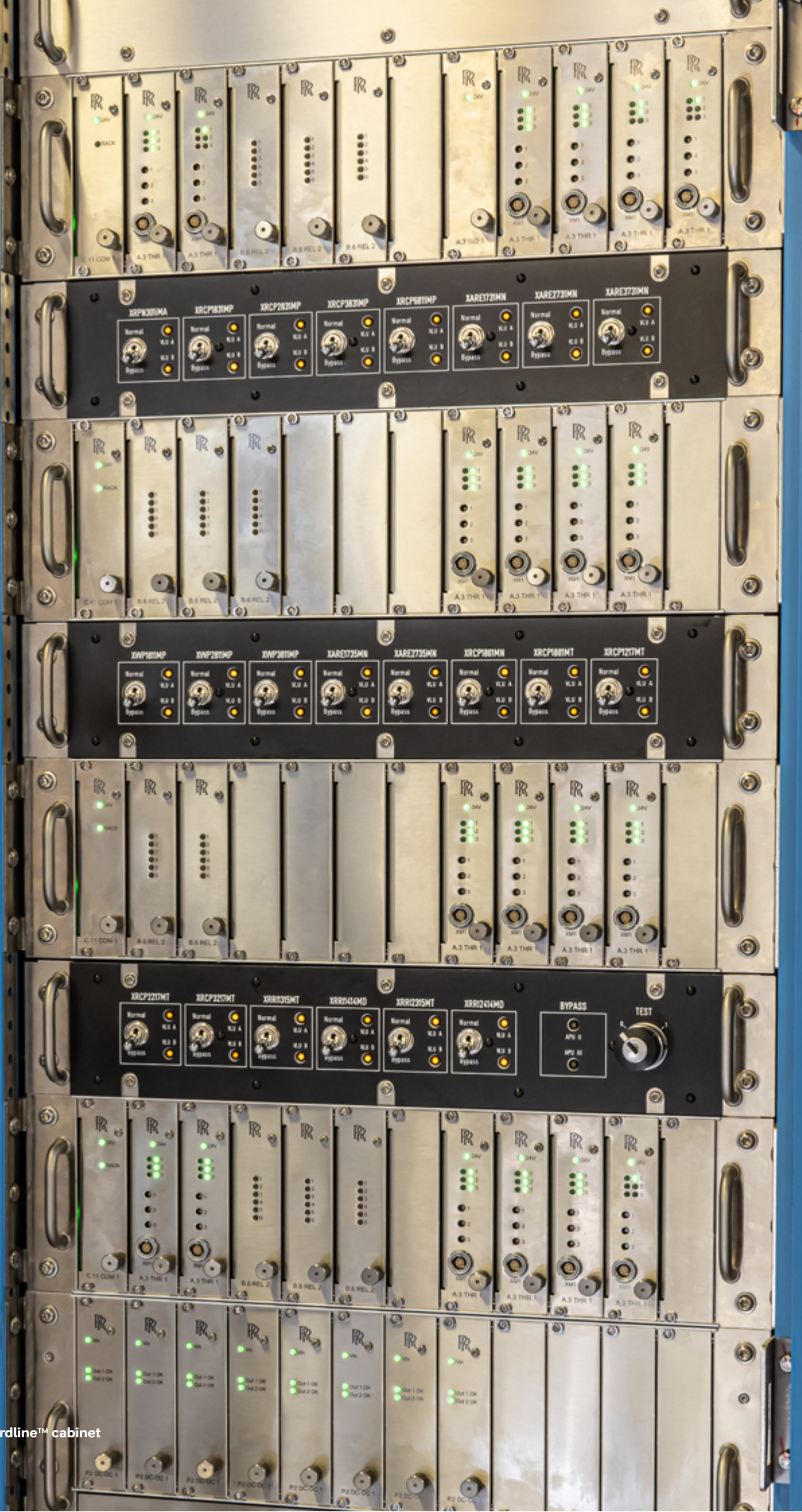




Pionners of nuclear Instrumentation & Control





Hardline™ cabinet

Our vision

Ensuring the safety of nuclear reactors

Rolls-Royce is a technology-independent nuclear I&C supplier, providing customers with nuclear safety instrumentation and control systems designed to improve the safety, availability and reliability of their high value assets, while reducing operating costs.

Rolls-Royce's Nuclear I&C business designs, manufactures, installs and maintains cutting-edge nuclear safety Instrumentation and Controls (I&C) solutions of more than 150 nuclear reactors worldwide. This includes all reactors in France and more than 40 reactors in China.

Thanks to more than 50 years' experience in this area, Rolls-Royce has developed a complete range of proprietary, analogue and digital safety I&C technologies (Spinline®, Rodline®, Hardline™, Boronline®) and safety critical instrumentations (ex-core neutron detectors, Bibloc® pressure transmitters, rod position indicator system, etc.) specifically designed for nuclear applications, as well as long term services solutions to support nuclear operators during the complete lifecycle of their reactor.

The I&C value proposition of Rolls-Royce nuclear I&C business to customers includes:

- The ability to serve customers throughout the plant life cycle with a complete range of solutions
- A range of modular, proven and up-to-date proprietary technologies, related IP and licensing expertise
- A highly trained and experienced workforce, with decades of experience working in I&C
- The delivery of new build and modernisation projects on-time
- A longstanding field experience with more than 3 000 reactors-years of successful operation of Rolls-Royce's installed I&C systems



“WITH OUR CUSTOMERS
FOR A SAFE WORLD.”

Our structure

A global I&C organisation

Rolls-Royce I&C business employs over 550 people in 4 countries.

The activities are coordinated by the center of excellence and expertise based in Grenoble, where our nuclear instrumentation and control solutions are designed, manufactured and tested.

Our engineering and service centers based respectively in Prague and Shenzhen allow us to be located close to our customers to deliver responsive and long-term high quality services, ensuring the safety and availability of nuclear power plants in these regions.



“AN ORGANISATION
DEDICATED TO THE
SATISFACTION OF OUR
CUSTOMERS.”



Our history

A continuous experience in the nuclear industry since the 60's

For more than 50 years, we have been involved in the major nuclear programmes worldwide, working with the main actors of the nuclear industry and providing analogue and digital safety instrumentation and control systems in nuclear reactors of all types all over the world.



60s to 80s

- 1962**
Supply of low level amplifiers and magnetic triggers for land-based prototype (PAT).
- 1966**
Development of analogue reactivity meter under CEA licence.
- 1967**
Supply of low level amplifiers and magnetic triggers for "Redoutable" submarine.
- 1967**
Cooperation contract with CEA. From the CEA design, Multibloc technology industrialization.
- 1970**
Acquisition of CEA licence for boron coated ionization chambers.
Cooperation with CEA on neutron detection and instrumentation.
- 1972**
Installation of neutron channels on Bugey 1 reactor in France (Graphite gas type).
- 1973**
Installation of neutron channels on Phenix reactor in France (fast breeder type).
- 1977**
First criticality of Fessenheim 1 reactor. First French pressurized water reactor to use our I&C systems (NIS, RCS, Boronmeter, Detectors, etc.).
- 1983**
First international project for I&C business unit.
Supply of neutron detectors and Boron meter in Doel 1 reactor in Belgium.
- 1984**
Installation of the first digital reactor protection system (SPIN) worldwide in Paluel 2 reactor in France and deployment on 20 reactors between 1984 and 1993.



90s to 00s

- 1991**
Signature of the first long term support agreement (Pérennité) with EDF for the French nuclear fleet.
- 1993**
First criticality of Daya Bay 1 reactor in China. Supply of Rod control system, neutron instrumentation system, neutron detectors and boron meter.
- 1996**
First criticality of Chooz B1 reactor in France, using our second generation of digital technology (SPIN N4).
- 2000**
Start of the I&C modernisation project at Dukovany nuclear reactors (4 VVER-440 type reactors) in Czech Republic. Project completed in 2009 to schedule.
- 2006**
Start of the Rod Control System (RCS) and in-core instrumentation system modernisation of the 900MW french fleet (34 reactors).
- 2007**
Pressure transmitters and temperature sensors: transfer of capabilities and intellectual property from ABB to Rolls-Royce.
- 2009**
First contract for CPR1000 reactors in China.
Supply of I&C systems for 24 reactors between 2009 and 2018.



10s

- 2011**
Start of the VD3 1300MW project: modernisation of the safety I&C systems for 20 reactors in France.
- 2012**
First criticality of Ningde 1 reactor in China (CPR1000 type). First reactor using Rodline® technology for Rod Control System (RCS).
- 2014**
Certification of Spinline® technology by NRC (US safety authority).
- 2014**
Signature of the I&C modernisation project of Loviisa nuclear reactors (2 VVER-440 type reactors) in Finland.
- 2015**
Contract by EDF to supply Boron meters (using Boronline® technology) to 34 nuclear reactors in France.
- 2016**
Contract with Framatome for the NIS modernisation of the 900MW fleet in France (28 reactors).
- 2017**
Renewal of Pérennité contract with EDF for 10 additional years.
Contract for the partial modernisation of rod control system of the 900MW fleet in France (32 reactors).
Contract to supply rod control system with Rodline® technology for Tianwan 5,6 nuclear reactors in China.
- 2018**
Contract to supply Spinline® for safety I&C systems of Ultimate Diesel generators of Hinkley Point C in UK.
Contract for NIS modernisation of Daya Bay nuclear reactors in China.
- 2019**
Contract to provide a NIS system for the CAP1400 reactor in Shidaowan, China.
Contract to provide a reactor protection system, priority logic and an individual control and protection system for actuator, based on Spinline®, Hardine™ technologies, for a research reactor in Brazil.
First LTSA contract with Fortum for 25 years.



20s

- 2020**
Contract to modernise ESFAS functions of Fortum's Loviisa nuclear reactors in Finland.

Contracts to provide the Neutron Flux Monitoring System using the Spinline® digital technology, and 200 Bibloc® safety classified pressure transmitters (Severe Accident, K1, K2, K3 SA) for two nuclear reactors currently under construction in China, Zhangzhou 1 and Zhangzhou 2, both of which use the Hualong One (HPR1000) reactor design.

Contract to supply 140 safety classified (K1) Bibloc® pressure transmitters, for the two EPR nuclear reactors of Hinkley Point C, currently under construction in Somerset, UK.

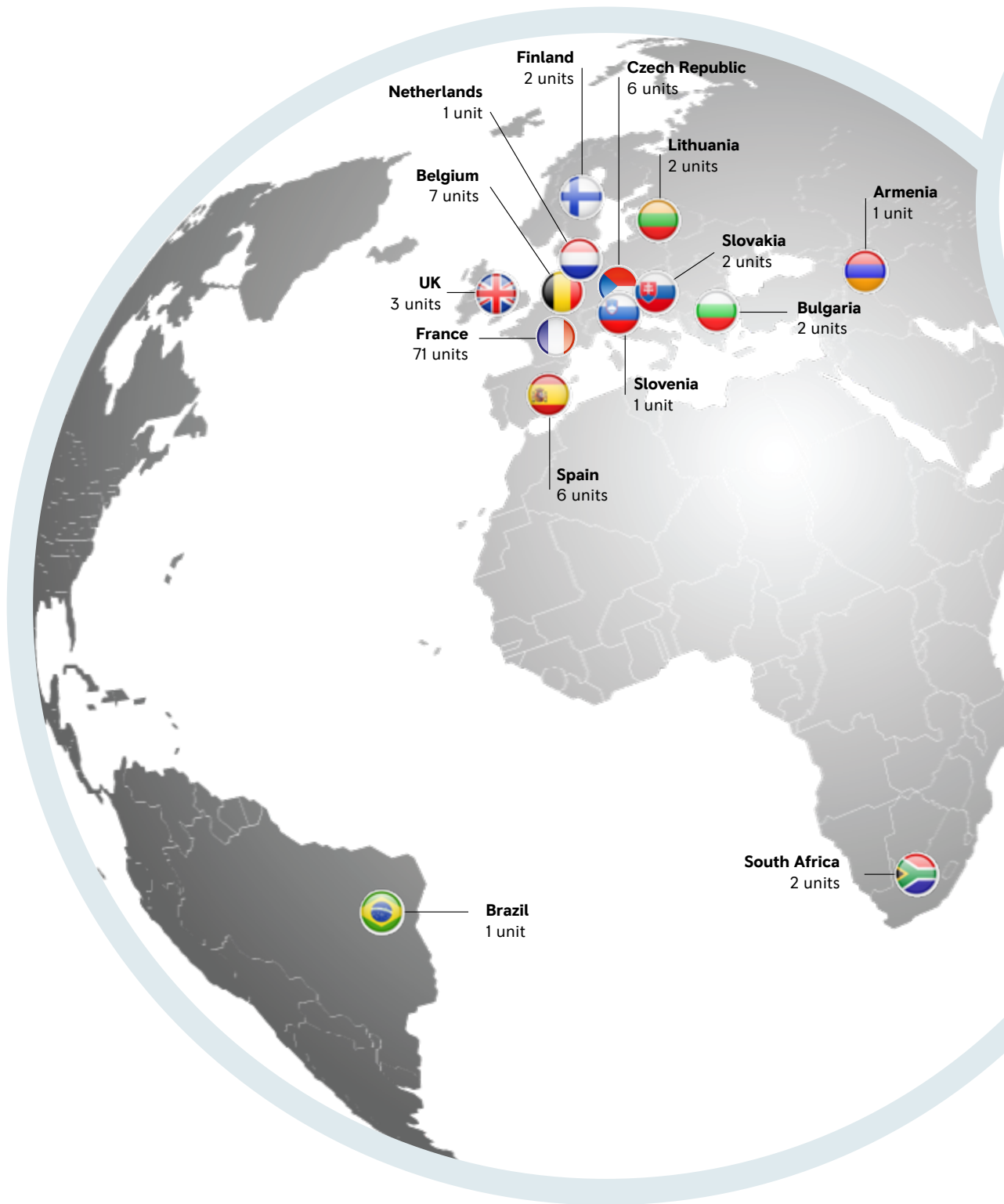
Our experience and references

Delivering I&C innovation and expertise for our customers thanks to proven experience with I&C systems

We have designed, manufactured, installed and renovated analogue and digital safety instrumentation and control systems in nuclear reactors of all types all over the world, including PWR, VVER and research reactors.

Today, our I&C solutions are installed on 150 nuclear reactors worldwide, helping customers to achieve safe and efficient operations.

80 nuclear reactors are supported through long term support contracts.





Number of units that have chosen our I&C solutions.



“I&C systems and solutions in more than 150 nuclear reactors worldwide.”

Our solutions

Flexible solutions that comply with international standards

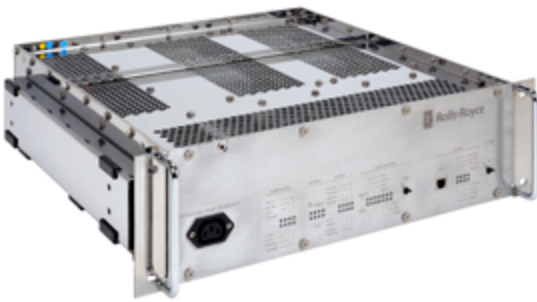
Rolls-Royce integrated I&C solutions are based on world-class engineering and state-of-the-art technologies that combine hardware, electronic and software components to produce a unique digital I&C platform for both new nuclear power plants and the refurbishment of existing plants.

Our technologies are robust, reliable and have been developed in line with the needs of our customers, ensuring they meet the most stringent international regulatory requirements and address obsolescence issues.

Our range of solutions covers digital and analogue safety and control systems, safety critical instrumentation and long-term support solutions.

All our systems are designed to meet the most stringent regulatory requirements, to simplify operation, diagnostics and maintenance, while improving safety.

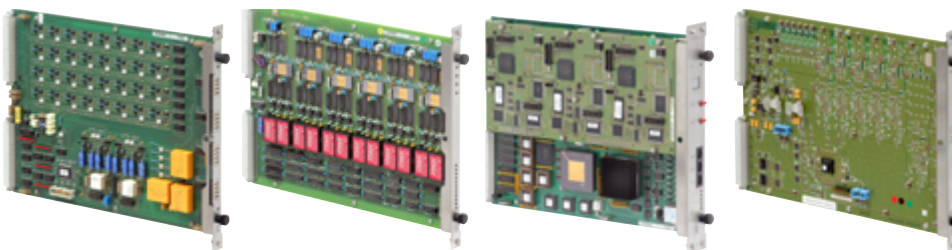
Boronline® rack



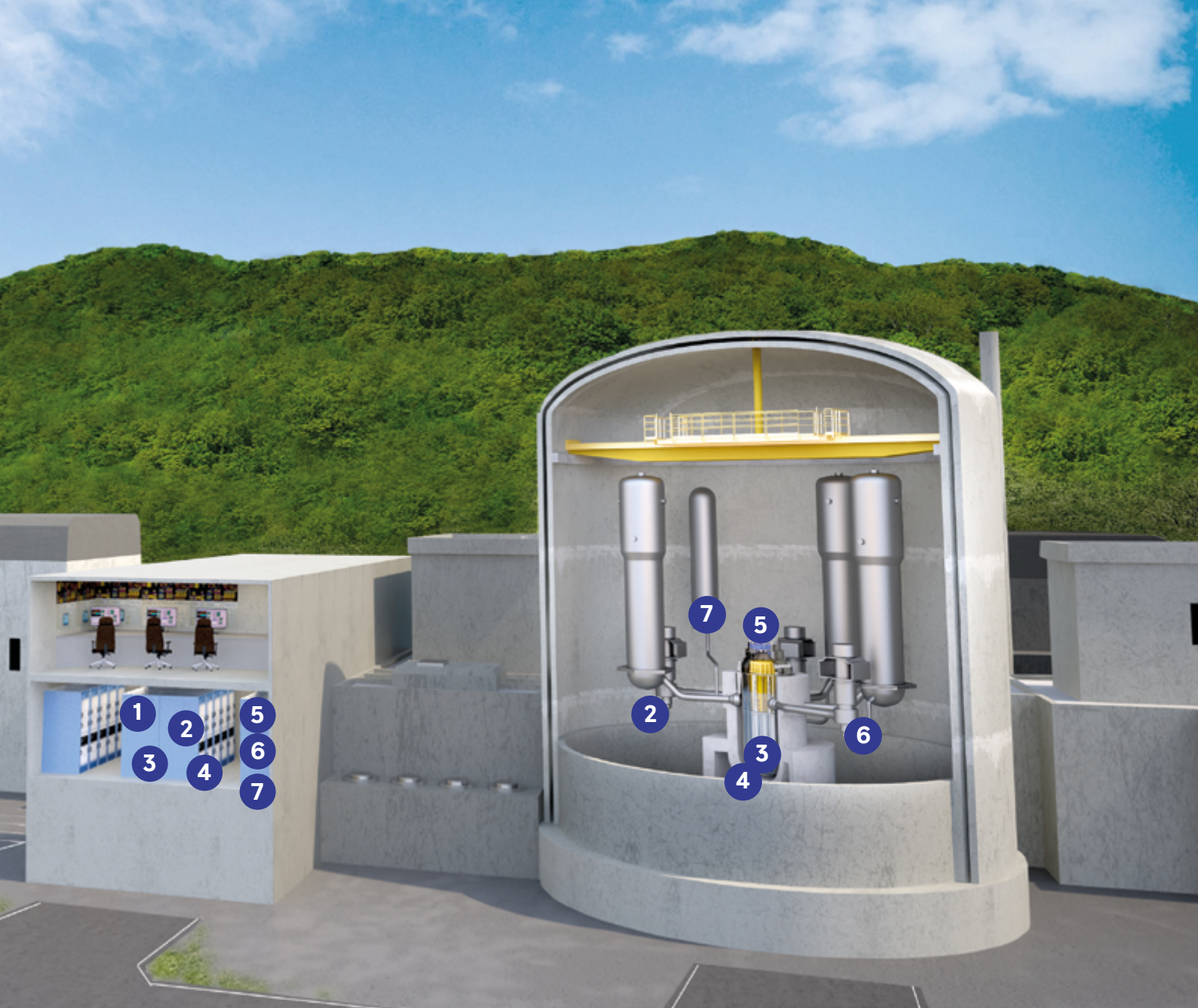
Spinline® rack



Spinline® Electronic boards



- 1 Reactor Protection System (Main & Diverse)
Engineered safety features actuation system
Diesel sequencing system
Reactor trip breakers
- 2 Temperature probes
Bibloc® Pressure transmitters
- 3 Neutron Instrumentation System
Ex-core neutron detectors
Reactivity meter



4 In-core instrumentation system

7 Safety valve control system
Pressurizer heat control

5 Rod control system
Rod position indication system
Rod position sensors

6 Boron meter

Bibloc® Pressure transmitters



Rodline® cabinet



Our main technologies

A range of modular, proven, up-to-date proprietary technologies, dedicated to nuclear industry

SAFETY SYSTEMS

Spinline[®], dedicated to nuclear safety I&C systems

Spinline[®] is a modular digital technology dedicated to developing or upgrading safety systems used in nuclear reactors.

Spinline[®] is specifically designed to implement any Class 1E and category A (IEC-61226) safety I&C functions, at a level of qualification and certification where conventional Distributed Control System (DCS) or Programmable Logic Controllers (PLC) cannot be used.

Spinline[®] can be easily adapted to various reactor types and configuration thanks to its modularity and flexibility.

In 2014, Spinline[®] has been approved by the Nuclear Regulatory Commission (NRC) for safety related applications (1E) in US nuclear reactors.

"OUR CUSTOMERS HAVE ALREADY CHOSEN SPINLINE[®] FOR 76 PWR AND VVER REACTORS WORLDWIDE."

Digital neutron instrumentation System

The Rolls-Royce NIS provides permanent monitoring of instantaneous nuclear power (i.e., neutron flux), and calculation of power fluctuations as well as axial power distribution of the reactor.

The NIS is designed to integrate with the Reactor Protection System (RPS) and plays a key role in the safety Instrumentation & Control (I&C).

The NIS is composed of in-house neutron detectors and electronics. Rolls-Royce has more than 50 years of experience in the design and delivery of Neutron Instrumentation systems for both new builds and modernisations.

As of today, Rolls-Royce has provided NIS to more than 115 nuclear reactors in the world.

"THE ROLLS-ROYCE NIS CAN BE TAILORED TO MEET CUSTOMER SPECIFICATIONS."



Spinline[®] wide range channel module

Hardline[™], the latest generation of hardwired technology designed for nuclear safety I&C.

Hardline[™] platform allows building non-programmed safety systems to monitor and control nuclear reactors. Hardline[™] technology allows operators to:

- Meet licensing requirements for IEC Cat. A / Class 1E applications
- Implement systems such as main or diverse protection systems, actuator priority logic systems and backup or post-accident systems
- Tackle potential software common cause of failure

Hardline[™] is the result of 50 years of operational experience in the development and use of analogue safety technologies.

"A MODERN PURELY HARDWIRED SAFETY TECHNOLOGY."



Hardline[™] cabinet

CONTROL & MONITORING SYSTEMS

Rodline[®], the latest generation of Rod Control System

Fourth generation of Rolls-Royce Rod Control System, Rodline[®] is the result of 40 years of experience in more than 80 nuclear reactors. Rodline[®] is a robust and reliable digital technology, easy to operate and maintain.

Rodline[®] has been chosen by main programmes worldwide, such as the construction of 2 new CPR1000 reactors in China, or the modernisation of 20 reactors in France (1300MW fleet).

"A ROBUST, STANDARDISED AND MODULAR TECHNOLOGY."

Boronline[®], our fourth generation of boron meter

Boronline[®] is the latest generation of Boron meter developed by Rolls-Royce. It provides real-time data on boron concentration in the nuclear reactor coolant, which is essential to control the reactivity of the core and ensure safe operation.

Based on 40 years of operating experience, Boronline[®] has the advantage of carrying out the measurements by permanent sampling through a tank, or through a surface sensor installed directly on the pipe.

Boronline[®] technology has been chosen to equip the 900MW EDF French fleet (34 reactors) and the EPR reactor at Flamanville.

"GREATER PERFORMANCE IN TERMS OF PRECISION, RESPONSE TIME AND RELIABILITY."

SAFETY CRITICAL INSTRUMENTATION

Ex-core neutron detectors

For over 40 years, Rolls-Royce has designed, manufactured and installed ex-core neutron detectors to measure the neutron flux of nuclear reactors. Throughout their life, neutron detectors will be subject to extreme conditions, in terms of radiation, temperature, pressure and humidity. We have implemented specific manufacturing and testing processes to ensure optimal safety.

Each year, approximately 160 neutron detectors are manufactured in our workshop.

"OUR NEUTRON DETECTORS ARE INSTALLED IN 120 NUCLEAR REACTORS OF ALL TYPES."

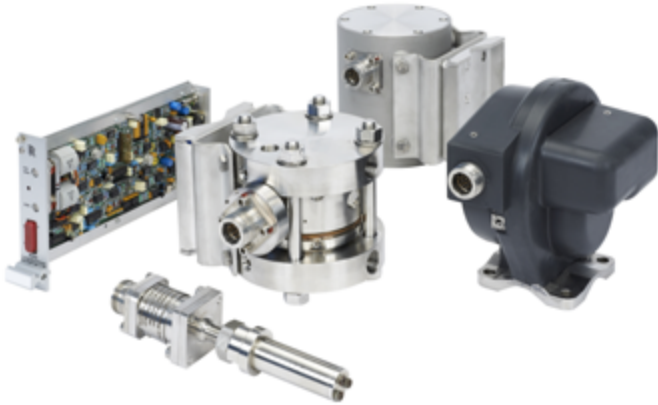
Bibloc® Pressure Transmitters

Bibloc® pressure transmitters are designed and manufactured to perform measurements such as pressure, flow and level in nuclear severe accident environment.

The unique structure of the Bibloc® transmitters means the electronics are not exposed to the extreme conditions of the reactor building – radiation and temperature – and facilitates and reduces maintenance time.

The design of our transmitters is fully compliant with most stringent nuclear standards and requirements.

"OUR BIBLOC® S TRANSMITTER OFFERS A 50-YEAR LIFE SPAN UNDER EXTREME CONDITIONS."



Bibloc® pressure transmitters



Our main ongoing projects

A global footprint with successful project, as part of the biggest I&C programmes worldwide

Modernisation of the 1300MW fleet in France (20 units)

In 2011, Rolls-Royce was awarded a contract, by Areva and EDF, for the modernisation of the safety instrumentation and control systems on the 20 French 1300MW reactors. Reactor Protection Systems and Neutron Instrumentation Systems will use the Spinline® technology while the Rod Control System are being modernised with the Rodline® technology.

A unique project to extend the 1300MW reactors lifetime to 60 years, while improving their safety, availability and reliability.



"THE LARGEST INSTRUMENTATION & CONTROL MODERNISATION PROJECT IN THE WORLD."

Long term support of EDF French fleet

Rolls-Royce is the Original Equipment Manufacturer (OEM) of the safety critical nuclear instrumentation and core control systems for all operating nuclear reactors in France.

In order to ensure the skills and tools availability on a long term basis -and to be able to manufacture, modify, repair and test our components and systems - Rolls-Royce designed nuclear long-term support services solutions for EDF, with a specific range of services and dedicated organisation and process.

The solutions include services like on-site maintenance, obsolescence management, expertise, technical support, training, repairs and spare parts supply, partial or global retrofit.

"ENSURING THE SAFETY AND AVAILABILITY OF 56 NUCLEAR REACTORS FOR 30 YEARS AND MORE."



ELSA project: I&C modernisation of LOVIISA reactors in Finland

In 2014, Rolls-Royce signed an agreement with Fortum for the I&C modernisation of Loviisa nuclear reactors (2 VVER), which covers most of the nuclear safety systems and safety related systems. The project has been implemented in three phases during 2016-2018. Project was successfully achieved on time and budget

The aim of this modernisation project was to ensure safe and reliable operation of the Loviisa nuclear reactors until the end of the plants' operational lifetimes, in 2027 for unit 1 and 2030 for unit 2.

Following the success of this modernisation, we have been awarded by Fortum a 25-year Long Term Support Agreement Contract and the modernisation of the ESFAS functions.

"AN AMBITIOUS PROJECT PERFORMED IN 5 YEARS AND SUCCESSFULLY ACHIEVED ON TIME AND BUDGET."



New build programme in China

Through the provision of our latest technologies - Spinline®, Rodline® and Bibloc® - and our services centre based in Shenzhen, we ensure the safety, availability and reliability of nuclear power plants in China on a long term basis.

For more than 30 years, Rolls-Royce has been involved on the nuclear programme's in China, working with the Chinese nuclear operators (CGN, CNNC, SPIC). Rolls-Royce has delivered systems, products and services (Rod Control Systems, Neutron Instrumentation Systems, ex-core neutron detectors and pressure transmitters) to 44 nuclear reactors.

"85% OF NUCLEAR REACTORS IN CHINA ARE USING OUR I&C SOLUTIONS."



Modernisation of the Rod Control Systems of the 900MW fleet in France (28 units)

As part of a contract signed in 2017 with EDF, Rolls-Royce is modernising the Rod control systems of the 900MW fleet, in the frame of its fourth ten-year review (VD4), to improve operating reliability and increase availability.

This modernisation project includes modifications of the ESP cabinets, changes to the DC hold cabinet, boards upgrades as well as evolutions of FPGA and monitoring HMI.

Successfully deployed on Tricastin 1 unit (First of a Kind unit) in 2019, the installations will continue in the next coming years, as part of the planned VD4 outages of the 28 reactors of the 900MW french fleet.

"A MAJOR 10-YEAR MODERNISATION PROJECT OF FRENCH NUCLEAR REACTORS"



Services offering

To support our customers throughout the lifetime of their plant, by providing the right answer

Rolls-Royce provides a global range of services and solutions enabling nuclear utilities to ensure a safe, efficient and long term operation of their nuclear I&C systems.

New Build services



During pre-build and construction phase, we provide the right support to deliver a qualified and turnkey I&C solution, in accordance with customer and regulator requirements:

- I&C conceptual, basic and detailed design
- I&C licensing and qualification support
- I&C turnkey projects
- Main I&C, Safety I&C, Control and Monitoring, Instrumentation
- Design, Licensing, manufacturing, tests, installation, commissioning
- I&C integration and supply chain management
- Funding strategy support
- After sales services

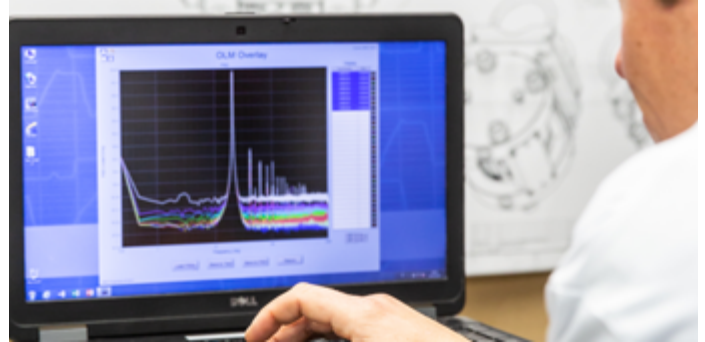
After sales services



As part of Long Term Support Agreement (25 years) or not, provide the right support to ensure an efficient long term operation of Rolls-Royce I&C systems:

- Spare parts supply
- Repairs
- Training
- Technical assistance
- Corrective maintenance
- Preventive maintenance
- Software evolution

Optimisation services



A series of advanced services to optimize the operation and improve the reliability of critical components:

- Predictive maintenance
- Expertise
- Televisual inspection
- Data science
- Obsolescence management
- Software evolution
- Obsolescence management
- Configuration management
- Retention of logistical means (manufacturing/test)

PLEX services



Ability to provide the right strategy, solution and/or support on I&C systems and component, as part of the PLEX process:

- Qualification and licensing support
- Extension of Qualification
- Definition of I&C PLEX strategy
- I&C PLEX turnkey projects (Modification, Partial and Global modernisation)
- Re-industrialisation of orphan systems/equipment
- Reverse engineering
- I&C integration and supply chain management

Our safety culture

Requirements to apply for the security of all

For Rolls-Royce, the safety of nuclear power plants is a top priority. The operation of a nuclear facility should not result in any negative impact on health and environment.

Our safety requirements are based on the professionalism of continuously trained teams, rigor in the manufacturing, inspection and maintenance we carry out, all in accordance with the regulations. We ensure, both at company and individual level, that all matters relating to safety are given priority attention.

Through the daily application of the 6 fundamental rules of our nuclear safety culture, we ensure the highest level of safety for all activities carried out.



“A DAILY UBIQUITOUS APPROACH
TO NUCLEAR SAFETY.”



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All our I&C brochures



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