Commissioning of new nuclear power units in Russia

Lessons learnt and key issues arising in new construction

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Construction of new nuclear power units in Russia

Units under construction:
- Rostov NPP unit No. 4 (VVER-1000)
- Leningrad NPP-II unit No. 1 (VVER-1200)
- Novovoronezh NPP-II unit No. 2 (VVER-1200)
- Leningrad NPP-II unit No. 2 (VVER-1200)
- Kursk NPP-II unit No. 1 (VVER-TOI)
- Kursk NPP-II unit No. 2 (VVER-TOI)

The following units were put in commercial operation:
- Rostov NPP unit No. 3 (VVER-1000) - 2015
- Beloyarsk NPP unit No. 4 (BN-800) - 2016
- Novovoronezh NPP-II unit No. 1 (VVER-1200) - 2017
Generic commissioning schedule for a VVER nuclear power unit

Stage A
Pre-commissioning alignment activities

Stage B
Physical startup

Stage C
Power startup

Stage D
Pilot commercial operation

Commercial operation

A-0
Preparatory substage

A-1
Equipment inspection and testing

A-2
Containment testing

A-3
Reactor cold and hot tests

A-4
Inspection of the reactor installation main equipment

B-1
Loading of nuclear fuel

B-2
First Criticality

D-1
Reactor power raise up to connection to the grid

D-2
Trial operation at power up to 100%

Integrated testing
## Duration of commissioning period for a VVER-1000 nuclear power unit

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**AES-2006 design with VVER-1200 reactor installation**

### Key milestones in the project implementation

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
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<tbody>
<tr>
<td>Commencement of the unit construction</td>
<td>2007</td>
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<tr>
<td>Beginning of the physical startup (B)</td>
<td>23.03.2016</td>
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<td>Reactor reached the minimum controllable power level</td>
<td>20.05.2016</td>
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<tr>
<td>Beginning of the power startup (C)</td>
<td>08.07.2016</td>
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<tr>
<td>Beginning of the pilot commercial operation (D)</td>
<td>09.09.2016</td>
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<td>Putting the unit into commercial operation</td>
<td>27.02.2017</td>
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</table>

### Basic Technical Characteristics (Novovoronezh NPP-II unit No. 1)

- **Thermal power:** 3200 MW
- **Lifetime:** 60 years
- **Combination of active and passive safety systems**
- **New systems for management of beyond-design basis accidents**
- **Double shell containment**
Main causes of the commissioning stages duration increase in case of Novovoronezh NPP-II unit No. 1

**Organization and planning of the activities:**
1. Partial unavailability of compartments and systems for transition to the next stages;
2. Non-readiness to installation of some systems by the time of commencement of a next stage of construction and installation activities;
3. Overlapping of construction, installation and commissioning activities

**Equipment:**
1. Delayed delivery of equipment and pipelines;
2. Delivered equipment non-conformance to the quality requirements;
3. Identified inconsistencies of the delivered equipment with the design requirements;
4. Defects and inconsistencies identified during various commissioning stages

**Documentation:**
1. Changes in design documentation at the unit commissioning stage;
2. Delayed development and updating of commissioning and operational documentation;
3. Deviations from the quality requirements of commissioning and operational documentation

**Design solutions**
1. Design solutions that insufficiently took into account the experience of the NPP units commissioning;
2. Application of new and no-reference equipment;
3. Inconsistency of the design solutions with the requirements of the newly imposed codes and standards
Management of inconsistencies

Distribution of the inconsistencies identified by their main causes - the example of Novovoronezh NPP-II unit No. 1 commissioning (percentage)

- Manufacturer defects (56)
- Installation errors (3,5)
- Delivery (12)
- Damage during storage (3)
- Design errors (22)
- Installation damage (3,5)
Key areas for resolution of the issues arising during commissioning of nuclear power units under construction

**Organization and planning of the activities:**
1. Establishment of a group for operative planning, management and coordination of works;
2. Establishment of a group for operative management and coordination of works in terms of addressing the comments to licensing documentation;

**Documentation:**
1. Improvement of the regulatory basis for commissioning activities;
2. Systematic monitoring of commissioning and operational documentation development;
3. Development of corporate standards with focus on the order of conducting the concurrent construction and commissioning activities;

**Equipment:**
1. Control of equipment quality and delivery deadlines;
2. Improvement of the system for inconsistency management and accounting of operating experience;
3. Application of reference equipment with positive operating record;

**Personnel:**
1. Advanced personnel recruitment to ensure operating preparedness at early stages of the nuclear power unit construction;
2. Strengthening the shifts during the NPP commissioning period to meet the requirement of the work orders and permits system.
Thank you for your attention