SNF management system development and deployment in Russia

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26-29 May 2015
ROSATOM- Fully Integrated Nuclear Technology Company

ROSATOM Operations

1. Mining
2. Gas centrifuges manufacturing
3. Fuel fabrication
4. Conversion and enrichment
5. Research and development
6. NPPs engineering & construction
7. Power equipment and services
8. Spent nuclear fuel management
9. Power Generation

ROSATOM- Fully Integrated Nuclear Technology Company
Russia operates 34 nuclear power units with the installed capacity of 25.2 GW.

LONG-TERM PLANNING: one-time large-scale construction of 9 units. Commissioning of 16 units in 2020, and 38 units in 2030.
The basis of the Russian Federation policy in the area of SNF management is the principle of SNF reprocessing in order to ensure ecologically acceptable management of nuclear fission products and return of the regenerated nuclear materials into the fuel cycle. The strategic areas in SNF management are establishment of a reliable system SNF storage, development of SNF reprocessing technologies, balanced involvement of the SNF regeneration products into the nuclear fuel cycle, final isolation (disposal) of radioactive waste generated after the reprocessing.
Roadmap: Development of SNF Management Infrastructure in Russia

- MOX-fuel production
- Pilot-demonstration center (start-up facility)
- «Dry» storage for VVERs-1000 and RBMK-1000 SNF

- Pilot-demonstration center (250 tons annually)
- Reprocessing plant RT-2 (700 tons annually)
RT-1 SNF Reprocessing Plant in Ozersk.
The first SNF Reprocessing Facility in Russia

- The only SNF reprocessing plant in Russia
- Operation since 1977
- Over 5000 ton of SNF reprocessed
- Annual reprocessing of appr. 120-140 tons of SNF (from VVER-440, BN-600, research reactors, icebreakers and submarines)
- The list of the reprocessed SNF is diversifying (supplemented by the damaged spent fuel from RBMKs, plans for reprocessing of SNF from AMB, EGP and all the types of research reactors)
- The technology of reprocessing: Purex-process (extraction of regenerated Uranium, Plutonium and Neptunium as the reprocessing products), vitrified HLW
- Production of isotopes Cs-137, Am-241, Pu-238, Sr-90
The infrastructure of SNF management to be created at Mining and Chemical Combine at Zheleznogorsk

- Centralized water-cooled (“wet”) SNF storage facility;
- Centralized air-cooled (“dry”) SNF storage facility;
- Pilot Demonstration Center for innovation-based SNF treatment;
- MOX fuel fabrication for fast neutron BN-800 type reactors

- URL (in future – disposal facility for MLW&HLW).
Centralized «Wet» Storage in Zheleznogorsk

• Since 1986;
• Iron-concrete steel coated reservoir filled with water
• Forced SNF cooling; minimum water transparency 97%
• Maximum water temperature 50 °C (never exceeded)
• Emergency water tank
• VVER SNF is intended to be moved to the dry storage in 2016-2025
Dry Storage in MCC(Zheleznogorsk): Centralized SNF Storage

- The start-up facility has been already in operation
- Fully automated transportation equipment
- Gas charged casks (N₂+He₂), natural cooling
- Withstands the earthquake up to 9.6 MCP
- Withstands the aircraft impact with weight up to 5 tons
- During 2012, this facility received 1 266 SFAs from RBMK-1000 units, and in 2013 the number of SFAs delivered for storage were 1 701; 3 400 SFAs delivered to the facility in 2014
The second stage of the “dry” storage will be applied for storing SFAs from RBMK-1000; VVER-1000 SFAs will be also stored there after cooling in the “wet” storage. Construction of the second stage of the storage facility for SFN from WWER-1000 and RBMK-1000 is currently underway and it is planned to be put into operation in 2015.
The “dry” storing technology is based on the **passive principle of safety protection** in case of a power supply loss all conditions of safe SNF storing will be retained thanks to the **natural air-cooling convection**.

All engineering operations while transferring SNF to the storage as well as the storing process itself are fully automated to exclude the influence of “human factor” on SNF storage safety.
2015 – The construction of the Pilot-demonstration center is currently in the progress, it is to be completed by 2015. The start-up facility incorporates research chambers (capacity -2-5 tons a year) , analytical center, and other elements of all necessary infrastructure. The purpose is to confirm the designed parameters of the new technological scheme.

2020 – The second start-up facility to be put into operation – full radio-chemical plant with capacities of reprocessing up to 250 tons/year. 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 fuel supply fast reactor BN-800

- Production plant of MOX-fuel assemblies was commissioned in December 2014 to supply fast BN-800 reactor.

- The production site is located in MCC underground facilities. The rock is a natural 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.

robotized complex to retract fuel elements bundle into FA cladding.

Legislative and regulatory framework

RW disposal tariffs

• All RW storage facilities located in the territory of the Russian Federation were put on a register (809).

• RW ownership right was specified.

2012 2013 2014

FSUE “National Operator for RW Management”
http://www.norao.ru

RW disposal reserve fund.
6.1 bln. RUB have been accumulated to date.

Territorial layout of planned RW disposal facilities sites
Siting of RW disposal facilities

1. Ural Electrochemical Integrated Plant, first unit was constructed (Sverdlovsk region)
2. Ural and Volga Federal districts – site adjacent to FSUE “PA “Mayak” was identified (Chelyabinsk region)
3. Siberian Federal district – site adjacent to Siberian Chemical Combine was identified (Tomsk region)
4. Central, Volga and Southern Federal districts (elaboration of siting options is underway).
5. Northwestern Federal district (the Leningrad region, Arkhangelsk region)
6. Nizhnekansky massif (Krasnoyarsk region)
Underground research laboratory

According to IAEA recommendations and international experience the obligatory first stage in construction of geological repositories for underground isolation of HRW is the establishment of an underground research laboratory for justification of the facility safety.

- Based on the results of research carried out in 1992-2011 there were gained the following characteristics for the rock mass on the Yeniseiskiy site:

  - structural and tectonic rock mass characteristics are suitable for long-lived RW final disposal facility creation. The category of rock varies from medium - to high - strength.
  - identified fractured zones are low-angle, sloping downward, filled with carbonate, feldspathic materials, quartz or argillaceous rock, and do not pass water;
  - underground facilities on the site are located deeper than the local base level of drainage - the bed of the Yenisei River, which precludes uptake of ground waters into surface water bodies;
Underground research laboratory – time frames

The project documentation was developed and approved:

- "Declaration of Intention" (2008)
- "Justification of investment" for RW disposal facility construction (2011)
- Federal Agency on Subsoil Usage favorable expert opinion on the suitability of the site for RW disposal facility construction (2012)
- Positive conclusion of the public hearings in the region regarding the disposal facility environmental impact analysis (2012)

Currently design and survey works for disposal facility and URL construction are finished and ready for license process.

The construction of the URL as the initial phase for the disposal facility construction – start in 2016

Start exploitation the object as a URL – in 2024
Underground research laboratory (URL) location and the aims of creation

• The aims of the URL creation:
  • Detailed research of host rock specifications, verification of the rock mass suitability for long-lived HLW and MLW safe deep geological disposal,
  • Research and verification of engineering barriers isolating properties,
  • Testing of technical solutions and transport-technological schemes for the future RW final disposal facility construction and operation.

• Location of the URL:
  • Nizhnekansky rock massif, Krasnoyarsk Territory,
  • 4.5 km from the Yenisei River, 6 km from the industrial part of Zheleznogorsk,
  • Depth of underground constructions is 450-525 m.
Underground disposal facility with URL concept scheme

- **URL main infrastructure**
  - Three vertical wells 500 m deep, 6.0m in section,
  - Surface infrastructure including land-building facilities and near-well constructions,
  - Horizontal capital-mining excavations with total length of 5000 m, 20 m in section,
  - Four horizontal excavations 40-60 m in section with total length of 600 m and four vertical excavations 75 m deep

- **Underground facilities depth: 450-525 m**
  - MLW placement – in piles in horizontal excavations on the horizons of 450 m and 525 m
  - HLW are placed in vertical wells 1.3 m in diameter and 75 m deep
Thank you for your attention

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