SNF DUAL-PURPOSE CASK: CREATION EXPERIENCE

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International Workshop on the Development and Application of a Safety Case for Dual Purpose Casks for Spent Nuclear Fuel
Austria, Vienna, 19 - 21 May 2014
One of the key tasks of nuclear power development in Russia

SNF and RAW management

- Accumulated problems
- One of the problems of dynamic nuclear power development

Solution:

- Federal target program «Nuclear and radiation safety for 2008 and for a period up to 2015»
- Consideration of the infrastructure for the safe SNF management, including
  - Commissioning of dual-purpose casks for SNF of the different types of the NPP reactors
Dual-purpose metal - concrete casks

UKH-104 (TUK-104)  UKH-109 (TUK-109)  UKH-121  UKH-123 (TUK-123)

TUK-108/1  TUK-120
Structural peculiarities of metal-concrete casks

1-steel shells of the metal-concrete cask (MCC) body; 2-coaming; 3-heavyweight high-strength concrete; 4-inner lid; 5-outer lid; 6-sealing sheet; 7-pack-offs; 8-sockets for storage cask (UKH) lifting and manipulating; 9-basket; 10-ampuls for RBMK-1000 reactor SNF; 11-SNF; 12-upper lid of the energy absorption container (EAC); 13-EAC cylindrical sheath; 14-tubular elastoplastic elements; 15-EAC bottom; 16-sockets for TUK lifting and manipulating

1-outer lid; 2-pack-offs; 3-inner lid; 4-coaming; 5-spacer grid; 6-SNF canisters; 7-heavyweight high-strength concrete; 8-sockets for TUK lifting and manipulating; 10-guidance device; 11-steel shells of the metal-concrete cask body; 12-bottom damping assembly
**Technical specifications of DPC’s for transport and storage of SNF from various reactor types**

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<th>Model</th>
<th>Description</th>
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| TUK-104 (UKH-104) | Storage and transportation of SNF from RBMK-1000 reactors, Leningrad NPP | Capacity: 114 bundles of spent fuel rods  
Weight of TUK with SNF: 120T.  
Weight of UKH (storage cask) with SNF: 95T.  
Experimental prototypes have been manufactured by JSC Izhora Plants. |
| TUK-108/1 | Storage and transportation of SNF from naval submarine, DalRAO, PA Mayak, Zvyozdochka and FAP Zvezda and other | Capacity: 7 canisters  
Weight with SNF: 40T.  
A pilot batch comprising 48 casks was manufactured by JSC Izhora Plants throughout 2000 to 2002.  
A pilot batch comprising 70 casks was manufactured by JSC PA Sevmash in 2005. |
| TUK-109 (UKH-109) | Storage and transportation of SNF from RBMK-1000 reactors, Leningrad and Kursk NPPs | Capacity: 144 bundles of spent fuel rods  
Weight of TUK with SNF: 126T.  
Weight of UKH with SNF: 101T.  
Manufacturing works:  
1) JSC Energotex  
2) JSC Izhora Plants  
3) JSC PA Sevmash. |
| TUK-120 | Storage and transportation of SNF from nuclear ice-breaker fleet | Capacity: 7 canisters  
Weight with SNF: 40T.  
50 casks have been manufactured at JSC PA Sevmash. |
| UKH-121 | SRW storage at the Kursk and Leningrad NPPs | Capacity:  
Basket– version 1 (for spent fuel assembly suspensions/brackets, 513 seats).  
UKH weight: 58.43T.  
Basket – version 2 (for filters, 15 seats).  
UKH weight 58.385T.  
Manufacturing works: JSC Energotex. |
| TUK-123 (UKH-123) | Transportation and storage of SNF from BN-350 reactor | Capacity: 8 canisters  
TUK weight with SNF: 124.2T.  
Weight of UKH (storage cask) with SNF: 98T.  
Manufacturing works: PA Sevmash |
Operational facilities of the dual-purpose casks

- Leningrad NPP (Sosnovy Bor, Leningrad region),
- Kursk NPP (Kurchatov, Kursk Region),
- the Mining and Chemical Combine (MCC) (Zheleznogorsk, Krasnoyarsk Krai),
- PA Mayak (Ozersk, Chelyabinsk Region),
- SNF storage facility on the FSUE Atomflot site (Murmansk),
- FAP Zvezda (Primorsky Kray),
- Zvezdochka (Severodvinsk)
Operational facilities of the dual-purpose casks
The main outcomes from MCC DPC creation

Design issue:

- Replacement of constructional materials:
  - 09G2SA-A low-carbon steel use for the MCC bearing structural elements (coaming, thimble);
  - concrete density to 3800...4100 kg/m3 use. Metallurgical waste (scale and steel shot) has been used as concrete aggregate.

Control methods:

- Radiometric method for checking the concrete aggregate/ filling continuity and efficiency of the MCC radiation shielding implementation;
The main outcomes from MCC DPC creation

Safety and reliability
All the casks have undergone design verification and preliminary tests at the manufacturing works while SNF casks have been tested at a specially constructed unique test facilities:
- tests to determine heat and physical properties of the MCC concrete aggregate/ filling, its radiation, chemical and heat resistance;
- tests on the MCC fire resistance;
- compliance of all MCC types to Russian legislation requirements and IAEA recommendations has been proved by tests on the test bench/ facility that included 9 and 1-metre drops onto a flat unyielding surface and a rigid metal pin correspondingly, as well as TUK-104 tests for fire resistance.

Technology for the MCC preparation for long-term storage:
- Drying of the cask internal cavity (dewatering);
- Leakiness inspection of all detachable joints.
The main outcomes from MCC DPC creation

Universal facility for testing of cask in case of emergencies

Testing of the dual-purpose TUK-108/1 for SNF

Testing of the dual-purpose TUK-120 for SNF on Atomflot, Murmansk (transfer to the storage)

Testing of the dual-purpose TUK-120 for SNF (SNF loading)
The main outcomes from MCC DPC creation

Technical specifications:

- **TUK-108/1 and TUK-120**
  - Special dumping elements functioning in the pastic range have been incorporated in the cask structure.
  - TUK-108/1 and TUK-120 dimensions are limited by the need to fit into the vehicles used for TK-18 metal cask transportation that required dumping elements to be built directly into the cask structure.

- **TUK-104, TUK-109, TUK-123**
  - Dumping elements for casks are made in the form of an energy absorption container (EAC) that incorporates energy absorption tubes plastically deformed in case of TUK drop. The EAC is releasable and used during transportation of the DPC with SNF only.
  - The EAC is an additional protective barrier of the MCC against external impacts during transportation, which enables DPC shipping.
  - Solution on special ampoules use where SNF from RBMK-1000 reactors should be placed after long-term storage in wet reactor pools at NPPs prior to being loaded into the MCC has been confirmed and justified.
The main outcomes from MCC DPC cask creation

- All metal-concrete casks that have been developed can hold a bigger number of SFAs due to creation of a special basket (spacer grid) that for the purposes of nuclear safety incorporates structural elements ensuring $K_{\text{eff}}$ reduction to the level required ($K_{\text{eff}}<0.95$) and required spacing between the ampoules and fuel basket both under normal operating conditions and in case of emergency.

- Aluminium-based metallised layer covered with paintwork has been created for anti-corrosion protection.

The technology of DPC manufacture for SNF from NPPs, the submarines and ice-breaker fleet has been verified and implemented at a number of Russian manufacturing plants: OAO Izhora Plants, ZAO Energotex, OAO PA Sevmash, ZAO Baltiysko-Rossiyskiy Sudoservis (Baltic-Russian Ship Service), OAO Atoll.
The technology of dry long-term storage and transport of SNF in metal-concrete DPC’s has become a commercial one.

Both the DPC, the technology and service equipment have been tested in transport and process operations including dry cask storage facilities at NPPs and other nuclear facilities and sites.

The DPC technology ensures reliable and safe SNF containment preventing any release into the environment.

Dual purpose casks for SNF based on metal-concrete casks have been created under Rosatom’s guidance. Russian research institutes, designers and engineering companies have participated in the Program of DPC creation.
THANK YOU FOR YOUR ATTENTION!