NUCLEAR FUEL FOR VVER REACTORS
Building the future today

The objectives of TVEL include solving strategic tasks of Rosatom State Corporation necessary for bringing export of nuclear technologies to a level comparable to the domestic use of such technologies.
TVEL Fuel company – Russian nuclear fuel designer, manufacturer and supplier

TVEL Fuel company is the fuel division of Rosatom State Corporation. The company’s core activity includes development, manufacture and sale of nuclear fuel, as well as related nuclear and nonnuclear products both in Russia and abroad. Currently, TVEL Fuel Company’s assets include fuel fabrication facilities, a separation and sublimation complex, as well as companies manufacturing gas centrifuges and related equipment. The fuel company on the basis of TVEL was set up in accordance with a resolution of Rosatom State Corporation for building an optimal management structure for nuclear fuel cycle enterprises in order to improve their performance and competitiveness in the global market.

The objectives of TVEL include solving strategic tasks of Rosatom State Corporation necessary for bringing export of nuclear technologies to a level comparable to the domestic use of such technologies.

In the context of strategic planning the TVEL is considered in connection with Tekhnabeksport, OJSC, which renders enrichment services for the market of west-designed reactors. These two companies form the fuel division of SC Rosatom.

The strategic goal of fuel division for 2030 is to increase the annual profit to the amount of $12 bln. in real terms; ~ $9 bln. of this sum will be made up by products/services of the front end of the nuclear fuel cycle.

For this purposes the company is taking a number of steps to secure and increase its share in the traditional markets, as well as to enter new markets, in particular, markets of fuel for the western design nuclear power plants.

In total, TVEL Fuel company provides for the needs of 76 power reactors in Russia, and in 15 European and Asian countries (17% of the world market), as well as for 30 research reactors throughout the world. Every sixth power reactor in the world operates on fuel produced by TVEL.

TVEL Fuel company strives to respect the interests of its customers as much as possible, as well as to fully meet their economic and technical performance requirements. It is for this very reason that for each contract the necessary complex of quality assurance measures is worked out. TVEL’s corporate quality management system of its main manufacturing facilities and management company was certified in accordance with ISO 9001 International Quality Standard.

Being environmentally conscious, the company also had its facilities certified to comply with ISO 14001 International Environment Management System.

The company’s product range is constantly extending, and the most up-to-date and complete information is available at the corporate web-site: www.tvel.ru

TVEL_Nuclear  Fuel company TVEL
TVEL-labeled fuel keeps running 76 power reactors in 15 countries, 30 research reactors and Russian fleet transport reactors.

17% of the world’s market of nuclear power plant fuel

76 power reactors in 15 countries

30 research reactors in 17 countries

45% of the world’s market of uranium enrichment services

JSC TVEL regularly supplies its products to CIS countries (Ukraine, Armenia), Central and Eastern Europe (Bulgaria, Hungary, Slovakia, Czech Republic, Finland), as well as Western Europe and Asia. TVEL-labeled nuclear fuel operates nuclear power plants in China and India. In addition, our enterprises, jointly with our foreign partner, produce fuel for nuclear power plants in Germany, Switzerland, the Netherlands and Great Britain.
Nuclear fuel for VVER-reactors

Promising product – tVsa – advanced nuclear fuel for reactors of Russian design

Promising product – TVS-KVADRAT for reactors of Western design

The TVEL Fuel Company participates in the International Thermonuclear Experimental Reactor (ITER) project, which is working to demonstrate the scientific and technological feasibility of the utilization of nuclear fusion energy.
TVEL’s production – the world class of quality

Products for power and research reactors

TVEL Fuel company develops, manufactures and supplies nuclear fuel that meets the most stringent international reliability requirements to both Russian and foreign nuclear power plants with such reactors as VVER-440, VVER-1000, BN-600, RBMK-1000, EGP-6, research reactors and marine nuclear steam generating plants. The company also develops PWR fuel.

In cooperation with AREVA NP, TVEL manufactures and supplies fuel for Western-European PWR and BWR reactors.

TVEL is a supplier of reactor core components and MOX-fuel for unit №4, which is under construction, of Beloyarskaya NPP with BN-800 reactor.

TVEL supplies its customers with modern nuclear fuels, taking into consideration the tasks pertaining to increasing the output of power units, introducing new fuel cycles with improved technical and economic parameters, and develops fuels for innovation-driven projects NPP-2006 and floating nuclear power plant.

TVEL supplies components of nuclear fuel in the form of uranium dioxide powder, pellets for fuel assemblies of various kinds (PHWR, BWR, CANDU), zirconium components of nuclear grade alloys.
Development of fuel for new reactors

- Fuel for the floating nuclear power plant with KLT-40S reactor based on ship-propulsion technologies that meets nuclear non-proliferation requirements and uses uranium enriched less than 20%.
- Fuel for reactors VVER-1200 NPP-2006, which ensures operation under more severe conditions (power, temperature, pressure, steam-content) in comparison with VVER-1000; operation in flexible fuel cycles of various time and possibility daily load follow mode in the rage of 100-75-100% Nel.
- TVEL JSC participates in development of MOX-fuel pellet production for BN-800 reactor that, according to the decision of the State Corporation Rosatom, is located at the site of FSUE GKhK and is to be put into operation in 2014.

TVSA-T for Temelin NPP

In 2004 CEZ Group company invited bids for nuclear fuel supply for Temelin NPP (Czech Republic). In 2006 TVEL won the tender and signed a contract for fuel supply for Temelin units №1 and 2.

TVSA-T design, which can be combined with fuel assemblies VWantage 6, was designed according to the terms of the contract. TVSA-T can be operated in flexible fuel cycles of 250-500 effective days.

Fuel for Temelin NPP is manufactured by Mashinostroitelnaya zavod. The first batch of TVSA-T in the volume of full loading of the reactor core was put into operation at power-generating unit №1 in 2010.

The construction of TVSA-T enables power-generating units №1 and 2 of NPP Temelin to work at 104% of the rated capacity.
## Main nuclear fuel types

### VVER-1000 TVS-2M

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tr>
<td>Geometry</td>
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<td>Number of fuel rods per assembly</td>
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<td>- fuelled</td>
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<tr>
<td>Spacer grid material</td>
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<tr>
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<td>Maximum assembly burnup MWd/kgU</td>
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<td>Fuel column height, mm</td>
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<td>UO₂ weight, kg</td>
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### VVER-1000 TVSA-12

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<td>Fuel rod length, mm</td>
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<td>Fuel rod outside diameter, mm</td>
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<td>Pellet density, g/cm³</td>
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<td>Cladding material</td>
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<td>Cladding thickness, mm</td>
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<td>Maximum cladding temperature, °C</td>
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<tr>
<td>Spacer grid material</td>
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<tr>
<td>Average discharge burnup, MWd/kgU</td>
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<td>Maximum assembly burnup MWd/kgU</td>
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<td>Fuel column height, mm</td>
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Modern fuel TVS-2M, TVSA-12 TVSA-PLUS, for reactors VVER-1000 enable consumers to increase technical and economical characteristics of NPP by means of extended fuel cycles introduction, raising of capacity of power-generating units, raising of fuel burn-up and decreasing of fuel operating limitations.

Second and third generation fuel assemblies for VVER-440 which feature higher technical and economic efficiency and facilitate implementing 5-6-year fuel cycles while increasing thermal power capacity up to 110%.

**VVER-1000 TVSA-PLUS**
- Geometry: hex
- Number of fuel rods per assembly: 331
  - fuelled: 312
  - unfuelled: 19
- Overall length, mm: 4570
- Overall width, mm: 235
- Fuel rod length, mm: 3988
- Fuel rod outside diameter, mm: 9.1
- Pellet length, mm: 9-12
- Pellet outside diameter, mm: 7.60
- Pellet density, g/cm³: 10.4-10.7
- Average linear fuel rating, kW/m: 16.8
- Peak linear fuel rating, kW/m: 44.8
- Cladding material: Zr-1%Nb
- Cladding thickness, mm: 0.5
- Maximum cladding temperature, °C: 355
- Spacer grid material: Zr-1%Nb
- Average discharge burnup, MWd/kgU: 58
- Maximum assembly burnup MWd/kgU: 66
- Fuel column height, mm: 3680
- UO₂ weight, kg: 525

**VVER-440**
- Working FA 2nd generation
- Control FA 2nd generation
- Geometry: hex hex
- Number of fuel rods per assembly: 127 127
  - fuelled: 126 126
  - unfuelled: 1 1
- Overall length, mm: 3217 3200
- Overall width, mm: 145 145
- Fuel rod length, mm: 2601.5 2540
- Fuel rod outside diameter, mm: 9.1 9.1
- Pellet length, mm: 9-12 9-12
- Pellet outside diameter, mm: 7.60 7.60
- Pellet density, g/cm³: 10.4-10.7 10.4-10.7
- Average linear fuel rating, kW/m: 12.96 12.96
- Peak linear fuel rating, kW/m: 32.5 32.5
- Cladding material: Zr-1%Nb Zr-1%Nb
- Cladding thickness, mm: 0.65 0.65
- Maximum cladding temperature, °C: 350 350
- Spacer grid material: Zr-1%Nb Zr-1%Nb
- Average discharge burnup, MWd/kgU: 51 42
- Maximum assembly burnup MWd/kgU: 57 52
Fuel Fabrication Plant

In order to improve its marketing policy, adapt it to the present market conditions and extend the line of products, the company makes available to consumers of nuclear fuel the following option: building of regional fabrication plants in the client’s country. To use this option the country should possess a considerable fleet of Russian design reactors and be devoted to further development on the basis of Russian reactor technologies.

Realization of this project is advantageous for all of its participants. Foreign partners gain access to new technologies and become capable of producing fuel in their countries. In addition to this, they can strengthen their energetic security and become less dependent on deliveries of import production.

TVEL offers to support the working process of plants abroad and on a regular basis is ready to provide up-to-date technologies and advanced equipment. Furthermore, it is guaranteed that the plants will be able to use Russian services of uranium enrichment what is quite a competitive advantage in terms of present day aggressive competition in this segment of the world market. Special attention should be paid to the fact that today only TVEL Fuel Company possesses reference and licensed technologies for production of nuclear fuel for Russian design reactors.
Contact information

**JSC Mashinostroitelny Zavod**
12 Karla Marks st., Elektrostal, Moscow region, 14001, Russia
Phone: +7 (495) 702-99-01
Fax: +7 (495) 702-92-21
E-mail: zymsz@elemash.ru
www.elemash.ru

**JSC Novosibirsk Chemical Concentrates Plant**
94 B. Khmelnitskogo st., Novosibirsk, 630110, Russia
Phone: +7 (383) 274-83-46
Fax: +7 (383) 274-30-71
E-mail: nzhk@nccp.ru
www.nccp.ru

**JSC Chepetsky Mechanical Plant**
7 Belova st., Glazov, Udmurt Republic, 427620, Russia
Phone: +7 (34141) 3-60-70
Fax: +7 (34141) 3-45-07
E-mail: post@chmz.net
www.chmz.net

**JSC Moscow Composite Metal Plant**
49 Kashirskoye shosse, Moscow, 115409, Russia
Phone: +7 (495) 324-72-34
Fax: +7 (495) 742-82-98
E-mail: mzp@mzp.ru
www.mzp.ru

**JSC Angarsk Electrolysis Chemical Complex**
Angarsk, Irkutsk region, 665804, Russia
Phone: +7 (3955) 54-00-40
Fax: +7 (3955) 54-00-00
E-mail: kran@aecc.ru
www.aecc.ru

**JSC Siberian Chemical Combine**
1 Kurchatov st., Seversk (Closed Administrative Territorial Unit), Tomsk region, 636039, Russia
Phone: +7 (3822) 76-55-93
Fax: +7 (3822) 72-44-46
E-mail: SHK@seversk.tomsknet.ru
www.atomsib.ru

**JSC Urals Electrochemical Combine**
2 Dzerzhinskogo st., Novouralsk, Sverdlovsk region, 624130, Russia
Phone: +7 (34370) 9-24-77
Fax: +7 (34370) 9-41-41, +7 (34370) 5-73-33
E-mail: condor@ueip.ru
www.ueip.ru

**JSC Electrochemical Plant**
1 Pervaya Promyshlennaya st., Zelenogorsk, Krasnoyarsk Territory, 663690, Russia
Phone: +7 (39169) 9-40-00
Fax: +7 (39169) 9-42-43
E-mail: talfun@ecp.ru
www.ecp.ru

**JSC Vladimir Production Association Tochmash**
1a Severnaya st., Vladimir, 600007, Russia
Phone: +7 (4922) 47-32-09
Fax: +7 (4922) 47-31-95
E-mail: pochta@vphotochmash.ru
www.vphotochmash.ru

**JSC Kovrov Mechanical Plant**
26 Sozialistischeskaya st., Kovrov, 601909, Russia
Phone: +7 (49232) 9-40-09
Fax: +7 (49232) 2-14-49
E-mail: info@kvmz.ru
www.kvmz.ru

**LLC Ural Gaseous Centrifuge Plant**
2 Dzerzhinskogo st., Novouralsk, Sverdlovsk region, 624130, Russia
Phone: +7 (34370) 7-80-05
Fax: +7 (34370) 7-84-00
E-mail: adm@ugcmp.ru

**LLC Uralpribor**
2 Dzerzhinskogo st., Novouralsk, Sverdlovsk region, 624130, Russia
Phone/fax: +7 (34370) 5-63-26
E-mail: info@uralpribor.com
www.uralpribor.com