Nuclear Latency (NL) Dataset
Country Coding Sheets

BRAZIL
COW COUNTRY CODE: 140

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

1. Aerospace Technical Center (Institute of Advanced Studies)
2. BRF Enrichment – Aramar Demonstration Center, Ipero, Sao Paolo
3. BRN Enrichment (Aramar Isotopic Enrichment Lab) Ipero, Sao Paulo
4. INB Resende – Enrichment Facility, Rio De Janeiro
5. INB Resende – Enrichment Facility, Rio De Janeiro
6. IPEN – Reprocessing
7. Pilot Enrichment Plant- Belo Horizonte (INB Resende)

Detailed Facility-Specific Information and Sources

1. Aerospace Technical Center (Institute of Advanced Studies)

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

Uranium enrichment, ALVIS.

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 likely began after 1975. The IAEA reports that the facility began operation in 1981 but had 0 MTSWU/year. Zentner et al. report that Brazil was known to have an interest in laser enrichment but that no formal program was identified. Laser enrichment was deemphasized in Brazil around 1989; we use this year for the end of facility operation (enrichment experimentation).

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

Yes, the facility was developed covertly as part of Brazil's parallel nuclear program. The facility was known by the early 1990s and was declared in the negotiating process with ABACC.

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

No, while IAEA safeguards were implemented in 1991 as part of the Quadripartite Agreement, this facility was not operational at this time. Brazil has not signed the additional protocol.

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

No. Regional safeguards did not come into effect until after the facility ceased operating.

g. Did the facility have a military purpose?

Yes, the facility was designed to enrich uranium for the Brazilian Air Force.

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

There is no evidence to suggest that the facility was built with the assistance of international partners. The individuals responsible for the research were educated in the United States, however.

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. The Brazilian Air Force ran the site.

j. Sources:

Ferguson, Charles D. 2005. "Laser Enrichment: Separation Anxiety.'' *Bulletin of Atomic Scientists*. March/ April. http://www.cfr.org/world/laser-enrichment-separation-anxiety/p7876. Accessed 11/10/2015.

Hibbs, Mark. 1989. "Bonn: There is 'No Military Background' to Brazil's Unsafeguarded Program." *Nuclear Fuel.* 14(16): 13.

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

International Atomic Energy Agency. 1994. "Agreement of 13 December 1991 Between the Republic of Argentina, the Federative Republic of Brazil, the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials and the International Atomic Energy Agency for the Application of Safeguards." INFCIRC/435. http://www.iaea.org/Publications/Documents/Infcircs/Others/inf435.shtml. Accessed 06/08/2015.

Interview with Dr. Paulo Barretto. NSSPI Research Scientist.

Long, William R. 1987. “Brazil's Nuclear Program: Constant as a Firefly: First Plant Has Gone Off and On 20 Times: Military Pushing Parallel Effort.” *Los Angeles Times*. http://articles.latimes.com/1987-04-25/news/mn-1006_1_nuclear-program/. Accessed 06/08/2015.

2. BRF Enrichment—Aramar Demonstration Center, Ipero, Sao Paolo

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

Uranium enrichment, centrifuge.

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.

Arms Control notes that COPESP began construction of the pilot enrichment plant in 1987. End construction is coded as 1998, the year operations started. The facility began operation in 1998 and continues to this day.[1]

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

Yes, this is a military facility that began in secret.

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

The facility was placed under IAEA safeguards in 1991 with the signing of the Quadripartite Agreement. In 1997 an exchange of letters occurred that stated the agreement satisfied NPT obligations and the Treaty of Tlatelolco.

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

The facility was under ABACC safeguards starting in 1991 and continues to the present. Inspections reportedly did not take place until 1993 (Redick).

g. Did the facility have a military purpose?

Yes. The military operated this facility.

[1] Note that the IAEA and Makhijani list 1998 while Arms Control states the first 20% enriched uranium was announced in 1989 and the nuclear weapons archive says the facility was inaugurated in 1988.

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

No, the facility is not multinational.

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

No. The Brazilian Navy was responsible for the development of this site. Redick states that Brazil's indigenous gas centrifuge development indirectly related to West Germany, as West Germany's increasing preference for the centrifuge method over the nozzle method helped show Brazil which enrichment path to take. It is possible that some equipment from West Germany may have been supplied to this facility. In 1953 for example, Brazil secretly agreed to buy three prototype centrifuges from West Germany. The centrifuges may have been sent to IPEN in 1956.

j. Sources:

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

Long, William R. 1987. "Brazil's Nuclear Program: Constant as a Firefly: First Plant Has Gone Off and On 20 Times: Military Pushing Parallel Effort." *Los Angeles Times*. April 25, 1987. http://articles.latimes.com/1987-04-25/news/mn-1006_1_nuclear- program/2. 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.

Nuclear Threat Initiative. 1991. "Brazilian-Argentine Agency for the Exclusively Peaceful Use of Nuclear Energy (ABACC)." http://www.nti.org/treaties-and-regimes/brazilian-argentine-agency-accounting-and-control-nuclear-materials-abacc/. Accessed 06/08/2015.

Perera, Judith. 1987. "Brazil's 'Parallel' Nuclear Industry." *The New Scientist.* 09/17/1987.

Redick, John R. 1995. "Nuclear Illusions: Argentina and Brazil." Henry L. Stimson Center. http://www.acamedia.info/politics/IRef/StimsonC/redick.pdf. Accessed 06/08/2015. 10.

Spector, Leonard S. and Jacqueline R. Smith. 1990. *Nuclear Ambitions*. Boulder, CO: Westview Press. 195.

Squassoni, Sharon and David Fite. "Brazil as Litmus Test: Resende and Restrictions on Uranium Enrichment." Arms Control Association. https://www.armscontrol.org/act/2005_10/Oct-Brazil. Accessed 11/17/2015.

3. BRN Enrichment (Aramar Isotopic Enrichment Lab) Ipero, Sao Paulo

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 on the site occurred from 1976. The facility became fully operational in 1988 and continues to operate.[2] Other sources provide various other operational dates: Makhijiani states 1992 and Redick states 1986.

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

Yes, the facility was developed covertly from 1976-1986. Brazil publicly announced successful enrichment to 20% in 1986.

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

The facility was under safeguards in the 1990s.[3]

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

The facility was placed under regional safeguards in 1991 with the creation of ABACC.

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

Yes, the facility was designed to provide HEU for the Navy.

[2] The 1988 full operational date is from the IAEA INFCIS, and is supported by Albright.
[3] Brazil signed a safeguards agreement with the IAEA in 1997. The Quadripartite Agreement was signed in 1991 and it stipulates that the countries will cooperate with the IAEA. The relationship between the IAEA and Brazil has been delicate. Brazil has negotiated to have inspections without the IAEA actually seeing the centrifuge technology, as it is likely Brazil got illicit assistance from German firms and individuals in the 80's and 90's.

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

No, though West Germany and Brazil agreed to an entire nuclear fuel cycle purchase from 1975-1980.

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

Yes. In 1975 West Germany signed an agreement to provide 10 nuclear reactors, a plutonium reprocessing plant, and a jet nozzle enrichment plant to Brazil. This deal was monumental, as it was the first sale of a complete nuclear fuel cycle to a developing nation. (Germany had first attempted to provide enrichment technology in 1956 but was thwarted by the CIA and British occupying authorities). There is uncertainty about whether centrifuges were actually supplied. We code this as a yes based on other sources including Zentner et al. This assumes the plant was partially constructed with West German technology.

j. *Sources*:

Albright, David. 1989. "Bomb Potential for South America." *Bulletin of the Atomic Scientists.* 45(4).

Barletta, Michael. "The Military Nuclear Program in Brazil." Center for International Security and Arms Control. http://iis-db.stanford.edu/pubs/10340/barletta.pdf. Accessed 06/08/2015.

Doyle, James E. 2008. "Argentina and Brazil." In *Nuclear Safeguards, Security, and Nonproliferation: Achieving Security with Technology and Policy (Butterworth-Heinemann Homeland Security).* Elsevier. 313.

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

International Institute for Strategic Studies. 2007. "Chapter Two: Nuclear Black Markets: Other Countries and Networks." In *Nuclear Black Markets: Pakistan, A.Q. Khan, and the Rise of Proliferation Networks- A Net Assessment.* http://archive.today/UsQbo. Accessed 06/08/2015.

Long, William R. 1987. "Brazil's Nuclear Program: Constant as a Firefly: First Plant Has Gone Off and On 20 Times: Military Pushing Parallel Effort." *Los Angeles Times*. http://articles.latimes.com/1987-04-25/news/mn-1006_1_nuclear-program/2. Accessed 06/08/2015.

Nuclear Weapons Archive. 2001. "Nuclear Weapons Frequently Asked Questions." http://nuclearweaponarchive.org/Nwfaq/Nfaq0.html. Accessed 06/08/2015.

Perera, Judith. 1987. "Brazil's 'Parallel' Nuclear Industry." *The New Scientist.* 09/17/1987.

Redick, John R. 1995. "Nuclear Illusions: Argentina and Brazil." Henry L. Stimson Center. http://www.acamedia.info/politics/IRef/StimsonC/redick.pdf. Accessed 06/08/2015. 10.

Spector, Leonard S. and Jacqueline R. Smith. 1990. *Nuclear Ambitions*. Boulder, CO: Westview Press. 195.

Zentner, M.D., G.L. Coles, and R.J. Talbert. 2005. "Nuclear Proliferation Technology Trends Analysis." Pacific Northwest National Laboratory. Report 14480. 29.

4. INB Resende – Commercial Enrichment Facility, Rio De Janeiro

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 began at the facility in 2000 and it was commissioned in 2005.[4] The facility continues to operate and will likely not reach full capacity until 2015.

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

No, the facility was internationally announced.

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

Yes, the facility was placed under IAEA safeguards in 2002 and the safeguards remain in place.

[4] There is disagreement concerning when the facility started operation. The IAEA lists 2005. Squassoni and Fite (2005) give 2005 as commissioning date. Zentner et al. (2005) give 2004 as commissioning date but do not describe introduction of material. We use 2005 because two independent sources provide this as commissioning date. Nuclear Engineering International lists the production start time as 2009.

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

Yes, the facility was placed under ABACC safeguards in 2002 and the safeguards remain in force.

g. Did the facility have a military purpose?

The Brazilian Navy was involved in the construction of the 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. INB, a subsidiary of CNEN operates the facility. The Brazilian Navy reportedly supplied the centrifuge technology. It is possible that German individuals may have assisted in the development of this facility, but their assistance would not have been state sanctioned. It is unlikely their assistance was crucial, as centrifuge development began in Brazil prior to the arrival of German centrifuge expert Schaab. Brazil has denied it received assistance from either Germany or Pakistan during the 1980's, 1990's, and 2000's.

j. Sources:

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

International Institute for Strategic Studies. 2007. "Chapter Two: Nuclear Black Markets: Other Countries and Networks." In *Nuclear Black Markets: Pakistan, A.Q. Khan, and the Rise of Proliferation Networks- A Net Assessment.* http://archive.today/UsQbo. Accessed 06/08/2015.

Nuclear Threat Initiative. 1991. "Brazilian-Argentine Agency for the Exclusively Peaceful Use of Nuclear Energy (ABACC)." http://www.nti.org/treaties-and-regimes/brazilian-argentine-agency-accounting-and-control-nuclear-materials-abacc/. Accessed 06/08/2015.

Open Source Center. 2009. "Brazil- Survey of Nuclear Agencies, Facilities." http://fas.org/nuke/guide/brazil/survey.pdf. Accessed 06/08/2015.

Squassoni, Sharon, and David Fite. 2005. "Brazil as Litmus Test: Resende and Restrictions on Uranium Enrichment." https://www.armscontrol.org/act/2005_10/Oct-Brazil. Accessed 06/08/2015.

5. INB Resende – Pilot Enrichment Facility, Rio De Janeiro

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

Uranium enrichment, aerodynamic.

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 started in 1982 (Perrera)[5] and it was completed in 1985 (Zentner). The facility started operations in 1985 and produced LEU in 1988. It ended operation by 1994.

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

No, the facility was internationally announced. It was widely reported in public sources that the plant was being built with West German assistance.

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

Yes, the facility was placed under IAEA safeguards in 1991. It was inspected in 1984 by the IAEA according to Brazil, but no documentation was found supporting their claim.

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

Yes, the facility was placed under ABACC safeguards in 1991.

g. Did the facility have a military purpose?

This does not appear to have been a military facility. However, several sources (including Reiss 1995) describe this as an Army facility. This seems odd given that the Army's nuclear related efforts centered on the production of a graphite moderated reactor.

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

[5] Zentner et al. detail that the facility was completed in 1985 and produced LEU in 1988. The facility went fully operational in 1990. We use the first introduction of nuclear material as the start date of operation.

No.

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

Yes, West Germany helped install parts and train facility operators.

j. Sources:

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

Perera, Judith. 1987. "Brazil's 'Parallel' Nuclear Industry." *New Scientist*. September 17.

Reiss, Mitchell. 1995. *Bridled Ambition: Why Countries Constrain Their Nuclear Capabilities.* Washington, DC: Woodrow Wilson Center Press, p. 78.

Spector, Leonard S. 1984. *Nuclear Proliferation Today*. New York, NY: Vintage.

Thurston, Charles. 1982. "Critics See Brazil As Taken For A Ride on Its 'Last Train' to SWU Technology." *Nuclear Fuel.* 7(9): 2.

Thurston, Charles. 1984. "Brazil Readies Enrichment Plant for Production of 64,000 SWU/YR in '89." *Nuclear Fuel.* 9(25): 7.

Zentner, M.D., G.L. Coles, and R.J. Talbert. 2005. "Nuclear Proliferation Technology Trends Analysis." Pacific Northwest National Laboratory. Report 14480. 29.

6. IPEN – Reprocessing

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 facility was under construction in 1960 and completed in 1982.[6] It operated until 1989.[7] The facility underwent several upgrades and improvements during that time.[8]

[6] The operational start date is from the IAEA. Franks only states the middle of the 1980's as the operational date.

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

Yes, Brazil kept the program secret from 1960 to 1975.[9] Public announcements about the facility have not been made.

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

No, Brazil signed agreements after the facility was closed.

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

No, the facility closed before ABACC existed.

g. Did the facility have a military purpose?

Yes, the facility was developed for and operated by the Brazilian military. The military announced plans to build a larger facility in 1991 but no facility was constructed.

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

The facility was not multinational.

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

No. The 1975 deal with Germany included reprocessing technology, but Brazil postponed the construction of the reprocessing plant in 1985 and it is unclear if any technology was transferred before this time. The Navy is thought to have operated the plant.

j. Sources:

Barnaby, Frank. 1993. *How Nuclear Weapons Spread: Nuclear Weapon Proliferation in the 1990's.* New York, NY: Routledge. 106-110.

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[7] Zentner et al. (2005) give 1989 as the probable end of operations. The IAEA states 1993 as the end of operations. The earlier date is chosen since if the later date were true, then ABACC would have meticulously detailed the facility during negotiations. No such report exists.

[8] Prior to 1990, all spent fuel was under safeguards from the providing country, so it is unlikely that Brazil was able to reprocess material.

[9] It is likely that that the facility was not known until 1989, the approximate closure date. The facility remained covert throughout its existence such that it is difficult to establish an exact time when the facility was identified.

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

Nuclear Weapons Archive. 2001. "Nuclear Weapons Frequently Asked Questions." http://nuclearweaponarchive.org/Nwfaq/Nfaq0.html. Accessed 06/08/2015.

Redick, John R. 1995. "Nuclear Illusions: Argentina and Brazil." Henry L. Stimson Center. http://www.acamedia.info/politics/IRef/StimsonC/redick.pdf. Accessed 06/08/2015. 7.

Zentner, M.D., G.L. Coles, and R.J. Talbert. 2005. "Nuclear Proliferation Technology Trends Analysis." Pacific Northwest National Laboratory. Report 14480. 99.

7. Pilot Enrichment Plant- Belo Horizonte (INB Resende)

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

Uranium enrichment, aerodynamic isotope separation.

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 likely began construction in 1975. Perrera notes a joint company began construction at the site in 1975. The facility started operating in 1979[10] and permanently closed in 1989.

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

No, the facility was developed through civilian channels.

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

This plant was safeguarded as part of an agreement with West Germany, even though the facility closed before Brazil concluded a comprehensive safeguards agreement with the IAEA.

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

[10] Spector and Smith (1990) list the facility size as laboratory and start date as 1980. INCFIS dates and size are used.

The facility may have been under ABACC safeguards during decommissioning, but was not under regional safeguards while it operated.

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

The facility was for civilian uses and was closed due to economic problems.

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

The facility was not multinational.

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

Yes, the West German firm Kraftwerk Union provided some technologies but not the entire fuel cycle as the deal originally stipulated. The technology transfer included aerodynamic information but probably not parts or complete sets.

j. Sources:

Albright, David. 1989. "Bomb Potential for South America." *Bulletin of Atomic Scientists* (May): 16-20.

Barnaby, Frank. 1993. *How Nuclear Weapons Spread: Nuclear Weapon Proliferation in the 1990's*. New York, NY: Routledge. 106-110.

Carnegie Endowment. "Brazil." http://www.carnegieendowment.org/static/npp/chapters/21-Brazil.pdf

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

Pererea, Judith. 1987 "Brazil's 'Parallel' Nuclear Industry." *New Scientist.* September 1987.

Spector, Leonard S. and Jacqueline R. Smith. 1990. *Nuclear Ambitions*. Boulder, CO: Westview Press. 261.

Thurston, Charles. 1984. "Brazil Readies Enrichment Plant for Production of 64,000 SWU/YR in '89." *Nuclear Fuel.* 9(25): 7.

Thurston, Charles. 1982. "Critics See Brazil As Taken For A Ride on Its 'Last Train' to SWU Technology." *Nuclear Fuel.* 7(9): 2.

Zentner, M.D., G.L. Coles, and R.J. Talbert. 2005. "Nuclear Proliferation Technology Trends Analysis." Pacific Northwest National Laboratory. Report 14480. 29.