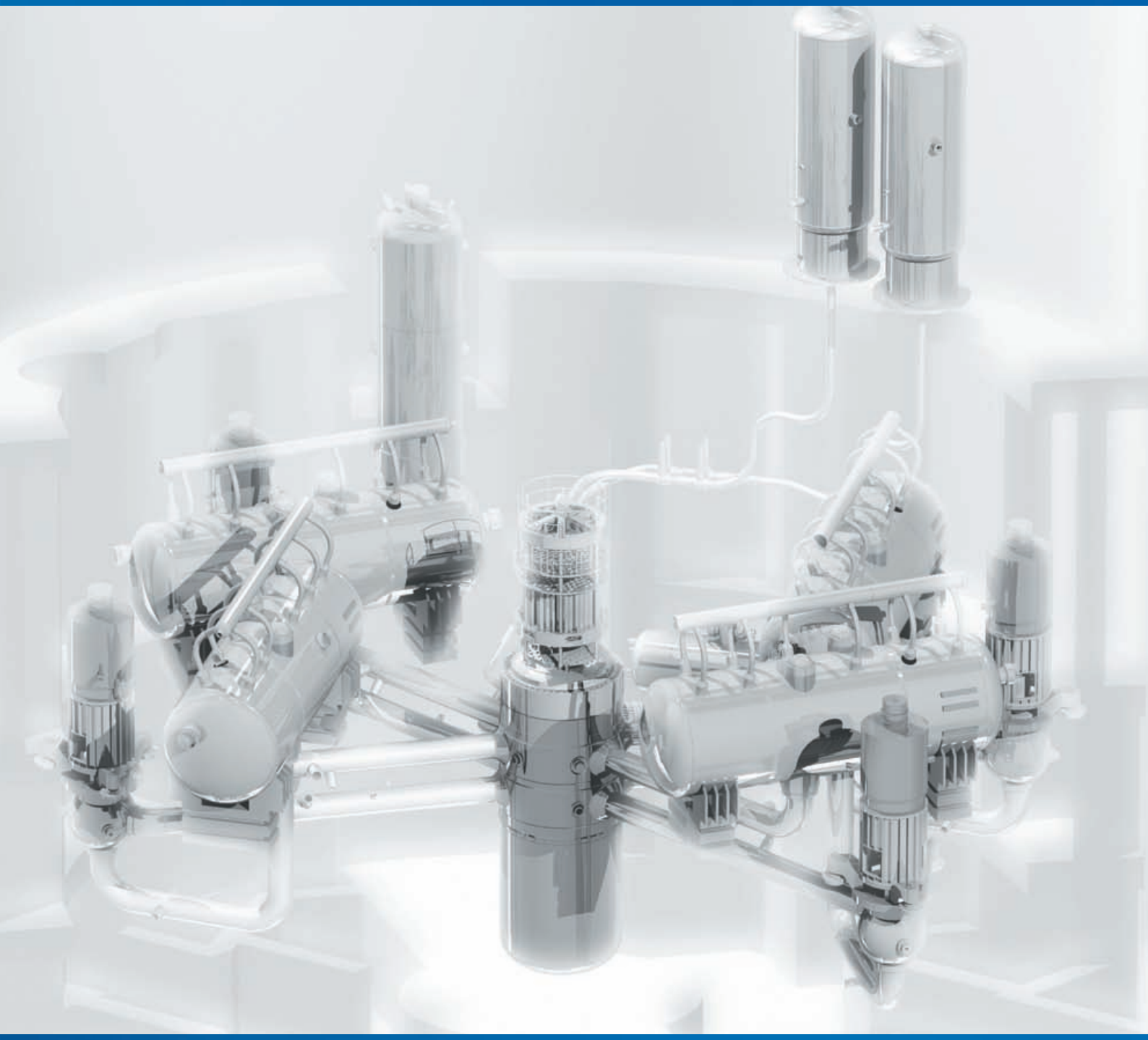
EXPERIMENTAL & DESIGN ORGANIZATION
GIDROPRESS



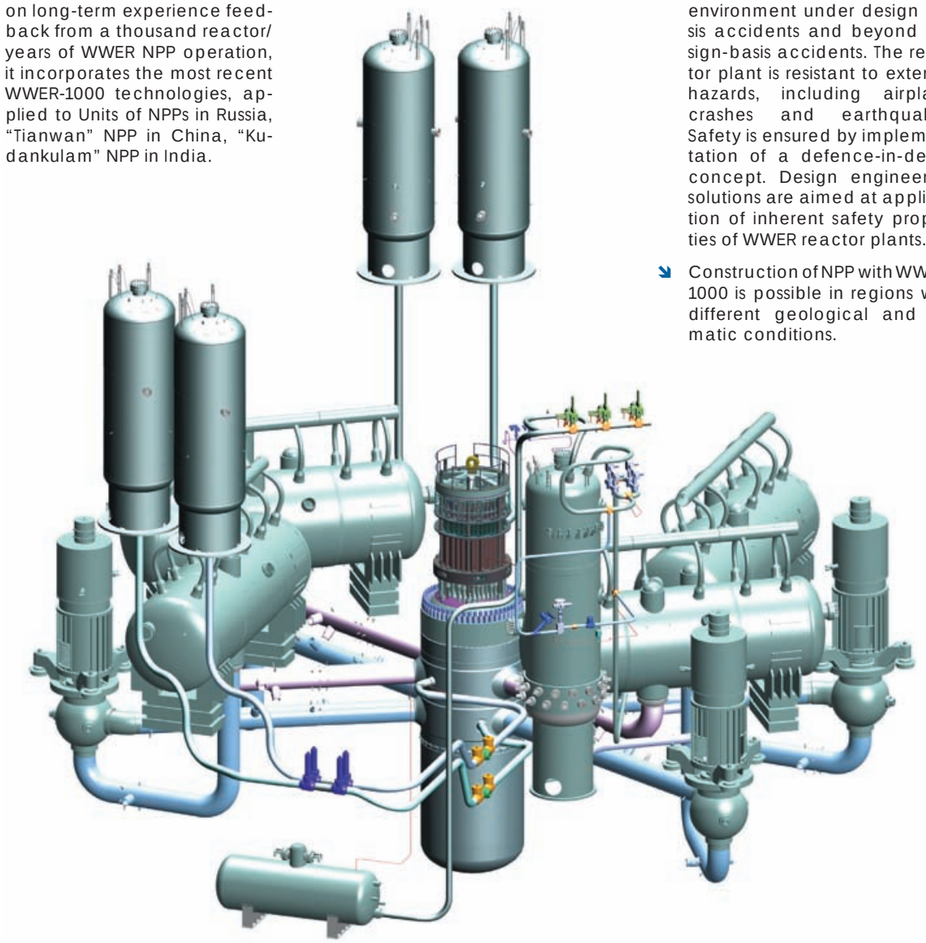
Reactor plant for NPP
WWER-1000

2008

Key assets to support a strategic choice

Evolutionary, safe and innovative design

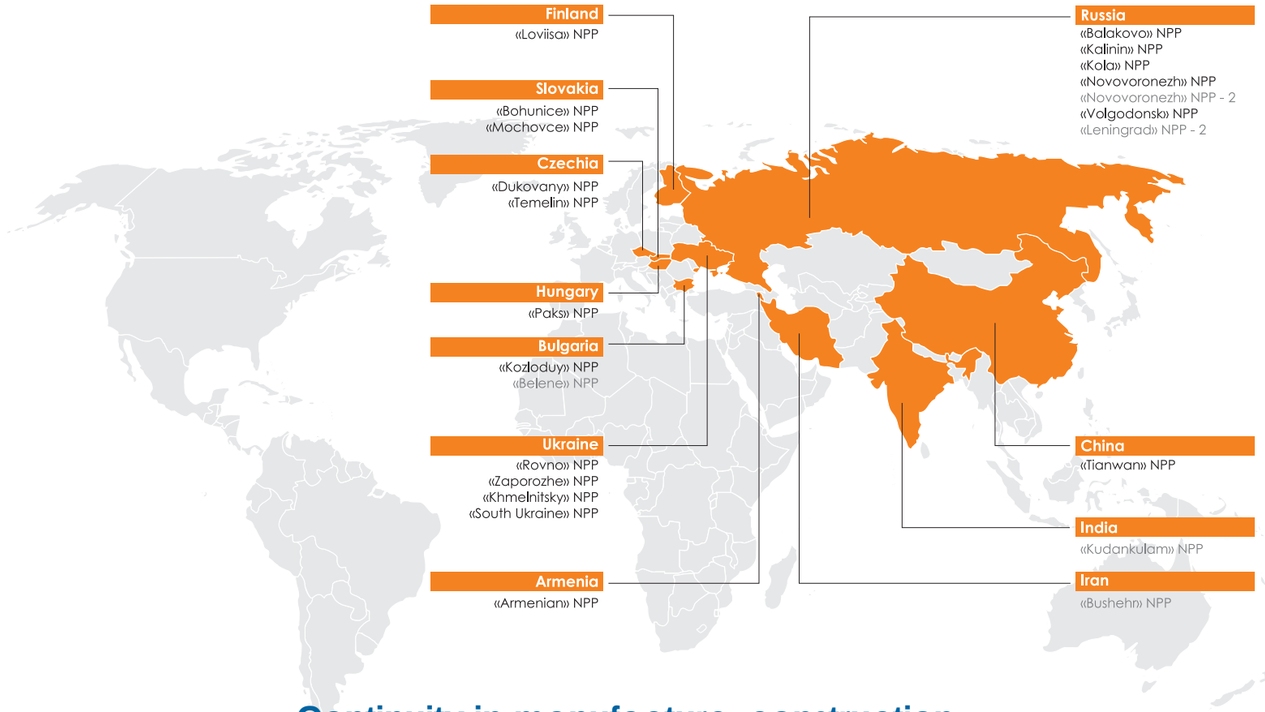
- WWER-1000 reactor plant is a reactor plant with water-cooled water-moderated power reactor for NPP Units up to 1000 MW (electrical). Its design is based on long-term experience feedback from a thousand reactor/years of WWER NPP operation, it incorporates the most recent WWER-1000 technologies, applied to Units of NPPs in Russia, “Tianwan” NPP in China, “Kudankulam” NPP in India.
- WWER-1000 reactor plant design integrates the results of dozens of R&D.
- WWER-1000 RP has safety systems that allow reducing the exposure doses of personnel and minimizing the release of radioactive substances into the environment under design basis accidents and beyond design-basis accidents. The reactor plant is resistant to external hazards, including airplane crashes and earthquakes. Safety is ensured by implementation of a defence-in-depth concept. Design engineering solutions are aimed at application of inherent safety properties of WWER reactor plants.
- Construction of NPP with WWER-1000 is possible in regions with different geological and climatic conditions.



Quality of nuclear power plants with WWER-1000 RP

High quality of engineering solutions and design documentation is based on the large experience in designing, application of home rules, regulations and standards in the field of nuclear power, recommendations of IAEA, EUR, INSAG, ICRP, IEC, home rules in the field of quality assurance, ISO 9001-2000 international standards in the scope that ensures competitiveness at the foreign market.

NPPs with WWER-type reactors (WWER-440, WWER-1000, WWER-1200) in operation and under construction



Continuity in manufacture, construction and operation technology

- The WWER-1000 RP is a product of an evolutionary development of the well-proven WWER RPs, guaranteeing fully mastered technology.
- Application of the mastered technology reduces essentially any design, manufacture and operating risks.
- The high level of professional skills of the WWER NPP operating personnel is maintained.
- Experience in designing, manufacture, construction and operation of NPPs with Russian WWER-type reactors in Russia as well as NPPs with WWER and PWR abroad is used.

Competitiveness is achieved through:

- Unit electric power up to 1100 MW;
- Service life of irreplaceable equipment is at least 60 years;
- Enhanced fuel utilization;
- Operational factor, averaged, for the entire service life of the NPP is 92 %;
- Period between refuellings is 12 to 24 months;

WWER-1000 RP: simplicity in design, safety and technological innovations

Proven and safe design

- One of the WWER-1000 RP main features is its simple design, the reactor plant comprises the reactor, four circulation loops and a pressuizer system. Each circulation loop includes circulation pipelines, reactor coolant pump sets and horizontal steam generators.
- Multi-train safety system is implemented in the design. One safety train can be always laid up for repair during power operation.
- High indices of usage of the inherent safety concept refer to a distinctive feature of the WWER-1000 RP in comparison with PWR.
- Depending on the requirements of Customer and national supervision authorities different safety concepts and, consequently, different combinations of active and passive safety systems can be implemented in the RP and NPP design.
- The RP main equipment is accessible to carry out in-service inspection that allows performing scheduled preventive maintenance of equipment in due time.
- The RP lay-out allows effective introduction of means for small-scale mechanization of repair work, automation of various methods for equipment control.

Technological innovations

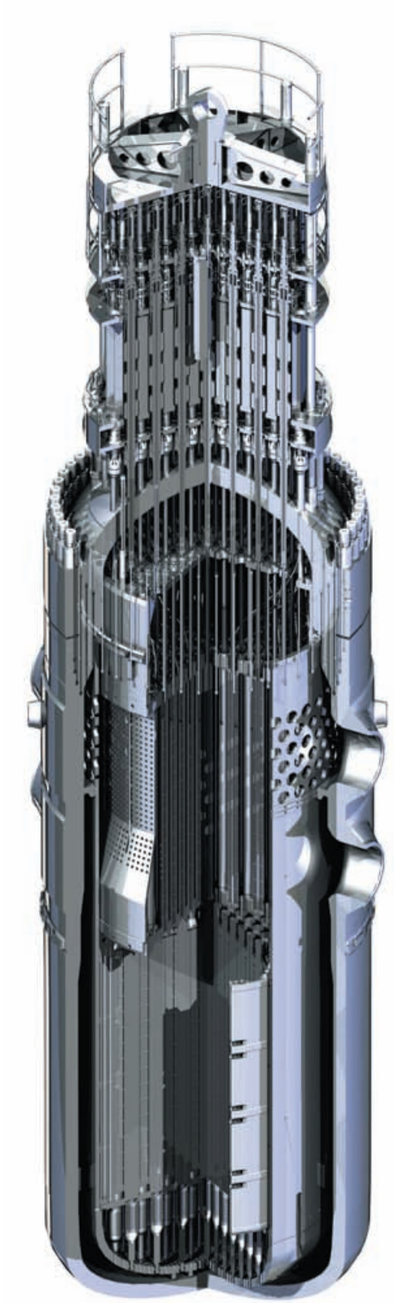
- The internal diameter of the reactor vessel is increased by 45 mm in the core area to reduce neutron flux on the reactor vessel.
- The reactor core is compact and practically free from xenon vibrations and has a smooth distribution of neutron flux. Thermal intensity of the reactor core provides for a significant DNBR of fuel rods under various transients, including accidents.
- The modernized design of the steam generator with increased vessel diameter and corridor layout of tubes in the heat exchanging bundles is applied.
- The concept “Leak before break” is applied for the RP main pipelines of large diameters (more than Dnom 200) that allows to simplify essentially the equipment and pipelines fastener. Meanwhile, the safety systems are designed with account of possibility of hypothetical break of the large diameter pipeline (to the extent of the main coolant pipeline break Dnom 850).
- Modular and removable heat insulation of the reactor plant equipment and pipeline is used which makes the equipment maintenance easy and quick, allows to reduce radioactive wastes amount during operation, has a service life equal to the equipment service life.
- A state-of-the-art facilities for the main equipment state monitoring during power operation are used.
- Automated remote control instruments are used in the design for equipment and pipeline inspection during shutdowns. Together with wide application of automatic power nut-driver and other mechanical aids as well as with the modernized fuel handling machine it allows to reduce time for reactor plant routine maintenance and repair and irradiation doses, as well as to increase usage factor.

Main equipment of WWER-1000 reactor plant

WWER-1000 reactor features

The WWER-1000 reactor design, a product of evolutionary development of WWER-type reactors, is featured by the following:

- The internal diameter of the reactor vessel is increased by 45 mm in the core area to reduce neutron flux on the reactor vessel;
- The number of CPS control rods is increased up to 121 pcs.;
- A new programme for surveillance specimens is envisaged (arrangement of irradiated surveillance specimens directly on the reactor vessel wall);
- Core cooling conditions in loss-of-coolant accidents are improved (due to increase in reactor coolant inventory);
- Radiation doses of personnel operating RCP sets and steam generators are reduced.



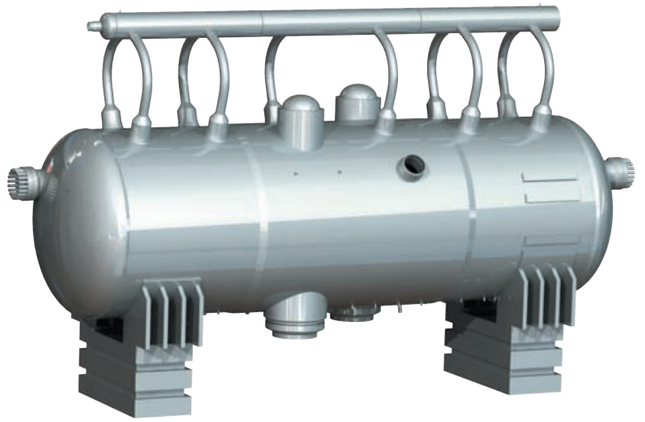
Features of the WWER-1200 reactor core and fuel cycle:

- The reactor core design ensures operation in flexible fuel cycles lengths from 12 up to 24 months;
- The core provides possibility for extension of fuel cycle due to use of temperature and power effects of reactivity for a term up to 60 days;
- The core provides increased fuel burn-up at the level of 70 MW day/kgU, on average, at the maximum burnt-up FA;
- The mass of fuel, loaded into the reactor, is increased due to improvement of fuel rod design;
- The FA structure is repairable and provides possibility of remote withdrawal and replacement of a defective fuel rod using simple repair tools.
- Uranium fuel UO_2 is used, application of uranium-gadolinium fuel UO_2-Gd_2O_3 is also possible;
- Temperature of recriticality is less than 100°C.

Steam generator features in WWER-1000 reactor plant design

To enhance operating reliability of steam generators a modernized design of the steam generator is used with the following basic design features:

- Spaced-out corridor layout of tubes is applied to heat exchanging bundles;
- Sealing of all joints of the primary and secondary sides is provided by expanded graphite gaskets;
- Installation of washing devices is provided that allows to ensure cleanness of “pocket” space due to periodic washings within preventive maintenance;
- The SG design is adapted to the maximum for application of automatic means of inspection and maintenance, both from the primary and secondary side;
- the space under the tube bundle is extended to simplify sludge removal.



Application of spaced-out corridor layout of tubes in the heat exchanging bundles allows:

- to increase intensity of circulation in the tube bundle that results in decrease in the rate of deposit formation on heat exchanging tubes;
- to reduce probability of tube space clogging by exfoliated sludge;
- to increase space under the tube bundle to simplify sludge removal;
- to make easier access to tube space for inspection of heat exchanging tubes and their cleaning, if required;
- to increase steam generator water inventory;
- to improve a stress condition of the coolant collector;
- to enhance technological effectiveness of heat exchanging tube repair (plugging);
- to improve manufacturability and quality of tube bundle assemblage.

Features of reactor coolant pump set in WWER-1000 reactor plant design

GCNA-1391, used in the design, is a reactor coolant pump with the following features:

- The torsion bar with a plate clutch, instead of the gear clutch, is used;
- The main radial-axial bearing with water lubricant is used;
- Under a standby mode the heat removal from the lower radial bearing is provided by natural circulation;
- The spherical form of stamped-welded vessel is used;

The motor has the following advantages:

- Individual system of lubrication
- Start-up of the motor up to 750 rpm is provided at the beginning, and then changing over to rated speed of rotation 1000 rpm is ensured
- Water lubrication of electric motor bearing is planned in order to exclude oil system to avoid fire risk.

EXPERIMENTAL & DESIGN ORGANIZATION
GIDROPRESS

21, Ordzhonikidze Street, 142103 Podolsk,
Moscow region, Russian Federation

Tel.: (495) 502-79-10, (4967) 54-25-16
Fax: (4967) 54-27-33, 69-97-83

Http://www.gidropress.podolsk.ru | Email: grpress@grpress.podolsk.ru