

Nuclear Latency (NL) Dataset
Country Coding Sheets

CHINA

COW COUNTRY CODE: 710

List of Country's Enrichment and Reprocessing (ENR) Facilities¹

1. China Institute of Atomic Energy (Diffusion Lab)
2. China Institute of Atomic Energy (Radiochemistry Research Institute)
3. Plant 405 Pilot Centrifuge Plant, Hanzhong
4. Hanzhong, Shaanxi Uranium Enrichment Plant, Hanzhong I
5. Hanzhong, Shaanxi Uranium Enrichment Plant, Hanzhong II
6. Hanzhong, Shaanxi Uranium Enrichment Plant, Hanzhong III
7. Hanzhong, Shaanxi Uranium Enrichment Plant, Hanzhong IV
8. Heping (located in Jinkouhe, Sichuan Province, Plant 814)
9. Heping (located in Jinkouhe, Sichuan Province, Plant 814) – Emeishan Centrifuge Project
10. Juiquan Atomic Energy Complex (Plant 404)
11. Juiquan 2 (Atomic Energy Complex)
12. Nuclear Fuel Component Plant (Plant 812, Yibin, Sichuan)
13. Lanzhou (RPP), Gansu
14. Lanzhou 1 (China Institute of Atomic Energy Tuoli, Plant 504)
15. Lanzhou 2, Gansu
16. Lanzhou 3 (Indigenous Centrifuge Plant I)
17. Lanzhou 3 (Indigenous Centrifuge Plant II)
18. Plant 821 (Plutonium Production Complex in Guangyuan, Sichuan)

Note: Recent evidence suggests that China had a centrifuge program that pre-dated its first nuclear test in 1964. Most notably, Scott Kemp indicates that China achieved the first separation of isotopes using centrifuges in 1961 and had mastered the centrifuge by the mid-1960s.² We find this evidence compelling, but there is very little information about centrifuge-related facilities that may have existed prior to the 1980s. In the absence of further details, we exclude these early centrifuge plants from the dataset, but they may be added later as new information becomes available.

Detailed Facility-Specific Information and Sources

1. China Institute of Atomic Energy (Diffusion Lab)

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

Enrichment, gaseous diffusion.

¹ In addition to these facilities, a new reprocessing facility is in development. It will be jointly run by Areva and China. The two parties signed an agreement in November of 2010 and further refined it in April 2013.

² Kemp, R. Scott. 2014. "The Nonproliferation Emperor Has No Clothes." *International Security* 38, no. 4: 51-52.

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

Laboratory.

- c. *Is the facility under construction or in operation? List the start and end year for construction and operation.*

Construction of the facility began in mid-1950s.³ The lab was “outfitted” in October 1958 (see Lewis and Xue 1988, p. 118). It is not clear when the lab ceased operations. We code the end year as 1963, since this coincided with the opening of the larger-scale enrichment plant at Lanzhou.

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

We did not find clear evidence indicating that this facility was built in secret. It is probable, however, that the plant was developed covertly given the ties to the weapons program.

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

No.

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

No.

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

Yes, the facility was developed for the nuclear weapons complex. The lab assisted in the development of the technology installed in the Lanzhou enrichment facility in the 1960s.

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

No, the facility was owned and operated by China.

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

The evidence is somewhat ambiguous, but it is likely that the Soviet Union assisted in the construction of this facility. There was considerable nuclear cooperation between

³ See Lewis and Xue 1988, 117-118 for more details on the facility. Song took over as director of the Gaseous Diffusion Plant in 1954 and this is used as the construction start date.

China and the Soviet Union in the 1950s. However, by 1958 the alliance began to fall apart, and by 1959-60 the USSR was no longer providing nuclear assistance to the PRC.

j. Sources:

Federation of American Scientists. "Touli China Institute of Atomic Energy (CIAE)." <http://www.fas.org/nuke/guide/china/facility/tuoli.htm>. Accessed 06/08/2015.

Lewis, John Wilson and Xue litai. 1988. *China Builds the Bomb*. Palo Alto, CA: Stanford University Press.

Nuclear Threat Initiative. "China Institute of Atomic Energy (CIAE)." <http://www.nti.org/facilities/700/>. Accessed 06/08/2015.

2. China Institute of Atomic Energy (Radiochemistry Research Institute)

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

Reprocessing. Research and development related to reprocessing occurred at this site. It is unclear, however, if plutonium was extracted at this facility, and there is little information about the lab available in the public record.

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

Laboratory.

c. Is the facility under construction or in operation? List the start and end year for construction and operation.

Construction of the radiochemistry lab began in late the 1950s and it continues to operate. Yet we do not know when (if ever) laboratory-scale reprocessing occurred here, as opposed to just basic R&D.

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

Unclear.

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

Unclear.

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

No.

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

Yes, the facility was developed in part for military purposes.

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

No, the facility was owned and operated by China.

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

The USSR provided some reprocessing-related assistance during the 1950s. It is likely that this support contributed to the development of this facility. The degree to which the Soviets supported this plant, however, is unclear.

j. *Sources:*

Ciricione, Joseph, Jon B. Wolfsthal, and Miriam Rajkumar. 2011. *Deadly Arsenals: Nuclear, Biological, and Chemical Threats*. Second Edition. Washington D.C.: Carnegie Endowment for International Peace.

Federation of American Scientists. "Touli China Institute of Atomic Energy (CIAE)." <http://www.fas.org/nuke/guide/china/facility/tuoli.htm>. Accessed 06/08/2015.

Lewis, John Wilson and Xue litai. 1988. *China Builds the Bomb*. Palo Alto, CA: Stanford University Press.

Lewis, John W. and Xue Litai. 2012. "Making China's Nuclear War Plan." *Bulletin of the Atomic Scientists*, 68(5): 64-65.

Nuclear Threat Initiative. "China Institute of Atomic Energy (CIAE)." <http://www.nti.org/facilities/700/>. Accessed 06/08/2015.

3. Plant 405 Pilot Centrifuge Plant, Hanzhong

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

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.*

Construction probably began in the early 1980s. The plant reportedly began operating in the mid-1980s. China was apparently not pleased with the technology that operated here, and sought centrifuge-related assistance from Russia in the early 1990s. Russia later built several centrifuge plants in China (see below). We code 1993 as the end of operations at the pilot plant, since this is the year of the first bilateral agreement with Russia.

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

Yes.

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

No. Pakistan may have provided assistance in building this plant. Even if that is true, however, it is unlikely that Islamabad would have demanded that the plant be safeguarded. China concluded a Voluntary Offer Agreement (VOA) with the IAEA in 1988, but only lists facilities as eligible for safeguards at the request of relevant suppliers.

- 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?*

Probably, but we do not have definitive evidence to substantiate this.

- 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.*

Some have alleged that Pakistan provided centrifuge-related assistance to China in the 1980s. It seems plausible that this aid could have resulted in the construction of the pilot plant at Hanzhong. We code the plant as being built with foreign assistance, but there is some uncertainty surrounding the level of external aid in this case.

- j. *Sources:*

Zhang, Hui. 2015. *China's Uranium Enrichment Capacity: Rapid Expansion to Meet Commercial Needs*. Cambridge, MA: Belfer Center for Science and International Affairs.

<http://belfercenter.ksg.harvard.edu/files/chinasuraniumenrichmentcapacity.pdf>

Zhang, Hui. 2015. "China's Uranium Enrichment Complex." *Science & Global Security*. 23: 171-190.

4. Hanzhong, Shaanxi Uranium Enrichment Plant, Hanzhong I

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

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 began in 1993.⁴ This was the first stage of an enrichment contract with Russia. The second and fourth stages were also built at Hanzhong.⁵ The facility is coded as becoming operational in 1997.⁶

- 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.*

The facility is under voluntary IAEA safeguards starting in 1993, though a safeguard agreement was discussed in 1989. China voluntarily placed the new additions to the facility in 1993 under INFCIRC/369 when the facility was still under construction. The facility remains under safeguards.

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

⁴ 1993 is the date the Russians and Chinese agreed to the gas centrifuge plants. NTI lists 1992.

⁵ Zentner et al. (2005) provide the 1996 operational date and list 1998 while the IAEA lists 1997. Laughter states 1996 and 1998 for completion dates of site I and II.

⁶ IAEA technical document and Zhang state 1997. Zentner et al. state 1996.

No. The facility was placed under Tripartite safeguard agreements, but the regime is through the IAEA, not through a separate regional safeguards regime.

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

No, the facility is civilian.

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

No, the facility is owned by China but Russia owns the technology and has ensured safeguard protections on the centrifuge technologies.

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

Yes. In 1992 or 1993 the PRC signed an agreement with Russia for the supply of gas centrifuges. The first two phases were constructed at Hanzhong, and a fourth phase was agreed upon in 2008. All of the Hanzhong plants use 6th generation Russian centrifuge technology. Russia has provided the turn-key centrifuges in a technological “blackbox” to protect its technology. Tenex was contracted to build the facility.

j. *Sources:*

Albright, David and Corey Hinderstein. 2005. “Chinese Military Plutonium and Highly Enriched Uranium Inventories.” Institute for Science and International Security Report. http://isis-online.org/uploads/isis-reports/documents/chinese_military_inventories.pdf. Accessed 06/08/2015.

Ciricione, Joseph, Jon B. Wolfsthal, and Miriam Rajkumar. 2011. *Deadly Arsenals: Nuclear, Biological, and Chemical Threats*. Second Edition. Washington D.C.: Carnegie Endowment for International Peace.

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

International Atomic Energy Agency. 2009. “Nuclear Fuel Cycle Information System: A Directory of Nuclear Fuel Cycle Facilities.” IAEA TECDOC 1613. http://www-pub.iaea.org/mtcd/publications/pdf/te_1613_web.pdf. Accessed 11/16/2015.

International Atomic Energy Agency. “Tripartite Enrichment Project: Safeguard At Enrichment Plants Equipped with Russian Centrifuges.” <http://www-pub.iaea.org/MTCD/publications/PDF/ss-2001/PDF%20files/Session%208/Paper%208-02.pdf>. Accessed 06/08/2015.

International Panel on Fissile Materials. “Countries: China.” <http://fissilematerials.org/countries/china.html>. Accessed 06/08/2015.

McGoldrick, Fred. 2011. "Limiting Transfers of Enrichment and Reprocessing Technology: Issues, Constraints, Options." Belfer Center. <http://belfercenter.ksg.harvard.edu/files/MTA-NSG-report-color.pdf>. Accessed 06/08/2015. 9.

Nuclear Threat Initiative "Hanzhong Enrichment Facility." <http://www.nti.org/facilities/726>. Accessed 06/08/2015.

Podvig, Pavel. 2011. "New Russian-Built Enrichment Plant in China Begins Operations." International Panel on Fissile Materials. http://fissilematerials.org/blog/2011/04/new_russian-built_enrichm.html. Accessed 06/08/2015.

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

Zhang, Hui. 2015. "China's Uranium Enrichment Complex." *Science & Global Security*. 23: 171-190.

5. Hanzhong, Shaanxi Uranium Enrichment Plant, Hanzhong II

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

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 start year could not be identified.⁷ The second phase was completed in 1999.⁸

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.*

⁷ Russia and China agreed to the gas centrifuge plants in 1993 but this is not necessarily the construction start time.

⁸ Zentner et al. (2005) list 1998. The IAEA lists 1997. Laughter states 1998 for the completion date of site II. WISE lists an operational date of 2000. We go with the Zhang coding.

The facility was placed under voluntary IAEA safeguards starting in 1993, though a safeguard agreement had been discussed in 1989. China voluntarily placed the new additions to the facility in 1993 under INFCIRC/369 when the facility was still under construction. The facility remains under safeguards.

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

No. The facility was placed under Tripartite safeguard agreements, but the regime is through the IAEA, not through a separate regional safeguards regime.

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

No, the facility is civilian.

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

No, the facility is owned by China, but Russia owns the technology and has ensured safeguard protections on the centrifuge technologies.

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

Yes. See the note above for Hanzhong I.

j. *Sources:*

Albright, David and Corey Hinderstein. 2005. "Chinese Military Plutonium and Highly Enriched Uranium Inventories." Institute for Science and International Security Report. http://isis-online.org/uploads/isis-reports/documents/chinese_military_inventories.pdf. Accessed 06/08/2015.

Ciricione, Joseph, Jon B. Wolfsthal, and Miriam Rajkumar. 2011. *Deadly Arsenals: Nuclear, Biological, and Chemical Threats*. Second Edition. Washington D.C.: Carnegie Endowment for International Peace.

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

International Atomic Energy Agency. "Tripartite Enrichment Project: Safeguard At Enrichment Plants Equipped with Russian Centrifuges." <http://www-pub.iaea.org/MTCD/publications/PDF/ss-2001/PDF%20files/Session%208/Paper%208-02.pdf>. Accessed 06/08/2015.

International Panel on Fissile Materials. "Countries: China." <http://fissilematerials.org/countries/china.html>. Accessed 06/08/2015.

McGoldrick, Fred. 2011. "Limiting Transfers of Enrichment and Reprocessing Technology: Issues, Constraints, Options." Belfer Center. <http://belfercenter.ksg.harvard.edu/files/MTA-NSG-report-color.pdf>. Accessed 06/08/2015. 9.

Nuclear Threat Initiative "Hanzhong Enrichment Facility." <http://www.nti.org/facilities/726>. Accessed 06/08/2015.

Podvig, Pavel. 2011. "New Russian-Built Enrichment Plant in China Begins Operations." International Panel on Fissile Materials. http://fissilematerials.org/blog/2011/04/new_russian-built_enrichm.html. Accessed 06/08/2015.

World Nuclear News. 2013. "China Builds Uranium Enrichment Centrifuge." http://www.world-nuclear-news.org/ENF-China_builds_uranium_enrichment_centrifuge-2502134.html. Accessed 11/16/2015.

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

Zhang, Hui. 2015. "China's Uranium Enrichment Complex." *Science & Global Security*. 23: 171-190.

6. Hanzhong, Shaanxi Uranium Enrichment Plant, Hanzhong III (Russian Phase 4)

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

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 started in 2009⁹ and trials began in 2011. Normal operation commenced in 2013.

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

No, the facility was not developed covertly.

⁹ World Nuclear gives 2007 as the start of construction.

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

While the previous two phases at Hanzhong are under voluntary IAEA safeguards, Zhang does not list this facility as being under safeguards. However, all Russian-supplied plants at Hanzhong are eligible for safeguards.

- 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?*

No, the facility is civilian.

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

No, the facility is owned by China but Russia owns the technology and has ensured safeguard protections on the centrifuge technologies.

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

Yes. China and Russia agreed on the provision of the fourth phase in 2008.

- j. *Sources:*

Albright, David and Corey Hinderstein. 2005. "Chinese Military Plutonium and Highly Enriched Uranium Inventories." Institute for Science and International Security Report. http://isis-online.org/uploads/isis-reports/documents/chinese_military_inventories.pdf. Accessed 06/08/2015.

Ciricione, Joseph, Jon B. Wolfsthal, and Miriam Rajkumar. 2011. *Deadly Arsenals: Nuclear, Biological, and Chemical Threats*. Second Edition. Washington D.C.: Carnegie Endowment for International Peace.

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

International Atomic Energy Agency. "Tripartite Enrichment Project: Safeguard At Enrichment Plants Equipped with Russian Centrifuges." <http://www-pub.iaea.org/MTCD/publications/PDF/ss-2001/PDF%20files/Session%208/Paper%208-02.pdf>. Accessed 06/08/2015.

International Panel on Fissile Materials. "Countries: China." <http://fissilematerials.org/countries/china.html>. Accessed 06/08/2015.

McGoldrick, Fred. 2011. "Limiting Transfers of Enrichment and Reprocessing Technology: Issues, Constraints, Options." Belfer Center. <http://belfercenter.ksg.harvard.edu/files/MTA-NSG-report-color.pdf>. Accessed 06/08/2015. 9.

Nuclear Threat Initiative "Hanzhong Enrichment Facility." <http://www.nti.org/facilities/726>. Accessed 06/08/2015.

Podvig, Pavel. 2011. "New Russian-Built Enrichment Plant in China Begins Operations." International Panel on Fissile Materials. http://fissilematerials.org/blog/2011/04/new_russian-built_enrichm.html. Accessed 06/08/2015.

Zhang, Hui. 2015. "China's Uranium Enrichment Complex." *Science & Global Security*. 23: 171-190.

7. Hanzhong, Shaanxi Uranium Enrichment Plant, Hanzhong IV

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

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 started in 2012 and was not finished by the end of that year (the last year for which our dataset includes information). Yet, as of 2014, the plant appears to have begun normal operations.

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

Western experts were surprised to learn about this facility in September 2013, more than a year after construction began. But it does not appear that China engaged in a concerted campaign to keep this facility secret; it was, after all, built right next to known Russian-supplied plants.

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

Unlikely, since China generally excludes indigenously built plants from its list of eligible facilities per the VOA with the IAEA.

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?*

Unclear.

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.*

This is an indigenously built plant.

j. *Sources:*

Lewis, Jeffrey. 2013. "China's New Centrifuge Plants." *Arms Control Wonk*, September 13. <http://www.armscontrolwonk.com/archive/206826/chinas-new-centrifuge-plants/>.

Nuclear Threat Initiative "Hanzhong Enrichment Facility." <http://www.nti.org/facilities/726>. Accessed 06/08/2015.

Zhang, Hui. 2015. "China's Uranium Enrichment Complex." *Science & Global Security*. 23: 171-190.

8. Heping (located in Jinkouhe, Sichuan Province, Plant 814)

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

Enrichment, gaseous diffusion.

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

Commercial.¹⁰

¹⁰ Ciricione et al. list the production capability of the facility at 750-2,950 kg HEU/year.

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

Construction began in the late 1960s.¹¹ The exact start year of construction could not be identified. The facility began operating in 1975¹² and is reported to still be operational. It ended production of HEU in 1987.¹³ China has signaled that the facility will be replaced with centrifuge technology.

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

Given the role of this facility in China's nuclear weapons program, it is likely that the plant was developed in secret.

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

No. Given that this facility was build indigenously, and its closure pre-dated the VOA, it was almost certainly not eligible for safeguards.

- 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 was a military facility used for the production of HEU. It is estimated that the facility could produce approximately 14 tons of HEU during its lifecycle. The facility was converted to civilian use in 1987 as part of the military-to-civilian conversion policy.

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

No, the facility was not multinational.

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

No. As part of its "third line" efforts, the PRC indigenously constructed this plant by replicating previous efforts.

- j. *Sources:*

¹¹ Zhang (2011) provides the approximate construction start date.

¹² The World Nuclear Association lists 1975 as the start date. Zhang also lists 1975 as the start of operation. Zentner et al. list "around 1975" as the start date.

¹³ Global Fissile Material Guide 2010 lists Heping as ending HEU production in 1987, as does Zhang.

- Albright, David and Corey Hinderstein. 2005. “Chinese Military Plutonium and Highly Enriched Uranium Inventories.” Institute for Science and International Security Report. http://isis-online.org/uploads/isis-reports/documents/chinese_military_inventories.pdf. Accessed 06/08/2015.
- Ciricione, Joseph, Jon B. Wolfsthal, and Miriam Rajkumar. 2011. *Deadly Arsenals: Nuclear, Biological, and Chemical Threats*. Second Edition. Washington D.C.: Carnegie Endowment for International Peace.
- Cordesman, Anthony H., Ashley Hess, and Nicholas S. Yarosh. 2013. “Chinese Military Modernization and Force Development: A Western Perspective.” Center for Strategic & International Studies. http://csis.org/files/publication/130930_Cordesman_ChineseMilitaryModernization_Web.pdf. Accessed 06/08/2015.
- Enger, Elin. 2013. “China’s Nuclear Weapons Programme.” The Norwegian Defence Research Establishment. <http://www.ffi.no/no/Rapporter/13-01887.pdf>. Accessed 06/08/2015. 15.
- International Panel on Fissile Materials. “Countries: China.” <http://fissilematerials.org/countries/china.html>. Accessed 06/08/2015.
- Laughter, M.D. 2009. “Profile of World Uranium Enrichment Programs—2009.” Oak Ridge National Laboratory
- Nuclear Threat Initiative “Hanzhong Enrichment Facility.” <http://www.nti.org/facilities/726>. Accessed 06/08/2015.
- World Nuclear Association. 2015. “China’s Nuclear Fuel Cycle.” http://www.world-nuclear.org/info/inf63b_china_nuclearfuelcycle.html. Accessed 06/08/2015.
- Zenter, M.D., G.L. Coles, and R.J. Talber. 2005. “Nuclear Proliferation Technology Trends Analysis.” Pacific Northwest National Laboratory. Report 14480.
- Zhang, Hui. 2011. “China’s HEU and Plutonium Production and Stocks.” *Science & Global Security*. 19. 68-89.

9. Heping (located in Jinkouhe, Sichuan Province, Plant 814) – Emeishan Centrifuge Project I¹⁴

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

¹⁴ There may have been a smaller pilot plant in Emeishan (referred to as CEP 3 by Zhang 2015) that preceded the development of this commercial facility. It would make sense if this were true. At this stage, however, we do not have sufficiently clear evidence to include the pilot plant in the dataset.

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 on this facility began around 2011. It was not operational by the end of 2012.

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

There is considerable secrecy surrounding this facility, particularly relative to the other Chinese centrifuge plants built recently at Lanzhou and Hanzhong. Most of what we know about the plant comes from commercial satellite imagery and analysis by scholars.

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?*

Probably.

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:*

World Nuclear Association. 2015. "China's Nuclear Fuel Cycle." November 24. <http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/China--Nuclear-Fuel-Cycle/>.

Zhang, Hui. 2015. *China's Uranium Enrichment Capacity: Rapid Expansion to Meet Commercial Needs*. Cambridge, MA: Belfer Center for Science and International Affairs.
<http://belfercenter.ksg.harvard.edu/files/chinasuraniumentrichmentcapacity.pdf>

Zhang, Hui. 2015. "China's Uranium Enrichment Complex." *Science & Global Security*. 23: 171-190.

10. Juiquan Atomic Energy Complex (Plant 404)

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

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 date could not be found. The reprocessing facility began operating in 1970 and closed in 1984.¹⁵

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

Given the role of this facility in China's nuclear weapons program, it is likely that the plant was developed in secret.

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

No, the facility was not under IAEA safeguards.

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

No, the facility was not under regional safeguards.

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

This was a military facility designed to produce plutonium for weapons. The NTI lists that potential production of weapons grade plutonium as approximately 0.9 tons.

¹⁵ ISGE has emission data starting in 1991.

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.*

Yes. The facility was designed with Soviet assistance in 1958 but the USSR withdrew in 1960 just after construction began. The original designs were provided by the USSR, but China decided to proceed indigenously using PUREX separation processes instead of the Soviet designs. It is unclear whether or not the early Soviet aid was pivotal for the reprocessing. One source notes as little as 5% of the parts were of Soviet origin. The exact nature of the technology exchange is unknown.

j. *Sources:*

Ciricione, Joseph, Jon B. Wolfsthal, and Miriam Rajkumar. 2011. *Deadly Arsenals: Nuclear, Biological, and Chemical Threats*. Second Edition. Washington, D.C.: Carnegie Endowment for International Peace.

Enger, Elin. 2013. "China's Nuclear Weapons Programme." The Norwegian Defence Research Establishment. <http://www.ffi.no/no/Rapporter/13-01887.pdf>. Accessed 06/08/2015. 16.

Kroenig, Matthew. 2009. "Exporting the Bomb: Why States Provide Sensitive Nuclear Assistance." *American Political Science Review*. 103(1): 128.

Lewis, John Wilson and Xue litai. 1988. *China Builds the Bomb*. Palo Alto, CA: Stanford University Press.

Nuclear Threat Initiative. 2013. "Jiuquan Atomic Energy Complex." <http://www.nti.org/facilities/722/>. Accessed 06/08/2015.

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

11. Juiquan 2 (Atomic Energy Complex)

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

Reprocessing.

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

Pilot.

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

Construction began at the facility in 1965. The reprocessing facility began operating in 1968 and closed in 1970.

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

Given the role of this facility in China's nuclear weapons program, it is likely that the plant was developed in secret.

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

No. China concluded a Voluntary Offer Agreement (VOA) with the IAEA in 1988 and reportedly only includes facilities as eligible for safeguards at the request of relevant nuclear suppliers.

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

No, the facility was not under regional safeguards.

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

This was a military facility designed to produce plutonium for weapons. The NTI lists the potential production of weapons grade plutonium as approximately 0.9 tons. When both facilities operated together they could produce approximately 70 kg of weapons grade plutonium per year.

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

No, this facility was done indigenously using the PUREX separation process.

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

The Soviets provided the initial designs, but withdrew from the project in 1960 and the PRC decided to pursue PUREX methods indigenously (see the discussion for Plant 404 above).

- j. *Sources:*

Ciricione, Joseph, Jon B. Wolfsthal, and Miriam Rajkumar. 2011. *Deadly Arsenals: Nuclear, Biological, and Chemical Threats*. Second Edition. Washington D.C.: Carnegie Endowment for International Peace.

Enger, Elin. 2013. "China's Nuclear Weapons Programme." The Norwegian Defence Research Establishment. <http://www.ffi.no/no/Rapporter/13-01887.pdf>. Accessed 06/08/2015. 16.

Kroenig, Matthew. 2009. "Exporting the Bomb: Why States Provide Sensitive Nuclear Assistance." *American Political Science Review*. 103(1): 128.

Nuclear Threat Initiative. 2013. "Jiuquan Atomic Energy Complex." <http://www.nti.org/facilities/722/>. Accessed 06/08/2015.

12. Nuclear Fuel Component Plant (Pant 812, Yibin Sichuan)

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

Reprocessing.

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

Commercial.

c. *Is the facility under construction or in operation? List the start and end year for construction and operation.*

Construction of the facility began in the late 1960s. The facility began operating in the early 1970s.

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

The facility was probably developed covertly.

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

No.

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

No.

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

Yes, the facility was designed to help with the production and processing of plutonium for nuclear weapons. The facility was part of the "Third Line" effort to duplicate nuclear weapons production.

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.*

While the plant was initially constructed indigenously, it has been modernized through technology transfers. In 1991 Framatome ANP provided fuel assemblies and in 1998 it provided further fuel technology. The facility also received technology from the Russian nuclear fuel company TVEL.

j. *Sources:*

Areva. "China." <http://www.aveva.com/EN/group-2274/china-nuclear-and-renewable-energy-to-meet-demand.html>. Accessed 06/08/2015.

Ciricione, Joseph, Jon B. Wolfsthal, and Miriam Rajkumar. 2011. *Deadly Arsenals: Nuclear, Biological, and Chemical Threats*. Second Edition. Washington D.C.: Carnegie Endowment for International Peace.

Federation of American Scientists. "Yibin Nuclear Fuels Factory: Nuclear Fuel Element Plant." <http://www.fas.org/nuke/guide/china/facility/yibin.htm>. Accessed 06/08/2015.

Nuclear Threat Initiative. 2012. "Yibin Nuclear Fuel Component Plant." <http://www.nti.org/facilities/706/>. Accessed 06/08/2015.

Spector, Leonard and Mark G. McDonough. 1995. *Tracking Nuclear Proliferation*. Washington, D.C.: Carnegie Endowment for International Peace. 55.

13. Lanzhou (RPP), Gansu

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

Reprocessing.

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

Pilot.

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

Construction of the facility started in 1997 and the facility became operational in 2006.¹⁶

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

No, the facilities have been publically announced.

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

China concluded a Voluntary Offer Agreement (VOA) with the IAEA in 1988 and reportedly only includes facilities as eligible for safeguards at the request of relevant nuclear suppliers. Given that this facility was build indigenously, it was probably not on Beijing's list of eligible facilities.

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?*

No, the facility is 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 assistance found. The plant was constructed using the Purex process.

j. *Sources:*

Ciricione, Joseph, Jon B. Wolfsthal, and Miriam Rajkumar. 2011. *Deadly Arsenals: Nuclear, Biological, and Chemical Threats*. Second Edition. Washington D.C.: Carnegie Endowment for International Peace.

Hibbs, Mark. 2004. "Separation Plant on Drawing Board Until 2006-2010 Plan, CIAE Says." *Nuclear Fuel*. November.

¹⁶ Zentner et al. give a start date of 2006. The World Nuclear Association provides the construction and operational dates as 2006 and 2010, respectively. World Nuclear states hot tests did not start until 2010. The IAEA lists 2001 as the operational start date.

Hibbs, Mark. 2000. "Chinese Pu Lab To Operate In 2002, But Interim Storage Now Foreseen." *Nuclear Fuel*. 25(22): 9.

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

World Nuclear Association. 2015. "China's Nuclear Fuel Cycle." www.world-nuclear.org/info/inf63b_china_nuclearfuelcycle.html. Accessed 06/08/2015.

Xie, Yanmei. 2012. "China Moves Toward Commercial Reprocessing of Spent Fuel." *Nuclear Fuel*. February 6, 2012.

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

Zhang, Hui. "China's Stockpile of Military Plutonium: A New Estimate." Project on Managing the Atom. <http://belfercenter.hks.harvard.edu/files/INMM-PU2.pdf>.

Zhang, Hui. 2011. "China's HEU and Plutonium Production and Stocks." *Science & Global Security*. 19. 68-89.

14. Lanzhou 1 (China Institute of Atomic Energy Tuoli, Plant 504)

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

Enrichment, gaseous diffusion.

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

Commercial.¹⁷

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 1958 and the first test run was completed in 1963.¹⁸ The facility first produced HEU in 1964¹⁹ and remained operational until 2000.²⁰ The facility stopped producing HEU in 1979.²¹

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

¹⁷ Zhang reports capacity increased from 0.2 million SWU/year to 0.3 SWU/year in 1979.

¹⁸ Lewis and Litai (1988, 125) provide the first operational test run dates. Albright & Hinderstein state construction began in 1957.

¹⁹ Lewis and Litai state HEU production first occurred in January 1964 (90%).

²⁰ This coding is based on Zhang. Ciricione et al. list the end year as 1999. Laughter provides the end of operation date of 1997.

²¹ Global Fissile Material Report 2010.

This plant was a critical centerpiece of China's nuclear weapons program in the early stages. Nuclear negotiations with the Soviets were carried out in secret, and Beijing attempted to conceal some of its activities at the site.

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

No, the facility is not under IAEA safeguards.

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

No applicable regional safeguards.

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

Yes, the facility produced the HEU used in China's first nuclear explosion. It produced approximately 6 tons of 90% HEU during its operation. The facility changed to commercial use in 1979 and switched production to LEU.

- 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.*

Yes. The plant was started with Soviet assistance in the 1950s and was based off Soviet technology.

- j. *Sources:*

Albright, David and Corey Hinderstein. 2005. "Chinese Military Plutonium and Highly Enriched Uranium Inventories." Institute for Science and International Security. http://isis-online.org/uploads/isis-reports/documents/chinese_military_inventories.pdf. Accessed 06/08/2015.

Ciricione, Joseph, Jon B. Wolfsthal, and Miriam Rajkumar. 2011. *Deadly Arsenals: Nuclear, Biological, and Chemical Threats*. Second Edition. Washington D.C.: Carnegie Endowment for International Peace.

Laughter, M.D. 2007. "Profile of Uranium Enrichment Programs." Oak Ridge National Laboratory.

Lewis, John Wilson and Xue litai. 1988. *China Builds the Bomb*. Palo Alto, CA: Stanford University Press.

- International Panel on Fissile Materials. "China." <http://fissilematerials.org/countries/china.html>. Accessed 06/08/2015.
- Nuclear Threat Initiative. 2014. "Lanzhou Uranium Enrichment Plant." <http://www.nti.org/facilities/724>. Accessed 06/08/2015.
- University of South China. 2011. "China's Nuclear Fuel Cycle 2011." <http://nec.usc.edu.cn/info/1051/1179.htm>. Accessed 06/08/2015.
- World Nuclear Association. 2015. "China's Nuclear Fuel Cycle." <http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/China--Nuclear-Fuel-Cycle/>. Accessed 06/08/2015.
- Zenter, M.D., G.L. Coles, and R.J. Talber. 2005. "Nuclear Proliferation Technology Trends Analysis." Pacific Northwest National Laboratory. Report 14480.
- Zhang et al. 2011. "The Active Commissioning Process for a Power Reactor Spent Fuel Reprocessing Pilot Plant in China." *Chinese Science Bulletin*. 56(23). <http://link.springer.com/article/10.1007%2Fs11434-011-4600-2#page-1>. Accessed 06/08/2015.
- Zhang, Hui. 2011. "China's HEU and Plutonium Production and Stocks." *Science & Global Security*. 19. 68-89.
- Zhang, Hui. 2015. "China's Uranium Enrichment Complex." *Science & Global Security*. 23: 171-190.

15. Lanzhou 2, Gansu (Russian Phase 3)

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

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 in 1997 and the facility became operational in 2001.²² The facility continues to operate.

²² ORNL 2009 and Zhnag list construction in 2001.

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.*

Because this is a Russian-built plant, it is eligible for IAEA safeguards. The degree to which the plant has actually been inspected is unclear, however.

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

No, the facility is not under regional safeguards.

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

No, this facility is for commercial use.

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

No. There was a government-to-government agreement about the facility in 1992 or 1993. When the Russians provided assistance they maintained proprietary rights to the technology.

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

Yes, the facility's enrichment technology is Russian and protected by safeguards following a 1992 or 1993 agreement to ensure that China does not acquire the centrifuge designs. China decided to build the facility to use existing workers and expertise. It is unclear what technology is installed at the site because of the lack of safeguards. Russia was particular about IAEA inspectors at the Hanzhong site in order to protect the centrifuge designs.

j. *Sources:*

Albright, David and Corey Hinderstein. 2005. "Chinese Military Plutonium and Highly Enriched Uranium Inventories." Institute for Science and International Security. http://isis-online.org/uploads/isis-reports/documents/chinese_military_inventories.pdf. Accessed 06/08/2015.

Ciricione, Joseph, Jon B. Wolfsthal, and Miriam Rajkumar. 2011. *Deadly Arsenals: Nuclear, Biological, and Chemical Threats*. Second Edition. Washington, D.C.: Carnegie Endowment for International Peace.

Enger, Elin. 2013. "China's Nuclear Weapons Programme." The Norwegian Defence Research Establishment. <http://www.ffi.no/no/Rapporter/13-01887.pdf>. Accessed 06/08/2015. 15.

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

International Panel on Fissile Materials. "China." <http://fissilematerials.org/countries/china.html>. Accessed 06/08/2015.

Laughter, M.D. 2007. "Profile of Uranium Enrichment Programs." Oak Ridge National Laboratory.

Nuclear Threat Initiative. "Lanzhou Uranium Enrichment Program." <http://www.nti.org/facilities/724/>. Accessed 06/08/2015.

Podvig, Pavel. 2011. "New Russian-Built Enrichment Plant in China Begins Operations." International Panel on Fissile Materials. http://fissilematerials.org/blog/2011/04/new_russian-built_enrichm.html. Accessed 06/08/2015.

World Nuclear Association. 2015. "China's Nuclear Fuel Cycle." <http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/China--Nuclear-Fuel-Cycle/>. Accessed 06/08/2015.

Zhang, Hui. 2011. "China's HEU and Plutonium Production and Stocks." *Science & Global Security*. 19. 68-89.

Zhang, Hui. 2015. "China's Uranium Enrichment Complex." *Science & Global Security*. 23: 171-190.

16. Lanzhou 3 (Indigenous Centrifuge Plant I)

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

Enrichment, centrifuge.

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

Pilot. This is a demonstration plant that preceded the commercial facility described below. It has an estimated capacity of 500,000 SWU/year.²³ The manager of the Lanzhou Enrichment plant, Zhu Ji, said that the centrifuges would be responsible for supplying fuel to all 17 nuclear power stations in China.²⁴

²³ International Panel on Fissile Materials Report, 17.

²⁴ See Xiaobo (2013).

- c. *Is the facility under construction or in operation? List the start and end year for construction and operation.*

Project reportedly started in 2007 or 2008 and it may have been operational in 2010.²⁵ The facility was commissioned in 2012. Enriched uranium was successfully produced in 2013.²⁶

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

Reports first emerged on the facility in 2010 and reporters were invited to the facility in 2013.

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

As noted previously, China excluded indigenously built plants from its list of eligible facilities per the VOA with the IAEA.

- 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?*

Unlikely. Pavel (2013) notes that the plant may be used for producing LEU for power reactors and Xiaobo says the plant will produce uranium for China's 17 power reactors.

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

No, the facility is owned and operated by China.

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

No. Multiple sources note the indigenous nature of this facility.

- j. *Sources:*

International Panel on Fissile Materials. 2010. "Global Fissile Material Report 2010." <http://fissilematerials.org/library/gfmr10.pdf>. Accessed 11/10/2015.

²⁵ International Panel on Fissile Materials Report, 17; Zhang (2011), 172.

²⁶ See Xiaobo (2013).

- Podvig, Pavel. 2013. "China's Centrifuges Produced First Enriched Uranium." International Panel on Fissile Materials Blog. http://fissilematerials.com/blog/2013/06/chinas_centrifuges_produc.html. Accessed 11/10/2015.
- Podvig, Pavel. 2010. "China is Believed to Operate Indigenous Enrichment Plant." International Panel on Fissile Materials Blog. http://fissilematerials.org/blog/2010/10/china_is_believed_to_oper.html. Accessed 11/10/2015.
- World Nuclear News. 2013. "China Builds Uranium Enrichment Centrifuge." http://www.world-nuclear-news.org/ENF-China_builds_uranium_enrichment_centrifuge-2502134.html. Accessed 11/10/2015.
- Xiaobo, Zhang. 2013. "China Develops Own Tech to Enrich Uranium." *Global Times*. <http://www.globaltimes.cn/content/791301.shtml#.UclTyj7k5YQ>. Accessed 11/10/2015.
- Zhang, Hui. 2011. "China's HEU and Plutonium Production and Stocks." *Science & Global Security*. 19. 68-89.
- Zhang, Hui. 2015. "China's Uranium Enrichment Complex." *Science & Global Security*. 23: 171-190.

17. Lanzhou 3 (Indigenous Centrifuge Plant II)

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

Enrichment, centrifuge.

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

Commercial. Estimated capacity of 500,000 SWU/year.²⁷

- c. *Is the facility under construction or in operation? List the start and end year for construction and operation.*

Construction start date unknown, but construction reportedly almost finished in 2010. Facility commissioned in 2012.

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

Initial construction may have been covert but the facility is mentioned in various sources around the time that operations commenced. For example, a report issued by

²⁷ Zhang (2011), 172.

the China National Nuclear Safety Administration (NNSA) mentions that trial tests occurred at the plant in 2012. It does not seem accurate to classify this facility as “covert,” even if China may not have been totally forthcoming about its efforts.

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

Because this facility is indigenously built, it probably does not appear on China’s list of eligible facilities under the VOA with the IAEA. As noted elsewhere, China only includes plants on this list at the request of relevant supplier countries.

- 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?*

Unlikely. The demonstration facility at this site is thought to be for civilian purposes.

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

No, the facility is owned and operated by China.

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

No. Sources note the indigenous nature of this facility.

- j. *Sources:*

Zhang, Hui. 2015. “China’s Uranium Enrichment Complex.” *Science & Global Security*. 23: 171-190.

18. Plant 821 (Plutonium production complex in Guangyuan, Sichuan)

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

Reprocessing.

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

Commercial.

- c. *Is the facility under construction or in operation? List the start and end year for construction and operation.*

Construction of the facility began in 1969.²⁸ The facility became operational in 1976 and was decommissioned in the late 1989, when it stopped producing plutonium.²⁹

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

Yes, the facility was built underground mainly as a defense against attack but also to conceal activity. The facility was no longer covert after 1989 after China signed agreements with the IAEA. Additional information on the production levels remains secret.

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

No.

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

No.

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

Yes, the facility was built as part of China's Third Line effort to diversify nuclear weapons production. It is estimated to have produced 1.1 tons of separated weapons-grade plutonium. It no longer process military fuel, however. It is believed that the facility probably produced tritium and Li-6 deuterium as well. The Federation of American Scientists lists the facility as a plutonium processing 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. The plant was built as part of a Chinese effort to establish a "third line." It was built by duplicating precious technology.

j. *Sources.*

²⁸ Construction of the reactor at the site began in 1969 (Zhang et al. 2011). It is likely that construction on the reprocessing facility began later than that date but an exact construction date was has not been found.

²⁹ Zhang et al. list 1976 for the operational date of the reprocessing facility. FAS list 1973 date as the operational date while NTI lists 1974. The decommissioning time period is from NTI. The 2010 Global Fissile Material Report provides the 1989 date as an approximation. NTI gives the closure date as the late 1980's or early 1990's. Zentner et al. only report it as early 1990's. 1991 is also a potential date as listed by Zhang et al.

- Ciricione, Joseph, Jon B. Wolfsthal, and Miriam Rajkumar. 2011. *Deadly Arsenals: Nuclear, Biological, and Chemical Threats*. Second Edition. Washington D.C.: Carnegie Endowment for International Peace.
- Enger, Elin. 2013. "China's Nuclear Weapons Programme." The Norwegian Defence Research Establishment. <http://www.ffi.no/no/Rapporter/13-01887.pdf>. Accessed 06/08/2015. 15.
- Federation of American Scientists. "Guangyuan Plant 821." <http://www.fas.org/nuke/guide/china/facility/guangyuan.htm>. Accessed 06/08/2015.
- Nuclear Threat Initiative. "Guangyun Plutonium Production Reactor and Reprocessing Plant." <http://www.nti.org/facilities/730/>. Accessed 06/08/2015.
- Spector, Leonard and Mark G. McDonough. 1995. *Tracking Nuclear Proliferation*. Washington, D.C.: Carnegie Endowment for International Peace. 55.
- World Nuclear Association. 2015. "China's Nuclear Fuel Cycle." <http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/China--Nuclear-Fuel-Cycle/>. Accessed 06/08/2015.
- Zenter, M.D., G.L. Coles, and R.J. Talber. 2005. "Nuclear Proliferation Technology Trends Analysis." Pacific Northwest National Laboratory. Report 14480.
- Zhang et al. 2011. "The Active Commissioning Process for a Power Reactor Spent Fuel Reprocessing Pilot Plant in China." *Chinese Science Bulletin*. 56(23). <http://link.springer.com/article/10.1007%2Fs11434-011-4600-2#page-1>. Accessed 06/08/2015.