The EPR™ reactor
the reference for New Build
The Reference for Safety
The EPR™ design offers the highest level of safety:
• Already licensed in France, Finland and China
• Strong resistance to extreme hazards - as confirmed by the European Safety checks
• Robustness of cooling capability: more than 7 days of autonomy

Evolutionary Design
The EPR™ design is based on:
• Proven French N4 and German Konvoi reactors
• Innovative features from decades of R&D programs
• Operational track-record of more than 80 Pressurized Water Reactors

Designed for Competitiveness
High power output and innovative features contribute to:
• Up to 20% savings on operation and maintenance costs
• Up to 15% savings on fuel costs
• Optimized site and land use

Confidence in Project Delivery
With four EPR™ projects underway in Finland, France and China, AREVA is gathering unique worldwide front-line experience in project delivery

AREVA’s comprehensive support capabilities
• In-house manufacturing and fully operational worldwide supply chain
• The world’s largest in-house nuclear EPC team
• Full nuclear fuel cycle expertise
• 250+ reactors serviced worldwide

“We are building the EPR™ reactor fleet. Together.”
With 4 EPR™ reactors being built in 3 different countries, AREVA can leverage an unparalleled experience in licensing and construction to deliver high-performance new-generation projects to nuclear utilities all over the world.

**Best practices from continuous project experience**

- **Licensing experience** with different regulators:
  - The only reactor with 5 separate licensing processes underway worldwide
  - Construction licenses granted in Finland, France and China
  - Licensing reviews underway in the United Kingdom and the United States
  - The only Gen3+ reactor design submitted to the European “post-Fukushima” stress tests

- **Project management excellence**
  - The largest in-house nuclear Engineering Procurement Construction (EPC) team:
    - More than 1,000 project management skilled people
    - 6,000+ Engineering and Project experienced workforce
  - Most Taishan Project Directors have worked on Olkiluoto 3 or Flamanville 3 projects

- **Company-wide feedback process**
  - Lessons learned from numerous nuclear facilities construction: EPR™ reactors and fuel cycle factories
  - Robust continuous capitalization process: more than 1,600 lessons learned captured and analyzed

**A demonstrated ability to capture experience and improve project delivery performance**

- **Manufacturing**
  - Integrated capabilities
  - Steam generators delivery time cut by 2 years between Olkiluoto 3 and Taishan projects

- **Procurement**
  - Worldwide nuclear-grade and fully operational supply chain
  - 600+ Qualified suppliers with demonstrated improvements in on-time quality deliveries
  - Demonstrated track record in localization strategy: China, South Africa, Finland, South Korea...

- **Construction**
  - Improved performance
  - 24 months
  - Construction period from first concrete to dome lifting at Taishan (23 months less than at Olkiluoto 3)
The EPR™ design is based on an evolutionary approach using experience feedback from more than 80 Pressurized Water Reactors previously built worldwide. It leverages experience from the recent, operating and proven French N4 and German KONVOI designs and includes key innovative solutions, fruit of decades of advanced R&D programs.

**Main Safety Principles...**

- **DIVERSITY** to prevent common cause failures
- **REDUNDANCY** to overcome a single failure
- **COMPLEMENTARITY** between active and passive systems

**Resistance to Extreme Hazards**
The EPR™ reactor is designed to offer unique resistance to extreme hazards, such as earthquake, flooding, extreme temperatures, airplane crash, explosion or a combination of issues.

**High Structural Resistance against Earthquake**
- Robustness of the nuclear island buildings ensured thanks to a single concrete basemat and a pre-stressed concrete inner shell
- Critical equipment are designed and tested for high resistance to earthquake

**Resistance to Flooding**
In addition to the initial elevation of the buildings (dry-site concept), the reactor building, safeguard buildings, fuel building and diesel buildings are watertight

**Physical Protection and Geographical Separation**
- The reactor building, fuel building and two safeguard buildings are protected by an airplane crash (APC) shell: the EPR™ can resist the impact of a large commercial airplane
- Geographical separation of the Safeguard and Diesel Buildings: only one of the buildings would be affected without any safety consequences on the others

**Safety first and foremost**

**... To achieve Essential Safety Imperatives**

- **Resistance to Extreme Hazards**
- **Robustness of Cooling Capability**
- **Prevention of Environmental Damage**

| Nuclear Island |
|----------------|
| RB – Reactor Building |
| FB – Fuel Building – Fuel Pool |
| 1,2,3,4 – Safety systems housed in Safeguard Buildings |
| DB – Diesel Buildings |

[Diagram showing the layout of the nuclear island with labels for RB, FB, DB, and emergency diesel generators.]
The EPR™ reactor was conceived from the start for enhanced safety, integrating the defense-in-depth concept and preventing the most inventoried issues. The EPR™ design includes redundant and diverse technologies as well as the right balance of active and passive systems to provide a comprehensive safety protection. The probability of a core damage is reduced by a factor of more than 10 compared to previous generations of reactors. However low the probability of a severe accident, the EPR™ systems would ensure robust safety and leaktight containment to prevent long-term impact on the environment.

**ROBUSTNESS OF COOLING CAPABILITY: MORE THAN 7 DAYS OF AUTONOMY**

Whatever the situation and in particular in case of the loss of off-site power or main cooling source, the EPR™ design offers multiple on-site solutions to ensure the cooling of the core and preserve the plant integrity.

- **Redundant safety systems**
  4 redundant, protected and geographically separated safety systems. Each of them can perform the cooling of the reactor on its own

- **Multiple, diversified and protected back-ups to power the safety systems**
  - 4 redundant Emergency Diesel Generators (EDG)...
  - ... backed-up by 2 diversified Stations Black Out (SBO) diesel generators
  One diesel generator can power the safety system on its own

- **On-site water reserves to cool the core**
  - 4 protected Emergency Feed-Water System (EFWS) tanks, one in each safeguard building
  - Additional protected on-site water sources such as the firefighting tank
  - The In-containment Refueling Water Storage Tank (IRWST) is a large volume of borated water located in the reactor building

- **Protected fuel pool**
  Located in a separate and protected building, it is equipped with two redundant cooling backed up by a third diverse one

- **Pressure control**
  Dedicated severe accident valves ensure fast depressurization to prevent a high-pressure core melt

- **Prevention of hydrogen detonation**
  The passive hydrogen recombiners associated with the specific design of the containment prevent any hydrogen detonation

- **Confinement of potential core melt with a core catcher**
  The core catcher is specifically designed to retain, confine and passively cool down a core melt

- **No long-term impact on the environment**
  A leaktight and double containment with an annulus between inner and outer shell drastically limits off-site radiological consequences
Taking into account the requirements of major European utilities and benefiting from AREVA’s large experience in reactor design and construction, the EPR™ safety features and evolutionary design contribute to high-level competitiveness and predictable performance.

**Competitive business performance**

- **Cost-effective power output**
  - Reduced Operation & Maintenance costs per MWh by up to 20%
  - Larger output for maximum scale effect
  - 60 year design lifetime
  - Optimized use of site
  - Flexible load follow

- **High availability (design target: 92%)**
  Calculated as per European Utilities Requirements methodology
  - Online preventive maintenance thanks to redundancy of the safety systems helping reduce maintenance times
  - Faster reactor cool down thanks to additional depressurization valves for shorter outages

- **Optimized fuel management**
  - Uranium consumption savings: up to 15% on natural uranium per produced MWh as compared to other reactors:
    - Axial economizer inside the steam generator induces higher pressure for a 37% thermal efficiency
    - Heavy neutron reflector improves core efficiency
  - Flexible fuel management
    - Operation cycle length of 12 to 24 months
    - Capability to load a full MOX core

The EPR™ reactor’s large size and high availability offer up to 20% savings on operation and maintenance costs and up to 15% savings on fuel costs as compared to other new-generation designs.
Minimized environmental footprint

With an optimized design and high overall efficiency, the EPR™ reactor achieves a reduced environmental footprint. In normal operations, it ensures a significantly reduced impact on the environment and workers. Designed for safety excellence, it also reinforces nuclear sustainability by improving containment capabilities with no long lasting consequences on the environment even in case of a severe accident.

- **Designed to minimize its environmental footprint**
  - Higher power output (1,650 MWe net) for optimized land used
  - Improved efficiency compared to Gen2 design with 37% of thermal efficiency
  - Lower water consumption

- **Optimized waste management**
  - Gaseous radioactive waste is filtered, controlled and monitored to verify that discharges have no noticeable impact under any circumstances
  - Larger core size and higher number of control rods allow a lower volume of liquid radioactive waste
  - The EPR™ higher operating performance has a direct impact on uranium consumption (reduced by up to 15%) and so in the quantities of high-level waste (up to 10%)

- **EPR™ higher operating performance leads to a reduction of high-level waste quantities**

- **Improved protection for operating and maintenance workers**
  - Shorter outages for refueling and maintenance
  - Improved layout of potentially radioactive systems and components
  - Optimization of the radiation shielding thickness in accordance to maintenance operations
  - Consequently, as one of the priority objective in the EPR™ design, the target collective dose is reduced by half compared to OECD countries

- **Designed to avoid long-term impact on the environment even in case of severe accident**

- **60 year design lifetime**
  Long-term use of land and assets

Improved efficiency: more electricity with the same release of thermal heat

Optimized waste management: lower volume of ultimate waste

Flamanville 3 construction site
AREVA supplies solutions for power
generation with less carbon. Its expertise and
unwavering insistence on safety, security,
transparency and ethics are setting the standard, and its
responsible development is anchored in a process of
continuous improvement.

 Ranked first in the global nuclear power industry, AREVA's unique
integrated offering to utilities covers every stage of the fuel cycle,
nuclear reactor design and construction, and related services.
The Group is also expanding its operations to renewable energies
– wind, solar, bioenergies, hydrogen and storage – to be one of the
leaders in this sector worldwide.

 With these two major offers, AREVA's 48,000 employees are
helping to supply ever safer, cleaner and more economical
energy to the greatest number of people.

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