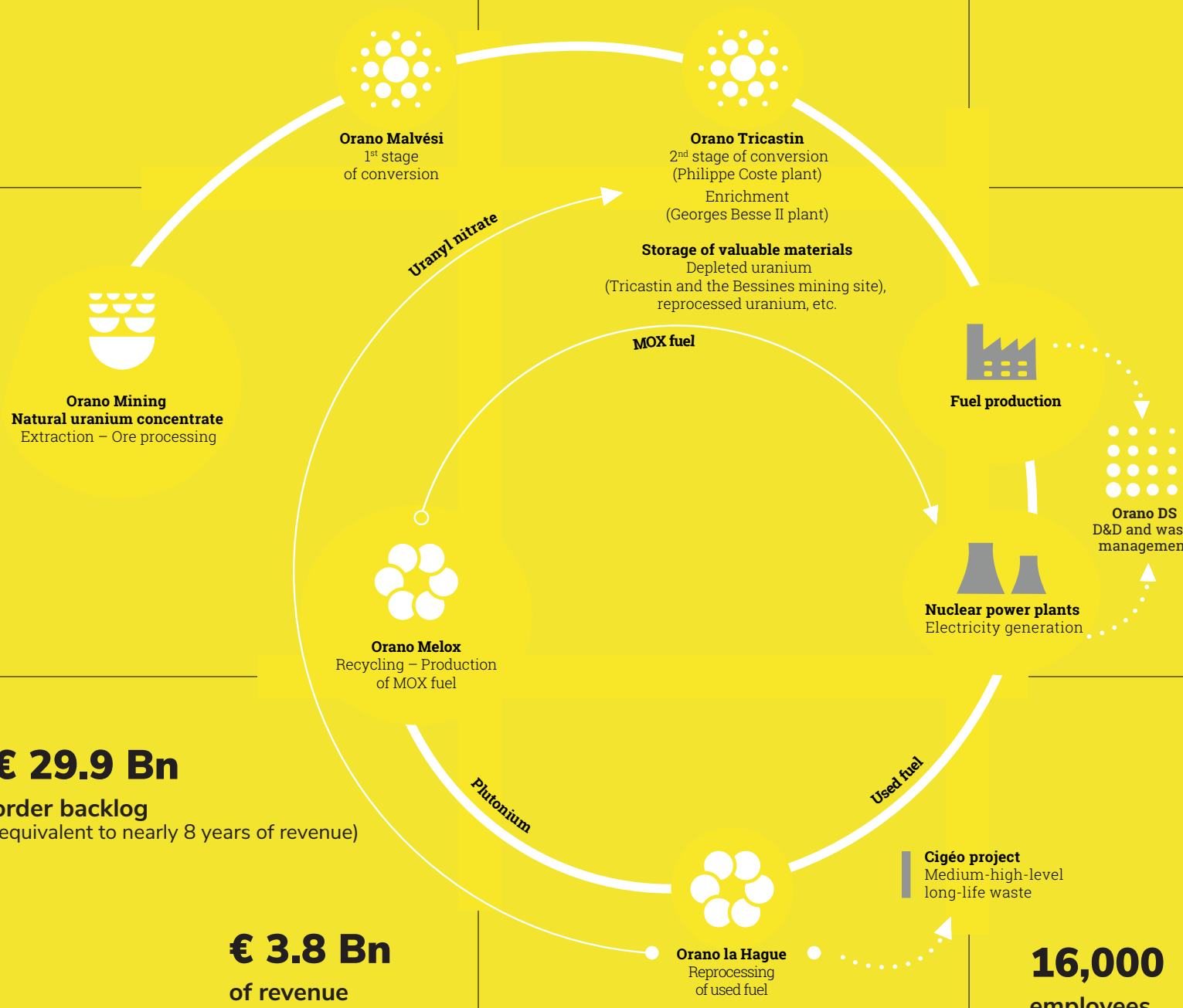
PROVEN SOLUTIONS FOR DECOMMISSIONNING & DISMANTLING AND WASTE MANAGEMENT

orano

Giving nuclear energy its full value

Our offer on the nuclear fuel cycle



€ 29.9 Bn
order backlog
(equivalent to nearly 8 years of revenue)

€ 3.8 Bn
of revenue

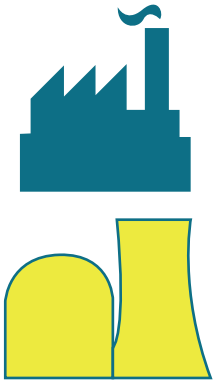
16,000
employees

Top 3
in the world
in its key activities

DECOMMISSIONING & DISMANTLING

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‘s added value for your D&D projects



PROGRAMME MANAGEMENT

CHARATERIZATION

D&D PLANNING

WASTE MANAGEMENT

We offer 40+ yeras experience and expertise in delivering D&D projects for fuel cycle facilities and reactors.

Site end state

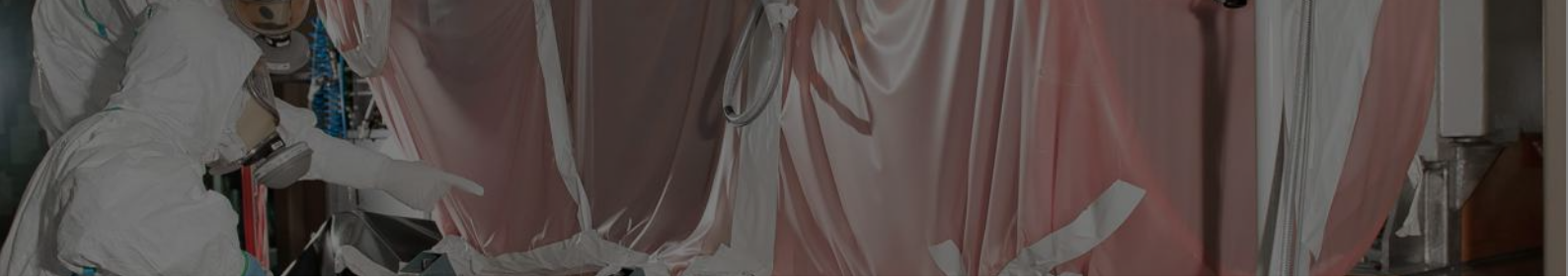
DEMOLITION CLEARANCE

Key Figures

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

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.



Orano has designed, developed and imlemented solutions ensuring a responsable management, both in terms of cost effectiveness and legacy to future generations, in regular dialogue with safety authorities and disposal operatos.

FACILITY SHUTDOWN
ENABLING WORKS

- We adapt our solutions to your specificities: scope, facilities and local regulations.
- We support you and your local partners ensuring that project execution is performed by local resources.

BALANCE OF PLANT DISMANTLING

NUCLEAR ISLAND DISMANTLING

40 + years of experience

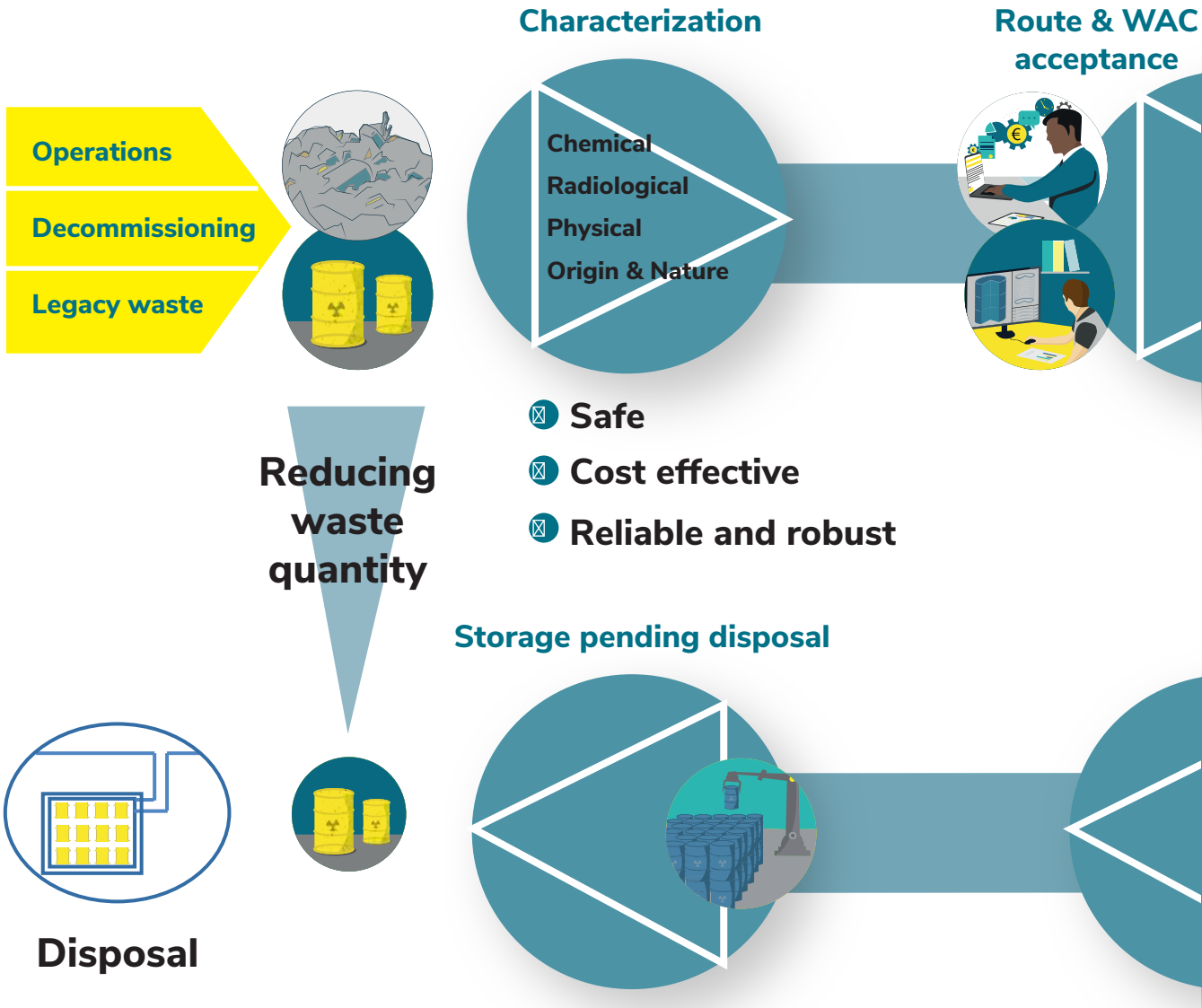
4,000 employees working for D&D waste management activities

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 miltary facilities.

Orano is part of decommissioning projects with continuously improving management.

WASTE MANAGEMENT

Orano's added value in waste management program

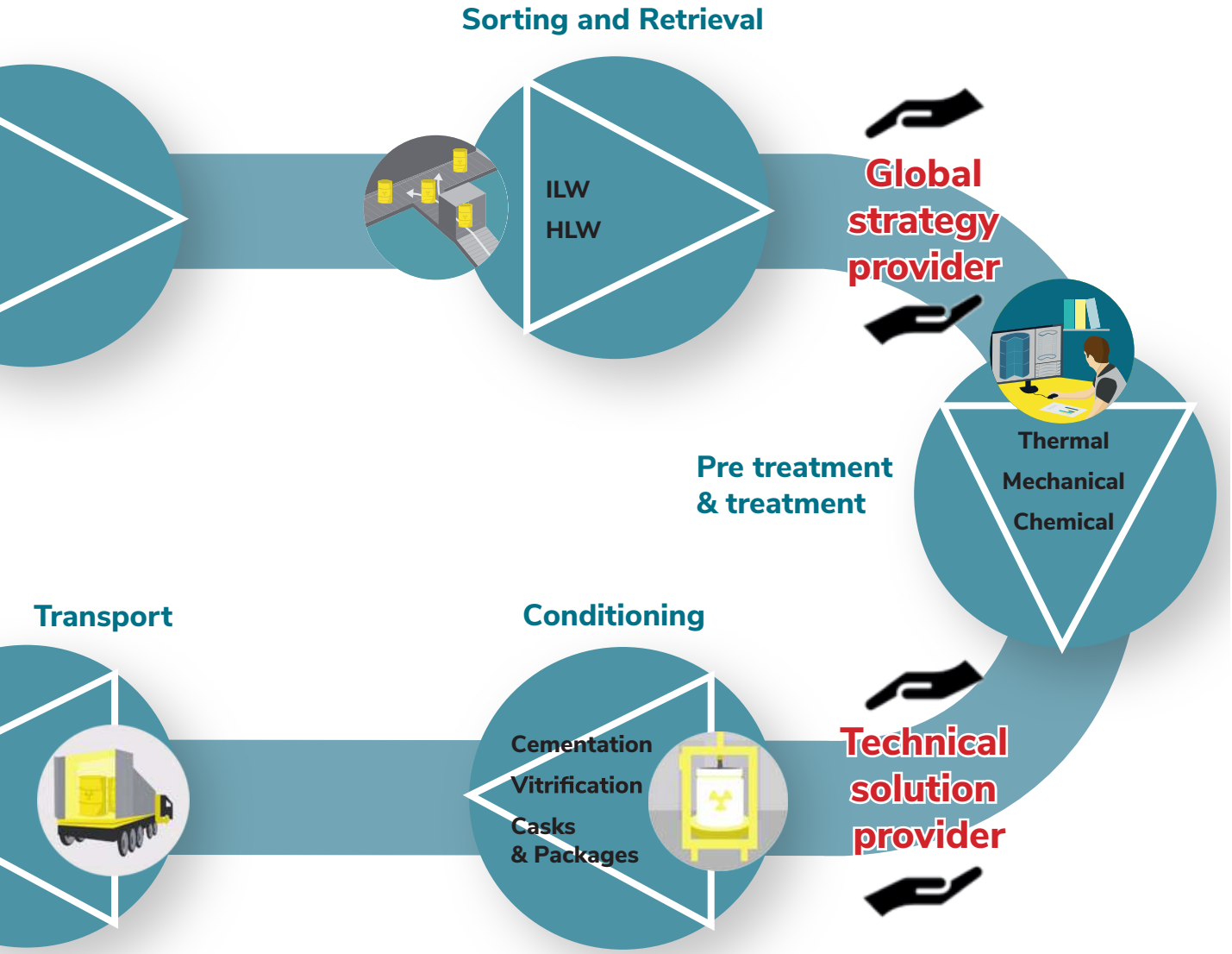


Your partner for complex waste management projects

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

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 gloabl expertise to your sites.
Sincce 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 wate)



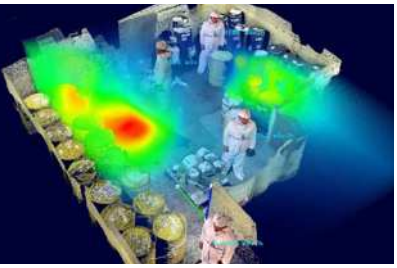
40 Nuclear sites
benefit from
Orano waste management
solutions

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 stop of the waste management strategy.

MANUELA™

Construction of 3D radiological and topographical maps



Scope

3D radiological mapping

- Simultaneous 3D radiological and topographical mapping of facilities
- 3D reconstruction of the existing environment in which the radiological measurements (dose rate, gamma spectra of emissions) performed by the operator are very precisely positioned

Spatial identification of the location of hot spots and their characteristics

- Visualization of the distribution of the intensity of gamma radiation within the premises or the cell at the time of measurement
- Spatial identification of irradiation sources location and characteristics

Assessment of the accumulated operators dose performing interventions

- Integration of virtual operators (avatars) into the reconstructed mapping in order to assess the accumulated dose of personnel performing interventions within the framework of ALARA approaches
- Simulation of operating scenarios and optimization of workstations

Transmission of information to teams prior to performing intervention

- Present the worksite environment to the operators, rehearse and repeat the gestures, understand the risks and thus make the intervention more reliable
- Export of data to a virtual reality interface for immersion of operators into the workspace

Advantages

- **SAFETY**
  Carrying out of risk and dose rate optimization studies
- **QUALITY**
  Reliability and traceability of radiological measurements and their spatial positioning
- **PERFORMANCE**
  Increase in the quantity of information transmitted to teams performing interventions
- **UNIVERSALITY**
  Can be adapted to all nuclear environments
- **EXPERTISE**
  Analysis of data with specific post-processing software

Key data

- **Autonomy:** 4 hours of scanning
- **Weight:** approx. 1.5 kg
- **Measurement probes:** dose rate and gamma spectrometry (CdZnTe)
- **Data processing:**
  - Retro-projection of radiological gamma distribution on a 3D model
  - Visualization in real time of the 3D reconstruction and of radiological measurements
- **Data export:**
  - Interface with various different modeling tools for the estimation of activities
  - Interface with Virtual Reality tools: prejob briefing , training, etc.
  - Interface with Augmented Reality tools: visualization of radiological information by the operator while performing the intervention

Portable system that is autonomous and easy-to-use, to perform real-time 3D radiological mapping

Our offer

- **The MANUELA™ equipment**
- **Expertise to support your team as an option**
- **Supplied with the 3D Scan package**

Our references

Mapping of facilities

- **Chinon and Fessenheim NPPs:** Mapping of different areas within the reactor building with the aim of identifying hotspots, validating the marking out of orange zones and making sure the radiological input data is reliable in anticipation of maintenance projects

Preparation of worksites and ALARA studies

- **Cattenom NPP:** Provision of 3D mapping as part of the ALARA study for the Steam Generator replacement worksite
- **Fessenheim NPP:** Participation in the ALARA study for maintenance activities
- **CEA Marcoule** (French reprocessing site in dismantling stage): Simulation of worksite layout based on 3D mapping
- **Orano La Hague:** Radiological mapping as part of the preparation work for a dismantling project

Design studies

- **Tricastin NPP:** 3D mappings performed as part of the project to modify biological protection

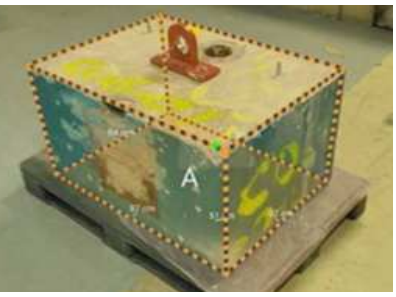
Contact us to discover the range of possible applications and services with MANUELA™

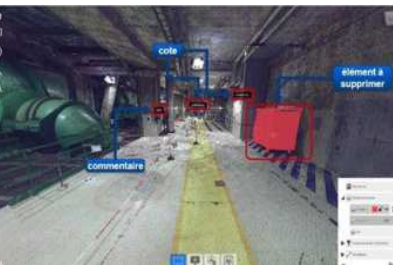
Orano KOREA Ltd

Tel. 054-077-6255
www.orano.group

3D Scan

Scanning, measurement and assisted design





Scope

Physical assessment of the environment

- 3D scanning of an environment and viewing in real time
- Performance of all the measurements of a complex environment in one take
- Measurements in real-time in the user environment: dimensions, surface, volume

Preparing operations

- Integration of 3D elements (tools, robots, airlock, etc.) in the environment to validate the layout of the worksite and to visualize any interferences
- Simulating replacement of equipment, checking of connections, etc.

Sharing of information

- Navigate a 3D virtual model as though it were real
- Extraction of drawings to visualize overall dimensions and accesses
- Presentation of the worksite environment to operators, to understand the risks and thus make the intervention more reliable

Advantages

- **SAFETY**
  Suitable for interventions in contaminated zones without risk of contamination of equipment
- **QUALITY**
  Reliability, precision and traceability of information gathered in the field
- **UNIVERSALITY**
  Standalone and adaptable to all environments
- **EXPERTISE**
  Analysis of data with CAD software
- **ADAPTABILITY**
  Scans can be conducted indoors or outdoors

Key data

3D Scan

- **Maximum range:** 130 m
- **Laser wavelength:** 1,550 nm (class 1)
- **Accuracy:** + 3 mm to 10 m
- **Controls:** Touch screen, triggered remotely via wired connection or Wi-Fi
- **Autonomy:** 5 h
- **Presentation of results in the form of panoramic photos or point clouds which can be converted into CAD models**

3D scanning and augmented reality tools for the preparation and execution of operations

Our offer and service

- **The tool can be supplied with the Manuela™ equipment to add a 3D radiological scan to a high resolution 3D environment.**
- **The service that can be adapted (quality and resolution of scans, types of deliverable) to meet your requirements.**

Our enclosure solution is patent-protected

Our references

CEA

- **CEA - Marcoule site (French reprocessing site in dismantling stage):** UP1 Plant - Room 55 – SPF/AVM – liquid effluent treatment station (STEL) cell 804
- **CEA Fontenay aux Roses:** Building 50, CARMEN shielded hot cell system
- **CEA Cadarache:** INB 54 - Cryotreatment Unit, Advanced Effluent Management and Treatment Facility (Atelier de Gestion Avancée et de Traitement des Effluents – AGATE) INB 171 Room 129 Building 815 – Circuit for the emptying of tanks
- **CEA Saclay:** Interior of the pit containing the MA 501 vessel, Decontamination workshop (Atelier de décontamination – ADEC), Experimental reactor ULYSSE, Liquid Effluent Treatment Station (Station de Traitement des Effluents Liquides – STEL) – Evaporator, Interior of the Expert Assessment, Cutting Up and Conditioning (Expertise, Découpe et Conditionnement – EDC) cell

EDF

- **Paluel NPP:** Exterior of Reactor Building Unit 2
- **Chinon NPP:** Machine room, Water chambers of the condenser extraction (CEX) system (inlet and outlet to and from the condensers of the Reactor Coolant System)

Orano

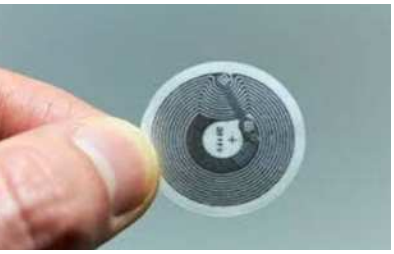
- **Orano Dessel (Belgium):** FBFC plant – Furnace room
- **Orano la Hague:** UP2 400 – High Oxide Activity (Haute Activité Oxyde – HAO) building – 3D scan of 8 cells or rooms including cell 813: Main route for the evacuation of waste resulting from the dismantling of cell 906 (zone 4)
- **Orano Pierrelatte:** Georges Besse 1 plant – Interior of plant 140 (on slab, under slab, Main Handling Corridor 140, end of the header box)

Orano KOREA Ltd

Tel. 054-077-6255
www.orano.group

MARA

Mesh with Augmented Reality Assistance



Scope

Mesh for mapping large areas

- MARA makes it possible to construct a mesh easily, rapidly and automatically prior to radiological investigations
- MARA serves as a replacement for conventional intrusive mesh solutions
- The information is entered on the tablet and can be used to generate an intervention report directly on leaving the worksite

Visualization of information collected

- Thanks to the use of augmented reality, the mesh created can be visualized directly on your connected tablet or smartphone
- Automatic synchronization of information by Wi-Fi communication between the tablet and the smartphone

Traceability of information

- Information is automatically saved to the tablet
- The information can also be written to NFC chips to be affixed to each constituent cell of the mesh
- Information stored the NFC chip can be written and read using the connected smartphone

Advantages

- EASIER TO INSTALL
  Can be installed on the worksite in less than 2 minutes
- ADAPTABILITY
  Intuitive interface means operators are able to get to grips with the tool immediately
- SAFETY / ALARA
  Less troublesome meshing phase and optimization of time spent in irradiated zone
- QUALITY
  Reduction of HOF risk due to your measurement values being entered online

Key data

- **Accuracy of mesh:** 5 to 10%
- **Size of mesh can be configured to meet your needs**
- **Generation of configurable intervention reports (addition of notes, sketches, etc.)**
- **The MARA pack consists of:**
  - 1 tablet
  - 1 smartphone
  - 1 laser rangefinder
  - 1 tripod

Make the meshing phase easier and quicker to complete, while ensuring full traceability of your radiological measurements

Our offer

- **The MARA equipment**
- **A solution customized to your needs**
- **Expertise to support your team as an option**

Our references

2015

- Development of MARA v1 in response to experience feedback from our teams on radiological investigation worksites (CEA Marcoule, a French reprocessing site in dismantling stage)

2017

- Development of MARA v2 (addition of smartphone) in response to experience feedback from experimental trials of MARA v1

2018

- MARA used as part of radiological investigations conducted on different nuclear plants:
  - Sellafield
  - Orano Malvési (French uranium conversion front end site)
  - Orano Tricastin

Orano KOREA Ltd

Tel. 054-077-6255
www.orano.group

RIANA SC

A robot to map the dosimetry of the bottom surface of containers

Scope

Radiological mapping of radioactive material containers before shipment

- System enabling the radiological mapping of the underside of containers
- Wireless robot-assisted mapping with autonomous navigation
- Dose rate measurement at point of contact

Supervision and traceability of data

- Control of the robot from a remote control station
- Real-time 2D mapping to identify areas of interest to be investigated by contact
- Real-time display of dose rate measurements
- Automatic recording of data for each investigation performed

Advantages

- QUALITY
  Elimination of non-quality costs related to inspection errors prior to shipment of containers
- SIMPLICITY
  Simple solution deployable in minutes
- ADAPTABILITY
  Wireless standalone solution with capability to include additional radiological measurements
- NUCLEAR SAFETY / RADIATION PROTECTION
  Remote control to reduce the radiological impact on the operator
- OCCUPATIONAL SAFETY
  Elimination of risks for the operator during the operation

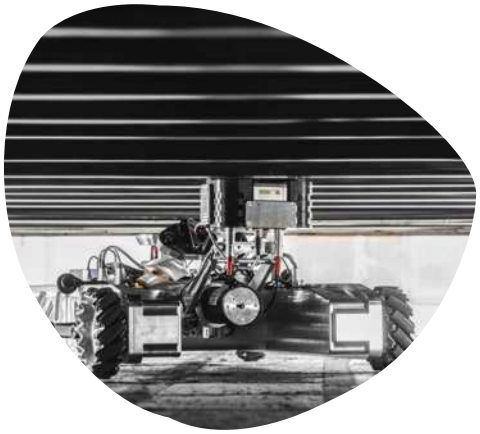
Key data

- **Wireless mobile base with omnidirectional wheels**
- **Autonomous navigation below the container**
- **Probe elevation system for contact measurements**
- **Real-time transmission of radiological data and creation of 2D mapping**
- **Extended measurement range (via two measurement probes) from a few tens of nSv/h to a few Sv/h**
- **Recording of mapping for traceability**

Strengthening safety and quality of radiological inspection operations on containers

Our offer

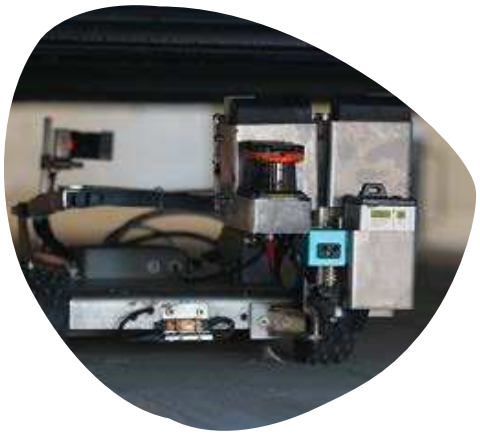
- **The RIANA SC equipement**
- **A solution customised to your needs**
- **Expertise to support your team in the field as an option**



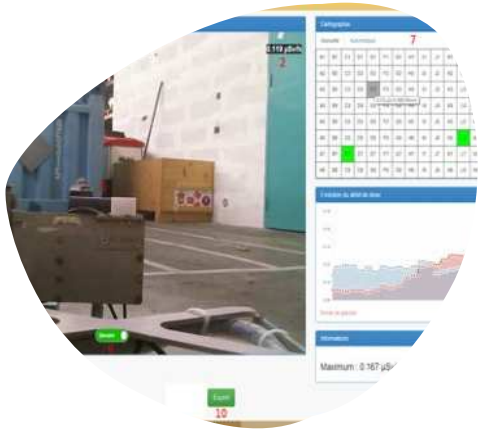
Our references

Orano DS

- **TRIADE classified environmental protection facility (ICPE):** Implementation since 2015 for the inspection of waste containers before shipment



Provision of the new version RIANA SC in 2018 specified from operating feedback



Orano KOREA Ltd

Tel. 054-077-6255
www.orano.group

D-CINNABAR

A dry process to stabilize metallic mercury

Bottle containing legacy metallic mercury

Stabilization process of metallic mercury by sulphur

Stabilized mercury HgS

Scope

Treatment of mercury without any available treatment route

- Recovery of both legacy or operational metallic mercury stocks
- Separation of aqueous supernatants associated with metallic mercury
- Final form of mercury after treatment: stable, insoluble and acceptable in a repository site

Risk management related to metallic mercury

- Risks related to mercury vapours are suppressed through its stabilization as mercury sulphide (HgS)
- Skin contact toxicity and risk of dissemination are limited by the solidification of a high surface tension and very low viscosity liquid into powder

Principle

- Process based on the following chemical reaction: Hg + S ➡ HgS
- Intimate mixture between metallic mercury and sulphur carried out in a specific equipment and under controlled Pressure and Temperature conditions

Advantages

- **SIMPLICITY:**
  A single, space-saving and mobile equipment for separating supernatants and stabilizing mercury.
- **EFFECTIVENESS:**
  The volume of mercury that can be stabilized per batch depends only on the size of the equipment. The transformation can be performed during a single work shift.
- **PERFORMANCE :**
  Once stabilized, the waste is insoluble, chemically stable and accepted by the French national radioactive waste management agency (Andra).
- **SAFETY / SECURITY / RADATION PROTECTION :**
  The toxicity risks on operators and on the environment, due to mercury vapours, are under control.

Key data

- The equipment fits on a laboratory bench.
- The current solution consists of a reactor that can process 1 kg of metal mercury in approximately 7 hours (i.e. 1 batch per work shift). This time includes the treatment logistics' (upstream and downstream). The reaction time is approximately 4 hours.
- The reactor is sealed and operates at low pressure (of the order of a few tens of mbar) and at moderate temperature (<90° C).

An effective solution for treating waste without any available management route

A solution developed by Orano DS for the treatment of contaminated metallic mercury from nuclear facilities.

Development phases

The reactor is sized to process 1 kg of metallic mercury per batch. A total of 5.3 kg of contaminated mercury from an Orano facility in France were completely treated in 6 batches. The waste issued from the stabilization (HgS and induced waste) was accepted for disposal in the French repository specialized in the management of very low level waste.

Pilot scale process for the treatment of contaminated mercury

Beginning of the reaction between sulphur and metallic mercury

Yours benefits

Elimination of a waste difficult to process until now

Toxicity risk reduced

D-CINNABAR is a patent protected solution

Our services may include

- Support for the implementation of D-CINNABAR for international markets
- Definition and installation of a working environment suitable for the handling and treatment of metallic mercury
- Support for the shipment of metallic mercury to processing facilities

Contact us to discover our D-CINNABAR offer.

Orano KOREA Ltd

Tel. 054-077-6255
www.orano.group

orano

Remotely controlled rover systems to drill concrete

RODSY30 rover

RODSY10+ rover and its control centre

RASCO² scanner system

Scope

Two rover drilling systems are proposed to sample concrete remotely in semi-automatic mode:

- **RODSY30**: rover allowing the drilling of a single drill-core 30 cm long
- **RODSY10+**: rover designed to drill 5 drill-core samples of 10 cm long each during the same operation

Simplicity and reliability of operations:

- These systems allow drilling core remotely in irradiating and/or contaminated areas
- The drilling operations are dry avoiding the management of contaminated effluents

Security and safety of operations:

- The remote control of the drill, whether manual or programmed, eliminates the exposure risk to the operators
- The on board vacuum is used to both remove the drill cuttings (i.e. small pieces of concrete removed by the drill bit) and cool the drill
- The systems have been designed to eliminate the risk of contamination of the area from drill cuttings
- The lack of water is favourable to avoid: 1) the criticality risk in a U/Pu environment and 2) the management of contaminated sludge

RASCO²: a mobile device for in-situ analysis

- Automated scanning system to determine the contamination profile of a drill-core by gamma spectrometry
- Processing software to visualize the 3D distribution of the contamination within the structure of a building

Advantages

- **SEMI-AUTOMATIC DRILLING SYSTEMS**
  Positioning of the systems in remotely-operated irradiated / contaminated areas
  Automated drilling sequence
- **EASY TO OPERATE**
  Easy to operate and maintain systems
- **SAFETY**
  No water used during the operations
- **CONTAMINATION AND RADIOLOGICAL EXPOSURE RISK**
  System remotely controlled by the operator
  The radioactivity levels of concrete fragments are checked before recovery
- **PERFORMANCE**
  In-situ concrete core analysis

Key data

Dimensions (in drilling position):

- RODSY10+:
  - L = 1665 mm, w = 750 mm, H = 1925 mm
  - Weight ~ 750 kg
- RODSY30 :
  - L = 1500 mm, w = 750 mm, H = 1595 mm
  - Weight ~ 600 kg
- RASCO² :
  - L = 170 mm, w = 72 mm, H = 115 mm
  - Weight ~ 380 kg

Drill core size:

- Length: 100 mm (RODSY10+) or 300 mm (RODSY30)
- Diameter: 50 mm

Operating distance:

- Up to 100 m depending on the length of the power and control cable

Dry drilling time:

- Between 10 and 15 min for 10 cm of core

Automated drilling systems enabling dry drilling free of contamination risk

Control centre of the RODSY30 rover

Power and control cable of the RODSY10+ rover

Core storage on the RODSY10+ rover

Our offer

Provision of services or sale of products customized to the needs of our customers:

- **Single drill-core**: inspection of limited access areas for in-depth analysis of the contamination penetration depth
- **Multiple drill-cores**: sampling and analysis of drill-cores over large areas (e.g. room, cell) to study by extrapolation the distribution of the contamination, while limiting the measurements
- **Radiological characterization**: analysis of concrete drill-cores using a mobile gamma spectrometry scanning system

Options

Programming sample locations

Resin injection to preserve the drill-core cohesion

Possible developments

Integration of larger diameter drill-cores

Oblique and horizontal drilling

Contact us to discover all possible solutions provided by both RODSY and RASCO² systems.

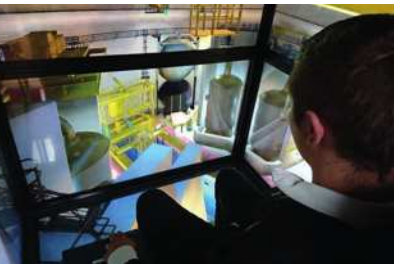
Orano KOREA Ltd

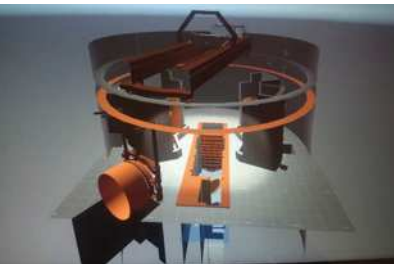
Tel. 054-077-6255
www.orano.group

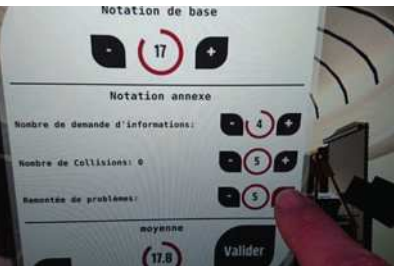
orano

Polar crane driving simulator

Learning and training in the driving of a polar crane in a nuclear power plant







Scope

Polar crane cab replica

- Total immersion of crane operators in the reactor building environment replica of driver station (same controls, seat, confinement, noise and heat)

3D modeling and scenarios

- 3D modeling of 1300 MW and 900 MW reactor building environments
- Incorporation of all typical scenarios related to movements to be performed during a unit outage (placing of elements into the pool or onto their stand), and possibility of adapting the scenarios to take into account exeptional cases

Incorporation of a foreman avatar with semi-artificial intelligence

- Guidance with movements of loads for the crane operator
- Physical load calculations related to the tension of slings to obtain a result that is close to reality
- Validation of scenarios based on compliance with the foreman's instructions

Monitoring and results

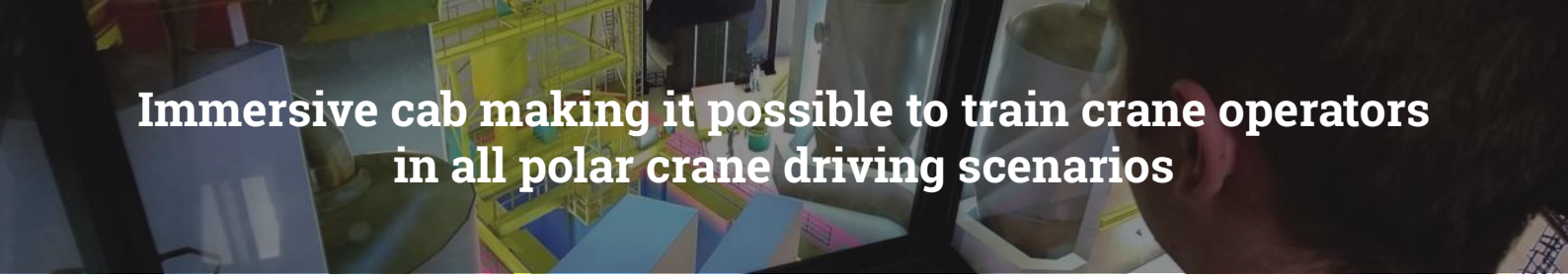
- Real-time monitoring of activity, possibility of interacting with the crane operator via the control desk
- Possibility of re-viewing the complete maneuver

Advantages

- AVAILABILITY
  Training of operators using a mobile solution that can be accessed outside of unit outage periods
- MODERNITY
  Modern and attractive solution for new operators that can be used in addition to learning periods
- TEACHING METHOD
  No physical risks and possibility of taking back over the controls at any time
- ADAPTABILITY
  Definition of specific scenarios in addition to conventional unit outage interventions
- TRACEABILITY
  Recording of data for analysis and discussion with the crane operator at the end of the training session

Key data

- **Weight:** Approx. 700 kg
- **Dimensions:**
  Length = 2.90 m
  Width = 1.70 m
  Height = 2.53 m
- **3D environment:**
  Modeling integrated into Unity 3D
- **3D immersion:** 7 screens positioned in the simulation cab



Immersive cab making it possible to train crane operators in all polar crane driving scenarios

Our offer

- **Supply of the equipment and the solution**
- On-demand **services and scenarios**

The simulator is protected by the European data protection agency, the APP (Agence de la Protection des Programmes)

Our references

EDF

- **Penly NPP:** Training provided as part of Just in Time approach
- **Paluel NPP:** Services / training for the removal of SG42 from unit 2

Orano DS

- Training of new operators
- Organization of days for experienced crane operators to raise awareness upstream of unit outages

Innovation Award to mark the 10th anniversary of GIP NO (Groupement des Industriels Prestataires du Nord-Ouest), the consortium of industrial contractors from North-Western France

Orano KOREA Ltd

Tel. 054-077-6255
www.orano.group

High Density Container

Concrete formulas and specialty products for waste conditioning

Orano TEMIS

- Production plant is located in Valognes (France)
- ISO 9001 – 14001 – 18001
- Workshop area : 10,000 m^2
- Since 1990
- Overall production : more than 100,000 containers

Products

- CBF-C1 & C2 (cylindrical)
  - Useful volume: 330 and 700 liters
  - Overall dimensions: 1200 mm H / 840 mm D and 1500 mm H / 1000 mm D
- CBF-K (cubical)
  - Useful volume: 3000 liters
  - Overall dimensions: 1700 mm

CBF-C

CBF-K

Materials

All materials listed below are characterized:

- Mechanical strength
  - Compressive strength at 60MPa
  - Splitting tensile strength at 5.5MPa
  - Bending strength at 8 MPa
- Shrinkage at 28 days
- Density and Porosity
- Elastic constants
- Gas and water permeability
- Tritium diffusion
- Linear expansion coefficient
- Thermal cycling resistance
- Radiation resistance

Customers

- Nuclear Power Plants (France, Switzerland, Germany)
- Reprocessing plants in operation or in decommissioning status (Orano and CEA France)
- Research centers (CEA France)

Characteristics

- Regulatory approval for the disposal of short lived low and intermediate level waste
- Concrete and containers durability and containment
- High capabilities
- Higher volume of cement paste
- High ratio of structural fiber
- Incorporation of high-adhesion concrete reinforcement

Applications

- Bare drums
- Bulk heterogeneous solid waste
- Cement-solidified liquid or powder waste

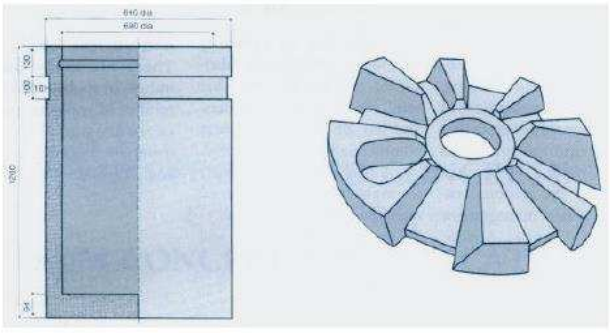
Design

- Cylindrical and rectangular shape
- A proven lifetime of 300 years
- Qualification as IP2 packages according to IAEA rules
- With or without internal metallic liner or shielding

Drop test of a rectangular fiber concrete container

Engineering services

- Development of specific containers and concrete formulas
- Design and supply of containers fabrication systems
- Production start-up support



CBF-C1 container with anti-float cover

Orano KOREA Ltd

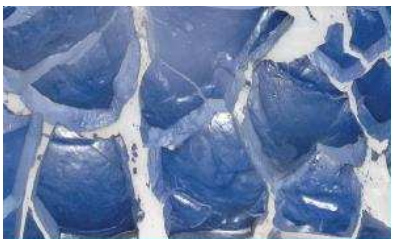
Tel. 054-077-6255
www.orano.group

RAN

Mineral Ion Exchangers for the separation of radioactive elements present in solution

Ion exchanger?

- The ion exchangers are made up of hydrated synthetic minerals, prepared from very pure raw materials in accordance with very strict production methods to ensure a high level of reproducibility and quality
- They can be used to perform more complex actions than an organic ion exchanger through the overlapping of a number of different phenomena: reduction and oxidation (or redox), in-situ precipitation, physical adsorption, the formation of mixed crystals, isomorphic substitution in the crystal lattice, ionic exchange, etc.



Selective fixing of contaminants dissolved in solution

- Decontamination of radioactive waste
- Separation of elements.
- Analysis of radionuclides in trace amounts (concentration then measurements). Cs in Sea water for example
- Drugs (e.g.: Fixation of radiocesium by precipitation in the intestinal lumen)

Optimized management of RAN after used

- Immobilization in a matrix formed using hydraulic binder (cement) then sent for disposal
- Management as a water filter to be sent to final storage
- Addition to package of heterogeneous waste up to 10% of the useful volume

Benefits of our products

HIGH SELECTIVITY

- Fixing of elements present in very low concentrations in liquids highly charged with ions

HIGH CAPACITY

- Able to capt up to several mg of radionuclides per g of RAN
- Low quantity needed: For example 100 g of RAN per m^3 of effluent to be treated

PERFORMANCE

- Very high decontamination factor (from 10 up to > 1000 for caesium in few hours)
- Resistant to acid, alkaline and corrosive environments (0.5 < pH < 10.5)
- Resistant to temperatures of up to 70° C
- Resistant to radiations (10^7 to 10^9 rad)

WASTE MANAGEMENT

- After use, compatibility of RAN products with cement

Key data

- **Different types of RAN according to intended selectivity**

Fe-CU *Copper ferrocyanide*

Fe-CoK *Cobalt potassium ferrocyanide*

OXTAIN *Tin oxide*

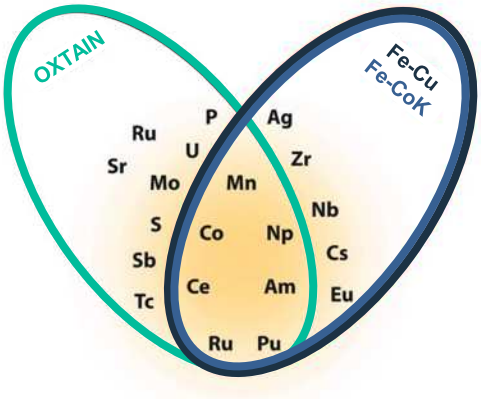
- **RAN conservation: Several years in a dry environment at room temperature**
- **Packaging according to customer needs: Flask, 10 kg or 20 kg plastic casks...**

A flexible solution for the separation of radioactive elements present in solution

Our offer

Orano DS propose an offer adapted to each customer's needs and that can include:

- Suppply of products RANs (Fe-Cu, Fe-CoK, OXTAIN).
- Feasibility studies and technical development of a customized solution to effluents to be treated as needed.



	PH of use	
Fe-Cu Fe-CoK	• Cs (pH 0,1 – 10) • Mn, Co, Zr, Nb, Eu, Ce (pH 7 – 10)	• Ag, Pu, Am, Np (pH 6 – 8)
OXTAIN	• Cations : U, Pu, Am, Np, Sr, Sb, Ru, Co, Mn, Ce (pH > 4) • Anions : TcO_4^- , SO_4^{2-} , PO_4^{3-} (pH 2 – 10)	

Our references

Decontamination of radioactive effluents

- **CNPE EDF of Bugey (FR)**

Treatment of 300 m^3 of effluent contaminated by ^{137}Cs (1000 Bq/l) : $FD_{Fe\text{-}Cok}$ > 200

- **CNPE EDF of Chinon (FR)**

Treatment of 250 m^3 of effluent contaminated by ^{137}Cs (650 Bq/l) ; $FD_{Fe\text{-}CoK}$ > 650

- **CNPE EDF of Chooz (FR)**

Treatment of 780 m^3 of effluent contaminated by ^{137}Cs (9000 Bq/l) : $FD_{Fe\text{-}Cu}$ = 500

- **UKAEA nuclear facilities, Dounreay (UK)**

Treatment of 370 m^3 of effluent contaminated by ^{137}Cs (1 GBq/l) : 1000 < FDFe-Cu < 10000

**FD : Decontamination factor = Initial activity (Bq/l) / Final activity (Bq/l)*

Seperation of elements

- **GE Healthcare (USA)**

Supply more than 350kg of RAN OXTAIN

- **MDS Nordion (CAN)**

Supply more than 100kg of RAN OXTAIN

- **DSD PHARMA GmbH (AUT)**

Supply several kg of RAN OXTAIN

Analysis of radionuclides at trace level in seawater

- **French Navy & CEA**

Supply more than 75kg of RAN Fe-CoK / Fe-Cu

Orano KOREA Ltd

Tel. 054-077-6255

www.orano.group

Orano DS

Tailored offer for all nuclear operators

Part of Orano, a leader in the nuclear fuel cycle, Dismantling and Services offers its customers a unique solution that is founded on 50 years of experience and covers the entire value chain in three areas of activity:

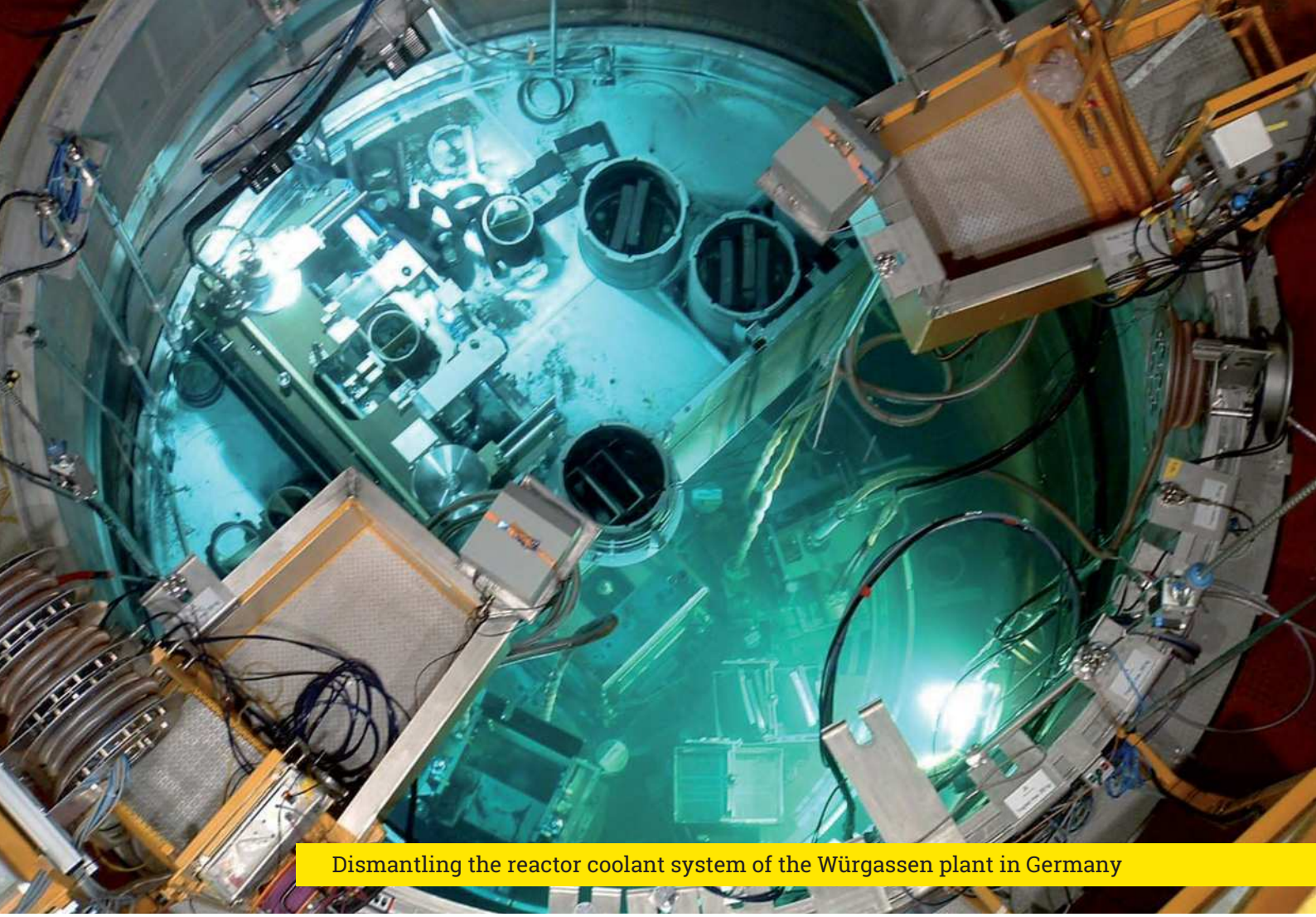
- **Dismantling of nuclear facilities and equipment**, from the design of projects to their eventual completion on the ground
- **Management of radioactive waste**, of all types and levels of radiological intensity, whether originating from production activities, the operation of facilities, their dismantling or major maintenance operations
- **Services to nuclear operators**, including expertise in site support logistics, specialized maintenance, radiological safety and nuclear training

On markets which are growing worldwide, the know-how, experience and capacity for innovation of our 4500 employees are what make the difference and give us our strength.

For nearly half a century, we have been working alongside our customers, operators of nuclear installations either in operation or at the end of their lifecycle, to help them meet their commitments in terms of nuclear safety, occupational safety and control over costs and delivery times.

A leader in dismantling and a key player in the management of radioactive waste and nuclear services, we provide our customers with technical know-how and rigorous project management built on the successful completion of a variety of complex worksites.

On an international scale, Orano DS harnesses two drivers of growth. On the one hand, the expertise of its German and American teams, which have unique know-how regarding the dismantling of nuclear reactors. On the other, targeted partnerships to combine the talents of Orano DS with those of local businesses, thereby creating a strong, competitive offer.



Dismantling the reactor coolant system of the Würgassen plant in Germany

More than 5 000
employees in France, Germany and the USA

50 years
of experience

€600m

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.

orano

Business corporation with a Board Directors. Capital of 118,868,750 euros
Registered company no.: 330 956 871 – Nanterre
Head Office: 125 avenue de Paris - 92320 Châtillon - France
Tel: +33 (0)1 34 96 00 00 - Fax: +33 (0)1 34 96 00 01

Energy is our future. Don’t waste it!