

Nuclear Latency (NL) Dataset  
Country Coding Sheets

**RUSSIA**

**COW COUNTRY CODE: 365**

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

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Detailed Facility-Specific Information and Sources

**1. Angarsk ElectroChemical Combine**

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

Uranium enrichment, gaseous diffusion.

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

Commercial.

- 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 gaseous diffusion facility began between 1949-1950. The gaseous diffusion facility started operating in 1957<sup>1</sup> and ceased operation in 1992.<sup>2</sup>

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

Yes, the facility was covert during its gaseous diffusion operation. Details of the facility, beyond knowing it existed, did not become available until 1989.

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

No. The gaseous diffusion and centrifuge facilities were not placed under IAEA safeguards. One expert, Pavel Podvig, stated that the potential international LEU fuel bank would be placed under IAEA safeguards but it is unclear if the centrifuge facility would be considered under the inspection regime.<sup>3</sup>

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

No.

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

Yes. The Monterey Institute notes the prime objective of installing new equipment at this facility was to expand the arsenal of the Soviet Military.

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

No.

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<sup>1</sup> Year start date is provided by AEXT company history. The IAEA INFCIS database appears to flip the dates of the centrifuge and diffusion facilities.

<sup>2</sup> IAEA INFCIS provides the operational date for the facility. Bukharin (2005) states that all diffusion operations ended by 1987. Irkutsk lists 1992 as the year the final diffusion machine was turned off. Zentner et al. say construction took place between 1949 and 1965. Other sources list earlier construction end dates.

<sup>3</sup> Private correspondence.

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

No. The center was built indigenously with several Russian research institutions involved in the development and creation of equipment. Since the 1980s the facility has offered enrichment services to other countries, but no other countries have contributed to the plant in substantial ways. In August 2007 an intergovernmental agreement was signed between Russia and Kazakhstan to allow for an International Uranium Enrichment Center to be set up at the pre-existing facility. The agreement was signed between Russia's Tekhnabeksport and Kazakhstan's Kazatomprom. Under the agreement, enrichment was to be carried out jointly between the two countries. Notably, no new equipment was to be installed at the plant and no technology would be available to Kazakhstan through the agreement.

- i. *Sources:*

Bukharin, Oleg. 2004. "Understanding Russia's Uranium Enrichment Complex." *Science and Global Security*. 12: 192-218.  
<http://fissilematerials.org/library/sgs12bukharin.pdf>. Accessed 07/16/2015.

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

Irkutsk. "Angarsk Electrochemical Combine"  
<http://www.irkutsk.org/hp/aec.html>. Accessed 07/06/2015.

Kassenova, Togzhan. 2008. "Kazakhstan's Nuclear Ambitions." *Bulletin of the Atomic Scientists*. <http://thebulletin.org/kazakhstans-nuclear-ambitions>. Accessed 07/06/2015.

Kruglov, Arkadii. 1994. *The History of the Soviet Atomic Industry*. Andrei Lokhov, Trans. New York City, NY: Taylor & Francis. 151.

Loukianova, Anya. 2008. "The International Uranium Enrichment Center at Angarsk: A Step Toward Assured Fuel Supply?" Nuclear Threat Initiative.  
<http://www.nti.org/analysis/articles/uranium-enrichment-angarsk/>. Accessed 07/06/2015.

Oak Ridge National Laboratory. 2007. "Profile of World Uranium Enrichment Programs." 8-9.

Podvig, Pavel. 2009. "Consolidating Fissile Materials in Russia's Nuclear Complex." International Panel on Fissile Material. <http://fissilematerials.org/library/rr07.pdf>. Accessed 07/06/2015.

World Nuclear Association. 2015. "Uranium Enrichment." <http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Conversion-Enrichment-and-Fabrication/Uranium-Enrichment/>. Accessed 07/06/2015.

—. "Angarsk Electrochemical Combine." Monterey Institute. <http://www.irkutsk.org/hp/aec.html>. Accessed 11/15/2015.

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

## 2. Angarsk ElectroChemical Combine

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

Uranium enrichment, centrifuge enrichment.

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

Commercial.

- 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 year could not be identified. Operations began in 1954.<sup>4</sup> The facility continues to operate. Sixth generation centrifuges began operating in 1980 at the facility.

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

Given its military focus early on, it is likely that this plant was developed covertly.

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

This plant is not actually safeguarded by the IAEA. However, during the plant's later years of operation, Russia reportedly listed it as an eligible facility per its Voluntary Offer Agreement (VOA) to the Agency. Russia includes fewer facilities on its VOA than most other nuclear weapons states.

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

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<sup>4</sup> McNeil and Unger list 1960 as the year centrifuges were introduced into the facility. Irkutsk.org provides the 1962 date as an alternative start year. Zentner et al. (2005) state that by 1957 Russia had an operating pilot enrichment facility. The operational start date is from IAEA INFCIS.

No.

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

Yes. Zentner et al. note the goal of the early centrifuge program was military in nature.

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

No. The facility is owned and operated by Rosatom and they have plans to commercialize production from the facility.<sup>5</sup>

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

No. The center was built indigenously with several Russian research institutions involved in the development and creation of equipment. Since the 1980's the facility has offered enrichment services to other countries, but no other countries have contributed to the plant in substantial ways. In August 2007 an intergovernmental agreement was signed between Russia and Kazakhstan to allow for an International Uranium Enrichment Center to be set up at the pre-existing facility. The agreement was signed between Russia's Tekhnabeksport and Kazakhstan's Kazatomprom. Under the agreement, enrichment was to be carried out jointly between the two countries. Notably, no new equipment was to be installed at the plant and no technology would be available to Kazakhstan through the agreement.

*i. Sources:*

Bukharin, Oleg. 2004. "Understanding Russia's Uranium Enrichment Complex." *Science and Global Security*. 12: 192-218.

<http://fissilematerials.org/library/sgs12bukharin.pdf>. Accessed 07/16/2015.

*Global Fissile Materials Report, 2013*. Princeton, NJ: International Panel On Fissile Materials. <http://fissilematerials.org/library/gfmr13.pdf>

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

Irkutsk. "Angarsk Electrochemical Combine."

<http://www.irkutsk.org/hp/aec.html>. Accessed 07/06/2015.

Kassenova, Togzhan. 2008. "Kazakhstan's Nuclear Ambitions." *Bulletin of the Atomic Scientists*. <http://thebulletin.org/kazakhstans-nuclear-ambitions>. Accessed 07/06/2015.

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<sup>5</sup> The facility may have become multinational in 2011. The most recent facility expansion included a 50% stage owned by Kazatomprom.

- Kruglov, Arkadii. 1994. *The History of the Soviet Atomic Industry*. Andrei Lokhov, Trans. New York City, NY: Taylor & Francis. 151.
- Loukianova, Anya. 2008. "The International Uranium Enrichment Center at Angarsk: A Step Toward Assured Fuel Supply?" Nuclear Threat Initiative. <http://www.nti.org/analysis/articles/uranium-enrichment-angarsk/>. Accessed 07/06/2015.
- Oak Ridge National Laboratory. 2007. "Profile of World Uranium Enrichment Programs." 8-9.
- Podvig, Pavel. 2009. "Consolidating Fissile Materials in Russia's Nuclear Complex." International Panel on Fissile Material. <http://fissilematerials.org/library/rr07.pdf>. Accessed 07/06/2015.
- World Nuclear Association. 2015. "Uranium Enrichment." <http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Conversion-Enrichment-and-Fabrication/Uranium-Enrichment/>. Accessed 07/06/2015.
- Zentner, M.D., G.L. Coles, and R.J. Talbert. 2005. "Nuclear Proliferation Technology Trends Analysis." Pacific Northwest National Laboratory. Report 14480.

### 3. Dneproetrovsk Physicochemical Institute

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

Enrichment, thermal diffusion.

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

Laboratory.

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

Construction of the facility began in 1941.<sup>6</sup> The facility started operating in 1941 and ended operation in 1941.<sup>7</sup>

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

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<sup>6</sup> 1941 is the year that <sup>235</sup>U was shown to be the fissionable isotope. Research on enrichment intensified at this time. The date provided is not an exact construction start time.

<sup>7</sup> The operational date is from Holloway (1994, 68-69, 74). Kurchatov and Ioffe, the directors of the labs, halted work with the German invasion in June 1941.

Yes, the facility was covertly developed and operated. However, the early scientific breakthroughs were published in internationally accessible journals. Similar to the US, eventually fission-based scientific advancements were no longer published for national security reasons.

- 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 part of the Soviet weapons program, and was used to explore potential avenues of commercialization of nuclear power. Thermal diffusion was thought to be too inefficient for commercialization as more energy was required than would be produced. However, Soviet scientists recognized that enrichment was an avenue to access atomic energy.

- 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. It is unlikely there was nuclear assistance given the time period and secretive nature of Soviet nuclear program. Additionally, enrichment research in the USSR was indigenous.

- j. *Sources:*

Alkhazov D, and A. Murin. 1941. "O Metode Razeleniia Izotopov S Pomoshchiu Lineinogo Uskoritelia." *Doklady AN SSR*. 3: 204-205.

Brodsky, A.E. 1942. "Partial Separation of Uranium Light Isotope by Thermodiffusion." *Acta Physicochemica*. 3-4: 225-7.

Holloway, David. 1994. *Stalin and the Bomb: The Soviet Union and Atomic Energy 1939-1956*. New Haven, CT: Yale University Press.

#### **4. Institute A (Near Sukhumi)**

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

Enrichment, centrifuge.<sup>8</sup>

- 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 year of the facility is not known. Experimentation started to occur in 1945 and ended in 1952 or 1953 when the site was moved.<sup>9</sup>

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

Yes. The facility remained secret throughout its construction and operation.

- 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 started during WWII as part of the weapons program. The facility was one of three initial lines of enrichment research formalized in 1945.

- 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.*

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<sup>8</sup> Research into gaseous diffusion possibly took place at this facility as well.

<sup>9</sup> Oleynikov (2000) provide the operational start date. Other research was conducted at the site prior to this start date, but there is no evidence nuclear material was introduced in the experiments. Work ended in 1952 when centrifuge work was transferred to Leningrad.



No evidence of foreign assistance found and many sources emphasize the indigenous nature of the Soviet nuclear program. It is important to note however, that this institute benefitted from considerable involvement from German scientists. Gustav Ludwig Hertz, a German Jew who had moved to the USSR, was in charge of the institute. Hertz was permitted to invite other Germans to come work at the facility.

*j. Sources:*

Richelson, Jeffrey T. 2006. *Spying on the Bomb: American Nuclear Intelligence from Nazi Germany to Iran and North Korea*. New York City, NY: WW Norton & Company.

Kruglov, Arkadii. 1994. *The History of the Soviet Atomic Industry*. Andrei Lokhov, Trans. New York City, NY: Taylor & Francis. 130.

Oleynikov, Pavel V. 2000. "German Scientists in the Soviet Atomic Project." The Nonproliferation Review. <http://cns.miis.edu/npr/pdfs/72pavel.pdf>. Accessed 07/06/2015.

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

## **5. Institute G (near Sukhumi)**

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

Enrichment, gaseous diffusion.<sup>10</sup>

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

Laboratory.

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

Construction of the facility began in 1945. Experimentation started to occur in 1945, but 1947 is used as the operational date following Zentner et al.<sup>11</sup> The facility stopped operating in 1949.<sup>12</sup>

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

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<sup>10</sup> EMIS research possibly took place at this facility as well.

<sup>11</sup> Kruglov (2002) provides the construction and operational dates of the research facility.

<sup>12</sup> The end of operation is provided by Zentner et al (2005). The authors state that the Soviet program was largely unsuccessful and end operation once gaseous diffusion became a practical option.

Yes. The facility remained secret throughout its construction and operation.

- 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 started during WWII as part of the weapons program. The facility was one of three initial lines of enrichment research formalized in 1945.

- 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 and many sources emphasize the indigenous nature of the Soviet nuclear program. It is important to note however, that this institute benefitted from considerable involvement from German scientists. Gustav Ludwig Hertz, a German Jew who had moved to the USSR, was in charge of the institute. Hertz was permitted to invite other Germans to come work at the facility.

- j. *Soures:*

Bernstein, Jeremy. 2007. "Where Those Reactors and Centrifuges Came From." *The New York Times*. March 10, 2007.

Gordon, Michael D. 2009. *Red Cloud at Dawn: Truman, Stalin, and the End of the Atomic Monopoly*. New York City, NY: Farrar, Strauss, and Groulx. 163.

Kruglov, Arkadii. 1994. *The History of the Soviet Atomic Industry*. Andrei Lokhov, Trans. New York City, NY: Taylor & Francis. 130.

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

## **6. Krasnoyarsk-45 Electronchemical Plant – Diffusion (Zelenogorsk in Laughter)**

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

Uranium enrichment, gaseous diffusion.

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

Commercial.

- 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 gaseous diffusion facility was from 1949 and 1964<sup>13</sup> and it became operational in 1964.<sup>14</sup> The facility produced HEU until 1989 and the last diffusion cascade was shut down in 1990.

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

Yes, the facility was initiated developed covertly but the US intelligence community identified 1964 as the year the facility was likely to produce HEU.

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

No.

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

No.

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

Yes, the facility was built in the late 1950s to supply HEU for the weapons program.

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

No, the facility is owned and operated by Russia.

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

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<sup>13</sup> Zentner et al. (2005) identify this range as the initial construction date for the gaseous diffusion facility. Podvig states construction occurred in the 1950s while Global Security lists the early 1960s.

<sup>14</sup> Bukharin provides an operational start date of 1962. The IAEA cites 1964 as the operational start date. ECP states 1954.

No evidence of foreign assistance found and many sources emphasize the indigenous nature of the Soviet nuclear program. In 1966 a joint US-Soviet program of processing uranium began and some fuel was processed at this site, but this does not qualify as foreign nuclear assistance.

*i. Sources:*

Bukharin, Oleg. 2004. "Understanding Russia's Uranium Enrichment Complex." *Science and Global Security*. 12: 192-218.

<http://fissilematerials.org/library/sgs12bukharin.pdf>. Accessed 07/16/2015.

ECP. "Joint Stock Company." [http://www.ecp.kts.ru/index\\_en.shtml](http://www.ecp.kts.ru/index_en.shtml). Accessed 07/06/2015.

Global Security. "Krasnoyarsk-25/Zelenogorsk."

[http://www.globalsecurity.org/wmd/world/russia/krasnoyarsk-45\\_nuc.htm](http://www.globalsecurity.org/wmd/world/russia/krasnoyarsk-45_nuc.htm). Accessed 07/06/2015.

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

Podvig, Pavel. 2011. "History of Highly Enriched Uranium Production in Russia," *Science & Global Security*, 19(1): 46-67.

## **7. Krasnoyarsk-45 Electrochemical Plant - Centrifuge (Zelenogorsk in Laughter)**

*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.*

The centrifuges reportedly started spinning in 1964.<sup>15</sup> The plant is still operating (but, as noted above, the diffusion plant at the same site ended operations in 1990). We were unable to locate precise construction dates for the centrifuge plant.

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

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<sup>15</sup> Bukharin provides an operational start date of 1962. The IAEA cites 1964 as the operational start date. ECP states 1954.

Yes.

- 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 to supply HEU for the weapons program. The facility is currently down-blending HEU for sale and use in US commercial reactors.

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

No, the facility is owned and operated by Russia.

- 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:*

Bukharin, Oleg. 2004. "Understanding Russia's Uranium Enrichment Complex." *Science and Global Security*. 12: 192-218.

<http://fissilematerials.org/library/sgs12bukharin.pdf>. Accessed 07/16/2015.

ECP. "Joint Stock Company." [http://www.ecp.kts.ru/index\\_en.shtml](http://www.ecp.kts.ru/index_en.shtml). Accessed 07/06/2015.

Global Security. "Krasnoyarsk-25/Zelenogorsk."

[http://www.globalsecurity.org/wmd/world/russia/krasnoyarsk-45\\_nuc.htm](http://www.globalsecurity.org/wmd/world/russia/krasnoyarsk-45_nuc.htm). Accessed 07/06/2015.

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

Podvig, Pavel. 2011. "History of Highly Enriched Uranium Production in Russia," *Science & Global Security*, 19(1): 46-67.

## **8. Krasnoyarsk-26**

- 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 on the facility began in 1950.<sup>16</sup> The facility became operational in 1964 and operated until the last batch of material arrived in March 6, 2012.

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

Yes, the facility was part of the Soviet weapons program. It was not revealed until 1991. The entire complex was built underground.

- 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 would have been used to produce plutonium. Krasnoyarsk is an enormous underground 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.*

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<sup>16</sup> The 1950 date is when the facilities at Krasnoyarsk began construction and likely start date for the facility. Podvig states construction during the 1950s. The operational dates are from Global Security.

No evidence of foreign assistance found. It is extremely unlikely foreign assistance occurred given the indigenous nature of the Soviet nuclear program, and the fact that this facility was located in a secret closed city.

*j. Sources:*

Global Security. Krasnoyarsk-26.

[http://www.globalsecurity.org/wmd/world/russia/krasnoyarsk-26\\_nuc.htm](http://www.globalsecurity.org/wmd/world/russia/krasnoyarsk-26_nuc.htm).

Accessed 07/06/2015.

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

## **9. Sverdlovsk Laboratory of Electric Phenomena**

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

Enrichment, centrifuge. Work on EMIS also occurred here.

- 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 constructed in 1943 and it became operational in 1944. The research facility operated until 1950. EMIS-related work ended in 1949.<sup>17</sup>

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

Yes, the facility was part of the nuclear weapons program. The facility was covert until 1989.

- 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.

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<sup>17</sup> The end of EMIS research and operation occurred in 1949 according to Zentner et al. (2005).

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

Yes, the facility was a research facility in the Sverdlovsk nuclear weapons complex. German scientist F. Lange, who was captured during the war, did the experimental work in the facility. His equipment was brought to the lab in 1944. The ideas of various forms of enrichment facility were discussed and lectured during 1945 prior to the establishment of the Special Committee responsible for the implementation of the Atomic Program.

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 Soviet centrifuge program was indigenous and no evidence of foreign assistance was found for this facility, though several German scientists did play important roles. Apparently many of these German scientists were involved in research activities at the Laboratory of Electrical Phenomena in the mid 1940s. Around 200 German nuclear specialists, including 33 doctors of science, 77 engineers, and around 80 assistants came to the USSR to work on nuclear projects, and many of these individuals were focused on isotope separation experiments at this facility.

j. *Sources:*

Bokharin, Oleg. 2004. "Understanding Russia's Uranium Enrichment Complex." *Science and Global Security*. 12: 194. <http://fissilematerials.org/library/sgs12bukharin.pdf>. Accessed 07/06/2015.

Kruglov, Arkadii. 1994. *The History of the Soviet Atomic Industry*. Andrei Lokhov. Trans. New York City, NY: Taylor & Francis. 130.

Kruglov, Arkadii. 2002. *The History of the Soviet Atomic Industry*. London, UK: Taylor & Francis.

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

## **10. Laboratory No. 2, Moscow**

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



Reprocessing and enrichment (gaseous diffusion, EMIS, and centrifuge). Note, however, that we only code this as a reprocessing facility in the dataset.

- 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 a critical centerpiece of the Soviet nuclear weapons program. It was established in 1943 to help produce nuclear bombs. In 1944, the Soviets separated micrograms of plutonium using a cyclotron at the site. Related experiments continued in the early days of the Soviet program. We code the end year as 1955, when the facility was no longer known by the secretive name “Laboratory No. 2.” There are certainly alternative end dates we could employ, however. This laboratory still exists today; it is now known as the Kurchatov Institute. ENR-related experiments undoubtedly occurred at this site throughout the nuclear age. Yet the early work was arguably the most relevant for the Soviet nuclear program.

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

Yes, there was a great deal of secrecy surrounding this facility.

- 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.

- 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. Like at other Soviet lab-scale facilities, foreign scientists (particularly from Germany) made critical contributions to the work being done. This does not constitute foreign assistance as we define it, however.

*j. Sources:*

Cochrane, Thomas, Rovert Norris, Oleg Bukharin. 1995. *Making the Russian Bomb*. Boulder, CO: Natural Resource Defense Council Inc. Westview Press.

Holloway, David. 1994. *Stalin and the Bomb: The Soviet Union and Atomic Energy 1939-1956*. New Haven, CT: Yale University Press.

Kruglov, Arkadii. 1994. *The History of the Soviet Atomic Industry*. Andrei Lokhov, Trans. New York City, NY: Taylor & Francis.

Shamberg, Vladimir. 2001. *The Soviet Atomic Bomb*. Colorado Springs: US Airforce Academy.

## **11. Leningrad Compressor Plant**

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

Enrichment, gaseous diffusion.<sup>18</sup>

- 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 constructed in December 27, 1945. The facility became operational in 1946. The facility is considered as discontinuing the R&D responsibilities in 1950 as the diffusion facilities became operational. This facility may have continued to produce the machines but was no longer actively testing enrichment technologies. The research staff was removed during the early 1950s.

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

Yes, the facility was developed covertly.

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<sup>18</sup> Albright and Arkadii both mention the possibility of the German team concurrently working on centrifuge design. No additional information could be found and it is not known whether nuclear materials would have been involved with the centrifuge project at this facility.

- 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 tasked with designing, building and experimenting with the main separating machines for producing enriched uranium.

- 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 and many sources emphasize the indigenous nature of the Soviet nuclear program. In 1951 the centrifuge research at Sukhumi was transferred to the Leningrad plant. Though German scientists had worked at Sukhumi, this does not count as foreign nuclear assistance.

- j. *Sources:*

Albright, David, Frans Berkhout, and William Walker. 1997. "Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities, and Policies." Stockholm International Peace Research Institute.  
<http://books.sipri.org/files/books/SIPRI97AlBeWa/SIPRI97AlBeWa.pdf>.  
Accessed 11/10/2015.

Kruglov, Arkadii. 1994. *The History of the Soviet Atomic Industry*. Andrei Lokhov, Trans. New York City, NY: Taylor & Francis.

## **12. Gorky Machine Building Plant**

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

Enrichment, gaseous diffusion.

- 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 constructed in 1947 and it became operational in 1947.<sup>19</sup> The facility is considered as having discontinued its R&D responsibilities in 1950 as the diffusion facilities became operational. This facility may have continued to produce the machines but is no longer actively testing enrichment technologies.

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

Yes, the facility was 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 tasked with designing, building, and experimenting with the main separating machines for producing enriched uranium.

- 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 and many sources emphasize the indigenous nature of the Soviet nuclear program.

- j. *Sources:*

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<sup>19</sup> Kruglov (2002, 134) provides the construction date. The operational date and end of operations are based on specific experiments at the facility. The transition from R&D to production signals the end of the facility's ENR operations.

Kruglov, Arkadii. 1994. *The History of the Soviet Atomic Industry*. Andrei Lokhov, Trans. New York City, NY: Taylor & Francis.

Podvig, Pavel. 2001. *Russian Strategic Nuclear Forces*. Cambridge, MA: MIT Press.

### 13. Mayak / B Plant

- 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 began in November or December 1946 and it became operational in 1948. The facility stopped operating in 1971.<sup>20</sup>

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

Yes, the facility was developed covertly as it was the first part of the weapons complex for plutonium in Russia.

- 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 the first plutonium reprocessing facility to be built.

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<sup>20</sup> Zentner et al. (2005) provide the construction and operation dates. They cite Cochrane, Norris, Bukharin (1995), 140 & 153 and Kruglov (2002). The end date of 1971 is because the B Plant was completely refurbished to reprocess plutonium using the Purex process. The new facility is designated as RT-1, which has received its own entry in the dataset. Emissions data is available beginning in 1950 from the Independent Group of Scientific Experts (iGSE) [http://www.igse.net/typo3conf/ext/naw\\_securedl/secure.php?u=0&file=fileadmin/kr-85/Pdfs/Mayak\\_Russia.pdf&t=1409333739&hash=b606403b19fadca6c09f49f1c55fd1e7](http://www.igse.net/typo3conf/ext/naw_securedl/secure.php?u=0&file=fileadmin/kr-85/Pdfs/Mayak_Russia.pdf&t=1409333739&hash=b606403b19fadca6c09f49f1c55fd1e7).

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. All radiochemical processes used in the B plant originated in the Radium Institute. Plant B was designed by the Leningrad Institute with source data from the Radium Institute.

j. *Sources:*

Cochrane, Thomas, Rovert Norris, Oleg Bukharin. 1995. *Making the Russian Bomb*. Boulder, CO: Natural Resource Defense Council Inc. Westview Press. 140, 1543.

Kruglov, Arkadii. 1994. *The History of the Soviet Atomic Industry*. Andrei Lokhov, Trans. New York City, NY: Taylor & Francis. 69.

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

#### **14. Pilot Centrifuge Plant, Urals Electro-Chemical Combine, Novouralsk**

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

Enrichment, centrifuge (built in the building of the D Plant).

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 1955 and the facility became operational in 1957.<sup>21</sup> This facility is no longer enriching uranium. However, it is not clear when the pilot plant ceased operations. We code the end of operations in 1962 – the year that the first commercial centrifuge plant at the same site came online.

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

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<sup>21</sup> The construction date was determined because of the two-year lag between the shutdown of D-1 and the operational date of the facility. Both Bukharin and Zentner et al. confirm the operational dates.

Yes, the facility was not well known until 1989.

- 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 part of the weapons complex.

- 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 and many sources emphasize the indigenous nature of the Soviet nuclear program. Additionally, the Urals Electrochemistry Combine (est. 1945) was the oldest enrichment facility in the USSR and played a large role in the development of centrifuge technology.

- j. Sources:

Bukharin, Oleg. 2004. "Russia's Gaseous Centrifuge Technology and Uranium Enrichment Complex." Program on Science and Global Security.  
<http://www.ransac.org/Documents/bukharinrussianenrichmentcomplexjan2004.pdf>

Bukharin, Oleg. 2004. "Understanding Russia's Uranium Enrichment Complex." *Science and Global Security*. 12: 192-218.  
<http://fissilematerials.org/library/sgs12bukharin.pdf>

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

## **15. Commercial Enrichment Plant 1, Urals Electro-Chemical Combine, Novouralsk**

- 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 on the facility in 1960 and it became operational in 1962.<sup>22</sup> The facility continues to operate and it has received at least three full modernization procedures.

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

Yes, the facility was covertly developed in the closed city of Novouralsk.

- 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 used to produce HEU for the weapons complex.

- 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 and many sources emphasize the indigenous nature of the Soviet nuclear program. Additionally, the Urals Electrochemistry Combine (est. 1945) was the oldest enrichment facility in the USSR and played a large role in the development of centrifuge technology.

- j. *Sources:*

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<sup>22</sup> Bukharin states that the decision to construct an industrial-scale centrifuge facility was determined in August 1960. The facility became operational in three phases between 1962 and 1964.



Bukharin, Oleg. 2004. "Understanding Russia's Uranium Enrichment Complex." *Science and Global Security*. 12: 192-218.

<http://fissilematerials.org/library/sgs12bukharin.pdf>. Accessed 07/06/2015.

Bukharin, Oleg. 2004. "Russia's Gaseous Centrifuge Technology and Uranium Enrichment Complex." Program on Science and Global Security.

<http://www.ransac.org/Documents/bukharinrussianenrichmentcomplexjan2004.pdf>.

## **16. Commercial Centrifuge Plant 2, Urals Electro-Chemical Combine, Novouralsk**

- 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.*

The Soviet Union began replacing diffusion technology with centrifuges at the other three sites beginning in 1971. We do not know exactly when this facility shifted to using exclusively centrifuge technology. We code the start date as 1987; this is the first year in which the Soviets ceased using diffusion-related technology at the site.

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

Yes, the facility was covertly developed in the closed city of Novouralsk.

- 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 used to produce HEU for the weapons complex.

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 and many sources emphasize the indigenous nature of the Soviet nuclear program.

j. *Sources:*

Bukharin, Oleg. 2004. "Understanding Russia's Uranium Enrichment Complex." *Science and Global Security*. 12: 192-218.

<http://fissilematerials.org/library/sgs12bukharin.pdf>. Accessed 07/06/2015.

Bukharin, Oleg. 2004. "Russia's Gaseous Centrifuge Technology and Uranium Enrichment Complex." Program on Science and Global Security.

<http://www.ransac.org/Documents/bukharinrussianenrichmentcomplexjan2004.pdf>.

## **17. Module 2 (\*Urals Electro-Chemical Combine, Novouralsk)**

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.*

The Soviet Union began replacing diffusion technology with centrifuges at the other three sites beginning in 1971. We do not know exactly when this facility shifted to using exclusively centrifuge technology. We code the start date as 1987; this is the first year in which the Soviets ceased using diffusion-related technology at the site.

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

Yes, the facility was covertly developed as part of the closed city of Novouralsk.

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 used to produce HEU for the weapons complex.

- 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:*

Bukharin, Oleg. 2004. "Understanding Russia's Uranium Enrichment Complex." *Science and Global Security*. 12: 192-218.  
<http://fissilematerials.org/library/sgs12bukharin.pdf>. Accessed 07/06/2015.

Bukharin, Oleg. 2004. "Russia's Gaseous Centrifuge Technology and Uranium Enrichment Complex." Program on Science and Global Security.  
<http://www.ransac.org/Documents/bukharinrussianenrichmentcomplexjan2004.pdf>.

### **18. Module 3 (\*Urals Electro-Chemical Combine, Novouralsk)**

- 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.*

The Soviet Union began replacing diffusion technology with centrifuges at the other three sites beginning in 1971. We do not know exactly when this facility shifted to using exclusively centrifuge technology. We code the start date as 1987; this is the first year in which the Soviets ceased using diffusion-related technology at the site.

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

Yes, the facility was covertly developed in the closed city of Novouralsk.

- 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 used to produce HEU for the weapons complex.

- 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:*

Bukharin, Oleg. 2004. "Understanding Russia's Uranium Enrichment Complex." *Science and Global Security*. 12: 192-218.

<http://fissilematerials.org/library/sgs12bukharin.pdf>. Accessed 07/06/2015.

Bukharin, Oleg. 2004. "Russia's Gaseous Centrifuge Technology and Uranium Enrichment Complex." Program on Science and Global Security.

<http://www.ransac.org/Documents/bukharinrussianenrichmentcomplexjan2004.pdf>.

## **19. Radium Institute**

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

Enrichment, thermal diffusion.

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

Laboratory.

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

Construction of the facility began in 1942.<sup>23</sup> The facility started operating in 1943.<sup>24</sup> The end of operation date could not be identified.

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

Yes, the facility was covertly developed and operated. However, the early scientific breakthroughs were published in internationally accessible journals. Eventually fission-based scientific advancements were no longer published for national security issues.

- 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 part of the Soviet weapons program and potential avenues of commercialization of nuclear power were explored at this facility. Thermal diffusion was thought to be too inefficient for commercialization as more energy was required than would be produced. However, Soviet scientists recognized that enrichment was an avenue to access atomic energy.

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

No.

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<sup>23</sup>1942 is the year that <sup>235</sup>U was shown to be the fissionable isotope. Research on enrichment intensified at this time. It is not an exact construction start time.

<sup>24</sup> The operational date is from Yudin.

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

No evidence of sensitive nuclear assistance. This was one of the early research and development sites in the USSR. Data from the Radium Institute (RIAN) was influential in the construction and operation of Radiochemical Plant B (Building 101), as well as other facilities.

- j. *Sources:*

Alkhazov D, and A. Murin. 1941. "O Metode Razeleniia Izotopov S Pomoshchiu Lineinogo Uskoritelia." *Doklady AN SSR*. 3: 204-205.

Brodsky, A.E. 1942. "Partial Separation of Uranium Light Isotope by Thermodiffusion." *Acta Physicochemica*. 3-4: 225-7.

Holloway, David. 1994. *Stalin and the Bomb: The Soviet Union and Atomic Energy 1939-1956*. New Haven, CT: Yale University Press.

Kruglov, Arkadii. 1994. *The History of the Soviet Atomic Industry*. Andrei Lokhov, Trans. New York City, NY: Taylor & Francis. 69.

Yudin, Yury. A. "Manuscript on the History of the Soviet Nuclear Weapons and Nuclear Infrastructure." ISTC Project # 1763.

[http://www.partnershipforglobalsecurity.org/Documents/history-manuscript\\_eng.pdf](http://www.partnershipforglobalsecurity.org/Documents/history-manuscript_eng.pdf).

## **20. RIAR (Research Institute of Atomic Reactors)**

- 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 began in 1956 and the facility became operational in 1965. The plant is still running.

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

Yes, the facility was covert initially. The full range of operation at the facility was not known until 1992.

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

No.

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

No.

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

Yes, the facility was the first Soviet nuclear weapons lab. The research activities included warheads and significant quantities of weapon-useable fissile material. It is unknown if nuclear weapons activities continue here.

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

No, the facility is not multinational, though Russia announced in 2010 that the facility would be open to international collaboration in connection with the IAEA INPRO program.

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

No evidence of foreign assistance found, and it is extremely unlikely given the indigenous nature of Soviet nuclear program.

- i. *Sources:*

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

International Atomic Energy Agency. "RIAR (Research Institute of Atomic Reactors)." Nuclear Fuel Cycle Information System. [https://infcis.iaea.org/NFCIS/NFCISMain.asp?Country=Russian%20Federation&Status=In%20operation&Scale=All&Type=SFRR&DetailedType=&Order=1&WhichFacility=691&RPage=1&Page=1&FacilityName=RIAR%20\(Research%20Institute%20of%20Atomic%20Reactors\)&RightP=Facility](https://infcis.iaea.org/NFCIS/NFCISMain.asp?Country=Russian%20Federation&Status=In%20operation&Scale=All&Type=SFRR&DetailedType=&Order=1&WhichFacility=691&RPage=1&Page=1&FacilityName=RIAR%20(Research%20Institute%20of%20Atomic%20Reactors)&RightP=Facility). 11/10/2015.

Ivanov, VB. 1995. "Research Institute of Atomic Reactors." International Atomic Energy Agency. [http://www.iaea.org/inis/collection/NCLCollectionStore/\\_Public/27/011/27011659.pdf](http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/27/011/27011659.pdf).

Podvig, Pavel. 2009. "Consolidating Fissile Materials in Russia's Nuclear Complex." International Panel on Fissile Material. <http://fissilematerials.org/library/rr07.pdf>.

Rosatom. "History." <http://www.niiar.ru/?q=en/history>.

## **21. RT-1, Combined Mayak in Ozersk/Chelyabinski-65**

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

Spent fuel reprocessing.

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

Commercial.

- b. *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 constructed in 1971<sup>25</sup> and it began operation the same year. Radiochemical reprocessing of spent civilian and naval fuel continues to the present in RT-1. The plutonium reactors were shut down during the 1987-1990 period. The production of weapons grade plutonium ceased in 1987.

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

Yes. This facility would have been covert since it was in a secret city.

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

No.

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

No.

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

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<sup>25</sup> The construction date is from Zentner et al. (2005). The authors outline that the facility used to be the Mayak / B Plant but was repurposed in 1970 using the newer Purex system. The older facility is considered as stopping operation in 1971. The reason for the two facilities is that the reprocessing method was altered. However, facilities undergoing renovations are typically not treated as separate facilities to avoid double counting a facility.



No. The previous facility at this site was used for military purposes, but this was a civilian facility.

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

No, the facility was not multinational.

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

No evidence of foreign assistance found, and extremely unlikely given indigenous nature of Soviet nuclear program.

i. *Sources:*

Bibilashvili, Yu.K, and F.G. Reshetnikov. 1993. "Russia's Nuclear Fuel Cycle: An Industrial Perspective." *Bulletin of Atomic Scientists*.  
<http://www.iaea.org/Publications/Magazines/Bulletin/Bull353/35304892833.pdf>. 28.

Bukharin, Oleg, Thomas B. Cochran, and Robert S. Norris. 1999. "New Perspectives on Russia's Ten Secret Cities." National Resource Defense Council. 21-25.

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

Podvig, Pavel. 2009. "Consolidating Fissile Materials in Russia's Nuclear Complex." International Panel on Fissile Material. <http://fissilematerials.org/library/rr07.pdf>.

World Nuclear Association. "Russia's Nuclear Fuel Cycle." [http://www.world-nuclear.org/info/Country-Profiles/Countries-O-S/Russia--Nuclear-Fuel-Cycle/#Used\\_Fuel\\_and\\_Reprocessing](http://www.world-nuclear.org/info/Country-Profiles/Countries-O-S/Russia--Nuclear-Fuel-Cycle/#Used_Fuel_and_Reprocessing). Accessed 07/06/2015.

## 22. RT – 2

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

Spent fuel reprocessing.<sup>26</sup>

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

Commercial.

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<sup>26</sup> The facility also contains weapons-material storage facilities that may have continued to operate after the facility closed.

- b. *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 began construction in 1976. The facility was not completed. Public pressure in the early 1980s impeded completion. Work has begun on the facility for future use starting in 2025-2030.<sup>27</sup>

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

Yes, the city was built covertly and kept as a state secret until 1991.

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

No.

- e. *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. However, the facility has been under joint US-Russia safeguards since 1995.

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

It is unlikely the facility had a weapons purpose.

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

No, the facility is not multinational.

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

No evidence of foreign assistance found, and it is extremely unlikely given the indigenous nature of the Soviet nuclear program.

- i. *Sources:*

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

Podvig, Pavel. 2009. "Consolidating Fissile Materials in Russia's Nuclear Complex." International Panel on Fissile Material. <http://fissilematerials.org/library/rr07.pdf>.

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<sup>27</sup> World Nuclear Association states construction began in 1984 but halted in 1989 due to complications. As of 1993 it was officially reported as "under construction."

Rush, David. 1995. "A Letter from Krasnoyarsk: Disarmament, Conversion, and Safety After the Cold War." *Medicine and Global Survival* 2(1): 19-25.

World Nuclear Association. 2015. "Russia's Nuclear Fuel Cycle." <http://www.world-nuclear.org/info/Country-Profiles/Countries-O-S/Russia--Nuclear-Fuel-Cycle/>. Accessed 11/11/2015.

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

—. 1993. "Russian Plutonium Program at the Crossroads: A Special Report." *Nuclear Fuel*. 18(1): 4.

### **23. D1, Urals Electro-Chemical Combine, Novouralsk<sup>28</sup>**

a. *ENR type (Enrichment or reprocessing? If enrichment, what type?).*

Uranium enrichment, gaseous diffusion.

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

Pilot. This plant was smaller than D2, D4, and D5 but could reasonably be called a commercial plant, too.

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 1946.<sup>29</sup> The diffusion facility began operating in 1948 and was closed in the 1955.<sup>30</sup>

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

Yes, the facility was initially developed covertly.

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

No.

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<sup>28</sup> The IAEA NFCIS combines the D1-D5 enrichment facilities as a single unit.

<sup>29</sup> Zentner et al. (2005) provides the construction and operational dates. Bukharin confirms the 1946 start of construction date. Kruglov (2002, 132) provides the decree for construction, which was issued on December 1, 1945 as well as numerous other details on the construction of Center No. 813 known as D1.

<sup>30</sup> The operational dates are provided by Zentner et al. (2005). Zentner et al. note that operational difficulties caused the first HEU to be produced in 1951. The facility was dismantled and reportedly shipped to China.

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 established to produce HEU for the military program. HEU was not produced until 1951 due to technical problems. Professor P. Tissen, a German enrichment expert, ran the laboratory. He received permission to run the diffusion set up to 50-90% HEU. Global Security notes, "The plant operated until 1955 when it was shut down and dismantled because of low efficiency. Three newer and larger gaseous diffusion plants - D-3, D-4 and D-5 - were brought into operation by 1953."

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

No. Operations ended in 1955 and the facility was reportedly shipped to China.

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

No evidence of foreign assistance found and many sources emphasize the indigenous nature of the Soviet nuclear program. The plant was built on the site of a former industrial aviation facility. From the very beginning, the technology at the plant was indigenous. Kruglov notes that the diffusion machines "were developed in accordance with the design assignment different from the American one-stage design."

j. *Sources:*

Bukharin, Oleg. 2004. "Russia's Gaseous Centrifuge Technology and Uranium Enrichment Complex." Program on Science and Global Security.  
<http://www.ransac.org/Documents/bukharinrussianenrichmentcomplexjan2004.pdf>

Global Security. "Sverdlovsk-44 Combined."  
[http://www.globalsecurity.org/wmd/world/russia/sverdlovsk-44\\_nuc.htm](http://www.globalsecurity.org/wmd/world/russia/sverdlovsk-44_nuc.htm).  
Accessed 07/06/2015.

Holloway, David. 1994. *Stalin and the Bomb: The Soviet Union and Atomic Energy*. New Haven, CT: Yale University Press.

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

Kruglov, Arkadii. 2002. *The History of the Soviet Atomic Industry*. London, UK: Taylor & Francis.

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

Richelson, Jeffrey T. 2006. *Spying on the Bomb: American Nuclear Intelligence from Nazi Germany to Iran and North Korea*. New York City, NY: WW Norton & Company.

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

#### **24. D3, Urals Electro-Chemical Combine, Novouralsk**

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

Enrichment, 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.*

The facility was built from 1950-1951 and became operational in 1951.<sup>31</sup> It was closed in 1987.<sup>32</sup>

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

Yes, the facility remained secret until 1991.

- 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?*

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<sup>31</sup> Kruglov provides the 1950 operational date while Bukharin (2004) states it was operational prior to 1953.

<sup>32</sup> This date is from Bukharin 2004. Zentner et al. (2005, 12) state that all Soviet diffusion facilities ceased operation in 1991.

Yes, the facility was part of the nuclear weapons complex.

*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 was found and many sources emphasize the indigenous nature of the Soviet nuclear program. The D-3 plant was put into operation in 1950-1951 at the same site as the D-1 plant (Center No. 813).

*j. Sources:*

Bukharin, Oleg. 2004. "Russia's Gaseous Centrifuge Technology and Uranium Enrichment Complex." Program on Science and Global Security.  
<http://www.ransac.org/Documents/bukharinrussianenrichmentcomplexjan2004.pdf>.

Bukharin, Oleg. 2004. "Understanding Russia's Uranium Enrichment Complex." *Science and Global Security* 12: 192-218.  
<http://fissilematerials.org/library/sgs12bukharin.pdf>. Accessed 07/06/2015.

Richelson, Jeffrey T. 2006. *Spying on the Bomb: American Nuclear Intelligence from Nazi Germany to Iran and North Korea*. New York City, NY: WW Norton & Company.

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

## **25. D4, Urals Electro-Chemical Combine, Novouralsk**

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

Enrichment, 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 began in 1950.<sup>33</sup> The facility became operational in 1953.<sup>34</sup> The facility ceased to operate in 1987.<sup>35</sup>

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

Yes, the facility remained secret until 1991.

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 part of the nuclear weapons complex.

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 and many sources emphasize the indigenous nature of the Soviet nuclear program.

j. *Sources:*

Bukharin, Oleg. 2004. "Russia's Gaseous Centrifuge Technology and Uranium Enrichment Complex." Program on Science and Global Security.  
<http://www.ransac.org/Documents/bukharinrussianenrichmentcomplexjan2004.pdf>.

Bukharin, Olge. 2004. "Understanding Russia's Uranium Enrichment Complex." *Science and Global Security* 12: 192-218.  
<http://fissilematerials.org/library/sgs12bukharin.pdf>. Accessed 07/06/2015.

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<sup>33</sup> Kruglov (2002, 149) states that the decision to build D3 occurred in 1950 and this is used as the start date of construction.

<sup>34</sup> Bukharin (2004) states operational prior to 1953.

<sup>35</sup> This date is from Bukharin 2004. Zentner et al. (2005, 12) state that all Soviet diffusion facilities ceased operation in 1991.

Kruglov, Arkadii. 2002. *The History of the Soviet Atomic Industry*. London, UK: Taylor & Francis.

Richelson, Jeffrey T. 2006. *Spying on the Bomb: American Nuclear Intelligence from Nazi Germany to Iran and North Korea*. New York City, NY: WW Norton & Company.

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

## **26. D5, Urals Electro-Chemical Combine, Novouralsk**

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

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 began in 1950 and the facility became operational in 1953.<sup>36</sup> The facility ceased to operate in 1987.<sup>37</sup>

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

Yes, the facility remained secret until 1991.

- 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?*

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<sup>36</sup> Bukharin (2004) provides the operational date for each phase (D-3, D-4, and D-5).

<sup>37</sup> This date is from Bukharin (2004). Zentner et al(2005, 12) state that all Soviet diffusion enrichment ceased in 1991.



Yes, the facility was part of the nuclear weapons complex.

*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 and many sources emphasize the indigenous nature of the Soviet nuclear program

*j. Sources:*

Bukharin, Oleg. 2004. "Russia's Gaseous Centrifuge Technology and Uranium Enrichment Complex." Program on Science and Global Security.  
<http://www.ransac.org/Documents/bukharinrussianenrichmentcomplexjan2004.pdf>

Richelson, Jeffrey T. 2006. *Spying on the Bomb: American Nuclear Intelligence from Nazi Germany to Iran and North Korea*. New York City, NY: WW Norton & Company.

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

## **27. Siberian Chemical Combine – Diffusion (Seversk formerly Tomsk-7)**

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

Uranium enrichment, gaseous diffusion.

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

Pilot plant/commercial.

*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 began in 1949.<sup>38</sup> The facility began operating in 1950 and produced its first HEU in 1956. The facility stopped diffusion operation at 1973.<sup>39</sup> The facility transitioned to centrifuge enrichment technology in 1973.

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<sup>38</sup> Bukharin provides the construction date of the closed city of Seversk, which is used as the construction date for the facility. Bukharin and Zentner et al. state 1953 as the operational start date. INFCIS states 1950 as operational

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

Yes, the city was built covertly and kept as a state secret. The city was revealed in 1992 but it is difficult to identify when the operations at the facilities became public knowledge.<sup>40</sup>

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

No.

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

No.

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

Yes, the facility was originally designed to produce weapons grade HEU.

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

No, the facility was developed indigenously. However, the facility provides enrichment of reprocessed fuel to international clients. The French company (COGEMA) signed an agreement in January 1991 that required SCC to enriched recovered uranium up to 4%. It was a ten year contract worth approximately 50 million USD.

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

No evidence of foreign assistance, and it is extremely unlikely given the indigenous nature of Soviet nuclear program. The entire facility was in one of the USSR's secret cities.

- i. *Sources:*

Albright, David, Frans Berkhout, and William Walker. 1997. *Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities and Policies*. New York City, NY: Oxford University Press.

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start date however. Albright, Berkout and Walker (1997, 97) is the source for Makhijani and likely the IAEA citation which gives 1950 as the date the facilities were established. The authors do not state when the facility started operating.

<sup>39</sup> Bukharin provides the transition year from gaseous diffusion to centrifuge technology.

<sup>40</sup> 1992 is an approximation; exact identification of the facility was not possible.

- Bukharin, Oleg. 2004. "Russia's Gaseous Centrifuge Technology and Uranium Enrichment Complex." Program on Science and Global Security. <http://www.ransac.org/Documents/bukharinrussianenrichmentcomplexjan2004.pdf>.
- Hibbs, Mark. 1993. "Russians Plan Use of Military Plants for Actinide Separation After 2002." *Nuclear Fuel*. 18(1): 6.
- 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.
- Nuclear Threat Initiative. 2014. "Siberian Chemical Combine." <http://www.nti.org/facilities/891/>. Accessed 07/06/2015.
- Podvig, Pavel. 2009. "Consolidating Fissile Materials in Russia's Nuclear Complex." International Panel on Fissile Material. <http://fissilematerials.org/library/rr07.pdf>.
- Von Hippel, Frank and Matthew Bunn. 2000. "Saga of the Siberian Plutonium-Production Reactors." *Federation of the American Scientists*. 53(6). <http://fas.org/faspir/v53n6.htm>.
- . "Russian Plutonium Program at Crossroads: A Special Report." *Nuclear Fuel*. 18(1): 4.
- . "Seversk (Tomsk-7)." <http://www.wentz.net/radiate/tomsk/index.htm#O5>.

## **28. Siberian Chemical Combine – Centrifuge (Seversk formerly Tomsk-7)**

- a. *ENR type (diffusion, centrifuge, EMIS, chemical and ion exchange, aerodynamic isotope separation, reprocessing).*  
  
Uranium enrichment, centrifuge.
- b. *Facility size (laboratory, pilot, commercial).*  
  
Pilot plant/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 centrifuge facility began in 1973.<sup>41</sup> The facility started operating as a centrifuge facility in 1973 and it continues to operate.<sup>42</sup>

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

Yes, the city was built covertly and kept as a state secret. The city was revealed in 1992 but it is difficult to identify when the operations at the facilities became public knowledge.

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 originally designed to produce weapons grade HEU, though Podvig notes it no longer produces HEU.

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

No, the facility was developed indigenously. However, the facility provides enrichment of reprocessed fuel to international clients. The French company (COGEMA) signed an agreement in January 1991 that required SCC to enriched recovered uranium up to 4%. It was a ten year contract worth approximately 50 million USD.

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

No evidence of foreign assistance, and it is extremely unlikely given indigenous nature of Soviet nuclear program. The entire facility was in one of the USSR's secret cities.

j. *Sources:*

Bukharin, Oleg. 2004. "Russia's Gaseous Centrifuge Technology and Uranium

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<sup>41</sup> The 1973 date is only a likely date given the adjustments to the plant. The operational date is from Bukharin.

<sup>42</sup> This information is for the diffusion plant. Construction of the diffusion facility began in 1949. The facility has been under operation since 1953 and produced its first HEU in 1956.

Enrichment Complex.” Program on Science and Global Security.  
<http://www.ransac.org/Documents/bukharinrussianenrichmentcomplexjan2004.pdf>.

Hibbs, Mark. 1993. “Russians Plan use of Military Plants for Actinide Separation After 2002.” *Nuclear Fuel*. 18(1): 6.

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

Nuclear Threat Initiative. 2014. “Siberian Chemical Combine.”  
<http://www.nti.org/facilities/891/>. Accessed 07/06/2015.

Podvig, Pavel. 2009. “Consolidating Fissile Materials in Russia’s Nuclear Complex.” International Panel on Fissile Material. <http://fissilematerials.org/library/rr07.pdf>.

Von Hippel, Frank and Matthew Bunn. 2000. “Saga of the Siberian Plutonium-Production Reactors.” *Federation of the American Scientists*. 53(6).  
<http://fas.org/faspir/v53n6.htm>.

—. “Russian Plutonium Program at Crossroads: A Special Report.” *Nuclear Fuel*. 18(1): 4.

—. “Seversk (Tomsk-7).”  
<http://www.wentz.net/radiate/tomsk/index.htm#O5>.

## **29. Siberian Chemical Combine (Seversk) II**

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

Reprocessing (purex).

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

Commercial.

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 began in 1949.<sup>43</sup> The facility has been under operation since 1954.<sup>44</sup> The facility operated from 1954 and continues to operate. The facility operated three production reactors until 1992. There is competing information concerning this facility in the literature. Podvig lists the expected closure date as

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<sup>43</sup> Bukharin states that the city of Seversk was established in 1949 and this is used as the construction start date of the reprocessing facility.

<sup>44</sup> Rush states 1953.

2010. However, Ostroff (2012) lists a new potential reprocessing facility at this location. The facility suspended producing military quality plutonium in 1995. The facility continues to reprocess fuel.

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

Yes, similar to other Russian facilities, conclusive positive identification of the facility did not occur until 1992. It is unknown if the facility was widely known prior to that date.

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

No.

- e. *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. However, the facility is under US-Russian safeguards as part of joint disarmament since 1998.<sup>45</sup>

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

Yes, this was a major plutonium production facility with up to five reactors operating simultaneously. Three of the five production reactors were shut down in the 1990-1992 period. Since 1995, the plutonium that is produced is no longer used for weapons. Production of plutonium pits and HEU components were scheduled to be resumed in 2014.

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

No.

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

No evidence of foreign assistance, and extremely unlikely given indigenous nature of Soviet nuclear program. The entire facility was in one of the USSR's secret cities.

- i. *Sources:*

Bukharin, Oleg. 2004. "Russia's Gaseous Centrifuge Technology and Uranium Enrichment Complex." Program on Science and Global Security.

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<sup>45</sup> 1998 back-dates the agreement as that date references a previous agreement between Russia and the US. The citation for the agreement was published in 1997, which makes the 1998 more plausible as a ratification date.

<http://www.ransac.org/Documents/bukharinrussianenrichmentcomplexjan2004.pdf>.

Nuclear Threat Initiative. 2014. "Siberian Chemical Combine."  
<http://www.nti.org/facilities/891/>. Accessed 07/06/2015.

Podvig, Pavel. 2009. "Consolidating Fissile Materials in Russia's Nuclear Complex."  
International Panel on Fissile Material. <http://fissilematerials.org/library/rr07.pdf>.

Rush, David. 1995. "A Letter from Krasnoyarsk: Disarmament, Conversion, and Safety After the Cold War." *Medicine & Global Survival*. 2(1).  
<http://www.ippnw.org/pdf/mgs/2-1-rush.pdf>.

US Department of State. 1997. "Agreement Between the Government Of The United States Of America and the Government of the Russian Federation Concerning Cooperation Regarding Plutonium Production Reactors."  
<http://www.state.gov/documents/organization/18557.pdf>. Accessed 07/06/2015.

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

### **30. Ukrainian Physicotechnical Institute in Khar'kov**

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

Enrichment, centrifuge.

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

Laboratory (bench top scale).

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 1941.<sup>46</sup> The facility started operating in 1941 and ended operation in 1941.<sup>47</sup>

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

Yes, the facility was covertly developed and operated. However, the early scientific breakthroughs were published in internationally accessible journals. Similar to the

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<sup>46</sup> 1941 is the year that <sup>235</sup>U was shown to be the fissionable isotope. Research on enrichment intensified at this time. It is not an exact construction start time.

<sup>47</sup> The operational date is from Holloway (1994,68-69 and 74). Kurchatov and Ioffe, directors of labs, halted work with the Germany invasion in June 1941.

US, eventually fission-based scientific advancements were no longer published for national security issues.

- 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 part of the Soviet weapons program.

- 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:*

Holloway, David. 1994. *Stalin and the Bomb: The Soviet Union and Atomic Energy 1939-1956*. New Haven, CT: Yale University Press.

Ivanov, V.E. and V.F. Zelenskii. 1978. "Fiftieth Anniversary of the Kharkov Physicotechnical Institute of the Academy of Sciences of the Ukrainian SSR." *Soviet Atomic Energy*. 45(4): 1008-1017.

National Science Center. "Kharkov Institute of Physics and Technology." <http://www.kipt.kharkov.ua/en/bhr.html>. Accessed 07/06/2015.

Shpinel, V.S. 1941. "Kak Rrazdeliaiut Izotopy." *Nauka I zhizn*. 6: 35.

### **31. SU-20 EMIS Plant**

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



Enrichment, EMIS.

- 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.*

Plans for the facility were initiated in 1946, and operations began in 1948. The EMIS plant initially raised the enrichment level of uranium after it had gone through the diffusion plant D-1. This plant was eventually shut down and replaced by a weapons assembly factory. We do not know precisely when this happened. The Soviets downplayed EMIS-related work in 1950; we use this as the end date for the facility, though it may have continued to operate for several more years (and possibly decades).

- 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.

- 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.

- 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.

- j. *Sources:*

Cochrane, Thomas, Robert Norris, Oleg Bukharin. 1995. *Making the Russian Bomb*. Boulder, CO: Natural Resource Defense Council Inc. Westview Press.

Holloway, David. 1994. *Stalin and the Bomb: The Soviet Union and Atomic Energy 1939-1956*. New Haven, CT: Yale University Press.

Oleynikov, Pavel V. 2000. "German Scientists in the Soviet Atomic Project." The Nonproliferation Review. <http://cns.miis.edu/npr/pdfs/72pavel.pdf>. Accessed 07/06/2015.

Podvig, Pavel. 2001. *Russian Strategic Nuclear Forces*. Cambridge, MA: MIT Press.

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

### 32. S-2, Arzamas-16

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

Enrichment, EMIS.

- 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.*

It is not clear when construction began, but this plant operated beginning in 1969. There is little information in the public record about this facility. Two stories published in *Nuclear Fuel* in 1994 imply that the plant was still operational at that time. We code this plant as still being in operation as of 2012, but there is considerable uncertainty about this coding decision. The facility may have, in fact, closed before that date.

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

Yes, the United States reportedly did not learn about its existence until the early 1990s.

- 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.

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.

j. *Sources:*

Cochrane, Thomas, Rovert Norris, Oleg Bukharin. 1995. *Making the Russian Bomb*. Boulder, CO: Natural Resource Defense Council Inc. Westview Press.

Hibbs, Mark. 1994. "Russian Data Suggests Seized Pu Was Enriched by Arzamas-16 Calutron," *Nuclear Fuel*. August 15.

Hibbs, Mark 1994. "Cache of Material Seized in Munich is Said to Be High-Grade MOX Fuel." *Nuclear Fuel*. August 29.

Holloway, David. 1994. *Stalin and the Bomb: The Soviet Union and Atomic Energy 1939-1956*. New Haven, CT: Yale University Press.

Oleynikov, Pavel V. 2000. "German Scientists in the Soviet Atomic Project." *The Nonproliferation Review*. <http://cns.miis.edu/npr/pdfs/72pavel.pdf>. Accessed 07/06/2015.

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