



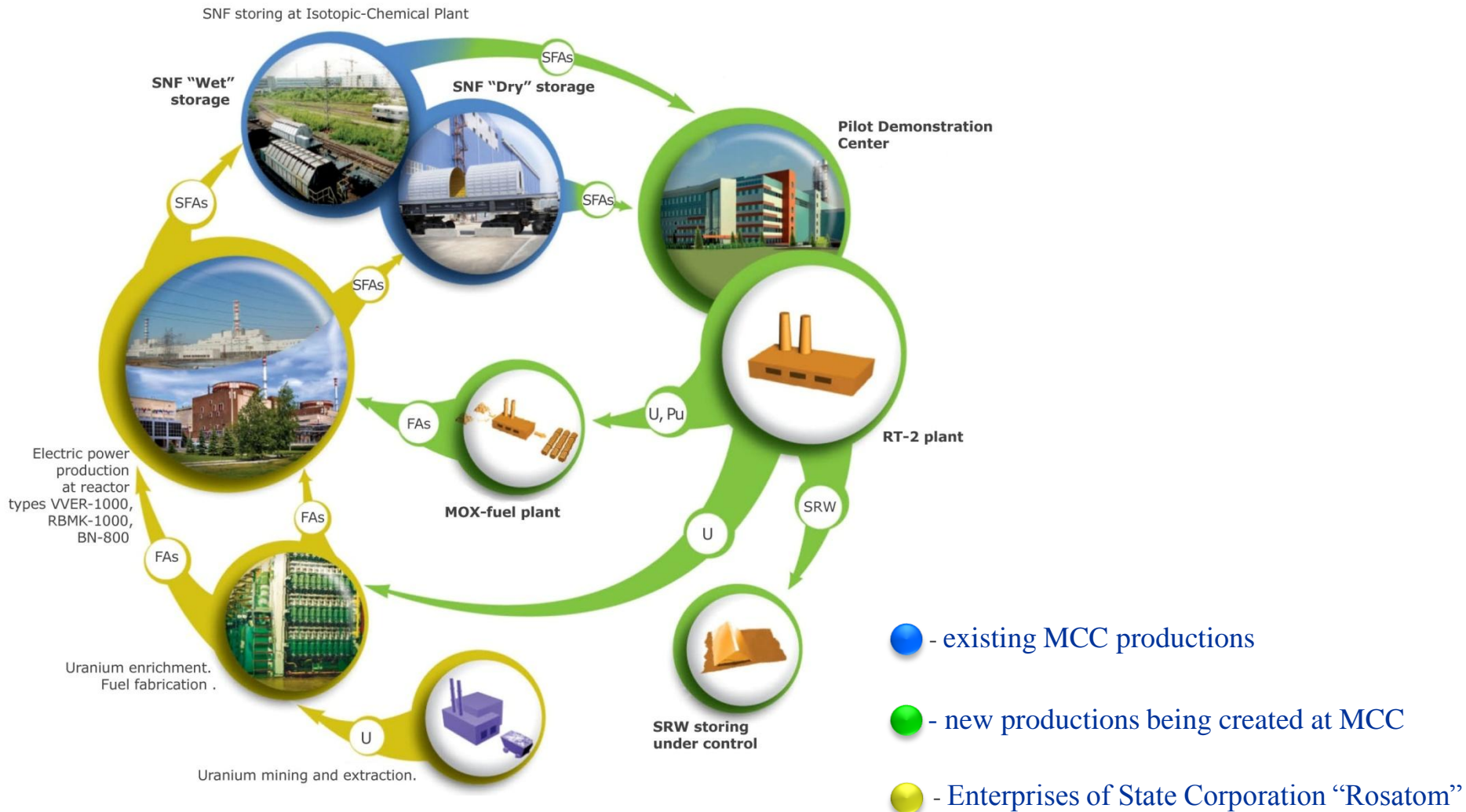
State Atomic Energy Corporation "Rosatom"

FSUE "Mining and Chemical Combine"

# Creating the new technologies of SNF treatment at FSUE "MCC" and closing the Nuclear Fuel Cycle

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# The concept of closing the nuclear fuel cycle at FSUE "MCC"



# Implementation of the industrial infrastructure for CNFC at FSUE “MCC”

- 1. Centralized “wet” storage for SNF from VVER-1000 reactors.**
- 2. Centralized “dry” storage for SNF from RBMK-1000 and VVER-1000 reactors.**
- 3. Pilot Demonstration Center for SNF reprocessing based on innovative technologies (PDC).**
- 4. MOX-fuel production to supply BN-800 reactor of Beloyarskaya NPP with necessary fuel.**

# Centralized water-cooled (“wet”) storage for SNF from VVER-1000, storing hall



**Successful acceptance and safe storing of VVER-1000 SNF since the year 1985.**

# Water-cooled (“wet”) storage for VVER-1000 SNF



## Parameters of the storage:

Capacity – more than 8000 t of VVER-1000 SNF;

Total water volume in the cooling system – 40000 m<sup>3</sup>;

Water temperature in bays – max 50 °C;

Hoisting machines available;

System of standby vessels for cooling water supply;

Each bay is hermetically sealed with an option of its maintenance and repair.

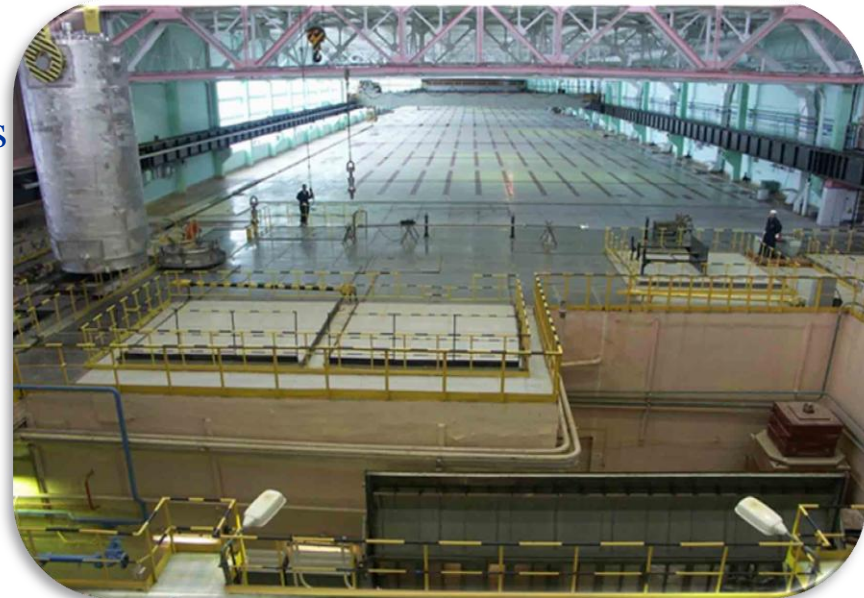
# Reconstruction of the “wet” storage

**As a result of reconstruction between the years 2008 and 2011 which had been started three years before the accident at Fukushima Daiichi NPP the following qualitative improvements were made:**

- The seismic stability of the building has been considerably increased: the foundation and building structures reinforced, the roof lightened;
- Several cranes are replaced with their weight-carrying ability improved;
- The cooling system has become more effective and reliable.

**The works implemented allowed the following:**

- Ensuring continuous operation of the Russian NPPs before commissioning of the new facilities for VVER-100 SNF storing and reprocessing;
- Enlarging the storage capacity by 2600 tons of SNF;
- Beginning of works to extend the storage lifetime.



# Results of deterministic analysis of the beyond-design-basis accidents for SNF “wet” storage

- For the first time ever deterministic analysis of the beyond-design-basis accidents was made for the “wet” storage as the SNF storing site.
- Analysis results show total probability of the beyond-design-basis accidents does not exceed  $0.9 \times 10^{-6}$  a year, which complies with standard criteria of safety protection applied for the sites using nuclear energy.
- Effective measures of beyond-design-basis accidents management are developed and successfully implemented according to the principle of passive safety protection:
  - Water irrigation of SFAs in damaged bays;
  - Stable cooling of undamaged basin bays;
  - Reliable operation of regular ventilation.

# Centralized air-cooled (“dry”) storage for SNF from RBMK-1000 reactors



The first starting complex of the “dry” storage for RBMK-1000 SNF has been in operation since February 2012.

The second stage for storing SNF from RBMK-1000 and VVER-1000 is planned to be put into full-scale operation in the year 2015.



# View of buildings under construction of the centralized storing complex designed for SNF from energy reactors.



The project of dry storage facility has successfully passed the international expert assessment at SGN company (France). Proposals stated in Expert's report were taken into account during the storage facility construction.

# SNF storing technologies

- Application of the unique equipment developed in Russia with no equals all over the world;
- All engineering operations related to SNF movement are executed in automatic mode with technical eye application to reduce the radiation influence to personnel considerably and exclude the influence of “human factor” to protection of SNF storing safety;
- Application of passive principle of safety protection when storing the SNF – natural cooling air-flow convection.

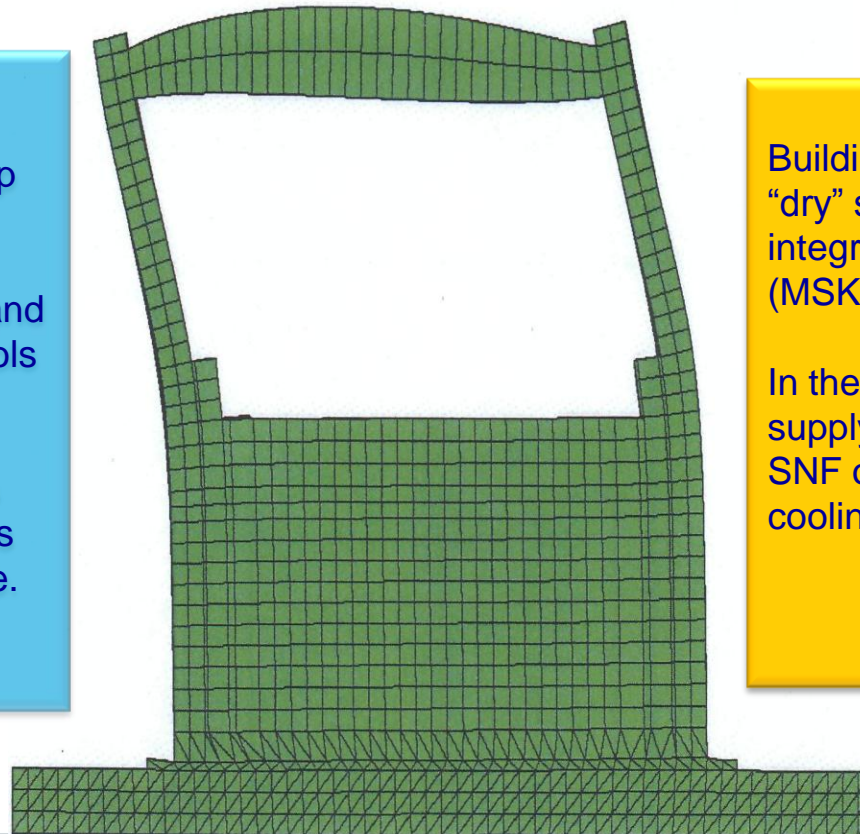
# Crash-test for SNF “wet” and “dry” storages

In 2011, the All-Russian Design and Scientific-Research Institute of Power Engineering Technology (VNIPIET) calculated the ultimate seismic stability for building constructions and equipment of SNF “wet” and “dry” storage facilities according to FSUE “MCC” instructions under specially developed strategies. Maximum seismic load for the site is 7 points (MSK-64 magnitude).

## «WET»

Building constructions of “wet” storage facility maintain integrity up to 8-point load (MSK-64 scale).

In the case of loss power supply, and seal failure of four SNF storing pools the cooldown of SNF is ensured within 72 hours due to irrigation system where self-flowing water is entered from emergency reservoirs on the basis of gravitation principle.

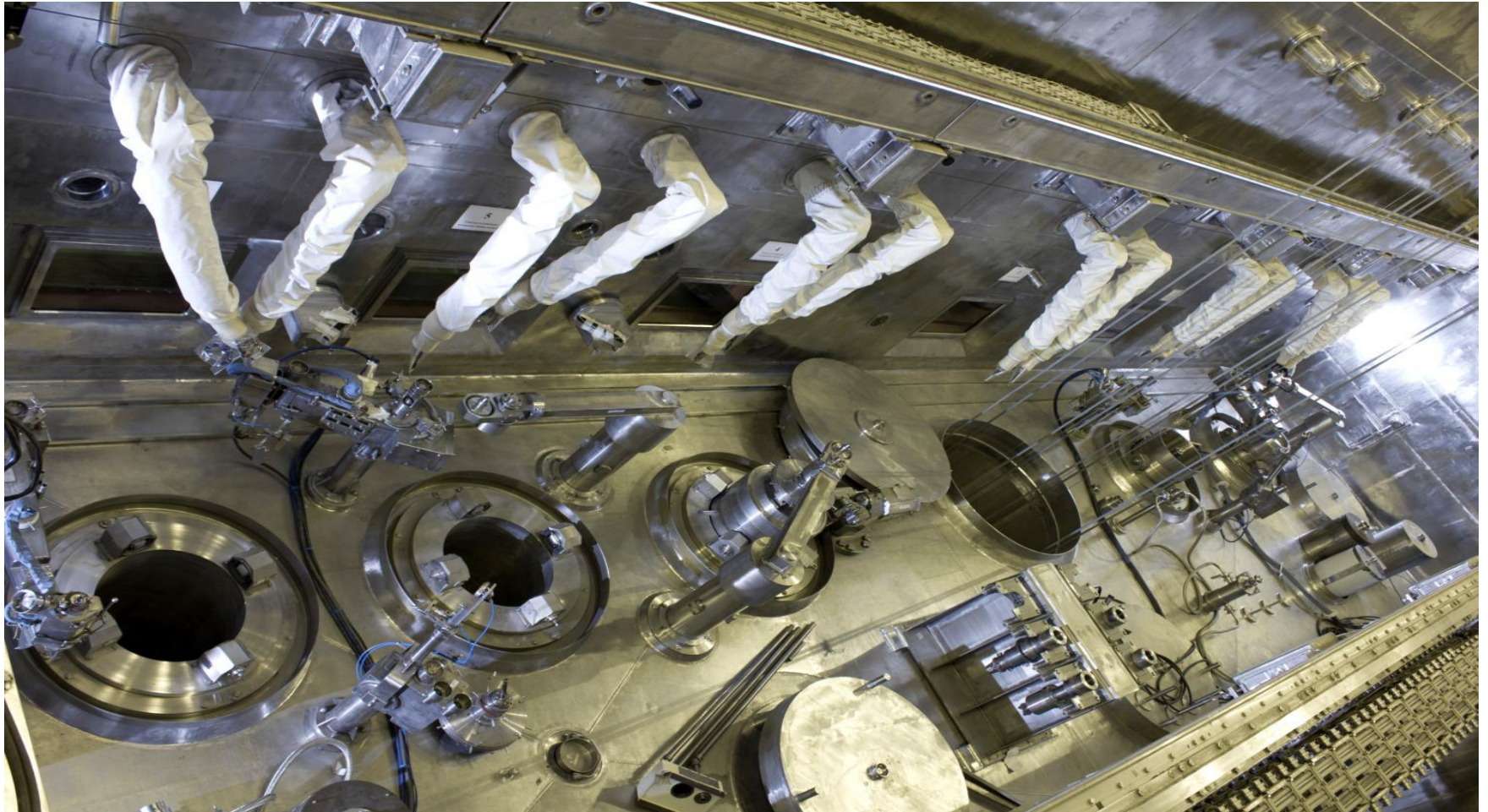


## «DRY»

Building constructions of “dry” storage facility maintain integrity up to 9.6 point load (MSK-64 scale).

In the case of loss power supply, heat is removed from SNF on the basis of natural cooling airflow convection.

# Hot cell to complete cases with RBMK-1000 SNF



**The centralized air-cooled chamber-type storage is the safest and the most economically sound one.**

# Pilot Demonstration Center for SNF treatment based on innovative technologies

**2015** – Start-up facility of research hot cells to be put into operation.

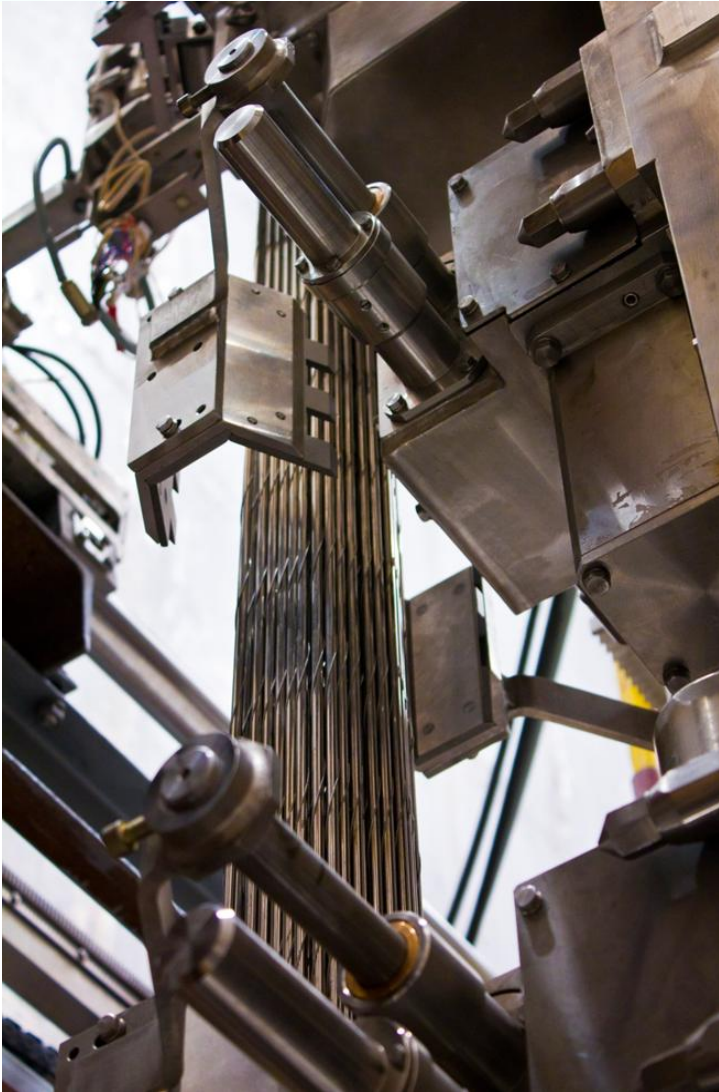
New treatment technologies of SNF from both thermal and fast neutron energy reactors along with closing the NFC to be developed.

**2018** – The second start-up facility to be put into operation – the basic technology of VVER-1000 SNF treatment with productivity up to 250 t/y. Innovative technologies of VVER-1000 SNF treatment to be developed; initial data for designing the full-scale radio-chemical plant and technology replication to be obtained.



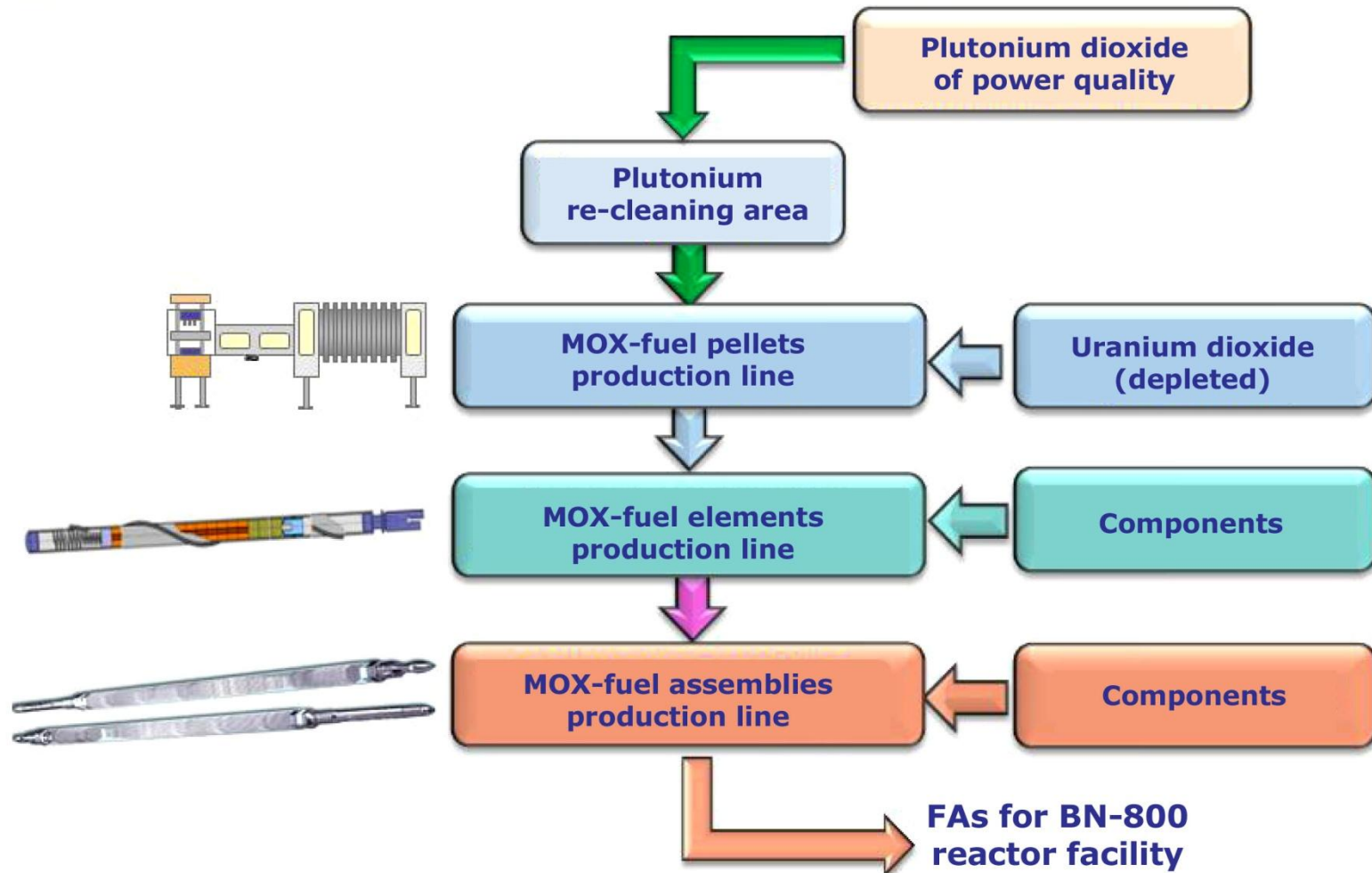


# MOX-fuel production to supply BN-800 reactor facility with fuel



- Production of MOX-fuel assemblies is scheduled for December 2014 to supply BN-800 reactor of Beloyarskaya NPP with necessary fuel.
- The production site is located in MCC underground facilities. The rock is a natural powerful containment ensuring protection from any external natural and anthropogenic threats.
- All the equipment is placed into a chain of protecting multi-barrier hot cells interconnected by transport-and-transfer devices.
- All working operations are automated as much as possible with remote control applied; the equipment has no equals worldwide.
- The best international practices are applied to handle with the recycled fissile materials.

# Process flow chart for FAs with MOX-fuel production at MCC





# Test bench to improve the technology of obtaining uranium-plutonium fuel pellets



# Conclusion

- The industrial productions of the closed nuclear fuel cycle have been created and are still in process of creation at FSUE ‘MCC’ site for the first time in world practice.
- In process of creating those productions the most complex scientific and technical tasks are being solved with leading branch institutes of State Corporation ‘Rosatom’ and scientific organizations of Russia involved.
- For the maximum technological and environmental safety along with economical efficiency all the abovementioned productions are in fact consolidated in the unified technology complex which is already able to supply atomic energy complex with necessary fuel to ensure Russia’s power safety and further economic development.