International Cooperation in the NFC Back End in Ukraine: benefits and challenges

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Topics to be described

1. Nuclear Power in Ukraine
2. National Policy and Practices regarding SF Management at acting NPPs
4. International cooperation on Radioactive Waste Treatment
5. International cooperation on SF Management
Nuclear Power Plants in Ukraine

Reactor types:
- WWER-1000
- WWER-440
- Under construction
The State Enterprise “National Nuclear Energy Generating Company “Energoatom” is the operator of 4 NPPs comprising 15 units with total installed capacity of 13,835 MW. In 2014 they generated 88,4 billion kWh of electricity.
The Energy Strategy of Ukraine till 2030 establishes the so-called deferred decision for spent fuel of Ukrainian NPPs that means long-term (50 years and more) storage of spent fuel and subsequent definition and approval of the final decision on fuel reprocessing or disposal.

There are 2 options regarding SF management implemented in Ukraine:

- SF transportation for treatment to Russia
- SF storage at Zaporizhzhya NPP

By 2017 a Start-Up Complex of Centralized Spent Fuel Storage Facility (CSFSF) for spent fuel of WWER-440 and WWER-1000 of operating NPPs and spent fuel of new nuclear units will have been constructed in the Chornobyl Exclusion Zone (CEZ).
Current SF Management System in Ukraine

Zaporizhzhya NPP
- SF Storage Facility (commissioned in 2005, design lifetime – 50 years)
  - Storage of SF WWER-1000 (Krasnoyarsk)
  - Storage and Reprocessing of SF WWER-440 (Chelyabinsk)

South Ukraine NPP

Khmelnyntskyi NPP

Rivne NPP
- Centralized SF Storage Facility (CEZ)

Available technology

Future technology

AREVA (reprocessing)

HLW Storage (CEZ)
The following issues regarding SF management should be solved:

1. Long-term storage or reprocessing of SF fabricated by Westinghouse Electric Sweden AB

2. Development of regulatory procedures on return of HLW resulting from Ukrainian NPP SF reprocessing and their approval by Russia

National Practices regarding SF Management at acting NPPs

Achievements regarding SF management at acting NPPs in Ukraine:

<table>
<thead>
<tr>
<th>Measure</th>
<th>Results</th>
<th>NPP</th>
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<tbody>
<tr>
<td>Operation of II generation fuel and core design with reduced neutron release</td>
<td>The number of unloaded SF assemblies reduced by 24 pcs for two power units with WWER-440</td>
<td>Rivne NPP (Units 1&amp;2)</td>
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<tr>
<td>SF storage racks in SF pools were compacted</td>
<td>The capacity of the ZNPP SF pools increased</td>
<td>Zaporizhzhya NPP</td>
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<tr>
<td>Introduction of the mast sipping systems into commercial operation at acting NPP units</td>
<td>Monitoring of the fuel claddings integrity</td>
<td>Rivne NPP, Khmelnytskyi NPP and SU NPP (Unit 1)</td>
</tr>
<tr>
<td>Operation of Dry Spent Fuel Storage Facility from 2005. Its design capacity is 380 containers, each for 24 SF assemblies.</td>
<td>As of 1 April 2014, there are 123 containers with 2946 SF assemblies on ZNPP site. The storage period – 50 years.</td>
<td>Zaporizhzhya NPP</td>
</tr>
</tbody>
</table>
The Strategy for Radioactive Waste Management in Ukraine defines major areas and tasks for development and improvement of the radioactive waste management system for a 50-year period in Ukraine:

- radioactive waste treatment on NPP sites to the state acceptable for disposal or long-term storage in central facilities of the Vector site in the CEZ;
- disposal of long-lived and high-level waste in a geological repository;
- development of a national organization for radioactive waste management;
- sustainable and adequate funding of radioactive waste management measures;
- development of regulatory/legal framework and international cooperation.
The Comprehensive Program for Radioactive Waste Management involves the deployment of Radioactive Waste Treatment Facilities at NPPs

RWTF at Zaporizhzhya NPP
Cost estimate – 324 677 UAH (Ukraine contribution)
including Tacis – 12.5 million EUR

RWTF at Rivne NPP
Cost estimate – 271 850 UAH (Ukraine contribution)
including Tacis – 8.8 million EUR

RWTF at Khmelnytskyi NPP
Cost estimate – 544 136 UAH

RWTF at South Ukraine NPP
Cost estimate – 300 000 UAH

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**TACIS international assistance project**

*on construction of systems for solid radioactive waste treatment at Zaporizhzhya NPP:*

<table>
<thead>
<tr>
<th>Equipment</th>
<th>International partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incineration facility</td>
<td>Iberdrola (Spain) – supplier</td>
</tr>
<tr>
<td>Monitoring Systems, TV surveillance camera system, mobile</td>
<td>Envikraft (Denmark) – manufacturer</td>
</tr>
<tr>
<td>decontamination system for Incinerator</td>
<td></td>
</tr>
<tr>
<td>Fragmentation Unit</td>
<td>Vuje (Slovenia) – supplier</td>
</tr>
<tr>
<td>Supercompacting Facility</td>
<td>NUKEM (Germany) – supplier</td>
</tr>
</tbody>
</table>
Solid Radwaste Treatment at Zaporizhzhya NPP

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**International Cooperation on Radwaste Treatment**

*TACIS international assistance project on construction of systems for solid radioactive waste treatment at Rivne NPP:*

<table>
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<th>Equipment</th>
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</thead>
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<tr>
<td>Retrieval Facility</td>
<td>ONET (France) – supplier</td>
</tr>
<tr>
<td>Fragmentation and Sorting Facility</td>
<td>NUKEM (Germany) – supplier</td>
</tr>
<tr>
<td>Supercompacting Facility</td>
<td>NUKEM (Germany) – supplier</td>
</tr>
<tr>
<td>Radioactivity Measurement</td>
<td>Envinet (Czech Republic) – supplier</td>
</tr>
</tbody>
</table>

The commissioning of radioactive waste treatment facilities at Zaporizhzhya and Rivne NPPs is scheduled for 2016, at South Ukraine and Khmelnytskyi NPPs – in 2018-2020.
Solid Radwaste Treatment at Rivne NPP

RAW GENERATION

SRAW collection
Sorting by activity

Units 1-4

PRELIMINARY TREATMENT

Sorting
Fragmentation
Sub-compaction

TREATMENT

Facility for Metal Decontamination
Super-compactor
Grout Treatment Facility

RAW retrieval facility

Solid RAW 1 and 2 group of activity

Solid RAW 3 group of activity

Activity Measuring Facility

Interim storage of concrete casks on NPP site

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Nuclear Fuel Qualification Project

Trial operation of fuel assemblies fabricated by Westinghouse Electric Sweden AB is underway at SUNPP Unit 3.

At present, Westinghouse SF is stored in SF pools of SUNPP Units 2 and 3.

Energoatom holds negotiations with the French company AREVA to solve the issue related to Westinghouse SF management with the following purposes:

- to diversify suppliers of services related to transportation and reprocessing of Westinghouse SF;
- to examine technology and cost of SF reprocessing at La Hague plant (France) with further management of valuable products and HLW of its reprocessing.
A three-party Confidentiality Agreement was signed in May 2013.
Centralized Spent Fuel Storage Facility

CSFSF for reactors of RNPP, KhNPP and SUNPP – a nuclear facility of nation-wide importance.

CSFSF is to be located in the CEZ.

CSFSF technology and equipment shall be supplied by the US-based Company Holtec International.

Total Capacity of the CSFSF – 16529 spent fuel assemblies (SFA) of WWER-440 and WWER-1000-type reactors.

Design lifetime of the CSFSF is not less than 100 years.
Centralized Spent Fuel Storage Facility

**Project Parameters**

Cost (capital value) of the whole project – **USD 359 M** including:
1. Construction – **USD 59 M**
2. CSFSF equipment design and supply under the Contract with Holtec International – **USD 299 M**

Stages of the Contract with Holtec International:
1. 2015-2017 – **Start-up complex (USD 78 M)**
2. 2018-2020 – Supply of **nuclear fuel storage casks** by Holtec International (USD 222 M)

<table>
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<tr>
<th>CSFSF design capacity</th>
<th>450 storage casks:</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>▪ 12 010 SFA of WWER-1000</td>
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<td></td>
<td>▪ 4 519 SFA of WWER-440</td>
</tr>
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<tr>
<th>including Start-up complex capacity</th>
<th>94 storage casks:</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>▪ 2 511 SFA of WWER-1000</td>
</tr>
<tr>
<td></td>
<td>▪ 1 105 SFA of WWER-440</td>
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**Design Lifetime**

100 years: 45-50 years for filling the CSFSF up and 50 years for SFA storage
Centralized Spent Fuel Storage Facility

Project Stakeholders

CSFSF Operating Organization

CSFSF Designer

Technology Holder
Holtec Technology

The multi-purpose canister (MPC) is loaded with the SF and sealed directly in the reactor hall.

SF is protected by the sealed MPC shell that represents the welded pressurized vessel made of stainless steel.

MPC is protected by the overpack.
The loaded MPC is placed in a transport cask on a special platform that is railed to the CSFSF site where MPC is retrieved from the transport cask and loaded in the storage cask.
Project Benefits

- Economic benefits to Ukraine allowing the $150 million annually saved on transportation of the spent fuel to Russia to be injected into the Ukrainian economy
- Increased control and enhanced safety and security over the spent nuclear fuel
- International financing of this transaction will be viewed as a positive beacon for other international investors and lenders
- Advanced technology transfer and capacity building
Project History and Current Status of the Contract with Holtec International

- In 2003-2004 the international tender for CSFSF deployment was carried out. By the end of 2004 the US-based company Holtec International was accepted as the tender winner.
- On December 26, 2005 the Contract between Energoatom and Holtec International was signed.
- In 2007-2011 – equipment design and safety analysis for future CSFSF.
- On February 9, 2012 – Law of Ukraine No. 4384-VI “On Siting, Design and Construction of the CSFSF for WWER-type Reactors of the Ukrainian NPPs”.
- In 2014 – start of preparatory works on site of the CSFSF.
- In 2015 Energoatom and Holtec International signed Amendment No. 6 to the Contract whereby:
  ✓ Holtec International shall supply the technology of SF management, manufacture and deliver the equipment required for preparation, transportation and storage of SF;
  ✓ Energoatom shall design and construct the CSFSF.
Experience of operating the on-site SFSF at Zaporizhzhya NPP

- Storage technology provided by DUKE ENGINEERING & SERVICES;
- Experience of licensing and operating the equipment is used in the framework of the CSFSF project.

Construction of SFSF-2 on the Chernobyl NPP site

- A turn-key contract was signed between Holtec International as a contractor and EBRD + Chernobyl NPP as the customers;
- Storage facility location – Chernobyl NPP site;
- Current status of the project – construction of the storage facility and equipment fabrication;
- Experience in design, licensing and equipment manufacturing is used in the framework of the CSFSF project.
THANK YOU FOR YOUR ATTENTION!