

framatome



Framatome Overview and Innovation

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Framatome at a glance

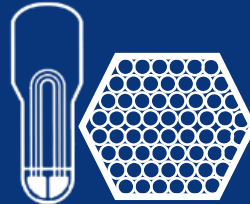
60 years of experience, alongside our customers, in developing safe and competitive nuclear power worldwide



Design



Supply



Manufacture



Integrate



Maintain

Framatome at a glance

High-performing people and technologies for safe and competitive nuclear plants worldwide

92

NPPs

As OEM

14 000

PEOPLE

Servicing ...

250

REACTORS

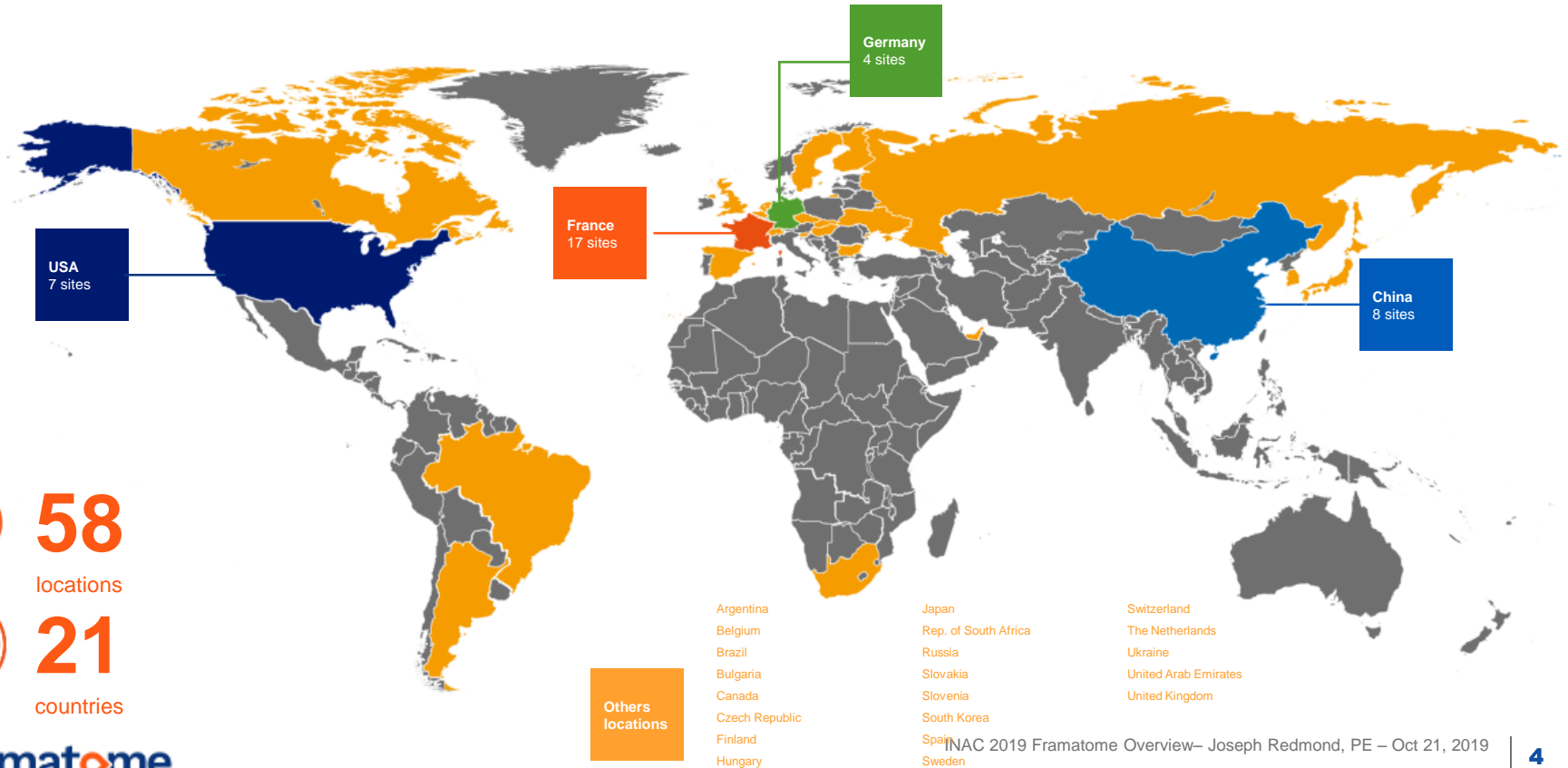
All over the world

3.3

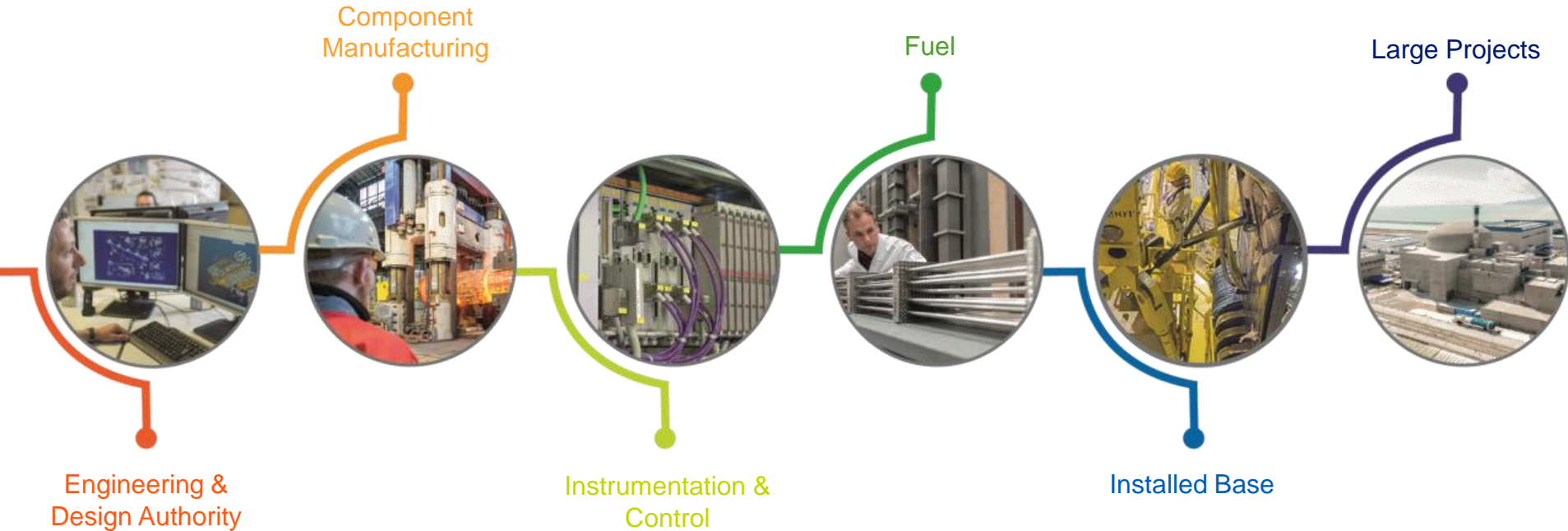
€ BILLION

2018 turnover

Framatome worldwide presence

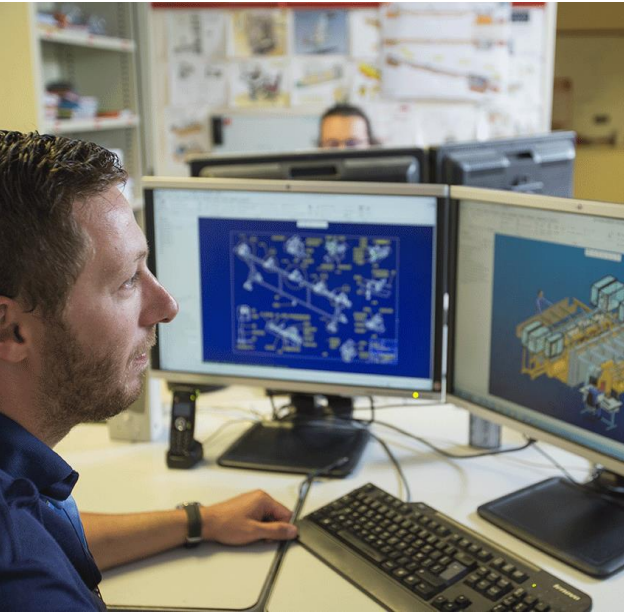


Our activities in a nutshell



Engineering Overview

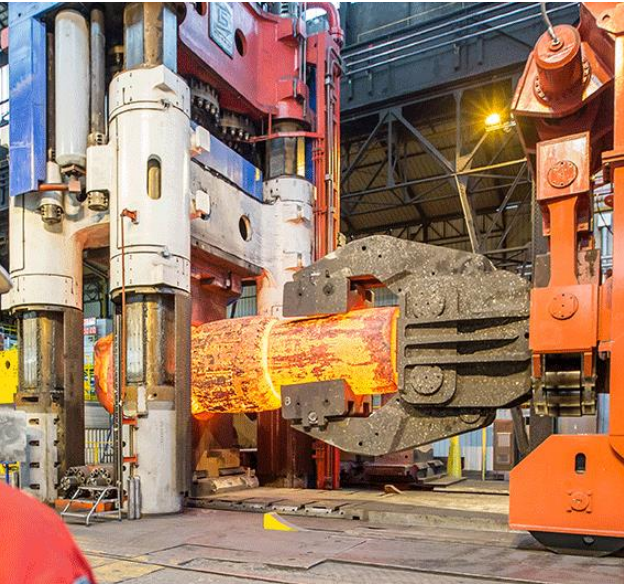
Engineering Design, Analyses, and Nuclear Plant Programs



- System and Hardware Design
- Safety Analysis and Studies
 - Probabilistic Risk Analysis (PRA), Risk Informed Engineering Programs, etc.
 - Dynamic Structural Analyses for Buildings, Systems and Components (caused by Seismic, APC)
 - Accident and Severe Accident Analyses (LOCA, Non-LOCA, Building Thermo-hydraulics, Core Melt Ex and In vessel scenarios, ...)
 - Special Fluid Dynamic calculations (pressure waves, vortex, ...)
 - Radiological Studies
- Plant Optimization and Studies
 - Flexible Load Operation
 - Power uprate and Efficiency Increase
- Nuclear Plant Program Development and Implementation

Equipment manufacturing for nuclear power plants

A key element in nuclear safety



- Production of the key equipment for nuclear steam supply systems to equip new-build power plants or to replace items of equipment at power plants in operation
- Manufacturing of advanced technology heavy equipment (reactor pressure vessel, steam generators, etc.) and primary system components (reactor coolant pumps and control rod drive mechanisms)

Since 1970, around 10,000 components have been produced: Framatome components equip more than 100 power plants in 11 countries, always meeting the most demanding nuclear safety and quality standards.

Instrumentation & Control

Multiple digital and analog safety I&C platforms for all NPP designs



- Safety automation systems
 - Reactor Protection System
 - Engineered Safety Feature Actuation System
 - Control and Limitation System
- Nuclear instrumentation to lifecycle solutions
 - Incore and Excore Solutions
 - Reactivity Measurement
 - Pressure, Temperature, Level, Flow
 - Radiation Monitoring
- Simulators and global I&C engineering expertise to human-machine interface design and human factors engineering.

Framatome has installed more than 300 comprehensive Instrumentation & Control systems in nuclear reactors of all types across the world.

Fuel

Cutting-edge technology vital for nuclear power generation



Mastery of the entire process from design to manufacturing of fuels for light water reactors Pressurized Water Reactors (PWR, excluding VVERs), Boiling Water Reactors (BWR) and research reactors

- Fuel assembly design
- Production of zirconium and its alloys
- Fuel assembly fabrication
- Services associated with fuel

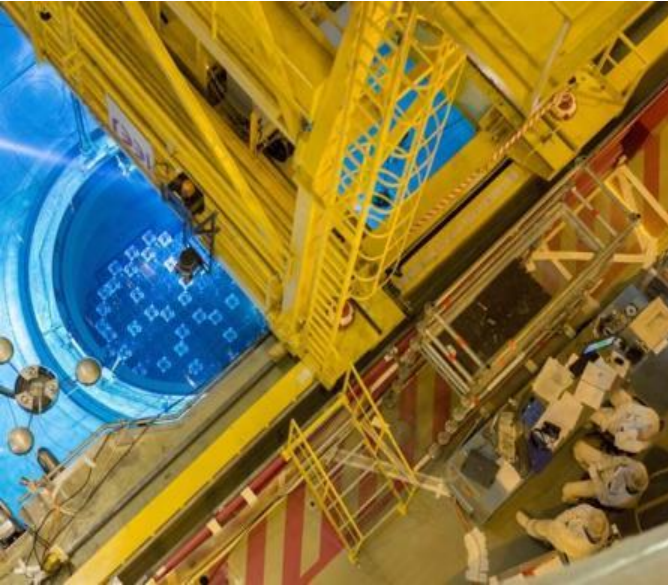
Framatome Develop Enhanced Accident Tolerant Fuel (EATF) products that deliver positive safety impact for the current fleet of operating reactors

- Can tolerate loss of active cooling in the reactor core for a considerably longer period of time than conventional fuel
- Maintains or improves fuel performance during normal operations, operational transients, design basis events and beyond design basis events

225,000 Framatome fuel assemblies are loaded in more than 100 reactors in operation around the world.

Installed Base - Operational power plants

Services and hardware solutions to maintain, modernize and extend the NPP life



- Framatome's Installed Base Business Unit delivers products and services to the world-wide nuclear fleet
 - Outage Services
 - Non-Destructive Examinations
 - Component Repair & Replacement
 - Products and Engineering
- Framatome Technical Centers perform equipment qualification, testing and commercial grade dedication services
- Framatome global footprint
 - OEM of 92 world-wide NPPs
 - > 250 NPPs serviced world-wide

Framatome has 60 years of international experience in all types of reactor designs and services to more than 250 reactors worldwide.

Construction and Commissioning of New NPPs

- Design, through procurement and supply, and onto commissioning for new-build nuclear reactors
- Edvance: an EDF and Framatome joined engineering subsidiary dedicated to new-build reactor projects

Framatome is actively involved in the construction of five EPR reactors worldwide: in Finland (Olkiluoto 3), in France (Flamanville 3), in China (Taishan 2), and in the United Kingdom (Hinkley Point C). Taishan 1 was put into commercial operation on 13 December 2018.





Innovation at the heart of our performance

Our customer experience is our major source of innovation



QuarTec™ Hydrophobic Products

QuarTec when applied to tooling exposed to the Reactor Coolant System reduces adherence of radiological contaminants. QuarTec when applied to components/structures in brackish water conditions reduces aquatic growth concerns.

Benefits

- ✓ Innovative solution to significantly reduce cost /schedule spent on outage equipment decontamination.
- ✓ Framatome Chemistry/Fuels approved for RCS compatibility to eliminate chemical intrusion concerns
 - Refueling/NDE/CR&R equipment
 - In-Vessel platforms
 - Dry cask storage containers
 - Decommission tooling
 - Seal plate covers or bellows regions
 - Hand tools
 - Service water systems
 - Heat exchangers
 - Condensers
- ✓ >97% improvement on reduction of contamination after wet wipe
- ✓ >60% improvement on reduction of aquatic growth/bio-fouling in brackish conditions

Timeframe

- Products ready now: 2019
- Applications complete/in progress at Dominion, FENOC, PSE&G, Duke, & APS



Film-Forming Amines (FFA) in Secondary Side

Patented process to protect the Water Steam Cycle of NPP using Film Forming Amines (FFA). Successfully applied at 5 different NPP's, Almaraz 1 & 2 (Spain), Borssele (Netherlands), Blayais (France) and the Candu plant in Embalse (Argentina), for a total of 11 applications to date.

Benefits

- ✓ Decreased formation of corrosion products in secondary side by building a “protective layer” in the ηm scale
- ✓ Mobilization and removal of corrosion products and corrosion impurities like chloride from surface during dosing phase of FFA
- ✓ Improves steam generator cleanliness - lower feedwater iron concentration
- ✓ Faster post outage start-up (experience at PWR)
 - ✓ Less time to obtain the secondary system chemical expectation to start drawing condenser vacuum.
 - ✓ Less time to obtain the required secondary system chemistry prior to steam production

Timeframe

- Completed qualification for release into Great Lakes for toxicity - Q4, 2018
- Planned for deployment in Canada - Q1, 2020
- Ready for deployment in PWR's the Americas

Effect of hydrophobicity on LP Turbine Blades



Protects Steam Generator Cleanliness and Pays for Itself due to Faster Outage Start-ups

TopWorx™ GO Switches for Proximity Indication

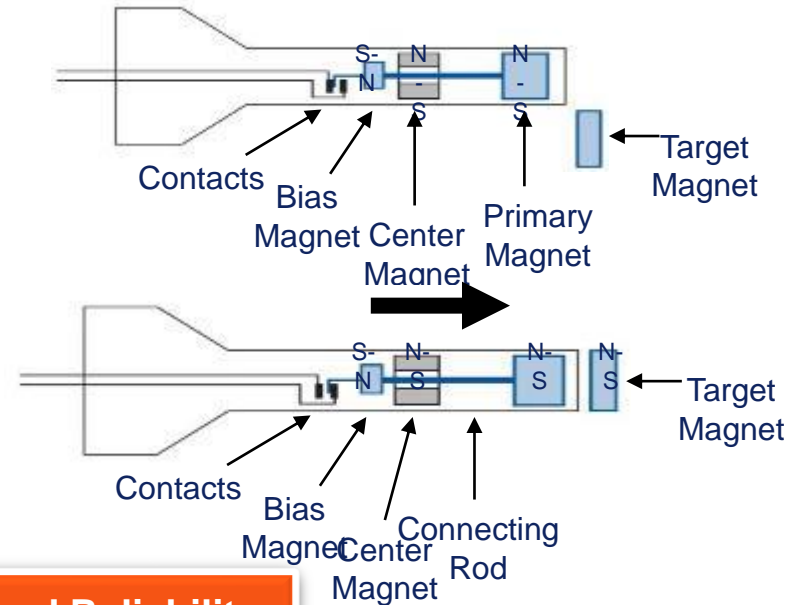
TopWorx™ proximity switches are rated and qualified for use in nearly all Nuclear Power Plant environments including seismic, high temperature and pressure, humid, radiation, and extreme transients

Benefits

- ✓ Increases safety and reliability by replacing the mechanical lever with target magnet technology
- ✓ Decreases costs and REM dose by extending service life over leading limit switch competitor (GO™ Series switches have a qualified life of 106 years at 120°F ambient)
- ✓ Tested to withstand nearly all Nuclear Power Plant environments
- ✓ Designed for easy installation with minimal plant change

Timeframe

- EQ documentation complete - Q3, 2019



Reduction in O&M costs and improved Safety and Reliability

MILES-14 Certification for Circuit Breakers

Maintenance Interval and Life Extension Solutions (MILES) 14 certifies that your breakers include the enhanced parts and synthetic lubrication required for extending maintenance intervals per our test program

Benefits

- ✓ Decreases operational costs by extending service intervals up to 14 years from as low as 3.5 years
- ✓ Establishes a 3 year extended warranty (compared to 12/18 month standard warranty) and a certificate of conformance to the MILES-14 Program
- ✓ Decreases maintenance costs by eliminating re-lubrication or rejuvenation required with conventional grease
- ✓ Increases safety and reliability by eliminating issues with conventional grease
- ✓ For use on new low and medium voltage circuit EATON and SEIMENS breakers
 - ✓ Can also be supplied on qualifying replacement operating mechanisms and reconditioning part kits

Timeframe

- Qualification program completed - Q1, 2019
- Commercial availability - Q2, 2019



MILES Program can reduce Circuit Breaker O&M Costs

Thermal Sleeve Removal and Replacement

Solution to address failed Thermal Sleeve emergently from below the head

Benefits

- ✓ Qualified tool to remove thermal sleeve remnant after separation
- ✓ Qualified EDM tool to remove worn thermal sleeves
- ✓ Both tools remove old thermal sleeve or remnant from bottom
- ✓ Qualified EDM tool to restore RV nozzle seat
- ✓ Tool to install equivalent thermal sleeve from bottom without removing Control Rod Drive Mechanism (CRDM)

Timeframe

- Removal tools used at sit in Q2, 20109
- Flow and structural analysis complete for replacement thermal sleeve
- Tooling qualified in Q3, 2019



Innovative Solution to Restore to Original Configuration

framatome

Obrigado

