



Long Term Operation



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Summary



Long Term Operations Glossary

- **SSCs: System Structures and components**
- **TLAAs: Time-Limited Aging Analysis**
- **RCM: Reliability Centered Maintenance**
- **AP-913: INPO Equipment Reliability Process**
- **AMR: Aging Management Review**
- **AMP: Aging Management Program**
- **PSR: Probabilistic Safety Review**
- **eMCO: I&C Obsolescence Management Website**
- **APOTS: AREVA Proactive Obsolescence and Tracking Service**
- **ACT: ACTive Cooling System**



Long Term Operation IAEA Definition

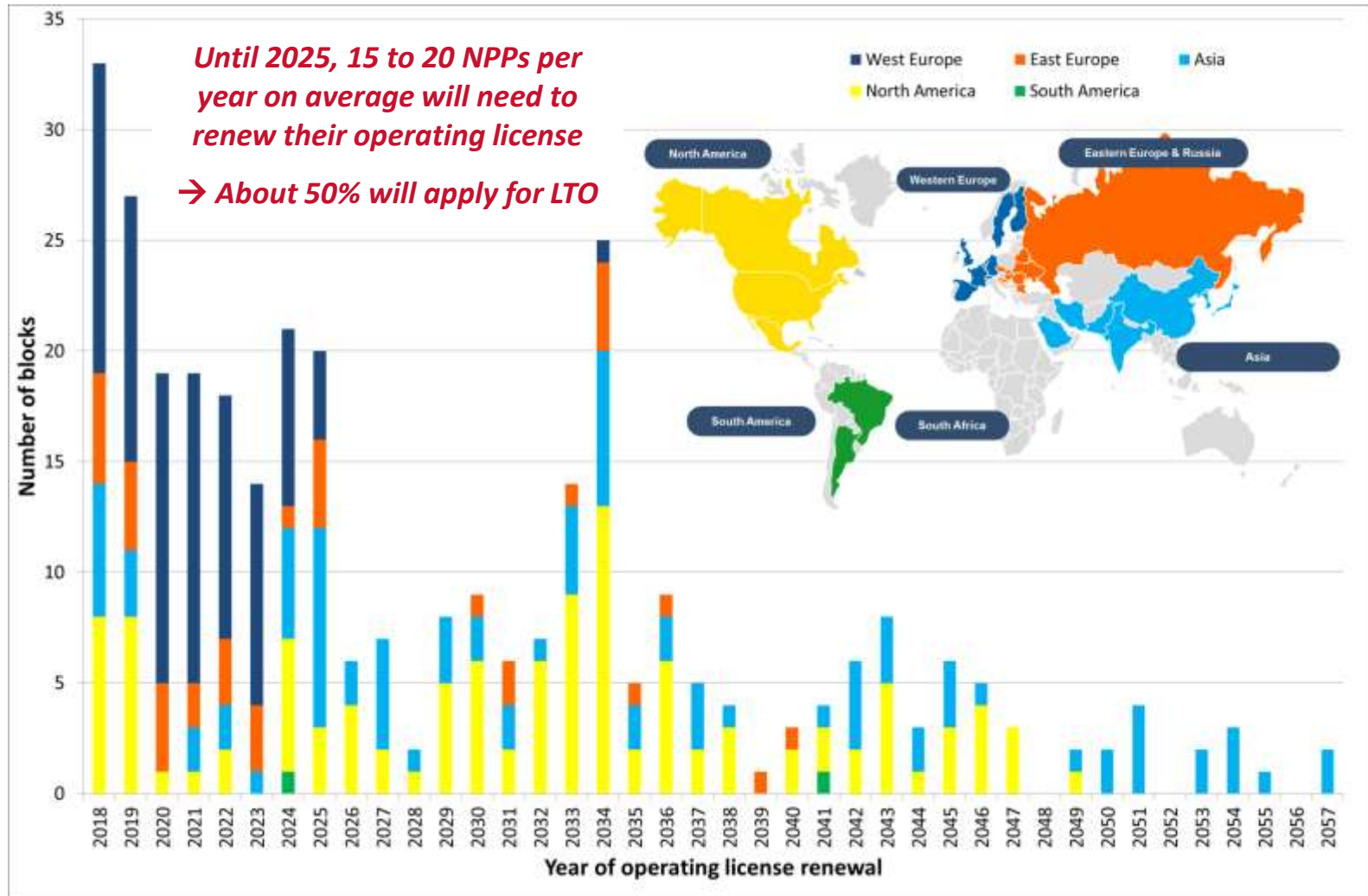
“The LTO of an NPP may be defined as operation beyond an established time frame set forth by, for example, license term, design, standards, license or regulations, which have been justified by safety assessment with consideration given to life limiting processes and features of Systems Structures and Components.

Long term operation is conditioned by regulatory requirements and subject to regulatory authorization, and usually also to public or political acceptance.

In practice, LTO is only possible when an appropriate safety assessment has been performed, and the results have been found to be favorable concerning safety of the NPP involved.”

Long Term Operation

IAEA Overview -Year in which the plants reach their respective design life



Long Term Operation Customer Issue



- Other energy sources can generate a higher investment rather than nuclear long term operation

- Building new NPP (or dismantling a NPP) can be expensive for major utilities, so one of the best alternative is to operate longer



- Justification is needed but uncertainties exist on:
 - Regulation evolutions
 - Potential replacement of components
 - Political situations
 - Public acceptance



Long Term Operation Launch / Relaunch Briefing

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Long Term Operation Value Drivers & Value Proposition

- Show the Return on Investment to the NPP shareholders to operate longer while maintaining a high level of safety and availability
- Get the approval from regulator to operate longer:
 - ◆ Get the right and most sufficient solution with the short-term ROI
 - ◆ Respect schedule
 - ◆ Meet budget
 - ◆ Apply the right concept in accordance to national/international guidelines
 - ◆ Minimize project risks
 - ◆ Get public acceptance

Customer Value proposition:

Framatome LTO solutions enable NPPs to operate longer while meeting state-of-the-art safety in balance with Return On Investment.



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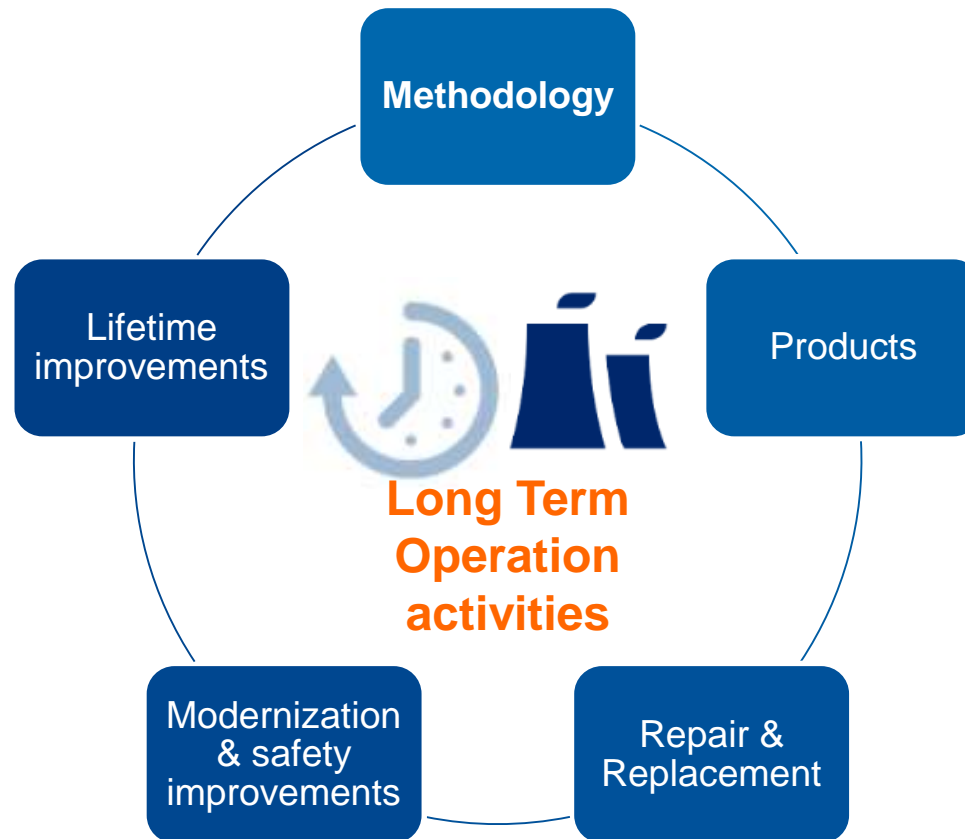
Differentiators & Battlecard

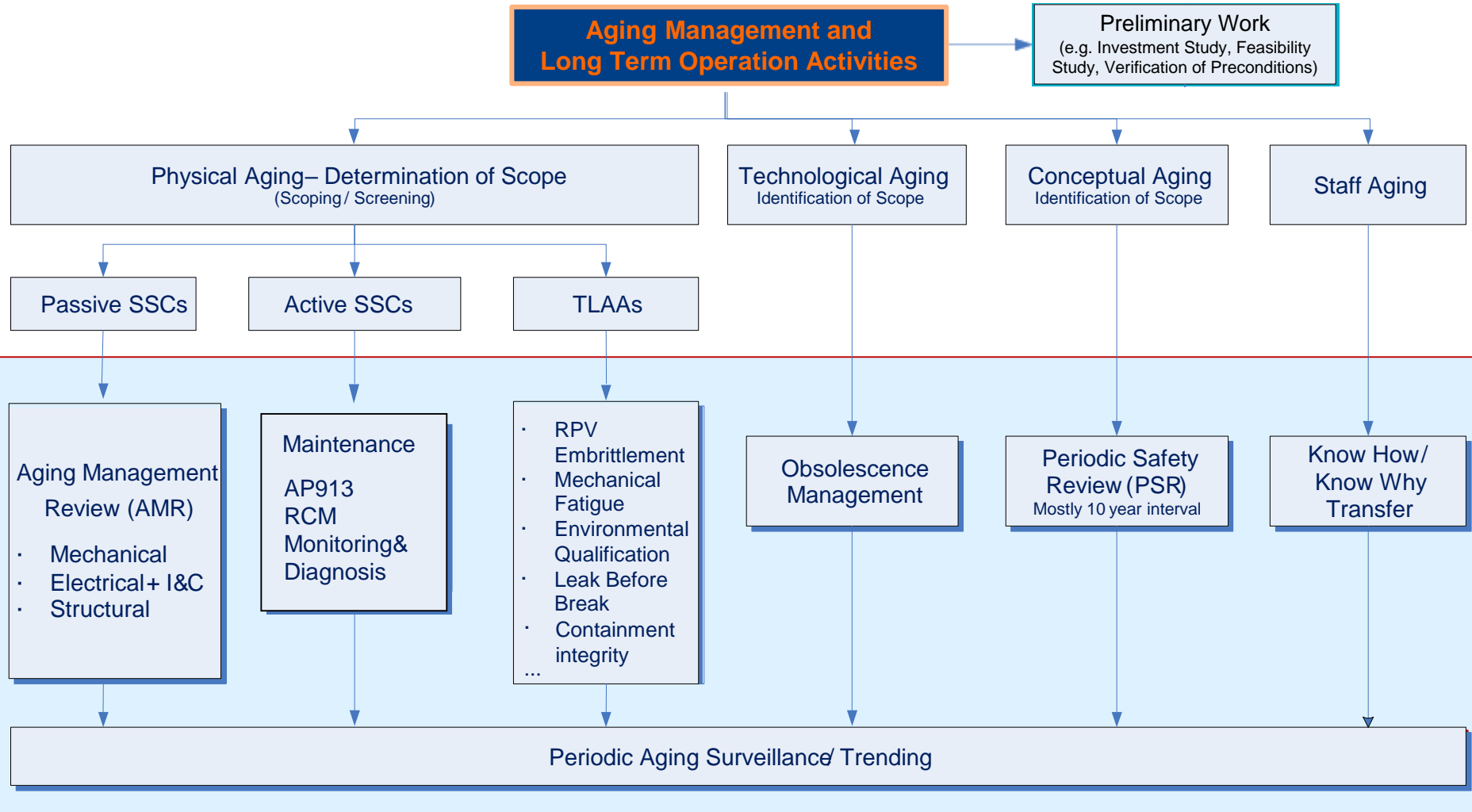
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Summary

Long Term Operation

Our Solution - What do we sell?





Products

Long Term Operation Our Solution – Techno Brief 2/5

COMSY-MEC
Mechanical components

FAMOSi,
Fatigue Monitoring System

COMSY-ELT
Electrical and I&C-Components

Framatome concept Script for commodity groups



Long Term Operation products

COMSY-Civil
Structural SSCs

Catalog of Aging mechanisms

COMSY-Active
predictive maintenance

Equipment qualification database

SIPLUG, DIROM...

Data Analytics N-Vision

eMCO

APOTS

Repair & Replacement

Long Term Operation Our Solution – Techno Brief 3/5

Services:

- Project Management (turnkey)
- Engineering, design, design calculations, licensing
- Planning, scheduling, preparation of all construction activities
- Subcontracting, purchasing, qualifications, training of personnel
- Planning and performance of all required activities



Baffle Bolt Replacement



Dissimilar weld



Austenitic cladding



Machining of a nozzle



Machining of RPV flange



In-situ Valve Repair

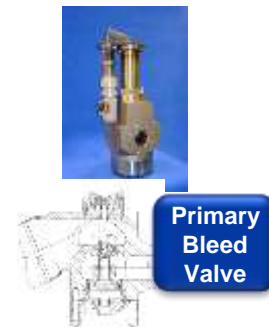
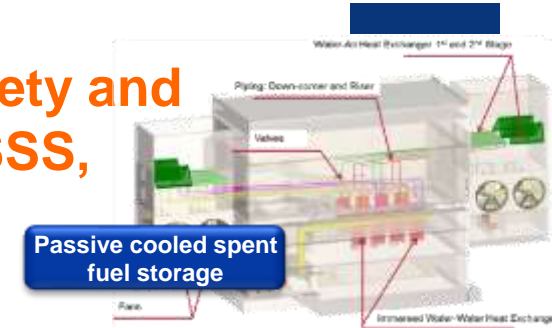


Sampling by EDM



Welding of Aluminum pipes

Plant and system modifications related to safety and modernization for all kinds of NPP's at NSSS, BNI and other auxiliary systems



■ NPP specific LTO plant modification related to safety and technological improvement include:

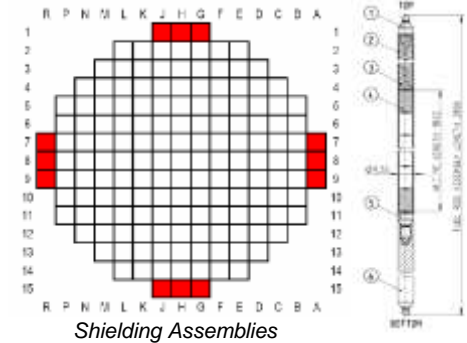
- ◆ Increase of safety margins
- ◆ Increase of performance components
- ◆ Increase in component life

Examples:

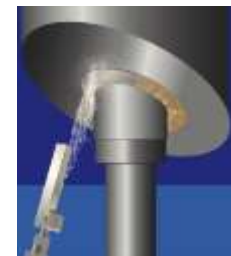
- Modernization of safety and operational I&C: TELEPERM XS, Tricon, Foxboro DCS,
- Digital Control: TELEPERM XS, Variable Frequency Drive, Rod Control System
- Computerized AIDS
- Primary Bleed & Feed Implementation (mechanical, electrical and I&C)
- Improvement of cooling systems (Residual heat Removal System and Spent Fuel Cooling Systems)
- Physical Plant Protection Systems (Explosion Pressure Wave Dampers, Toxic Gas retention Systems, ...)
- Filtered Containment Venting (FCVS), Hydrogen Recombiners
- EDG (Emergency Diesel Generator sets) and related control systems
- Separation of signals into different categories (monitoring systems, protection systems)
- Fixed Incore Detectors
- Ex-Core and In-Core Instrumentation
- Data Analytics: N-Vision
- New Safety studies due to the evolution of the regulation

Long Term Operation Our Solution – Techno Brief 5/5

- Effective neutron fluence control of RPV base material by implementing shielding fuel assemblies
- Film Forming Amines to protect inner surfaces of structures and component against corrosion and corrosive damage
- Cavitation peening to protect dissimilar welds



FFA Application



Cavitation Peening

Long Term Operation Our Solution – Key Features

■ Increase margins for mechanical

- ◆ Pressurized Thermal Shock studies (use of Advanced Methodology)
- ◆ Fast fracture analysis (primary components)
- ◆ Fatigue Analysis based on online monitoring (FAMOSi) to reduce conservatism
- ◆ Apply COMSY reliable degradation assessment to minimize maintenance effort

■ Increase margins for electrical and I&C

- ◆ Equipment qualification: Perform tests, Performing of calculations based on real data (e.g. COMSY – Electrical)
- ◆ Cable Aging; Evaluation of Electrical and I&C components
 - Evaluation based on Arrhenius and Power law considers e.g. Temperature Index TI*, qualification, manufacturer information, activation energy, ambient temperature, installation time of equipment, qualified total dose, exponent of the Power law
- ◆ Electrical Motors and Actuators
- ◆ Field Instrumentation

■ Modernization / Safety Improvement

- ◆ Regulatory requirements and practices leading to safety upgrading, e.g. findings of PSR, new regulations, serious events, like TMI, Chernobyl, Fukushima, etc.
- ◆ Fields of safety enhancement based on external and internal events, increase of redundancy/ separation/ independence, isolation, decoupling, safety of Spent Fuel Pool...

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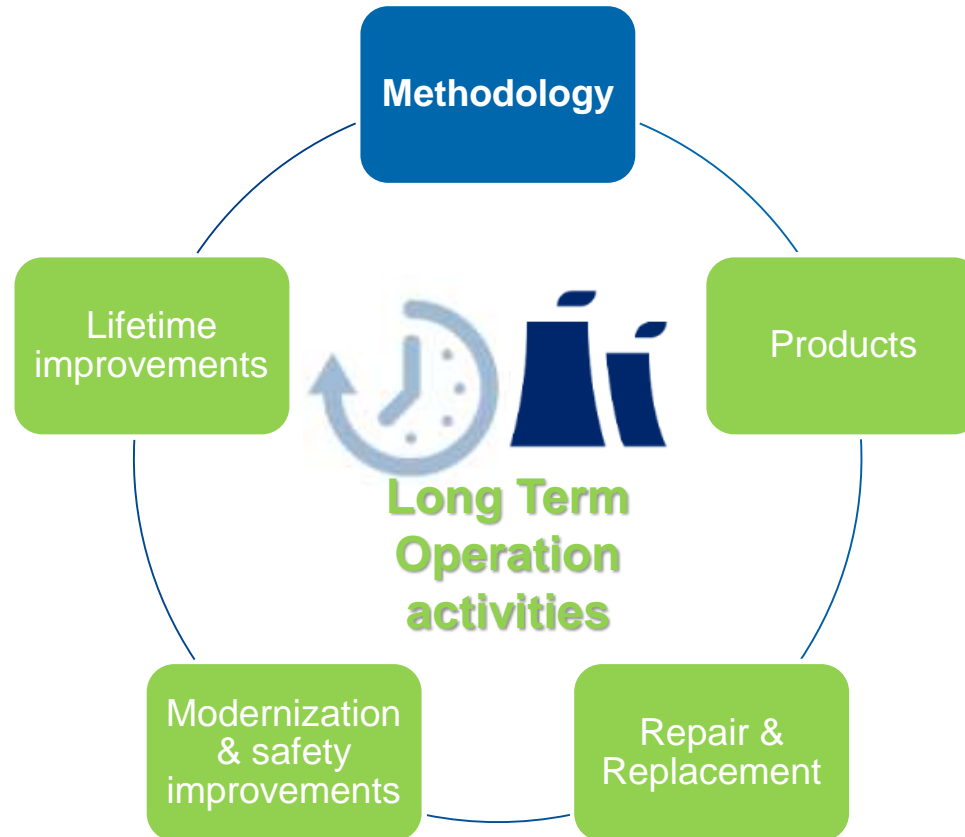
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Summary

Long Term Operation Differentiators



Long Term Operation Differentiators 1/4

Products

- **COMSY is a unique tool which has the capability to perform automatic evaluation of the degradation mechanisms**
- **FAMOSi is an online monitoring tool which has the capability to perform automatic evaluation of the individual components usage factors**
- **Framatome script grouping which performs automatically commodity grouping based on existing data**
- **Equipment qualification database (I&C, Electrical and Mechanical)**
- **N-Vision fulfils the Data Analytics Promise: Reduce / optimize cost while maintaining or improving plant reliability**
 - Framatome offers engineering knowledge of systems, failures, and plant programs unique among providers of data analytics services

Long Term Operation Differentiators 2/4

Repair & Replacement

- **High level Engineering and Project Management resources**
 - Turnkey heavy component repair & replacement services
 - Expertise in welding, mechanical, tooling, robotics, controls engineering
 - Nuclear safety focus
 - Global experience base – “bench strength”

- **Wide scope of technical skills and experience:**
 - Repair / replacement process engineering
 - Implementation of sophisticated on-site techniques: handling, machining, welding...
 - Development of special processes and tools: tailored solutions to challenging and complex problems
 - Knowledge of components, their design basis and aging issues

- **Reactive Culture: Ability to mobilize crews quickly to support emergent problems**

- **Quality Assurance: ”High standard” quality control for all circumstances**
 - Global experience in interpreting and qualification to Codes and Standards
 - Qualification and field hardening of new / innovative processes

Long Term Operation Differentiators 3/4

Modernization
& safety
improvements

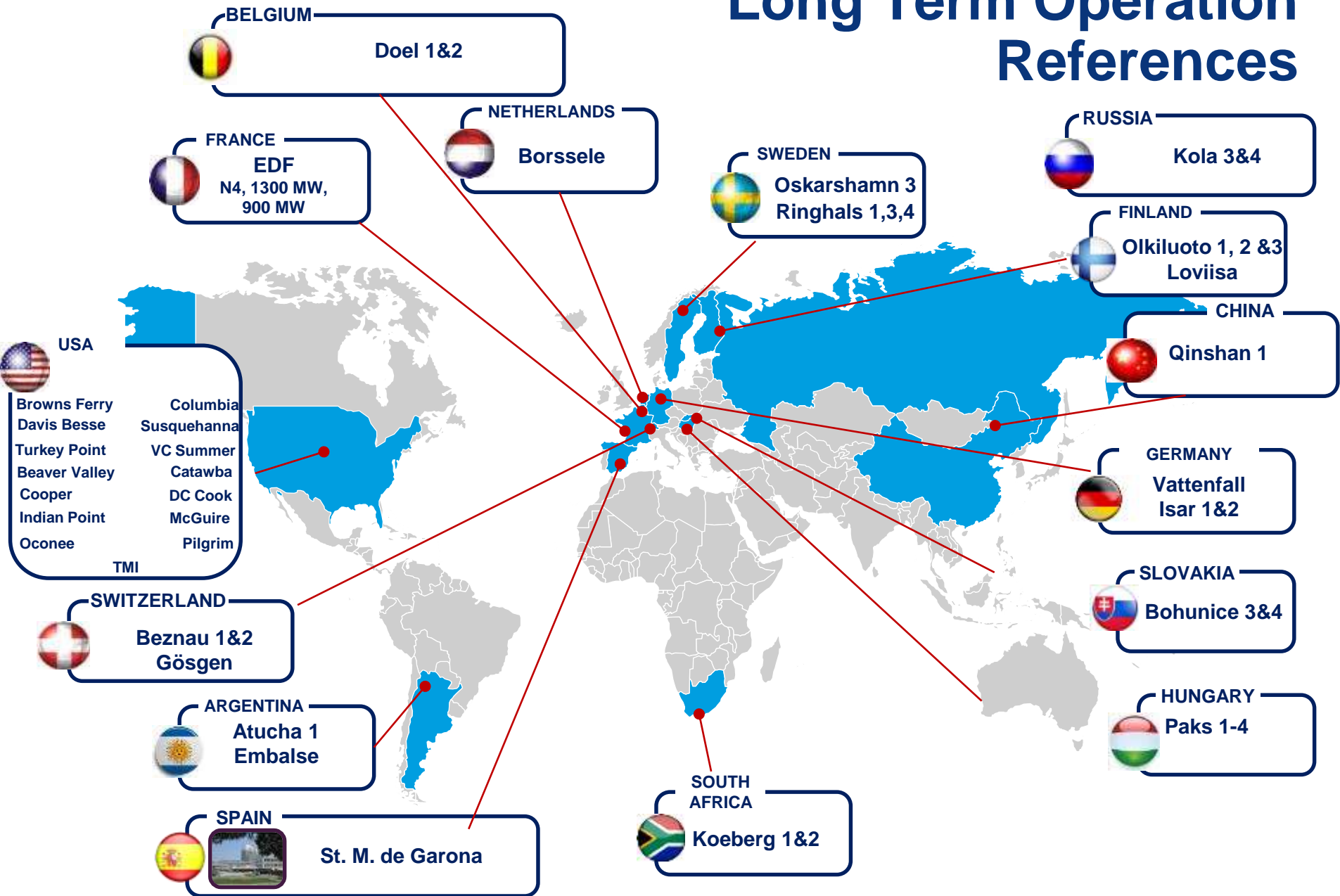
- Framatome as Architect Engineer and Original Equipment Manufacturer (OEM) of the Nuclear Island provides tailored and dedicated products and solutions, (Mechanical, Electrical and I&C)
- Framatome as Architect Engineer and OEM of the Nuclear Island has the expertise available to utilities at any field in order to guarantee an optimal implementing process tailored for the individual needs.
- Based on participation in national and international working groups (e.g. KTA, RCC-M/E, IEC, IEEE, ASME, IAEA, WANO, FROG, PWROG, INPO, EPRI etc.) Framatome is aware of new regulations and follow-up of international trends related to safety improvements

Long Term Operation Differentiators 4/4

Lifetime improvements

- **Shielding fuel assemblies**
Only Framatome has a proven Shielding assembly design
- **Film-forming amines** is a patented chemical solution by Framatome used to prevent fast-progressing damages on the structural materials inside the steam generator due to corrosion or pollution. The amines are introduced into the working fluid and deposit on the surfaces, thus creating a water-repellent protective layer that keeps corrosion particles and other debris from adhering to the surfaces (lotus effect).
- **Cavitation peening:** The Ultra High Pressure Cavitation Peening process will help mitigate the risk of occurrence of Primary Water Stress Corrosion Cracking (PWSCC) for the remaining life of the plant at a much lower cost and lower outage impact than traditional repair methods and without risk of damaging the primary circuit components, and will likely reduce the frequency of Non Destructive Examination inspections

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Long Term Operation Exploratory Questions

Questions	Answers
Why should I apply Framatome's concepts and solutions?	Framatome makes its global expertise available to utilities in order to guarantee an optimal implementing process tailored for the individual needs
What is the advantage to contract a large company like Framatome?	High <u>global</u> expertise All in one hand
How Framatome products help and/or support the process of LTO?	<ul style="list-style-type: none"> - Systematic data collection and degradation assessment function - Maintenance and inspection procedures as well as NDT results can easily be validated in respect to their sufficiency to control degradation
What would be the rough investment I need to operate beyond the design life?	Thanks to the feasibility studies, we analyze the necessary improvements based on state-of-the-art safety issues. It can vary between 100 and 700M€.
What could be the estimated Return Of Investment?	The ROI can be 2 years at a minimum depending on the investments.

Long Term Operation Go To Market Strategy

Consolidate (within 6 months)	Pursue market penetration (within 1 year)
<ul style="list-style-type: none"> • France (EDF fleet) • Belgium (Tihange 3&4) • China (Daya Bay) • RSA (Koeberg) • Switzerland (Goesgen, Leibstadt) • USA (Oconee 1,2,3; ANO-1; North Anna; Surry) • Brazil (Angra 1) • Canada (Bruce, Pickering, Darlington, Point Lepreau) 	<ul style="list-style-type: none"> • Argentina (Atucha 1) • UK (Sizewell B) • Czech republic (Temelin 1&2) • Romania (Cernavoda)
Grow (within 1 year 1/2)	Explore (Within 2 years)
<ul style="list-style-type: none"> • Sweden (Ringhals 3&4, Oskarsham 3, Forsmark 1&2) • Finland (Olkiluoto 1&2, Lovisaa) • Bulgaria (Kosloduy) • South Korea (Hanul 1&2) 	<ul style="list-style-type: none"> • Brazil (Angra 2) • Spain (Almaraz, ...)



Long Term Operation Success Story

■ Customer target

- ◆ Borsselle



■ Customer issue

- ◆ Operate beyond the design life (20 years of longer operation)
- ◆ Small utility with limiting resources



■ Framatome solution

- ◆ A turnkey solution has been proposed with experts from each field (mechanical, electrical and I&C)
- ◆ COMSY and FAMOS were successfully implemented

■ Customer results

- ◆ Approval from the regulator
- ◆ 3 years ROI

■ Framatome Results

- ◆ Good example of LTO capabilities
- ◆ Framatome OIT > 10 Mill.€

Long Term Operation Summary

CUSTOMER ISSUE

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OUR SOLUTION



Customer Benefits at a Glance

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