DIIS REPORT

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Anton Khlopkov
and Valeriya Chekina

Governing Uranium in Russia

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DIIS · DANISH INSTITUTE FOR INTERNATIONAL STUDIES

Danish Institute for International Studies, DIIS
Østbanegade 117, DK 2100 Copenhagen
Ph: +45 32 69 87 87
Fax: +45 32 69 87 00
E-mail: diis@diis.dk
Web: www.diis.dk

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Anton Khlopkov, Director, Center for Energy and Security Studies (CENESS)
khlopkov@ceness-russia.org

Valeriya Chekina, Research Associate, Center for Energy and Security Studies (CENESS)
chekina@ceness-russia.org

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Introduction

Russia has one of the world's largest fleets of nuclear power plants, with 33 reactors in operation. The country's nuclear energy output is expected to double by 2035. Russia is also a leading nuclear exporter, with 5bn dollars worth of annual exports. It supplies enriched uranium product and nuclear fuel, and builds nuclear power plants based on Russian reactor designs. The Russian nuclear industry therefore generates a lot of demand for nuclear materials.

This study analyses the Russian nuclear industry's demand for natural uranium, the sources of supply, and the legal framework that regulates the use of nuclear materials in Russia. It was conducted as part of an international project implemented under the leadership of the Danish Institute for International Studies (DIIS).

The opinions and conclusions in this paper reflect only the authors' personal views, which may not coincide with the position of the organizations they represent.

1. Russia's Nuclear Industry's Demand for Uranium

At present, the overall annual demand for natural uranium generated by the global nuclear energy industry stands at about 66,000 tonnes.[1] Rosatom state nuclear energy corporation does not release official figures about its the annual demand. According to the estimates provided below, it currently stands at about 20,000 tonnes; the figure includes demand generated by Russia's own NPPs, and export contracts. The breakdown of that figure by category is as follows: Russian NPPs require about 5,000 tonnes; exports of nuclear fuel another 5,000 tonnes, and exports of uranium products and services 10,000 tonnes (the latter two figures do not take into account the feed material supplied by the customers themselves, which partially cover the demand).

Table 1. Russian nuclear industry's demand for natural uranium, tU

Russian NPPs	*Exports*		*Total*
	Nuclear fuel	*EUP*	
5,000	5,000	10,000	20,000

Section 1 analyzes the structure of the Russian nuclear industry's demand for uranium, the current state, and the outlook for that demand.

1.1 Demand generated by Russian NPPs

Current state

In recent years, the share of nuclear energy in the Russian electricity generation has been fairly steady at 16-17%, well above the world average of 12-13 per cent. In 2013 Russian NPPs generated 171.6bn KWh of electricity[2]; by that indicator, Russia ranks third internationally after the United States

[1] Uranium Markets. Updated April 2014. http://www.world-nuclear.org/info/nuclear-fuel-cycle/uranium-resources/uranium-markets/ (Retrieved on June 26, 2014).

[2] Rosatom: Russian NPPs Achieve Corporate Energy Production Target Early. Rosenergoatom Department for Information and Public Relations. 2013, December 31. http://www.rosenergoatom.ru/journalist/news/1d97f20042629e86a91dbfb5588d816b (Retrieved on June 1, 2014); Uranium Supply Will Meet Demand Beyond 2030, WNA Says. 2013, October 24. http://www.nei.org/News-Media/News/News-Archives/Uranium-Supply-Will-Meet-Demand-Beyond-2030,-WNA-S (Retrieved on June 26, 2014).

and France.[3] As of June 1, 2014, there were 33 nuclear reactors in operation at Russia's 10 nuclear power plants. That number includes 17 VVER-type reactors (11 VVER-1000 units and six VVER-440), 15 channel-type reactors (11 RBMK-1000 units and four EGP-6), and a single fast neutron reactor (BN-600).[4] The total installed generation capacity of Russia's NPPs is 25.2 GW. *Table 2* lists the Russian nuclear power reactors currently in operation.

Table 2. Operational Russian NPPs

NPP	*Reactor type*	*Reactors*	*Capacity*
Balakovskaya NPP (Saratov Region, Volga Federal District)	VVER-1000	4	4,000 MW
Beloyarskaya NPP (Sverdlovsk Region, Urals Federal District)	BN-600	1	600 MW
Bilibinskaya NPP (Chukotka Autonomous District, Far Eastern Federal District)	EGP-6	4	48 MW
Kalininskaya NPP (Tver Region, Central Federal District)	VVER-1000	4	4,000 MW
Kolskaya NPP (Murmansk Region, Northwestern Federal District)	VVER-440	4	1,760 MW
Kurskaya NPP (Kursk Region, Central Federal District)	RBMK-1000	4	4,000 MW
Leningradskaya NPP (Leningrad Region, Northwestern Federal District)	RBMK-1000	4	4,000 MW
Novovoronezhskaya NPP (Voronezh Region, Central Federal District)	VVER-440	2	1,800 MW
	VVER-1000	1	
Rostovskaya NPP (Rostov Region, Southern Federal District)	VVER-1000	2	2,000 MW
Smolenskaya NPP (Smolensk Region, Central Federal District)	RBMK-1000	3	3,000 MW
Total	*11 VVER-1000, 6 VVER-440, 11 RBMK-1000, 4 EGP-6, 1 BN-600*	*33*	*25,208 MW*

[3] Top 10 Nuclear Generating Countries. http://www.nei.org/Knowledge-Center/Nuclear-Statistics/World-Statistics/Top-10-Nuclear-Generating-Countries (Retrieved on June 1, 2014).

[4] VVER-440 and VVER-1000 are water-cooled, water-moderated nuclear power reactors with a power output of 440 and 1,000 MW, respectively. EGP is a 12 MWe graphite-moderated boiling water reactor. BN-600 is a 600 MW fast reactor.

Plans

Russia plans to increase electricity production at its nuclear power plants as part of its Energy Strategy. Nuclear energy development is seen as an important element of long-term Russian policies to reduce greenhouse gas emissions, preserve non-renewable minerals for non-energy use, and increase the share of high-tech products in Russian exports. The authors of the Russian Energy Strategy believe that building new NPPs will have significant direct and indirect multiplier effects on the development of the Russian mining industry (uranium production and processing) and its high-tech sector (nuclear fuel manufacturing, etc.)[5].

The draft of the new Russian Energy Strategy to 2035 sets an ambitious target of increasing the share of nuclear power in the country's energy balance to 22.5 per cent by 2035. At present, there are 13 countries in the world that have already achieved or surpassed that target.[6] In Russia itself, NPPs already account for 30 per cent of electricity produced in the European part of the country, and 37 per cent in the Northwestern part.

Table 3. Past, current, and projected share of nuclear power in Russian energy balance

2010	*2012*	*2020*	*2025*	*2030*
16.4%	16.6%	16.4%	18.1%	22.5%

Source: Draft Russian Energy Strategy to 2035. Russian Energy Ministry. Moscow, 2014. P. 229.

Ten reactors are already under construction at this time in Russia; only China has more reactors being built (28). Three reactors are expected to be launched by the end of 2014: one at the Beloyarskaya NPP, one at the Novovoronezhskaya NPP, and one at the Rostovskaya NPP. In accordance with the draft of the new Russian Energy Strategy, the country's installed nuclear generation capacity should almost double to 50 GW by 2035.

Table 4. Projected growth of Russian nuclear generation capacity, GW

2013	*2020*	*2025*	*2035*
25.2	29.0	35.0	50.0

Source: Draft Russian Energy Strategy to 2035. Russian Energy Ministry. Moscow, 2014. P. 231.

5 Draft Russian Energy Strategy to 2035. Russian Energy Ministry. Moscow, 2014. P. 157. http://minenergo.gov.ru/upload/iblock/665/665a6512e64ffd5e3d30d9448d7b7fff.pdf (Retrieved on June 10, 2014).

6 World Statistics: Nuclear Energy Around the World. http://www.nei.org/Knowledge-Center/Nuclear-Statistics/World-Statistics (Retrieved on June 1, 2014).

In addition to building new reactors, Russia is also upgrading the existing ones to extend their service life. In 2012 upgrade projects were under way at nine reactors.[7] Service life of the RBMK-1000, 1st Generation VVER-440, and BN-600 reactors has been extended by 15 years, and of the 2nd Generation VVER-440 and VVER-1000 units by 20 years. For example, the No 3 and 4 reactors of the Novovoronezhskaya NPP will now remain in service until 2016 and 2017, respectively. The shut-down of reactors at the Bilibinskaya NPP and the beginning of the power plant's decommissioning have been scheduled for 2019-2021. The No 1 and No 2 reactors of the Leningradskaya NPP will cease production of electricity in 2018 and 2020, respectively, and of the Kolskaya NPP in 2018 and 2019. Twelve first-generation nuclear power reactors with a total capacity of 5.7 GW are scheduled for decommissioning by 2025.[8] These reactors are not suitable for further service life extension because of their design. For example, the RBMK reactors cannot be kept in service any longer because of the degradation of their graphite bricks due to the neutron irradiation.[9]

A nuclear power plant of 1,000 MW requires around 200 tonnes of natural uranium per year.[10] The annual demand for natural uranium generated by the Russian nuclear power reactors at this time can therefore be estimated at 5,000 tonnes. By 2035 Russia's installed nuclear generation capacity is projected to reach 50 GW, meaning that annual demand for natural uranium will rise to 10,000 tonnes.

Table 5. Russian NPPs' projected demand for uranium based on the Energy Strategy to 2035 data, tU[11]

2013	*2020*	*2025*	*2035*
5,000	5,700	6,900	10,000

[7] Rosatom State Nuclear Energy Corporation 2012 Annual Report. Moscow, 2013. P. 17. http://www.rosatom.ru/resources/1dd17b804fe7f604b58abdc97ccc3c4c/annualreport2012.pdf (Retrieved on June 12, 2014).

[8] Nemytov S.A. Key Results and Objectives of Preparations for Decommissioning Nuclear Power Reactors. http://www.atomeco.org/mediafiles/u/files/Prezentetion_31_10_2013/Nemytov.pdf (Retrieved on June 11, 2014).

[9] Muratov O.E., Tikhonov M.N. Decommissioning of NPPs: Problems and Solutions. *ProAtom*. 2008, January 14. http://www.proatom.ru/modules.php?name=News&file=article&sid=1198 (Retrieved on June 11, 2014).

[10] See, for example: The Nuclear Fuel Cycle. http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Introduction/Nuclear-Fuel-Cycle-Overview/ (Retrieved on March 10, 2014).

[11] The table is based on the authors' own calculations.

1.2 Other domestic sources of demand for uranium

Russia has many nuclear research facilities, including research reactors, critical and subcritical assemblies, and neutron generators. All of them use various forms of uranium fuel. There are more than 30 research reactors at Russia's research facilities and universities, not counting the nuclear weapons laboratories in Sarov (Nizhniy Novgorod Region) and Snezhinsk (Chelyabinsk Region).[12] But all these reactors are much smaller than the ones used at nuclear power plants, and they require much less uranium fuel for their operation. In addition, most of the Russian research reactors use HEU-based nuclear fuel, which is made from secondary sources, i.e. from the existing stockpiles of highly-enriched uranium.

The Russian Navy operates 51 nuclear-powered submarines, and one heavy nuclear-powered guided missile cruiser; six nuclear ice-breakers are operated by Rosatom state nuclear energy corporation. All together they carry approximately 90 propulsion reactors.[13] All these reactors, however, use HEU fuel, which is made from secondary sources too.

Russia ended production of highly-enriched uranium for weapons purposes in 1989.

The bulk of Russia's domestic annual demand for natural uranium is therefore generated by its nuclear power plants. According to previously cited estimates, the annual demand for natural uranium generated by Russia's power reactors currently stands at about 5,000 tonnes.[14] If Russia achieves its targets for the construction of new NPPs, by 2035 that figure will reach 10,000 tonnes.

1.3 Demand for uranium generated by Russian nuclear exports

Russia is one of the world's leading nuclear exporters. Foreign trade operations account for about a third of the Rosatom state nuclear energy corporation revenues. It currently holds 73bn USD worth of long-term export contracts.[15] The figure is

[12] Diakov Anatoly. On Conversion of Research Reactors in Russia. http://armscontrol.ru/pubs/en/on-conversion-of-research-reactors-in-russia-en-corr.pdf (Retrieved on March 1, 2014).

[13] Online Reference Materials on the Russian and Soviet Navy's Ships and Boats. http://russian-ships.info/today/ (Retrieved on June 10, 2014); Kuznetsov V.M. Reactors of the Nuclear Submarine Fleet. 2007, January 24. http://www.proatom.ru/modules.php?name=News&file=article&sid=798 (Retrieved on June 10, 2014).

[14] This Assessment Matches the Data Cited in the Article "Deficit of Uranium Fuel". http://www.mox26.net/uran-fuel (Retrieved on March 1, 2014).

[15] Komarov Kirill. Orders on Hand. *Vestnik Atomproma*. 2014, №4. P. 9.

expected to rise to 98bn by the end of 2014.[16] Rosatom controls 42 per cent of the global market for uranium enrichment and 17 per cent of the market for nuclear fuel. This generates additional demand for natural uranium by the Russian nuclear industry.[17]

Table 6. Russia's share of the global nuclear market, by segment

Uranium enrichment	*Nuclear fuel fabrication*	*Nuclear reactors*
42%	17%	19%

Source: Draft Russian Energy Strategy to 2035. Russian Energy Ministry. Moscow, 2014. P. 24. http://minenergo.gov.ru/upload/iblock/665/665a6512e64ffd5e3d30d9448d7b7fff.pdf (Retrieved on June 10, 2014); Rosatom 2012 Annual Report. Moscow, 2013. P. 18.

As of January 2014, Russia also controlled one-third of the global uranium conversion capacity, and about 27 per cent of the global market for uranium hexafluoride production.[18]

Further development of exports of nuclear power plants, nuclear fuel cycle products and services is an important element of the Russian national strategy of nuclear industry development. The growth in domestic Russian demand for electricity is slowing down, and plans for the launch of new Russian power reactors are being pushed back. It is therefore important for Russian companies to secure new export contracts that would pick up the slack in domestic demand in the nuclear engineering, machine-building, and nuclear fuel cycle industries.[19]

In 2011-2013 the Russian nuclear industry totally earned more than 13bn USD in export revenues. The target for 2015 is 8.5bn USD.[20] At present, uranium products and services (including uranium conversion and enrichment services, as well as enriched uranium product) and nuclear fuel account for about 68 per cent of Russian nuclear exports. In 2013 exports of uranium products and services (not count-

16 Conversation between Dmitry Medvedev and Sergey Kiriyenko, Head of the Rosatom State Nuclear Energy Corporation, June 2, 2014. http://government.ru.3s3s.org/news/12773 (Retrieved on June 2, 2014).

17 Rosatom 2012 Annual Report. Moscow, 2013. P. 18. http://www.rosatom.ru/resources/1dd17b804fe7f604b58abdc97ccc3c4c/annualreport2012.pdf (Retrieved on June 12, 2014).

18 Conversion and Deconversion. Updated in April 2014. http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Conversion-Enrichment-and-Fabrication/Conversion-and-Deconversion/ (Retrieved on June 26, 2014).

19 Conversation between Dmitry Medvedev and Sergey Kiriyenko, Head of the Rosatom State Nuclear Energy Corporation, June 2, 2014. http://government.ru.3s3s.org/news/12773 (Retrieved on June 2, 2014).

20 Komarov Kirill. Orders on Hand. *Vestnik Atomproma*. 2014, №4. P. 11.

Table 7. Soviet/Russian-designed nuclear power reactors, by country

Country	*Reactors (NPP)*		*Installed capacity*
Armenia	1	(Metsamor NPP - 1)	440 MW
Bulgaria	2	(Kozloduy NPP - 2)	2,000 MW
China	2	(Tianwan NPP)	2,000 MW
Czech Republic	6	(Dukovany NPP - 4, Temelin NPP - 2)	3,868 MW
Finland	2	(Loviisa NPP - 2)	1,000 MW
Hungary	4	(Paks NPP - 4)	2,000 MW
India	1	(Kudankulam NPP - 1)	1,000 MW
Iran	1	(Bushehr - 1)	1,000 MW
Slovakia	4	(Bohunice NPP - 2, Mochovce NPP - 2)	1,760 MW
Ukraine	15	(Zaporizhzhya NPP - 6, Rivne NPP - 4, Khmelnytskyy NPP - 2, South Ukrainian NPP - 3)	13,835 MW
Total	*38*		*28,903 MW*

ing deliveries under the HEU-LEU contract) reached 2bn USD.[21] Nuclear fuel exports stood at 1.4bn USD[22]. The overall value of the export contracts fulfilled by the Russian nuclear industry that year was about 5bn USD (excluding HEU-LEU contract)[23]. The share of the contracts for uranium products and nuclear fuel in Rosatom's portfolio of long-term contracts is about 50 per cent.[24]

At this time Russia exports nuclear fuel to 10 countries operating a total of 38 Soviet/Russian-designed nuclear power reactors. *For more details, see Table 7.*

[21] Draft 2013 Annual Report by Techsnabexport. P. 10. http://tenex.ru/wps/wcm/connect/tenex/site/resources/5377060043aee5cd8f44bf1ec6ec1853/TENEX_AnnualPublicReport_2013_draft_06.05.2014.pdf (Retrieved on June 10, 2014).

[22] TVEL Net Profit Rose by 11.4 per cent in 2013 – Company Documents. *RIA Novosti*. 2013, December 19. http://www.atominfo.ru/newsg/n0541.htm (Retrieved on June 10, 2014).

[23] Rosatom 2013 Annual Report. Moscow, 2014. P. 12. http://www.rosatom.ru/resources/37117a004494c2369041b0e920d36ab1/rosatom_anrep_2013.pdf (Retrieved on July 3, 2014).

[24] Rosatom 2012 Annual Report. Moscow, 2013. http://ar2012.rosatom.ru/#/ru/1605 (Retrieved on June 10, 2014).

Under the existing 2008 contract between Ukraine's Enerhoatom national nuclear energy generation company and America's Westinghouse, Ukraine may buy American TVS-W type fuel for reloading three of the South Ukrainian NPP's reactors in 2011-2015. The remaining 35 reactors use only Russian fuel made by TVEL fuel company, a subsidiary of Rosatom.

The Russian nuclear industry requires an estimated 5,000 tonnes of natural uranium every year to produce nuclear fuel under export contracts. This figure is set to grow as Rosatom continues to implement its ambitious program of building new power reactors abroad. As of June 1, 2014, Russia has intergovernmental agreements for the construction of 21 nuclear power reactors, of which 11 are at the different stages of building or preparations for building (four at the Akkuyu NPP in Turkey, one at the Kudankulam NPP in India, two at the Ostrovetskaya NPP in Belarus, two at the Ruppur NPP in Bangladesh, and two at the Tianwan NPP in China). Under the existing Rosatom roadmap for the construction of NPPs, a total of 19 new power reactors are to be launched in foreign countries by 2024. Additionally, negotiations are under way about building another 27 power reactors, and preliminary consultations for a further 34 reactors.[25] A growing proportion of the NPP projects Russia offers to its foreign customers include long-term contracts for fresh nuclear fuel and spent nuclear fuel return (including the projects in Belarus, Jordan, and Vietnam).

Uranium enrichment services and deliveries of enriched uranium product (EUP) are the biggest sources of Rosatom's export revenues (about 40 per cent in 2013). Deliveries from Russia supply about a third of the demand for EUP generated by NPPs in the United States, Western Europe, and Asia Pacific. As of late 2013, Rosatom's portfolio of long-term contracts for such services stood at almost 25bn USD in comparable prices. A total of 34 companies from 16 countries have placed orders with Techsnabexport, the Rosatom subsidiary specializing in exports of Russian uranium enrichment services.[26] In 2013, European customers accounted for 60 per cent of Russian commercial exports of uranium products and services (including EUP deliveries), the United States and Mexico 20 per cent, and the Asia Pacific, Middle East, and Africa 15 per

[25] Komarov Kirill. Rosatom: Course Towards Global Development. Round Table "Financing of NPP construction projects", Atomexpo-2014 Forum, Moscow, June 10, 2014.

[26] Draft 2013 Annual Report by Techsnabexport. P. 10. http://tenex.ru/wps/wcm/connect/tenex/site/resources/5377060043aee5cd8f44bf1ec6ec1853/TENEX_AnnualPublicReport_2013_draft_06.05.2014.pdf (Retrieved on June 10, 2014).

cent.[27] EUP export contracts generate estimated annual demand for natural uranium of about 10,000 tonnes.

In the longer term, Russian demand for natural uranium is set to increase. The main driver of that growth will be the launch of new VVER-type power reactors in Russia and abroad. If Rosatom manages to achieve its targets, Russia's annual demand for natural uranium will rise to 30,000 tonnes by 2035.

[27] Ibid.

2. Meeting Russia's Nuclear Industry's Demand for Uranium

The nuclear industry's demand for uranium is met from primary and secondary sources (for the purposes of this paper, let us leave out the use of plutonium for making MOX fuel). The primary source is natural uranium mined domestically or supplied from mines located abroad. The secondary sources include national stockpiles of natural, low-enriched, and highly-enriched uranium; commercial stockpiles of natural and enriched uranium; depleted uranium or "tails" with lower U-235 concentration (a byproduct of enrichment of natural uranium that can also be used after additional enrichment); and reprocessed uranium (RepU) obtained by reprocessing spent nuclear fuel. The nations that export nuclear fuel or EUP, such as Russia, can also source some of the uranium from their own foreign customers, i.e. enrich the uranium provided by the customer or by a third party on the customer's behalf.

Let us now look in greater detail at the sources that supply the Russian nuclear industry with uranium.

2.1 Uranium mining in Russia

As of January 1, 2013, Russian uranium deposits held 708,000 tonnes of uranium, including 333,700 tonnes in the A+B+C1 categories and 374,300 tonnes in the C2 category[28]. Most of the Russian uranium deposits are difficult to produce and require capital-intensive underground mining technology. In addition, the uranium ore grade held in those deposits is not high, making production even more costly.[29]

Over the past decade, Russia's own uranium mines have supplied no more than 20 per cent of the national nuclear industry's requirement for natural uranium. In 2013 the country's three uranium mining centers produced about 3,100 tonnes of uranium, covering about 16 per cent of the demand. *For more details, see Table 8.*

[28] A+B+C1, according to IAEA classification, Reasonably Assured Resources (RAR); C2 — Inferred Resources.

[29] Draft Russian Energy Strategy to 2035. Russian Energy Ministry. Moscow, 2014. P. 94. http://minenergo.gov.ru/upload/iblock/665/665a6512e64ffd5e3d30d9448d7b7fff.pdf (Retrieved on June 10, 2014).

Table 8. Uranium mining in Russia

Company	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*
Priargun-sky	3,200 t	2,900 t	3,037 t	3,050 t	3,005 t	2,920 t	2,191 t	2,001 t	2,133 t
	94%	92%	89%	87%	84%	82%	73%	70%	68%
Dalur	200 t	262 t	350 t	410 t	463 t	508 t	535 t	529 t	562 t
	6%	7%	10%	12%	13%	14%	18%	18%	18%
Khiagda	20 t	28 t	26 t	61 t	97 t	135 t	266 t	332 t	440 t
	less than 1%	1%	1%	1%	3%	4%	9%	12%	14%
Total	*3,420 t*	*3,190 t*	*3,413 t*	*3,521 t*	*3,565 t*	*3,563 t*	*2,992 t*	*2,862 t*	*3,135 t*

Sources: ARMZ 2007 Annual Report. http://www.annual-report.ru/catalog/2007/armz2007.pdf (Retrieved on June 9, 2014); ARMZ 2010 Annual Report. http://www.armz.ru/media/File/facts/2011/investors/annual_report_2010_final.pdf (Retrieved on June 9, 2014); ARMZ 2011 Annual Report. http://www.armz.ru/media/File/facts/2012/ARMZ_ar2011-full1508-enc.pdf (Retrieved on June 9, 2014); ARMZ 2012 Annual Report. http://www.armz.ru/media/File/facts/2013/armz_annual_report_20120608_encr.pdf (Retrieved on June 9, 2014); PPGKhO Achieves Main 2013 Targets. http://www.priargunsky.armz.ru/about/news/?id=251 (Retrieved on June 9, 2014); Khiagda Reports Improved 2013 Figures, News. http://www.armz.ru/press/news/?id=480&p=1; Dalur Reports Improved Production Indicators. *Region 45.* http://oblast45.ru/publication/3535 (Retrieved on June 9, 2014); PPGKhO Sells 3,200 tonnes of Uranium in 2005. *Finmarket*. 2006, January 19. http://www.finmarket.ru/news/450654 (Retrieved on June 9, 2014); Kiriyenko: Uranium Production at PPGKhO Should Rise by 50 per cent to 5,000 tonnes by 2014-2015. *RIA Novosti*. May 31, 2007. http://sibir.ria.ru/economy/20070531/81585549.html (Retrieved on June 9, 2014); ZAO Dalur, Kurgan Region, Uksyanskoye village. OAO Commercial Center. http://www.kc-tvel.ru/partnery/dalur/ (Retrieved on June 9, 2014); Industrial-Scale Uranium Production to Begin in Kurgan Region. *Regnum*. 2006, February 6. http://www.regnum.ru/news/economy/585081.html (Retrieved on June 9, 2014); ARMZ Hopes to Increase Uranium Production at Least Sixfold by 2020. *Novosti VPK*. 2007, October 4. http://vpk.name/news/10345_atomredmetzoloto_rasschityivaet_k_2020_g_uvelichit_dobyichu_urana_kak_minimum_v_shest_raz.html (Retrieved on June 9, 2014); Shumilin M.V. Problems of the Development of Uranium Production in Russia and of Ensuring the Balance of Real Supply and Demand. Russia's Mineral Resources. *Ekonomika i Upravleniye*. 2006, №5. http://www.vipstd.ru/gim/content/view/93/148/ (Retrieved on June 9, 2014); 2007 Annual Report Submitted to the General Shareholders Meeting. Khiagda. http://www.khiagda.armz.ru/media/File/gofotch2007.pdf (Retrieved on June 9, 2014).

To understand how that situation came about, let us look at the history of uranium mining in Russia.

Historical background

Soviet efforts to discover uranium deposits and start uranium production were launched as part of the nuclear weapons program, in accordance with a November 27, 1942 Resolution "On Uranium Mining" by the State Defense Committee. The resolution ordered the launch of uranium production at the Taboshar field in Tajikistan. The first uranium ingot was produced in a Soviet laboratory in late 1944. The first Soviet uranium mining and processing center was the No 6 Mining and Chemical Combine. The facility was built in Tajikistan's Fergana valley in accordance with the State Defense Committee's Resolution No 8582 ss/op of May 15, 1945. The company is now known as Vostokredmet. The uranium ore for the facility was mined at various fields in Central Asia.[30] During the first phase of the Soviet uranium industry's development, there was a complete lack of the required infrastructure and machinery. Eyewitnesses recall that in the mid-1940s, uranium ore was transported from the mines to the processing facility by mountain trails, in large sacks carried by mules and camels.[31]

In the second half of the 1940s, the focus shifted to mining uranium from the already explored deposits in Eastern Europe. In 1945 the Soviet Union signed its first international agreement on cooperation in uranium exploration with Bulgaria. Similar deals on joint uranium exploration and production were soon signed with the governments of Czechoslovakia, Hungary, Poland, and Romania.[32] In 1947 Moscow set up the Wismuth (Bismuth) uranium mining company in East Germany (it later became a joint-stock Soviet-East Germany company).

The first batch of uranium fuel loaded into the Soviet Union's first industrial plutonium production reactor came from the uranium stockpiles seized by Soviet troops in Germany in 1945 and from the material also came from the Soviet Union's own No 6 Mining and Chemical Combine.[33] The Soviet-German Wismuth company was instrumental in keeping the Soviet nuclear program supplied with uranium in the late 1940s, when uranium mining in the Soviet Union itself was still in the ear-

30 A.P. Zavenyagin: Life Pages. Compiled by M.Y. Vazhnov, I. Aristov. Moscow: PolyMedia, 2002.

31 Kruglov A.K. How the Soviet Nuclear Industry Was Built. Moscow: TsNIIatominform, 1995. P. 254.

32 Andryushin I.A., Chernyshev A.K., Yudin Y.A. Taming the Atom. Pages of History of Soviet Nuclear Weapons and Nuclear Infrastructure. Sarov, 2003. P. 294.

33 Kruglov A.K. How the Soviet Nuclear Industry Was Built. Moscow: TsNIIatominform, 1995. P. 28.

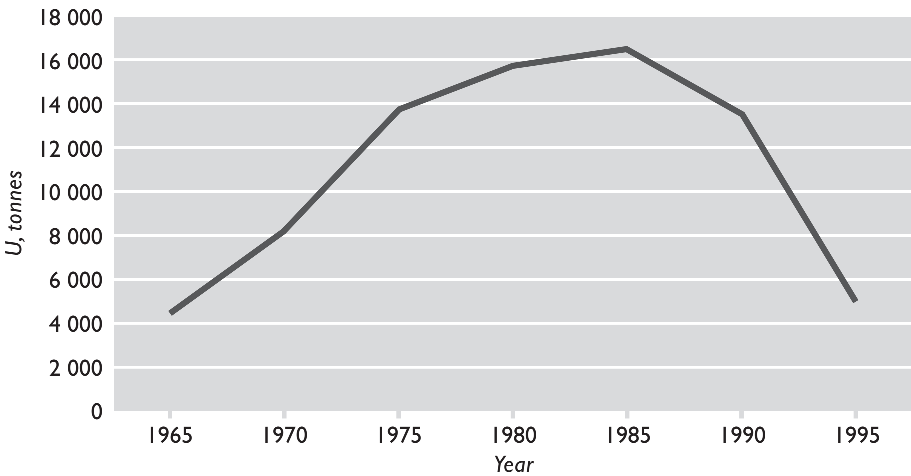
ly phases. In 1946-1950 Wismuth delivered 2,478 tonnes of uranium to the Soviet Union, whereas the country's own uranium mines produced only 1,056 tonnes between them.[34] *For more details, see Table 9*. Uranium production in the East Germany peaked at 7,100 tonnes in 1967.[35] The second-biggest supplier of uranium to the Soviet Union at the time was Czechoslovakia.

Table 9. Sources of uranium supplied to the Soviet Union in 1946-1950

Year	*Soviet production, tU*	*Eastern Europe (Bulgaria, Czechoslovakia, East Germany, Poland), tU*
1946	50	60
1947	129	210
1948	182	452
1949	278	989
1950	417	1640

Source: Kruglov A.K. How the Soviet Nuclear Industry Was Built. Moscow. TsNIIatominform, 1995. P. 263.

Figure 1. Soviet/CIS uranium production



Source: Shumilin M.V. Problems of the Development of Uranium Production in Russia and of Ensuring the Balance of Real Supply and Demand. Russia's Mineral Resources. *Ekonomika i Upravleniye*. 2006, №5. http://www.vipstd.ru/gim/content/view/93/148/ (Retrieved on June 9, 2014).

[34] Wismuth: Uranium for the Soviet Union. January 28, 2014. http://www.proatom.ru/modules.php?name=News&file=print&sid=5036 (Retrieved on June 10, 2014).
[35] Ibid.

Most of Soviet uranium production was located in Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan), as well as Ukraine. According to available data, it peaked at 16,000-16,500 tonnes in 1985-1986.[36] Global uranium production peaked at 68,000 tonnes in 1982.[37] In the 1970s and 1980s the Soviet Union accumulated large stockpiles of uranium.

By the middle of 1980s the Soviet Union had built the world's largest uranium mining industry, most of which was concentrated in Kazakhstan, Russia, Ukraine, and Uzbekistan. Much of the production relied on in-situ leaching, a highly efficient technology that was introduced in the Soviet Union in the mid-1960s. [38] By the mid-1980s, that technology accounted for up to 35 per cent of Soviet uranium production.

After the break-up of the Soviet Union in 1991, Russia inherited about 70 per cent of the installed nuclear power generation capacity. The newly independent republics, however, were left in control of more than 80 per cent of the Soviet Union's uranium mining assets. Only one of the seven Soviet uranium mining centers, the Priargunsky Mining and Chemical Combine (now known as the Priargunsky Mining and Chemical Company, PPGKhO), was based in Russia proper.

Priargunsky (Trans-Baikal Territory, Siberian Federal District)

The Priargunsky Mining and Chemical Combine was built in Chita Region (which has since become the Trans-Baikal Territory) in accordance with a February 1968 Resolution by the Soviet Council of Ministers. Uranium is mined underground at several sites of the Streltsovskiy uranium field. The ore produced here is processed at a hydrometallurgical plant, where it is turned into triuranium octoxide, also known as yellowcake. The first tonne of uranium ore was mined there in 1970. Production peaked at 5,400 tonnes in 1985, when the facility was one of the largest in the world. The company has produced about 140,000 tonnes of uranium since its launch.[39]

[36] Pushchayev Yuriy. Kazakhstan's Uranium Pulse. *Strana Rosatom*. 2011, March. P. 11; Ryabov L.D. Nuclear Weapons Cuts and Their Effects on the Russian Nuclear Weapons Industry. Lectures of the Course "Nuclear Nonproliferation Regime, WMD Reductions and National Security", Center for Arms Control, Energy and Environmental Studies, Moscow Institute of Physics and Technology (MFTI), 2003. Slide 2. http://www.armscontrol.ru/course/lectures03b/ldr031126.ppt (Retrieved on June 10, 2014).

[37] Cherkasenko Andrey. Investing in Uranium. Moscow: Alpina Publisher, 2013. P. 72.

[38] Zhivov V.L., Boytsov A.V., Shumilin M.V. Uranium: Geology, Production, Economics. Moscow: RIS VIMS, 2012. P. 265.

[39] Priargunskoye Mining and Chemical Company. Slide 5. http://www.priargunsky.armz.ru/media/File/priargunsky/investoram/ppgho.pdf (Retrieved on June 1, 2014).

In 1993 the Russian government stopped buying the company's produce. As a result, Priargunsky was forced to look for foreign customers. Its uranium production fell by more than 50 per cent, and operations at most of its mines were halted. Up until 1998, the company exported up to 95 per cent of its output. In 1999 it resumed uranium supplies to domestic nuclear industry.[40].

In fact, annual production at Priargunsky began to fall off in 1990, even before government contracts had dried up, due to the depletion of reserves.[41] The ore grade in the remaining deposits has dropped from 0.25 per cent when mining began to 0.16 per cent, i.e. by more than a third. The remaining reserves at the Streltsovskiy uranium field were estimated at about 130,000 tonnes in 2009. Most of the richest ores have already been mined. Some of the remaining ore is technically or economically unrecoverable[42]. Production stood at 2,133 tonnes in 2013[43]. Launched almost 45 years ago, Priargunsky is currently the world's oldest operational uranium mining facility. All of its uranium output is supplied to domestic Russian customers. Priargunsky's share of Russian production of natural uranium has fallen from 94 per cent in 2005 to 68 per cent in 2013 (it was 97% in the year of 1997).[44]

The company's economic and financial indicators also began to deteriorate because of declining of ore grade in the remaining deposits, high production costs, and various systemic problems. As of early 2014, the cost of uranium mined by Priargunsky was the highest among all the world's major uranium production companies. In the 2012 financial year it reported losses of about 20 mn USD. In the period from 2011 to 2013 the company's losses rose fivefold from 688m roubles to 3.4 bn (about 100m USD).[45]

[40] Report by the Department for the Use of Mineral Resources in the Trans-Baikal Territory, Federal Agency for the Use of Mineral Resources. P. 33. https://www.google.ru/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CBsQFjAA&url=http%3A%2F%2Fgeo.chita.ru%2Fdocuments%2Fdownload%2F4&ei=Fw7VU-bEKsbnywOoj4GoDw&usg=AFQjCNGlKH2vFXfJsat_tm2NdTPKHUOaTA (Retrieved on July 26, 2014).

[41] Kurtov Adzhar. Russia's uranium problem. *Promyshlennye Vedomosti*. 2009, No 3-4. http://www.promved.ru/articles/article.phtml?id=1651&nomer=58 (Retrieved on June 1, 2014).

[42] Shumilin M.V. Problems of the Development of Uranium Production in Russia and of Ensuring the Balance of Real Supply and Demand. Russia's Mineral Resources. *Ekonomika i Upravleniye*. 2006, №5. http://www.vipstd.ru/gim/content/view/93/148/ (Retrieved on June 9, 2014).

[43] PPGKhO Increases Uranium Production to 2,133 tonnes in 2013. *Nuclear.ru*. 2013, December 20. http://nuclear.ru/news/89605/ (Retrieved on June 1, 2014).

[44] Developments in Uranium Resources, Production, Demand and the Environment. Proceedings of a Technical Committee Meeting. 2005, January. P. 2. http://www-pub.iaea.org/MTCD/publications/PDF/te_1425_web.pdf (Retrieved on June 1, 2014).

[45] PPGKhO Losses Rise Fivefold to 3.4bn Roubles in Three Years. *Chita.Ru*. http://news.chita.ru/59750/ (Retrieved on June 27, 2014).

Despite such woeful figures, Priargunsky is expected to continue operating. The decision not to shut it down is based mainly on social and national energy security considerations. It is the only major employer in the town of Krasnokamensk. Together with its subsidiaries it provides jobs to about 10,000 people, out of the town's population of about 55,000.[46] Besides, if Priargunsky were to be shut down, the current output of Russia's remaining two uranium mining facilities would cover less than 5 per cent of Russia's nuclear industry demand, and less than 20 per cent of the demand generated by the Russian nuclear power plants.

Rosatom is taking a whole set of measures to support Priargunsky. It pays the company 120 USD for every kilo of uranium it produces, well above the current world price of about 80 USD.[47] Priargunsky receives 6bn roubles (~175 million USD) in annual subsidies from Rosatom.[48] A total of 12bn roubles (350m USD) in loans has been made available to it.[49] As part of its efforts to end the crisis, the company has developed a medium-term program that aims to improve efficiency and stabilize annual uranium production at 2,000 tonnes.[50] The goal is to break even in 2016 thanks to cost-cutting measures.

The two other Russian uranium production centers are Dalur and Khiagda.

Dalur (Kurgan Region, Urals Federal District)

Dalur produces uranium using the in-situ leaching technology. Uranium reserves at its Dalmatovskoye deposit are estimated at only about 11,400 tonnes; the ore grade is 0,03%[51]. Situated in Kurgan Region, the deposit was discovered in 1979. Small-scale experimental production at the site began in 1984, reaching an annual

[46] Ruling No 27 by the Krasnokamensk Town Hall, April 26, 2012. http://xn----7sbbuvccofffvoi.xn--p1ai/gosserv/ofitsialnoe_opublikovanie/akty_soveta.php?ELEMENT_ID=2020 (Retrieved on June 27, 2014).

[47] Zhiltukhin Yuriy. A Hard Day for Informing. *Slava trudu*. (Krasnokamensk, Chita Region). 2014, 2 May. http://www.slava-trudu.ru/files/archive/48-49%202%20may.pdf (Retrieved on June 27, 2014).

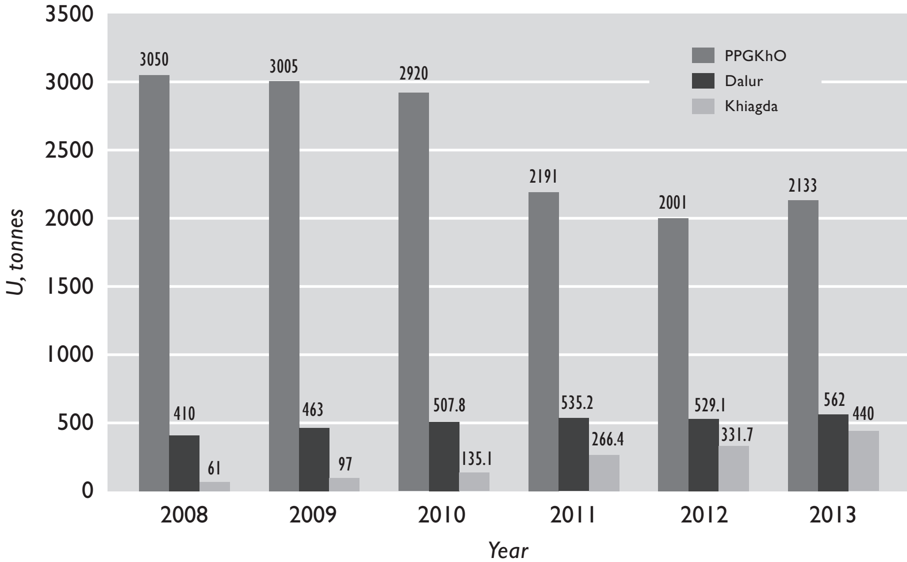
[48] Implementation of the PPGKhO Program to Achieve a Break-even Point and Diversity Production Was Discussed during a Working Trip to Krasnokamensk by ARMZ CEO Vladimir Verkhovtsev. 2014, April 24. http://armz.ru/press/news/?id=518&p=1 (Retrieved on June 1, 2014).

[49] Sergey Shurygin: "We Do No Aim for Lower Numbers". *Gornyak Priargunya*. 2014, April 14. P. 2. http://www.priargunsky.armz.ru/media/gornyak/156/gornyak_801s.pdf (Retrieved on June 27, 2014).

[50] ARMZ 2012 Annual Report. http://www.armz.ru/media/File/facts/2013/armz_annual_report_20120608_encr.pdf (Retrieved on June 1, 2014).

[51] Alexander Boytsov, Uranium Mining Capabilities in the Russian Federation, International Symposium on Uranium Raw Material for the Nuclear Fuel Cycle, 24 June 2009, Vienna, Austria. Slide 8. http://www-pub.iaea.org/mtcd/meetings/PDFplus/2009/cn175/URAM2009/Session%201/7_79_%20Boytsov%20_Russia.pdf (Retrieved on June 1, 2014).

Figure 2. Uranium production in Russia



Sources: ARMZ 2012 Annual Report. http://www.armz.ru/media/File/facts/2013/armz_annual_report_20120608_encr.pdf (Retrieved on June 1, 2014); ARMZ 2011 Annual Report http://www.armz.ru/media/File/facts/2012/ARMZ_ar2011-full1508-enc.pdf (Retrieved on June 1, 2014); ARMZ 2010 Annual Report http://www.armz.ru/media/File/facts/2011/investors/annual_report_2010_final.pdf (Retrieved on June 1, 2014); PPGKhO Achieves Main 2013 Production Targets. http://www.priargunsky.armz.ru/about/news/?id=251 (Retrieved on June 1, 2014); Khiagda Reports Improved 2013 Figures. http://www.armz.ru/press/news/?id=480&p=1 (Retrieved on June 1, 2014); Dalur Reports Improved Production figures. *Region 45*. http://oblast45.ru/publication/3535 (Retrieved on June 1, 2014).

Table 10. Existing uranium production centers in Russia

	*RAR+Inferred reserves, tU**	*Ore-grade, %*	*2013 U production, tU*	*Mining technology*
Dalur	11,379	0.03	562	In situ leaching
Khiagda	27,356	0.04	440	In situ leaching
Priargunsky	132,823	0.16	2,133	Underground

*RAR= Reasonably Assured Resources.

Sources: Alexander Boytsov, Uranium Mining Capabilities in the Russian Federation, International Symposium on Uranium Raw Material for the Nuclear Fuel Cycle, 24 June 2009, Vienna, Austria. Slide 8. http://www-pub.iaea.org/mtcd/meetings/PDFplus/2009/cn175/URAM2009/Session%201/7_79_%20Boytsov%20_Russia.pdf (Retrieved on June 1, 2014); PPGKhO Increases Uranium Production to 2,133 tonnes in 2013. *Nuclear.ru*. 2013, December 20. http://nuclear.ru/news/89605/ (Retrieved on June 1, 2014).

output of 45 tonnes.[52] The project was halted in 1995 due to lack of financing, and resumed after 1997. The first batch of uranium produced after the facility was reactivated was about 40 tonnes.[53] Production reached 562 tonnes in 2013. It is expected to reach 1,000 tonnes at some point, but that figure can be sustained for only a very short period. Average annual production in the period to 2020 will be in the region of 500-700 tonnes.

Khiagda (Trans-Baikal Territory, Siberian Federal District)
Khiagda also relies on the in-situ leaching technology. Individual deposits that constitute the Khiagda uranium field were discovered in 1980-1987, but production began only in 1999. The Khiagda company was registered that same year; previously the facility was a division of the Trans-Baikal Ore Enrichment Combine, and then of the TVEL fuel company.

The uranium deposits mined by Khiagda are part of the Vitimskiy uranium field. The uranium reserves held by that field are fairly large (about 27,500 tonnes), but they are spread out over a large number of individual deposits. The ore grade is 0,04%[54]. On the plus side, ore lies at the depth of only 150-200 meters, and it has a higher uranium ore grade than the deposits at the Dalmatovskoye site. The location and terrain, however, are much more difficult. Most of the area is covered by dense forests. Some of it is impassable wetlands. The climate is very harsh, with extremely cold and long winters, and the presence of permafrost. The distance to the nearest railway station (Chita) is more than 300 km. Production at Khiagda stood at 440 tonnes in 2013. The figure is expected to rise to 1,000-1,500 tonnes at some point[55].

All the Russian producers of natural uranium are part of the ARMZ holding, which is a subsidiary of the Rosatom state nuclear energy corporation. As of December 31, 2013, ARMZ controls a 89.85-per-cent stake in PPGKhO. It also owns 98.89 per cent of Dalur, and 100 per cent of Khiagda[56]. The holding plans

[52] History of Dalur. http://www.dalur.armz.ru/about/history/ (Retrieved on June 1, 2014).

[53] Dalur Finance. A 520m-rouble Bond Issue. Russian Funds Information Memo. http://data.cbonds.info/emissions/8526/Dalur_memo_L.pdf (Retrieved on June 1, 2014).

[54] Alexander Boytsov, Uranium Mining Capabilities in the Russian Federation, International Symposium on Uranium Raw Material for the Nuclear Fuel Cycle, 24 June 2009, Vienna, Austria. Slide 8.

[55] Shumilin M.V. Problems of the Development of Uranium Production in Russia and of Ensuring the Balance of Real Supply and Demand. Russia's Mineral Resources. *Ekonomika i Upravleniye*. 2006, №5. http://www.vipstd.ru/gim/content/view/93/148/ (Retrieved on June 9, 2014).

[56] ARMZ 2013 Annual Report. Moscow, 2014. P. 16. http://www.armz.ru/media/File/facts/2014/annual_report_2013%20-%20sec.pdf (Retrieved in June 1, 2014).

Figure 3. Russia's uranium mining and conversion facilities map*

* PIMCU=PPGKhO=*Priargunsky;* OMCC=*Orlovskoe*
Source: ARMZ 2010 Annual Report. Moscow, 2011. P. 19.
http://www.rosatom.ru/en/resources/6ba2bc00496b412a9684ff0103932185/armz_annual_report_2010_eng.pdf (Retrieved on July 25, 2014).

to launch the development of several new uranium mining projects, including Lunnoye and Elkon (the Republic of Sakha, Yakutia), Berezovoye-Gornoye, and Orlovskoye (both in the Trans-Baikal Territory). The Lunnoye company (Republic of Sakha) began mining operations in 2012. The largest of the new uranium deposits is Elkon, which holds an estimated 320,000 tonnes of uranium with an average ore grade of 0.15 per cent[57]. The new projects are still looking for investors, conducting geological exploration works, and obtaining various licenses. The main obstacles they are facing include the lack of financing and the difficult location of the uranium fields in remote and inaccessible mountainous terrain.

As of 2012, Russia ranked the world's sixth-largest producer of natural uranium. *For more details, see Table 11.*

Table 11. Leading uranium producers in 2012

Country	*Uranium production*	*Share of global production*
Kazakhstan	20,900 t	36%
Canada	8,956 t	15%
Australia	7,305 t	12%
Niger	4,571 t	7%
Namibia	4,245 t	7%
Russia	*2,862 t*	4%
Uzbekistan	2,300 t	4%
USA	1,596 t	2%
Malawi	1,100 t	1%
Others	3,465 t	6%
Total	*57,300 t*	*100%*

Source: ARMZ 2012 Annual Report. http://www.armz.ru/media/File/facts/2013/armz_annual_report_20120608_encr.pdf (Retrieved on June 1, 2014).

57 Alexander Boytsov, Uranium Mining Capabilities in the Russian Federation, International Symposium on Uranium Raw Material for the Nuclear Fuel Cycle, 24 June 2009, Vienna, Austria. Slide 9. http://www-pub.iaea.org/mtcd/meetings/PDFplus/2009/cn175/URAM2009/Session%201/7_79_%20Boytsov%20_Russia.pdf (Retrieved on June 1, 2014).

The draft Russian Energy Strategy to 2035 outlines the following priorities in natural uranium production:

- Developing uranium deposits in Russia itself;
- Increasing production at foreign joint ventures;
- Exploration and development of new uranium deposits in the most promising parts of the world.[58]

The facts and figures cited above suggest that in the medium term, domestic Russian production of uranium will reach 5,000 tonnes at the very most. In 2014 ARMZ plans to produce 2,963 tonnes of uranium.[59]

In view of the existing market situation (low uranium prices and the high cost of domestic Russian production), over the past few years Rosatom has been pursuing projects in other countries, focusing on uranium fields with low production costs as it tries to increase its uranium reserves and annual production. Rosatom regards Kazakhstan as its most important partner for such projects.

2.2 Uranium production at Russian-owned facilities abroad

The first foreign country where Russia launched a uranium mining project was Kazakhstan. In 2001 Russia, Kazakhstan, and Kyrgyzstan set up a joint venture to develop the Zarechoye uranium deposit.[60] In 2009 ARMZ acquired 100 per cent of the shares in the Effective Energy N.V. company (registered in the Netherlands), which owned uranium mining assets in Kazakhstan (Karatau and Akbastau Uranium Mines), and a 19.9-per-cent stake in Canada's Uranium One Inc. By 2012 ARMZ had increased its stake in Uranium One Inc., which developing mines in Australia, Kazakhstan, and United States, to 51.4 per cent. In late 2013 it bought the remaining ordinary shares in the Canadian company.[61] In 2011 ARMZ also acquired a 100-per-cent stake in Australia's Mantra Re-

[58] Draft Russian Energy Strategy to 2035. Russian Energy Ministry. Moscow, 2014. P. 159. http://minenergo.gov.ru/upload/iblock/665/665a6512e64ffd5e3d30d9448d7b7fff.pdf (Retrieved on June 10, 2014).

[59] ARMZ 2013 Annual Report. Moscow, 2014. P. 63-65. http://www.armz.ru/media/File/facts/2014/annual_report_2013%20-%20sec.pdf (Retrieved in June 1, 2014).

[60] ARMZ 2006 Annual Report. P. 6. http://www.annual-report.ru/catalog/2006/armz2006.pdf (Retrieved on February 13, 2014).

[61] ARMZ Consolidation of 100 per cent Stake in Uranium One Inc. Receives the Approval of the High Court of Ontario Province, Canada, and of the Russian, U.S., and Australian Regulators. 2013, March 27. http://www.armz.ru/press/news/?id=412&p=1; The Deal to Consolidate 100 per cent of Uranium One Inc. Shares Has Been Closed. 2013, October 19. ARMZ Uranium Holding. http://www.armz.ru/press/news/?id=444&p=1 (Retrieved on February 11, 2014).

sources Limited, which is developing uranium mining Mkuju River project in Tanzania.

As part of the restructuring of Rosatom assets in 2013, the corporation decided to put its Russian and foreign uranium mining assets under separate management. Starting from December 2013, ARMZ controls only domestic uranium mining assets. To manage its foreign assets, Rosatom has set up Uranium One Holding N.V. (U1H), a Dutch-registered company. To ensure effective coordination between ARMZ and U1H, the two companies have formed a joint venture called United Uranium Companies, which has been operating as a "one stop shop" for customers of Rosatom's mining division since 2014.

Today Rosatom state nuclear energy corporation through its subsidiaries ARMZ and U1H, controls uranium assets in Australia, Kazakhstan, Russia, and the United States. Uranium production at all of foreign mines uses the in-situ leaching technology.

U1H owns and manages a 100% stake in Uranium One Inc., which has interest in five uranium mining joint ventures in Kazakhstan, including:[62]

- Betpak Dala: the Akdala and South Inkai Uranium Mines (Uranium One holds 70 per cent interest in the joint venture);
- Karatau: the Karatau Uanium Mine (50 per cent interest);
- Akbastau: the Akbastau Uranium Mine (50 per cent);
- Zarechnoye: the Zarezhnoye Uranium Mine (49.67 per cent);
- Kyzylkum: the Kharasan Uranium Mine (30 per cent).

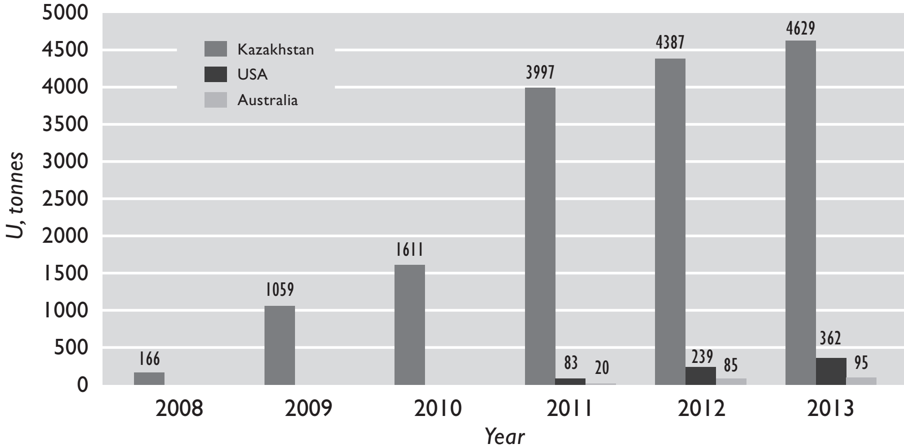
Uranium production in Kazakhstan has been growing steadily in recent years thanks to new geological exploration projects, increased production at the existing sites, and the licensing of new deposits. Uranium is exported from Kazakhstan in the form of triuranium octoxide better known as yellowcake. *See Figure 4 for more details.*

Uranium One owns the Willow Creek mine in the United States and owns 100 per cent interest in the Honeymoon Uranium Project in Australia.[63] For economic rea-

[62] ARMZ 2012 Annual Report. http://www.armz.ru/media/File/facts/2013/armz_annual_report_20120608_encr.pdf (Retrieved on February 11, 2014).

[63] Production and Processing. http://www.uranium1.com/index.php/ru/mining-operations-ru (Retrieved on February 7, 2014).

Figure 4. Uranium production by Rosatom-owned companies abroad



Sources: ARMZ 2012 Annual Report. http://www.armz.ru/media/File/facts/2013/armz_annual_report_20120608_encr.pdf (Retrieved on February 11, 2014); ARMZ 2011 Annual Report. http://www.armz.ru/media/File/facts/2012/ARMZ_ar2011-full1508-enc.pdf (Retrieved on February 11, 2014); ARMZ 2010 Annual Report http://www.armz.ru/media/File/facts/2011/investors/annual_report_2010_final.pdf. (Retrieved on February 11, 2014); ARMZ 2013 Annual Report. Moscow, 2014. P. 65-66. http://www.armz.ru/media/File/facts/2014/annual_report_2013%20-%20sec.pdf (Retrieved in June 1, 2014).

sons, the uranium produced in Australia and the United States (which made up about 9 per cent of production at Russian-owned uranium mines abroad in 2013) is sold in the American and Asian markets rather than being imported into Russia.[64] In 2013 the company obtained an uranium production license for the Mkuju River project in Tanzania.[65] The foreign uranium production assets owned by Rosatom have some the lowest production costs in the world. All uranium is produced via in-situ leaching (ISL) method. The 2013 average production cost was 42 USD/kgU.[66]

The target set in the Russian Energy Strategy to 2030 is for annual uranium production at Russian-owned facilities in Russia itself and abroad to reach 17,000

[64] ARMZ 2011 Annual Report. P. 32. http://www.armz.ru/media/File/facts/2012/ARMZ_ar2011-full1508-enc.pdf (Retrieved on June 9, 2014);

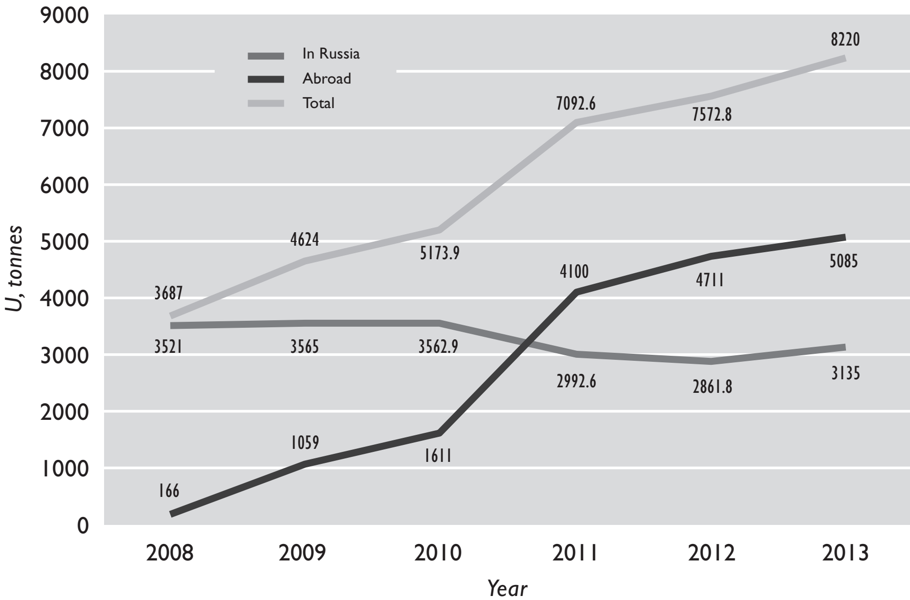
[65] Tanzanian Energy and Mineral Resources Ministry Issues Uranium Production License for the Mkuju River Mine. 2013, April 8. http://www.rosatom.ru/journalist/main/246ac3804f2ef982a4deffe78e7a3442 (Retrieved on February 11, 2014).

[66] Boytsov A., Stander S., Martynenko V.. The Outlook on Potential Uranium ISL Mining at Nyota Deposit (Tanzania). Slide 3. The International Symposium on Uranium Raw Material for the Nuclear Fuel Cycle: Exploration, Mining, Production, Supply and Demand, Economics and Environmental Issues (URAM-2014), IAEA, Vienna, Austria.

tonnes by 2020-2022.[67] The draft of the new Energy Strategy, which is still being discussed, does not contain any targets at the moment.

In 2013 overall uranium production by Rosatom-owned companies reached 8,220 tonnes, more than doubling over a five-year period. A particularly rapid growth spurt was reported in 2011, when production rose by 37 per cent on the previous year[68]. That growth was generated by the acquisition of Canadian and Australian assets by ARMZ, as well as the results of geological exploration projects the company had completed at new uranium deposits in Kazakhstan. The bulk of the growth in production is generated by the company's foreign assets, although it is investing in domestic production as well. The ARMZ investment program is worth about 4bn USD.[69]

Figure 5. Uranium production by Rosatom-owned companies in Russia and abroad



[67] Russian Energy Strategy to 2030. Approved by Resolution No 1715-r of the Russian Cabinet of Ministers on November 13, 2009. P. 70.

[68] ARMZ 2013 Annual Report. Moscow, 2014. P. 7. http://www.armz.ru/media/File/facts/2014/annual_report_2013%20-%20sec.pdf (Retrieved in June 1, 2014).

[69] Investing in Uranium Production. ARMZ Uranium Holding. http://www.2010.atomexpo.ru/mediafiles/u/files/Present/9.4_ZHilkin_Atomredmetzoloto_kruglyy_stol_09062010_Atomekspo_2010.pdf (Retrieved on February 11, 2014).

To summarize, Rosatom currently owns several uranium mining assets in Russia, including the Priargunsky mine, which has some of the highest production costs in the world. It also controls various foreign assets, including uranium production centers in Kazakhstan that have some of the lowest uranium production costs in the world.

However, due to the unfavorable market situation, in 2013 Rosatom froze investment into new uranium mining projects in Russia and abroad, and decided to mothball several ongoing projects. The facilities that are already producing uranium will remain operational, but the company has no current plans of building new ones because of the low uranium prices. In particular, Rosatom has decided to push back the deadlines for Elkon, Russia's largest new uranium project. The Priargunsky facility has abandoned plans to develop a new mine (the No 6), and will shut down one of the operational mines (No 2). The Honeymoon project in Australia will be mothballed; there will be no increase in production at Willow Creek in the United States; and further "optimizations" will be implemented at the Mkuju River project in Tanzania, which is planned to be the first in-situ leaching mine in Africa.[70]

Primary uranium production currently supplies 85 per cent of the global demand generated by nuclear power reactors.[71] Existing uranium stockpiles and reprocessed uranium account for the remaining 15 per cent.

2.3 Secondary sources of uranium

When demand outstrips the output of uranium mines, the shortfall can be covered from secondary sources. These include the existing stockpiles of natural uranium, LEU, and HEU, uranium tails (depleted uranium), and reprocessed uranium (RepU).

Russia has accumulated a national uranium reserve, a strategic stockpile that ensures a stable supply of uranium for national energy needs. According to the existing estimates, the Soviet Union's uranium stockpiles stood at 200,000 tonnes

[70] Fomicheva Anastasiya, Dzaguto Vladimir. Rosatom Buckles under Strain of Low Prices. *Kommersant*. 2013, 14 November; Boytsov A., Stander S., Martynenko V.. The Outlook on Potential Uranium ISL Mining at Nyota Deposit (Tanzania). Slide 18. The International Symposium on Uranium Raw Material for the Nuclear Fuel Cycle: Exploration, Mining, Production, Supply and Demand, Economics and Environmental Issues (URAM-2014), IAEA, Vienna, Austria.

[71] Cherkasenko Andrey. Investing in Uranium. Moscow: Alpina Publisher, 2013. P. 80.

in 1991.[72] During the deep economic crisis in the 1990s Russia sold off much of that stockpile to help keep its nuclear industry afloat. In 1990 alone it sold 10,500 tonnes of uranium from that stockpile.[73] According to the information available, by 2010 Russian uranium reserves had dwindled to 47,000 tonnes, and were expected to run out completely in another 10-15 years' time.[74] Russia has now stopped selling uranium from its national reserve to foreign customers, but uses 3,000 tonnes of uranium from that reserve every year domestically.[75] Some estimates suggest that by 2020 Russia's national uranium stockpile will shrink to a bare minimum held in reserve for emergency situations, and routine supplies of uranium from that stockpile to the market will end completely.[76]

Uranium tails are a byproduct of isotopic enrichment of natural uranium. That byproduct (also known as depleted uranium) has a reduced U-235 concentration, but it can be re-enriched. Such a process would require a greater input of separative work units (SWUs), and the resulting enriched material would be more expensive compared to enriching natural uranium. Nevertheless, re-enrichment of depleted uranium could become more economical if the natural uranium prices start to grow. Uranium enrichment spare capacity is used in Russia to process the accumulated stocks of depleted uranium hexafluoride. Up until 2013 Russia used about 5.5m SWU every year to produce blendstock as part of the HEU-LEU Program.[77]

Reprocessed uranium (RepU) is produced from spent nuclear fuel. The U-235 content in the RepU depends on the initial U-235 enrichment of the fuel before irradiation and to the extent of burnup. In the case of RepU derived from VVER it is up to 1.1 %, while U-235 presence in natural U is about 0.7%.[78]

RepU can be extracted from spent nuclear fuel and used to manufacture fresh fuel. The economic feasibility of the process depends on the market prices of natural uranium. Russia reprocesses spent fuel from its VVER-440 and BN-600 nuclear

72 Kruglov A.K. How the Soviet Nuclear Industry Was Built. Moscow: TsNIIatominform, 1995. P. 265.

73 Leskov S.L. Uranus in Mercury's Orbit. Moscow, 2013. P. 57.

74 Ibid. P. 89.

75 Zhivov V.L., Boytsov A.V., Shumilin M.V. Uranium: Geology, Production, Economics. Moscow: RIS VIMS, 2012. P. 274.

76 Ibid. P. 268.

77 Grigoryev Aleksey. Prospects for the Russian Enrichment Industry on the International Markets. *Nuclear Club*. 2010, № 5-6. P. 4.

78 Use of Reprocessed Uranium: Challenges and Options. IAEA Nuclear Energy Series. № NF-T-4.4. P. 8. http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1411_web.pdf (Retrieved on June 10, 2014).

reactors, naval propulsion reactors, and research reactors. The reprocessed uranium is used to produce fresh fuel for RBMK-type reactors (of which Russia has 11). According to an IAEA data, in 2006 Russia used about 500 tonnes of reprocessed uranium to produce nuclear fuel, whereas globally, reprocessed uranium made up only 2.3 per cent of the material that went into the production of reactor fuel.[79]

2.4 Customer-provided uranium

Under some types of contracts for nuclear fuel deliveries, the customer supplies natural uranium to the Russian contractor, which then enriches it and uses it to manufacture nuclear fuel for that customer. Depending on the form of the uranium supplied by the customer, a conversion at Russian facilities may also be required.

This mechanism is used in the fabrication of nuclear fuel for the Czech nuclear power plants. A similar mechanism is used in contracts with Ukraine.[80] In the latter case, Ukraine supplies natural uranium to Russia, which then gives Ukraine an equivalent discount on nuclear fuel supplies. Of the 2,400 tonnes of natural uranium required for the production of fuel for Ukrainian NPPs every year, 1,000 tonnes (42 per cent) is supplied by Ukraine itself.

The remaining 17 Soviet/Russian-designed nuclear power reactors operated in eight countries (including reactors of the Loviisa NPP in Finland) receive fully finished fuel assemblies from Russia. In other words, Russia's TVEL fuel company handles the entire production cycle, including the purchase of natural uranium.[81] All together, Russia's nuclear fuel customers supply about 1,800 tonnes (29 per cent) of the natural uranium required for the fabrication in Russia of nuclear fuel for Soviet/Russian-designed reactors in foreign countries.

No figures are available for the amount of natural uranium supplied to Techsnabexport by its foreign customers for the production of enriched uranium.

[79] Ibid. P. 47.

[80] Nuclear Power in Czech Republic. Updated April 10, 2014. http://www.world-nuclear.org/info/country-profiles/countries-a-f/czech-republic/ (Retrieved in June 1, 2014).

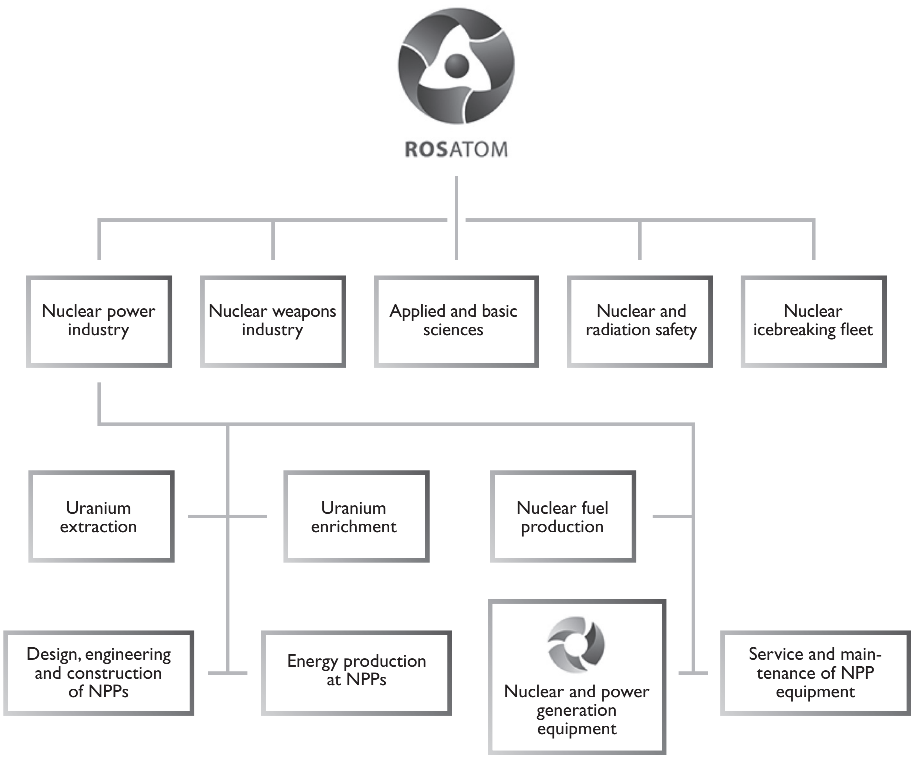
[81] Nuclear Power. 2013, 11 April. http://www.fortum.com/en/sustainability/environmental-responsibility/environmental-impacts-by-production-form/nuclear-power/pages/default.aspx (Retrieved in June 1, 2014).

3. Russia and Uranium Regulation

3.1 Russian nuclear industry governance structure and uranium conversion

All Russian nuclear industry assets are owned by the Rosatom state nuclear energy corporation. As of December 31, 2013, Rosatom included 364 subsidiary companies and organizations.[82] Its average annual payroll stood at 255,300 people in 2013. (When the Soviet Union broke up, there were about 1.1 million people employed in its nuclear industry).

Figure 6. Rosatom organizational structure



Source: Atomenergomash in the Technological Production Cycle of Rosatom. http://www.ar2011.aem-group.ru/en/company/role/ (Retrieved in June 1, 2014).

[82] Rosatom State Nuclear Energy Corporation 2013 Annual Report. Moscow, 2014. P. 7. http://www.rosatom.ru/resources/37117a004494c2369041b0e920d36ab1/rosatom_anrep_2013.pdf (Retrieved on June 27, 2014).

The Russian nuclear industry's uranium mining assets in the country itself and abroad are owned by the mining (uranium extraction) division of Rosatom, which include ARMZ and U1H companies. In 2013 Rosatom ranked the world's second in terms of uranium ore reserves, and third in terms of natural uranium production. Its mining division employs about 11,700 people.[83]

The Rosatom uranium conversion, enrichment and fuel fabrication facilities are part of the company's fuel division. The division includes the TVEL fuel company and Techsnabexport, which are the main consumers of natural uranium produced by the mining division. A more detailed look at the uranium conversion facilities is in order because, a) they are currently undergoing major restructuring, and b) they constitute the first stage in the nuclear fuel cycle to which IAEA safeguards are applied.

Uranium conversion in Russia

Natural uranium is used by TVEL to make nuclear fuel for Russia's own NPPs and nuclear power plants in foreign countries, as well as to fulfill Techsnabexport contracts for uranium enrichment services and deliveries of enriched uranium product. As part of that process, natural uranium undergoes a conversion to uranium hexafluoride (UF6) and is then delivered to uranium enrichment plants.

Up until recently Russia had three uranium conversion facilities in operation at the Siberian Chemical Combine (SKhK, Tomsk Region, Siberian Federal District), the Angarsk Electrolysis Chemical Combine (AEKhK, Irkutsk Region, Siberian Federal District), and the Chepetsk Mechanical Plant (ChMZ, the Republic of Udmurtia, Volga Federal District). The former two facilities produced uranium hexafluoride. The facility at ChMZ produced uranium tetrafluoride, which was then supplied to AEKhK, where it was converted to hexafluoride. The combined annual output capacity of the three facilities was 25,000 tonnes of uranium (tonnes U as UF6). According to various estimates, however, only 35-55 per cent of that capacity was actually in use. The equivalent figure for large uranium conversion facilities in other countries is in the range of 70-85 per cent.[84]

[83] ARMZ 2013 Annual Report. Moscow, 2014. P. 7. http://www.armz.ru/media/File/facts/2014/annual_report_2013%20-%20sec.pdf (Retrieved in June 1, 2014).

[84] Gulyayeva Alina. SKhK Launches a National-Scale Project. *Tomskiye Novosti*. 2012, February 3. http://tomsk-novosti.ru/shk-pristupil-k-realizatsii-proekta-rossijskogo-masshtaba/ (Retrieved on June 26, 2014); Conversion and Deconversion. Updated in April 2014. http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Conversion-Enrichment-and-Fabrication/Conversion-and-Deconversion/ (Retrieved on June 26, 2014); Konstantinov V.L. Plans and Outlook for the Modernization of Uranium Conversion at TVEL, Opportunities for Joint Ventures, Round Table: "International Cooperation in the Nuclear Fuel Cycle", Atomexpo-2013, June 27, 2013. http://2013.atomexpo.ru/mediafiles/u/files/2013/27_June/cooperation_in_the_nuclear_fuel_cycle/Konstantinov.ppt (Retrieved on June 26, 2014).

As part of its optimization and cost cutting program, Rosatom state nuclear energy corporation has decided to concentrate all its uranium hexafluoride production at a single facility. The new conversion facility will be set up at SKhK to replace the existing one, which was built about 50 years ago for the Soviet nuclear weapons program. SKhK was chosen to host the new facility among other reasons due to its easier logistics. The site offers advantages over ChMZ and AEKhK in terms of the convenience of transportation of raw materials (i.e. natural and RepU) and the uranium hexafluoride. The conversion facility at AEKhK was shut down on April 1, 2014. ChMZ will follow after the launch of the first stage of the new conversion facility at SKhK. Planning for decommissioning has already begun.[85]

An estimated 12bn roubles (more than 350 million USD) will be spent on building the new Rosatom uranium conversion plant.[86]

The average cost of uranium hexafluoride production in Russia at the moment is about 10 USD/kgU, which is in line with international figures. Uranium conversion prices continued to decline in the American and European markets in 2013. Spot prices fell from 10.5 USD/kgU to 8.5 USD/kgU in America and from 11 to 9 USD/kgU in Europe. Prices under long-term contracts also fell from 16.75 USD/kgU to 16 USD/kgU in America and from 17.25 to 17 USD/kgU in Europe[87]. The launch of the new facility at SKhK is expected to slash Russian costs by 50 per cent

Table 12. Russian uranium conversion capacity, tU/year

<table>
<tr><th>2013 (tonnes U as UF6)</th><th colspan="2">2018 (projection)</th></tr>
<tr><td rowspan="2">25,000</td><td rowspan="2">20,000</td><td>2,000
(from reprocessed uranium)</td></tr>
<tr><td>18,000
(from natural uranium)</td></tr>
</table>

[85] Chepetskiy Mechanical Plant Annual Report. P. 20. http://www.chmz.net/shareholder/project_2012.pdf (Retrieved on June 26, 2014).

[86] SKhK Uranium Conversion Project to be Submitted for State Vetting in August. *RIA Novosti*. 2013, June 28. http://ria.ru/tomsk/20130628/946284547.html (Retrieved on June 26, 2014).

[87] Draft 2013 Annual Report by Techsnabexport. P. 35. http://tenex.ru/wps/wcm/connect/tenex/site/resources/5377060043aee5cd8f44bf1ec6ec1853/TENEX_AnnualPublicReport_2013_draft_06.05.2014.pdf (Retrieved on June 10, 2014).

to 5 USD/kgU. The facility will employ 400 people, and the investment is expected to be recouped in eight years' time.[88]

The new conversion facility will use natural as well as RepU. Its projected output is 18,000 tU/year for natural uranium, and 2,000 tU/year for RepU.[89]

The original plan was to start building the new facility at SKhK in late 2013 and launch it in 2016. All these deadlines, however, have now been pushed two years back because of the unfavorable market situation following the Fukushima nuclear accident.[90] SKhK expects to obtain all the necessary licenses for the construction of the new conversion facility in 2015.[91]

3.2 Regulation of the use of nuclear materials

The core of Russian legislation that regulates the nuclear energy industry is Federal Law No 170-FZ of November 21, 1995 "On the use of nuclear energy".

Article 3 of the Law defines "nuclear materials" as "materials that contain fissionable nuclear substances, or can be used to produce such substances". In other words, Russian law uses a broader definition of "nuclear materials" than the one used, for example, in the Convention on the Physical Protection of Nuclear Material (CPPNM), inasmuch as it also covers such materials as natural uranium, depleted uranium, and thorium.

Chapter X of the law regulates management of nuclear materials, including their transportation. Chapter XI regulates physical protection of nuclear materials, and storage sites that hold nuclear materials. The principles governing Russian exports and imports of nuclear materials are outlined in Chapter XIV.

[88] Uranium Conversion at SKhK: a Reasonable Increase in Costs. 2013, June 28. http://atomicexpert.com/content/%D0%BA%D0%BE%D0%BD%D0%B2%D0%B5%D1%80%D1%81%D0%B8%D1%8F-%D0%BD%D0%B0-%D1%81%D1%85%D0%BA-%D1%80%D0%B0%D0%B7%D1%83%D0%BC%D0%BD%D0%BE%D0%B5-%D1%83%D0%B4%D0%BE%D1%80%D0%BE%D0%B6%D0%B0%D0%BD%D0%B8%D0%B5 (Retrieved on June 26, 2014).

[89] Deadlines for the SKhK Conversion Project Pushed Back. *RIA Novosti.* 2013, October 30. http://ria.ru/tomsk/20131030/973618332.html (Retrieved on June 26, 2014).

[90] Ibid.

[91] TVEL Studying the Potential of the Tomsk Industry. 2014, May 21. http://www.tvel.ru/wps/wcm/connect/tvel/tvelsite/presscentre/news/22da058044139570a46cae6e6a7b41cf (Retrieved on June 26, 2014).

In addition to the “Law on the use of nuclear energy”, Russia has several other pieces of legislation that regulate the use of nuclear materials, including:

- Cabinet of Ministers Resolution No 973 of December 15, 2000 “On exports and imports of nuclear materials, equipment, special non-nuclear materials, and related technologies”;
- “Rules for physical protection of nuclear materials, equipment, and nuclear materials storage facilities”, approved by the Russian Cabinet of Ministers’ Resolution No 456 of July 19, 2007;
- Cabinet of Ministers Resolution No 352 of May 6, 2008 “On approving the regulation on the state system of accounting for and control of nuclear materials”;[92]
- Federal norms and procedures regarding the use of nuclear energy outlined in the “Rules of nuclear material control and accounting”, approved by Resolution No 255 of the Federal Service for Environmental, Technological and Nuclear Supervision on April 17, 2012.

The key documents that regulate ownership rights to nuclear materials include:

- Federal Law No 12-FZ of February 5, 2007 “On the specifics of management of assets and shares in organizations involved in the use of nuclear energy, and on changes to individual legislative acts of the Russian Federation”;
- Cabinet of Ministers Resolution No 724 of October 31, 2007 “On the procedure and terms of signing contracts on the transfer of ownership rights to nuclear materials to a foreign state of foreign legal entity”;
- Federal Law No 317-FZ of December 1, 2007 “On the Rosatom state nuclear energy corporation”.

The most substantial changes to the 1995 nuclear energy law were made in Federal Law No 317-FZ of December 1, 2007 “On the Rosatom state nuclear energy corporation”.[93] Article 5 of the 1995 law stipulated that all nuclear materials are owned by the Russian state. Any use of state-owned nuclear materials was allowed only by legal entities that hold licenses or permits issued by government regulation bodies for operations involving the use of nuclear energy, based on contracts signed with an authorized government agency.

[92] Russian Cabinet of Ministers Resolution No 352 of May 6, 2008 “On Approving the Regulation on the System of State Accounting and Control of Nuclear Materials”. http://www.consultant.ru/document/cons_doc_LAW_110431/ (Retrieved on July 3, 2014).

[93] Russian Federal law No 317-FZ of December 1, 2007 “On the Rosatom State Nuclear Energy Corporation”. http://www.rg.ru/2007/12/05/rosatom-doc.html (Retrieved on July 1, 2014).

With the amendments made in 2007, the law "On the use of nuclear energy" contains the following provisions:

- nuclear materials can now be owned not only by the state but also by legal entities (i.e. companies);
- the list of nuclear materials that can only be owned by the state is approved by the President;
- the list of the Russian legal entities that are allowed to own nuclear materials is approved by the President;
- the law recognizes foreign states' or foreign legal entities' ownership of nuclear materials and the products of their processing that have been imported into the Russian Federation or bought from the Russian Federation;
- deals that involve transfers of the title to nuclear materials from Russian legal entities to a foreign state or legal entity require the vetting of an authorized Russian executive agency in accordance with a procedure approved by the Russian Cabinet of Ministers;
- nuclear materials owned by the Russian state, foreign states, Russian legal entities, or foreign legal entities can be managed by organizations that hold the relevant licenses for operations in the area of nuclear energy.

Under Article 7 of Federal Law No 317-FZ of December 1, 2007 "On the Rosatom state nuclear energy corporation", said corporation supervises nuclear materials management in the Russian Federation. Under the regulation on the supervision of nuclear materials management (approved by Rosatom corporate Resolution No 708 of October 9, 2009), supervision of nuclear materials includes:

- monitoring compliance with laws and technical regulations;
- making sure that nuclear materials are used in accordance with the stated purposes defined in the relevant documents, licenses, and contracts;
- monitoring all movements of nuclear materials;
- monitoring compliance with the procedures of writing off nuclear material losses;
- holding inspections to ascertain the presence of nuclear materials and the accuracy of accounting and reporting documents submitted to the state system of nuclear materials accounting for and control.

The list of nuclear materials that can only be owned by the state includes, among other items, uranium enriched to 20 per cent or more of U-235 content. In accordance with the same document, nuclear materials held in state reserve are also owned by the Russian state.

Legal entities are allowed to own nuclear materials acquired in accordance with the approved procedure and not on the list of materials that can only be owned by the state. The definition of the term "acquire" includes:

- production at uranium mines;
- purchase from other legal entities, including foreign ones (import);
- transfer of ownership from the Russian state, include purchase of such materials from a federal state unitary company (FGUP) with Rosatom's consent, or purchase of material from the state reserve in accordance with established procedure;
- formation of waste/tails stockpiles as a result of processing/enrichment of nuclear materials, including materials imported from other countries

Any nuclear materials in Russia should be the subject of the State MC&A activities provided by the State System of Accounting for and Control of nuclear materials (SSAC):

- to define the nuclear materials inventory in the places where it exist;
- to prevent nuclear materials losses, unauthorized use and theft,
- to provide information on nuclear materials inventory and transfers, export and import for the State authorities.

In accordance with the "Rules of nuclear material control and accounting" approved by the Russian nuclear regulator, the Federal Service for Environmental, Technological, and Nuclear Supervision (Rostekhnadzor) on April 17, 2012, organizations must use compulsory accounting and control procedures for any amounts of natural or depleted uranium that are equal to or exceed 500 kg. The minimum amount of enriched uranium (in U-235 equivalent) that is subject to compulsory accounting and control procedures is 15 g. [94]

The owners of nuclear materials and facilities are responsible for the control of its containment and appropriate use in compliance with federal laws and other Russian Federation regulatory documents. The key document organizations must comply with is the aforementioned "Rules".

In May 2009 the government launched the Information System for the Supervision of Nuclear Material Accounting and Control. The system automates various licens-

[94] Resolution by Rostekhnadzor of April 17, 2012, No 255, "On Approving the Federal Norms and Regulations in the Area of Use of Nuclear Energy, Entitled 'Rules of Nuclear Material Control and Accounting". http://www.seogan.ru/np-030-12-osnovnie-pravila-ucheta-i-kontrolya-yadernix-materialov.html (Retrieved on July 25, 2014).

ing procedures stipulated in the 1995 Federal Law "On the use of nuclear energy", including the input, collection, storage, processing, and access to information required by Rostekhnadzor officers to fulfill their remit in the area of regulation and supervision of nuclear material accounting, control, and physical protection. The system has a common interface and strong information security features.[95]

Russia is a member of all international conventions in the area of nuclear security. The stipulations outlined in these conventions have been integrated into Russian legislation. Russia signed the CPPNM on May 22, 1980, and completed the ratification procedures on May 25, 1983. Russian experts were heavily involved in drawing up the Amendment to the Convention agreed at the diplomatic conference in Vienna on July 8, 2005. The amendment greatly enhances the scope of the Convention. The physical protection regime now applies not only to international transportation of nuclear materials but also to operations within individual states, as well as to the facilities at which such materials are produced, processed, used, or disposed of. Some of the stipulations of the Amendment were integrated into Russian legislation, including the Russian Penal Code, even before the Amendment itself was agreed in Vienna.[96].

Because the Amendment to CPPNM pertained to matters of international peace and security, its enactment required the adoption of a federal law in accordance with Subparagraph A, Paragraph 1, Article 20 of the Federal Law "On International Treaties Signed by the Russian Federation". On July 22, 2008, Russia adopted Federal Law No 130-FZ "On the Adoption of the Amendment to the Convention on the Physical Protection of Nuclear Material". On July 30, 2008 it completed the ratification of the Amendment.

As part of international efforts to strengthen the international nuclear security regime, Russia initiated the adoption of the International Convention for the Suppression of Acts of Nuclear Terrorism (ICSANT). The convention entered into force on July 7, 2007. Russia was one of the first countries to ratify the convention in October 2006.

[95] Information System for the Supervision of Nuclear Material Accounting and Control. http://arch.gosnadzor.ru/osnovnaya_deyatelnost_slujby/informatizatsiya-sluzhbi/sushchestvuyushchie-informatsionnie-sistemi/informatsionnaya-sistema-nadzora-za-uchetom-i-kontrolem-yadernih-materialov/ (Retrieved on July 25, 2014).

[96] On the Amended Convention on the Physical Protection of Nuclear Material. 2005, July 25. http://www.mid.ru/bdomp/ns-dvbr.nsf/10aa6ac6e80702fc432569ea003612f0/432569d800226387c325703700450bf1!OpenDocument (Retrieved on July 25, 2014).

3.3 Nuclear materials transportation regulations

Providing security for the transportation of nuclear materials in Russia is a complex challenge because of the large amount of materials being transported and the large distances they must travel. In 2012 Rosatom completed 1,586 operations by railway transport alone.[97] Six or seven trains carrying nuclear or radioactive materials are heading for their destinations every single day.[98] Rosatom reports that very strict security measures are used for the transportation of nuclear materials because these operations are the most vulnerable phase of the entire nuclear energy generation process.[99]

To reduce the risk of unauthorized manipulations with nuclear materials during their transportation, Rosatom has developed an Automated Transportation Security System (ATSS)[100], which went operational in 2007. The system consists of a network of control stations; physical protection, communication, and vehicle positioning systems; and specially trained personnel. Its functionality includes real-time monitoring of the location of the vehicles carrying nuclear materials; monitoring of the state of the physical protection systems used during the transportation; and information exchange between the vehicles and control stations operated by Rosatom. These systems were designed to remain fully operational in emergency situations.

The ATSS meets the requirements for continuous monitoring of transportation operations involving nuclear and radioactive materials set out in the "Key elements of national policy on nuclear and radiation safety and security of the Russian Federation to 2025" (Document Pr-539, approved by the Russian President on March 1, 2012) and the federal law "On the Rosatom state nuclear energy corporation" (No 317-FZ of December 1, 2007). As of January 1, 2013, 122 railway carriages and 56 special trucks were fitted with ATSS equipment. According to the information at

[97] Rosatom Nuclear Safety and Security Report. Moscow: Komtekhprint publishing, 2013. P. 19. http://www.rosatom.ru/resources/9da4828040d05a848066f66048932ed2/report_safety_2013.pdf (Retrieved on June 26, 2014).

[98] Sorokin A.I., Stovbur A.V., Yarmiychuk A.V. System of Emergency Response during Transportation. 2012, March 12. http://www.atomic-energy.ru/articles/2012/03/12/31740 (Retrieved on June 26, 2014).

[99] Rosatom: Protecting Nuclear Materials during Transportation is a Priority. *RIA Novosti*. 2009, October 28. http://ria.ru/business/20091028/190980994.html#ixzz36Ccx0Fnt (Retrieved on June 1, 2014).

[100] Automated Security System for the Transportation of Nuclear Materials. http://www.eleron.ru/50-years/ssi/articles/01-asbt (Retrieved on June 1, 2014).

our disposal, however, natural uranium transportation operations are not subject to ATSS monitoring[101].

Comprehensive measures to protect nuclear facilities and materials, including security during transportation operations, are implemented by Rosatom in close cooperation with the Russian Interior Ministry and the Federal Security Service (FSB), as well as several other government agencies. The rules outlining measures for physical protection of nuclear materials, equipment, and storage facilities were approved by the Russian Cabinet of Ministers' Resolution No 456 of July 19, 2007. The resolution is the key document that regulates nuclear transportation operations in Russia, including the transportation of natural uranium.[102] Another important document that regulates safe and secure transportation of nuclear materials is the "Safety and Security Procedures During the Transportation of Radioactive Materials" (NP-053-04). The document was drawn up on the basis of IAEA recommendations and guidelines for the transportation of hazardous cargos issued by international organizations (the International Maritime Organization and the International Civil Aviation Organization). Relevant procedures were approved by a resolution of the Federal Service for Environmental, Technological, and Nuclear Supervision of October 4, 2004.[103]

Articles 52-78 in Section IV of the Rules for Physical Protection of Nuclear Materials, Equipment, and Nuclear Materials Storage Facilities outline key requirements to the physical protection measures for nuclear materials and equipment during transportation, and set out the procedures for cooperation between the various ministries and agencies, as well as outlining the scope of their remit.

The Rules stipulate that, as part of the national system of physical protection, federal government bodies and Rosatom organize, within the scope of their remit and in cooperation with all relevant federal government agencies, the transportation of nuclear materials and equipment, and provide physical protection during these operations.

[101] Rosatom Nuclear Safety and Security Report. Moscow: Komtekhprint publishing, 2013. P. 20. http://www.rosatom.ru/resources/9da4828040d05a848066f66048932ed2/report_safety_2013.pdf (Retrieved on June 26, 2014).

[102] Rules for Physical Protection of Nuclear Materials, Equipment, and Nuclear Materials Storage Facilities. Approved by the Russian Cabinet of Ministers' Resolution No 456 of July 19, 2007. http://www.consultant.ru/document/cons_doc_LAW_160489/?frame=1#p85 (Retrieved on June 1, 2014).

[103] Buchelnikov Aleksandr, Ershov Vladimir, Agapov Aleksandr. Providing Security during Transportation of Radioactive Materials. 2012, March 4. http://www.atomic-energy.ru/articles/2012/03/04/31541 (Retrieved on July 25, 2014).

The Interior Ministry provides, within the scope of its remit, security for the nuclear facilities designated by the Russian government; it also provides security and escort during the transportation of nuclear materials and equipment.

The FSB participates, within the scope of its remit, in the provision of security during the transportation of nuclear materials and equipment, as well as the provision of security at nuclear facilities during normal operation and in emergency situations.

The Russian Ministry of Defense provides security at its nuclear facilities. It also provides security and escort during the transportation of nuclear materials and equipment, with the exception of spent nuclear fuel.

The Ministry of Transport is in charge of state regulation of special transportation operations. It also cooperates with the relevant federal agencies and Rosatom in the provision of security for special transportation operations.

The Federal Agency for Railway Transport draws up regulations in the area of special transportation operations, and coordinates performance requirements for the design of special trains and other hardware (with the exception or transportation and packaging containers) used in special transportation operations.

The Federal Agency for Maritime Transport provides physical protection for the nuclear materials and equipment at its facilities and at the organizations in whose coordination and regulation it participates. It also provides physical protection during the transportation of nuclear materials and equipment by ships. It participates in drawing up regulations pertaining to physical protection of nuclear materials and equipment at the facilities it operates.

The Federal Customs Service ensures priority customs clearance of nuclear materials and equipment during their transportation across the Russian border.

According to Paragraph 74 of the Rules, security for the transportation operations involving uranium hexafluoride with any level enrichment is provided by armed and trained guards, who must be equipped with bulletproof vests, communication systems, and night vision systems.

It is allowed to transport natural uranium without a security detail, but the shipment must be accompanied by a representative of the supplier or the recipient (Paragraph 75). When more than 500 kg of natural uranium or more than 1,000 kg of depleted uranium is being transported, Paragraph 77 of the Rules stipulates that the recipient must be given prior notification of the time of the shipment's departure and the expected time of arrival; the notification must also indicate the type of transport. The progress of such a batch en route must be monitored, and the recipient must provide a confirmation of receiving the delivery. These thresholds were chosen on the basis of recommendations outlined in the Nuclear Export Guidelines by the Nuclear Suppliers Group (p.1.2.ii.b) and the CPPNM (Annex I, p. 2c). In practice, the trucks carrying uranium ore concentrate (UOC) are accompanied by representatives of the mining companies.

Natural uranium is transported into and within Russia in TUK 44/8 transportation and packaging containers (210 L steel barrels) which are loaded into standard 20-foot shipping containers. The containers are transported by railway, with specially trained people accompanying each carriage. In the case of imports of Kazakh uranium to Russia, all the senders in Kazakhstan and the recipients in Russia use universal containers on their leg of the journey. The railway stations used to send and receive the shipments have a license to process Class 7 cargos.

Kazakh uranium, which makes more than 56% (2013) of natural uranium produced by Rosatom-controlled companies, is imported into Russia via two main border crossings: the Lokot station (East Kazakhstan Region, Kazakhstan) – Rubtsovsk station (Altay Region, Russia), and the Zernovaya station (Kostanay Region, Kazakhstan) – Zauralye station (Kurgan Region, Russia). Natural uranium in the form of triuranium octoxide (yellowcake) is shipped to conversion facilities by railway (up until recently, natural uranium from Kazakhstan was supplied to all three of the Russian conversion facilities)[104]. The hexafluoride produced at the conversion facilities is then transported, also by railway, to one of the uranium enrichment plants. From there, it is transported using the same mode of transport to a fuel fabrication plant.

Nuclear transportation operations in Russia rely on all four modes of transport: road, rail, air, and water, with a heavy emphasis on rail. UOC is transported to conversion plants only by railway. Dalur and Khiagda facilities use trucks only to

[104] Kazatomprom To Begin Deliveries of Uranium to India via the St Petersburg Seaport in 2010. 2010, May 24. http://www.atomic-energy.ru/news/2010/05/24/11129 (Retrieved on July 25, 2014).

deliver uranium ore concentrate from their storage depots to the nearest railway station. To strengthen security during transportation operations, Rosatom conducts regular inspections of special transport operations to ensure compliance with nuclear legislation. A total of 15 such inspections were conducted in 2013 at the Gorky, Sverdlov, South Urals, Western Siberia, Krasnoyarsk, Eastern Siberia, and Trans-Baikal branches of the Russian Railways.[105]

Rosatom also holds regular drills at the facilities where nuclear materials are stored or used. A total of seven drills were held in 2013 in cooperation with the FSB and the Ministry of the Russian Federation for Affairs for Civil Defence, Emergencies and Elimination of Consequences of Natural Disasters (MChS). The findings were used to develop programs of improving the physical protection of nuclear materials and facilities by 2017.[106]

Uranium enriched at Russian facilities under contracts with foreign customers is shipped by railway to a temporary storage depot operated by Izotop, a Techsnabexport subsidiary, and located near St. Petersburg. From there it is delivered by trucks, with all the appropriate security measures, to the commercial port of St. Petersburg, which is situated only a few kilometers from the depot. Izotop is currently Russia's largest transporter of Class 7 hazardous cargos. It uses different modes of transport (road, air, sea and railway) for radioactive cargos, and can deliver to any destination in Russia and abroad.

When nuclear materials are transported by trucks, a security detail for such operations is provided by the Interior Ministry's Special Center for Road Safety or special traffic police units of the Interior Ministry's regional departments. All Izotop trucks are equipped with the GLONASS satellite navigation system, so their location can be tracked in real time.

The GLONASS system (as well as GPS) are used to track the location of vehicles operated by Russia's uranium mining companies. The SKAUT satellite positioning system, which relies on both GLONASS and GPS technologies, enables the operator to monitor the vehicles' route, the number of bed lift operations on dump-

[105] Rosatom 2013 Annual Report. Moscow, 2014. P. 18. http://www.rosatom.ru/resources/37117a004494c2369041b0e920d36ab1/rosatom_anrep_2013.pdf (Retrieved on July 3, 2014).

[106] Rosatom Nuclear Safety and Security Report. Moscow: Komtekhprint publishing, 2013. P. 8. http://www.rosatom.ru/resources/9da4828040d05a848066f66048932ed2/report_safety_2013.pdf (Retrieved on June 26, 2014).

er trucks, and other parameters.[107] For example, the Priargunsky company has installed this system on about 450 of its vehicles, including 100 mining and heavy trucks.[108]

ARMZ, which controls all Russian uranium mining assets, relies on the services of Atomspetstrans, a Rosatom subsidiary, for the transportation of UOC by railway. The mining companies operate a fleet of trucks certified to carry Class 7 cargos and licensed to transport nuclear materials. These trucks are used to deliver natural uranium to the nearest railway station.

To minimize the risks during the transportation of nuclear materials and cut costs, Rosatom is working to optimize the map of its nuclear fuel cycle facilities and supply routes. As already mentioned, it has decided to concentrate all its uranium conversion at a single facility (instead of three). It is also looking at possible optimizations with regard to enrichment facilities, of which it currently has four.

Efforts are also being made to optimize the routes for exports of uranium products from Russia. Since 1973 (when shipments began under the Soviet Union's first export contract for enriched uranium product with France's Atomic Energy Commission) and up until recently, all shipments of enriched uranium product to foreign countries, including countries in the Asia Pacific (except China)[109], were made via the commercial port of St. Petersburg. In October 2012 Techsnabexport dispatched the first pilot shipment of low-enriched uranium product to Japan via the Vostochnyy commercial port (Primorskiy Territory) in the Russian Far East. The shipment demonstrated the viability of that shorter alternative route for exports to Asia Pacific. Two batches of enriched uranium product were shipped via the port of Vostochnyy to South Korea in November-December 2013. Using the new route on a regular basis for shipments to South Korea, and Japan will minimize the risk of loss of nuclear material. At this time, that material makes what amounts to a round the world trip on its way to Japan or Korea. The journey from one of the Russian uranium enrichment plants to customers in Japan via Vostnochny port takes

[107] Belsky A. Satellite Technologies in Traffic Control. *Gornyak Priargunya*. 2011, April 29. P. 2. http://www.priargunsky.armz.ru/media/File/priargunsky/newspaper/go654.pdf (Retrieved on July 25, 2014).

[108] The SKAUT System Has Helped to Achieve a 15-per-cent Saving on Fuel at the Transport Department of Priargunsky. http://b2blogger.com/pressroom/120492.html (Retrieved on July 25, 2014).

[109] Enriched Uranium Product Delivered to China by Railway. See: Kazatomprom to Begin Deliveries of Uranium to India via the St Petersburg Seaport in 2010. 2010, May 24. http://www.atomic-energy.ru/news/2010/05/24/11129 (Retrieved on July 25, 2014).

only two-three weeks, while via the commercial port of St. Petersburg two-three months.

As a next step, Russia is planning to develop the requisite infrastructure in the Far East. That will enable Rosatom to use the short Far Eastern route for enriched uranium product shipments to Asia Pacific on a regular basis. Russia is also negotiating with shipping companies to arrange regular shipments and obtain the necessary licenses. At this time the companies that have the license to transport Class 7 cargos do not have any regular services from Vostochnyy.[110]

Rosatom is also working to reduce the amount of nuclear material transportation operations required to fulfill foreign contracts by means of opening material accounts with the leading foreign companies involved in the fabrication of nuclear fuel and natural uranium conversion. Techsnabexport has opened such accounts with all the North American and European nuclear fuel fabrication companies. On June 3, 2014 Techsnabexport signed a material account agreement with South Korea's KEPCO Nuclear Fuel (KEPCO NF). It is also working to open material accounts with the world's leading uranium conversion companies. On July 11, 2014 Techsnabexport signed a delivery management agreement with the U.S.-based ConverDyn, one of the world's largest providers of natural uranium conversion services.[111]. In 2013 the Russian nuclear industry laid the foundation of a system of material accounts in Russia itself. In June such an agreement was signed with Kazakhstan's Kazatomprom.[112]

The utility of material accounts can be demonstrated using the example of the September 15, 2011 uranium enrichment contract between America's Exelon Generation Company and Russia's Techsnabexport.[113] The U.S. company is the largest owner and operator of nuclear power plants in the United States, with 23 operational power reactors. Exelon purchases natural uranium for the production of nuclear fuel for its power plants on the global market. One of the suppliers is Canada's Cameco. The natural uranium is supplied to a conversion plant in Metropolis,

[110] Japan Realizes Need to Restart its NPPs. *Finmarket.* 2012, March 27. http://www.finmarket.ru/main/article/2842740 (Retrieved on June 26, 2014).

[111] Techsnabexport Developing Cooperation with ConverDyn. 2014, July 15. http://www.tenex.ru/wps/wcm/connect/tenex/site/media/5304668044bcee16a084fb7858d6750e (Retrieved on July 25, 2014).

[112] Techsnabexport and KEPCO NF Sign a Material Account Agreement. 2014, July 15. http://www.tenex.ru/wps/wcm/connect/tenex/site/media/f38258804441277a9622deddb9bca448 (Retrieved on July 25, 2014).

[113] Techsnabexport Signs Another Contract for Commercial Deliveries of Uranium to the United States. *Interfax.* 2011, September 15. http://www.interfax.ru/business/208048 (Retrieved on July 25, 2014).

Illinois operated by ConverDyn, a U.S. company. Because Techsnabexport has a material account with that conversion plant, there is no need to transport the uranium hexafluoride produced in Illinois to Russia. The material stays at the plant in Illinois, but it is credited to Techsnabexport's material account. Techsnabexport, for its part, produces enriched uranium product for Exelon using natural uranium from its own stockpiles or uranium purchased from other supplies, including Kazakhstan. The material account therefore enables the companies involved to avoid actual transportation of uranium hexafluoride by road, sea, and railway to the enrichment facility in Russia, which is 10,000 km away from the conversion plant in the United States. As for the uranium hexafluoride credited to the Techsnabexport account but physically stored at the conversion plant in the United States, the Russian company can sell that material to an American customer who wants to buy uranium conversion services, thereby making it unnecessary to transport the material from Russia. The beneficial effects of having a material stock account are therefore enhanced even further.

3.4 IAEA safeguards[114]

The Soviet Union, of which Russia is the legal successor, signed the Safeguards Agreement with the IAEA on February 21, 1985.[115] The agreement entered into force on June 10 the same year. Since Russia is a nuclear-weapon state under the NPT, it is not required to place its nuclear facilities under IAEA safeguards, but it can choose to do so on a voluntary basis at selected facilities.

Three Russian (Soviet) nuclear facilities were placed under IAEA safeguards at different periods during the 20th century[116]:

- The IR-8 research reactor at the Kurchatov Institute;
- The No 5 unit at the Novovoronezhskaya NPP (a VVER-1000 reactor);
- Fresh HEU fuel (weighing over 12 kg in U-235 equivalent) of an IRT-5000 reactor; that fuel was removed from Iraq and stored at the Machinery Plant in

[114] This Section Draws on the Author's Article 'Practical Implementation: the Russian Experience' published in: UNIDIR 'Multilateralization of the Nuclear Fuel Cycle. The First Practical Steps. Edited by Yuri Yudin. New York and Geneva: UNIDIR, 2011. P. 5-44.'

[115] INFCIRC/327. Agreement between the Union of Soviet Socialist Republics and the Agency for the Application of Safeguards in the Union of Soviet Socialist Republics, 21 February 1985. http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc327.pdf (Retrieved on June 26, 2014).

[116] Due to budget constraints for the IAEA safeguards operations, at present the IAEA safeguards are not being applied at any of the listed facilities. The HEU fuel of the Iraqi research reactor no longer exists; it was downblended and used for the production of fresh nuclear fuel for the Paks Nuclear Power Plant (Hungary), which is under IAEA safeguards.

Elektrostal, Moscow Region.[117] The facility is now owned by the TVEL fuel company.

The decision to apply IAEA safeguards to the former two facilities was made in order to test technical control procedures for the types of nuclear reactors which Russia has exported to several countries. For the same reason, IAEA inspectors developed and tested safeguards procedures on one of the VVER-440 reactors of the Novovoronezhskaya NPP even before the signing of the Safeguards Agreement. based VVER-440 reactors were being built at the time in several East European countries. The nuclear fuel was removed from Iraq and placed under IAEA safeguards in Russia in accordance with UN Security Council Resolution 687 (1991) of April 3, 1991. The resolution was adopted after the discovery of Saddam Hussein's secret nuclear weapons program. It authorized the removal and destruction of all Iraqi nuclear materials, equipment, and facilities.[118]

In 1991 Russia was making preparations for placing the BN-600 fast neutron reactor at the Beloyarskaya NPP under IAEA safeguards. The reactor was thought to have great potential in terms of future nuclear energy development, so the Agency wanted to use it as a test bed for safeguards procedures that would be required for fast-neutron reactors. These plans, however, were never implemented because the IAEA did not have enough money in its safeguards budget.[119] For the same reasons, up until recently the Agency had not chosen any of the facilities put by Russia on the eligible list for safeguards inspections. A total of about 20 Russian facilities are now on the eligible list, including two uranium enrichment plants, nuclear power plants, and several nuclear research facilities.

As part of the International Uranium Enrichment Center (IUEC) project, Moscow set a precedent in Soviet and Russian history by including a nuclear fuel cycle facility on the list of facilities that are eligible for IAEA safeguards. The facility in question was the Angarsk Electrolysis Chemical Combine (AEKhK), which hosts uranium enrichment plant and the IUEC. Also, as part of the initiative to create IAEA-controlled guaranteed low-enriched uranium (LEU) reserve at the IUEC,

[117] Fisher David. Nuclear Energy and Nuclear Safeguards in the CIS and East-Central Europe: The Case for "Eurasiatom". *Nonproliferation Review*. 1994, Spring/Summer. P. 60.

[118] UN SC Resolution 687 (1991), 3 April 1991. http://daccess-dds-ny.un.org/doc/RESOLUTION/GEN/NR0/596/23/IMG/NR059623.pdf?OpenElement (Retrieved on June 26, 2014).

[119] Note Verbale Dated 24 April 1995 from the Delegation of the Russian Federation Addressed to the Secretary-General of the 1995 Review And Extension Conference of the Parties to the Treaty on the Nonproliferation of Nuclear Weapons. NPT/CONF.1995/25. 25 April 1995.

the Agency chose for the safeguards procedures the first Russian facility involved in operations with enriched uranium product. That facility was the IUEC storage, where safeguards have been applied since October 1, 2010. The IUEC storage is the first Russian facility in recent years to have been placed under IAEA safeguards. Funding for the application of safeguards is being provided from the Russian treasury.

IAEA Additional Protocol

Russia signed the Additional Protocol on March 22, 2000. The ratification procedures were completed on October 2, 2007. The agreement between Russia and the IAEA entered into force on October 16, 2007.

Under the terms of the Additional Protocol, Russia must submit regular reports (statements) to the IAEA about its exports and imports of equipment and nuclear and other controlled materials to or from non-nuclear weapon states, as well as about the uranium mines whose output is exported.[120]

In accordance with Article 2, Russia has undertaken an obligation to provide the following information to the IAEA:

- Information specifying the location of uranium mines and concentration plants [...] in the Russian Federation which are involved in production for a NNWS, and the current annual production of such mines and concentration plants for the same NNWS [...].
- Information regarding source material which has not reached the composition and purity suitable for fuel fabrication or for being isotopically enriched, as follows: The quantities, the chemical composition and destination of each export out of the Russian Federation to a NNWS, of such material for specifically non-nuclear purposes in quantities exceeding ten metric tons of uranium, or for successive exports of uranium from the Russian Federation to the same NNWS, each of less than ten metric tons, but exceeding a total of ten metric tons for the year [...].
- The quantities and chemical composition of each import into the Russian Federation from a NNWS of such material for specifically non-nuclear purposes in quantities exceeding ten metric tons of uranium, or for successive imports of

[120] INFCIRC/327/Add.1. Protocol between the Russian Federation and the International Atomic Energy Agency Additional to the Agreement between the Union of Soviet Socialist Republics and the International Atomic Energy Agency for the Application of Safeguards in the Union of Soviet Socialist Republics, 22 March 2000. http://www.iaea.org/Publications/Documents/Infcircs/2008/infcirc327a1.pdf (Retrieved on June 26, 2014).

uranium into the Russian Federation from the same NNWS, each of less than ten metric tons, but exceeding a total of ten metric tons for the year [...].

Let us recall, however, that Russia does not export domestically produced natural uranium at this time. Moscow therefore does not submit reports on this particular segment of Russian nuclear exports to non-nuclear weapon states because there is nothing to report. At the same time, the natural uranium production of Russian mines and the Rosatom-owned mines in foreign countries is fully reported in the ARMZ and Uranium One corporate annual reports.[121]

Nevertheless, Russia annually informs the IAEA about its exports of uranium products to non-nuclear weapon states, as well as about imports of nuclear materials (including natural uranium) from non-nuclear weapon states. The reports for the IAEA are prepared by Rosatom and its subsidiaries in accordance with Federal Law No 227-FZ of October 2, 2007 "On the ratification of the Additional Protocol between the Russian Federation and the IAEA to the Agreement between the Soviet Union and the IAEA on the application of safeguards in the Soviet Union, signed in Vienna on March 22, 2000".

To comply with these international obligations, the Russian government's Resolution No 973 of December 15, 2000 "On exports and imports of nuclear materials, equipment, special non-nuclear materials and related technologies" was amended by Resolution No 484 of June 15, 2009. The amendment reads, in particular: "[...] The Russian entities involved in foreign trading operations that have obtained a nuclear materials export and/or import license shall submit appropriate notifications to the Federal State Unitary Company 'Rosatom Central Research Institute of Management, Economics, and Information' (FGUP TsNIIatominform), which maintains records of the exports and imports of nuclear materials. [...]. The notifications shall be submitted no later than 10 days after the actual date of shipment or taking delivery of the said export or import items."[122]

[121] See, for example: JSC Atomredmetzoloto Integrated Annual Report for 2011. http://www.rosatom.ru/en/resources/4741bd804ceb89b7bc59bdb02198ada2/ARMZ-2509-eng.full.pdf (Retrieved on June 26, 2014); Uranium One Inc. Audited Annual Consolidated Financial Statements. For the years ended December 31, 2013 and 2012. http://www.uranium1.com/index.php/en/investor/financial-reports-and-filings/annual-reports (Retrieved on June 26, 2014).

[122] Russian Cabinet of Ministers Resolution No 484 of June 15, 2009 (amended on December 22, 2011) "On changes to Cabinet Resolutions on Regulation of Foreign Trading Operations in Regard to Certain Types of Products". http://www.consultant.ru/document/cons_doc_LAW_124845/ (Retrieved on June 26, 2014).

Bilateral agreements

Bilateral intergovernmental agreements on cooperation in peaceful use of nuclear energy augment the IAEA safeguards system in many important ways. In several countries, national legislation and standards of nuclear materials control go beyond the requirements imposed by the IAEA. These requirements are reflected in the legal framework that regulates nuclear cooperation with these countries. In the case of Russia, such additional requirements apply to cooperation with Australia, Canada, and Japan.

Table 13. Requirements contained in bilateral agreements that go beyond the standards of the Russia-IAEA safeguards agreement

	Additional requirements on top of the Russia-IAEA safeguards agreement
Australia, Canada	Nuclear materials of Australian/Canadian origin must be stored, processed and/or used only at those nuclear facilities that have been put on the IAEA safeguards eligible list. The substitution principle is allowed.
Japan	Japanese nuclear materials must be held only at those facilities where IAEA safeguards are applied. The substitution principle is allowed. The minimum requirement to the facilities processing Japanese materials is that they must be on the IAEA safeguards eligible list.

Australia

The Russian-Australian agreement on cooperation in peaceful use of nuclear energy was signed on September 7, 2007, and entered into force on November 11, 2010.[123] The document superseded the peaceful nuclear energy cooperation agreement signed between the Soviet Union and Australia on February 15, 1990. The old agreement had a limited scope; it covered only the conversion and enrichment of Australian uranium and the fabrication of nuclear fuel from that uranium in Russia for third countries (Finland and Sweden).

Australian law requires that nuclear materials of Australian origin be stored, processed, and used only at those nuclear facilities that have been put on the eligible

[123] Agreement between the Government of Australia and the Government of the Russian Federation on Cooperation in the Use of Nuclear Energy for Peaceful Purposes, 7 September 2007. https://www.dfat.gov.au/geo/russia/treaties/aus_ru_safeguards_agreement.html (Retrieved on June 26, 2014).

list for IAEA inspections. Australia does not insist that the IAEA necessarily apply safeguards at all the facilities where nuclear materials of Australian origin are stored or used. It does insist, however, that the IAEA be allowed to do so if it so chooses.[124]

As part of the new agreement, Russia and Australia have also agreed to use the substitution principle. It means that if Australian uranium is processed at facilities that are not eligible for IAEA safeguards, Rosatom must identify an equivalent quantity of nuclear material of the same category and quality (such as natural uranium hexafluoride, for example) stored or processed at one of the Russian facilities that are on the list.[125]

In order to fulfill its obligations under the agreement with Australia, in late 2010 the Russian government put the Siberian Chemical Combine (SKhK) on the list of facilities eligible for the application of IAEA safeguards. The combine's operations include conversion and enrichment of natural and reprocessed uranium.

In the medium term it is expected that uranium delivered from Australia to Russia under the agreement will be enriched in the interests of third countries. For now, there are no plans to import into Russia any Australian uranium produced at the Honeymoon uranium mine, which is controlled by Rosatom; the reasons for that are mostly economic.

A pilot batch of natural uranium arrived from Australia to the commercial port of St. Petersburg on November 8, 2012. The material was imported under a contract between Techsnabexport, and Energy Resources Australia, Ltd (a Rio Tinto subsidiary) signed on June 6, 2012. That batch of uranium underwent conversion and enrichment at SKhK, which is on the IAEA safeguards eligible list. The natural uranium from the Ranger uranium mine in Australia's Northern Territories was converted into low-enriched uranium hexafluoride and supplied to a nuclear power company of a third country; the identity of that company has not been disclosed by the parties to the contract.[126]

124 Carlson John. Russia, Australia and New Horizons of Nuclear Cooperation. *Nuclear Club*. 2010, №5-6. P. 7-8.

125 Ibid. P. 10.

126 Techsnabexport and Australia's ERA Import the First Consignment of Australian Natural Uranium into Russia. Techsnabexport Press Service. 2012, November 8. http://www.tenex.ru/wps/wcm/connect/tenex/site/press/events/ebc2f6004d5fbeac8a9b8b9d55a72459 (Retrieved on June 1, 2014); Techsnabexport Signs Contract for a Pilot Delivery of Australian Uranium. *Nuclear.ru*. 2012, June 6. http://www.nuclear.ru/news/66232/ (Retrieved on June 1, 2014).

Canada

On December 13, 2011, and February 7, 2012, Rosatom and the Canadian Nuclear Safety Commission signed an Amended Administrative Arrangement for Cooperation in the Peaceful Uses of Nuclear Energy. The original agreement was signed on November 20, 1989, between the Soviet and Canadian governments.[127] The amended arrangement sets out the principles of using nuclear materials of Canadian origin at Russian facilities; requirements for the protection, control and accounting of such materials; and reporting principles. Canadian legal requirements are similar to Australian ones; uranium supplied by Canada can be held only at those facilities that are on the IAEA safeguards eligible list, although there is no requirement for the actual application of safeguards at those facilities.

The signing of the amended administrative arrangement has completed the formation of the legal framework for cooperation in the processing of Canadian-origin nuclear materials at Russian nuclear cycle facilities for customers in Russia and abroad. At present, Russia does not import any uranium from Canada for the needs of its own nuclear industry. In the foreseeable future, the most likely mode of cooperation would be for the foreign customers that buy Techstanbexport's enrichment services to supply Canadian-origin natural uranium to the Russian company as a source material for enrichment at Russian facilities.

Japan

The Russian and Japanese governments signed an agreement on peaceful nuclear energy cooperation on May 12, 2009. The document entered into force on May 3, 2012. Among other things, it has made it possible to process nuclear materials of Japanese origin in Russia.

Techsnabexport has been supplying enriched uranium product to Japan since 1999. Such deliveries, however, do not require in Japan an intergovernmental agreement because they do not involve any imports of Japanese nuclear materials or technologies into Russia.

[127] Rosatom HQ Hosts the Signing of Administrative Arrangement between Rosatom and the Canadian Nuclear Safety Commission. 2011, December 15. http://www.atomic-energy.ru/news/2011/12/15/29525 (Retrieved on June 1, 2014); The CNSC and ROSATOM (Russian Federation) Sign an Amended Administrative Arrangement for Cooperation in the Peaceful Uses of Nuclear Energy. Canadian Safety Commission. News Release. 2012, March 2. http://www.nuclearsafety.gc.ca/eng/resources/news-room/news-releases/index.cfm?news_release_id=406 (Retrieved on June 1, 2014).

Approximately 6,400 tonnes of Japanese RepU is currently stored in Britain and France.[128] Japanese energy utilities are planning to use that material for the production of fuel for power plants. Under the terms of Japanese legislation, RepU can be converted or enriched at Russian facilities only if there is a bilateral agreement that defines the standards of IAEA controls at these facilities. Unlike Australia and Canada, Japan requires such facilities not merely to have been put on the IAEA safeguards eligible list but actually to have been placed under IAEA safeguards.

In order to meet that requirement, Article 3.2 of the Russian-Japanese intergovernmental agreement includes a stipulation that at least one of the Russian facilities must be selected by the IAEA for the application of safeguards. Moscow and Tokyo also agreed to apply the substitution principle. As a minimum requirement, the Russian-Japanese agreement stipulates that nuclear materials of Japanese origin can be delivered to facilities that have been put on the eligible list but not actually selected by the IAEA for the application of safeguards.[129] In practice it means that Japanese nuclear materials can be processed at one of Russia's two operational conversion plants (there will be only two left once the conversion facility at AEKhK is shut down), and/or enriched at two of the four enrichment plants (AEKhK and SKhK). This is because the other two enrichment combines, the Urals Electrochemical Combine (UEKhK) and the Electrochemical Plant (EKhZ), as well as the uranium conversion facility at the Chepetsky Mechanical Plant, are not on the IAEA safeguards eligible list.

The current expectation is that once Japan restarts its NPPs and its demand for uranium picks up, reprocessed Japanese uranium could be processed at the Siberian Chemical Combine, which is on the IAEA safeguards eligible list. The two countries will rely on the substitution principle using the IUEC storage, where IAEA safeguards are already being applied.

Russia's bilateral agreement with Kazakhstan, which is the largest exporter of uranium ore to Russia at this time, does not require the country to use any additional controls that go beyond the stipulations contained in the safeguards agreement

[128] Persbo Andreas. "Routine" Safeguards in Russia? 2007, March 2. http://www.armscontrolverification.org/2007/03/routine-safeguards-in-russia.html (Retrieved on June 26, 2014).

[129] Agreement between the Government of the Russian Federation and the Government of Japan for Cooperation in the Peaceful Uses of Nuclear Energy, 12 May 2009. http://allmedia.ru/laws/DocumShow.asp?DocumID=164839&DocumType=29 (Retrieved on June 26, 2014).

with the IAEA. The Russian-Kazakh agreement on peaceful nuclear energy cooperation was signed on September 23, 1993, and entered into force immediately.[130]

Table 14. Selected Russia's safeguarded nuclear facilities and facilities placed on the eligible facilities list (EFL)

Safeguarded nuclear facilities
International Uranium Enrichment Center (IUEC) LEU storage facility (Irkutsk Region, Siberian Federal District)
Enrichment and Conversion Facilities placed on EFL
Angarsk Electrolysis Chemical Combine (AEKhK, Irkutsk Region, Siberian Federal District)
Siberian Chemical Combine (SKhK, Tomsk Region, Siberian Federal District)
Nuclear facilities and material safeguarded in the past
The IR-8 research reactor, the Kurchatov Institute (City of Moscow, Central Federal District)
The No 5 unit, the Novovoronezhskaya NPP (VVER-1000 reactor) (Voronezh region, Central Federal District)
Fresh HEU fuel, the Machinery Plant (Moscow Region, Central Federal District)

3.5 Nuclear export control

Russia is one of the world's leading nuclear exporters. As already mentioned, Russian nuclear export revenues reached 5bn USD in 2013. The target for 2015 is 8.5bn.[132] At present, uranium products and services and nuclear fuel account for about 68 per cent of Russian nuclear exports. The share of the contracts for uranium products and nuclear fuel in Rosatom's portfolio of long-term contracts is about 50 per cent.

Russia was actively involved in establishing the Nuclear Suppliers Group and drawing up its Guidelines for nuclear exports. Russia has adopted national export control legislation and built a system of government agencies involved in export controls. It has also developed licensing procedures for controls of all sensitive exports.

[130] Peaceful Nuclear Energy Cooperation Agreement between the Governments of Russia and Kazakhstan, 23 September 1993. http://www.ippe.ru/nd/exp-cont/sb1/docs/kazah4.htm (Retrieved on June 1, 2014).

[131] Over 12 kg in U-235 equivalent removed from Iraqi RT-5000 research reactor.

[132] Komarov Kirill. Orders on Hand. *Vestnik Atomproma*. 2014, №4. P. 11.

The central element of the legal framework that underpins the Russian export control system is the federal law "On export control" of July 18, 1999. The first block laid in the foundation of that system was Presidential Decree No 388 of April 11, 1992 "On measures to establish an export control system in Russia". The decree contained the following instructions to government agencies:

- to develop a system of export control that would include government agencies;
- to set up a governmental export control commission that would coordinate government policy in that area; the commission should include deputy heads of all the key government agencies;
- to draw up lists of materials, equipment, and technologies that are used for peaceful purposes but can also be used to create missile, nuclear, chemical, and other types of weapons of mass destruction, to be put on the export control lists;
- to draw up proposals on introducing criminal and/or administrative responsibility for illegal exports of products on the controlled lists.[133]

The Russian controlled lists are drawn up and updated by presidential decrees. The Cabinet of Ministers also adopts resolutions that contain the requirements and licensing procedures for exports of various items on those lists.

On August 16, 2004, the Russian President issued Decree No 1085 that designated the Federal Service for Technical and Export Controls (FSTEC) as the authorized government agency in charge of export control.[134] The FSTEC manages Russian exports of nuclear materials by issuing the required import and export licenses. The agency is subordinated to the Ministry of Defense.

Russian exports and imports of nuclear materials are regulated by the Provision on Exports of and Imports of Nuclear Materials, Equipment, Special Non-Nuclear Materials and Related Technologies, which was approved by the Cabinet's Resolution No 973 of December 15, 2000.[135]

[133] Vladimirova S.V., Zyabkin M.V., Klochko G.G., Koryagin S.L., Levchenko V.M., Merzlikin V.G., Khabarov V.S., Shevchenko N.N., Novikov M.Y. Export Control. Textbook. Obninsk: IPPE, 2010. P. 55-60.

[134] Russian Presidential Decree No 1085 of August 16, 2004 "On the Federal Service for Technical and Export Control". http://www.consultant.ru/document/cons_doc_LAW_156349/ (Retrieved on June 27, 2014).

[135] Russian Cabinet of Ministers Resolution No 973 of December 15, 2000 "Exports of and Imports of Nuclear Materials, Equipment, Special Non-Nuclear Materials and Related Technologies". http://www.consultant.ru/document/cons_doc_LAW_128152/ (Retrieved on June 27, 2014).

The Provision stipulates the requirements for exports of nuclear materials and uranium products to non-nuclear weapon states. These requirements are based on the NSG Guidelines, and include the following:

- the recipient country must have enacted a Safeguards Agreement with the IAEA; all its peaceful nuclear activities must fall within the scope of that agreement;
- the authorized agencies of the recipient country must provide assurances that the items imported from Russia or the nuclear and special non-nuclear materials, equipment and hardware produced using those imports will not be used for making nuclear weapons or any other nuclear explosive devices, or be put to any other military uses;
- the nuclear materials and equipment received from Russia must be placed under IAEA safeguards for as long as they remain under the jurisdiction of the recipient state;
- said materials and equipment must be secured using physical protection measures that meet or exceed the standards recommended by the IAEA;
- said materials and equipment can be re-exported or transferred to any other recipient country only on the conditions outlined above.

Exports of uranium products to nuclear-weapon states are allowed only if authorized government agencies of the country in question provide the following assurances with regard to the imported items or items produced using those imports:

- these items shall not be used to make nuclear weapons or other nuclear explosive devices, or put to any other military uses;
- the items in question shall be secured using physical protection measures that meet or exceed the standards recommended by the IAEA.
- said items can be re-exported or transferred to any other recipient country only with prior written consent of the Rosatom state nuclear energy corporation cleared by the Federal Service for Technical and Export Controls.

This means, for example, that enriched uranium products supplied by Russia to China or the United States cannot be used to make fuel for propulsion reactors installed on these countries' nuclear submarines.

If the supplier country requires similar assurances from Russia, the decision is made by Rosatom in coordination with the Russian Foreign Ministry and other government agencies.

The principle of comprehensive safeguards as a precondition of nuclear exports was introduced in Russian legislation by a Presidential Decree on March 27, 1992. Under another decree issued on May 6, 2000, nuclear exports from Russia to those non-nuclear weapon states that have not placed all their nuclear activities under IAEA safeguards can be allowed in exceptional circumstances by a special decision of the Russian government, and only for the purpose of ensuring safe and secure operation of existing nuclear facilities.[136]

Russia emphasizes that decision to sign the IAEA Additional Protocol is a voluntary one – but argues that such signature should be regarded as an important requirement for any transfers of sensitive nuclear technologies and equipment. At the moment, however, this is not reflected in Russian legislation as a compulsory requirement.[137] For example, at one point Rosatom was considering the possibility of building a research reactor in Myanmar and supplying nuclear fuel for that reactor; this was conditional on the country singing and enacting the Additional Protocol. At the same time, TVEL supplies nuclear fuel for Iran's Bushehr NPP even though Tehran has yet to ratify the Additional Protocol after signing it in December 2003.

The requirements contained in Russian legislation are integrated into the Russian intergovernmental agreements on peaceful nuclear energy cooperation. These agreements require non-nuclear weapon states to place any nuclear materials imported from Russia under IAEA safeguards; secure these materials using physical protection measures that meet or exceed the standards recommended by the IAEA document "The Physical Protection of Nuclear Material and Nuclear Facilities" (INFCICR/225/Rev.4); and secure Russia's written consent before re-exporting them to third countries. Some of the intergovernmental agreements Russia has signed give Moscow the right to ascertain how these materials are used in the recipient country.[138]

[136] The Nuclear Nonproliferation Encyclopedia. Edited by A.V. Khlopkov. Moscow: ROSSPEN, 2009. P. 75-76.

[137] Statement by Mikhail Ulyanov, Head of the Delegation of the Russian Federation, Director of the Department for Security Affairs and Disarmament, Ministry of Foreign Affairs of the Russian Federation, at the Second Session of the Preparatory Committee for the 2015 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons, Cluster I1 (Non-Proliferation and IAEA Safeguards), Geneva, April 2013. P. 2. http://www.reachingcriticalwill.org/images/documents/Disarmament-fora/npt/prepcom13/statements/26April_Russia-EN.pdf (Retrieved on June 27, 2014).

[138] Lysenko M.N., Shamin E.A. (comp.) Peaceful Use of Nuclear Energy. Russian Intergovernmental Agreements with Foreign Partners. Moscow: 2013. P. 117.

Conclusions

Despite the nuclear accident at the Fukushima nuclear power plant, Russia continues to place a heavy emphasis on nuclear energy as a means of supplying its economy's growing energy demand. Under the draft Energy Strategy to 2035, the country's installed nuclear generation capacity is set to double to 50 GW. The government has drawn up a road map for increasing Russian nuclear exports, including exports of uranium products, with export revenues expected to reach 8.5bn dollars in 2015. Meanwhile, the government is also pressing ahead with the separation of the military and civilian sectors of the Russian nuclear industry. Projects are under way to optimize the structure of that industry. Their goals include reducing the risks related to the use of nuclear materials.

One of the key developments in the evolution of the Russian nuclear industry in the 1990s and 2000s was Russia's transformation from a leading producer of natural uranium (production peaked in 1985) to a large importer. In 2013 the country's three uranium production centers supplied only 16 per cent of Russian demand. This trend, as well as Russia's increased presence on the global market for nuclear fuel cycle services, is driving an increase in the Russian nuclear industry's transparency in order to comply with domesticc legislation of the partner countries, including the producers of natural uranium. Russia is a nuclear-weapon state under the NPT, so it may place its nuclear facilities under IAEA safeguards on a voluntary basis. Nevertheless, more Russian facilities are being added to the eligible list. In the early 2010s a precedent was set in Russian and Soviet history when Russia placed uranium enrichment facilities on the eligible list. The application of IAEA safeguards at the IUEC storage facility, which has been selected by the IAEA for its verification activities, is funded from the Russian treasury.

Rosatom state nuclear energy corporation regards nuclear material transportation operations as one of the most vulnerable phases of the nuclear fuel cycle. The company is therefore working to optimize the logistics of such operations. In particular, it is developing new transportation routes and using modern market instruments that help to reduce the risks related to nuclear materials transportation, including the opening of material accounts with its foreign partners. It is also rapidly introducing modern real-time monitoring technologies (based on the GLONASS and GPS satellite navigation systems) at its nuclear operations, including uranium mining and transportation. Rosatom in cooperation with other Russian government agencies hold regular exercises to improve physical protection of nuclear materials, including transportation operations.

Russia has put in place a sophisticated legal framework for the management of nuclear materials, including natural uranium. Russian regulations in the area of physical protection, accounting and control of nuclear materials are constantly being improved using the experience of the country's own nuclear industry as well as other countries and international organizations, such as the IAEA. Russia fulfills all its obligations to the IAEA as part of the Additional Protocol, which stipulates regular reports about exports of uranium products to non-nuclear weapon states, as well as imports of nuclear materials, including natural uranium, from such states. Since Russia has halted exports of domestically produced natural uranium, it is no longer under an obligation to inform the IAEA about its domestic production. Nevertheless, this information is fully disclosed in annual reports by Rosatom and its subsidiaries.

Russia is actively involved in improving the international legal framework in the area of nuclear security. Russian specialists took part in drawing up the Amendment to the Convention on the Physical Protection of Nuclear Material (CPPNM). Russia also initiated the adoption in 2005 of the International Convention for the Suppression of Acts of Nuclear Terrorism. The country has completed the ratification of both conventions. It uses its experience and expertise to deliver international training programs in the area of nuclear material protection, control, and accounting. These programs are delivered at Rosatom training centers in Russia under the IAEA auspices.

Russia's priority in the near and medium term is to ensure the security of direct-use nuclear materials (HEU and weapons-usable plutonium), including the optimization of the number of their storage sites, and economically justified programs of disposal of excess stockpiles of these materials. Programs to eliminate the nuclear legacy of the Cold War remain high on the list of Russian priorities. These objectives are expected to be met by 2025. Such an approach explains the differences in the requirements to the physical protection of enriched uranium versus natural uranium, as well as the fact that natural uranium is not included in the scope of the Automated Transportation Security System (ATSS) for nuclear materials.

Effective implementation of the relevant projects following the completion of international programs in the area of nuclear material protection, control, and accounting (such as the Global Partnership and the Cooperative Threat Reduction) will require reliable and sustainable financing of these projects from the Russian treasury.

Annex A. Abbreviations

AEKhK	Angarsk Electrolysis Chemical Combine
ARMZ	JSC AtomRedMetZoloto
ATSS	Automated Transportation Security System
BN	Fast Neutron Reactor
CENESS	Center for Energy and Security Studies
ChMZ	Chepetsk Mechanical Plant
CIS	Commonwealth of Independent States
CPPNM	Convention on the Physical Protection of Nuclear Material
EGP	Graphite-Moderated Boiling Water Power Reactor
EKhZ	Electrochemical Plant
EUP	Enriched Uranium Product
FGUP	Federal State Unitary Company
FSB	Federal Security Service of the Russian Federation
FSTEC	Federal Service for Technical and Export Controls
GLONASS	Global Navigation Satellite System
GPS	Global Positioning System
HEU	Highly Enriched Uranium
IAEA	International Atomic Energy Agency
ICSANT	International Convention for the Suppression of Acts of Nuclear Terrorism
INFCIRC	Information Circular
ISL	In-Situ Leaching
IUEC	International Uranium Enrichment Center
LEU	Low Enriched Uranium
MC&A	Material Control and Accounting
MChS	Ministry of the Russian Federation for Affairs for Civil Defence, Emergencies and Elimination of Consequences of Natural Disasters
MEPhI	Moscow Engineering Physics Institute
MOX	Mixed-Oxide Fuel

NNWS	Non-Nuclear Weapon States
NPP	Nuclear Power Plant
PPGKhO	Priargunsky Mining and Chemical Company
RAR	Reasonably Assured Resources
RBMK	High Power Channel-Type Reactor
RepU	Reprocessed Uranium
SKhK	Siberian Chemical Combine
SWU	Separative Work Unit
TUK	Transportation Container
TVEL	JSC TVEL Fuel Company
U1H	Uranium One Holding
UEKhK	Urals Electrochemical Combine
UN	United Nations
UOC	Uranium Ore Concentrate
VVER	Light-Water Power Reactor

About the authors

Anton Khlopkov is Director of the Moscow-based Center for Energy and Security Studies (CENESS) and Editor-in-Chief of the Nuclear Club journal. He is a Member of the Advisory Board under the Security Council of the Russian Federation. Previously, he worked for the Center for Policy Studies in Russia (PIR Center, 2000-2009), including as Executive Director (2007-2009), and was a Visiting Fellow at the James Martin Center for Nonproliferation Studies (2000). He graduated from the National Research Nuclear University 'MEPhI'.

Valeriya Chekina is a Research Associate at the Center for Energy and Security Studies (CENESS).