

ENCLOSURE 8

M190012

2018 Technology Update Presentation

Non-Proprietary Information

INFORMATION NOTICE

Enclosure 8 is a non-proprietary version of the 2018 Technology Update Presentations from Enclosure 7, which has the proprietary information removed. Portions that have been removed are indicated by open and closed double brackets as shown here [[]].



TVS-K PWR Fuel

2018 NRC Technology Update

August 28, 2018

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Bringing TVS-K in to the United States

- TVEL fuel is currently used in non-US pressurized water reactors
- Current program is to evaluate and qualify TVS-K through a Lead Test Assemblies (*) program in US PWRs
- The LTAs use an E110opt-Niobium bearing alloy (developed using the Kroll process) for the fuel rod cladding and spacer grids
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- Joint initiative among Exelon, GNFA and TVEL

(*) LTA used to be consistent with PWR Technical Specifications. These assemblies are best viewed as preproduction prototypes.

TVS-K Advantage Overview

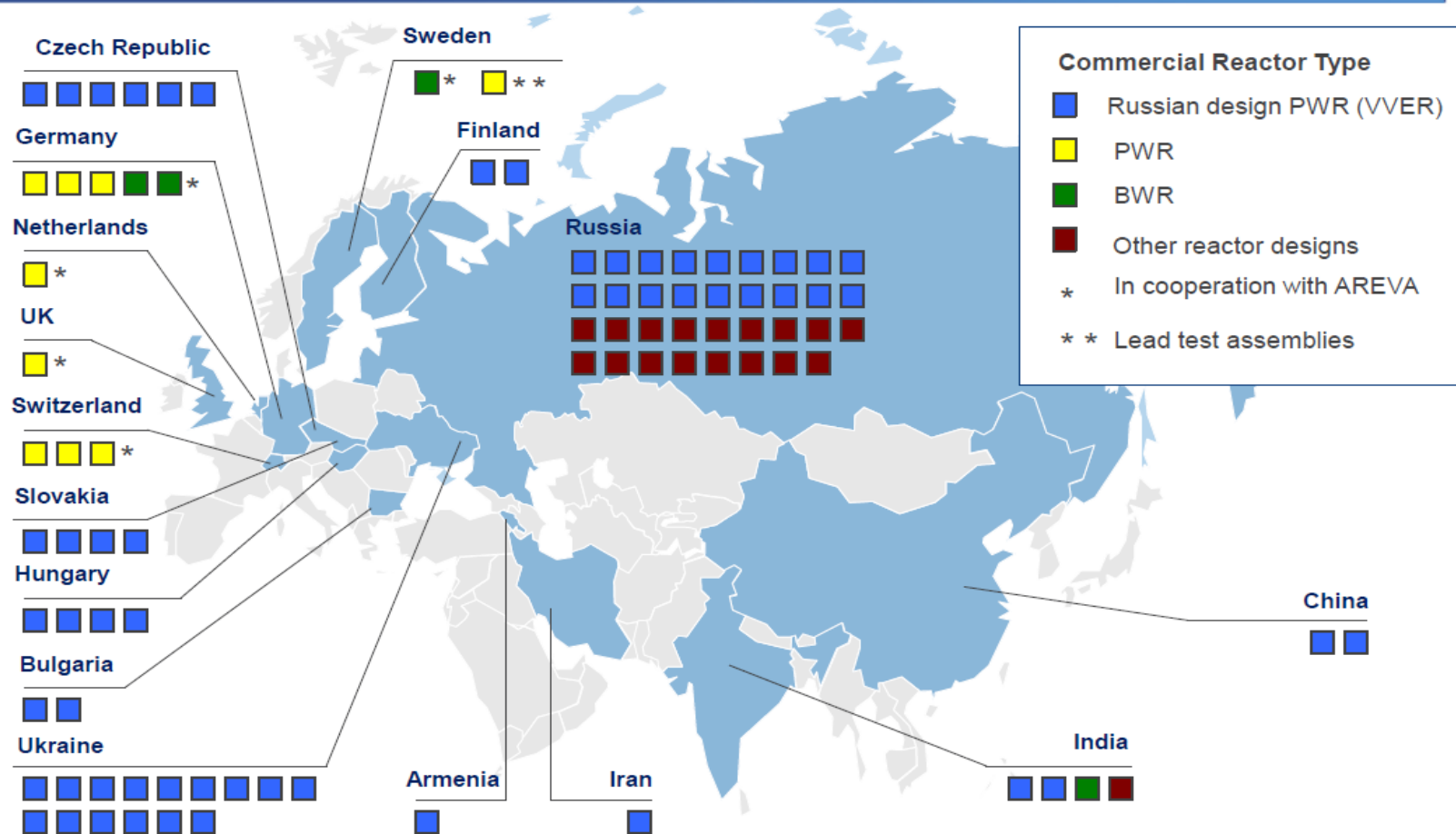
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- E110opt and E635 alloys with optimal characteristics of radiation growth, creep, corrosion resistance and hydriding.
- Improved Thermal Hydraulic performance with flow mixing
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- Improved operating characteristics and technical solutions for high reliability and allowing core power up-rate
- Will discuss overview of TVEL

TVEL – Fuel Company of Rosatom

89 commercial power reactors worldwide operate using TVEL fabricated nuclear FAs and components



TVEL – Fuel Company of Rosatom

TVEL operates industrial facilities with 60+ years production and engineering experience in front-end nuclear fuel cycle



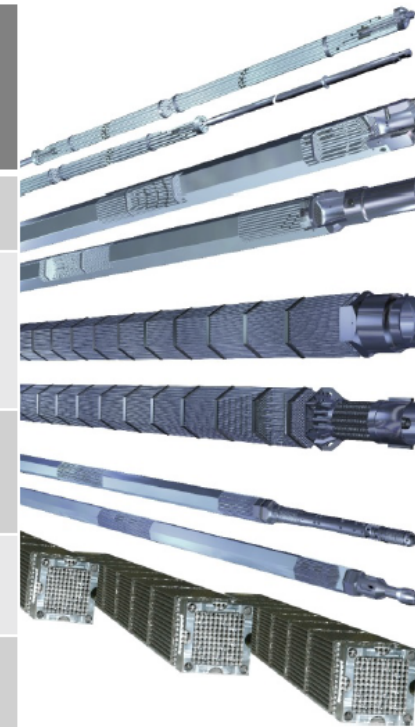
TVEL facilities cover all stages of the Nuclear Fuel Cycle and make TVEL technologically and commercially competitive. The facilities have advanced level of automation, successful record of services for Russian and international customers and adhere to the highest environmental standards

TVEL – Fuel Company of Rosatom

TVEL reputation as fuel fabricator is based on long history and production experience of virtually any type of nuclear fuel



Reactor type	Number of FAs manufactured
RBMK	>130 000
VVER-440	>90 000
VVER-1000	>30 000
BN (fast reactor)	>9 000
BWR, PWR	>3 500



TVEL fuel has a unique genesis and long history: FAs for commercial power reactors are manufactured by TVEL facilities since 1954. The TVS-K design is based on the TVEL knowledge in engineering and core experience of various fuel type and cladding material

LTA Design Features – Assembly

Prevention of lift-off by 12 leaf springs
(Inconel [[]])

17x17 (264 fuel rods, 24 guide thimbles)

[[]]

14 ft overall length, 12 ft fuel column

TVEL used Operating Experience and

Lessons learned from VVER and

Ringhals-3

Will present

E110opt

E110opt Uses (Fuel Rods, Spacer Grids)

E635

E635 Uses (Guide Thimbles, Inst Tube)

Nozzles

2-Lower Grids

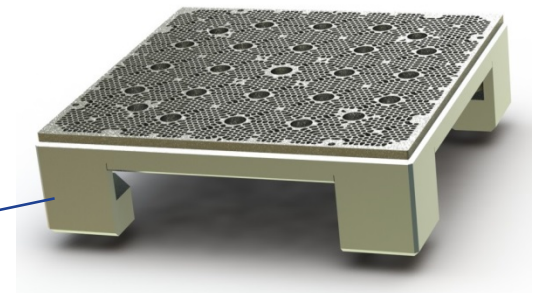
Top Nozzle

[[]]

[[]]

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Bottom Nozzle with
integrated debris filter



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E110opt Zirconium Alloy

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E110opt Zirconium Alloy

LTA Design Features – Fuel Rod

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E110opt-Niobium bearing alloy developed using Kroll process

Superior growth/hydrogen pickup characteristics

High temperature steam kinetics equivalent to Zr-4

Repeating testing in ORNL labs

Parameter	TVS-K LTA	Westinghouse OFA	Westinghouse RFA
Fuel Pellet Diameter (in)	[[]]	0.3088	0.3225
Fuel Rod Inside Diameter (in)	[[]]	0.315	0.329
Fuel Rod Outside Diameter (in)	0.374	0.360	0.374
Fuel Pellet Density (%)	[[]]	95	95.5
Clad Material	E110opt	ZIRLO	ZIRLO
End Grid Material	Stainless Steel	Inconel 718	Inconel
Mid Grid material	E110opt	ZIRLO	ZIRLO
Burnable Absorbers	Gadolinia	IFBA/WABA	IFBA/WABA

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TVS-K Spacer Grid

- Advantages:**
- Avoidance of Fuel Rod fretting wear;
 - Free axial Fuel Rod growth;
 - Grid Chamfer or lead in for reduction of spacer grid interactions;

TVS-K Intermediate Flow Mixer

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Design basis and technical solutions:

- Additional coolant mixing in the upper part of the core to improve TVS-K thermal characteristics.
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Anti-Fretting Grid

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E635 Zirconium Alloy

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LTA Design Features – Assembly Skeleton

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Skeleton Design Features

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TVS-K Nozzles

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- ◆ Protection of fuel rod bundle from debris by filter.

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Fuel Assembly Testing

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Transport Container TK-C69





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