Rosatom Energy Solution: Engineering Perspective

Rosatom Seminar on Russian Nuclear Energy Technologies & Solutions

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NIAEP-ASE is an EPC contractor for VVER new build projects

Role of NIAEP in Rosatom’s Key Activities

- Mining
- Gas centrifuges manufacturing
- Fuel fabrication
- Conversion and enrichment
- Spent nuclear fuel treatment
- Power Generation
- Research and development
- NPPs engineering & construction
- Power equipment and services

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VVER – MATURE RUSSIAN TECHNOLOGY

Gen1 VVER-440, 70-ies ➔ Gen2 VVER-440, 70-80-ies ➔ Gen2 VVER-1000, 80-90-ies ➔ VVER-1000 Generation 3 90-ies/2000\textsuperscript{th} ➔ VVER-1200 Generation 3+ 2000/2010\textsuperscript{th} ➔ VVER-1200 “+” Generation 3+ New export version

Gen3 VVER-1000: Compliance with international safety standards

Gen3+ VVER-1200: improved economics

Gen3+ VVER-1200 ”+”: Compliance with the Western regulations & supply models

- Innovative approach to ensure reliable and safe operation

- 1400 reactor-years operation for VVER NPP and 11000 reactor-years operation for ice-breakers and submarines with reactors of similar type

- Main technical and economic parameters including service life, capital investments per unit of installed power are in compliance with best world indicators

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VVER – MATURE RUSSIAN TECHNOLOGY

- Reliable
- Safe
- Referential

- Russian VVER is the only one of the PWR type reactors of Generation III/III+, having a referential management system for beyond design basis accidents and a device of core melt retention – corium catcher (successfully operates at Tianwan NPP in China)

- Stress tests made after the events at Fukushima have confirmed the safety of Russian design nuclear power plants and the ability to withstand catastrophic external hazards such as were at Fukushima site
VVER – MATURE RUSSIAN TECHNOLOGY

- Pressurized light water reactor
- Loop-type reactor plant
- Horizontal steam generators
- A high level of inherent safety

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### VVER NPPs worldwide

<table>
<thead>
<tr>
<th>Country</th>
<th>Constructed</th>
<th>In progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armenia</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Belorussia</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Bulgaria</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>China</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>India</td>
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<td></td>
</tr>
<tr>
<td>Iran</td>
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<td></td>
</tr>
<tr>
<td>Russia</td>
<td>9</td>
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</tr>
<tr>
<td>Slovakia</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Turkey</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Ukraine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Vietnam</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>67</td>
<td>30</td>
</tr>
</tbody>
</table>
Strong Synergetic Effect

1. Proven high level of expertise and experience on NPP design and construction worldwide

2. Wide range of project implementation options (up to turnkey projects)

3. Strict adherence to time & budget

4. Safety of the projects is proven by numerous licenses and certificates.

5. Positive conclusion on EU stress-tests

6. Innovative designing technologies (including Multi-D technology)

• One of the leading NPP design companies of Rosatom
  • Experience > 60 years

• Leading overseas NPP engineering company of Rosatom.
  • Experience > 50 years.

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Advantages of 6D Technology

Application of the 6D Technology to NPP construction:

• Assembly optimization with detailed planning down to the level of a welding joint;

• Effective manpower utilization due to correct distribution of the workload during construction period;

• Decrease of labour cost in the construction area due to utilisation of larger pre-assembled building blocks;

• Construction management based on scheduled equipment delivery and taking into account possible delays;

• Execution of detailed work planning (around the clock) which allows for timely personnel planning

• Real time management of building erection

NPP construction according to defined time period and budget
ROSTOV NPP. UNIT 2

Key Project Parameters

Reactor design: VVER-1000 (V - 320)

Gross capacity: 1000 MW

First criticality: 22 Jan 2010

First grid connection: 18 Mar 2010

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**KALININ NPP. UNIT 4**

### Key Project Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reactor design</strong></td>
<td>VVER-1000 (V - 320)</td>
</tr>
<tr>
<td><strong>Gross capacity</strong></td>
<td>1000 MW</td>
</tr>
<tr>
<td><strong>First criticality</strong></td>
<td>08 Nov 2011</td>
</tr>
<tr>
<td><strong>First grid connection</strong></td>
<td>24 Nov 2011</td>
</tr>
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**NOVOVORONEZH NPP-II. UNIT 2, MARCH 2012**

<table>
<thead>
<tr>
<th>Key Parameters</th>
</tr>
</thead>
</table>
| **Reactor design:** VVER-1200  
(V-392M) |
| **Total Gross Capacity:** 2400 MW (2 x 1200 MW) |
| **Construction start:** 24 Jun 2008 (unit 1)  
12 Jul 2009 (unit 2) |
| **Commercial Operation Date:** end of 2013 (anticipated date, unit 1)  
end of 2014 (anticipated date, unit 2) |
**TIANWAN NPP, CHINA**

*Tianwan*

**Lianyungang, Jiansu province**

**Key Parameters**

- **Reactor design:** VVER-1000 (V-428)
- **Total Gross Capacity:** 2120 MW (2 x 1060 MW)
- **First criticality:**
  - 20 Dec 2005 (unit 1)
  - 01 May 2007 (unit 2)
- **First grid connection:**
  - 12 May 2006 (unit 1)
  - 14 May 2007 (unit 2)
- **Commercial operation date:**
  - 17 May 2007 (unit 1)
  - 16 Aug 2007 (unit 2)
- **Legal basis:** IGA (1992)
Russian Side obligations:
- installation activities in principal plant buildings
- Power plant commissioning
- Chinese personnel training

Companies from China were responsible for the installation works in the reactor building, safety systems building, steam chamber and pumping station for essential consumers.

Erecting and assembly works were also carried out by China Nuclear Industry Construction Corporation.

Supply Shares

Units 1 and 2 under operation

- 70% Chinese
- 30% Russian and European countries

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**KUDANKULAM NPP, INDIA**

### Key Parameters

<table>
<thead>
<tr>
<th>Reactor design:</th>
<th>VVER-1000 (V-412)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Gross Capacity:</strong></td>
<td>2000 MW (2 x 1000 MW)</td>
</tr>
<tr>
<td><strong>First criticality:</strong></td>
<td>2012 (anticipated date)</td>
</tr>
<tr>
<td><strong>First grid connection:</strong></td>
<td>2012 (anticipated date)</td>
</tr>
<tr>
<td><strong>Legal basis:</strong></td>
<td>IGA (1998)</td>
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</table>

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According to the Agreement between the USSR and India of 20 November 1998 and the Addendum to the Agreement of 21 June 1998, Russia renders technical assistance to India in the construction of two power units at Kudankulam NPP, 1000 MW each unit (AES-92 design).

NPCIL, the Indian side implements design of buildings and structures, erecting and installation works including assembling of mechanical, electrical and I&C equipment, commissioning operations, etc.

NPCIL obligations for design and construction were carried out by Indian contractor (LARSEN&TURBO).

EU Companies supplied:
- 3500 units of fitting MSA a.s., MAPOL s.r.o., ARACO s.r.o.
- 50 pumps SIGMA GROUP a.s., P.K.INVEST s.r.o.
- 2500000 meters of cables KABEX.
BUSHEHR NPP, IRAN

Reactor design: VVER-1000 (V-446)

Total Gross Capacity: 1000 MW (1 x 1000 MW)

First criticality: 08 May 2011

First grid connection: 03 Sep 2011

Commercial Operation Date: 30 Jul 2012 (anticipated date)

Legal basis: IGA (1992)

Construction on the “turn-key” basis
BUSHEHR NPP, IRAN

- NPP construction started in 1974 by the German company Kraftwerk Union (Siemens/KWU)

- The unique example of the Russian technology integration into developed project solutions
«Coming together is a beginning
Keeping together is progress
Working together is success»
Henry Ford

www.rosatom.ru
Thank You for Attention!

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