Nuclear_Reactor_Fuel_Reprocessing_Program.pdf). Accessed 06/11/2015. 5.

**5. Aster, Saclay Essonne**

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

Uranium enrichment, laser (MLIS).

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 began in 1988. The facility operated from 1988 to 2003.<sup>6</sup> The first successful experiment did not occur until 1996.<sup>7</sup>

- 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.*

France includes facilities on its Voluntary Offer Agreement (VOA) to the IAEA only if they contain materials from third parties who require safeguards. It seems unlikely, then, that this plant was eligible for safeguards.

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

All *civilian* nuclear plants in France are 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.*

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 was found.

- j. *Sources:*

Carlson, John. 2011. "Safeguards in Nuclear-Weapon State: Should More Be Done?" Paper prepared for the Annual Meeting of the Institute of Nuclear Materials Management, Palm Desert, CA, July 17-21.  
<http://belfercenter.ksg.harvard.edu/files/uploads/INMM2011NWS.pdf>

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<sup>6</sup> Makhigani, Chamlers and Smith (2004) provide the start of operations from 1988 to 2003. Zentner et al. (2005) give 1984 as the start date.

<sup>7</sup> The 1996 date is from Global Security.

Global Security. "Saclay." <http://www.globalsecurity.org/wmd/world/france/saclay.htm>. Accessed 06/11/2015.

Makhijani, Arjun, Lois Chalmers, and Brice Smith. 2004. "Uranium Enrichment." Institute for Energy and Environmental Research. <http://www.helencaldicott.com/uranium.pdf>. Accessed 06/12/2015.

World Information Service on Energy. 2015. "Uranium Enrichment and Fuel Fabrication—Current Issues (France)." <http://www.wise-uranium.org/epfr.html>. Accessed 06/12/2015.

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

## 6. Atelier Pilote

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

Spent fuel reprocessing, MOX.

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.*

This facility is the former Marcoule-UP1 plant. It started operating in 1988 and was shut down in 1997. The facility changed names and operations in 1988 as the reprocessing plant was refurbished and expanded. It was to be used for reprocessing spent fuel from the 250 MW prototype breeder Phoenix, and operated until 1997.

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

No, the facility was announced publicly.

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

The facility was reportedly not part of France's VOA with the IAEA.

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

All civilian nuclear plants in France are under Euratom safeguards.

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

No. The Marcoule-UP1 plant was for military purposes, but with the expansion in 1988 this plant became civilian.

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 nuclear assistance found.

j. *Sources:*

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

MacLachlan, Ann. 1983. "France Stays Course on FBR Reprocessing While Outlook Dims for Reactor Orders." *Nuclear Fuel*. 8(12): 14.

MacLachlan, Ann. 1988. "French Breeder Fuel Reprocessing Plant Given New Mission Involving LWR Fuels." *Nuclear Fuel*. 13(3): 8.

Makhijani, Arjun, Howard Hu, and Katherine Yih. 2000. *Nuclear Wastelands: A Global Guide to Nuclear Weapons Production and Its Health and Environmental Effects*. Cambridge: MIT Press.

Organization for Economic Cooperation and Development. 2006. The NEA Co-operative Programme on Decommissioning. <https://www.oecd-nea.org/rwm/reports/2006/nea6185-decommissioning.pdf>. Accessed 06/ 11/2015.

## 7. La Hague – AT1

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

Spent fuel reprocessing.

a. *Facility size (laboratory, pilot, commercial):*

Pilot.

- b. *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 between 1961 and 1963. No definitive construction date could be identified. The facility operated from 1969-1979.<sup>8</sup>

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

No, the facility was publicly declared in 1964.

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

No, the facility was closed prior to safeguard agreements being signed with the IAEA in 1981.

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

All *civilian* nuclear plants in France are under Euratom safeguards.

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

No, the facility was used “for the reprocessing of fuel from Rapsodie and for perfecting the process for treating fast neutron reactor fuel in general” (Davis 2009).

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

No, it was a development plant for commercial facilities.

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

No indication of foreign assistance. This plant was focused on SILVA experiments, the French-origin laser enrichment process.

- i. *Sources:*

ASN. 2007. “List of Basic Nuclear Installations.” Annual Report 2007. <http://annual-report2007.asn.fr/PDF/french-nuclear-installations.pdf>. Accessed 06/11/2015.

Coates, J.H. et al. 1988. “France Makes Steady Progress with Lasers.” *Nuclear Engineering International*. 33: 409.  
[http://inis.iaea.org/search/search.aspx?orig\\_q=RN:20003389](http://inis.iaea.org/search/search.aspx?orig_q=RN:20003389). Accessed 06/12/2015.

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<sup>8</sup> The operational dates are from Petite and Garcia (1998).

- Cornu, F. 1992. "Pilot Dismantling of the AT1 FBR Reprocessing Facility at the Hague." International Atomic Energy Agency.  
[http://inis.iaea.org/search/search.aspx?orig\\_q=RN:24009831](http://inis.iaea.org/search/search.aspx?orig_q=RN:24009831). Accessed 06/11/2015.
- Davis, Mary Bryd. 2009. "The La Hague Reprocessing Plant: Basic Facts." EcoPerspectives: A Project of Earth Island Institute.
- Davies, M. W. "A Review of the Situation of Decommissioning of Nuclear Installations in Europe." European Commission Nuclear Safety and the Environment, Report EUR 17622.
- International Atomic Energy Agency. "Integrated Nuclear Fuel Cycle Information Systems." <https://infcis.iaea.org>. Accessed 06/08/2015.
- Liebert, Wolfgang. 1992. "Risks of Horizontal and Vertical Proliferation of Emerging Nuclear Technologies: The Case of Laser Isotope Separation." <http://www.ianus.tu-darmstadt.de/media/ianus/pdfs/arbeitspapiere/2-1992.pdf>. Accessed 06/11/2015. 12.
- Petit, X. and A. Garcia. 1998. "Decommissioning of the AT1 FBR Fuel Reprocessing Facility at La Hague." European Commission on Nuclear Science and Technology.

## 8. La Hague (Marcoule-UP1)

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

Spent fuel reprocessing, PUREX.

- 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 began in 1952. The facility operated from 1958<sup>9</sup> until 1997.

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

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<sup>9</sup> IAEA (2008) state 1965 and 1997 as the operational dates. INFCIS dates are used.

There does not appear to have been a concerted effort to conceal this facility from the public. An article in the *New York Times* (“French Finishing 3 Atom Reactors,” August 17, 1957) references this plant while it was still under construction, without alluding to a French campaign to keep it secret.

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

This facility is reportedly not part of France’s VOA with the IAEA.

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

Unlikely, since Euratom safeguards apply to civilian nuclear plants only.

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

This facility is designated as a military facility. It was adjacent to two heavy-water reactors designed for plutonium production. The facility reportedly continued to produce plutonium until 1991, though tritium production continued after this date. This was the first large-scale site constructed for plutonium separation. The facility reprocessed up to 960 tons per year. Military reprocessing ended in 1993 with commercial reprocessing ending in 1997.

- 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 nuclear assistance found.

- j. *Sources:*

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

MacLachlan, Ann. 1983. “France Stays Course on FBR Reprocessing While Outlook Dims for Reactor Orders.” *Nuclear Fuel*. 8(12): 14.

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Makhijani, Arjun, Howard Hu, and Katherine Yih. 2000. *Nuclear Wastelands: A Global Guide to Nuclear Weapons Production and Its Health and Environmental Effects*. Cambridge: MIT Press.

Organization for Economic Cooperation and Development. 2006. The NEA Co-operative Programme on Decommissioning. <https://www.oecd-nea.org/rwm/reports/2006/nea6185-decommissioning.pdf>. Accessed 06/ 11/2015.

**9. ATTLA, (FONTENAY: ATTaQue d'Irradiés-combustibles-en Lits d'Alumine)**

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

Spent fuel reprocessing (hot cell).

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 began in 1966 and was operational from 1966 to 1975.<sup>10</sup>

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

There is no evidence that France attempted to conceal this plant.

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

The facility was closed prior to agreements with the IAEA in 1981.

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

It is unclear but we code this as “no” given our classification of the facility as “military.”

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

It is unclear if the facility was used for military reprocessing. However, per the coding rule described above, we code this as a military plant.

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<sup>10</sup> MacLachlan's *Nuclear Fuel* article states the dates of operation of the facility from 1976 to 1981. The French national report lists 1966 as the operational start date.

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.*

It does not appear that this facility was built with foreign assistance. However, France later carried out joint research with the Soviet Union on dry reprocessing.

j. *Sources:*

Davis, Mary Byrd. "Centre de Fontenay-Aux-Roses." France Nuclear Archive. <http://archive.today/TnFOe>. Accessed 06/11/2015.

"Fifth National Report on Compliance with the Joint Convention Obligations." France. September 2014.

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Terrasson, L. 1989. "Some Steps of the Dismantling of the Hot Cell Atilla." International Atomic Energy Agency. <http://inis.iaea.org/search/searchsinglerecord.aspx?recordsFor=SingleRecord&RN=20069135>. Accessed 06/12/2015.

## **10. Plutonium Chemistry Laboratory (LCPu) – Fontenay-aux-Roses**

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

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 facility is coded as being operational from 1966 to 1995.

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

We could not find any evidence in available records that this facility was revealed prior to 1966. However, there is no clear indication that France attempted to conceal this facility.

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

It is unlikely, given the military nature of this facility.

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

No, Euratom safeguards apply to civilian nuclear plants only.

- g. Did the facility have a military purpose?

Yes.

- 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 nuclear assistance found.

- j. *Sources:*

ASN. 2012. "Nuclear Safety and Radiation Protection in France in 2011." Autorité de Sûreté Nucléaire. <http://www.french-nuclear-safety.fr/Information/Publications/ASN-s-annual-reports/Nuclear-safety-and-radiation-protection-in-France-in-2011>. Accessed 06/12/2015.

Davis, Mary Byrd. "Centre de Fontenay-Aux-Roses." France Nuclear Archive. <http://archive.today/TnFOe>. Accessed 06/11/2015.

“Fifth National Report on Compliance with the Joint Convention Obligations.” France. September 2014.

MacLachlan, Ann. 1984. “France and USSR Consider Experimental Dry Reprocessing for Breeder Fuel.” *Nuclear Fuel*. 9(12): 14.

Nuclear Weapons Archive. 2001. “Origin of the Force de Fappe.” <http://nuclearweaponarchive.org/France/FranceOrigin.html>. Accessed 06/12/2015.

## 11. FONTENAY: BÂTIMENT RADIOCHIMIE (Building 18)

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 construction of the facility began in 1959. The facility operated from 1961 to 1995.<sup>11</sup>

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

We could not find definitive evidence indicating it was covert, but given links to the weapons program, it may have started as a covert facility. In the absence of conclusive evidence, we assume that it was not built in secret.

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

France includes facilities on its Voluntary Offer Agreement (VOA) to the IAEA only if they contain materials from third parties who require safeguards. It seems unlikely, then, that this plant was eligible for safeguards.

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

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<sup>11</sup> The NCFIS lists operation as 1959-1995. Construction of the facility occurred between 1959 and 1962 for the entire French Atomic Energy Centre at Fontenay aux Roses complex (Jean Jacques et al 2007). Jean Jacques et al. (2008) state the facility operated from 1961 to June 1995 and is the date that is used. French achieves state 1960 for operation (<http://archive.today/TnFOe>).

We assume that the plant was not safeguarded by Euratom given our coding of it as a “military” facility.

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

It is unclear if the facility was used for military reprocessing. However, per the coding rule described above, we code this as a military plant.

*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 nuclear assistance found.

*j. Sources:*

Davis, Mary Byrd. “Centre de Fontenay-Aux-Roses.” France Nuclear Archive. <http://archive.today/TnFOe>. Accessed 06/11/2015.

“Fifth National Report on Compliance with the Joint Convention Obligations.” France. September 2014.

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

Jean Jacques, Michel, Marie Pierre Bremond, Carole Marchand, Cecile Poyau, Cecile Viallefont, Laurent Guatier, and Frederic Masure. 2007. “Clean-up of Nuclear Licensed Facility 57.” International Conference on Environmental Remediation and Radioactive Waste Management, Bruges (Belgium). 2-6 September 2007.

## **12. FONTENAY: BÂTIMENT PLUTONIUM (Building 19)**

*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 precise construction year could not be identified. The facility operated from 1957 to 1984 (INFCIS).

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

No, the facility was not developed covertly.

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

France includes facilities on its Voluntary Offer Agreement (VOA) to the IAEA only if they contain materials from third parties who require safeguards. It seems unlikely, then, that this plant was eligible for safeguards.

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

We assume that the plant was not safeguarded by Euratom given our coding of it as a “military” facility.

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

It is unclear if the facility was used for military reprocessing. However, per the coding rule described above, we code this as a military plant.

- 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 nuclear assistance found.

- j. *Sources:*

Davies, M. W. “A Review of the Situation of Decommissioning of Nuclear Installations in Europe.” European Commission Nuclear Safety and the Environment, Report EUR 17622.

Davis, Mary Byrd. “Centre de Fontenay-Aux-Roses.” France Nuclear Archive. <http://archive.today/TnFOe>. Accessed 06/11/2015.

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

### 13. Fontenay Pilot 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).*

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 likely began in 1952 (CIA). The facility was commissioned in 1954 and built by Saint Gobain. The facility was operational from 1954 to 1957. The facility was dismantled between 1959 and 1962.

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

The French government financed work on this plant – and other related activities from 1945 to 1958 – in secret (see Makhijari et al 2000, 437). It is unclear if the facility itself was built in secret or if France merely concealed its intentions (i.e., how it planned to use the facility). France did not attempt to hide the lab-scale plant or the larger reprocessing facility at Marcoule, so it would be strange if this facility was concealed from the public. That said, we did not find evidence of this facility being discussed in English language media sources while it operated. Although we lack clear evidence one way or the other, it seems likely that France did *not* attempt to keep the existence of this facility secret from the public.

- 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?*

The facility almost certainly had a military purpose.

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 nuclear assistance found.

j. *Sources:*

Davis, Mary Byrd. 1994. "The French Mess Nucleaire." *Bulletin of the Atomic Scientists*. July/ August.

Davis, Mary Byrd. "Centre de Fontenay-Aux-Roses." France Nuclear Archive. <http://archive.today/TnFOe>. Accessed 06/11/2015.

Donnay, Albert and Martin Kuster. 1995. "France" in *Nuclear Wastelands: A Global Guide to Nuclear Weapons Production and Its Health and Environmental Effects*. Edited by Arjun Makhijani, Howard Hu, and Katherine Yi. Cambridge, MA: MIT Press. 463.

Makhijani, Arjun, Howard Hu, and Katherine Yih. 2000. *Nuclear Wastelands: A Global Guide to Nuclear Weapons Production and Its Health and Environmental Effects*. Cambridge: MIT Press.

Regnaut, P. et al. 1959. "The Processing of Irradiated Uranium Results of the Operation of the Fontenay-aux-Roses Pilot Plant." Commissariat a l'Energie Atomique, Paris. <http://www.osti.gov/scitech/biblio/4269306>. Accessed 11/10/2015.

US CIA. 1964. "The French Nuclear Weapon Program." Central Intelligence Agency, Office of Scientific Intelligence. [http://www.foia.cia.gov/sites/default/files/document\\_conversions/89801/DOC\\_0001478997.pdf](http://www.foia.cia.gov/sites/default/files/document_conversions/89801/DOC_0001478997.pdf). Accessed 11/10/2015.

#### **14. Experimental Reprocessing Facility (Building 211)**

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.*

The exact construction start year could not be identified, though the OECD notes construction occurred between 1960 and 1963. The facility is thought to have operated from 1960 to 1997 (INFCIS).

- 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.*

France includes facilities on its Voluntary Offer Agreement (VOA) to the IAEA only if they contain materials from third parties who require safeguards. It seems unlikely, then, that this plant was eligible for safeguards.

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

We assume that the plant was not safeguarded by Euratom given our coding of it as a “military” facility.

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

It is unclear if the facility was used for military reprocessing. However, per the coding rule described above, we code this as a military plant.

- 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 nuclear assistance found.

- j. *Sources:*

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

Organization for Economic Cooperation and Development. 2006. The NEA Co-operative Programme on Decommissioning. <https://www.oecd-nea.org/rwm/reports/2006/nea6185-decommissioning.pdf>. Accessed 06/ 11/2015.

## 15. Eurodif (Georges Besse I)

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

Uranium enrichment, gaseous diffusion

- 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 began in 1974.<sup>12</sup> Operations at the facility began in 1979,<sup>13</sup> and it reached full operational capacity in 1982 before closing in 2012. The facility began nominal production capacity in 1982. The facility stopped operations in May of 2012.<sup>14</sup>

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

No, the facility was publicly announced and received international customers.

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

Yes, the facility was included on France's voluntary offer. However, the actual occurrence and duration of inspections is unknown.

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

Yes, Euratom safeguards apply to all civilian plants in France.

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

No, the facility is used to produce civilian enriched uranium for power plants.

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

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<sup>12</sup>Zentner et al. (2005) provide the construction start date.

<sup>13</sup>The date listed is the one cited by the *Nuclear Fuel* article, Areva website, and NFCIS.

<sup>14</sup>Areva provides the end of operation date.

Yes, the facility was based on a consortium between France, Belgium, Italy, Spain and Sweden—though Sweden withdrew from the project in 1974. Iran acquired the 10 percent share belonging to Sweden in 1974. Spain owns a 10% share of Eurodif. Iran's 10% share was removed following the 1979 Islamic Revolution.

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

Not much is known about the exact contributions of various countries. Italy did contribute to the technology at Eurodif. Technological support was coordinated within Italy by the Gruppo Italiano Arricchimento Uranio (GIAU). GIAU developed some centrifuge technology that was not used, as well as the gaseous diffusion systems employed at Eurodif.

- j. *Sources:*

Areva. "All About Checks and Controls." <http://www.Areva.com/EN/operations-1147/la-hague-inspections-by-the-french-authorities-and-international-bodies.html?xtmc=safeguard&xter=8>. Accessed 06/15/2015.

Areva. "Eurodif Production: Natural Uranium Enrichment." <http://www.Areva.com/EN/operations-800/eurodif-production-natural-uranium-enrichment.html>. Accessed 06/15/2015.

Areva. 2012. "Eurodif's Uranium Enrichment Plant Ceases Production Permanently." <http://www.Areva.com/EN/news-9364/eurodif-s-uranium-enrichment-plant-ceases-production-permanently.html>. Accessed 06/15/2015.

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Merlini, Cesare. 1988. "A Concise History of Nuclear Italy." *The International Spectator*. 23(3): 141.

Oak Ridge National Laboratory. 2007. "Profile of World Uranium Enrichment Plants." 10.

—. 2012. "Areva, EDF Agree to Close Eurodif in Late 2012." *Nuclear Fuel*.

35(25): 1.

- . 2012. “Eurodif Gaseous Diffusion Plant in France Shuts After 33 Years.” *Nuclear Fuel*. 37(12): 1.

## 16. Georges Besse II—North Plant

- 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.*

Initial discussions began in 2003. Construction began in 2006. The facility was completed in 2009 and uranium hexafluoride was first introduced in 2009.<sup>15</sup> Commercial operations began in April 2011.

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

No, the facility was publicly announced.

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

Yes, the facility is under IAEA safeguards.

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

Yes, Euratom safeguards apply to all civilian plants in France.

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

No, the facility is part of Areva and Eleltricite de France. One issue with the facility is the economic viability of other enrichment facilities in France and Europe once GB II is online.

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

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<sup>15</sup> The IAEA states 2009 as the operational start date while McClachlan (2009) states 2010 as when uranium was first introduced into the facility. Commercial production began in 2011 (Areva).

Yes, the facility was multinational. The centrifuge design is from the Enrichment Technology Company (ETC), which has similar centrifuge designs operating in Urenco facilities. ETC is a 50-50 venture between Areva and Urenco. The facility boasts contracts with at least 100 customers from 14 different countries.<sup>16</sup> The memorandum of understanding to cooperate on centrifuge technology excludes them both from centrifuge design and did not call for joint research. Areva is the majority owner of the plant, though several other foreign companies own shares including GDF Suez, Korea Hydro & Nuclear Power Co Ltd, Kansai, Kyushu Electric Power, Tohoku Electric Power.

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

Yes. The Société d'Enrichissement du Tricastin (SET) operates the plant using centrifuge technology developed by the Enrichment Technology Company (ETC). The ETC licenses the processes and supplies the equipment. ETC was formed through a 2006 agreement between Areva and Urenco. The agreement allows for Areva to use Urenco centrifuge technology.

- j. *Sources:*

Areva. "Tricastin Site: The Georges Besse II Enrichment Plant."

<http://www.Areva.com/EN/operations-887/tricastin-site-the-georges-besse-ii-enrichment-plant.html>. Accessed 06/15/2015.

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McGoldrick, Fred. 2011. "Limiting Transfers of Enrichment and Reprocessing Technology: Issues, Constraints, Options." The Belfer Center. <http://belfercenter.ksg.harvard.edu/files/MTA-NSG-report-color.pdf>. Accessed 06/15/2015. 9.

Oak Ridge National Laboratory. 2007. "Profile of World Uranium Enrichment Plants." 10.

MacLachlan, Ann. 2009. "Startup of GB II finds Areva, EDF at Odds." *Nuclear Fuel*. 34(25): 1.

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<sup>16</sup> These numbers reflect the total from the inaugural celebration of the beginning of the facility.

MacLachlan, Ann. 2003. "Cogema to Start Construction on Centrifuge SWU Plant in April 2005." *Nuclear Fuel*. 28(26): 4.

World Nuclear Organization. 2015. "Nuclear Power in France." <http://www.world-nuclear.org/info/inf40.html>. Accessed 06/15/2015.

—. 2003. "Areva Buys Stake in Urenco's ETC, Will Build New SWU plant at Tricastin." *Nuclear Fuel*. December 8, 2003.

## 17. Georges Besse II—South Plant

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 was started in 2007. The facility is expected to be completed in 2015.

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

No, the facility was publicly announced.

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

Yes, the facility is under IAEA safeguards as of 2011.

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

Yes, Euratom safeguards apply to all civilian plants in France.

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

No, the facility is part of Areva and Eleltricite de France. One issue with the facility is the economic viability of other enrichment facilities in France and Europe once GB II is online.

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

Yes, the facility was multinational. The centrifuge design is from the Enrichment Technology Company (ETC), which has similar centrifuge designs operating in Urenco facilities. ETC is a 50-50 venture between Areva and Urenco. The facility boasts contracts with at least 100 customers from 14 different countries.<sup>17</sup> The memorandum of understanding (MOU) to cooperate on centrifuge technology excludes them both from centrifuge design and did not call for joint research.

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

The Société d'Enrichissement du Tricastin (SET) operates the plant using centrifuge technology developed by the Enrichment Technology Company (ETC). The ETC licenses the processes and supplies the equipment. ETC was formed through a 2006 agreement between Areva and Urenco. The agreement allows for Areva to use Urenco centrifuge technology. Areva is the majority owner of the plant, though several other foreign companies own shares including GDF Suez, Korea Hydro & Nuclear Power Co Ltd, Kansai, Kyushu Electric Power, Tohoku Electric Power.

j. *Sources:*

Areva. "Tricastin Site: The Georges Besse II Enrichment Plant." <http://www.Areva.com/EN/operations-887/tricastin-site-the-georges-besse-ii-enrichment-plant.html>. Accessed 06/15/2015.

Hibbs, Marks, and Ann MacLachlan. 2005. "French Centrifuge Plant Will Be 'Black Box' Equipped with TC-21 Machine." *Nuclear Fuel*. 30(26): 1.

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

Laughter, M.D. 2009. "Profile of World Uranium Enrichment Programs 2009." Oak Ridge National Laboratory.

McGoldrick, Fred. 2011. "Limiting Transfers of Enrichment and Reprocessing Technology: Issues, Constraints, Options." The Belfer Center. <http://belfercenter.ksg.harvard.edu/files/MTA-NSG-report-color.pdf>. Accessed 06/15/2015. 9.

Oak Ridge National Laboratory. 2007. "Profile of World Uranium Enrichment Plants." 10.

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<sup>17</sup> These numbers reflect the total from the inaugural celebration of the beginning of the facility.

MacLachlan, Ann. 2009. "Startup of GB II finds Areva, EDF at Odds." *Nuclear Fuel*. 34(25): 1.

MacLachlan, Ann. 2003. "Cogema to Start Construction on Centrifuge SWU Plant in April 2005." *Nuclear Fuel*. 28(26): 4.

World Nuclear Organization. 2015. "Nuclear Power in France."  
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## 18. PL81 Grenoble

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

Enrichment, chemical.

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 started in 1968.<sup>18</sup> The facility started to operate in 1974 and ended operations in 1984.<sup>19</sup>

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

The Chemex process was first announced in 1977. This facility was apparently concealed from the public during its initial phase of operation.

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

France includes facilities on its Voluntary Offer Agreement (VOA) to the IAEA only if they contain materials from third parties who require safeguards. It seems unlikely, then, that this plant was eligible for safeguards.

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

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<sup>18</sup> Construction is based on program initial listed by Zentner et al. (2005).

<sup>19</sup> The operational dates are from MacLachlan (1984). The IAEA lists 1980 and Davis notes discrepancies over dates.

We assume that the plant was not safeguarded by Euratom given our coding of it as a “military” facility.

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

It is unclear if the facility was used for military reprocessing. However, per the coding rule described above, we code this as a military plant. France also developed this technology for commercial purposes, and emphasized its resistance to proliferation to make it seem more attractive for export.

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:*

MacLachlan, Ann. 1984. “CEA Readies Chemical Enrichment Pilot, But Expansion Hinges on Foreign Demand.” *Nuclear Fuel*. 9(3): 5.

MacLachlan, Ann. 1987. “French Find Chemical Enrichment is a Pleasant Economic Surprise.” *Nuclear Fuel*. 12(2): 1.

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

**19. Laboratory RM2 (FONTENAY: LABORATOIRE D’ÉTUDES DE COMBUSTIBLES À BASE DE PLUTONIUM. (Laboratory for studies of plutonium-based fuel), also known as the Bâtiment radioméallurgie (Radiometallurgy Building) or Bâtiment 52**

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.*

Construction start year could not be identified. The facility operated from 1968 to 1982.<sup>20</sup>

- 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.*

France includes facilities on its Voluntary Offer Agreement (VOA) to the IAEA only if they contain materials from third parties who require safeguards. It seems unlikely, then, that this plant was eligible for safeguards.

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

We assume that the plant was not safeguarded by Euratom given our coding of it as a “military” facility.

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

The facility housed 13 hot cells for plutonium reprocessing, possibly for France’s military weapons program. The laboratory was designed to conduct destructive testing on irradiated fuel. It is unclear if the facility was used for military reprocessing. However, per the coding rule described above, we code this as a military plant.

- 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 nuclear assistance found.

- j. *Sources:*

Albright, David. 2007. “Shipments of Weapons—Usable Plutonium in the Commercial

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<sup>20</sup> The start operational date is from the IAEA NFCIS. The European Union Report by Davies, listed in the sources, lists the dates as 1964-1984. First National Report lists 7/31/1982 as the shut down date. 1982 is used as the last operation date.

Nuclear Industry.” Institute for Science and International Security. [http://isis-online.org/uploads/isis-reports/documents/plutonium\\_shipments.pdf](http://isis-online.org/uploads/isis-reports/documents/plutonium_shipments.pdf). Accessed 06/15/2015.

Davis, Mary Byrd. “Centre de Fontenay-Aux-Roses.” France Nuclear Archive. <http://archive.today/TnFOe>. Accessed 06/11/2015.

Croff, A.G., R.G. Wymer, L.T. Tavlarides, J.H. Flack, H.J. Larson. 2007. “Background, Status, and Issues Related to the Regulation of Advanced Spent Nuclear Fuel Recycle Facilities.” A White Paper of the US Nuclear Regulatory Commission’s Advisory Committee on Nuclear Waste and Materials. <http://pbadupws.nrc.gov/docs/ML0728/ML072850765.pdf>. Accessed 06/15/2015.

Davies, M. W. 1997. “A Review of the Situation of Decommissioning of Nuclear Installations in Europe.” European Commission Nuclear Safety and the Environment. Report EUR 17622.

France. 2003. “First National Report on Compliance with the Joint Convention Obligations” Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. <http://wacid.kins.re.kr/DOCU/FILE/%ED%94%84%EB%9E%91%EC%8A%A4.pdf>. Accessed 06/15/2015.

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

International Atomic Energy Agency. “International Decommissioning Network.” Waste Technology Section. [http://www.iaea.org/OurWork/ST/NE/NEFW/WTS-Networks/IDN/Video\\_demonstrations.html](http://www.iaea.org/OurWork/ST/NE/NEFW/WTS-Networks/IDN/Video_demonstrations.html).

## 20. PL4

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

Uranium enrichment, chemical processing.

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

Laboratory.<sup>21</sup>

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 and operation of the facility began in 1984. The facility ran for one year.

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<sup>21</sup> The IEER report lists this facility size as pilot but INFCIS claims it is a laboratory size.

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.*

France includes facilities on its Voluntary Offer Agreement (VOA) to the IAEA only if they contain materials from third parties who require safeguards. It seems unlikely, then, that this plant was eligible for safeguards.

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

We assume that the plant was not safeguarded by Euratom given our coding of it as a “military” facility.

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

It is unclear if the facility was used for military reprocessing. However, per the coding rule described above, we code this as a military plant.

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 nuclear assistance found.

j. *Sources:*

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

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.

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

## **21. Pilot Chemical Enrichment Plant**

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

Uranium enrichment, chemical processing.

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

Pilot.<sup>22</sup>

- 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 and operation of the facility began in 1987. In 1988 the French decided to terminate the chemical enrichment program to focus on laser enrichment.

- 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.*

France includes facilities on its Voluntary Offer Agreement (VOA) to the IAEA only if they contain materials from third parties who require safeguards. It seems unlikely, then, that this plant was eligible for safeguards.

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

We assume that the plant was not safeguarded by Euratom given our coding of it as a “military” facility.

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

It is unclear if the facility was used for military reprocessing. However, per the coding rule described above, we code this as a military plant.

- 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 nuclear assistance found.

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<sup>22</sup> The IEER and Zentner et al. report this facility size as pilot but INFCIS claims it is a laboratory size.

j. Sources:

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

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.

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

## 22. Pierrelate GDP

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

Uranium enrichment, gaseous diffusion.

- 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 began in 1960. The facility operated from 1964<sup>23</sup> to 1996.<sup>24</sup>

- 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.*

It is unlikely the facility was placed under IAEA safeguards as it was used for the military production of uranium.

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<sup>23</sup> Zentner et al. (2005) provide the 1960 start of construction date and the operational start date. HEU uranium was first produced in 1967.

<sup>24</sup> Makhijani, Chalmers and Smith state 1982 as the end of the operation date. Laughter states early 1980's as the end of operation in the lower stages of the plant. Zhang and Hippel (2000) provide the shutdown date. ORNL 2009 notes 2006 is the year President Jacques Chirac announced the plant would be immediately shut down and dismantled.

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

We assume that the plant was not safeguarded by Euratom given our coding of it as a “military” facility.

- g. *Did the facility have a military purpose? Be as specific as possible.*

Yes, the facility was designed for military enrichment to produce 90% HEU in 1967. French President Jacques Chirac announced in 1996 that France would no longer produce fissile material for nuclear weapons and announced the closure of the facility.

- 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.

- j. *Sources:*

Laughter, M.D. 2009. “Profile of World Uranium Enrichment Programs.” Oak Ridge National Laboratory.

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.

Oak Ridge National Laboratory. 2007. “Profile of World Uranium Enrichment Programs.” 10.

Zhang, Hui and Frank N. von Hippel. 2000. “Using Commercial imaging Satellites to Detect the Operation of Plutonium Production Reactors and Gaseous Diffusion Plants.” *Science and Global Security*. 8: 219-271.

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

### **23. Pierrelatte, Laser**

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

Uranium enrichment, laser (AVLIS).

- 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 occurred in 1984.<sup>25</sup> The facility operated from 1984-1996.<sup>26</sup>

- 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.*

France includes facilities on its Voluntary Offer Agreement (VOA) to the IAEA only if they contain materials from third parties who require safeguards. It seems unlikely, then, that this plant was eligible for safeguards.

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

We assume that the plant was not safeguarded by Euratom given our coding of it as a “military” facility.

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

It is unclear if the facility was used for military reprocessing. However, per the coding rule described above, we code this as a military plant.

- 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 nuclear assistance found.

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<sup>25</sup> Exact date of construction was not found. The Pierrelatte facility was already operating at this time. The additional laser research was built as an addition.

<sup>26</sup> Zentner et al. (2005) provide the operational dates. Makijani, Chalmers, and Smith state operational start date as 1977.

*j. Sources:*

Donnay, Albert and Martin Kuster. 1995. "France" in *Nuclear Wastelands: A Global Guide to Nuclear Weapons Production and Its Health and Environmental Effects*. Edited by Arjun Makhijani, Howard Hu, and Katherine Yi. Cambridge, MA: MIT Press. 463.

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.

Oak Ridge National Laboratory. 2007. "Profile of World Uranium Enrichment Programs." 10.

**24. PP35 Pierrelatte**

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

Enrichment, chemical.

*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 started in 1968 and was completed in 1974.<sup>27</sup> The facility started to operate in 1974 and ended operations in 1985.<sup>28</sup>

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

The Chemex process was first announced in 1977. This facility was apparently concealed from the public during its initial phase of operation.

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

France includes facilities on its Voluntary Offer Agreement (VOA) to the IAEA only if they contain materials from third parties who require safeguards. It seems unlikely, then, that this plant was eligible for safeguards.

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<sup>27</sup> Construction is based on program initial listed by Zentner et al. (2005).

<sup>28</sup> The operational dates are from MacLachlan (1987).

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

We assume that the plant was not safeguarded by Euratom given our coding of it as a “military” facility.

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

It is unclear if the facility was used for military reprocessing. However, per the coding rule described above, we code this as a military plant.

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:*

MacLachlan, Ann. 1984. “CEA Readies Chemical Enrichment Pilot, But Expansion Hinges on Foreign Demand.” *Nuclear Fuel*. 9(3): 5.

MacLachlan, Ann. 1987. “French Find Chemical Enrichment is a Pleasant Economic Surprise.” *Nuclear Fuel*. 12(2): 1.

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