



AREVA
Safety Alliance



AREVA
Forward Alliance



NUCLEAR POWER PLANTS AFTER FUKUSHIMA

AREVA Safety Alliance & Forward Alliance Programs

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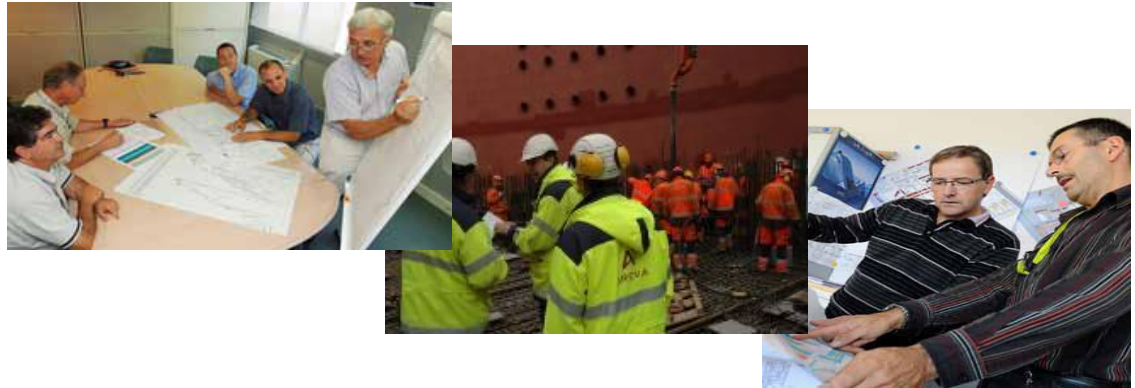
RECIFE - November, 27th-29th, 2013



AREVA Post-Fukushima Initiative

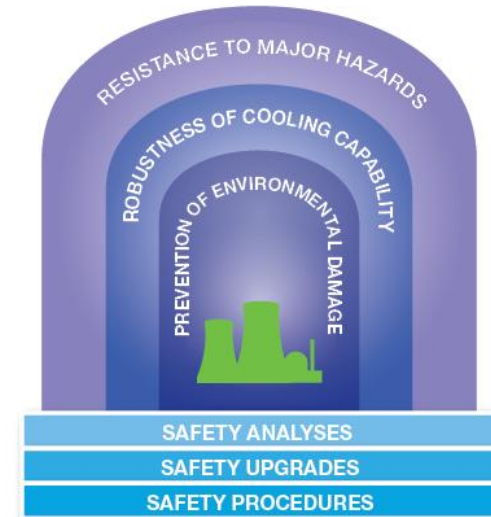
▶ Engaging with utilities to help them meet ever-increasing safety requirements

- ◆ Safety analyses
- ◆ Safety upgrades
- ◆ Safety procedures



▶ A safety framework structured around three imperatives:

- ◆ Resistance to Major Hazards
- ◆ Robustness of Cooling Capability
- ◆ Prevention of Environmental Damage



AREVA Post-Fukushima Initiative

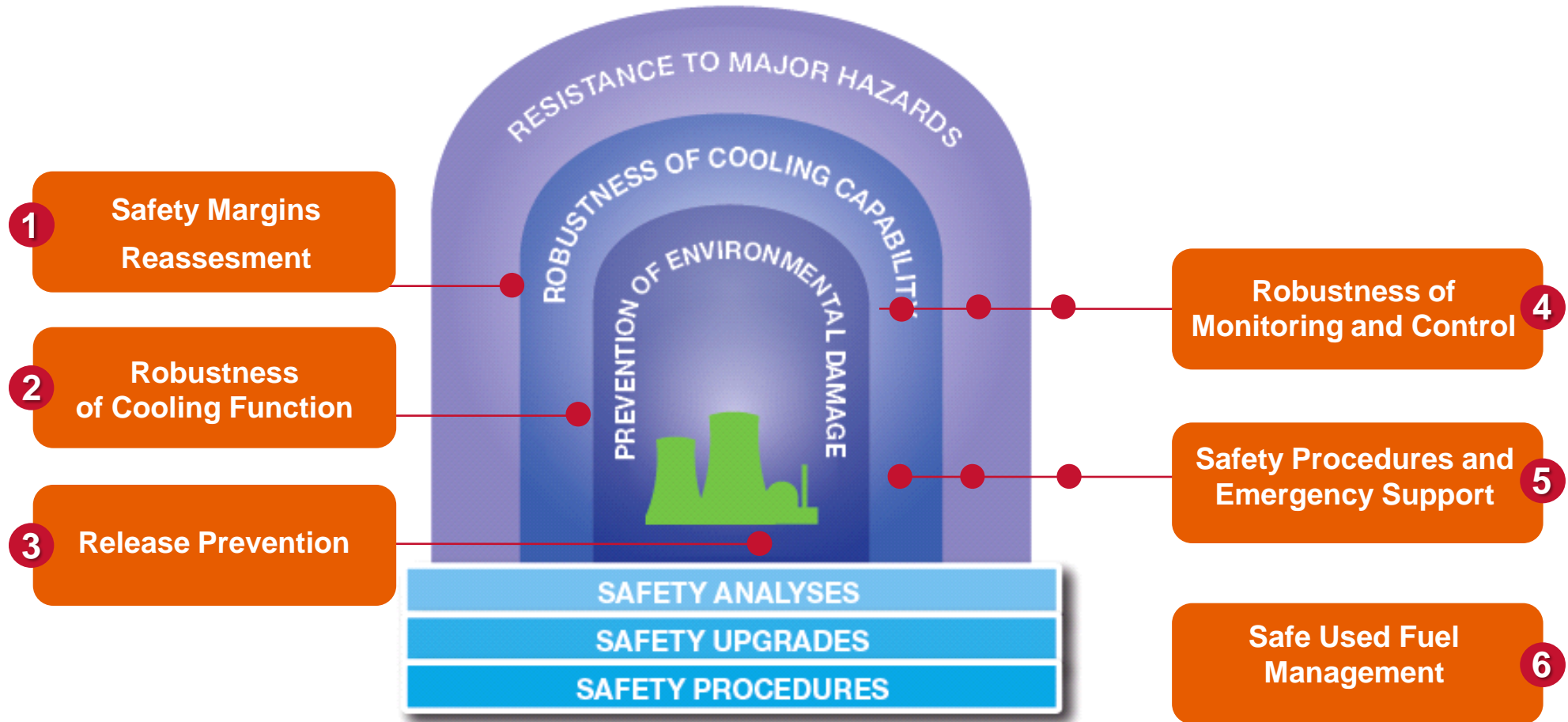
- ▶ **Immediate mobilization of international AREVA competences and skills to build a global solutions offering**
 - ◆ 35+ solutions, products and services selected in the AREVA global Nuclear Services Portfolio

- ▶ **A dedicated R&D organization for prioritized projects**
 - ◆ Secured communications for Monitoring
 - ◆ Hardened Intelligent Sensors
 - ◆ Post-Accidental re-inforced surveillance systems
 - ◆ Improved Capability of Passive Cooling Systems
 - ◆ Organic Iodine Filtering Improvement





The 6 Main Safety Themes as defined with our customers





1

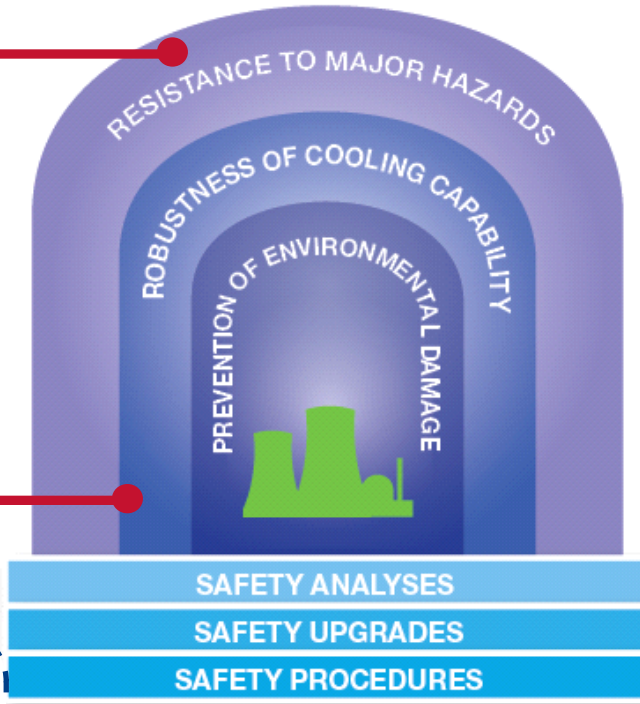
Safety Margins Reassessment

- Probabilistic Safety Analysis (Brazil)
- Flooding Margins Studies (USA)
- Seismic Studies (Switzerland)

2

Robustness of Cooling Capability

- “Feed & Bleed” Implementation (Brazil/Spain)
- Ultimate Heat Sink diversification studies (Switzerland)
- Safety Injection reinforcement France)



Safety Margin Reassessment

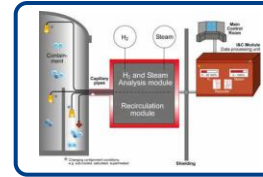
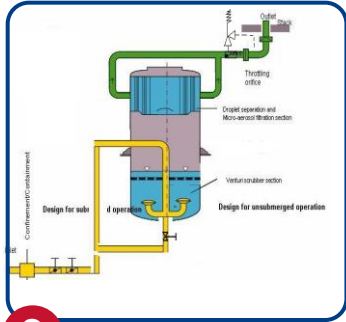


Passive Cooling Systems



AREVA Safety Alliance Projects

2/2

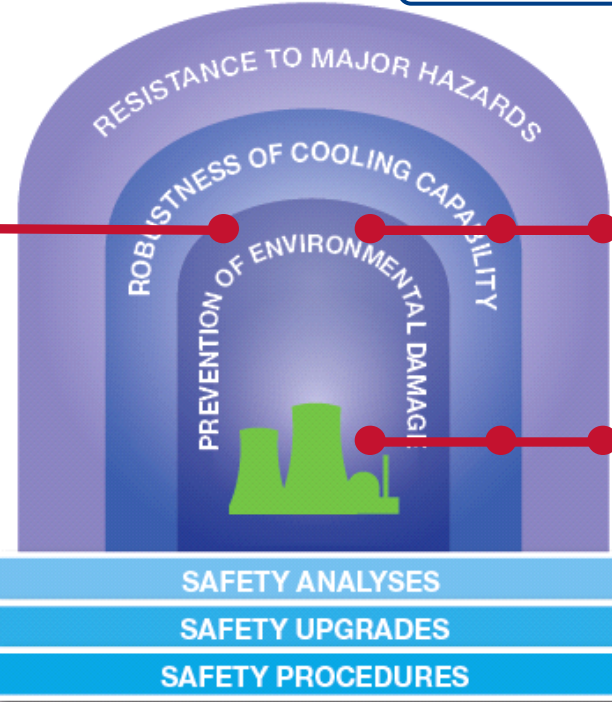


- SFP Level measurement (USA)
- H2 Monitoring (Romania)
- Hardened Electrical Systems (Netherlands)

3

Release Prevention

- Passive Autocatalytic Recombiners (Japan)
- FCVS (Argentina)
- FCVS (Romania)
- FCVS (South Korea)



4

Robustness of Monitoring & Control

5

Safety Procedures & Emergency Support

- National Response Center (USA)
- Emergency Support Teams (Germany)
- Post-Accidental Procedures (Spain)

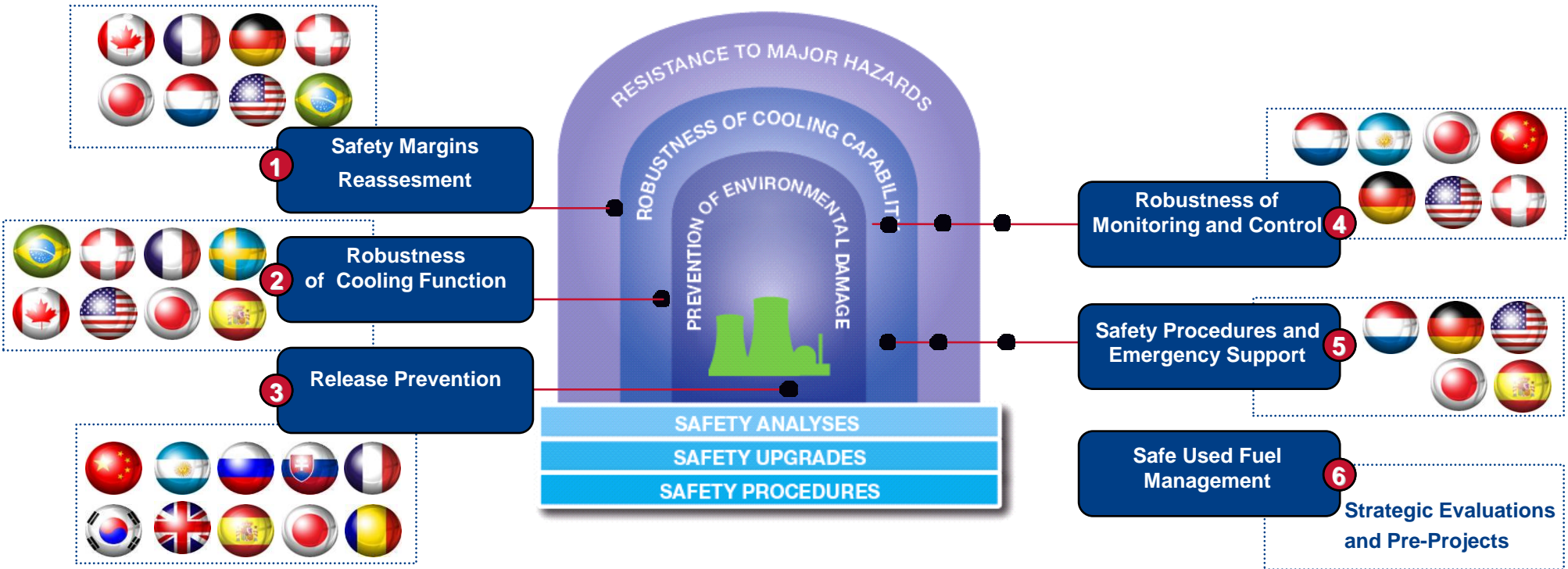




AREVA engaged with the Nuclear Community



85 projects launched in 16 countries for 42 Nuclear Utilities Worldwide*



* Source AREVA End 2012

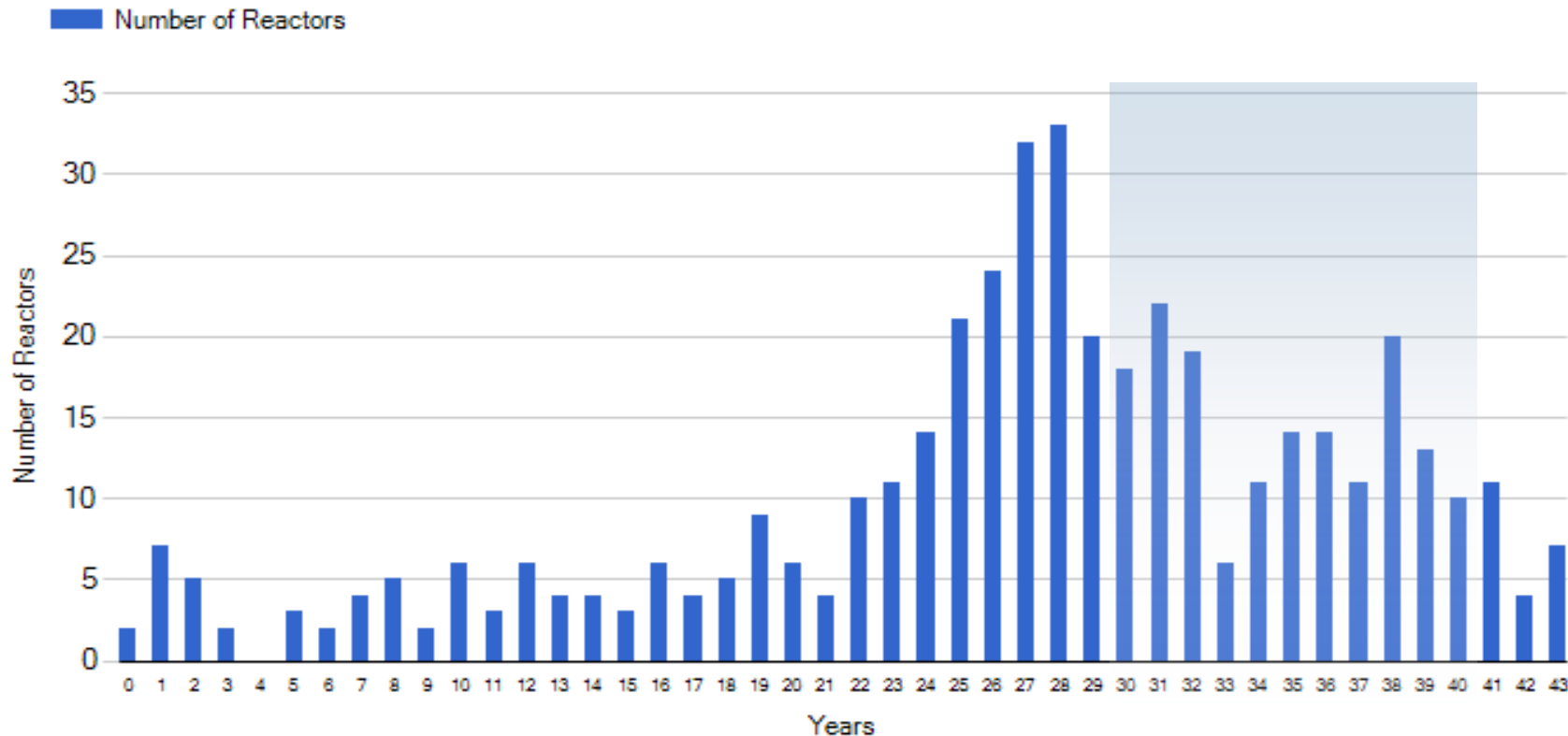


From Safety Alliance to Forward Alliance



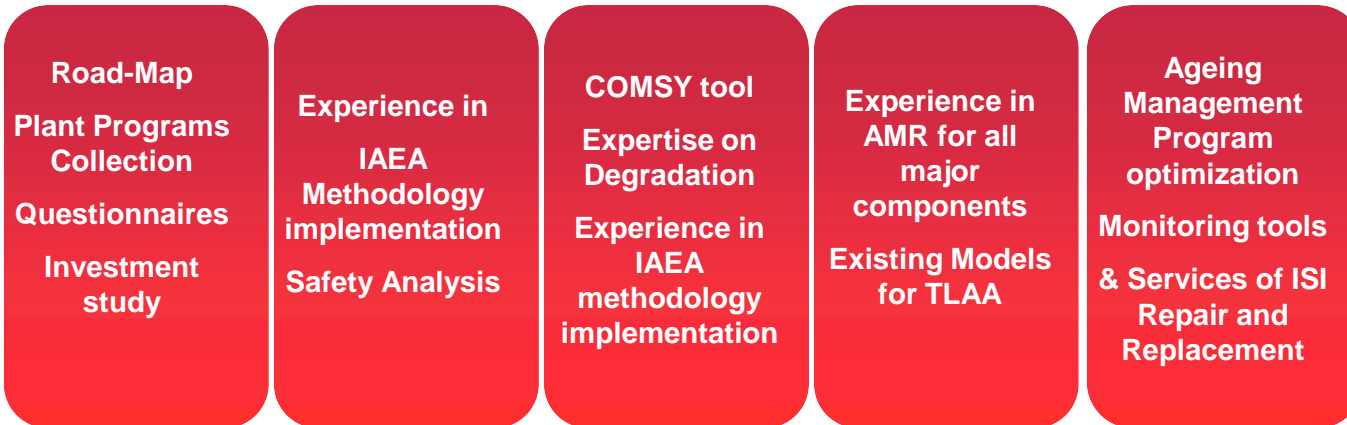
► In the next decade, 150+ new reactors will be operated after license renewal

Total Number of Reactors: 437



AREVA Long Term Operation Initiative

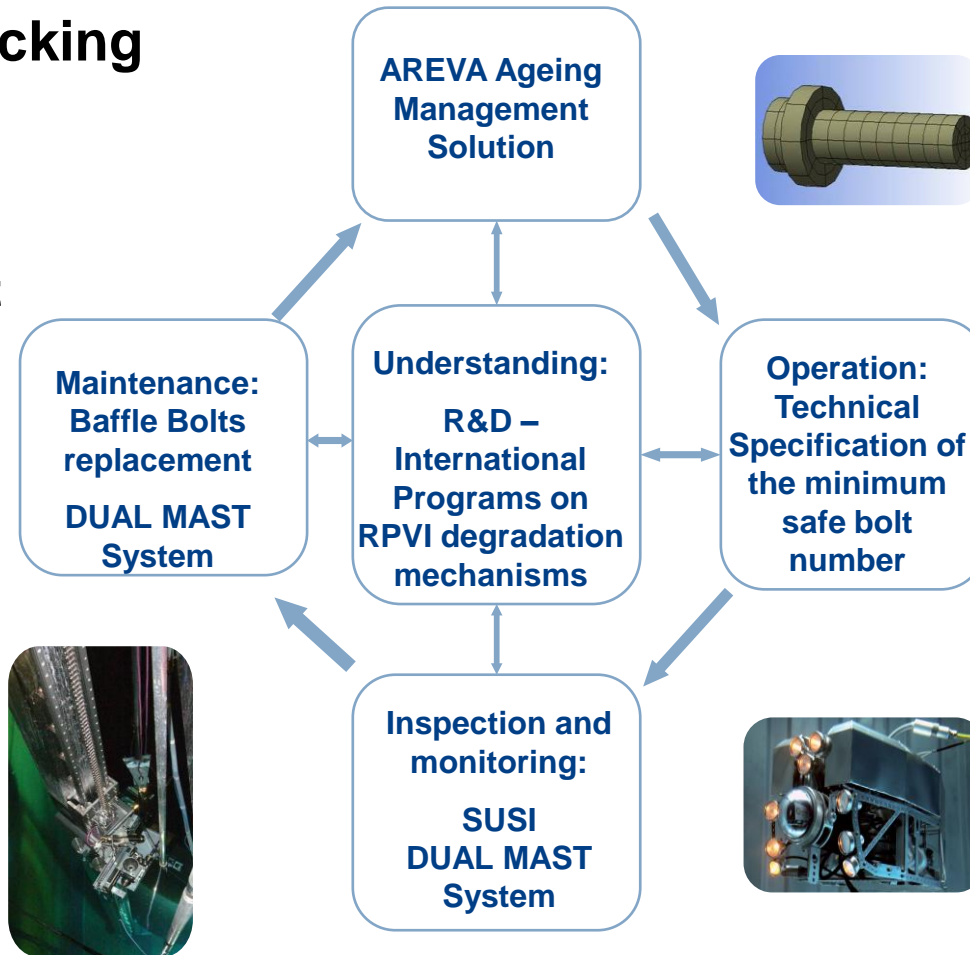
- ▶ **Supporting Utilities building and deploying their strategy, during all the LTO process**



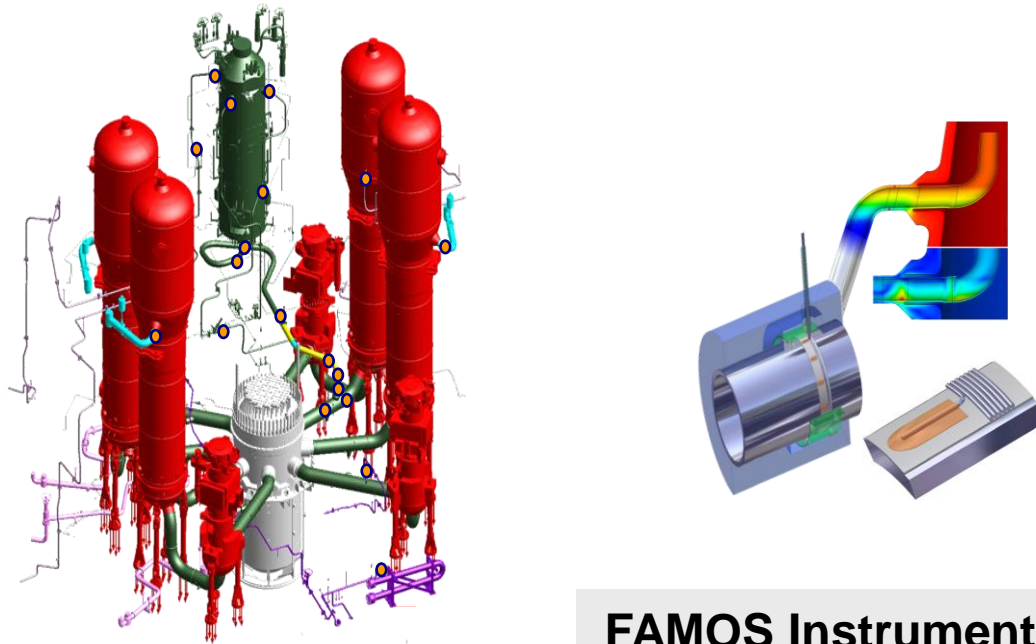
Example of Ageing Management Solutions for key components: RPV Internals

► Baffle Bolts Cracking

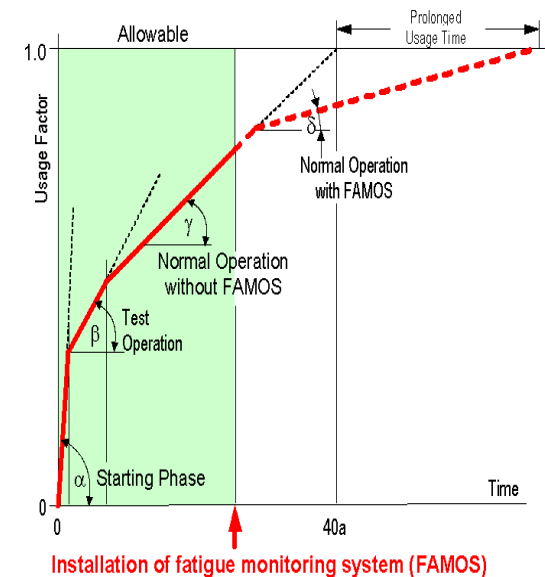
- ◆ Justification
- ◆ Inspection
- ◆ Replacement



Tools for degradation surveillance and condition monitoring: Example of fatigue



FAMOS Instrumentation

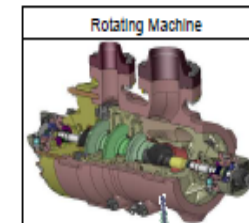


FAMOS Fatigue Monitoring System:

- ▶ Local load measurement at fatigue relevant part of components
- ▶ Automatic stress history calculation based on real loading condition
- ▶ Realistic fatigue cycle counting (rain flow) leads to realistic usage factor calculation

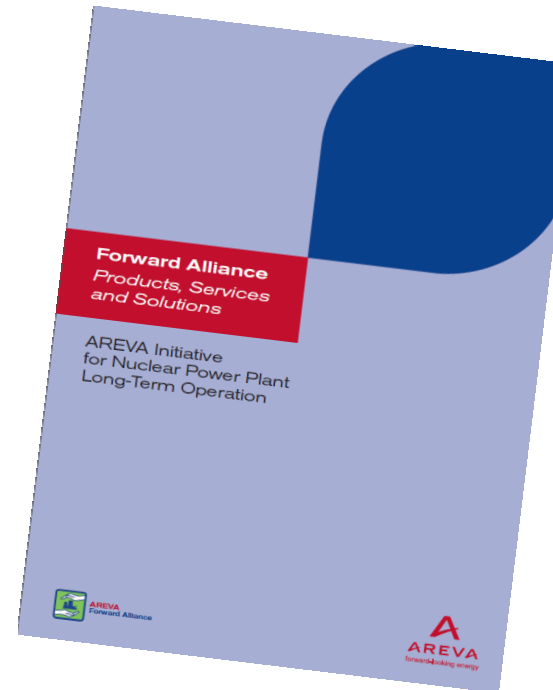
Tools for degradation surveillance and condition monitoring

- ▶ **Component Condition Monitoring tools help optimizing maintenance while keeping ageing degradation under surveillance**
 - ◆ **DIROM: Monitoring of Rotative Machines**
 - ◆ **RCP Reliability Solution: Monitoring of the Main Coolant Pump**
 - ◆ **ADAM/SIPLUG: Monitoring of Electrically operated valves**
 - ◆ **iDEX: Integrated Diagnosis/prognosis Expert**



AREVA Forward Alliance Catalogue

- ▶ AREVA Forward Alliance catalogue contains 25+ products, services and solutions for Long-Term Operation*



* June 2013 version

Building the Future of Our Industry, Together



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Muito Obrigado



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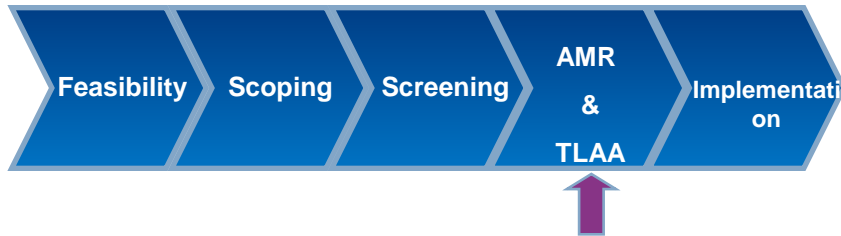
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Attachments

► ***Attachments:***

- ◆ Ageing Management Reviews
- ◆ COMSY: an AREVA Tool - Slides 1 + 2
- ◆ Monitoring & Diagnostic Systems
- ◆ FAMOS - Technology Overview
- ◆ Monitoring & Diagnostic Systems
- ◆ FAMOS - Technology Overview
- ◆ AREVA - World Wide Experience
- ◆ Reference Base World Wide

Illustration - Ageing Management Reviews



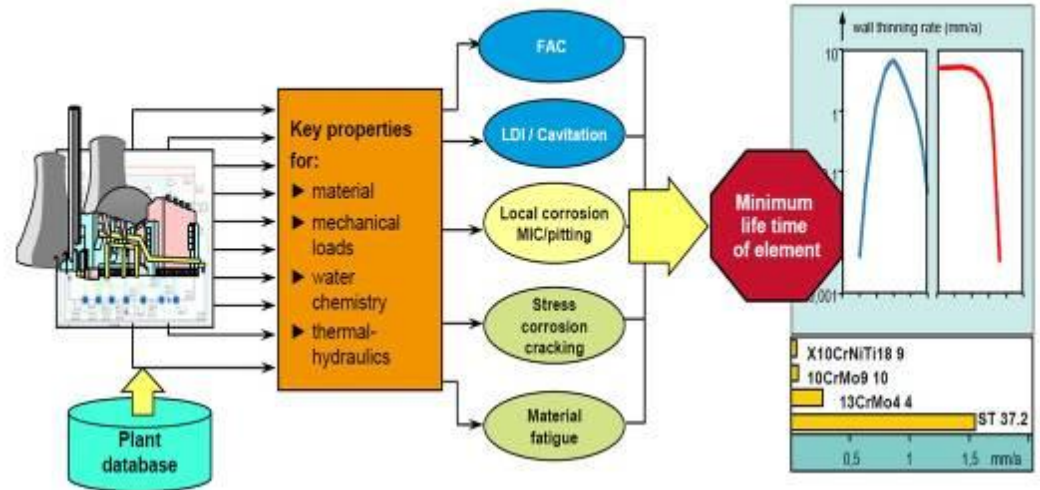
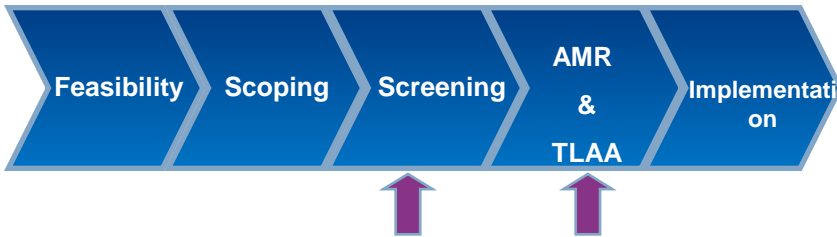
▶ Ageing Management Review to check

- ◆ Identification of all significant ageing mechanisms for each SSC of the scope
- ◆ Thorough understanding of ageing mechanisms and their effects
- ◆ Consistency between the ageing behavior of SSC to date and prediction
- ◆ Adequate margins of ageing to ensure safe operation until next PSR
- ◆ Effectiveness of ageing management program for future operation addressing

▶ Example of components requiring detailed AMR (with revalidation of TLAA)

- ◆ RPV, MCL, MCP, SG, PZR
- ◆ Containment
- ◆ Electrical equipments and cables
- ◆ I&C

Illustration COMSY: an AREVA tool 1/2



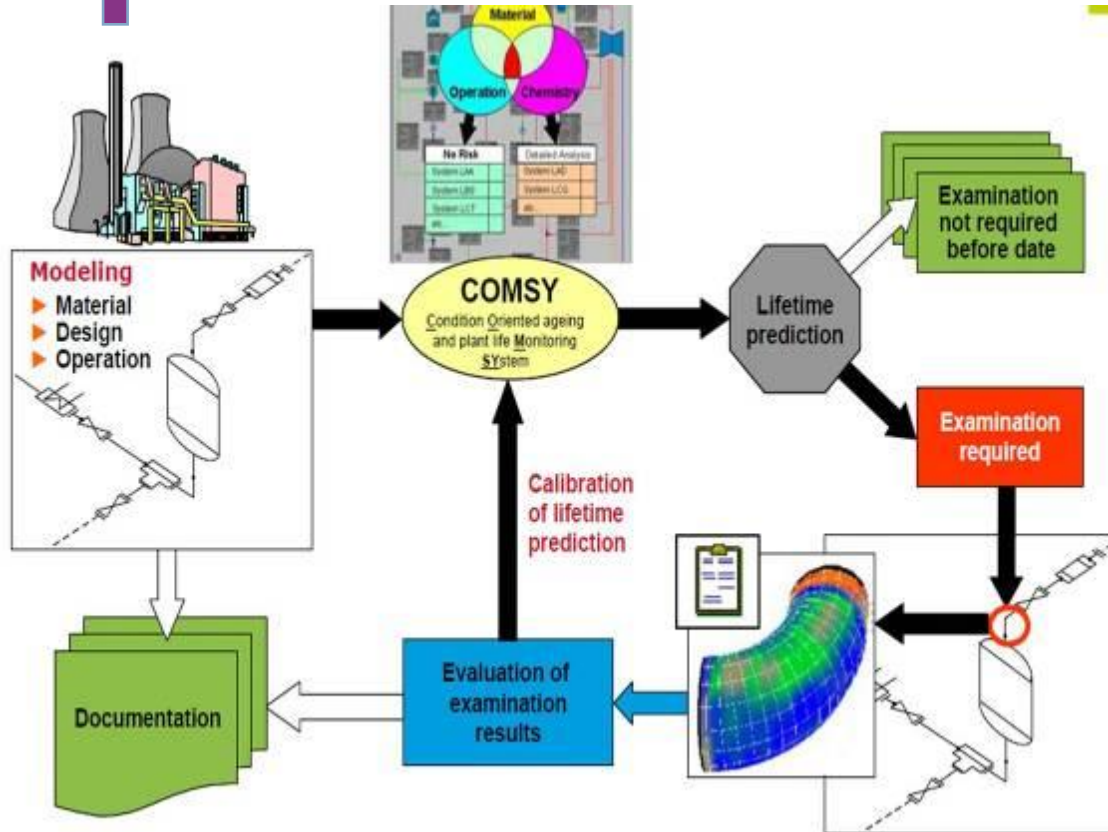
► **COMSY software functions for Mechanical Equipments:**

- ◆ Knowledge/data Base
- ◆ Life-Time Prognosis

► **COMSY makes the analysis efficient and reproducible**

► **Similar functions are available for Electrical, Civil SSCs and active components**

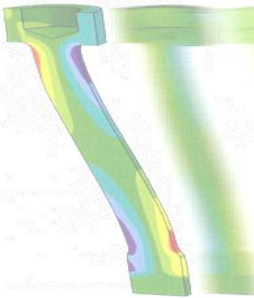
Illustration COMSY: an AREVA tool 2/2



» **Closed loop for Ageing Management
Program optimization (ex. ISI program)**

AREVA has developed an integrated range of Monitoring & Diagnostic Systems

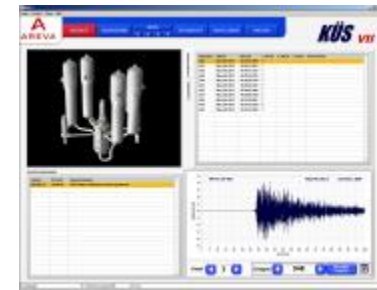
Fatigue Monitoring System (FAMOS)



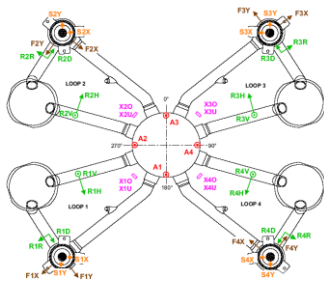
Valve Diagnostic (ADAM/SIPLUG)



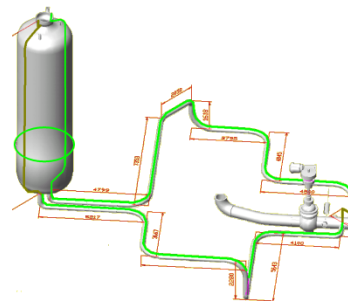
Loose Parts Monitoring (LPMS)



Vibration Monitoring System (VMS)



Leakage Monitoring System (FLUS)

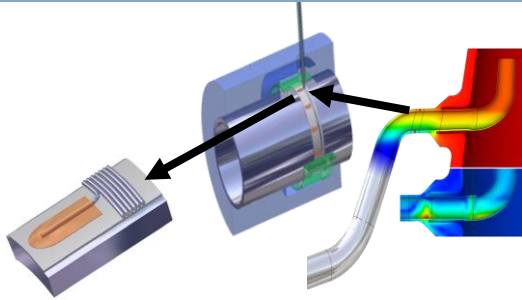


Diagnostic Rotating Machinery (DIROM)



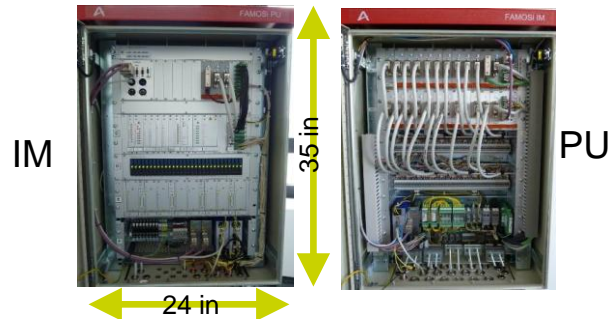
FAMOS - Technology overview

Measurement section



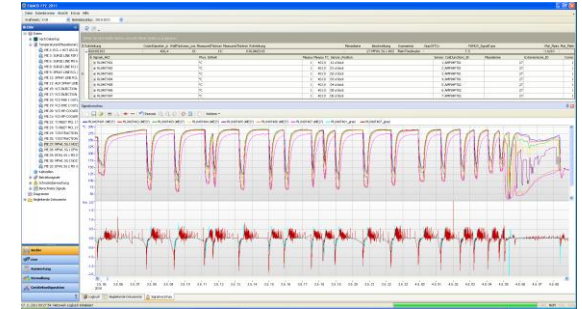
- ▶ measurement sections installed at the outer surface of the pipe
 - ◆ 7 thermocouples in case of stratification
 - ◆ 2 Thermocouples in case of plug flow / thermal shock

Processing Hardware (Inside containment)



- ▶ Highly integrated hardware cabinets for minimal footprint
 - ◆ Information Module (IM) for data acquisition
 - ◆ Processing Unit (PU) for data conditioning
 - ◆ Only two fiber penetrations required for connection to the software

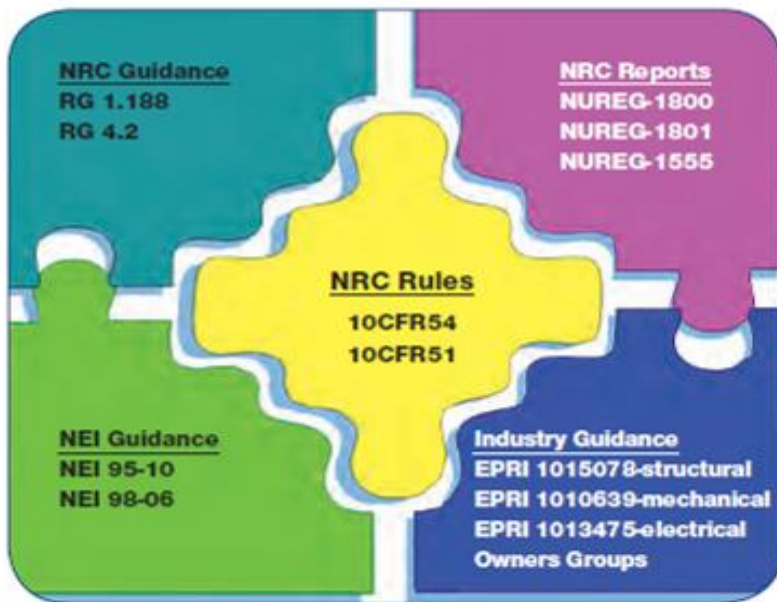
Software



- ▶ Fast Fatigue Evaluation software (FFE)
 - ◆ Online fatigue analysis and temperature visualization
 - ◆ 10,000 times faster than a normal finite element calculation
 - ◆ +/-3% precision

AREVA – A world wide experience

- ▶ In US, AREVA's License Renewal (LR) services have helped US utilities extend the safe operating life of their PWR and BWR nuclear power plants by 20 years, while ensuring continued return on investment to their shareholders
- ▶ AREVA has been involved in over 50% of US License Renewal



Key US regulatory guidelines regarding License Renewal

- | | |
|-----------------------------|-----------------------------|
| DC Cook Units 1 & 2 | Cooper Unit 1 |
| Calvert Cliffs Units 1 & 2 | Browns Ferry Units 1, 2 & 3 |
| H.B. Robinson Unit 2 | Arkansas Nuclear One Unit 1 |
| Ginna Unit 1 | Indian Point Units 2 & 3 |
| Oconee Units 1, 2 & 3 | Columbia |
| McGuire Units 1 & 2 | Susquehanna Units 1 & 2 |
| Catawba Units 1 & 2 | Crystal River 3 |
| Three Mile Island | V.C. Summer Unit 1 |
| Turkey Point Units 1, 2 & 3 | |
| Beaver Valley Units 1 & 2 | |
| Davis Bessie Unit 1 | |
| Monticello Unit 1 | |

AREVA has the largest reference base worldwide



Americas

Europe

Asia

References of Monitoring & diagnostics in **64 NPP in 18 countries**

References with **all reactor types:**
CPR1000, Westinghouse PWR, EPR, VVER, PHWR, GE BWR, KWU PWR/BWR

References for **new builds** and **back fitting** projects