

Orano transforms nuclear materials so that they can be used to support the development of society, first and foremost in the field of energy.

The group offers products and services with high added value throughout the entire nuclear fuel cycle, from raw materials to waste treatment. Its activities, from mining to dismantling, as well as in conversion, enrichment, recycling, logistics and engineering, contribute to the production of low carbon electricity.

Orano and its 16,000 employees bring to bear their expertise and their mastery of cutting-edge technology, as well as their permanent search for innovation and unwavering dedication to safety, to serve their customers in France and abroad.

Orano, giving nuclear its full value.

Let's talk more about it; join us on



orano

Giving nuclear energy its full value

Business corporation with a Board Directors. Capital of 118,868,750 euros

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Energy is our future. Don't waste it!

**Securing complex projects
of waste management with
customized and proven solutions**



**Waste
management**



orano

Giving nuclear energy its full value

Your partner for complex waste management projects

- ✓ Compliance with Waste Acceptance Criteria
- ✓ Footprint, cost and risks reduction
- ✓ Solution's Robustness on the very long term
- ✓ Comprehensive safety
- ✓ Operation and Planning Excellence
- ✓ Efficient Waste management strategy



Waste management

Securing your assets with optimized waste management

Whatever the waste's nature and the project's complexity, nuclear operators aim at securing management of waste inventories while minimizing risks & volumes to benefit industrial assets. We support **complex projects** with continuously improving management based on 40 years of experience targeting:

- Waste acceptance criteria compliance
- Volumes and Costs reduction
- Robust solutions
- Comprehensive safety
- Operation and Planning Excellence

Safety, minimized footprint & costs

Proven compact & certified **conditioning** solutions for the very long term

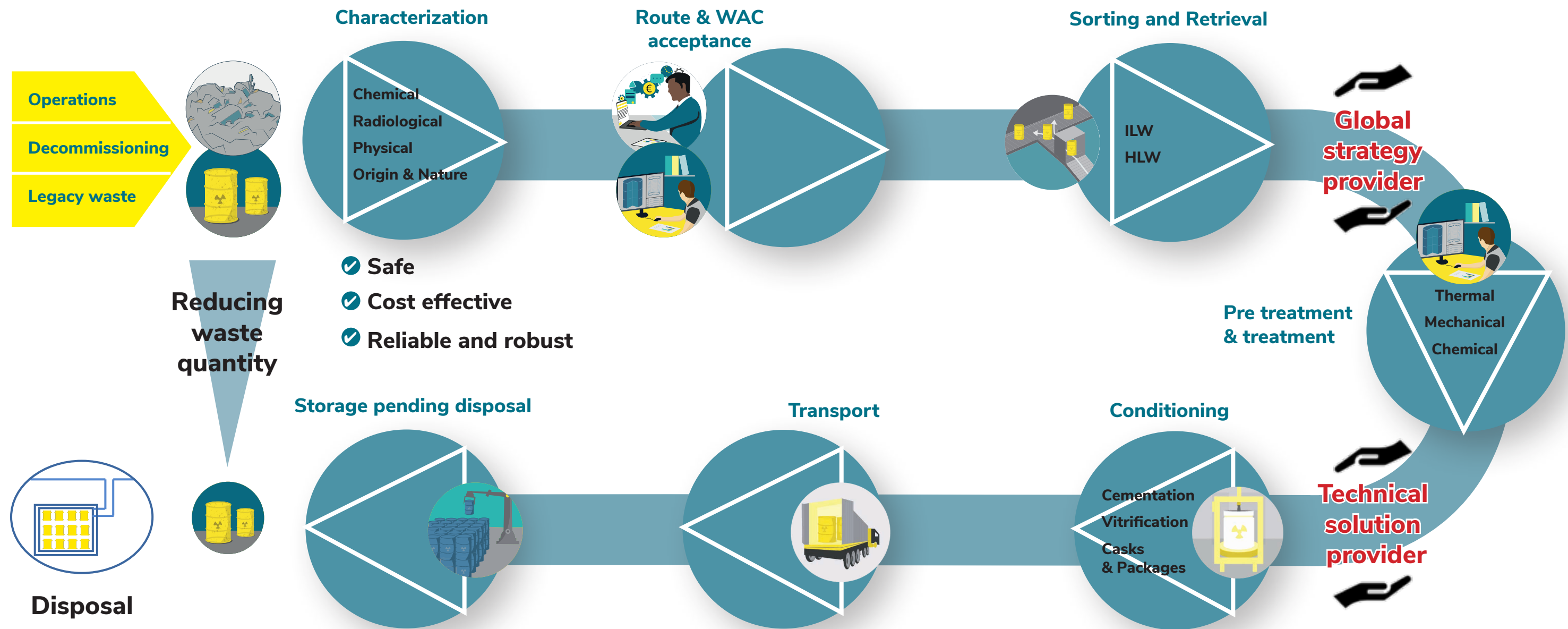
Defined management paths up through disposal: a complex balance only achieved by a significant range of expertise.

We bring nuclear operators our **unique track records on the most complex waste management project with demonstrated benefits.**

To reduce your risks, Orano offers an **integrated and modular** range of solutions for waste, from your D&D projects or from operations. Backed with industrial capabilities, comprehensive expertise and international **references** with **all kinds** of nuclear facilities and waste, Orano has built a global offer for the most complex environments on operational excellence.

Through continuous engagement, Orano has responsibly applied its solutions, both in terms of cost effectiveness and legacy to future generations, **in constant interaction with safety authorities and disposal operators.**

Orano's added value in waste management program



Did you know

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

As a nuclear operator managing waste and provisions, Orano is the project owner of D&D and waste management operations in France. They encompass the entire waste range, with sharp expertise in the most hazardous and unusual natures and situations. We bring this global expertise to your sites.

Since the beginning of our nuclear activities, we have integrated waste management, developed innovative solutions and helped nuclear operators comply with the waste acceptance criterias (WAC).

100% of HLW
destined for
underground disposal
in France is
conditioned by Orano
(80% considering all types
of waste)

40 Nuclear sites
benefit from
Orano waste management
solutions

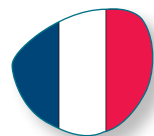
Orano contributes
to solutions for
50% of waste
with undefined
routes

As a nuclear fuel cycle specialist, from the front end to the back end through all transport and conditioning activities, we have combined focusing specialties into a global and high-level knowledge base available to nuclear operators worldwide.

Orano is one of the pillars of the deployment of waste management in France with global capabilities ready to support you at any step of the waste management strategy.

Worldwide references & capabilities

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



EDF: Brennelis, Bugey NPPs,
Superphenix Sodium reactor

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

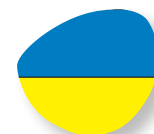
Orano: Georges Besse 1, La
Hague, SICN, Miramas, Comurhex,



Central Organization
for Radioactive
Waste (COVRA)



EnergAtom



BR1 Research
Reactor
MOL



Trillo NPP
Enresa ATC



SVAFO Research Reactor
Forsmark NPP
Oskarshamn NPP



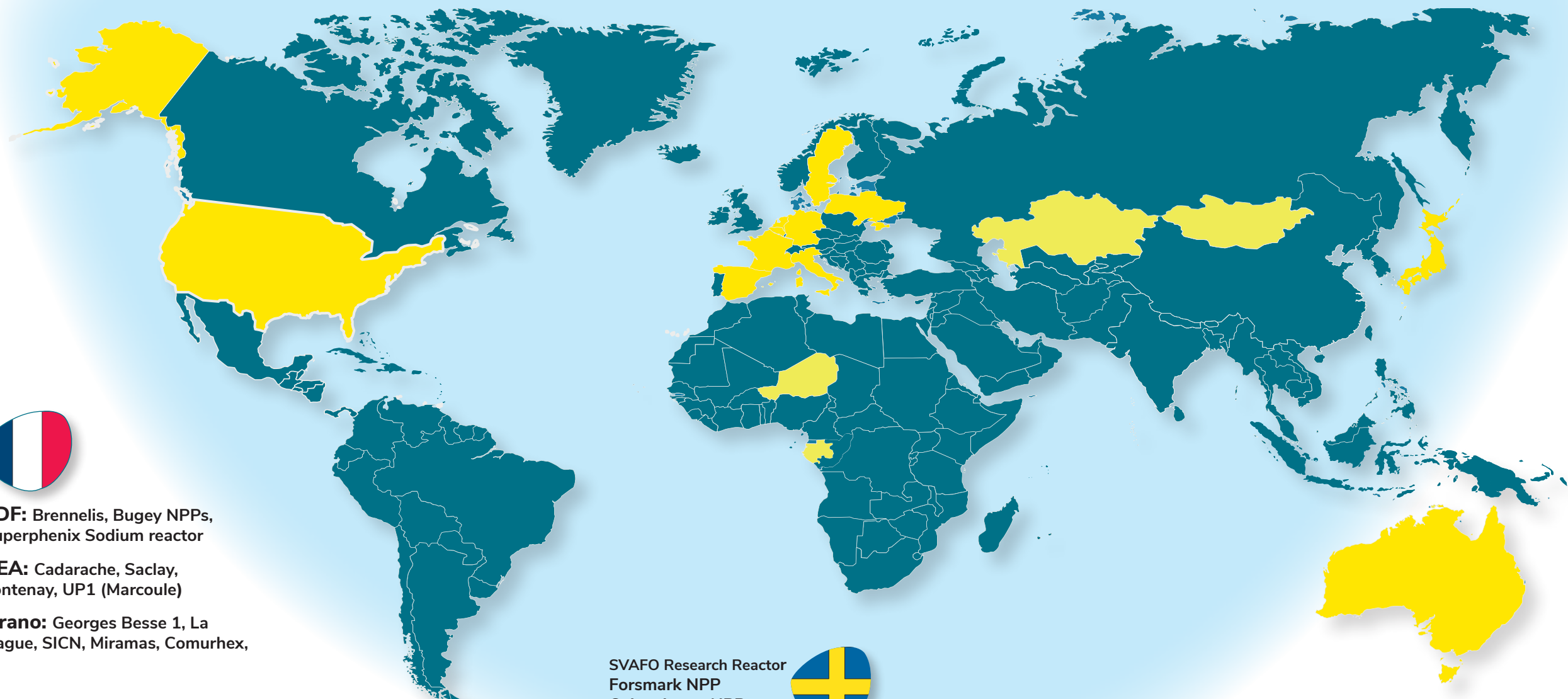
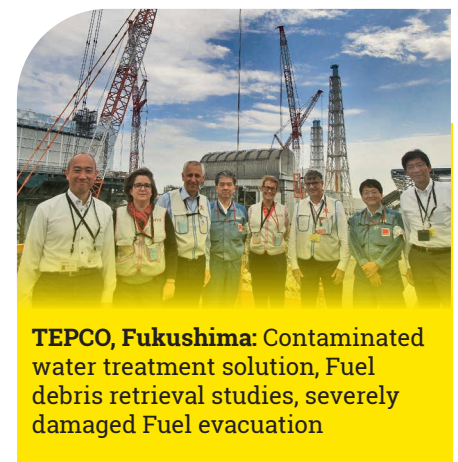
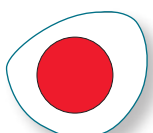
Stade NPP
Würgassen NPP
Gundremmingen NPP
Braunschweig
Isar NPP
Krümmel NPP
Biblis NPP
Philippsburg NPP
Brünsbittel NPP
Neckarwestheim NPP
Mülheim-Kärlich NPP



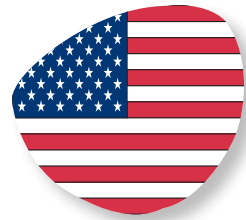
NDA Sellafield Ltd
Dounreay Site Restoration Ltd (DSRL)
Magnox NPPs
Low Level Waste Repository Ltd
Radioactive Waste Management Ltd



**Fukushima Tokai Reprocessing
Plant**



Field Report: key facts



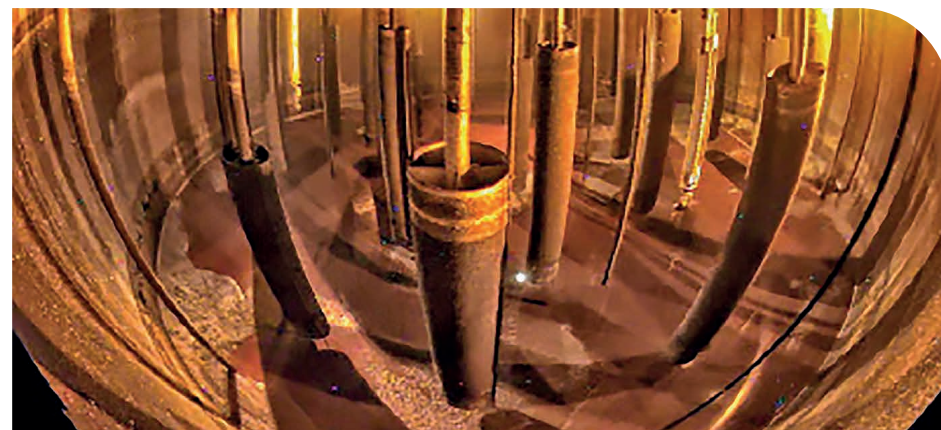
US Department of Energy Hanford AY-102 Recovery Project (management of legacy waste and retrieval), USA

Challenge

A leak was discovered in tank AY-102's primary liner in one of Hanford's double-walled underground storage tanks, containing radioactive liquid and sludge.

Critical requirements:

- Retrieval of highly toxic and radioactive liquid and sludge
- Engineering
- Procurement
- Construction
- Remotely operated waste retrieval and transfer system
- Unprecedented execution timeframe

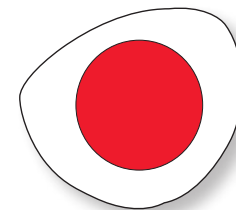
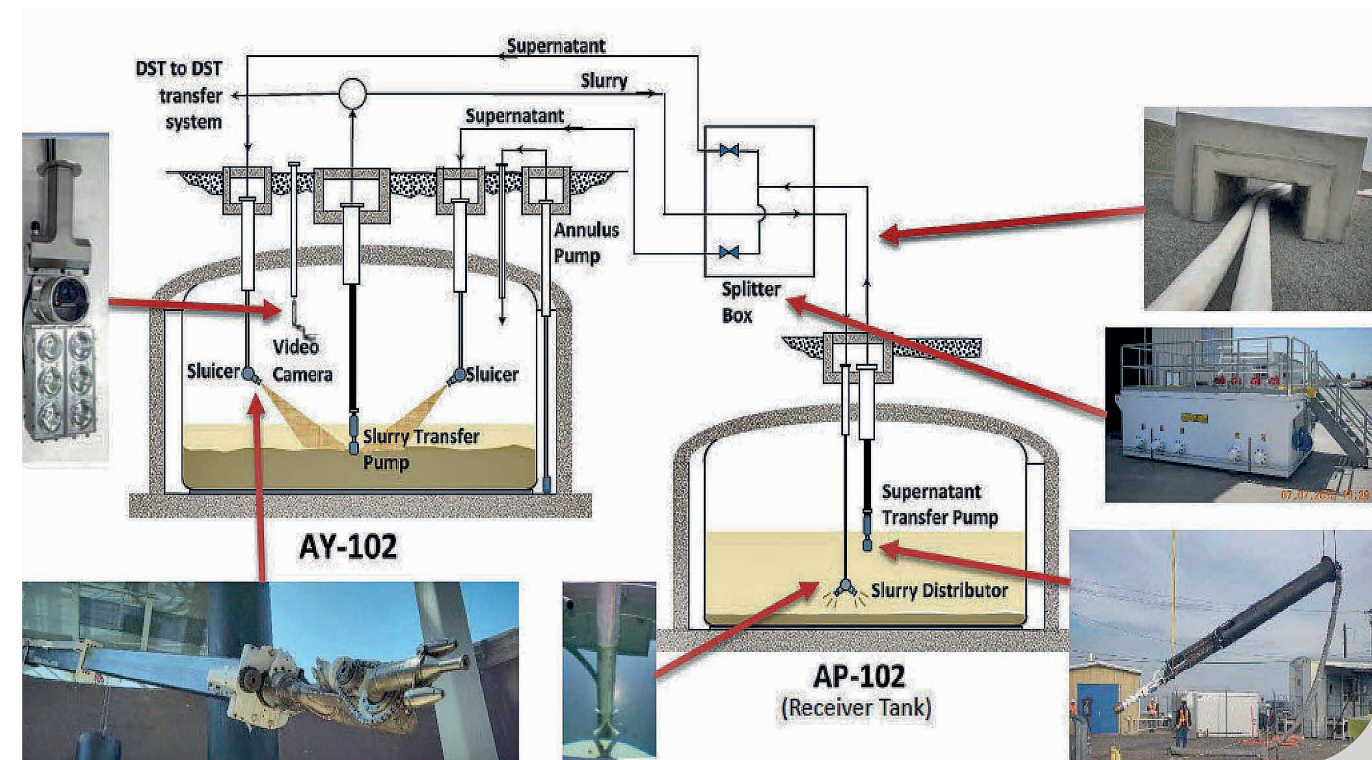


Orano value: Award-winning delivery ahead of schedule and on budget

17 days ahead of schedule despite estimated 12% chance of success from early Monte Carlo analysis.

Benefits:

- 97% of the AY-102 waste removed, totalling more than 725,000 total gallons
- 590,000 gallons of supernate
- 135,000 gallons of sludge
- 0 lost time accidents
- 9,000 activities performed



TEPCO Fukushima remediation and cleanup operations, Japan



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.

Challenge

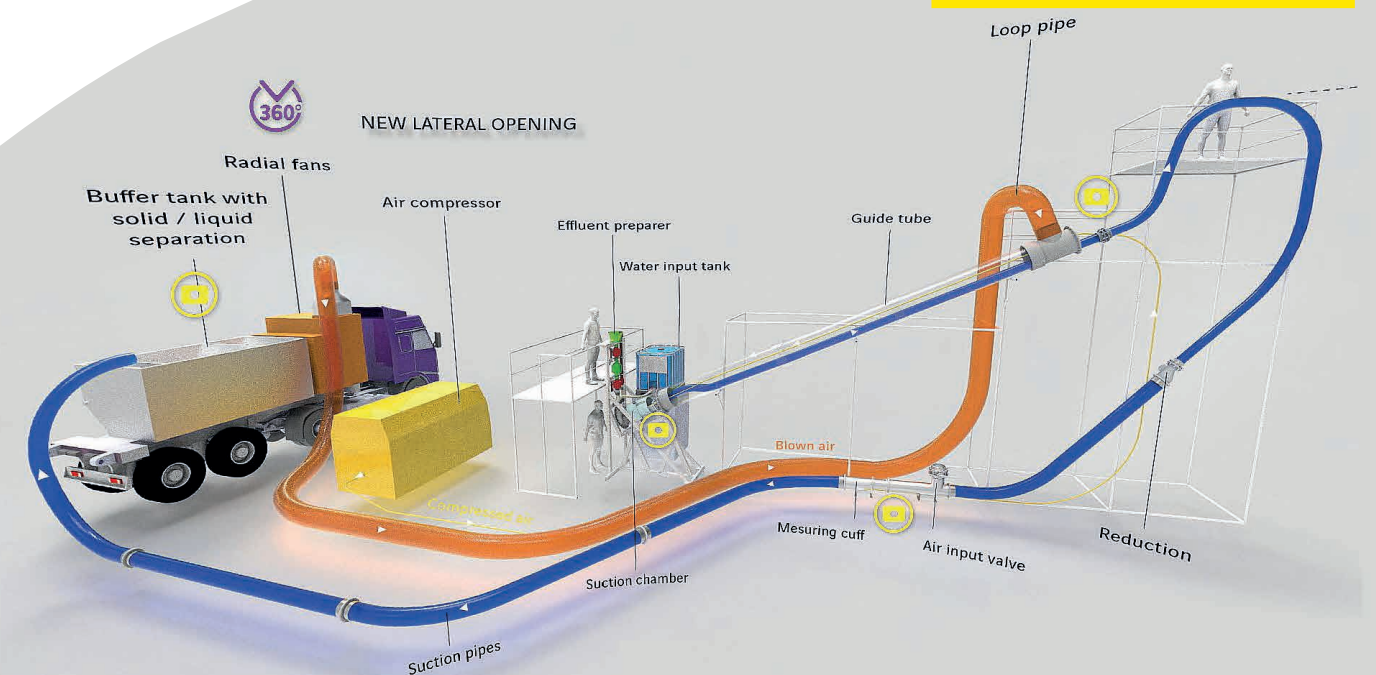
The cleanup and remediation at Fukushima Daiichi requires first-of-a-kind and diversified operations with a large range of waste in a constrained environment.

Among critical requirements regarding waste retrieval, treatment and conditioning:

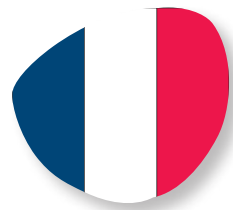
- Engineering for waste access and evacuation (corium and used fuel)
- Innovative technologies to address complex and unique situations
- Project execution in coordination with key partners, such as Mitsubishi Heavy Industries (MHI)

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 Marcoule (UC3) Special waste management, France

Challenge

UP1 former Fuel Reprocessing Plant: Decommissioning of a Cementation unit (UCC3) LLW and ILW-SL stored in 16 vaults.

All types of waste, from metallic parts of pumps to small pieces of Uranium and a high percentage of Magnesium waste.

Critical requirements:

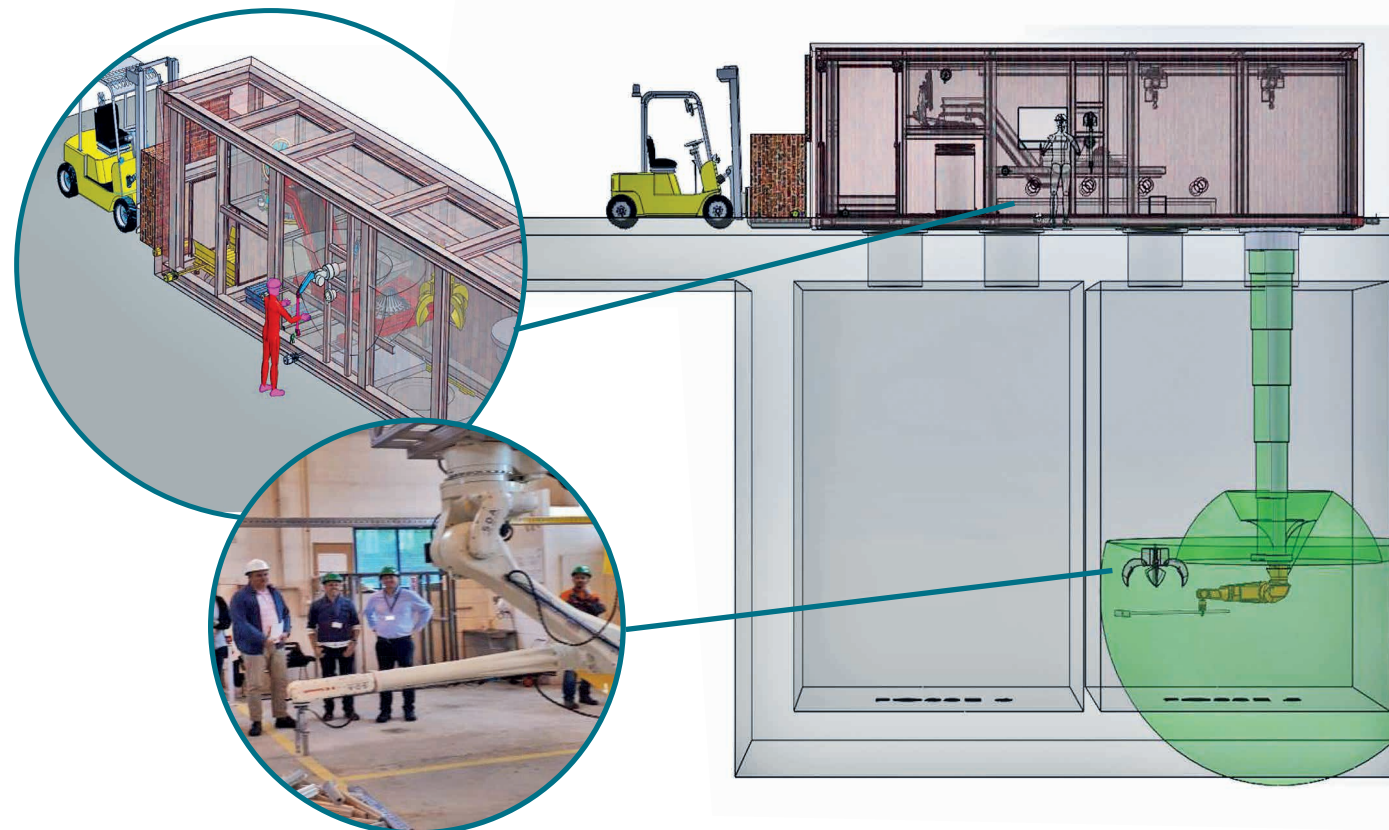
- Retrieval from vaults to drums – no direct human intervention possible
- Sorting and measurement
- Specific treatment and packaging for Magnesium

Orano value : Integrate a modular solution for post-retrieval treatment into the existing building

- Preliminary design: Process and hot cells in existing building and limited space
- Specific equipment customized for nuclear environment: robotic arm, shredder and briquetting machine, sorting device

Benefits:

- Mobile unit :
 - Mobility, modularity
 - System directly plugged in the workshop cell
- Dedicated robotic arm:
 - Operator's safety
 - Eased and shortened maintenance: the arm can be replaced in case of issue
- 1,500 tons of radioactive waste removed, sorted and packaged in 400 or 800-liter drums



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 unknown waste stored inside
- Optimized scenario definition, strategy and associated costs and planning up to NDA approval
- Design and first operational steps

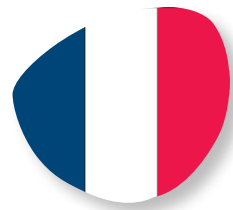
Benefits:

- 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

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



Field Report: key facts



CEA Marcoule Legacy waste evacuation (ERCF), France



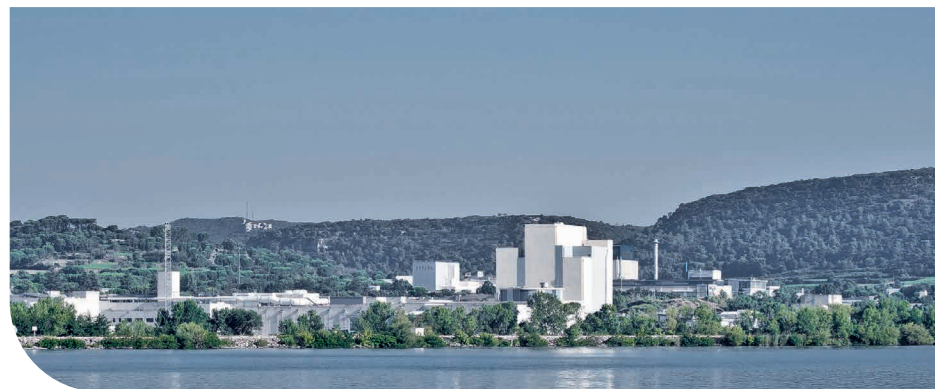
Challenge

Legacy waste stored in dedicated casemates (ERFB). Drums deteriorating over the years.

Critical requirements:

- Remove of drums from casemates to intermediate casemate (ERFB-bis)
- Sorting and characterization
- Specific treatment and conditioning in adapted packages to be defined

Orano value: overall strategy development, design and implementation

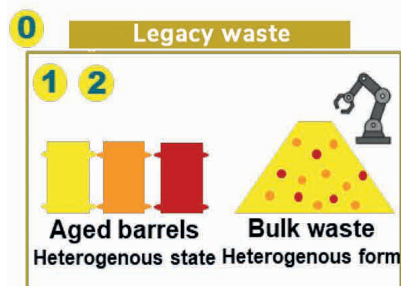


Benefits:

- Design of a customized trolley
- 4,600 bituminous mix drums retrieved since 2007
- 600 salting out drums retrieved

- 0 Waste management strategy
- 1 Retrieval design & manufacturing
- 2 Characterization strategy & system
- 3 Treatment: characterization, sorting & repacking

- 4 Conditioning: cementation & other processes
- 5 Waste package manufacturing
- 6 Interim Storage facility
- 7 Transfer and logistic



Enresa centralized storage installation ATC, design studies, Spain

Challenge

Enresa responsible for dismantling and waste management in Spain intends to design and build a facility for the long-term storage of used fuel and special residues..

Critical requirements:

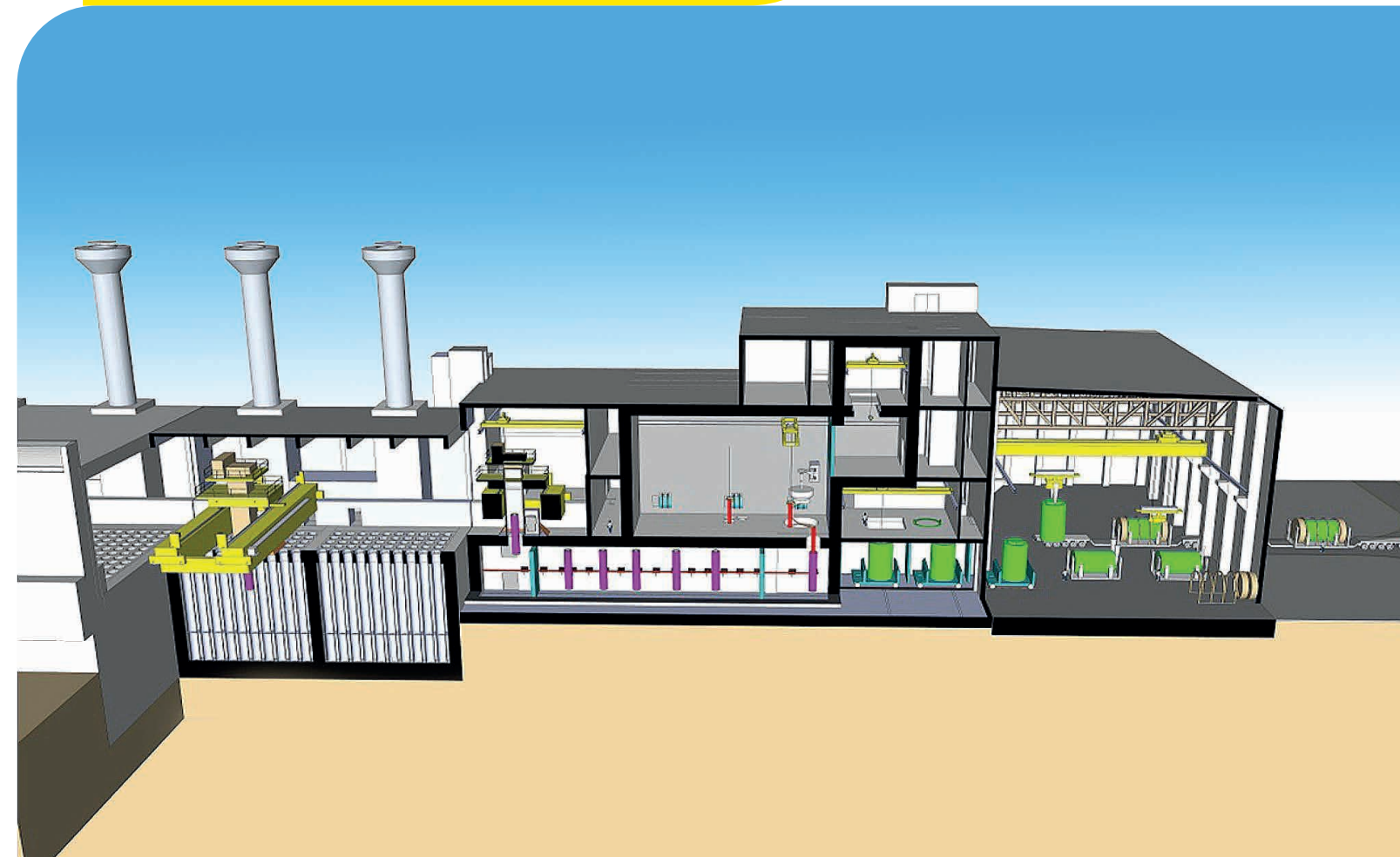
- Building for temporary cask storage
- 6700 tHM coming from Spain reactors,
- Lifetime design for 100 Years,
- Modular flexible vault and passive cooling concept
- Spent fuel storage with retrievability

Orano value: Preliminary studies and Design

- Unloading hot cell with hot cell with 20 years operation as LFE
- Cask Maintenance Facility, with 20 years operation as LFE
- Vault storage passively cooled for vitrified waste, with 15 years operation as LFE
- Examinatory and research laboratory, with 25 years operation as LFE.

Benefits:

- Engineering benefiting from 40 years of used spent fuel management.
- Design adapted to retrievability storage of 20 000 assemblies from BWR's and PWR's.
- Design benefiting from 20 years of operation.



Operational excellence driven by innovative and proven technologies

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

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:

The Solutions



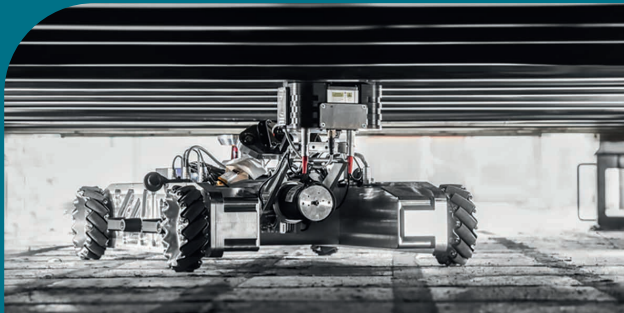
ORANEF™ Drones augment operators in Zone 4: time saving and reduced costs



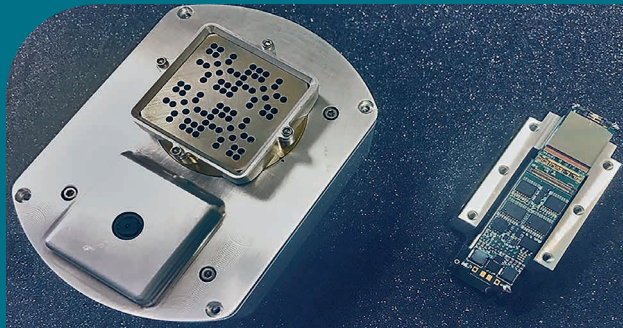
MARA™ screen for mapping large areas using augmented reality: ALARA, quality and simplicity



MANUELA™ 3D radiological and topographical mapping



RIANA SC™ radiological mapping of underside of containers



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



RFID application for package tracking: safety, traceability and performance

Remote Operated Vehicle (ROV) Sludge retrieval

The Challenges

At La Hague, Orano is planning the retrieval of radioactive sludge from liquid effluent chemical treatment processes (old waste retrieval project). This sludge is currently stored in the silos of the STE2 facility (about 10,000 m³).

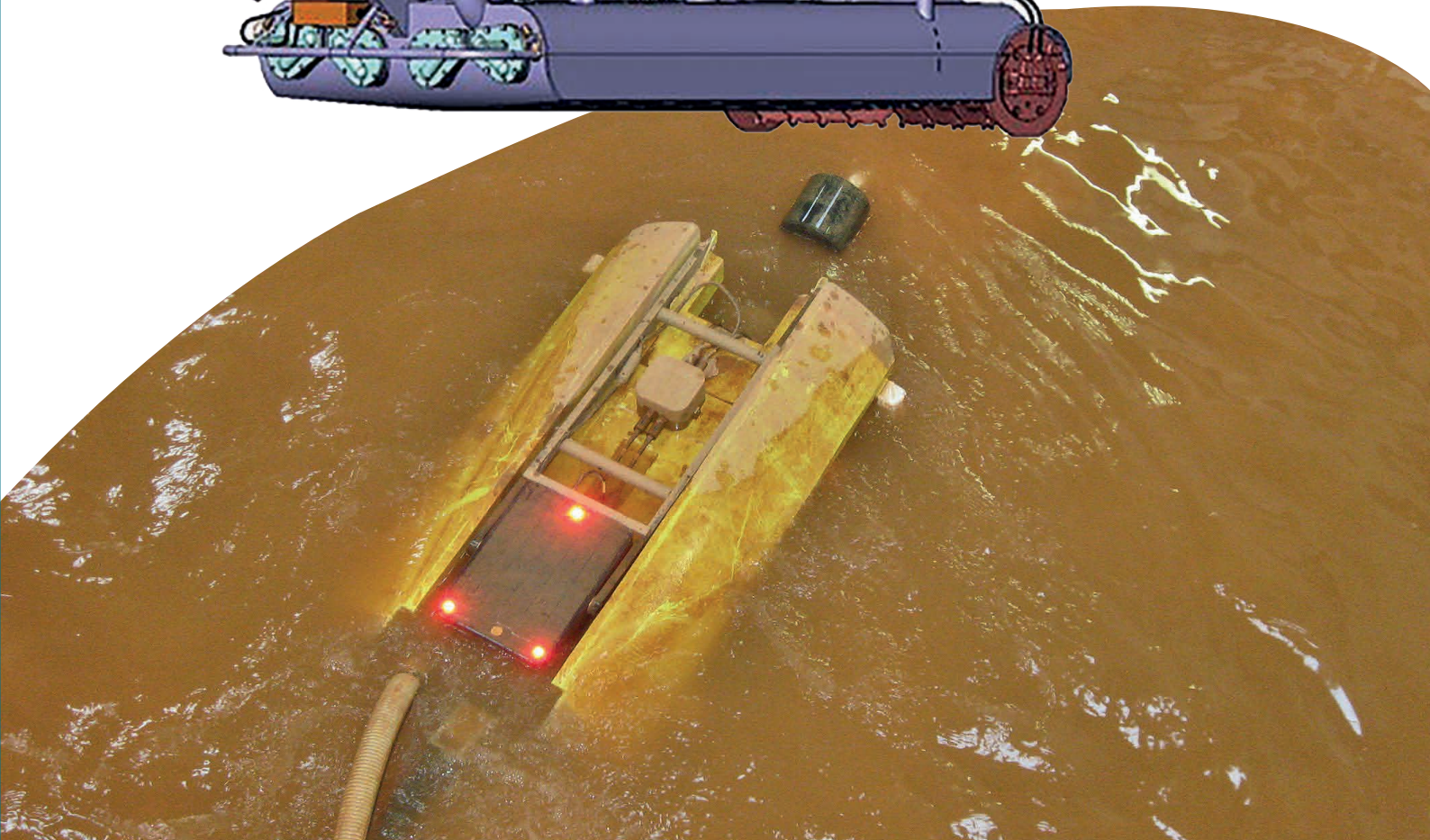
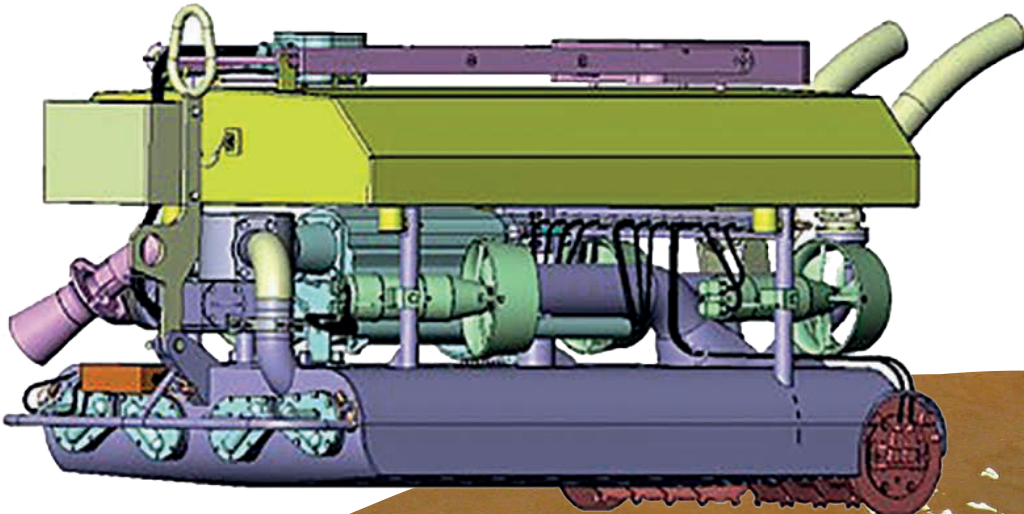
These sedimented sludge will be remobilized and characterized before transfer to another facility to ensure conditioning.

The Solutions

ROV is a remote-controlled submarine (250kg) with a rotating screw (Archimedes screw) for de-stratification of the sludge. The diluted sludge is then pumped and transferred to an intermediate tank.

Tracking the ROV is ensured by LEDs on a buoy and a camera system fitted under the roof of the silo. The tracking system ensures the driving and the positioning of the equipment.

The ROV enables the retrieval of old tamped sludge (~600g / l) in silos with remotely submarine in a complex environment.



Operational excellence driven by innovative and proven technologies

Modular In-Can Vitrification Process: Dem&Melt

The Challenges

As Intermediate and High-Level waste result from remediation and D&D operations, specific solutions must be developed in accordance to the final disposal requirements.

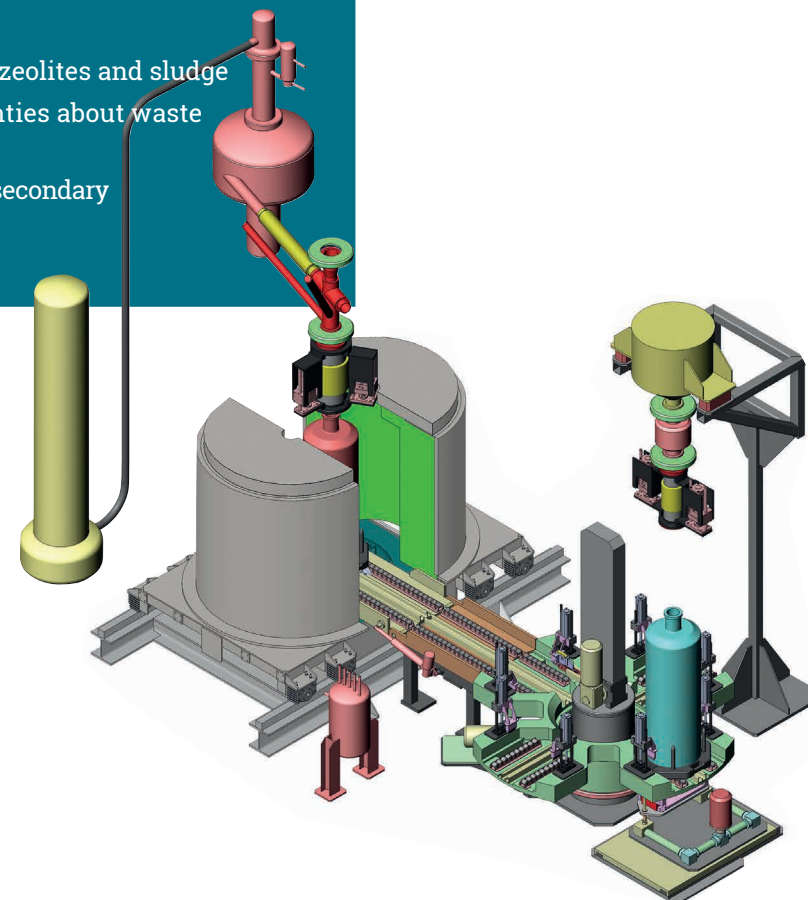
Isolation and containment solutions for the waste must be designed for the very long term combined with volume minimization to ensure the best balance.

The Solutions

The Dem&Melt project is a partnership between Orano, CEA, ECM technologies and Andra, the French disposal agency, leveraging their expertise from decades of experience in waste vitrification.

Significant benefits:

- Compact enough to be implemented in a decommissioned cell or close to the waste to be treated
- Requiring low investment and operation costs
- Canister used as the melter: no pouring device and no corrosion issue
- Heated by a simple and robust resistance furnace
- Allowing efficient control of the temperature (over a wide range) and homogeneity of the melted mixture
- Efficient volatility management
- Highly efficient Off-Gas Treatment System
- Suitable for solid or liquid waste, including zeolites and sludge
- Flexible enough to accommodate uncertainties about waste composition
- Designed to produce a minimized amount of secondary waste



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

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.

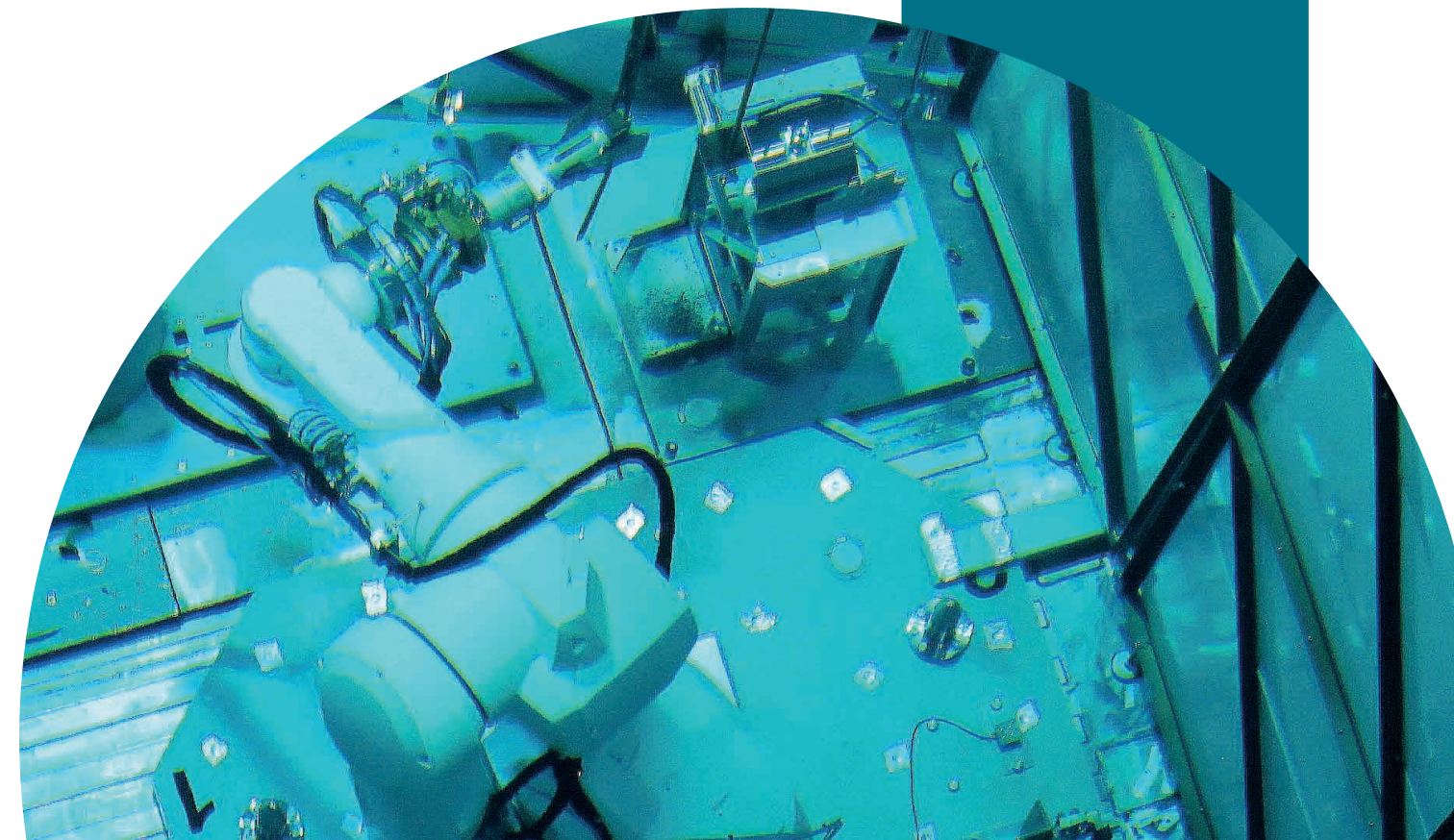
Significant benefits:

- 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



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.



Operational excellence driven by innovative and proven technologies

Triple-purpose family casks for storage, transport, disposal

The Challenges

Nuclear operators are looking for optimized conditioning solutions to limit the volume of waste, reduce handling and reconditioning operations and improve cost efficiency with safe, flexible and even reversible solutions. Solution applicable to complex waste from ILW to HLW for Transport, Storage, and up to final Disposal.

The Solutions

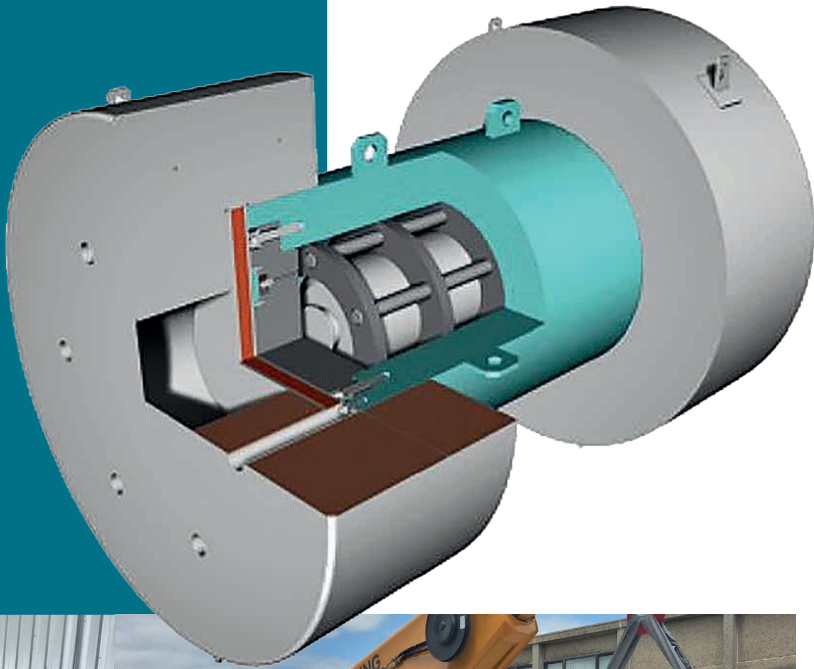
Using 50+ years of experience in package design and regulatory approval, Orano has developed the “All-in-One” TN® MW family. Accommodating various waste types such as metallic-activated and legacy waste, sludge, resins, fissile materials with the best combination of waste form and container.

Different formats designed for :

- ILW and HLW
- IP-2 to B Type Transport license
- Modularity, compactness & flexibility

With a large range of services and significant benefits:

- Loading/unloading
- Transport
- Drying system
- Monitoring
- Virtual reality training

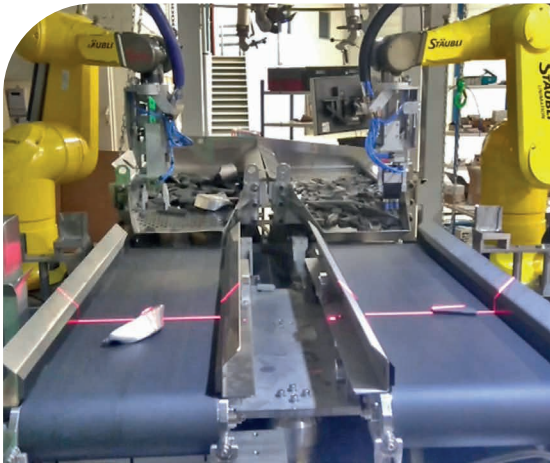


Robotic arm Short-Lifecycle building for complex diversified waste (Silo 130 La Hague reprocessing facility, France)

The Challenges

Removal of a wide range of legacy and diversified waste inherited from the Gas-Cooled program of the 1960s with the following requirements :

- Retrieval and processing operations due to incomplete knowledge of waste specifications.
- Consideration for chemical interactions with processes' and conditioning components for storage and transfer operations.
- High flexibility margin as the disposal routes are incompletely defined.



The Solutions

1. Robotic retrieval arm

To minimize the retrieval operational planning and optimize workers' safety, Orano and its industrial partners have designed a dedicated robotic arm based on analyzing the waste nature, volume and specifications.

2. Short-Lifecycle treatment and conditioning building

The project required the construction of a new facility. Orano developed a specific design out of a lightweight fabric structure, instead of using traditional solid construction.

Significant benefits:

This solution minimizes the time and costs of construction as well as the final dismantling cost of the facility and associated secondary waste.

