

Application of the Uranium Stewardship Philosophy to the Safe Management of Enrichment By-Products in Russia



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With contribution by the *Angarsk Electrolysis Chemical Complex* management

The Overarching Principle of Sustainable Development

The Uranium Stewardship philosophy is in part derived from the overarching principle of **Sustainable Development**

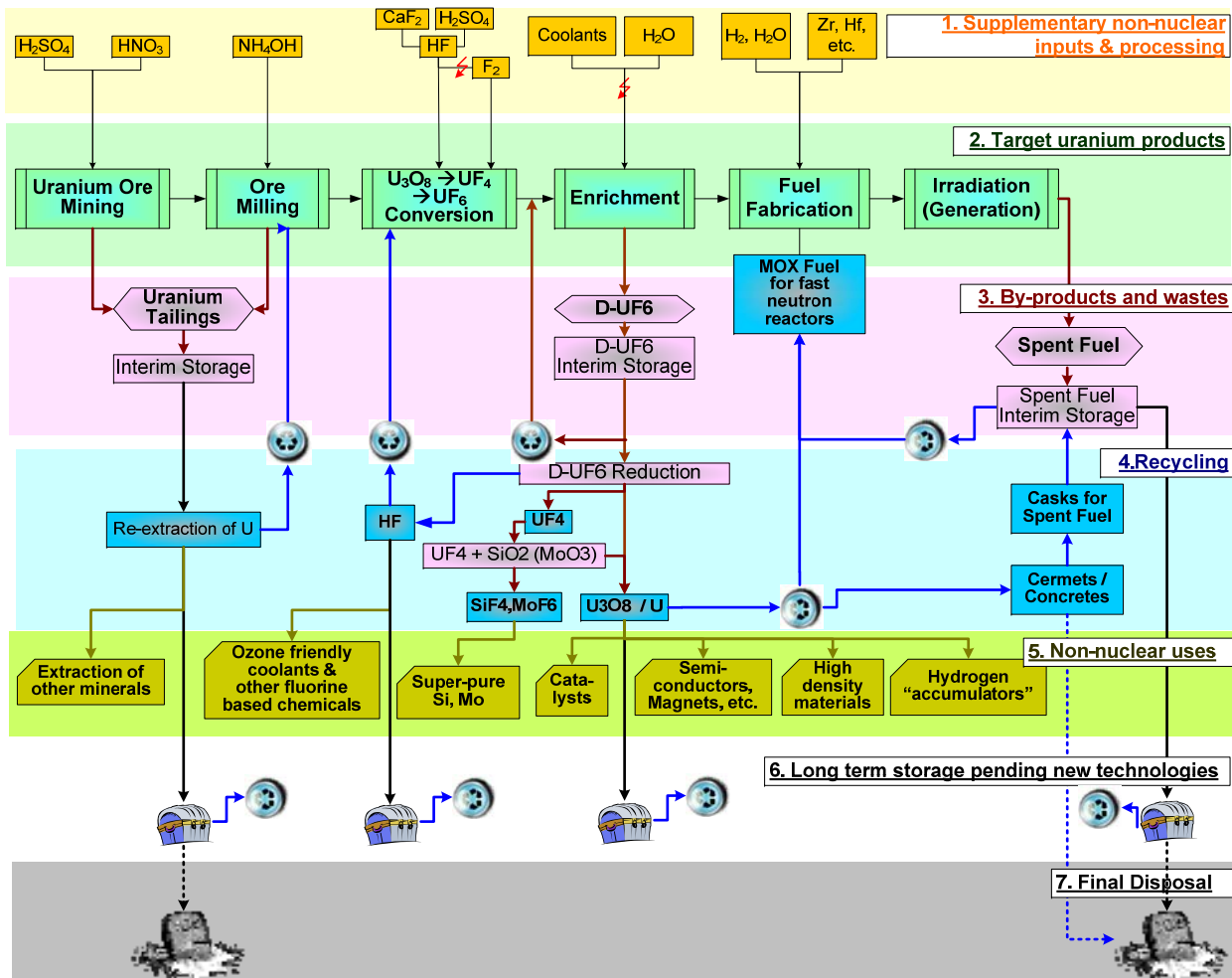
Sustainability, as defined in the WNA Charter of Ethics means: “*meeting the needs and aspirations of the present generation **without compromising the opportunity of future generations to fulfill their needs and aspirations***” ...

The target products of the Nuclear Fuel Cycle are being consumed today to satisfy the needs of the present generation, however, its **by-products may affect the prosperity of future generations.**

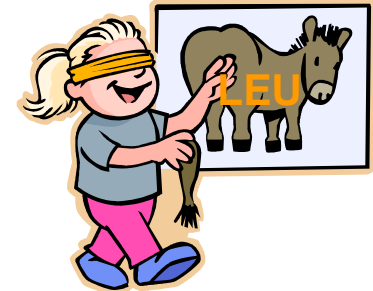
The by-product of the uranium enrichment processes is **Depleted Uranium Hexafluoride (D-UF₆)**. The issue is, whether D-UF₆ is a burden or a value to future generations?

Best efforts shall be applied today by Nuclear Fuel Cycle operators to make D-UF₆ a value, not a burden, to future generations

Comprehensive Approach to the Ontology of the Nuclear Fuel Cycle



Meeting the needs of the present generation in reliable and clean energy



Multiple options for useful application of D-UF₆ to get a value from it for future generations.

→ No reasons to condemn D-UF₆ as a waste

Uranium Stewardship principles shall be equally applied to uranium and its by-products, including D-UF₆ to ensure they «are managed in a safe, environmentally reasonable, economical and socially acceptable manner».

Legal Status of D-UF₆ in Some Countries Hosting Enrichment Plants

The United States

- ❑ D-UF₆ is not directly classified in any U.S. statutory law. NRC, in “Memorandum and Order” dated January 18, 2006 concluded and ordered that: “*depleted uranium property is considered a low-level radioactive waste*”, but made a reservation: “*assuming it is not treated as a resource*”.
- ❑ D-UF₆ was declared a waste in the U.S. for a very specific purpose - to confirm DOE’s obligation to accept it from enrichers for a fee and, therefore, to facilitate licensing of the new enrichment plants. At the same time DOE is entitled to store D-UF₆ indefinitely or to pursue other options.

The Euratom countries

- ❑ *France*: On Nov. 5, 1998, a French appeals court ruled that depleted uranium is not a waste, but a “*directly usable raw material that is effectively used for multiple uses*” - and D-UF₆ therefore may be stored indefinitely in the form of U₃O₈ in purpose-built storage buildings.
- ❑ “*Urenco countries*”: in the United Kingdom, Germany and the Netherlands D-UF₆ is not statutory classified as waste but the regulators limit the quantities of fluorine that can be stored at the Urenco’s storage yards.

IAEA/OECD

- ❑ *In the Joint Report by the OECD Nuclear Energy Agency and the IAEA “Management of Depleted Uranium”* it was recognized that: “*the strategy for the long-term management of depleted uranium is based on the consideration that depleted uranium is a valuable material, which may have various applications, and is not considered a waste*”.

In the majority of jurisdictions, hosting enrichment plants, D-UF₆ is deemed to be a valuable resource, not a waste.

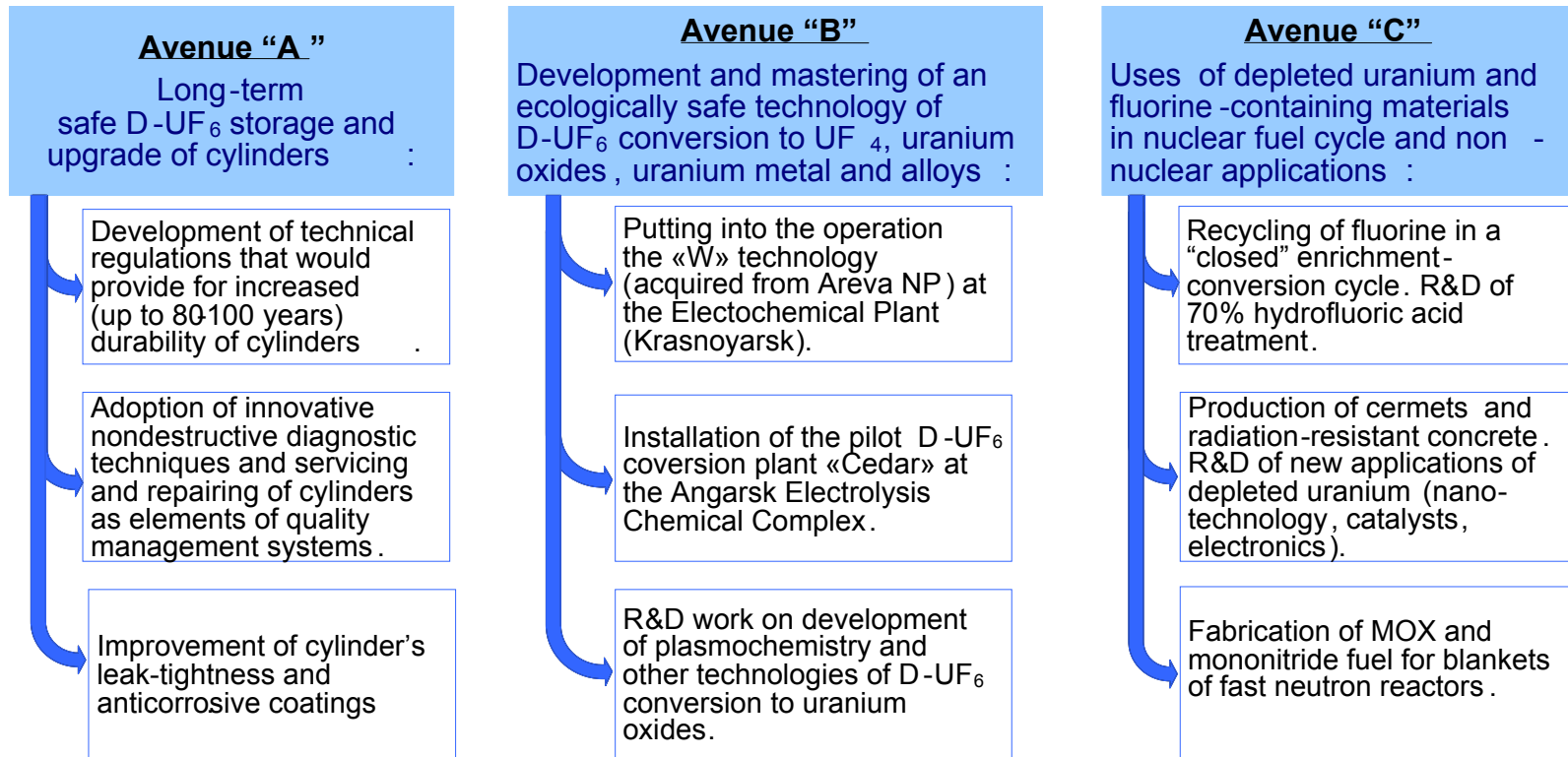
Legal Status of D-UF₆ in Russia

- Like in the U.S. and in Euratom countries, the legal status of D-UF₆ is not directly defined in any Russian legislative act.
- However, a complex legal analysis of relevant legislative acts shows that **D-UF₆ is considered in Russia to be a valuable resource**:
 - Article 3 of the Federal Law “On the Use of Atomic Energy” defines as **radioactive wastes “nuclear materials and radioactive substances, the further use of which is not foreseen”**.
 - The same Federal Law provides that the classification of nuclear materials as belonging to either category shall be made by the operators themselves and shall be subject to confirmation by the regulators. No Russian enricher has put D-UF₆ in the category of wastes so far.
 - Authorized Russian expert organizations, including “VNIИHT”, stated and justified in their conclusions that D-UF₆ and its derivatives are valuable and usable resources.
 - Rosatom in the «The Concept of Safe Handling of Depleted Uranium Hexafluoride» of December, 2006 has determined (with reference to the Federal Law “On the Use of Atomic Energy” and the conclusions of IAEA/OECD experts) that D-UF₆ **«is not a radioactive waste and is considered as a valuable energy resource and the potential source of fluorine for the closed conversion-enrichment cycle»**.
 - These expert conclusions were recognized and accepted by Russian licensing and customs authorities and have never been rebutted by court decisions or otherwise.

Therefore D-UF₆ is deemed in Russia to be a valuable energy resource and a potential source of fluorine. This qualification of D-UF₆ predetermines its management in Russia.

Rosatom's Concept of Depleted UF₆ Safe Handling

Basic Avenues of the D-UF₆ Safe Handling



The Concept provides for simultaneous pursuing of long-term storage and conversion strategies in order to achieve non-accumulation of D-UF₆ in Russia by the middle of the next decade.

Avenue “A”: Replacement of Standard Practice with Best Practice in the Course of Long-Term Storage of D-UF₆



Pre-Filling Procedures:

- Cylinders inspected by certified inspectors only (certified by the Russian regulator “Rostechndzor”);
- Cylinders are stored empty for ≥ 6 months to give short-living isotopes time to decay;
- Washing of cylinders from heels, drying, hydro-tests (5 bar), pneumo- tests (28 bar) and vacuum tightness tests;
- Ultrasonic measurement of wall thickness and rejection of cylinders with wall thickness below acceptable .

Cylinders Monitoring at the Storage Yard and Leakage Prevention:

- Each cylinder is observed 2 times a month if temperature is above $+20^{\circ}\text{C}$ and 1 time a month if temperature is below $+20^{\circ}\text{C}$;
- Concentration of HF in the air is constantly monitored and indicated on the plant’s information tableau;
- Cylinders with a disruption of 40% or more of the protective coating are subject to immediate painting with advanced paints;
- Preventive replacement of gaskets, which have lost elasticity, and bolted joints with application of joint sealant.

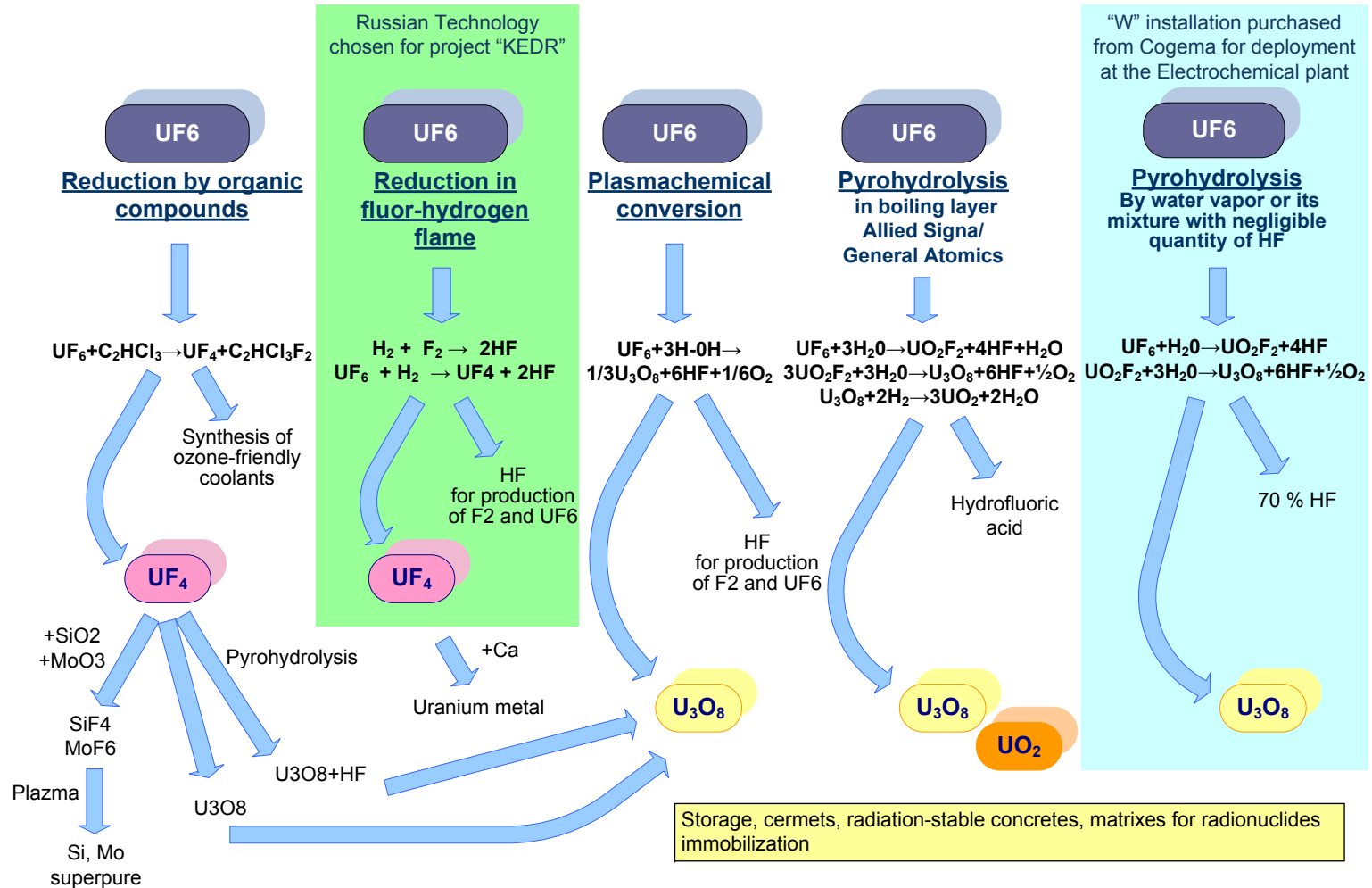
Handling of Detected Defective Cylinders:

- In case of welding joint defect - immediate application of a patch based on advanced patented metal-ceramic material “LEO” tolerating temperatures up to 250°C and pressures up to 25 bar (no welding – no local heating – no sublimation);
- Defective cylinder must be emptied and replaced within 30 days after leakage detection;
- In case of plug / valve defect – immediate placement of cylinder in protective hook, cooling in Dewar vessel for 1 day and replacement of plug / valve.

Avenue “A”: R&D Work to Improve D-UF₆ Storage Safety

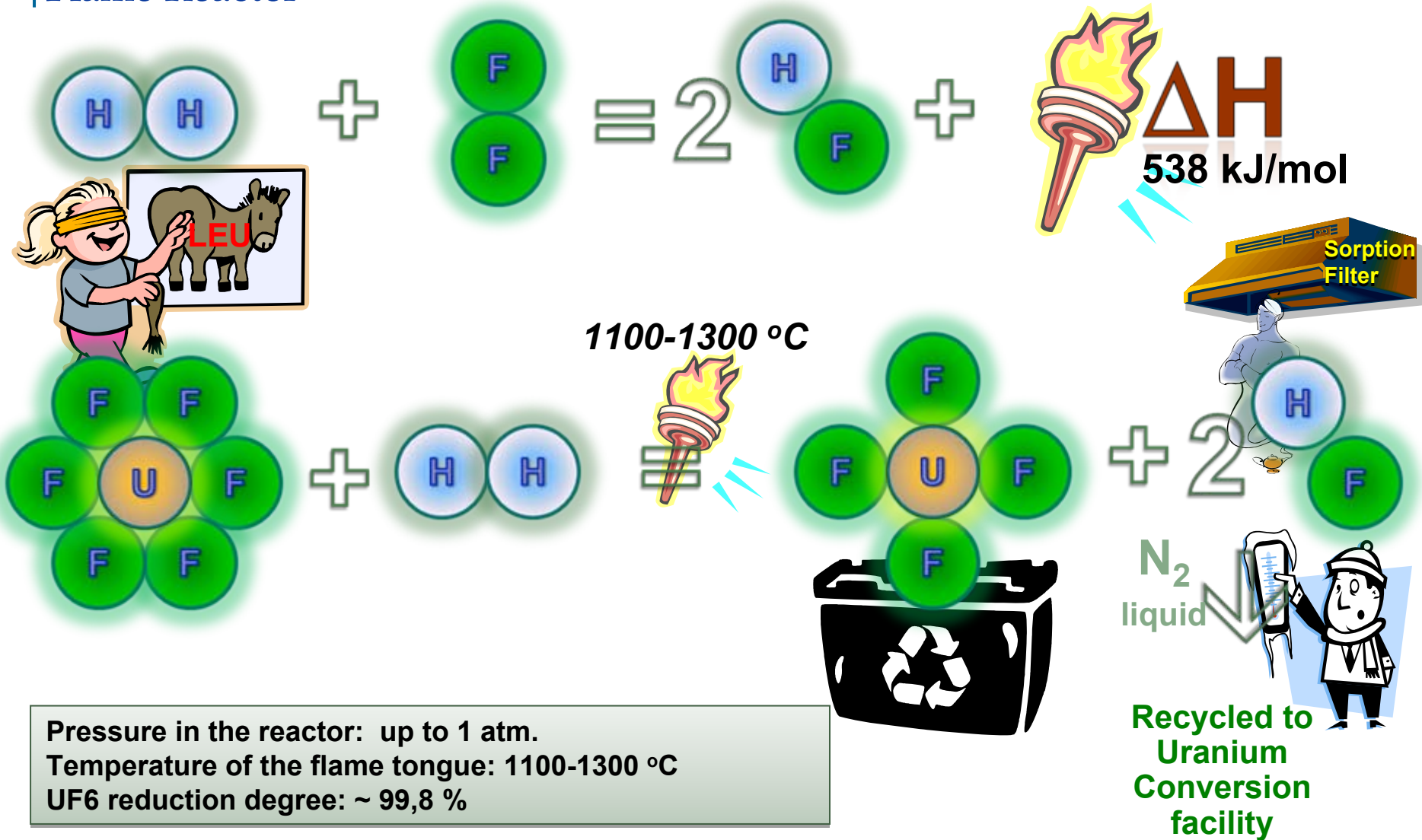
- ❑ Development and production of state-of-the-art horizontally-stored cylinders (similar to the 48-type cylinders) to replace old-fashioned vertically-stored cylinders with uneven temperature distribution (R&D work already completed).
- ❑ Seeking the most effective anti-corrosive coatings / paintings.
- ❑ Development and adoption at Russian enrichment plants as a part of their quality management systems of non-destructive techniques of diagnosing and even forecasting future cylinders defects.
- ❑ Modeling of leakage rates in case of damages to cylinders, including those caused by severe fire in such highly unlikely events as heavy aircraft crashes.
- ❑ Analysis of storage statistics to justify the prolongation of the regulation prescribed cylinder service life (it has been already proven that even with the high range changes of daily and seasonal temperatures in the continental climate of Siberia cylinders durability can be increased to 80-100 years).
- ❑ Preparation and adoption of technical regulations that would contain measures to prolong the durability of D-UF₆ storage cylinders up to 80-100 years.

Avenue "B": D-UF₆ Conversion Technologies Considered and Researched



While the R&D work on other methods is in progress, the technologies based on pyrohydrolysis (Areva's plant "W") and reduction in fluor-hydrogen flame are currently being introduced at two Russian enrichment plants – Zelenogorsk and Angarsk, respectively.

Project "KEDR": Chemistry of D-UF₆ Conversion in the Fluorine-Hydrogen Flame Reactor



Lake Baikal – Unique Ecosystem, included in UNESCO’s World Heritage List and Preserved in accordance with Special Russian Legislation

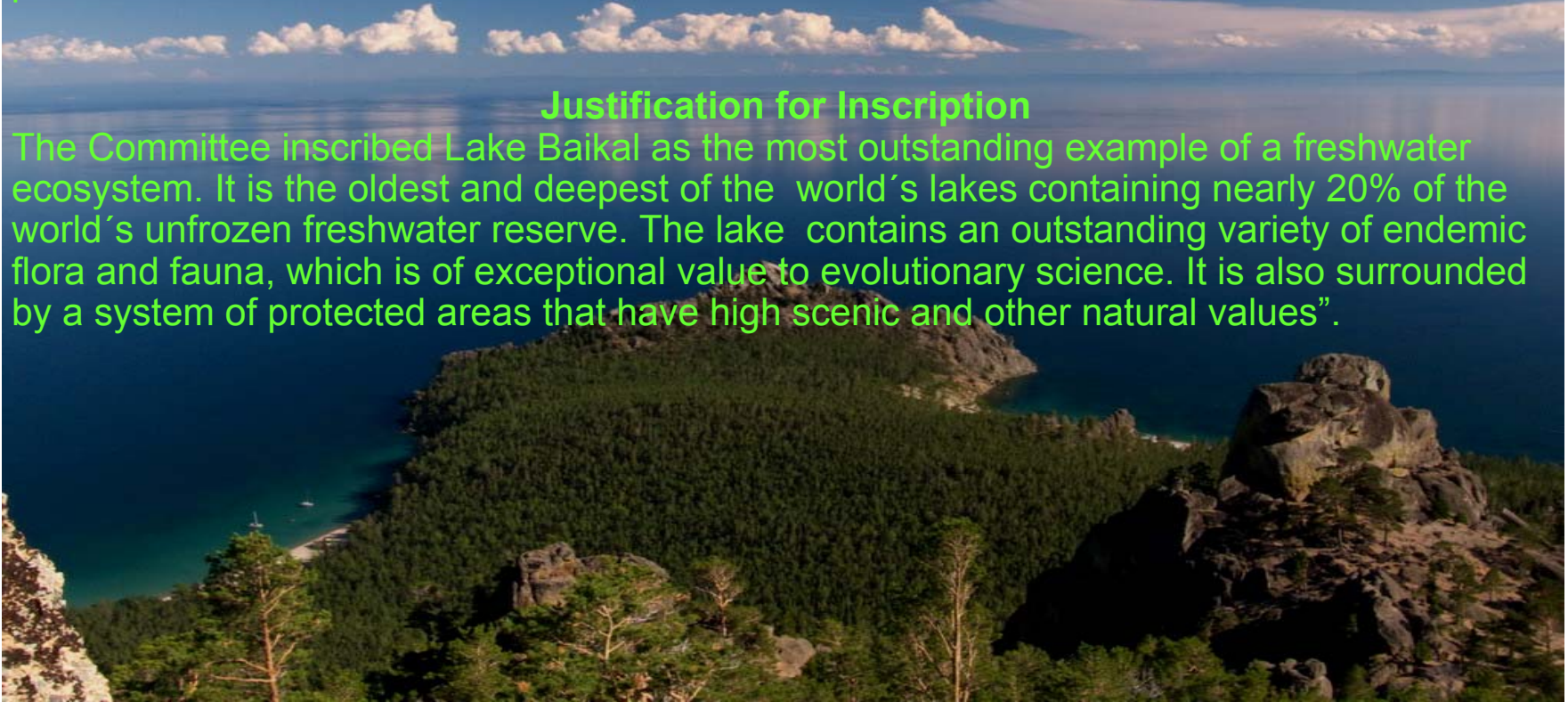
Lake Baikal. Inscribed by UNESCO’s World Heritage Committee in 1996

Brief Description

“ Situated in south-east Siberia, the 3.15-million-ha Lake Baikal is the oldest (25 million years) and deepest (1,700 m) lake in the world. It contains 20% of the world's total unfrozen freshwater reserve. Known as the 'Galapagos of Russia', its age and isolation have produced one of the world's richest and most unusual freshwater faunas”.

Justification for Inscription

The Committee inscribed Lake Baikal as the most outstanding example of a freshwater ecosystem. It is the oldest and deepest of the world’s lakes containing nearly 20% of the world’s unfrozen freshwater reserve. The lake contains an outstanding variety of endemic flora and fauna, which is of exceptional value to evolutionary science. It is also surrounded by a system of protected areas that have high scenic and other natural values”.





Features of the Angarsk Electrolysis Chemical Complex as the Site for the Deployment of Project “KEDR”



✓ Combination of conversion and enrichment plants within one site justifies recycling of fluorine and closing the enrichment-conversion cycle.



✓ Although the distance between the Angarsk Complex and the Baikal lake (which is inscribed in UNESCO’s World Heritage List) exceeds the “buffer zone” the plant pays increased attention to environmental protection, including the D-UF₆ handling techniques.

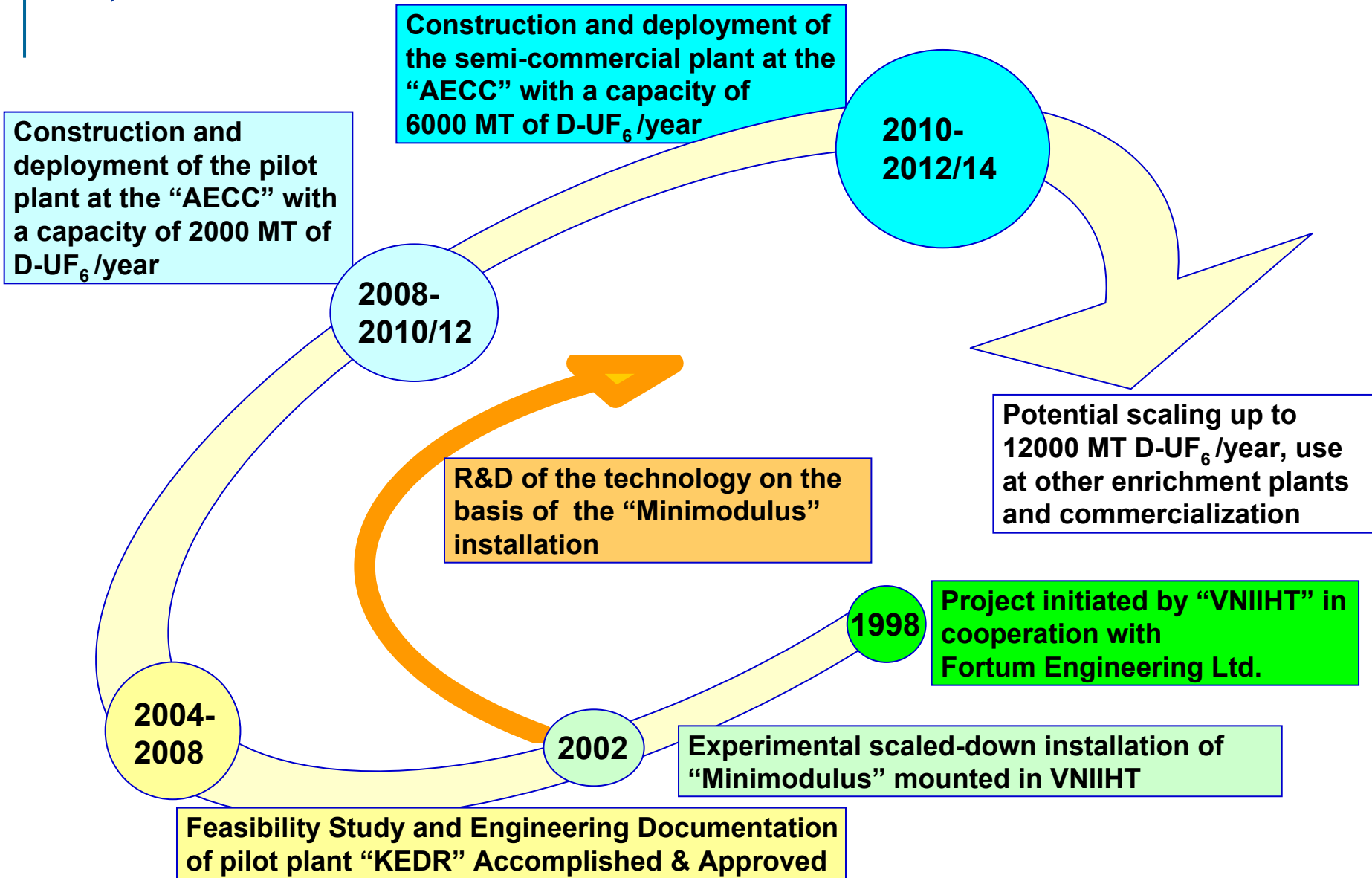


✓ ISO 9001 / 14001 Certified.



✓ The plant hosts the first “International Uranium Enrichment Center”.

Project “KEDR” Milestones



R&D Work on the Uses of Depleted Uranium under the Umbrella of the International Science Technology Center (ISTC)

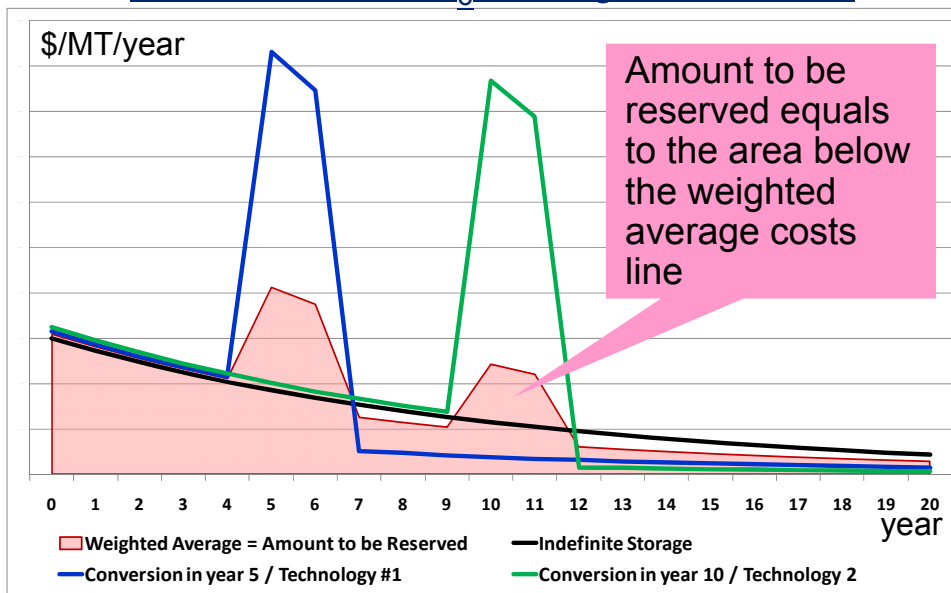
Project #	Title:	Participants:
2691	Production and Testing of Heavy Concretes Including Depleted Uranium Dioxide Concerning their Use as Shielding Materials in Constructions of Casks for Spent Nuclear Fuel	<ul style="list-style-type: none"> ❑ «Russian Federal Nuclear Center - All-Russia Research Institute of Experimental Physics» (VNIIEF); ❑ “VNIHT”; ❑ «All-Russian Scientific Research Institute of Non-Organic Materials named after A. Bochvar» (VNIINM) ❑ Oak Ridge National Laboratory
2693	Production and Testing of Cast Cermet on the Base of Stainless Steel and Depleted Uranium Dioxide as Applied to its Use as Shielding Materials in Constructions of Casks for Spent Nuclear Fuel and Radioactive Wastes	<ul style="list-style-type: none"> ❑ VNIIEF ❑ A.N.Frumkin Institute of Physical Chemistry and Electrochemistry of the Russian Academy of Sciences (IPCE RAS) ❑ Oak Ridge National Laboratory
2694	Investigation of Sorption Capture of Long-lived Radionuclides from Underground Waters by Depleted Uranium Oxides and Hydroxides	<ul style="list-style-type: none"> ❑ VNIIEF ❑ A.N.Frumkin Institute of Physical Chemistry and Electrochemistry of the Russian Academy of Sciences (IPCE RAS) ❑ Oak Ridge National Laboratory

These international efforts in researching areas of combined utilization of several nuclear fuel cycle by-products (D-UF₆ and spent fuel) and wastes (contaminated steel) demonstrate that the problem of environment-friendly D-UF₆ disposition could be most effectively solved on the basis of international cooperation.

Contributing to Sustainable Development by Ensuring that D-UF₆ is Managed in an Economically Acceptable Manner

- ❑ The Russian Federal Law dated December 1, 2007 concerning the state corporation «Rosatom» provides for the establishment of centralized funds to be managed by «Rosatom» and controlled by its governmental Oversight Council to finance future costs.
- ❑ Previously, the creation of similar funds was regulated by the Federal Law of 1996 “Concerning the financing of nuclear-dangerous and radiation-dangerous production facilities”.
- ❑ Besides the centralized funds the enrichment plants themselves contribute a share of their cost of production to their own funds of future costs.
- ❑ “Rosatom” is currently developing the mechanisms of management of the above funds.

Discounted D-UF₆ Management Costs

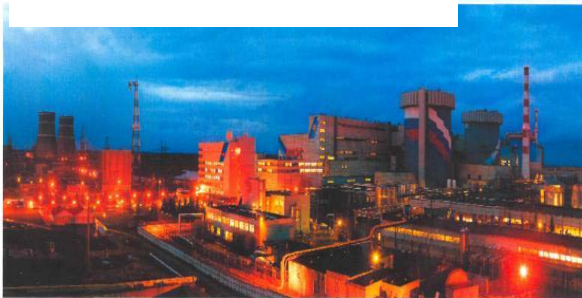


Financial Problems to be Resolved:

- ❑ Estimation of the weighted average discounted costs in ∞ period depending on the future choice of technologies for D-UF₆ processing and timing of conversion;
- ❑ Choice of a proper discount rate;
- ❑ Protection of funds from inflation by depositing money in non-risky securities, etc.

Rosatom's Interaction with the Society on the Issues of D-UF₆ Safe Handling

D-UF₆: Safe Storage, Handling and Processing



ОБЩЕСТВЕННЫЙ
СОВЕТ

Москва
2008

Nuclear fuel Cycle

Природный уран состоит из трех радиоактивных изотопов:

природный уран

U-238 (около 99,3%),
U-235 (около 0,7%),
U-234 (около 0,005%)

На урановом топливе, обогащенном изотопом U-235, сегодня работает большинство атомных энергетических реакторов.



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How D-UF₆ is stored?



Для хранения ОГФУ используются емкости российского производства и контейнеры иностранного производства. Емкости и контейнеры изготавливаются из легированной углеродистой стали с толщиной стенки не менее 8 мм. В конструкцию емкостей и контейнеров закладывается значительный запас прочности, обеспечивающий устойчивость как к механическому воздействию, так и к воздействию высоких температур.

Емкости и контейнеры изготавливаются на специализированных предприятиях, имеющих лицензии национальных органов технадзора. В Российской Федерации это Федеральная служба по экологическому, технологическому и атомному надзору.

На каждом этапе изготовления емкости в соответствии с установленным регламентом осуществляется независимый контроль соблюдения технологии изготовления и качества проведенной операции. Проверка осуществляется как визуальным, так и инструментальными методами. Проводится 100% контроль качества сварных швов радиографическим методом. Средства измерения, используемые для контроля, проходят обязательную метрологическую поверку с установленной периодичностью.



Дополнительно, емкость подвергается штатным испытаниям: на герметичность, на прочность сварки, на устойчивость корпуса к гидростатическому давлению, значительно превышающему технологически достижимое при эксплуатации, а также другие испытания, предусмотренные технологическим процессом.

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In January, 2008 Rosatom's "Public Council" has issued a popular brochure on the problems of D-UF₆ Storage, Handling and Processing (some pages shown) and is continuously interacting with public by means of press conferences, answering FAQs, etc.

Summary: Application of the Uranium Stewardship Philosophy to the Management of D-UF₆ in Russia

- ❑ The concept of D-UF₆ management in Russia are based on the principle of the Sustainable Development and the Uranium Stewardship philosophy:
- ❑ First, it declares D-UF₆ a valuable resource, therefore, leaving multiple options for getting benefit from D-UF₆ for present and future generations.
- ❑ Second, it encourages management of D-UF₆ *in a safe manner* by continuous replacement of standard practices with *best practices* of long-term storage of D-UF₆.
- ❑ Third, reflecting the necessity to manage D-UF₆ *in an environmentally responsible manner*, it is aimed at reversing the accumulation of D-UF₆ by means of deployment of D-UF₆ conversion technologies at Russian enrichment plants.
- ❑ Fourth, management of D-UF₆ in *an economically viable manner* is ensured by:
 - establishment and management of funds for financing future D-UF₆ handling costs;
 - combining storage and conversion technologies to optimize the overall costs;
 - recycling of fluorine derived from D-UF₆; and
 - seeking economically viable applications for D-UF₆ conversion products.
- ❑ Fifth, *social responsibility* is maintained by means of continuous interaction between the Public Council of Rosatom and the local communities, NGO's and the society as a whole on the subject of D-UF₆ safe management.

Thank You for Your Attention

and

*I Am Ready to Answer
Your Questions*