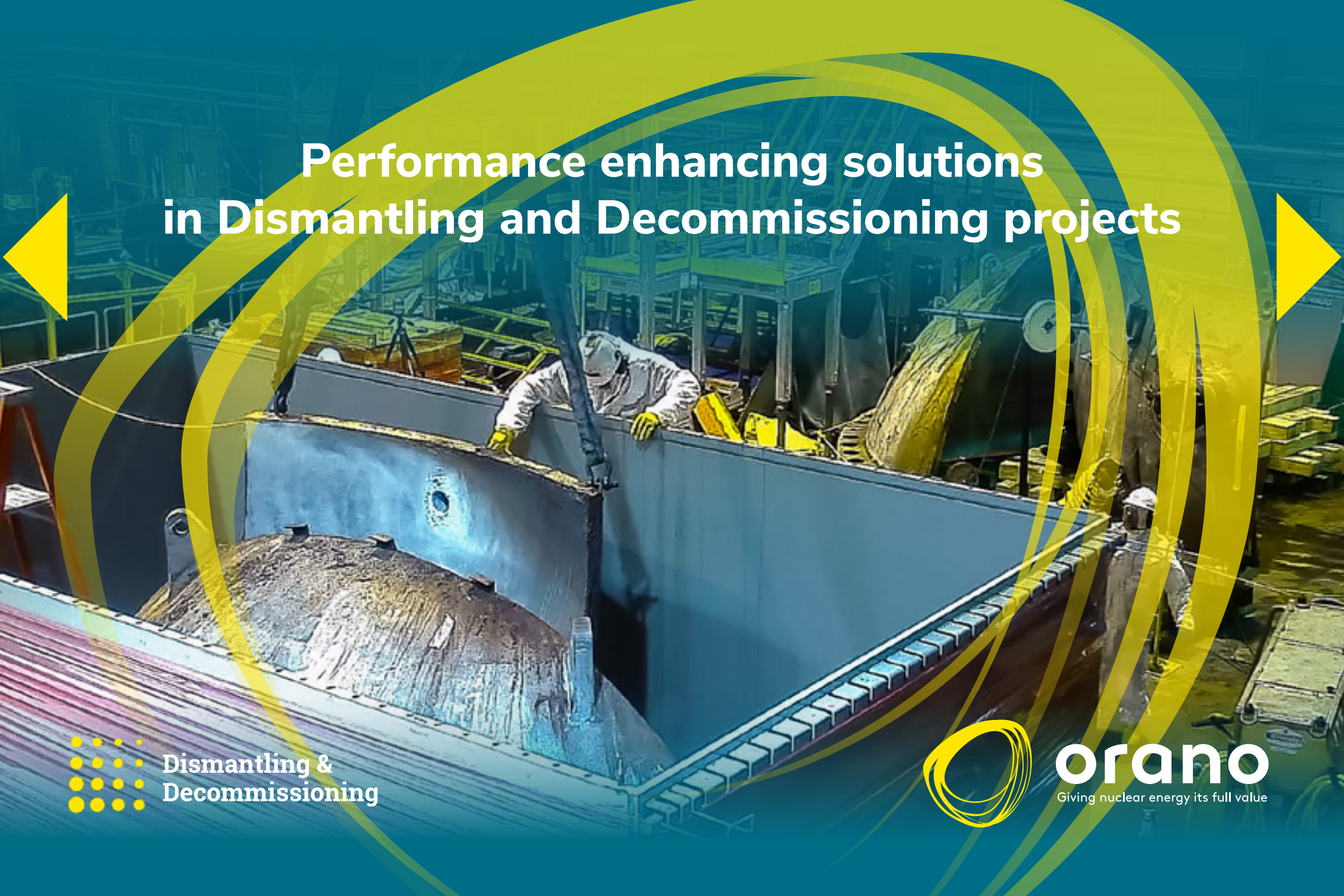
Performance enhancing solutions in Dismantling and Decommissioning projects



Dismantling & Decommissioning

orano
Giving nuclear energy its full value

Dismantling & Decommissioning

Leveraging from its 40 years of experience in the execution of complex projects, Orano delivers unique support for D&D preparation, training and operations.

The path to success for Dismantling and Decommissioning

After years of productive operations, dismantling and decommissioning projects require adaptation of processes in many areas: management, day-to-day activities, planning, budget, human resources, supply chain, risk management, almost every routines change.

Waste management - from characterization to disposal - becomes the main driver of project's milestones. It requires different expertise from nuclear operators' core business.

Developing strong partnerships between suppliers to achieve project' success is one of the cornerstones of Orano's approach.

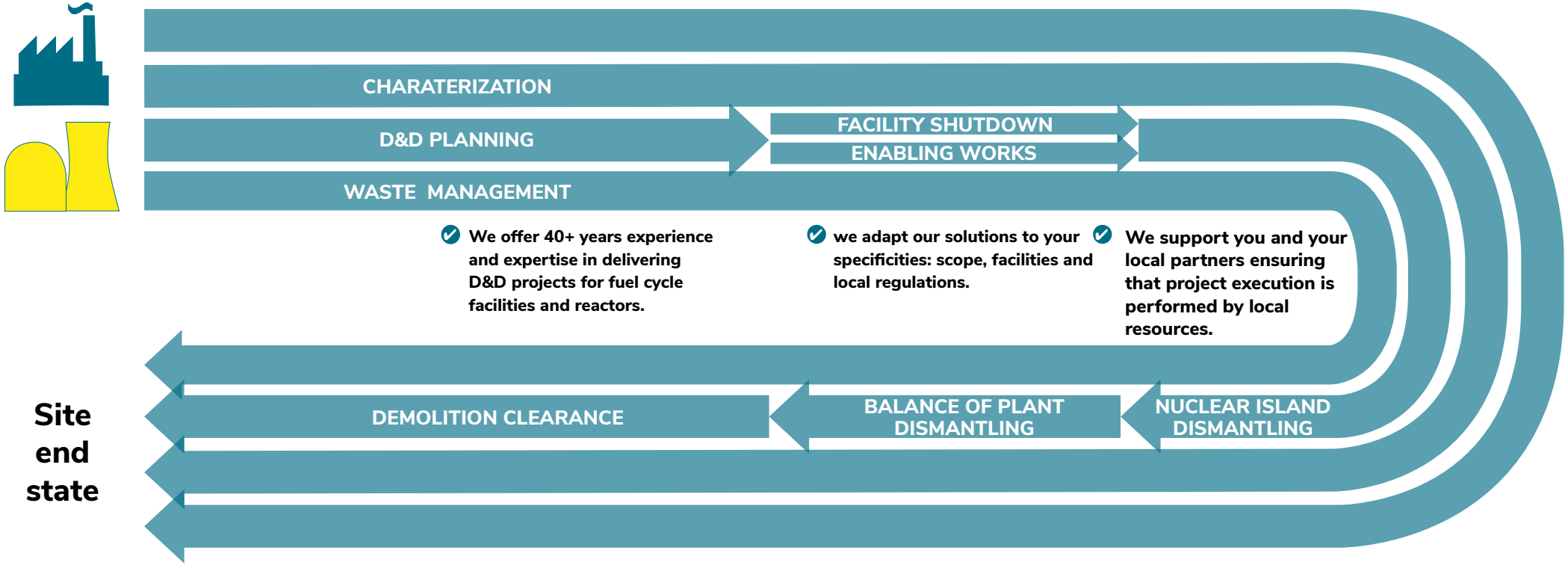
The highest level of performance in:

- **Safety**
- **Optimisation of financial provisions**
- **Project performance with certified solutions**
- **Definition of waste management routes up to final disposal**

Orano offers **agile** solutions and expertise from early stages for decommissioning services and waste management while minimizing risks. Backed with industrial **capabilities**, comprehensive expertise and international **track record** on **all kinds** of nuclear facilities and waste, Orano is by your side to deliver efficient projects.

Orano has designed, developed and implemented solutions ensuring a **responsible management**, both in terms of cost effectiveness and legacy to future generations, **in regular dialogue with safety authorities and disposal operators.**

Orano's added value for your D&D projects



Orano’s added value for your D&D projects

As a nuclear operator managing dismantling and waste provisions, Orano is project owner of D&D and waste management operations in France encompassing all the waste range, with sharp expertise for the most hazardous and unusual natures and situations.

Nuclear operators can rely on processes, expertise and solutions that the Group has already implemented its own sites, including lessons from the field for project optimization, series effect and best practices.

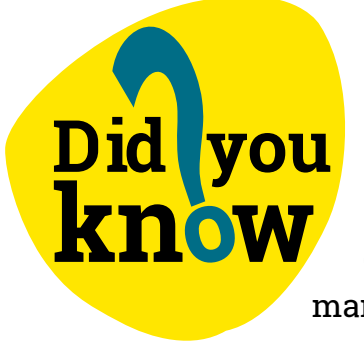
40+ years of experience

4,000 employees
working for D&D & waste management activities

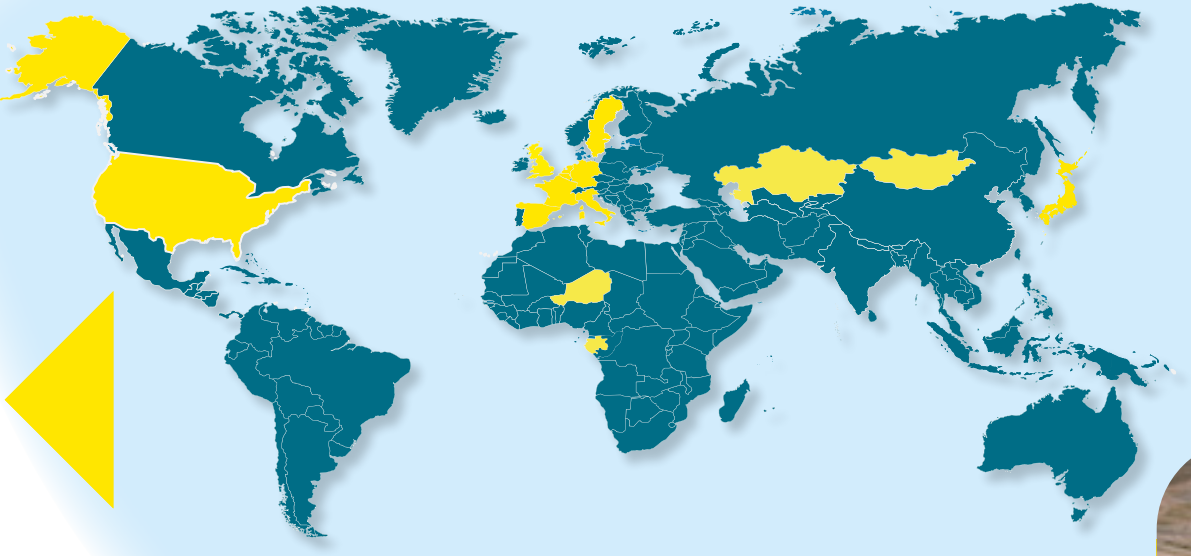
Over decades, our expertise has been successfully deployed worldwide to a comprehensive range of nuclear facilities, from the most complex nuclear laboratories to the largest commercial power plants, research reactors or military facilities.

Orano is part of decommissioning projects with continuously improving management.

.



Orano manages
13.3 B€
of D&D and Waste management provisions



We think globally, we deliver locally

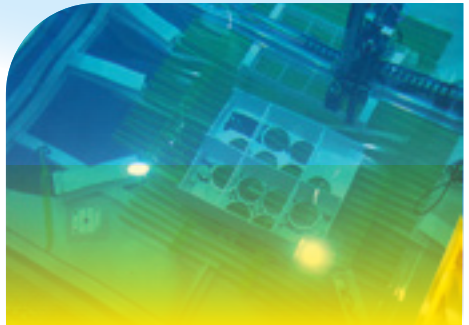
EDF: Brennelis, Bugey NPPs, Superphenix Sodium reactor

CEA: Cadarache, Saclay, Fontenay, UP1 (Marcoule)

Orano: Georges Besse 1, La Hague, SICN, Miramas, Comurhex,

Department of Energy (DoE) **Hanford Management** of legacy HLW retrieval operations tank

CEA Cadarache Pu facility: Pu contaminated residues and scraps

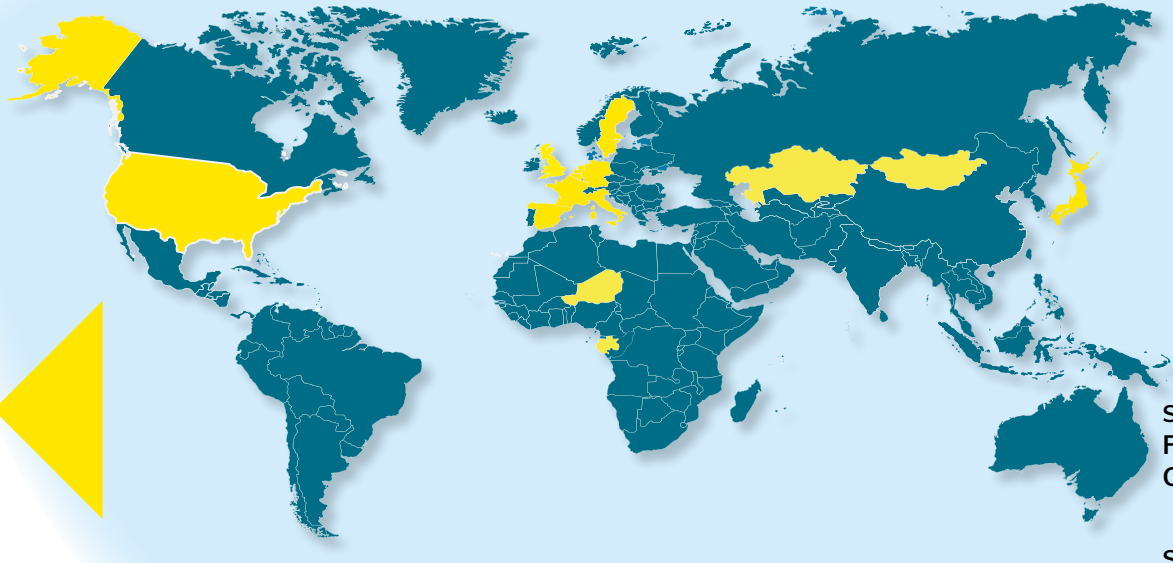


NorthStar Yankee NPP: RPV/RPVI IL/LLW segmentation, packaging & transport to disposal, ISFSI monitoring

DoE, **Savannah River Remediation** operations and maintenance of 243 HLW tanks located at the DoE complex

Orano **La Hague UP2-400** Waste management associated to D&D program; in situ interim storage or transport to disposal

Crystal River-3 NPP
Vermont Yankee NPP
Connecticut Yankee NPP
Maine Yankee NPP
Millstone NPP
Rancho Seco NPP
Yankee Rowe NPP
Oak Ridge National Laboratory
Handford Savannah River



We think globally, we deliver locally

SVAFO Research Reactor
Forsmark NPP
Oskarshamn NPP

Stade NPP
Würgassen NPP
Gundremmingen NPP
Braunschweig
Isar NPP
Krümmel NPP
Biblis NPP
Philippsburg NPP
Brünsbuttel NPP
Neckarwestheim NPP
Mülheim-Kärlich NPP

E.On **Stade NPP:** RPVI ILLW segmentation and conditioning

BR1 Research Reactor
MOL

Trillo NPP
Enresa ATC

NDA Sellafield Ltd
Dounreay Site Restoration Ltd (DSRL)
Magnox NPPs
Low Level Waste Repository Ltd
Radioactive Waste Management Ltd

Management of **Sellafield** legacy waste retrieval operations & process equipment in highly radioactive environment

Fukushima Tokai Reprocessing Plant

TEPCO, Fukushima: Contaminated water treatment solution, Fuel debris retrieval studies, severely damaged Fuel evacuation

Field Report: key facts

NorthStar Vermont Yankee Nuclear Power Plant RPV & RPVI segmentation and ISFSI monitoring, USA

Challenge

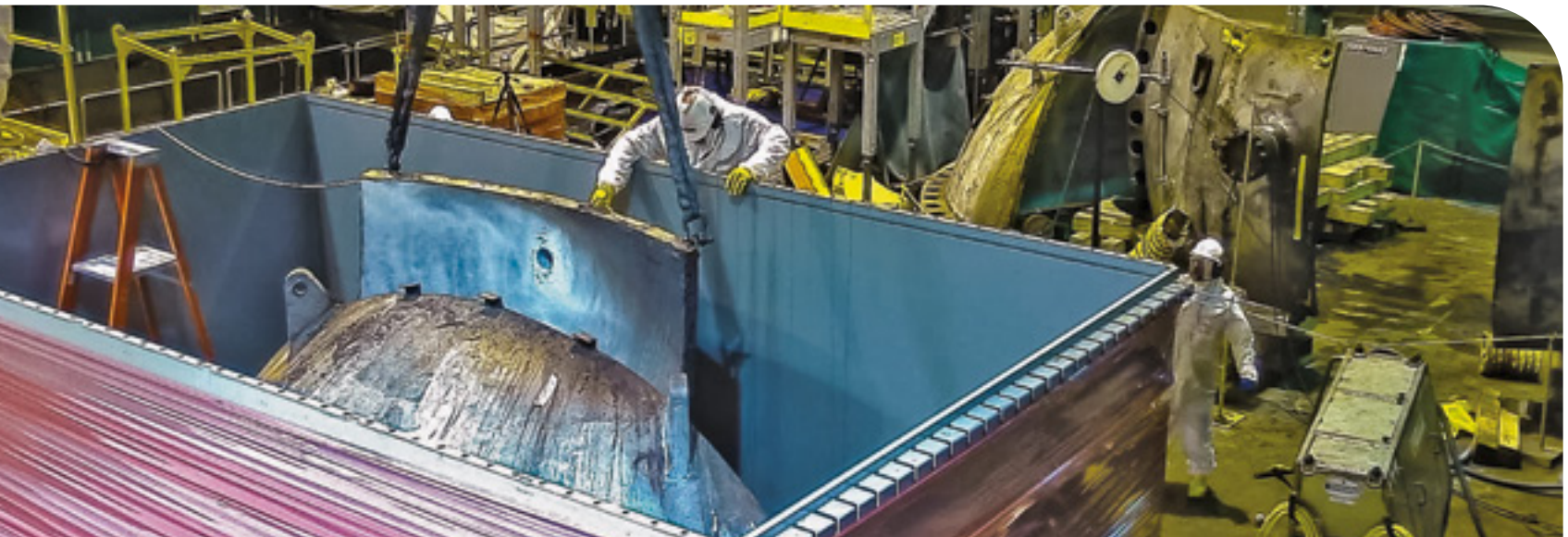
The deployment of a decommissioning schedule 4 decades earlier than orginally anticipated through an orginal organization led by our partner NorthStar. The NPP license associated with legacy and risks has been transfered from Entergy to NorthStar.

Orano is responsible for the segmentation of the reactor vessel (RPV) and internals (RPVI), in addition to the management of the Independent spent fuel storage installation (ISFSI). All operations must be deployed safely, on time, on budget, to secure the project's success.

Orano Value: Know-how in the managing the most active material

- Segmentation of RPV & RPVI
- Innovative large-size waste containers
- Transports to disposal site
- Cold Cutting technology
- Control Rod Blades crushing, packaging and transport
- ISFSI monitoring and interim storage ageing management

VIDEO



Benefits:

- Field-proven segmentation and water purification systems
- Segmentation activities ahead of schedule
- Minimized waste footprint
- Reduced number of transports
- Leading expertise in used fuel interim storage: 1,500+ systems operating worldwide.

Field Report: key facts

CEA Plutonium technology workshop (ATPu) and chemical purification laboratory (LPC), France

VIDEO

Challenge

At the start of the project, a reported incident, level 2 on INES scale, has been an additional challenge to manage this complex project.

The initial characterization has shown in 2009 an underestimation of the quantity of fissile material. This event was the occasion to improve processes, methodologies and levers for performance on this project covering 2 facilities with 60 cells.

Orano Value: Proven and flexible solutions for optimized perfomance

Despite difficult conditions, Orano has performed all regulatory and public steps with an adapted schedule supported by a constant transparency with stakeholders.

Orano has completed the dismantling and clean-up operations (2009-16, 500M€) of unprecedented scale Plutonium facilities from former CEA's MOX fuel fabrication plant

Benefits:

- **Proven methodologies and experience able to adapt to underestimated conditions.**
- **Unprecedented amount of highly contaminated cells : 500 glove boxes, 30 casemates, of which 5 bituminized and 30,000 wastepackages ready for repository.**
- **Thousands of operations in redzone with 80% of annual dose below 1mSv**
- **500M€ project involving 300 people of which 120 Orano experts.**

Field Report: key facts

La Hague High Oxyde Activity (HAO) workshop reprocessing Plant, France

Challenge

The major challenge of this dismantling project relies on the retrieval and separation of different kind of waste from the used fuel shearing and dissolution activities: used ion-exchange resins, fines like insoluble fission products and pieces of Zircaloy, stainless steel, hulls and end pieces.

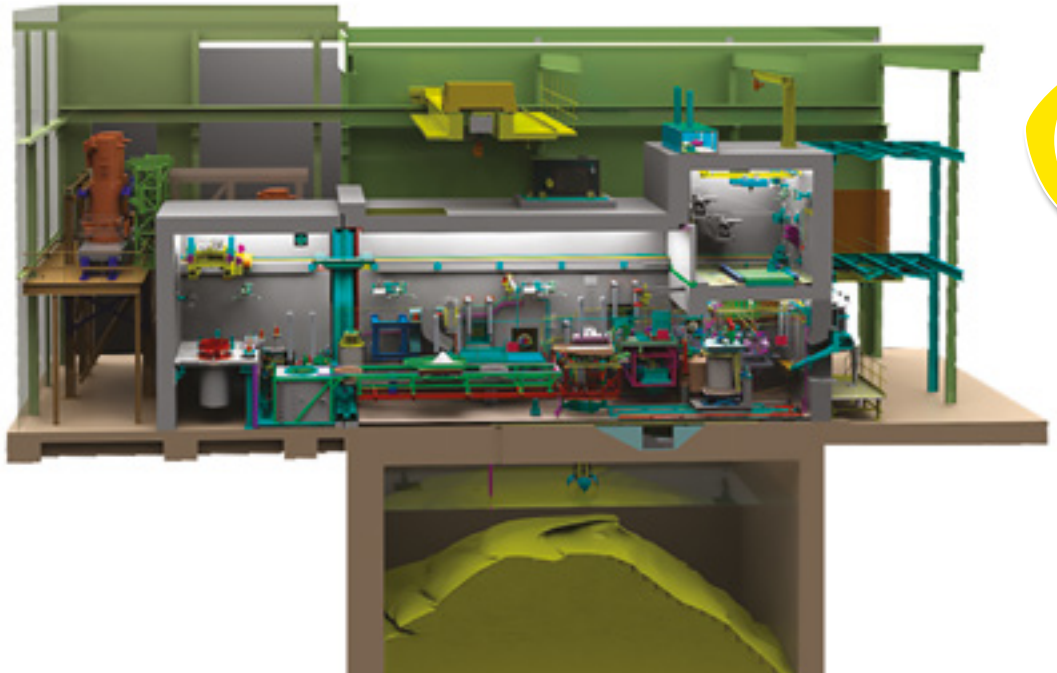
Benefits:

- **Complete studies to robust projects' directions:**
  - **Scenarios**
  - **Costing**
  - **Financial flow**
  - **Planning**
- **Risk and opportunity management**
- **Back up options to absorb unexpected events**

Orano Value: Proven and flexible solutions for optimized perfomance

Upstream to the deployment of the dismantling project, Orano has delivered:

- Complete cost evaluation including primary, secondary waste and effluent.
- Provisions' evaluation for risk management
- Cost definition of action plans
- Gain tracking and REX integration along the engineering studies' progress
- Planning and safety milestones' requirements
- Risk management



VIDEO

Field Report: key facts

VIDEO

~~Vattenfall Brunsbüttel~~ NPP, dismantling and packaging for final storage of RPV Internals and core waste in consortium with EWN~~, Germany~~

Challenge

In the context of intense dismantling program in Germany since 2011, in consortium with EWN, Orano has been selected for dismantling activities at Biblis, Brunsbüttel, Neckarwestheim, Philippsburg 2 and Mülheim-Kärlich NPPs, further to projects before 2015 (~~Grundremmingen,~~ Stade, Würgassen). The challenge was to pioneer the dismantling of controlled areas in Germany and more recently to perform several parallel projects in a tight schedule, both on PWR and BWR designs.

Benefits:

- Engineering studies leading to optimized operations
- Underwater works reducing dose to operators
- Proven robotic solution (AZURo) with experienced operators
- Flexible segmentation techniques minimizing secondary waste
- Arrangement of segmented parts in the conditioning solution for minimized footprint

Orano Value: Experience and proven solutions serving project's performance

Orano has performed the remote controlled underwater segmentation and packaging of RPVI~~, RPV~~ and core waste:

- studies and strategy consolidation segmentation in reactor cavity, spent fuel pool and in-situ in RPV
- segmentation among others with under water robot
- total mass of internals: ca. 180 t
- documentation for interim and final storage
- Risk management

Field Report: key facts

Waste management Program for dismantling the Redundant Active Handling Facility (RAHF) at Sellafield, United Kingdom

Challenge

The Redundant Active Handling Facility (RAHF), also known as B14 had to be dismantled. This facility was used for the treatment of used fuels with about 100 workshops and hot cells, with radioactivity up to 300 mSv/h.

Critical requirements:

- Waste characterization, investigations and route definition
- Evacuation of a significant number of hot cells with unknow waste stored inside
- Optimized scenario definition, strategy and associated costs and planning up to NDA approval
- Design and first operational steps

Orano value: Lessons Learned from Experience (LFE) gained from past projects

Benefits:

- Orano's macro decommissioning scenario tool, LEOPARD to provide outputs such as cell data sheets and inventories
- Baseline scenario definition based on waste quantity and type

Field Report: key facts

TEPCO Fukushima remediation and cleanup operations, Japan

VIDEO

Challenge

The cleanup and remediation at Fukushima Daiichi requires first-of-a-kind and diversified operations with a large range of waste in a constrained environment.

Among critical requirements regarding waste retrieval, treatment and conditioning:

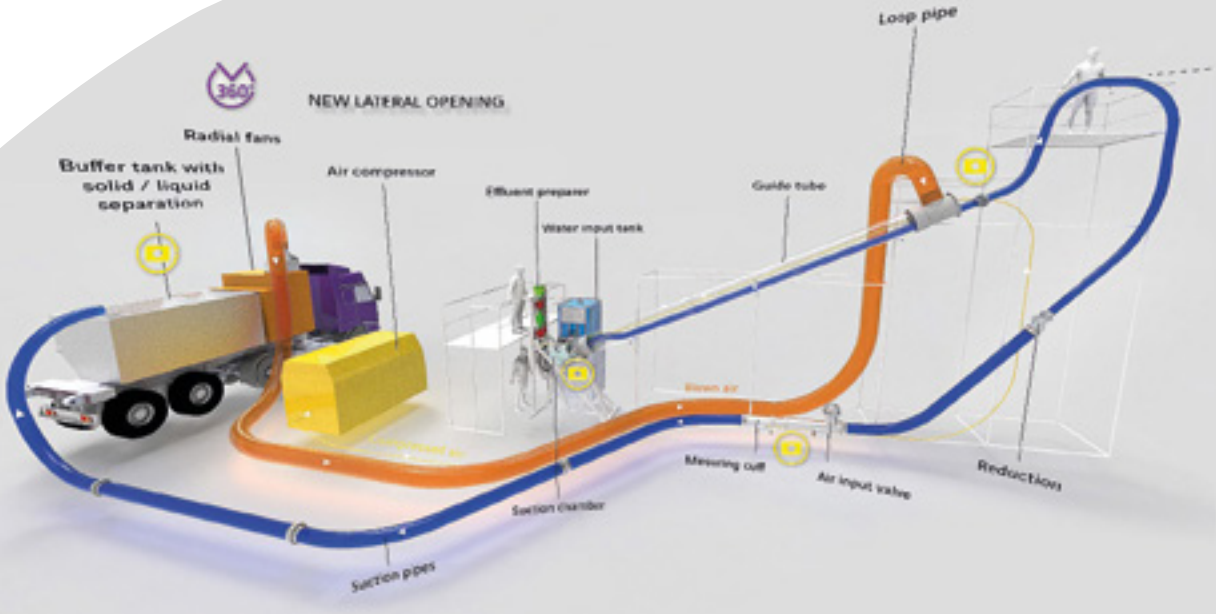
- Engineering for waste access and evacuation (corium and used fuel)
- Innovative technologies to address complex and unique situations
- Project execution in coordination with key partners, such as Mitsubishi Heavy Industries (MHI)

Orano value: customized technology solutions based on proven concepts

- Engineering support for New Lateral Opening (NLO)
- System design for secondary waste to access corium
- Full-scale model of the solution for demonstration
- Engineering and procurement of used fuel casks for the removal of potentially contaminated assemblies.

Benefits:

- Studies, probes and tests of a corium sampling solution
- Effluent vacuum of the pieces of concrete and steel
- Immersive interface solution, providing the customer with a virtual reality headset pre-loaded with the 360° video
- Safe and efficient solution by utilizing MX6 casks, originally designed for the transport of fresh MOX Fuels.



Field Report: key facts

CEA, Dismantling of two used fuel storage pools, France

Challenge

Orano DS has been awarded at Marcoule to dismantle the entirety of the stainless steel walls and metal structure of the two former used fuel interim storage pools in the south-east of France. One of the largest dismantling projects of its type carried out in France, this project, of four years, will include technical studies and the performance of dismantling operations.

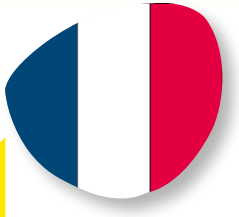
Benefits:

- Integrated solution endorsing associated risks and responsibility
- Engineering studies optimizing safety, costs and planning
- Innovative equipment sized to the project's dimensions.
- Tests, qualification and documentation of the project

Orano Value: Performing engineering and field activities

Studies and are to be performed by Orano: 15 workers and innovative technologies for this type of worksite - the largest remote cutting machine on the market - and controlled remotely are to minimize the radiological exposure of operators and optimizing the planning. The elements will then be sorted according to radiological activities, conditioned and removed to an approved waste disposal center.

Field Report: key facts



CEA Ulysse research reactor dismantling, France

Challenge

CEA Ulysse research reactor (100 kW) has operated for 41 years till 2007 for the training and experimentation under neutronic flux. It has required the construction of new equipment such as the ventilation system and the removal of asbestos that needed specific processes.

This project was unique as the Ulysse reactor was a specific design requiring a customized approach and tools.

Orano Value: Proven and flexible solutions for optimized perfomance

Orano has been selected as technical operator of the project by the CEA to manage the dismantling operations. They required the management of 420 tons of conventional waste and 170 tons of radioactive waste (VLLW): metal, graphite, concrete mainly.

The project has encompassed the reactor pool, casemates, pits with activated materials, with associated equipment.

Benefits:

- One-of-a-kind project performed in due time according to the French Safety Authority's requirements.
- CEA has been delivered with the 3 lots (conventional and nuclear dismantling, cleanup) by Orano...
- ... in addition to all associated safety and project's documentation

Operational excellence driven by innovative and proven technologies

Characterization & Investigation modules designed to work in any environment, maximize safety

The Challenges

Tailored-made characterization equipment and processes combined with proven experience are key success factors for operational performance in a waste management project. Decades of field experience have enabled Orano to develop ready-made solutions for your facilities and achieve project success.

Here are some examples:

VIDEO

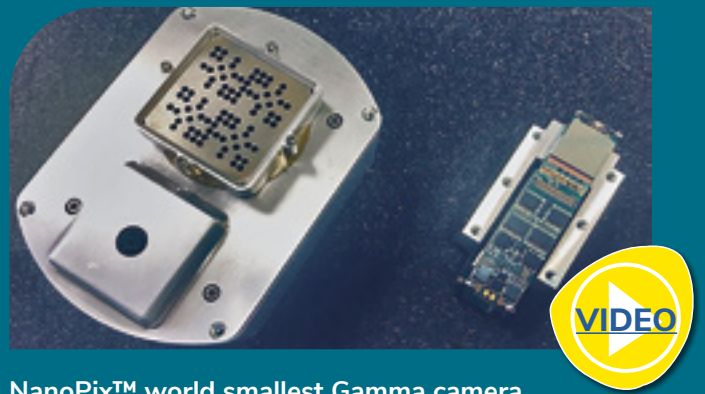
The Solutions

ORANEF™ Drones augment operators in Zone 4: time saving and reduced costs

MANUELA™ 3D radiological and topographical mapping

RIANA SC™ radiological mapping of underside of containers

MARA™ screen for mapping large areas using augmented reality: ALARA, quality and simplicity



NanoPix™ world smallest Gamma camera (8x5x4.5 cm) for tiny areas

RFID application for package tracking: safety, traceability and performance

Operational excellence driven by innovative and proven technologies

Decontamination to minimize final waste footprint

The Challenges

By isolating the waste pellicle from components to facilitate the segmentation process, decontamination allows the minimization of secondary waste and the optimization of decommissioning operations. Orano has developed a comprehensive range of proven solutions. These solutions are constantly improved in a continuous progress approach with the right level of innovation to minimize costs.

The Solutions

Single component Strippable resins

The sprayable resin forms a strippable film after crosslinking. When removed, this film keeps the contaminated material while protecting equipment and work area. In addition, surfaces are contained and sealed to facilitate the dismantling operations.

VIDEO

ICLAREC II

Simple, adaptable and multi-function technology allowing the clarification of pools' water, the skimming of water surface and the retrieval of solid elements from the bottom of the pool.

Laser decontamination

is a dry process based on the interaction of a Laser irradiation with the superficial part of a structure (oxide layer, coating, paint, etc.). It leads to the surface preparation before non destructive examination (NDE) and a safe, efficient decontamination with no production of liquid effluent.

Operational excellence driven by innovative and proven technologies

Innovative sampling technologies for optimized characterization

The Challenges

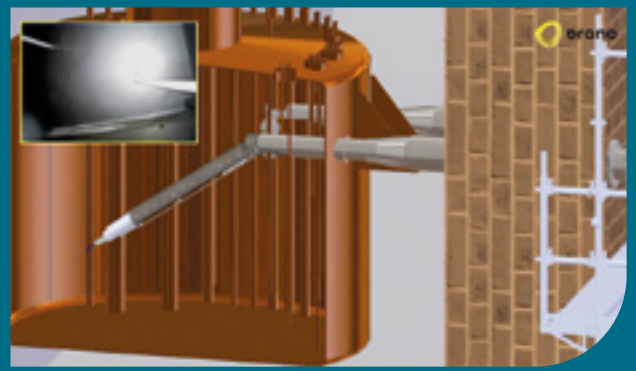
Sampling is a critical operation leading to the necessary characterization of equipment and material before the dismantling operations. Incorrect sampling leads to non-representative characterization or worse, with serious consequences on the project's performances, costs and planning.

The Solutions

Orano masters the 4 technical elements critical to ensure a successful sampling operation, i.e.:

- The sampling tool adapted to the nature of the sample to be collected, as well as the environment (access, carrier...) that will bring the sampler to the sample collection area
- The sampler carrying device bridging the gap between the sample location and the working area where the operators will collect and transfer the sample
- The access to the sampling area, if required, considering safety aspects of ventilation and confinement
- The sample transfer and transport interface adjusted according to the sample nature and dose rate.

Orano provides the manufacturing & supply of equipment developed and proven on delivered projects, with appropriate documentation. We provide equipment specification and manufacturing based on surrogates (inactive sample simulants) adapted to the description of your sampling environment. We also conduct factory acceptance tests will with customer at delivery, along with the training on the use of equipment can be proposed as well.



Operational excellence driven by innovative and proven technologies

Simulations and Training

The Challenges

Dismantling operations are complex operations which are carried out in constrained environments which require upstream preparation to ensure operations under optimal security / reliability conditions.

In order to reduce the risks and prepare the workers in the conditions closest to the field, Orano put its expertise of operator and supplier to good use for the development of training modules in virtual reality responding to the need to secure the intervention while adapting to the specifics features of each of them.

Orano supports you !

- Training sessions for your teams
- Realization of services and scenarios on demand
- Monitoring and traceability of interventions carried out

The Solutions

Sensitive activity simulator

Preparation for the plating operations at the bottom of a swimming pool in an environment as close as possible to reality: integration of hazards, awareness of radiological risks, stress and time management.

Serious games

Training on targeted themes (quality, safety, security, jobs, etc.) allowing employees to assimilate the right actions when faced with risky situations.

Transition from operations to decommissioning activities

Customized solutions to help your team get the most proven methodologies in performing a decommissioning project or program.

Operational excellence driven by innovative and proven technologies

AZURo Automated cutting of reactor pressure vessel internals using underwater robot technology

VIDEO

The Challenges

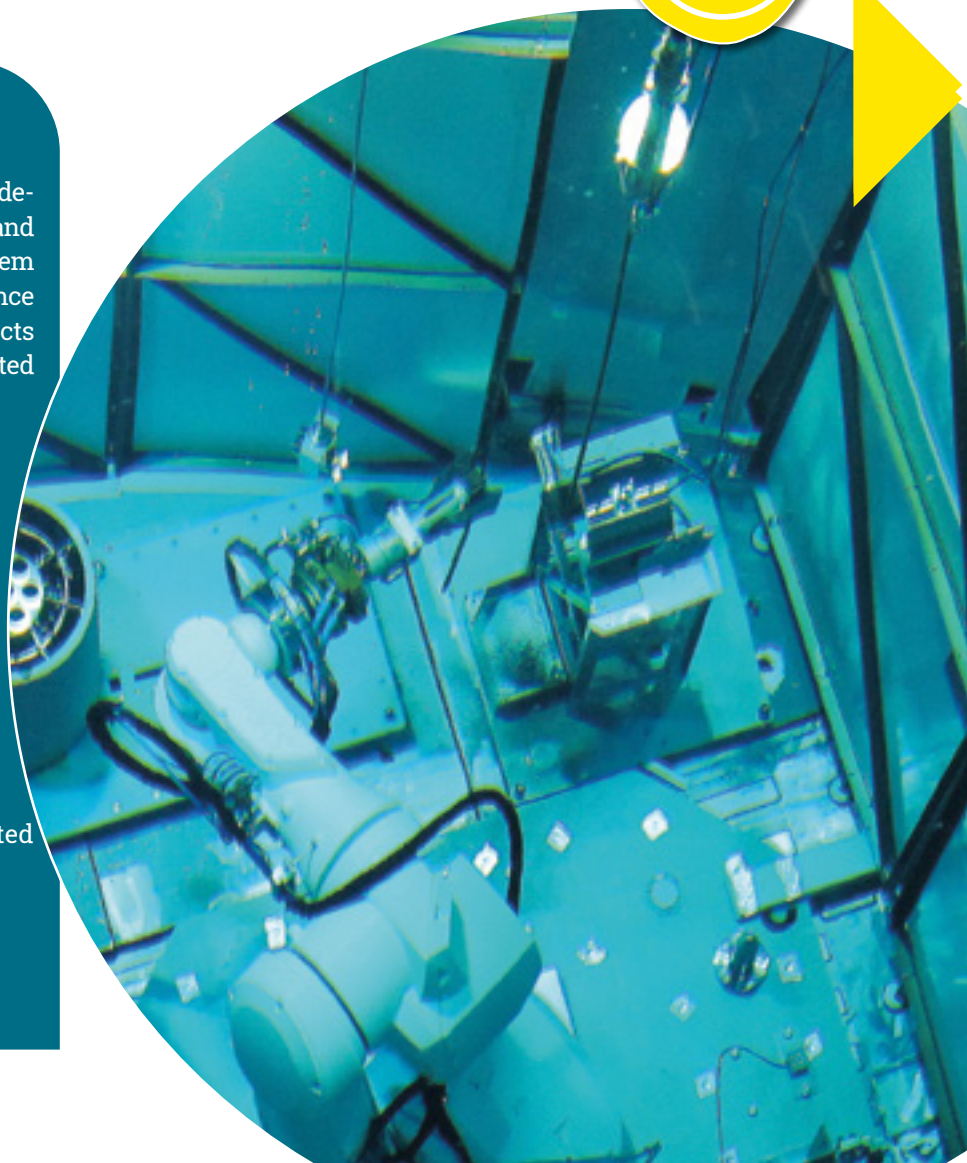
When nuclear power plants are dismantled, the cutting and packaging of the reactor pressure vessel takes place underwater for radiological reasons. This work largely involves frequently repetitive routine activities, yet requiring flexibility and modularity. Robotics offers significant benefits to improve project performance and safety, but requires the combination of specific expertise in automation systems and nuclear operations.

The Solutions

Orano and its partner have developed, qualified, tested and operated an underwater system that has proven its excellence through several D&D projects in Germany and in the United States.

Significant benefits:

- Reduced dose rate for personnel (ALARA)
- High flexibility and easy handling of a modern industrial robot
- High reliability of an industrial robot
- Accelerated performance
- High quality standard by standardized and automated handling
- Reduced cost




✔ Safety
✔ Cost effectiveness
✔ Project performance
✔ Project acceptance
✔ Proven solutions
✔ Risk mitigation