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ELECTRIC POWER DIVISION OF ROSATOM

Rosenergoatom - safe operation and modernization

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www.rosenergoatom.ru

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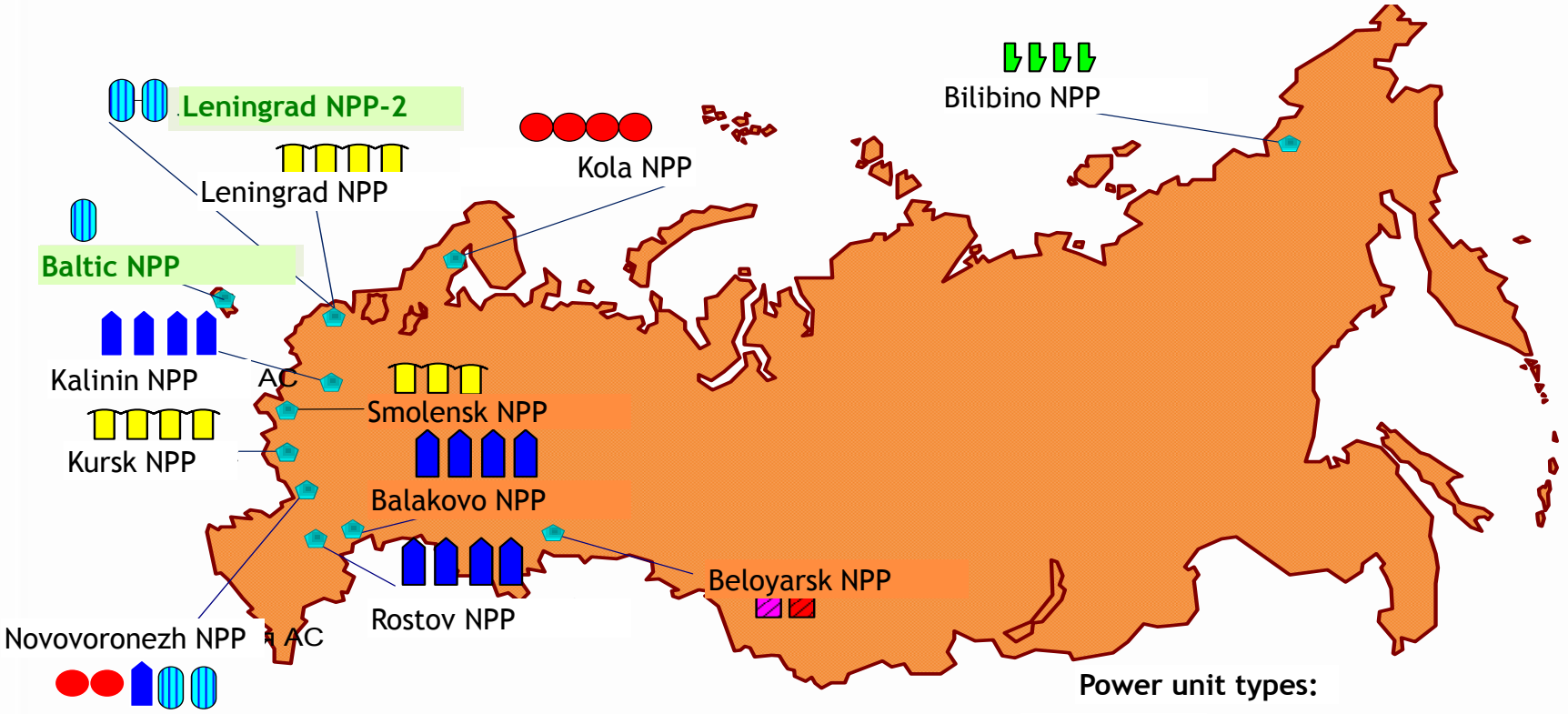
Moscow

Russian NPP units in operation and under construction

Operating: 10 NPPs, 33 units, $N_{inst.}$ = 25242 MW



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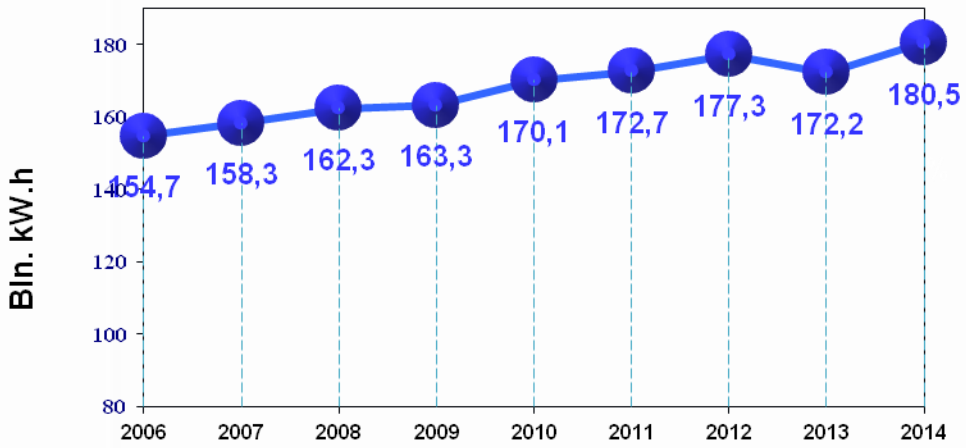
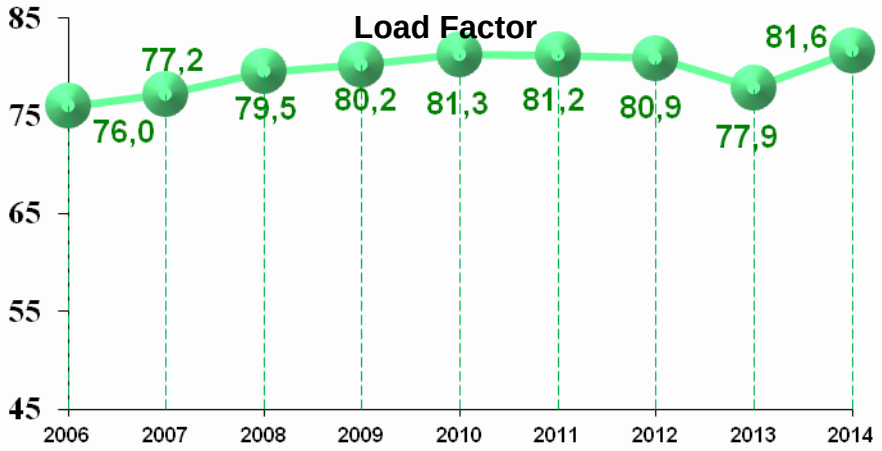
Main NPP performance indicators

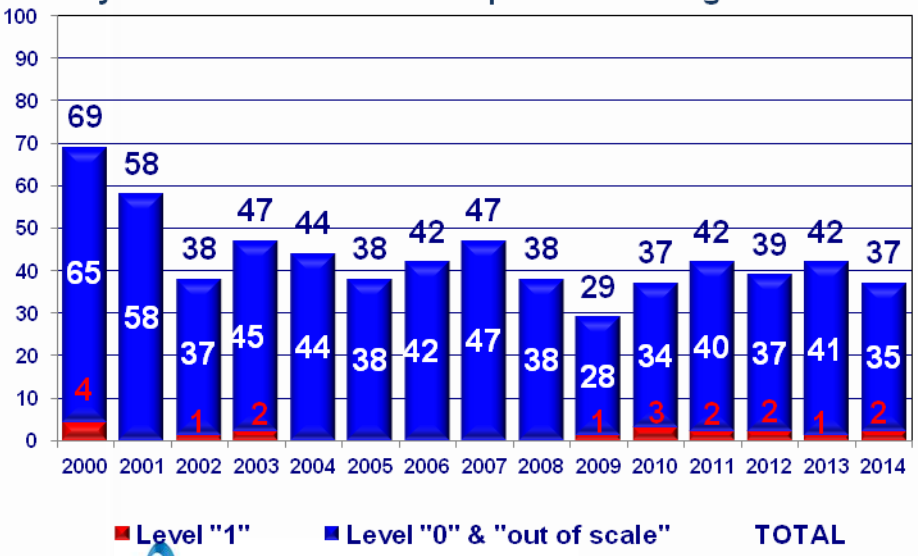
Electric power generation by Russian NPPs



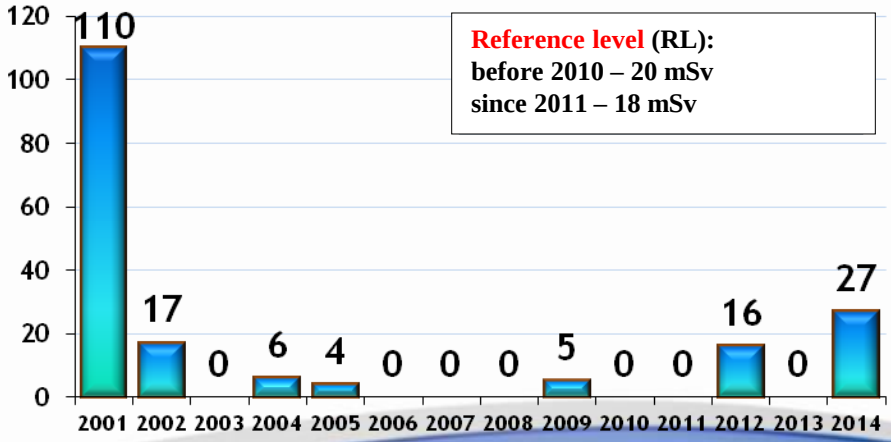
Load Factor



Dynamics of NPP events reportable to Regulator



Number of personnel with individual exposure dose exceeding RL



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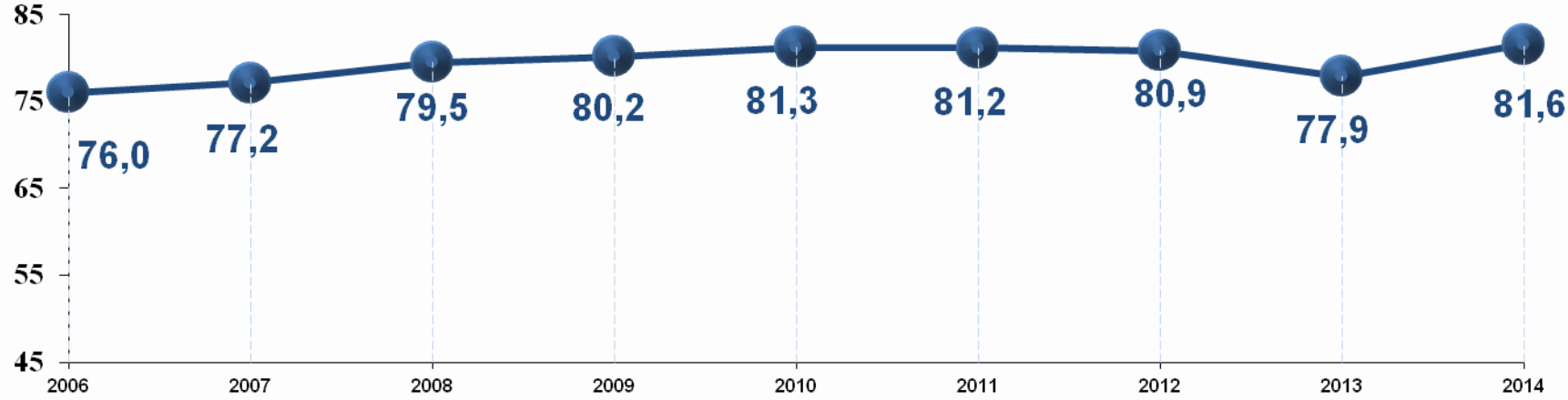
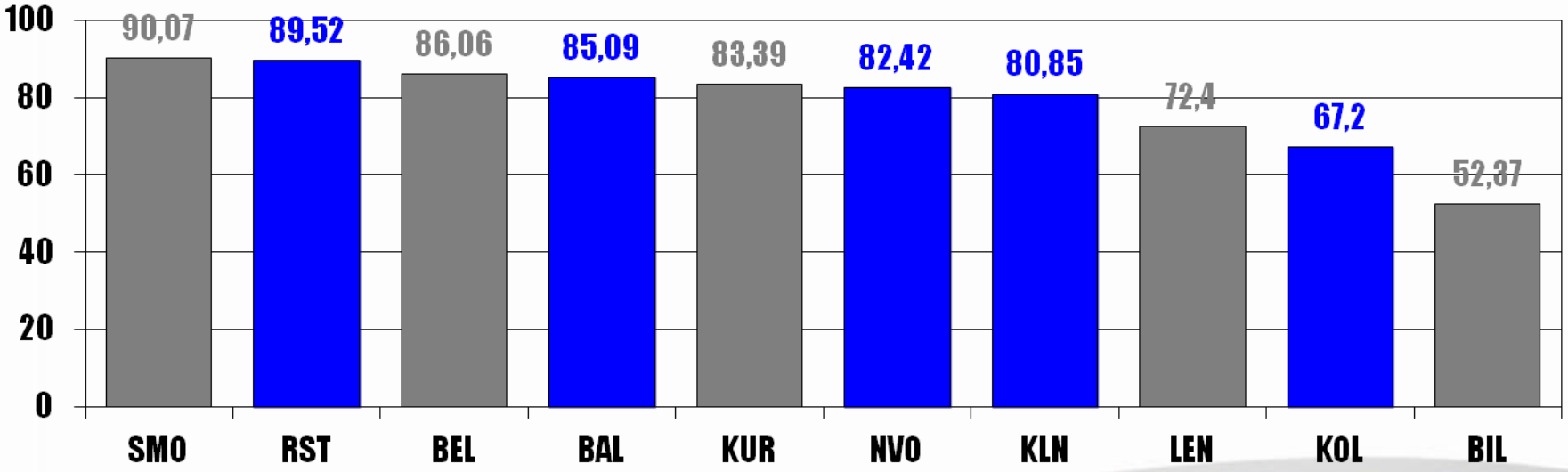
Load Factor (%) Rosenergoatom average and by NPP in 2014





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Main actions for unit power uprating

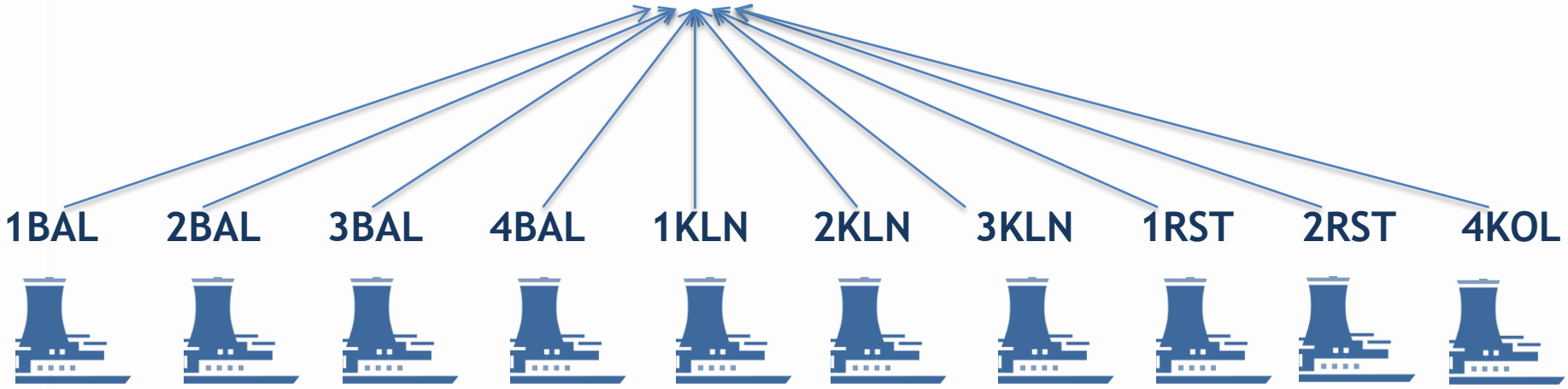
1. Preparation of justification calculations, identification of required modernizations. Changing the reactor plant engineering design.
2. Modernization of monitoring and control facilities at the unit.
3. Obtaining changes in licensing conditions for power uprate to 104% Nnom. and tests performance.
4. Step-by-step power uprate to 104%, performance of tests, issueing reporting materials.
5. Completion of modernizations with due account of the testing results.
6. Obtaining changes in licensing conditions for pilot operation at 104% power level during 2 to 3 fuel cycles.

Main actions for unit power uprating

7	Unit pilot operation during 2 to 3 fuel cycles.
8	Preparation of reports «Environment protection in NPP unit power uprating and operation at power beyond nominal level», «Environment impact assessment».
9	Preparation of report on pilot operation results.
10	Post-modernization unit engineering design updating.
11	Obtaining Statement of the State environmental expert review.
12	Obtaining changes in licensing conditions for commercial operation.

Results of VVER units operation in 2014 at increased power level

Additional power generation in 2014 due to operation of 10 NPP units at the increased power level amounted to: **2.77** bln.kW.h



TOTAL for 2008 ÷ 2014:

Additional generation = **14.26** bln.kW.h

Cost of units modernization ~ **2.7** bln. rub.

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Current status of operating power units at Rosenergoatom NPPs

34 operating units
(incl. 3RoNPP - PO)

25242 MW

12 units of the I-st generation

5762 MW

21 units of the II-nd generation

19480 MW

12 units with service life extended

8 units with service life extended

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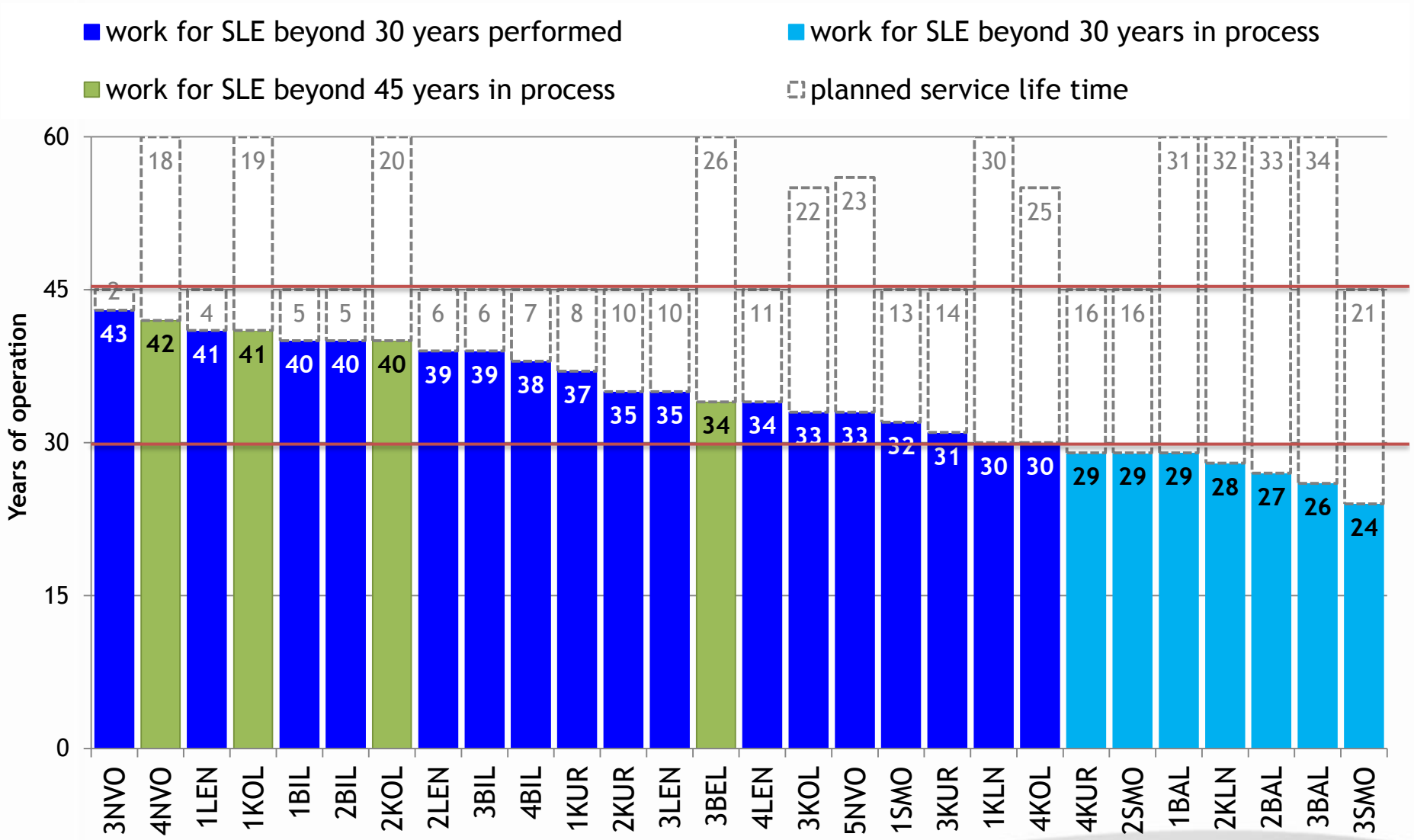
Status of SLE actions at NPP units



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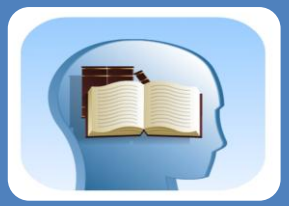
Factors facilitating NPP service life extension work implementation

Conservatism of the adopted calculation base for justification of 30-year service life of the operating NPPs

Large scope of modernization during the design life time



New knowledge in material science, safety and lifetime assessment, computer codes

Unit financial cost of plant service life extension is significantly lower than the cost of any new plant commissioning

Main factors for decision making on NPP units service life extension

Decision on unit preparation for service life extension and estimation of the additional lifetime duration for NPP units

- Possibility of safety assurance and maintaining in long-term operation
- Possibility for temporary storage of additional SNF amount or its removal from the site
- Safety level upgrading due to modernization and equipment replacement
- Availability of required residual life of non-recoverable plant components
- Capability of safety assurance in management of radwaste generated during long-term operation

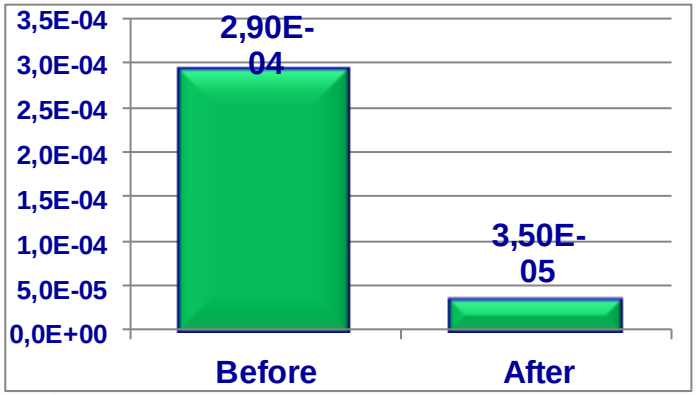
Main areas of unit modernization for SLE :

- Creation of additional systems and independent safety system trains with inherent redundancy
- Creation of additional trains of emergency power supply systems
- Implementation of diagnostic systems
- Implementation of state-of-the-art fire-fighting systems
- Construction of radwaste processing and storage facilities
- Construction of protected emergency response action management stations

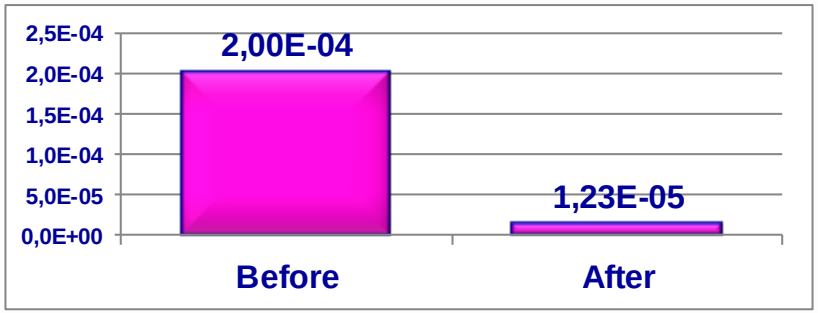
Results of operating units safety upgrading by way of modernization (SLE)

Severe core damage probability

3BEL (BN-600)

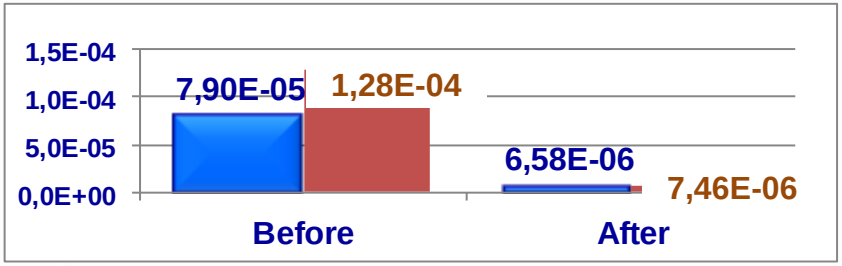


4LEN (RBMK)

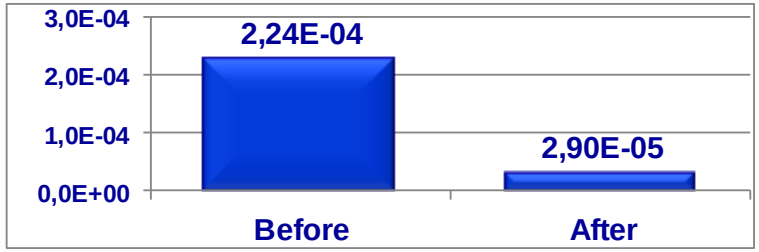


3KOL (VVER-440)

4KOL (VVER-440)



5NVO (VVER-1000)



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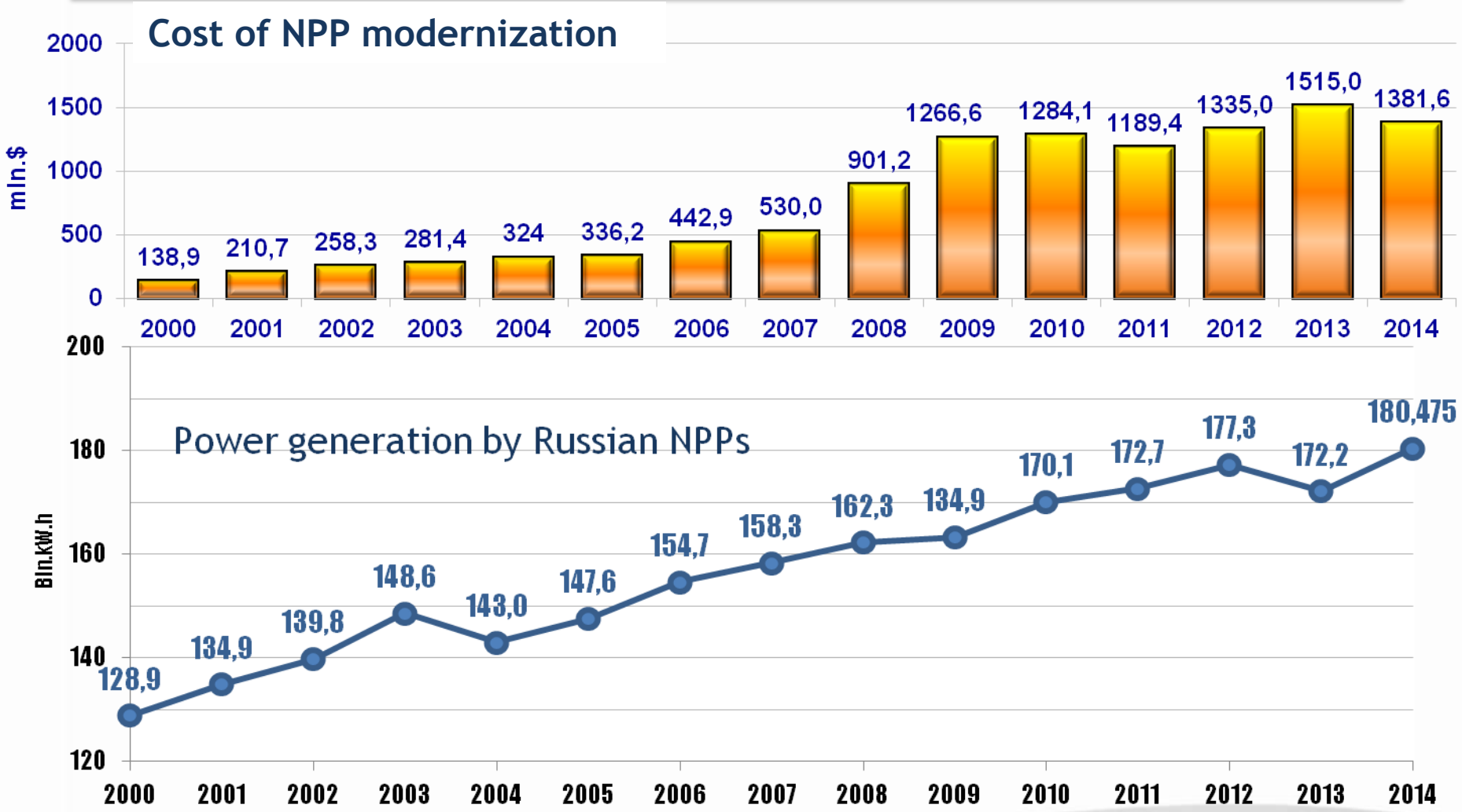
Cost of NPP unit modernization and service life extension



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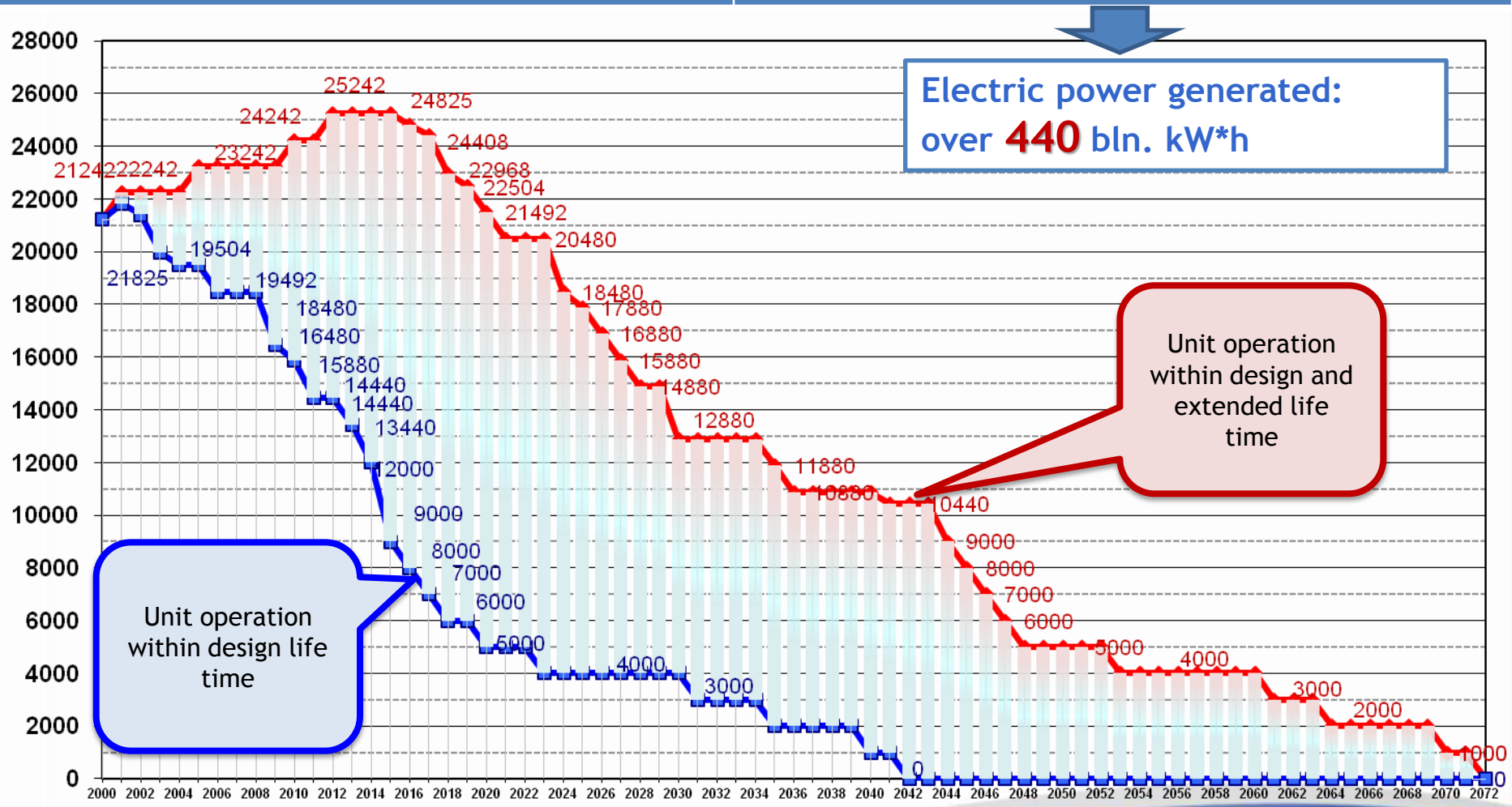
Scenario of NPP generating capacities retirement in Russia

10 NPPs, 33 units, $N_{inst.}$ = 25242 MW | **SLE NPPs - 21 units, $N_{inst.}$ = 13242 MW**



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NPP service life management – a competent service

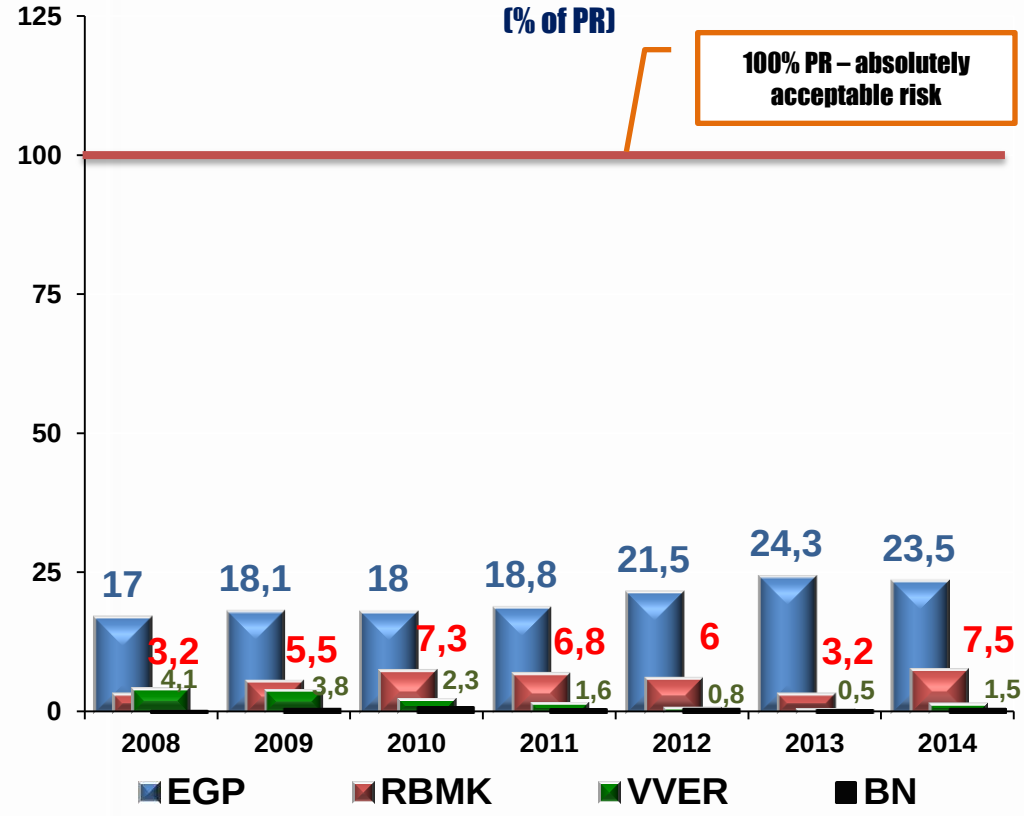
NPP unit service life extension is one of the strategic directions of nuclear power development in Russia, assuring continued power generation and safety upgrading of the operating power units

High level of competences, rich reference experience, unique regulatory, material and technical basis allow implementing SLE projects of any complexity and in the shortest times. We are ready to provide support both in solution of a comprehensive task, and in provision of engineering services in individual phases of unit preparation for operation beyond design life time.

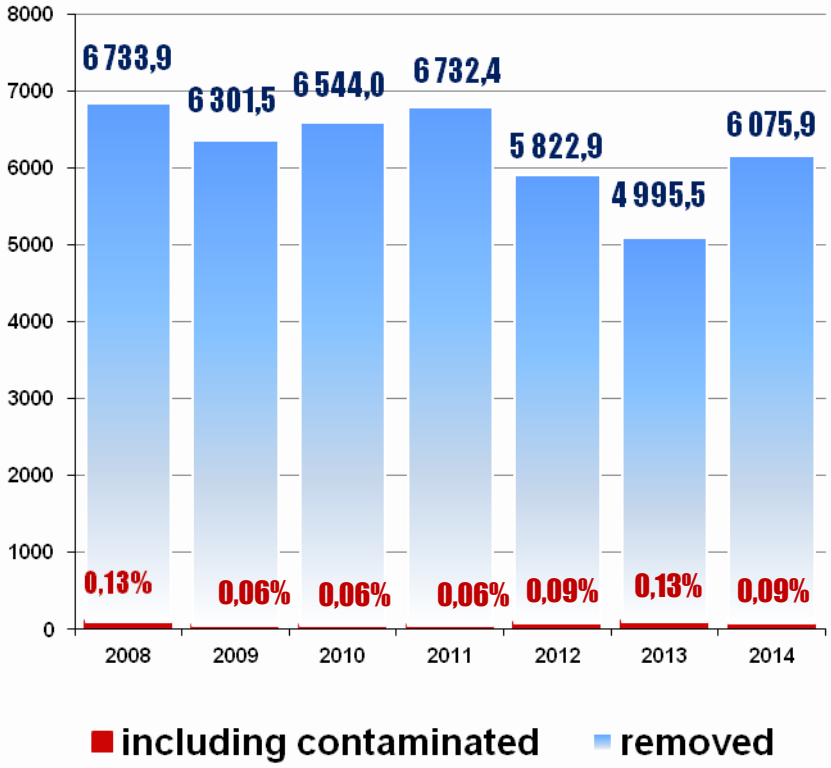
Results of NPP environmental impact

Release of inert radioactive gases

(% of PR)



Volume of contaminated effluents (mln. m3)



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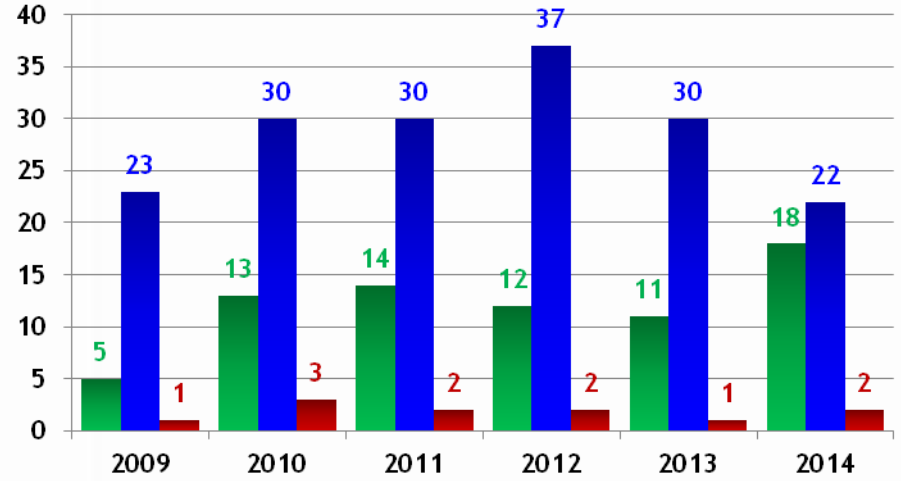
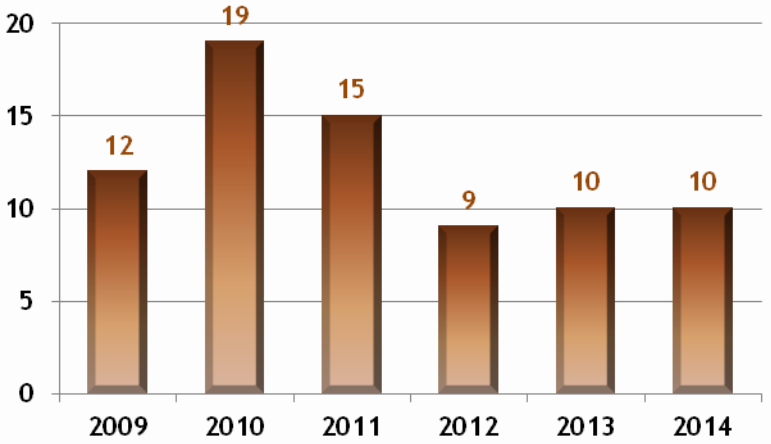
Main NPP safety indicators

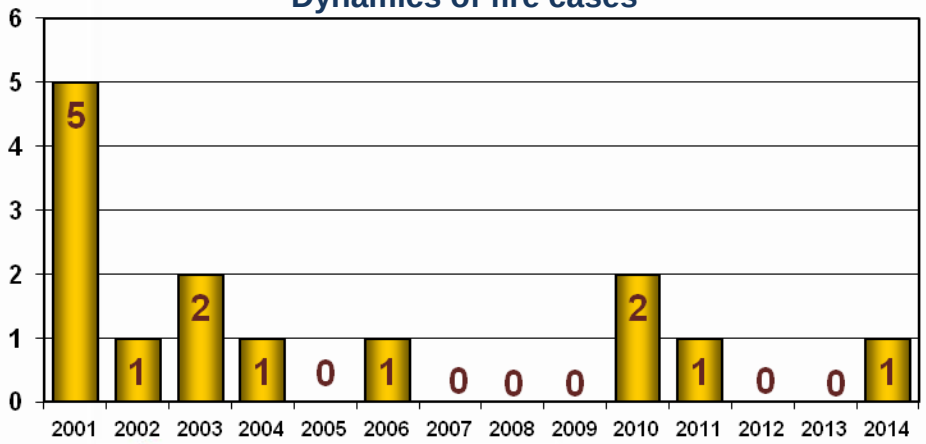
Dynamics of plant performance failures rated by the International nuclear event scale INES



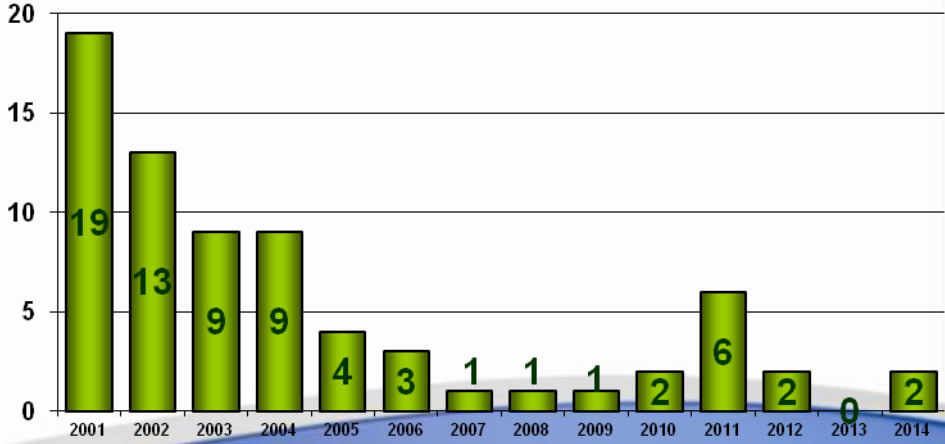
Dynamics of emergency protection activation (FPR)



Dynamics of fire cases



Dynamics of industrial safety accident rate



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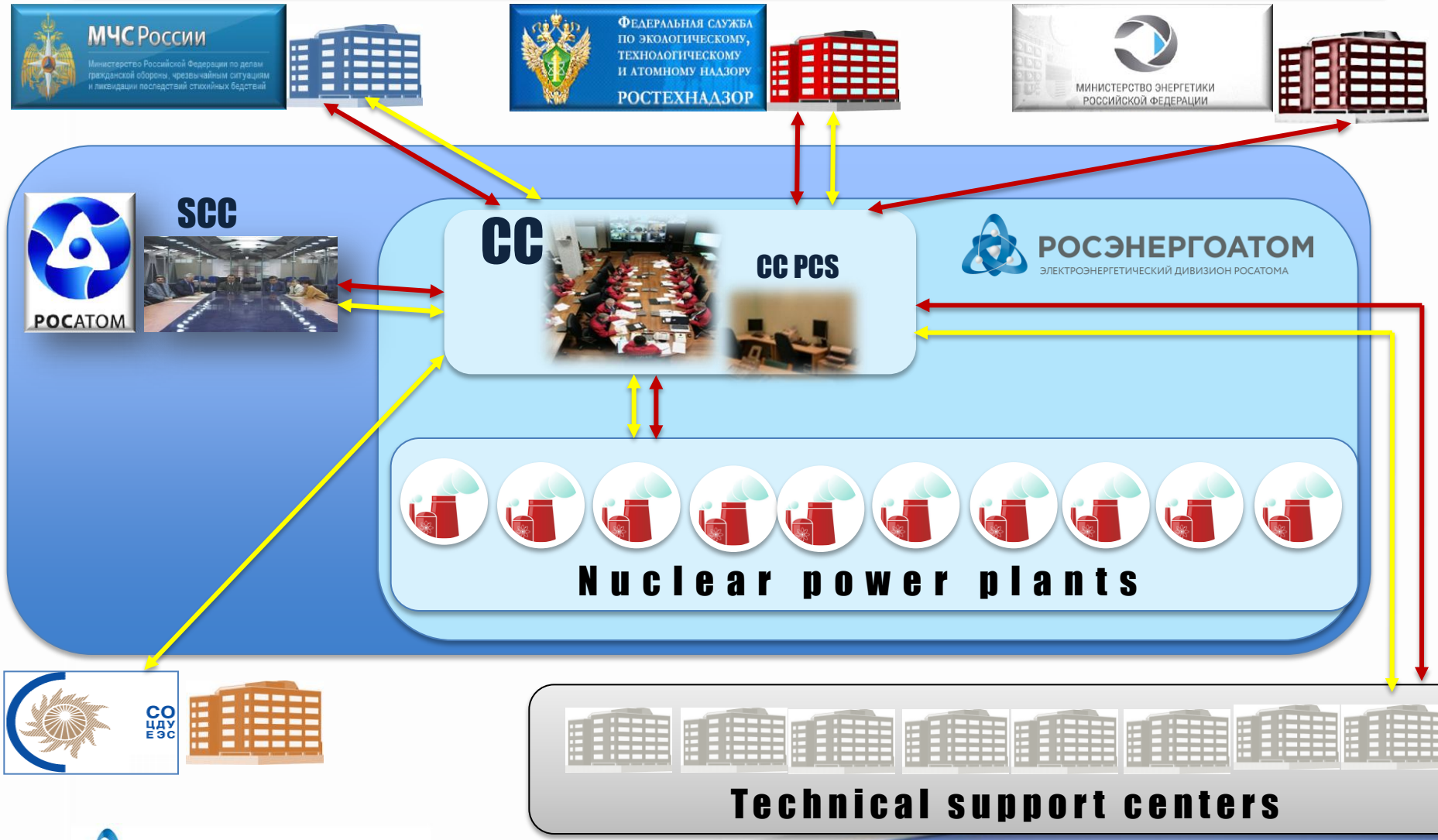
Actions for systematic safety upgrading of operating power units

- Transfer to uranium-gadolinium fuel of up to 5,0%U5 enrichment;
- Introduction of zirconium FAs with rigid rack at VVER-1000 NPPs;
- Transfer to control rods with combined absorber;
- Introduction of anti-debris filters;
- Introduction of vibration-resistant spacer grids.
- Transfer to uranium-erbium fuel of 2,8%U^5 enrichment;
- Replacement of control rods with cluster type ones

Actions for systematic safety upgrading of operating power units

- Modernization of reactor monitoring, control and protection systems with introduction of the second reactor shut-down system;
- Modernization of safety systems (emergency reactor cool-down system, accident localization system, emergency power supply system);
- Modernization of emergency power supply system: replacement of storage batteries, DC panel, diesel generator load following system);
- Modernization of service water system to rule out common cause failures (geographical separation and pumps redundancy);
- Modernization of radiation monitoring system;
- Implementation of gas fire-fighting systems in power unit control and protection systems room

Emergency response system at Russian NPPs



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Data transfer system

Video-conference system

Actions of Operating Organization following Fukushima events

Maintaining personnel and additional facilities preparedness for BDBA without additional design solutions implementation at NPP

- **URGENT** completed in full — 1-3 months
- **SHORT-TERM** completed in full — 6-9 months

Development and implementation of additional design solutions at NPP

- **MEDIUM-TERM** completed in full — 2012-2013
- **LONG-TERM** Under implementation — 2014-2016

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Main long-term post-Fukushima actions

- Development and implementation of "Emergency I&C" system at NPP units
- Implementation of "Emergency & Post-Accident Sampling system"
- Implementation of "Containment depressurization and filtration system"
- Improvement of NPP units seismic resistance

Module of sampling $ sample dilution

Completed updated actions for beyond-design-basis accident mitigation at NPPs

- final lists of beyond-design-basis accidents for VVER-440 and VVER-1000 have been developed;
- beyond-design-basis accident management guidelines have been developed at Kola NPP, Novovoronezh NPP, for Balakovo Units 1,2,3 and Rostov Unit 2;
- refined technical requirements have been developed for “Emergency I&C” system for VVER power plants;
- reactor plants seismic protection system has been commissioned at Kola NPP.

Updated actions under implementation for beyond-design-basis accident mitigation at NPPs

- improvement of communication system between NPPs, Concern's Crisis Center and Protected Control Stations;
- creation of mobile accident management stations;
- development and updating of emergency response documents;
- implementation of "Emergency I&C" system;
- implementation of "Emergency & Post-Accident Sampling" system;
- implementation of "Containment Depressurization and Filtration" system ;
- analysis of seismic effects on NPP.

In 2014 the work was continued to implement actions for beyond-design-basis accident mitigation, similar to the ones for operating NPPs :

- at 5 VVER units **under construction** : Novovoronezh Units 6,7; Leningrad Units 1,2 and Rostov Unit 3
- at newly **designed** VVER power plants.

Rosenergoatom – reliable partner

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