



Orano D&D Activities

A Focus on D&D Program Management and Reactor D&D

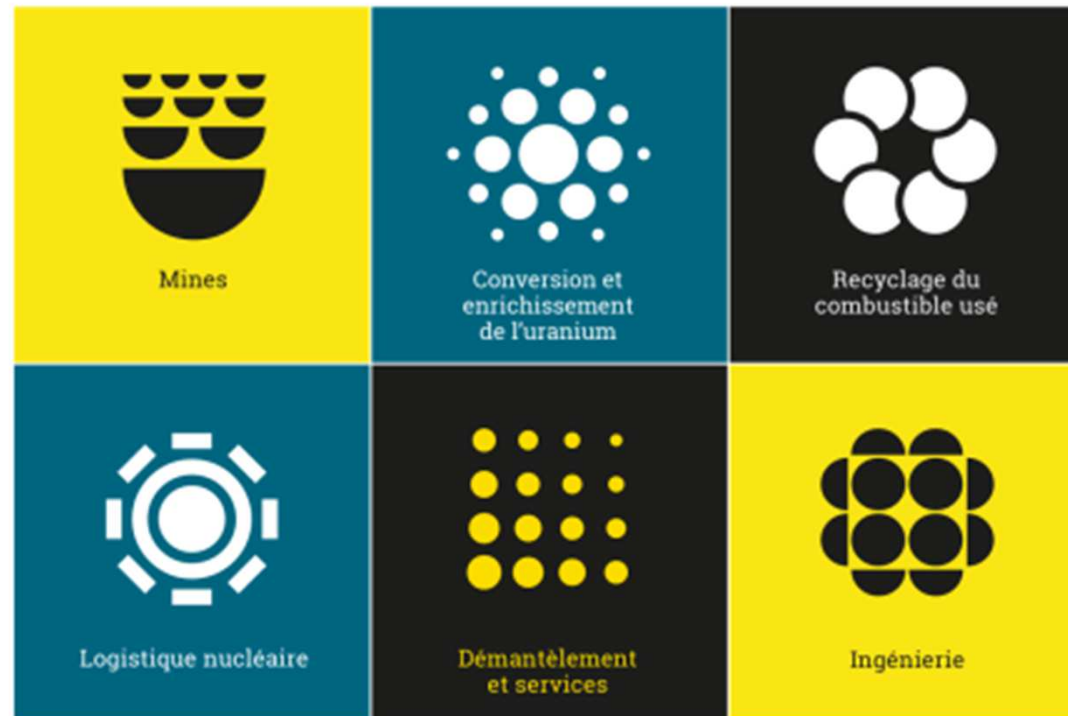
Frédéric Chamboon

TECHNICAL MEETING "EXPERIENCE OF REACTORS DISMANTLING", IGNALINA NPP, LITHUANIA,
18th October 2018



Orano

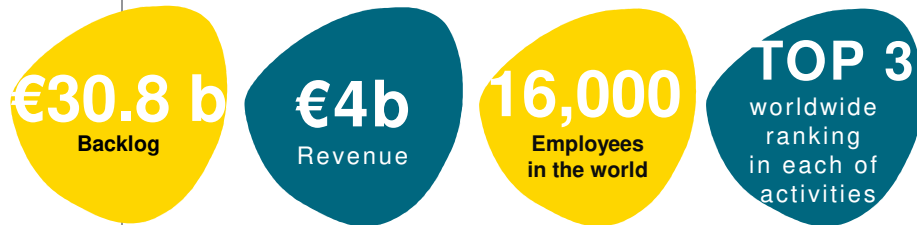
a strategic refocusing on nuclear fuel cycle business



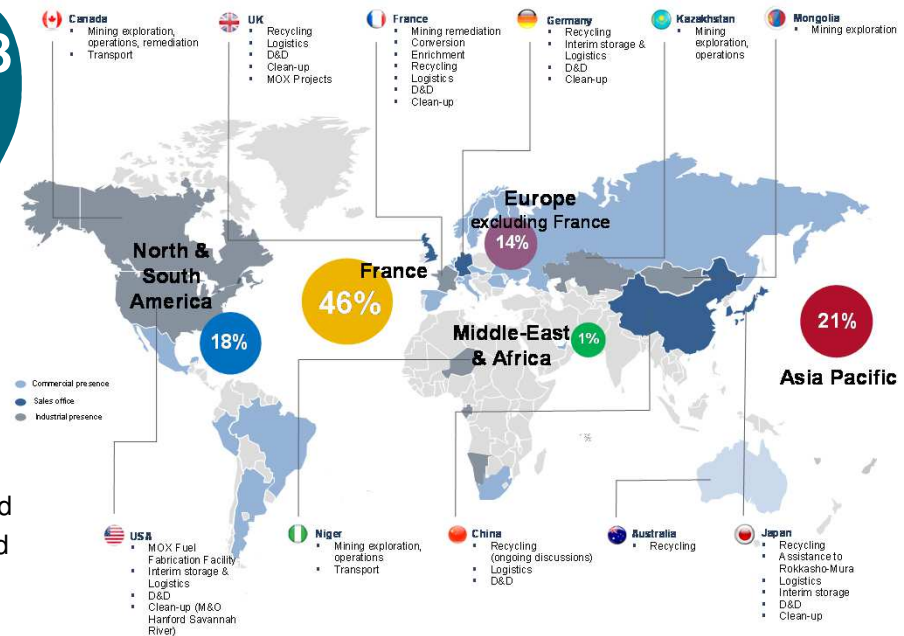
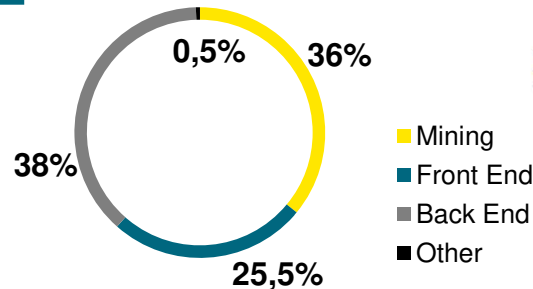
90% French State, 5% MHI*, 5% JNFL*

* after 2nd capital increase

Orano : Launching new global company from solid foundation



Key Figures



Constant Innovation for Technologies and Business Models

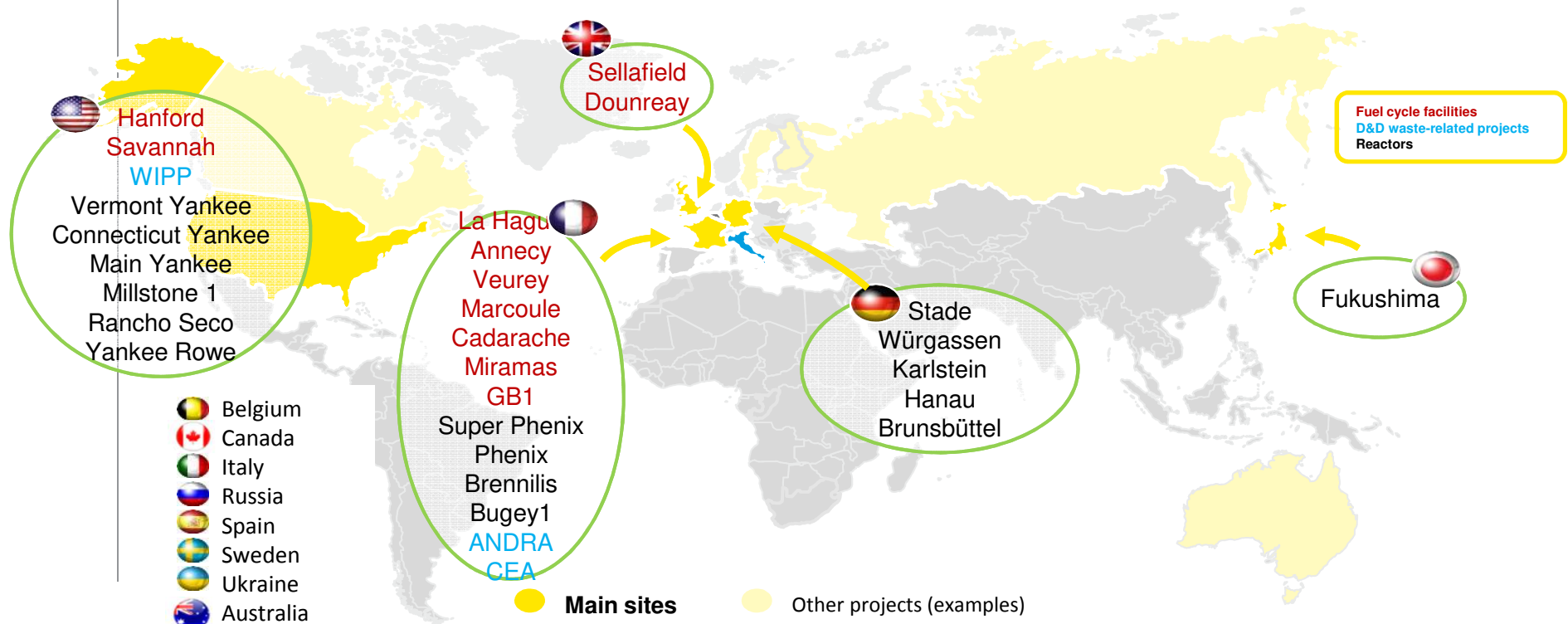
D&D and Waste Management is where Back-End Expertise comes together



Reducing risks & costs,
enhancing
Public
Acceptance



Orano involved in many D&D and waste management projects worldwide

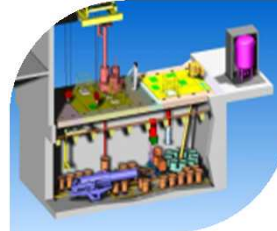
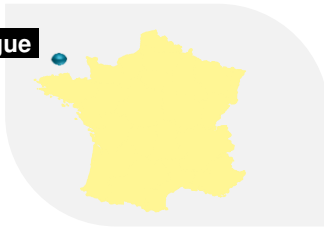


Experience from decommissioning projects World Wide as Owner, Operator and Supplier

Orano La Hague UP2 – 400

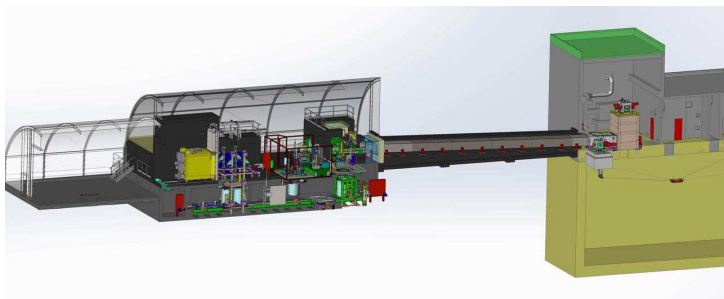
First dismantling project of a civil used fuel recycling unit

La Hague

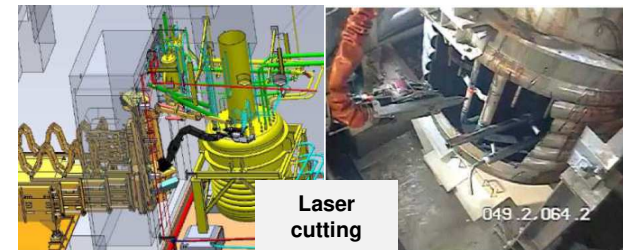


A massive Decommissioning & Dismantling program to manage diverse, complex issues (waste retrieval, ponds, silos, concrete buildings, process equipment... in high Rad environment)

30 years of D&D and Waste Retrieval
~4 Billion Euros
6M working hours
50000 m3 of waste
~500 persons at peak



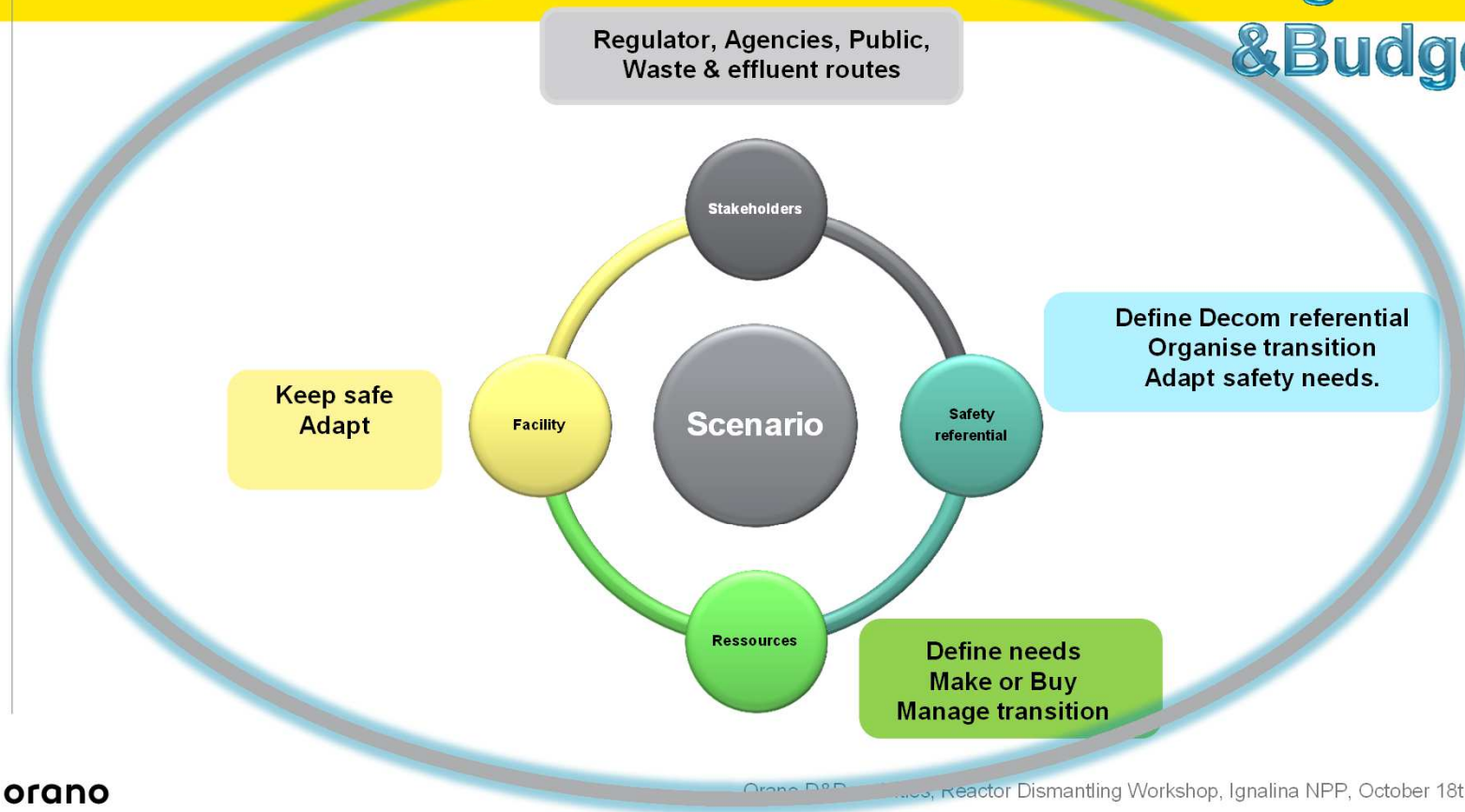
High-activity waste expertise



Laser cutting

D&D program management

Programme & Budget



UP2 400 Decommissioning programme

Orano plant, decommissioning with Orano funding, Orano project management, engineering and delivery (~80% of the work)

Legally binding schedule

- Key milestones and hold points set by regulator

Financially binding budget

- Budget in Orano financial provisions are regularly audited by external bodies

Binding waste forecasts towards authority and repository operator

- Waste forecasts are used by repository operator to design Geological Disposal Facility

Environmental impact reviewed and challenged

- Report submitted every three years to regulator to demonstrate chosen scenario is the « best » approach

UP2 400 D&D – Main Lessons Learned

Managing people during transition is as important as technical issues

One single authority for all (Operations, Projects, Safety)

- Operations/safety & projects have different missions, they must be guided towards the same objective

Incorrect knowledge of initial state is the most impacting contingency

Anticipating uncertainty

- **Decommissioning is subject to contingencies (technical or not)**
 - Risk & Opportunity management as a driver
 - Establishing performance plans to compensate contingencies

Regulatory procedures are long processes over which control is limited

Waste management is the backbone of the DECOM scenario and an major cost contributor

Ageing and adaptation of the facility must be dealt with from shutdown to end

External parties can impact the project significantly

- Supply chain maturity & availability, waste or effluent routes...

Key takeaways from one of our Reactor D&D Manager

Anticipate

1 to 3 years before final shutdown, create a dedicated project team, establish a shutdown, POCO* and Decom scenario, describe the safety needs/evolutions associated with it and submit to the regulator for approval

This will allow to avoid delays and repeated approval requests from regulator

Knowledge of facility

Maintain key resources with knowledge of the plant history, condition, circuits for as long as needed

Adapt safety referential as work progresses

Surveillance & maintenance costs can be reduced gradually as hazards are removed. Equipment can be shutdown, plant documentation & safety requirements updated

*POCO=Post Operation Clean Out

Orano GmbH Reactor D&D Competence Center

In 2017 Orano has turned the former “AREVA’s Back-End Germany” into a subsidiary which regroups all the qualified engineering forces, the patents, projects references and the qualified tools dedicated to Reactor D&D in the frame of the German Phase Out

Core competences

- Support during post-closure phase / deregulation
- D&D engineering services and licensing support
- Radiological characterization and nuclear measurement
- Radiological calculations
- Project- and site-management
- Segmentation of components (RPV, RPVI, Core equipment)
- Documentation



D&D activities worldwide

Germany:

- Stade
- Würgassen
- Isar
- Krümmel
- Biblis
- Brunsbüttel
- Neckarwestheim
- Philippsburg

Sweden:

- Svafo
- Ågesta



Switzerland:

- Mühleberg

Spain:

- Trillo

Netherlands:

- Pallas

France

USA:

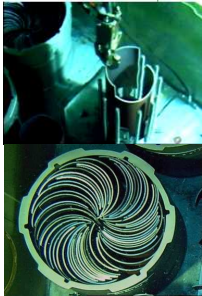
- Vermont Yankee

Japan:

- Mihama
- Fukushima
- Ikata
- Genkai
- Hamaoka
- Tokai



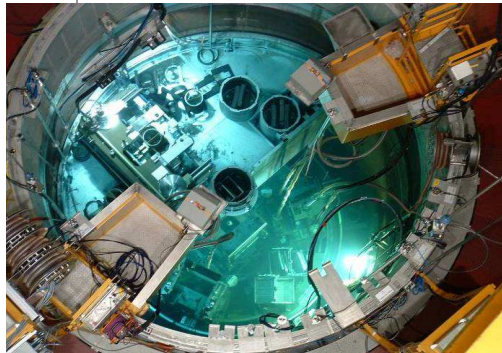
RPV and RPVI Segmentation



control rod guide tubes (nibbling)

The value of ORANO experience is the minimization of the waste cost through an integrated waste management scheme:

- Starting from sampling technologies and strategies
- Reconstruction of activation and contamination map of RPVI and RPV
- Clever segmentation plan (3D virtual mockup) to find the best cut operation versus pieces ratio
- Smart waste management reducing higher activity inventories and minimizing waste containers filling



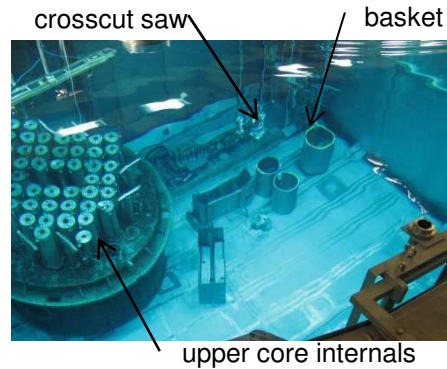
Cutting and Packaging in situ



first cut on core shroud



last cut of an ejector pump retainer



Stadt (PWR)

- Remote controlled underwater segmentation and packing
- Segmentation in pool and inside RPV
- Total mass of 85 t

Customer benefits

- 19% reduction of shielded casks
- Collective dose as low as specified
- No work accident
- Completion according to project specifications (quality, time, budget)

Wurgässen (BWR)

- Remote controlled underwater segmentation and packing
- Segmentation in pool and inside RPV
- Total mass: 160 t Internals and 320 t RPV

Customer benefits

- 9% reduction of containers
- Collective dose as low as specified
- No work accident
- Completion according to project specifications (quality, time, budget)

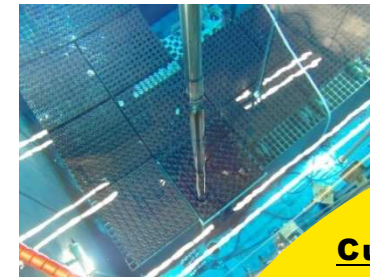
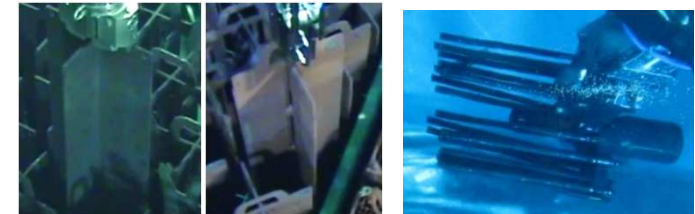
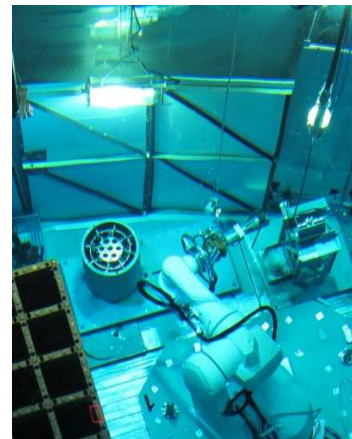
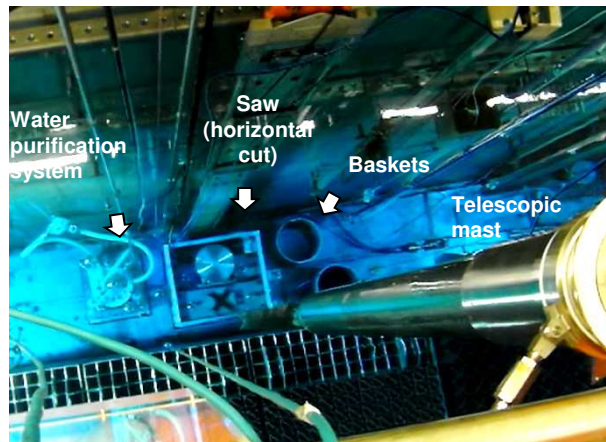
This effective segmentation and waste management knowledge and experiences is available for both BWR, PWR and Research Reactor D&D

Core Waste Processing

Core Waste can be conditioned before the utility gets the license for decommissioning

Advanced, Customized and proven technologies and experienced personnel

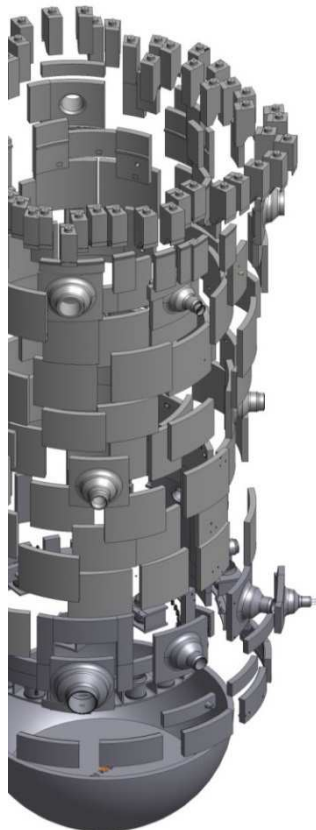
Innovative Solutions: qualified underwater robot system



Customer benefit

- **High packaging density**
- **Compact & flexible usable equipment**
- **Small footprint and short execution time**

Experience gained in Germany is being deployed in the US



Nuclear Reactor	Type	Size	Segmentation	Packaging	Dismantling	Waste Mgmt
Connecticut Yankee	PWR	619 MWe	X		X	X
Maine Yankee	PWR	900 MWe	X	X		X
Millstone 1	BWR	660 MWe	X	X	X	X
Rancho Seco	PWR	918 MWe	X	X		X
Stade	PWR	640 MWe	X	X	X	
Wuergassen	BWR	640 MWe	X	X	X	
Yankee Rowe	PWR	180 MWe	X		X	X
Vermont Yankee	BWR	620 MWe	X	X	X	X

Orano is leveraging successful project experiences to propose solutions in response to WW utilities needs

Developing specific solutions for field operations adaptable to different markets



Abrasive Water Jet

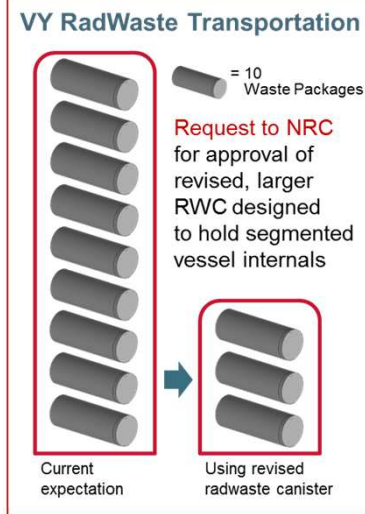


Underwater Band Saw



Cut Pieces in Storage Container

Developing Technologies & Systems Segmentation & Dismantling technology



Optimizing waste volume

R&D Programs Underwater Robotic AZURo R&D

General task

Qualification of standard robot hardware for (semi-) automated application in the field of service, dismantling, measuring of RPV (NSSS)

Common R&D project



VORWEG GEHEN



Application at NPP Biblis B (spent fuel pool) 2015

Sorting of CR heads
Sorting of flow limiters
Segmentation and Sorting of core instrumentation



**Accelerating execution (dose reduction)
Improving quality and standardization
Reducing costs**

Orano Research Reactor Decommissioning Experience

PHEBUS – Cadarache/France – 2008 to 2010

- Former research reactor
- Decontamination & dismantling of reactor internal test circuits
- High operator dosimetry challenge

PHENIX – Marcoule/ France – 2008 to now

- CEA- Experimental fast breeder reactor
- Scenario optimization, fuel unloading, investigations, preparation for DECOM..

SVAFO – Sweden – 2014-2015

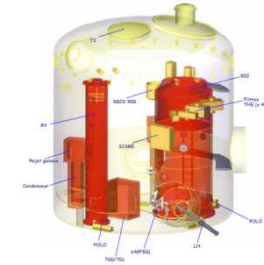
- 2 research reactors (60s-2005)
- Dismantling of reactors +waste management

ULYSSE – France – CEA -2016 to now

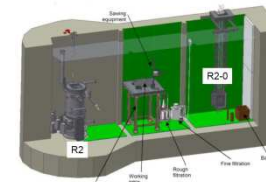
- 110 Kw power reactor operated 1967-2001
- Operation & maintenance of reactor under decommissioning
- Dismantling of reactor and all ancillary equipment
- Final decontamination and delicensing

As well as TRITON, EL3, PEGASE, MELUSINE, SCARABEE...

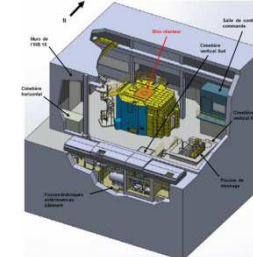
PHEBUS



SVAFO



ULYSSE



Conclusion

Orano has organized and deployed the final shutdown and post operation cleanout of several facilities, from reactors to entire fuel cycle sites, as a site owner or on behalf of a customer as a site operator/manager

Over the past thirty years, we have developed a huge experience in all the aspects of D&D Program Management, Facility Shutdown, Post Operation Clean Out, Decommissioning Preparation, D&D design and engineering, Execution work

The value in D&D is not created by the engineering of the D&D process but from operational experience and risk management which is Orano genome and which creates competitiveness

Orano has invested Ms of € to takeover the reactor D&D activities in Germany (incl. Patents, competencies, tools and equipment, commercial references etc.) and we are now developing this business World Wide

Orano expertise in D&D program management linked to our Reactor D&D competences and capabilities are key assets to support our clients to be successful managing their own D&D program

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