ROSATOM

ATOMEXPO 2016

STATE ATOMIC ENERGY CORPORATION ROSATOM

Back-end solutions in the world market: Russian experience and referents

Federal target programs ”Nuclear and radiation safety” implementation

O.V. Kryukov

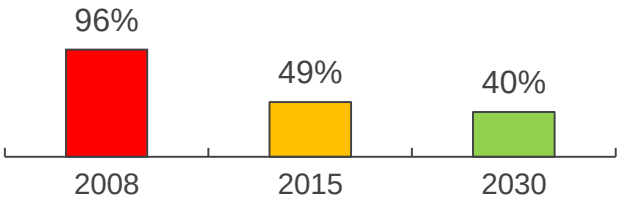
Director of State Policy
in the field of Radwaste management,
SNF Management and NF Decommissioning

Back End strategy evolution

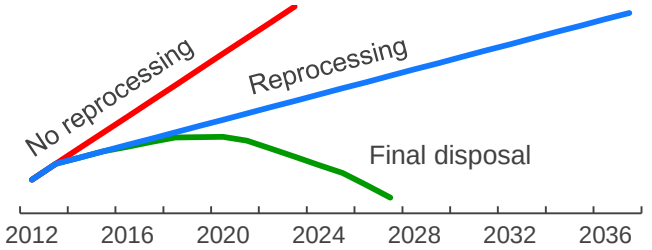
The main objectives in Back End

	Key objectives:	Priority tasks:
SNF	Reduce SNF volumes through reprocessing	Develop technologies and infrastructure: • dry storage at MCC; • SNF reprocessing; • MOX fuel for FR; • REMIX fuel for LWR.
RW	Reduce RW volumes in storage. Conditioning and disposal .	• Construction final disposal facilities for LLRW, MLRW, HLRW and industrial facilities for RW • Establishment of the Unified State Radwaste Management System
Decommissioning	Decrease the cumulative burden of maintaining shutdown facilities	• Establish an inventory of nuclear facilities subject to decommissioning • Rank facilities to be decommissioned by their potential hazard and roadmap development

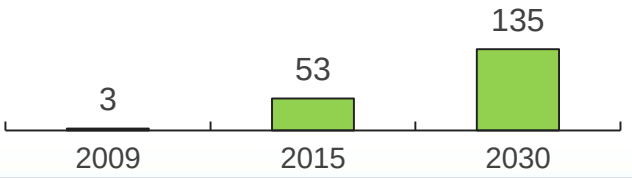
Filling of SNF storage facilities (at NPP and centralised ones)



Termination of radwaste accumulation



Phase-out of hazardous nuclear and radiation facilities (pcs)



Back End strategy evolution

Establishment of the Unified State Radwaste Management System

The fundamental principles in the Radioactive Waste Management Federal Law (Ref. No. 190-FZ dated 11th July 2011):

- principle of mandatory final disposal of radwaste;
- introduction of radwaste categories for the purpose of radwaste final disposal;
- principle of responsibilities separation between the state and business;
- establishment of the Unified State Radwaste Management System.

Accumulated radwaste,
Owned by the State

- Initial registration of radwaste
- Ownership of radwaste registered
- Source of funding identified: Federal Target Programme for Nuclear and Radiation Safety (NRS)

Newly generated radwaste,
Radwaste business

- Tariffs for final disposal established depending on the category
- Source of funding identified: radwaste disposal fund
- Annual assessment of companies liabilities

NO RW

- Establishment of the National Operator for Radioactive Waste Management.
- Development of a map that indicates planned siting of radwaste repositories.

The programme was adopted in 2007.

Programme objectives:

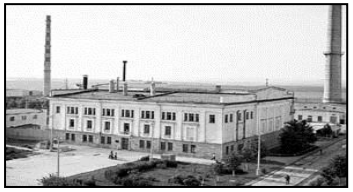
1. Remove the risk of accidents at legacy nuclear facilities;
2. Hold legacy facilities in stable controlled condition;
3. Establish a legislative framework in the area of SNF and radwaste management, and nuclear facilities decommissioning;
4. Establish a mechanism for accumulating funds for guaranteed ensuring of nuclear and radiation safety in the current and long-term periods.

SNF reloading into a ‘dry’ storage facility at MCC

Decommissioning of the radwaste storage facility

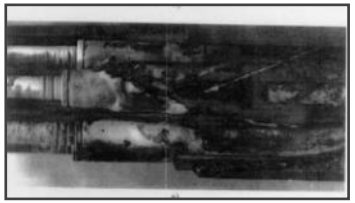
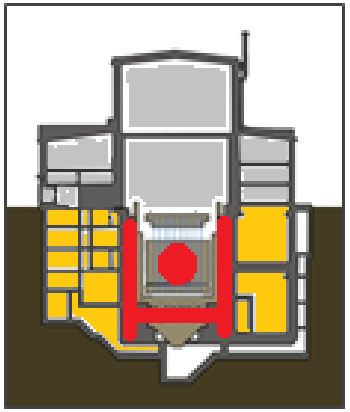
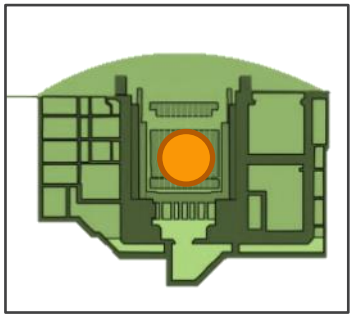
Federal target program

Solution of accumulated problems

Used to be in 2008		Present day condition: 2015	
SNF storage facilities at NPP (RBMK reactors) were filled up to a critical level – **96%.**		The level of filling up storage facilities has been reduced to **49%.** 'Dry' SNF storage facility has been commissioned at MCC.	
Storage RW in open water reservoir. Activity: 140 mil. Ci.		November 2015 : – Karachai Lake, – B2 water reservoir at CC have been completely closed. Monitoring of their condition has been arranged via 140 observation wells.	
134 facilities were in shutdown mode (RRs, nuclear installations, NPP units).		**53** facilities have been decommissioned. 2.7 mil. m^2 of radioactively contaminated areas have been remediated.	
No technology for dismantling heavy-tonnage ships		The Volodarsky tanker ship has been dismantled	

Federal target program

Development of key technologies

Used to be in 2008		Present day condition: 2015	
Accumulation of SNF from VVER-1000 reactors. No reprocessing technologies.		For PDF SNF reprocessing technology without release into the environment was developed. A 3rd generation plant for SNF reprocessing is under construction.	
Risk of cladding corrosion of ‘ damage’ SFAs.		Technologies for reprocessing ‘damage’ uranium-zirconium and uranium-beryllium SNF have been developed. Pilot batches of ‘damage SNF from RBMK and AM reactors have been reprocessed.	
No technology for mothballing of commercial uranium-graphite reactors (CUGR).		– Fuel has been unloaded; – 2,800 t of equipment have been dismounting; – 60,000 m^3 of compartments have been filled with barrier material; – Monitoring of the condition has been ensured; – Safety for over 1000 years has been guaranteed. EI-2 is the world’s first mothballed uranium-graphite reactor.	

Programme objectives for 2016 to 2030:

1. Making nuclear legacy facilities safe and secure to be subsequently phased-out;
2. Establishment of infrastructure for federal SNF reprocessing and final isolation of radwaste;
3. Final isolation disposal of accumulated federal disposable radwaste.

SNF removal for reprocessing and centralised storage

Programme funding:

1. Making nuclear legacy facilities safe and secure to be subsequently phased-out	**72 %**
2. Establishment of infrastructure for federal SNF reprocessing and final isolation of radwaste	**20 %**
3. Development of NRS (nuclear & radiation safety) control systems and ensuring	**5 %**
4 R&D and methodological support to activities in the NRS area	**3 %**

Development of key technologies

Philosophy of SNF reprocessing – maximum natural resources use

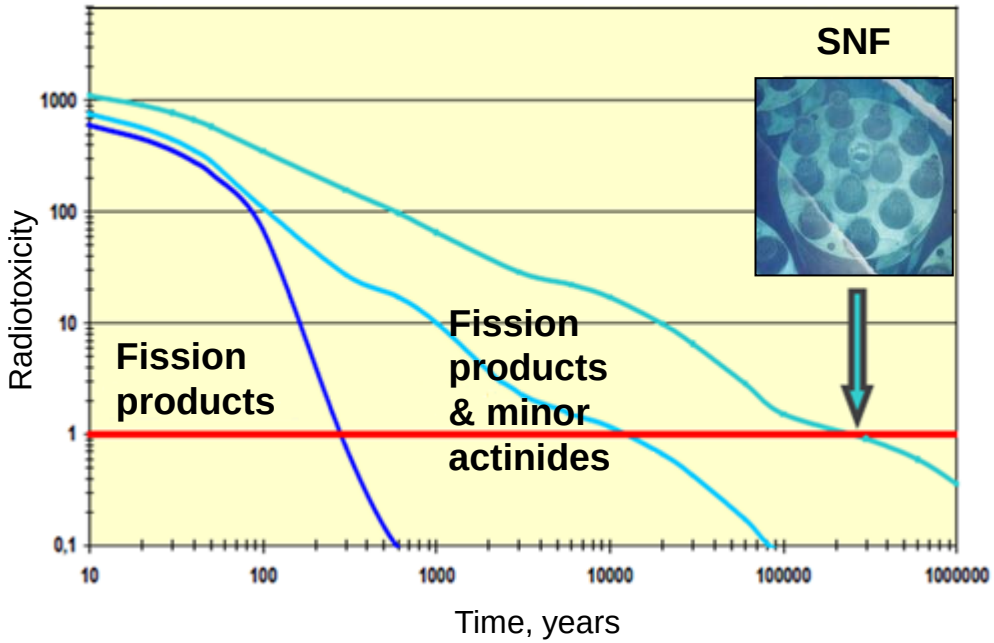
1. The spent fuel contains unused energy potential about 25% of the "fresh" fuel assemblies.

1 assembly (440 kg. HM) ~ 31,5 MH/hour

This power consumption = 12 400 flats per year.

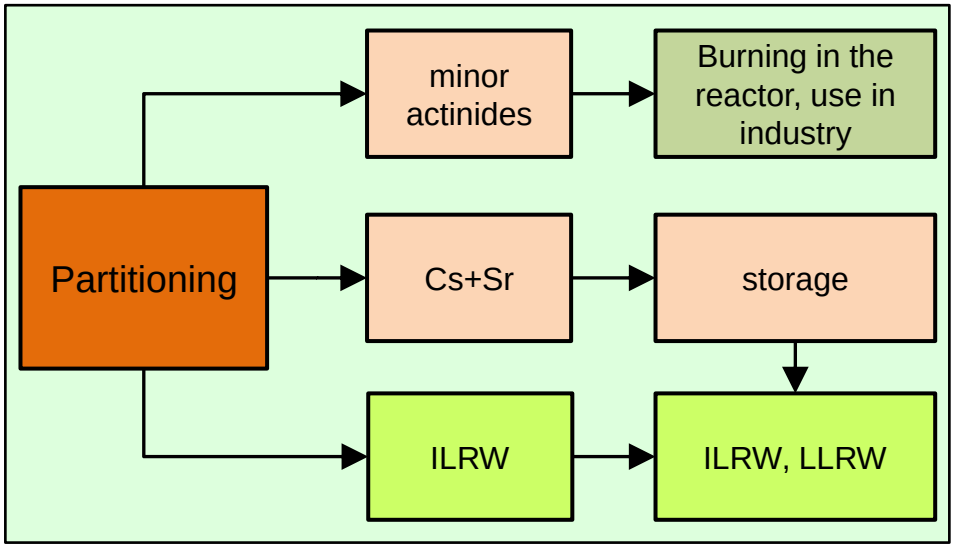
2. Reduce the radiotoxicity

Schedule of spent nuclear fuel and radioactive waste (solidified)



In relative terms, the unit adopted radiotoxicity of natural uranium

Partitioning of HLW



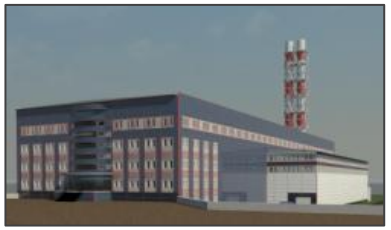
Development of key technologies

Rosatom's innovation technologies in the SNF management area

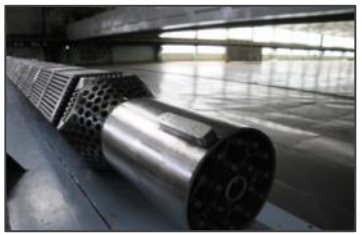
Storage technologies: from 'wet' to 'dry' SNF storage –

Transition to passive safety systems of SNF storage

Technologies of reprocessing and new fuel fabrication: MOX and REMIX fuel.



SNF reprocessing; from the 1st generation plant to the 3rd generation plant. Absence of radwaste releases. Minimisation of radwaste to be disposed of.

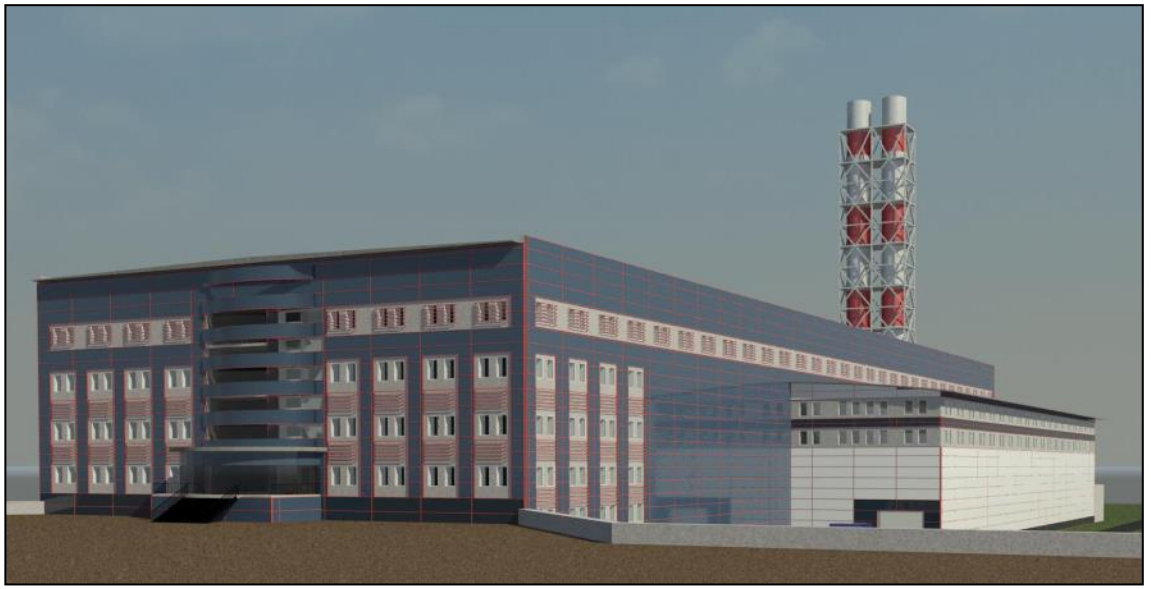


Start to recycle nuclear materials in thermal and fast reactors

Development of key technologies

SNF Reprocessing Pilot Demonstration Centre

The PDC – an innovative reprocessing plant of the third generation – no RW realese.



Cconstruction of the 3rd generation SNF reprocessing complex at MCC

2016 – commissioning of a start-up complex of research hot cells. Confirmation of new technologies for reprocessing SNF from both thermal and fast reactors.

2020 – commissioning of the next start-up complex: for reprocessing SNF from VVER-1000 reactors. The capacity of the complex will be up to 250t of SNF annually.

Development of key technologies

MOX fuel

MOX fuel fabrication industrial plant was constructed at MCC in 2014.

For Russia, this is the first step towards commercial involvement of the plutonium potential into the nuclear fuel cycle by closing the nuclear fuel cycle at BN-800 fast neutron reactors.

System for fuel pellets sintering,
MOX fuel fabrication

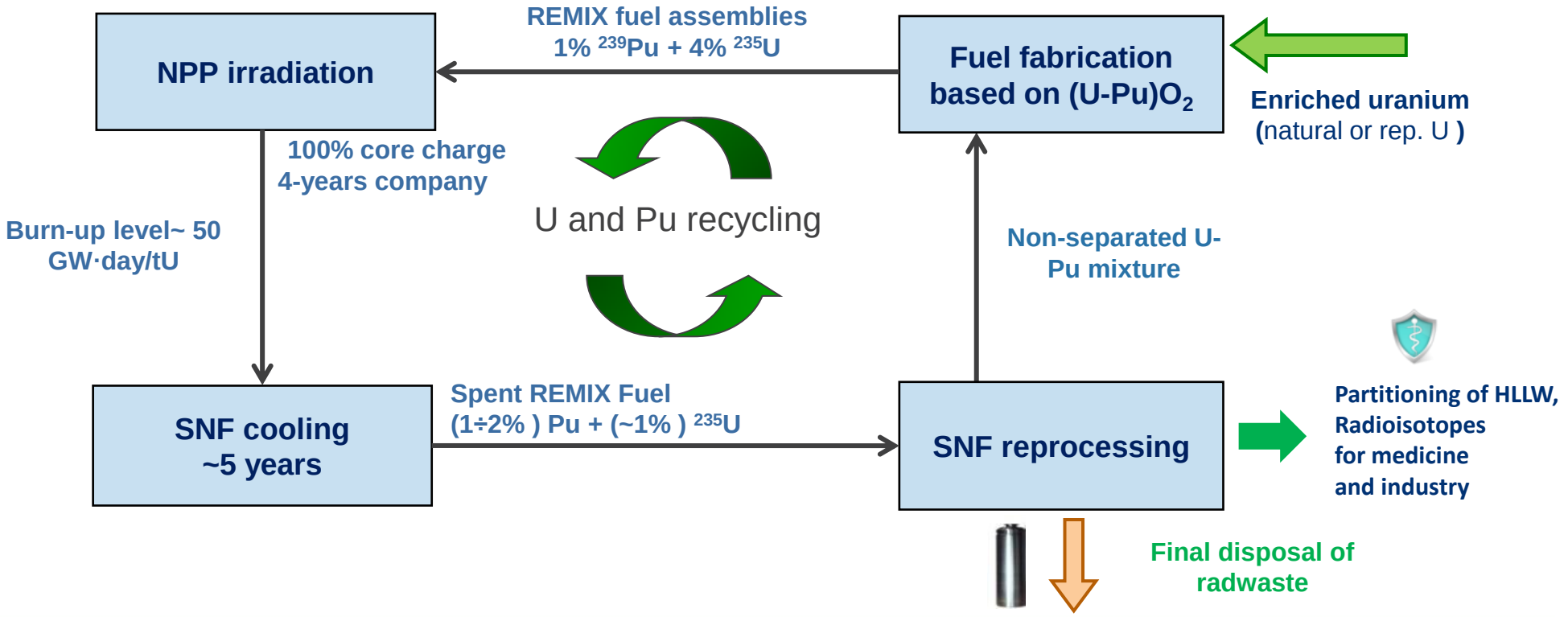
System for assembling fuel rods into
the final fuel assembly structure

Development of key technologies

REMIX fuel - plutonium multi - recycling in thermal reactors (VVER-1000)

REMIX fuel is the non-separated mixture of U and Pu from LWR SNF reprocessing, with the addition of enriched uranium (natural or rep. U)

REMIX fuel enables multiple recycling of the entire quantity of U and Pu extracted from SNF, with the 100% charging of the reactor core and 20%- saving of natural uranium in each cycle.



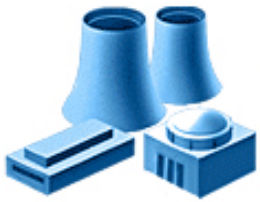
Development of key technologies

SNF reprocessing in order to close the nuclear fuel cycle (NFC)

Thermal reactors

Integrated SNF management complex

Fast reactors



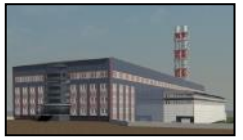
VVER-1000/1200

Uranium and REMIX SNF

Storage

SNF

SNF reprocessing

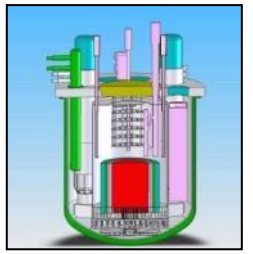


U, Pu

Fabrication of nuclear fuel with Pu

Fresh uranium and REMIX fuel

MOX SNF



BN-800/1200

Fresh MOX fuel

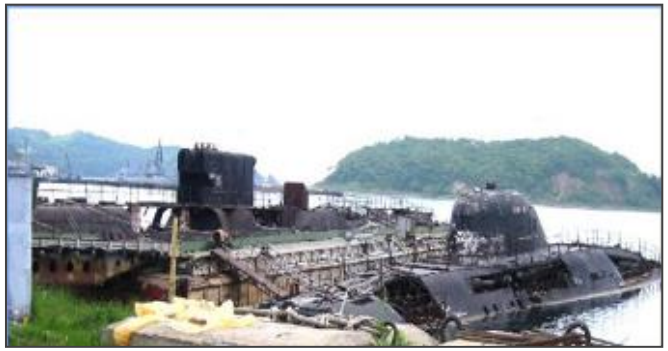
Final disposal of radwaste

Solution of the accumulated problems in the far East

Management of nuclear submarines and reactor compartments

POCATOM

A shelter has been established for fragments of nuclear submarines in an emergency condition



Used to be: nuclear submarines in an emergency condition afloat with SNF in reactors

Present day condition: Nuclear submarine units emplaced for safe long-term storage

Emplacement of reactor compartments (RCs) for long-term storage

Used to be: Site for RC interim storage afloat at Razboynik Bay

Present day condition: RC long-term storage site

Solution of the accumulated problems in the far East
Removal of spent nuclear fuel generated at submarines

Infrastructure for SNF retrieval (unloading) and removal for reprocessing has been refurbished

Retrieval equipment

Cranage and lifting equipment

Motor roads and transport vehicles

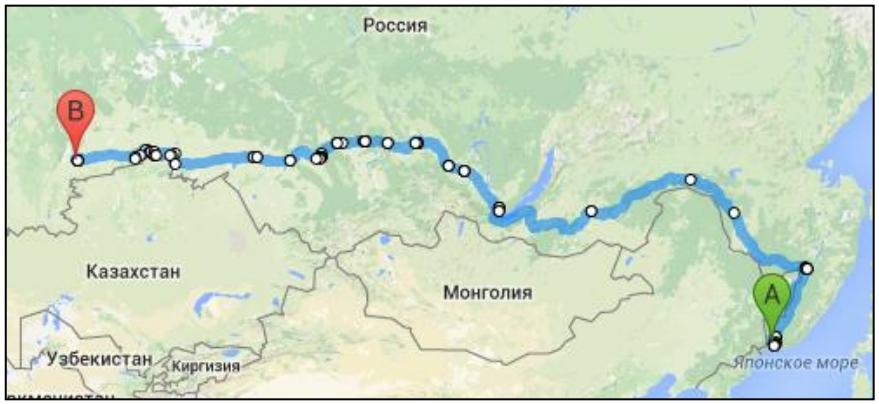
Railway section and SNF transhipment infrastructure

All SNF accumulated by the Navy was removed for reprocessing

between 2002 and 2014.

(23,616 SFAs,total activity: ~ 84 mil. Ci).

Transport route



Transportation distance: 7,256 km.