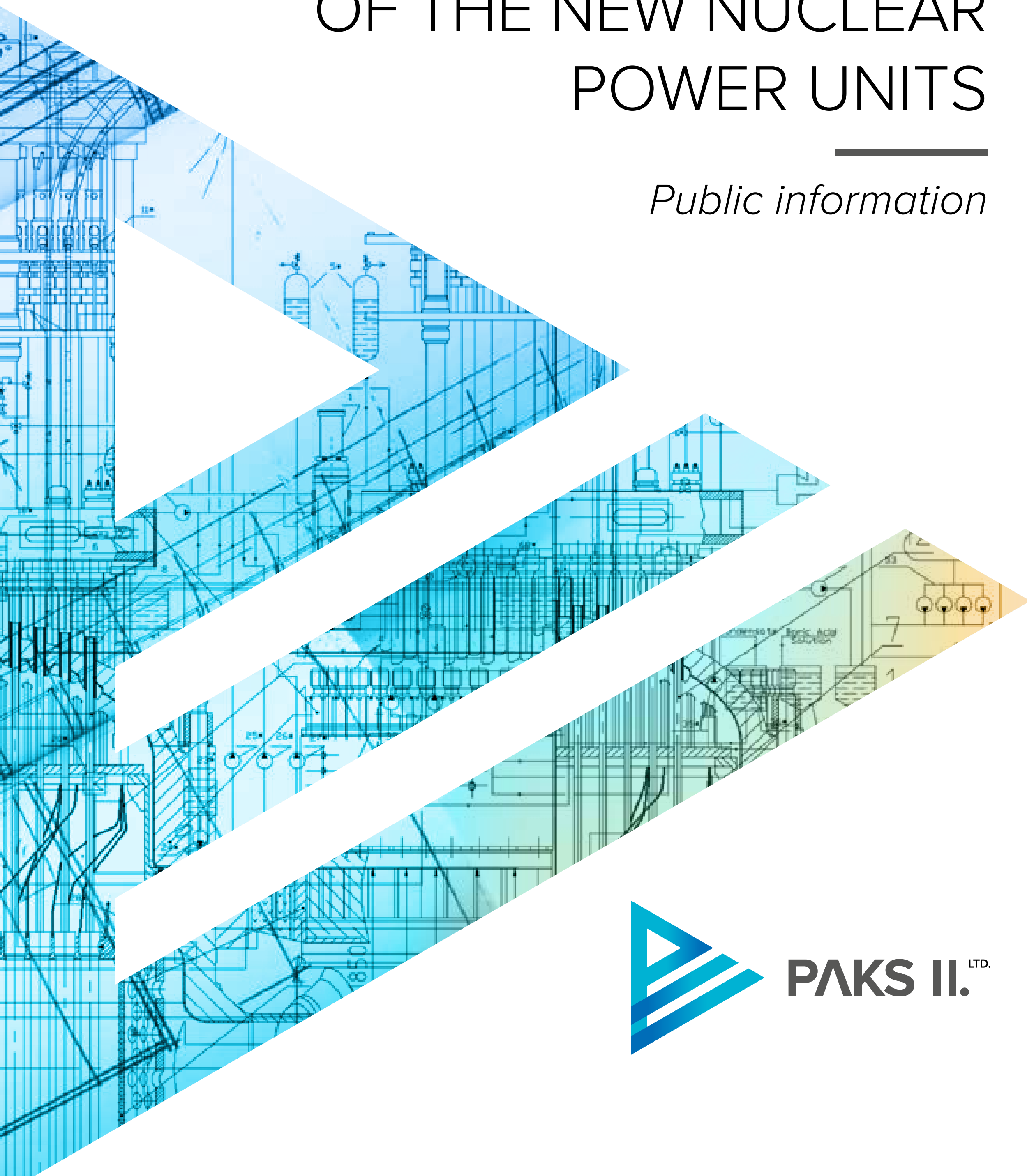
IMPLEMENTATION LICENSING

OF THE NEW NUCLEAR POWER UNITS

Public information

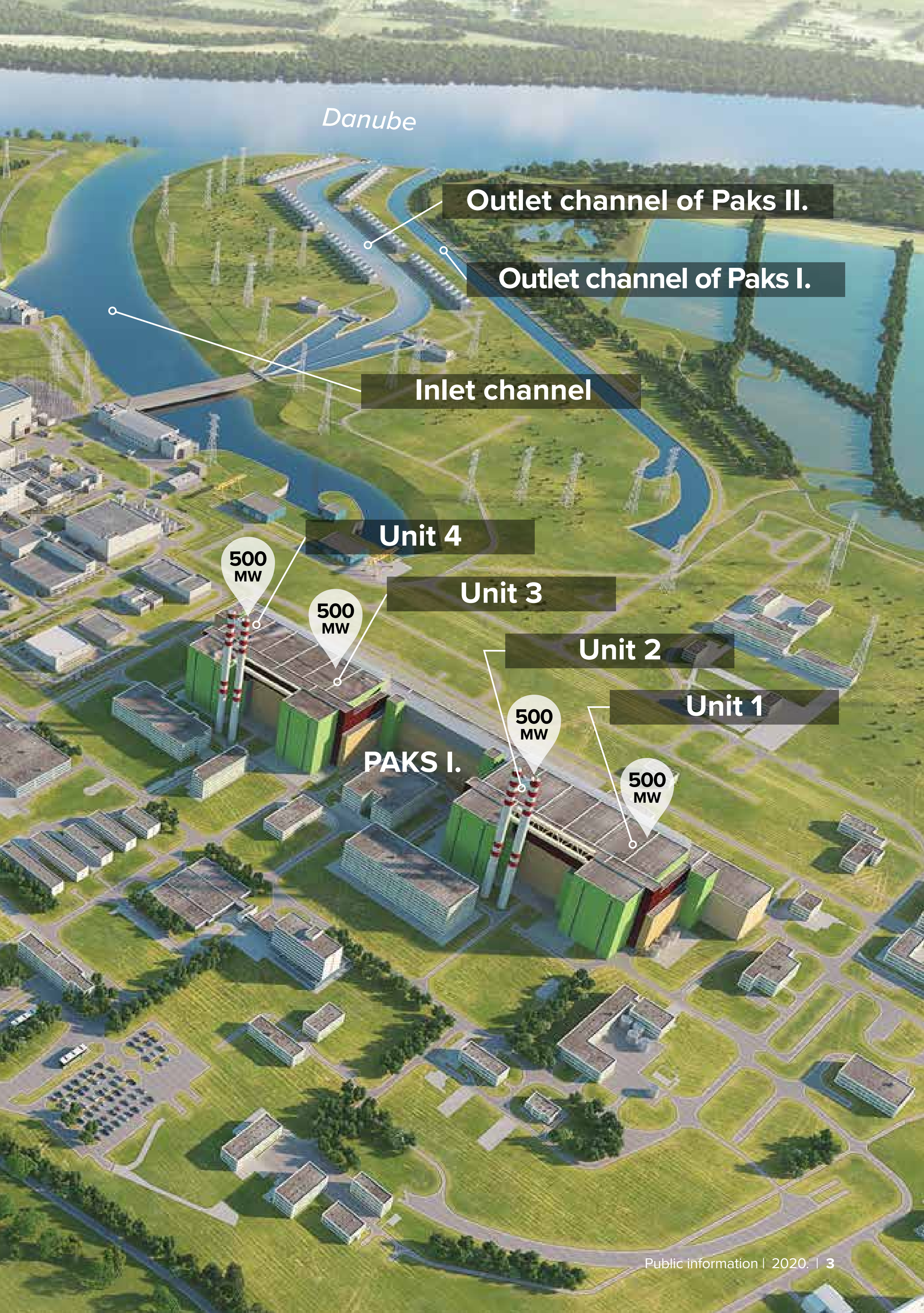


PAKS II. LTD.

PAKS II. PROJECT

The main objective of Paks II. Nuclear Power Plant Private Company Limited by Shares (Paks II. Ltd.) is the construction and subsequent operation of new nuclear power plant units at Paks site.
As of today, the most important task of the company is the designing activity and obtaining the required licenses and permits; the on-site work performance was commenced in June 2019 with the Construction and Erection Base facilities.
Concerning the long-term competitiveness of the national economy, the task of key importance is to provide the Hungarian households and industrial consumers with clean electricity – independent on prevailing weather conditions – at an affordable price all around the clock, in summer and winter alike.

It is not possible to assure a long-term electricity supply without Paks II. At the present moment, approximately two-thirds of the domestic electricity demand is supplied by the nuclear power plant units operating in Paks; however, their lifetime will expire in the 2030s. In the long run, two new nuclear power plant units are implemented to replace the phased out old capacities.
Implementation of the new units is the key industrial investment of this century in Hungary. During the peak years of the construction, over 10 000 people will be working at the project and another 10-15 000 workers throughout this country will be involved in the performance of project-related tasks and activities.
The goal of Paks II. Ltd. is to construct a nuclear power plant corresponding to the best technical standards and complying with the most stringent requirements that will be operating safely for decades, securing the supply of climate friendly electricity for Hungarian consumers and giving an impulse to the further development of domestic industries, trade and education.


Danube
Outlet channel of Paks II.
Outlet channel of Paks I.
Inlet channel
Unit 4
500 MW
Unit 3
500 MW
Unit 2
500 MW
Unit 1
500 MW
PAKS I.

VVER-1200 NPP UNIT OF GENERATION 3+

The VVER-1200 NPP unit type designed by Rosatom belongs to the so-called 3+ generation or in other words, is a further developed power unit of the third generation.

KEY CHARACTERISTICS OF VVER-1200 POWER UNITS

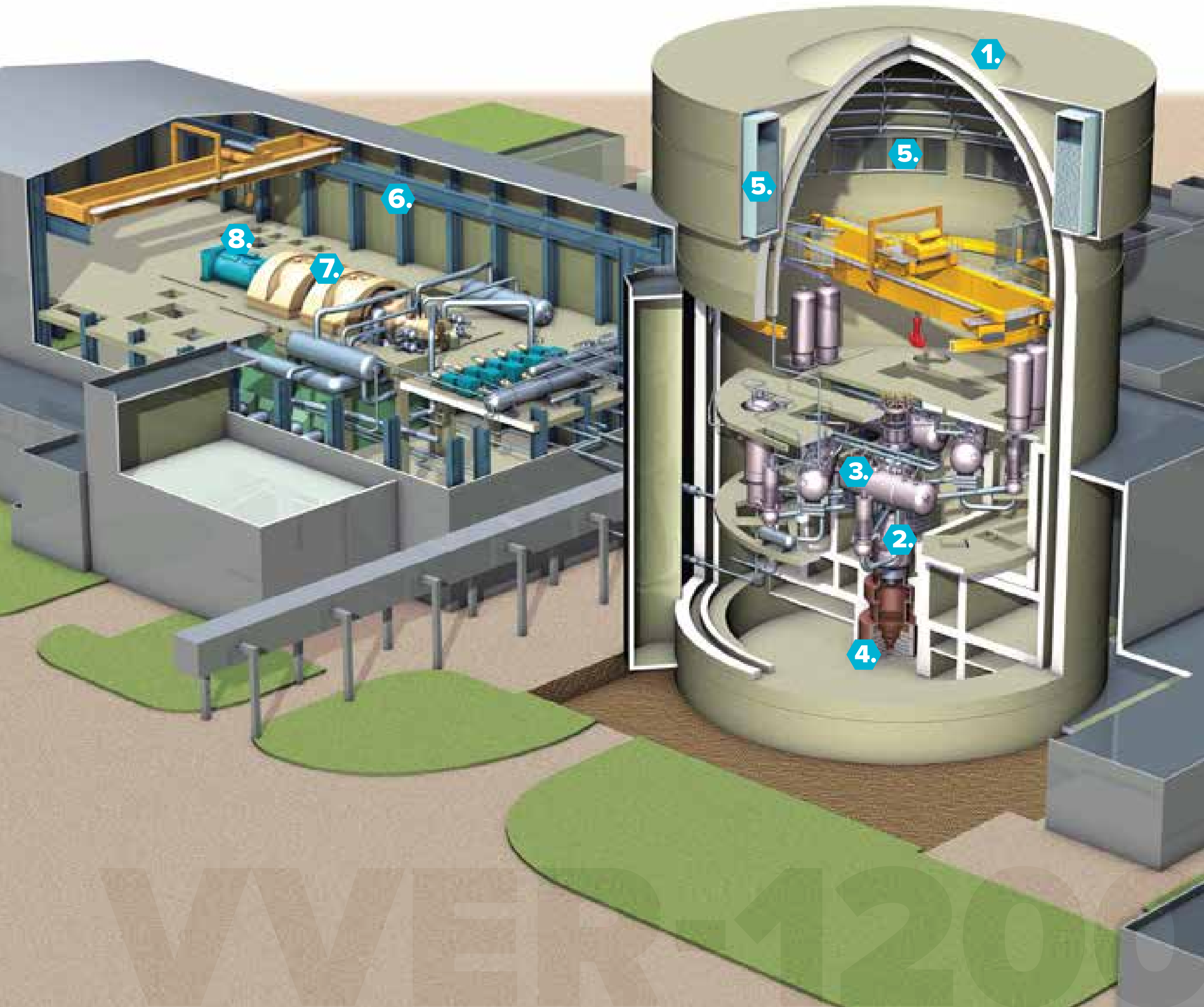
Reactor type	**Pressurised water reactor**
Thermal output	**Ca. 3220 MW**
Electrical output	**Ca. 1200 MW**
Fuel	**U-235**
Number of primary loops	**4**
Number of steam-generators	**4**
Safety systems	**Active and passive safety systems**
Designed lifetime	**Min. 60 years**
Availability Factor	**>90%**
Independence from external power supply	**72 hours**

Rosatom possesses more than 40 years of experience in the design and operation of VVER type power units. As of June 2020, 62 power units of VVER type are operating worldwide. The currently operating four units of Paks Nuclear Power Plant belong to this reactor family as well.

The first units of VVER-1200 type were commissioned in Russia: at the moment, two power units are generating electricity in Novovoronezh and another one in Sosnovy Bor; one more power unit of this type is currently under construction at the plant site in Sosnovy Bor. In addition to the projects being under implementation in Russia, 11 power units of this type are being constructed all around the world from Finland to Belarus and Turkey.

SCHEMATIC DESIGN OF VVER-1200 POWER UNITS

1.	Double walled containment
2.	Reactor pressure vessel
3.	Steam generator
4.	Core catcher
5.	Passive containment heat removal system
6.	Turbine hall
7.	Turbine
8.	Generator



LOCATION OF THE NEW UNITS

The two new nuclear power units will be constructed northwards from the presently operating units of Paks Nuclear Power Plant. The plant site will accommodate all other systems and buildings necessary for subsequent plant operation, as well as Construction and Erection Base facilities and areas used during the construction period.

IMPLEMENTATION LICENSING PROCEDURE

Rules for the application of nuclear energy in Hungary are laid down in the Act CXVI of 1996 on the Atomic Energy Govt. Decree No. 118/2011. (VII.11.) and its annexes presenting the Nuclear Safety Code contain specific regulatory rules and requirements to the licensing procedure, which are essential in terms of obtaining regulatory licenses and permits. The competent licensing authority in case of nuclear facilities is the Hungarian Atomic Energy Authority (HAEA); however, the regulator may involve other specialised authorities competent in various topics. Over 6000 licenses and permits are required for the project implementation; the most important ones are the so-called facility-level licenses, i.e. the environmental license, site license, implementation license, commissioning license and license for operation.

The **environmental license** was received by Paks II. project on 29 September 2016, the **site license** was granted on 30 March 2017. It should be emphasised that the procedure of Environmental Impact Assessment conducted by Paks II. was qualified by the Secretariat of Espoo Convention as the „best practice" to be followed.
The next – most important milestone up to the present moment – will be the issue of **implementation license** by the HAEA. After receiving the above license, Paks II. will be in capacity to obtain further licenses and permits required to commence the activities related to the construction, procurement, equipment manufacturing and installation.

The primary document of the implementation license application is the Preliminary Safety Analysis Report, the purpose of which is to confirm that the implemented nuclear power plant – by means of using technical and process solutions and operation modes presented in the design documentation – fulfils the specified nuclear safety requirements and can be constructed and operated safely.

The Preliminary Safety Analysis Report comprises the results of a several-year complex activity. The first step consisted in the development of the design basis determining nuclear safety-related and other requirements, as well as design criteria applicable for the nuclear power plant, its systems and components that should be taken into consideration during the designing process. After finalisation of the design basis, the preparatory work was continued to develop the Basic Design documentation. In addition to the Basic Design of plant buildings, systems and components, various analyses and evaluations had to be prepared in order to confirm the adequacy of technical solutions contained in the Basic Design documents. Based on the Basic Design and other related evaluations, the Preliminary Safety Analysis Report provides an overview of nuclear safety characteristics of the constructed nuclear power plant and contains an item-wise confirmation of fulfilling the relevant nuclear safety requirements.

NUCLEAR SAFETY CHARACTERISTICS OF VVER-1200 UNITS

During the development of VVER-1200 power units, specific attention was paid to safety enhancement. Rosatom took into consideration all nuclear safety requirements of the International Atomic Energy Agency and lessons learnt from nuclear events and accidents that had occurred in the nuclear industry.

Safety concept applied for this type of power units is based – in the full compliance with international recommendations in the nuclear safety field – on the defence-in-depth principle meaning that various independent defence levels ensure that even extremely low probability failures and anticipated operational occurrences will be detected, compensated and managed, as appropriate. Another feature of the applied safety concept is inherent safety. Inherent safety means that in case of an unauthorised reactor power increase, the chain reaction – after achieving some certain level – will terminate on its own, without any human intervention, according to the law of physics, and the reactor will enter the safe, so-called sub-critical state.

Regarding VVER-1200 NPP units, safety is assured by the application of active (electric power supply dependent) and passive (able to function without electric power supply and human intervention) systems. The operation of active safety systems is based on the principle of redundancy implying that these safety systems are comprised of four parallel sub-systems (channels) and the operation of one of those is already sufficient to execute the anticipated safety-related intervention in full. Spatial separation of the above sub-systems is assured at excluding common cause failures (e.g. fire). An important safety feature is the availability of safety systems operating on the principle of diversity (e.g. active and passive systems).

In sense of stringent safety-related design requirements, it should be confirmed for the Paks site that in case of hazards resulting from natural disasters (e.g. great earthquakes) with the frequency of occurrence exceeding 10^{-5}/year (return frequency of 100,000 years) and external events induced by man-made activities (e.g. heavy aircraft crash) with the frequency of occurrence over 10^{-7}/year (return frequency of 10,000,000 years), safe state of the power unit can be maintained. In terms of technology- or operator-related failures the confirmation of compliance should be conducted for initial events with the frequency of occurrence exceeding 10^{-6}/year (return frequency of 1,000,000 years).

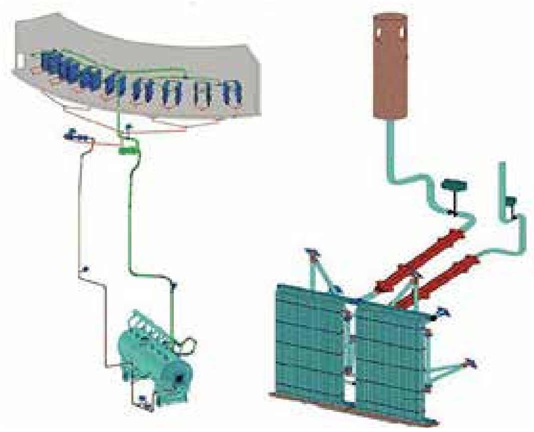
INNOVATIVE SAFETY-ENHANCING TECHNICAL SOLUTIONS APPLIED AT VVER-1200 POWER UNITS

PRIMARY AND SECONDARY CONTAINMENT

The reactor, its process and auxiliary systems, as well as the spent fuel pool designed for the interim storage of spent fuel assemblies are protected by the primary containment. The containment inner wall is a pre-stressed reinforced concrete structure with steel lining. In addition to active and passive heat removal systems, the primary containment ensures the retention of radioactive materials and prevents their escape into the environment in case of operational occurrences and severe accidents. The secondary containment made of reinforced concrete is able to protect the primary containment even in case of a heavy aircraft crash.

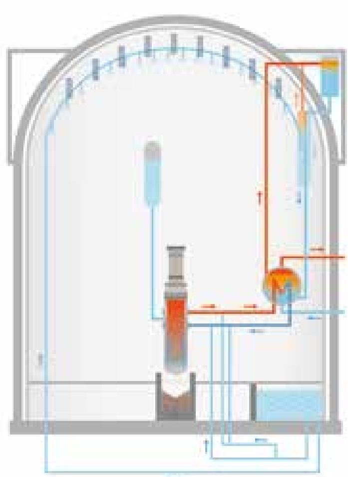
RESIDUAL HEAT REMOVAL

After the shutdown, a large amount of energy (so-called residual heat) is released in the reactor during some certain time period, due to the continuing decay of radioactive elements in the fuel assemblies. In order to ensure the removal of residual heat released in the reactor core, power units are equipped with passive heat removal systems. In the event of station blackout or loss of steam generator feedwater supply – when the removal of residual heat to the Danube cannot be assured by active heat removal systems – this residual heat can be released into the atmosphere by means of passive heat removal systems. The process is implemented via a heat exchanging tube, preventing the escape of radioactive materials into the environment.



Passive heat removal systems

The containment is designed with a passive heat removal system aimed at the limitation of temperatures prevailing under accident circumstances in the case of unavailability of the water sprinkler system intended for the cooling of containment space.



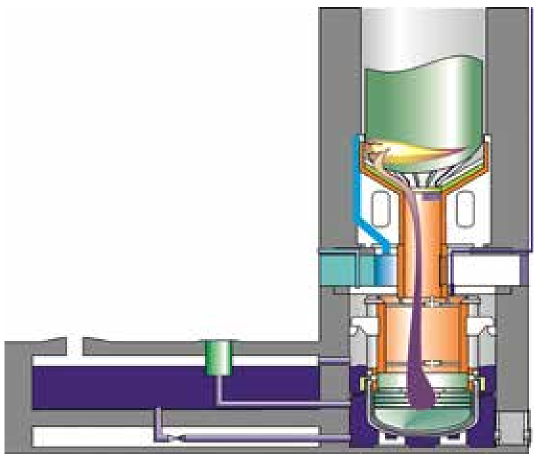
Passive heat removal systems

HYDROGEN CONTROL

The chemical reaction being the result of interaction between fuel rod zirconium claddings and water steam under accident conditions may lead to the generation of hydrogen and pose the risk of fire and explosion. Catalytic oxidation of hydrogen and maintenance of low-level hydrogen concentration is assured by passive autocatalytic hydrogen recombiners. The recombiners are installed in all such points of the containment annular space that may pose the risk of hydrogen concentration increase based on the analysis results.

CORE CATCHER

The plant is also prepared to manage severe accidents occurring with very low probability. In order to mitigate the consequences of core meltdown, the reactor designs implies the installation of a core catcher. The core catcher is aimed at preventing corium-concrete interactions and reducing the amount of hydrogen generation and environmental release of radioactive materials.



Core catcher

A core catcher is a special device installed underneath the reactor pressure vessel with the purpose to receive corium in case of reactor vessel damage. The core catcher tank is filled with special aluminium- and iron oxide mixture with neutron-absorbing properties allowing to reduce the corium specific heat release. The above mixture is also supplemented with gadolinium preventing – due to its neutron absorbing characteristics – corium chain reaction. In case of severe accidents, the steel tank of the core catcher can be cooled from outside with the use of borated water.

IMPLEMENTATION LICENSING PROCEDURE

The implementation licensing procedure starts upon the submission of the implementation license application to the HAEA. General provisions concerning the content of implementation license application are specified in the Govt. Decree No. 118/2011. (VII.11.), while more detailed requirements to the application content and form are described in the respective HAEA Guide. The implementation license application consists of substantiating and supporting documents.

SUBSTANTIATING DOCUMENTS	
1.	Preliminary Safety Analysis Report
2.	Facility Model
3.	Preliminary Nuclear Accident Preparedness and Response Plan
4.	Long-term storage and disposal of radioactive waste originating during the operation of new power units in Paks and spent nuclear fuel
5.	Modernisation strategy for Instrumentation and Control systems
6.	Determination of safety area
7.	Demonstration of the implementation activities time-schedule and preliminary version of the general construction plan
8.	Proof of ownership or trust in real estate belonging to the safety area of the nuclear facility
9.	Effective local building code and regulatory plan for the plant site
10.	Independent safety analysis
11.	Documentation of the independent technical expert review
SUPPORTING DOCUMENTS	
12.	Deterministic safety analysis
13.	Probabilistic safety assessment
14.	Potential impact of the new builds and related activities on the safety of existing nuclear facilities
15.	Calculation and analysis results

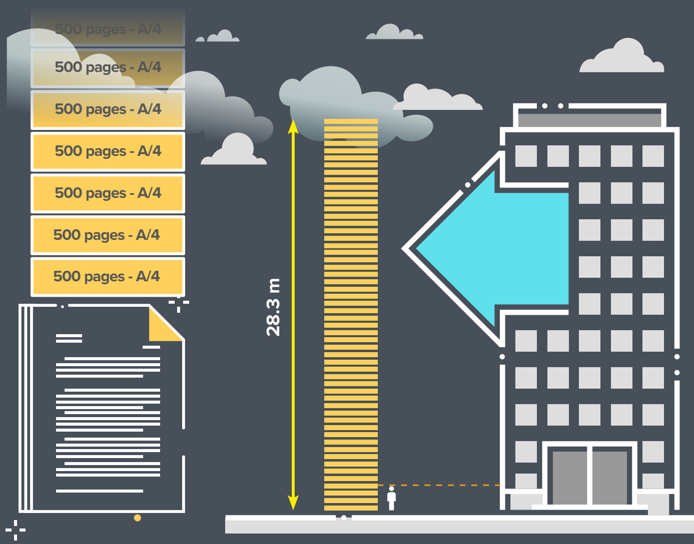
The total volume of substantiating, supporting and background documentation accounts for

283 000

PAGES

28.3 m

The total documentation volume means 566 packages of A/4 pages: should we place them on one another, a 28,3 m high „tower” – comparable in its height with a 10-storey residential building.*



** The documentation has been submitted by Paks II. Ltd. to the regulatory authority electronically.*

The official administrative deadline for the implementation licensing procedure is 12 months (that may be extended by the authority by maximum 3 months). This period will be coupled with intensive communication between the Hungarian Atomic Energy Authority and Paks II. project since the authority may require the provision of additional data and information during the application evaluation process. The Atomic Act provides for the involvement of the following special authorities for the review of certain professional issues:

- in respect of environmental and nature protection, mining supervision issues: Government Office of Baranya County
- in respect of fire protection and disaster management issues: National Directorate General for Disaster Management of the Ministry of Interior

To support the regulatory decision-making process connected to the implementation license application, the HAEA involves international expertise. The authority has concluded an agreement with the International Atomic Energy Agency concerning the review and commenting of the Preliminary Safety Analysis Report.
In sense of Section § 11/A (4) of the Atomic Act, the HAEA will hold public consultations in course of the implementation licensing procedure; the concerned parties (organisations involved in the licensing process) and the general public shall be informed of the venue and date of these public consultations at least 15 days prior to consultations. During these public consultations, the concerned parties and all the interested entities may get acquainted with the subject and progress of the licensing procedure, may express their standpoints and put their questions.

For further details related to implementation licensing and Paks II. project, please visit our website at:

www.paks2.hu/en

IMPRINT

Publisher: István Mittler – *Communications Director, Member of the Board of Directors,* Paks II. Ltd.
Editor-in-chief: Gábor János Volent– *Lead Licensing Expert,* Paks II. Ltd.
Graphics, layout: Tamás Nagy – Paks II. Ltd.
Photos/figures: Paks II. Ltd. archive, Rosatom, Depositphotos
Manuscript finalised on 23. 06. 2020.

www.paks2.hu/en

PAKS II. LTD.

Contacts

Paks II. Nuclear Power Plant Ltd.
H-7030 Paks, Gagarin Street 1. 3rd floor No. 302/B, Hungary

Telephone: +36 75 999 200
E-mail: info@paks2.hu
Web: www.paks2.hu/en

Paks II. Atomerőmű Zrt. | Paks II. Nuclear Power Plant Ltd.