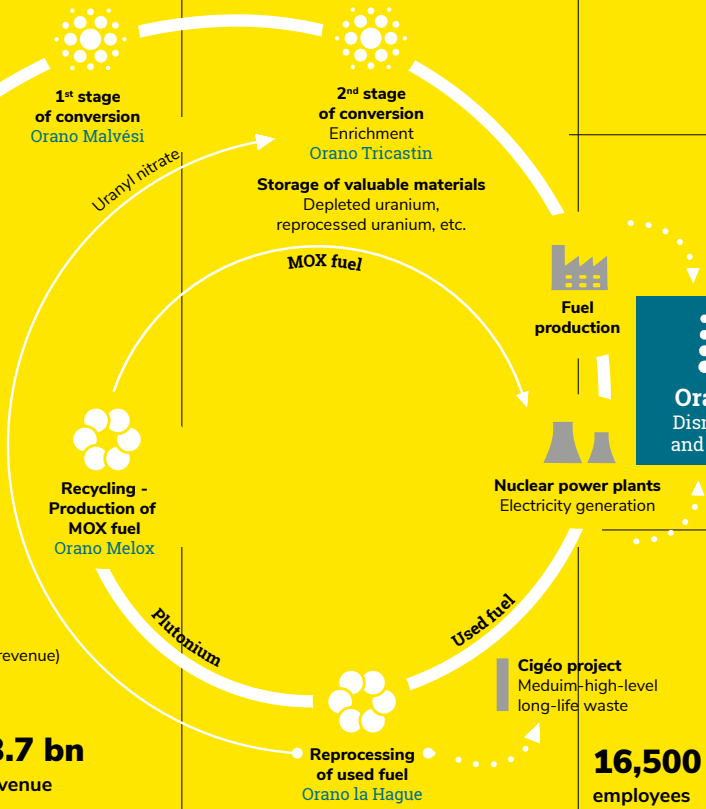
Innovation at the service of your activities

Orano DS

orano

orano



€ 27 bn
order backlog
(equivalent to nearly 8 years of revenue)

€ 3.7 bn
of revenue

16,500
employees

Top 3
in the world
in its key activities

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 more than 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 5,000 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.

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

+ 50 years
of experience

€ 600 M

Themes

1 Radiological mapping and radiation protection

To improve our knowledge so we can optimize intervention scenarios and the occupational/nuclear safety of operations

2 Investigation and characterization

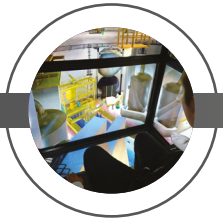
To improve our knowledge so we can optimize intervention scenarios (for dismantling in particular) and our waste strategy

5 Decontamination

To optimize performance and production of waste while keeping overall costs under control

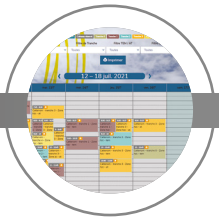
6 Cutting/ Robotics

To raise productivity and reduce risks for operatives



3 Simulation and training

To ensure the quality of our interventions through knowledge building and transfer of know-how based on digital technologies



4 Monitoring of facilities and tracking of operations

To gain in productivity and quality thanks to dematerialized management of data

7 Support for operations

To simplify and enhance intervention working conditions while increasing productivity

8 Characterization and conditioning of waste

To improve waste characterization, processing and monitoring to optimize the overall costs of waste routes (processing, transportation and storage)

Summary

Legend

- **Maturity of technologies**

Development under way

Tests under way

Tests completed

Operational

- **Links**

Video link

Link to detailed service factshet

Solution patented or patent pending

Award - winning technology

3 Simulation and Training

4 Monitoring of facilities and tracking of operations

5 Decontamination

6 Cutting / Robotics

7 Support for operations

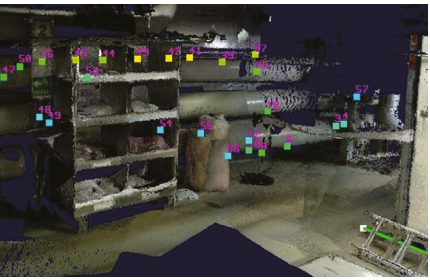
8 Characterization and conditioning of waste

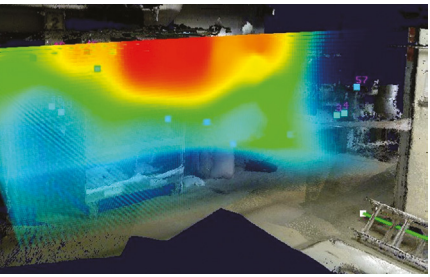
MANUELA™

3D radiological and topographical mapping

Virtual 3D space reconstructed as it exists and in real time:

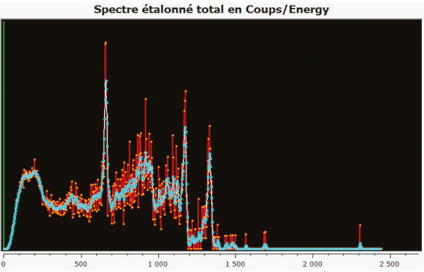
- 3D reconstruction of the existing environment with precise, simultaneous positioning of the measurements taken by the operator
- Measurements related to their context as scanned in 3D, allowing changes in the environment to be monitored and archived
- Interpolation of dose rate field and back-projection of hot spots directly accessible by the operator at the end of the scan





Precise positioning of measurement points:

- Radiological measurements (dose rate, gamma spectrum) linked to coordinates in an X, Y, Z coordinate system
- Measurement repeatability and management of positional uncertainty



Measurement automation:

- Automatic measurements, saved in situ
- More measuring points per gesture for complete characterization of the area

ACCURACY
Data accurate to within 2 cm without GPS

QUALITY
Measurement reliability and traceability

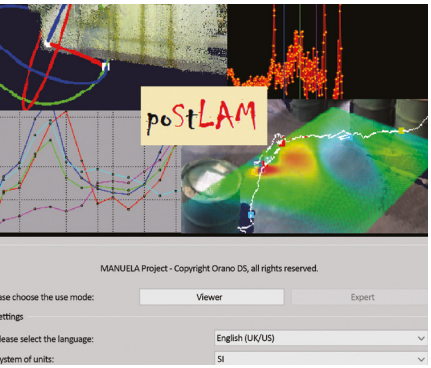
PERF'
More information from a single operation

REFERENCES

- **EDF Cattenom NPP:** 3D maps for SGR ALARA study
- **EDF Fessenheim NPP:** contribution to ALARA studies for maintenance operations
- **Orano la Hague:** investigations prior to decontamination of facilities
- **Idaho National Laboratory:** preparatory investigations for maintenance operations

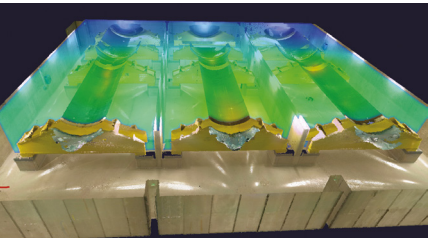
PoStLAM

3D analysis of physical and radiological data



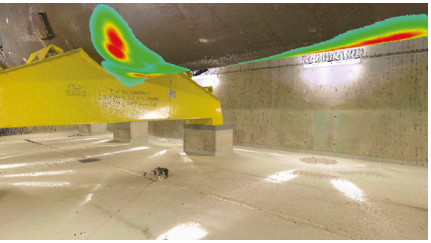
PoStLAM Viewer - Enhanced 3D environment:

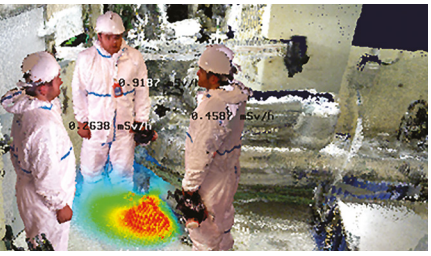
- Visualization of 3D scan and positioned measurements (dose rates, gamma spectra)
- Visualization of results interpreted with Standard and Expert PoStLAM:
  - Gamma radiation intensity distribution
  - Spatial identification of sources of irradiation and their characteristics



Standard PoStLAM - ALARA tool:

- Investigations saved as digital archives
- Management of single part up to whole building (digital twin)
- Integration of virtual operators (avatars) into 3D model to assess accumulated dose of personnel as part of ALARA approach
- Simulation of operating scenarios and optimization of workstations
- Export to CAD applications in various standardized formats (e.g. .obj, .fbx, .sat, etc.)





Expert PoStLAM - Expert tool:

- Gamma spectrometry
- Activity calculations using transfer and solving functions

OP

8 & 36

PERF'
Digitization of the environment, data archiving and management

ALARA
Visualization of isodoses and dose rate optimization

EXPERTISE
Gamma spectrometry and activity calculation

REFERENCES

- **EDF Cattenom NPP:** 3D maps for SGR ALARA study
- **EDF Fessenheim NPP:** contribution to ALARA studies for maintenance operations
- **Orano la Hague:** investigations prior to decontamination of facilities
- **Idaho National Laboratory:** preparatory investigations for maintenance operations

MARA

Mesh with Augmented Reality Assistance

Mesh for mapping large areas:

- Rapid and automatic construction of a mesh prior to radiological investigations
- Information entered on the control unit (smartphone) and used to generate an intervention report directly prior leaving the worksite
- Replacement for conventional intrusive mesh solutions

Visualization of information collected:

- Wireless communication between the MARA box and the smartphone
- Augmented reality (AR) to view the mesh directly on the control unit

Traceability of information:

- Information acquired in situ is automatically saved on the smartphone
- These data can also be written on NFC chips to be fixed on each cell of the mesh
- The reading/writing of this information is done using the smartphone connected to a NFC reader

ALARA
60% less time spent in irradiated zone

QUALITY
Traceability of measurements

SIMPLICITY
Installation in less than 2 mins

REFERENCES

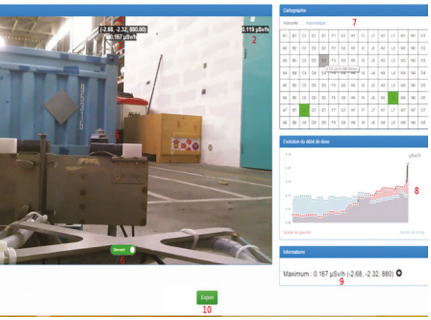
- **Orano Tricastin:** investigation of large surfaces upstream of dismantling operations
- **CEA Marcoule:** investigation of pools upstream of dismantling operations

RIANA SC

Autonomous radiological mapping beneath containers

Autonomous radiological mapping (dose rate) of undersides of waste containers:

- Mobile robot enabling autonomous radiological mapping of underside of containers
- Trajectory designed to cover 100% of surface to be mapped
- Robot remains under container at all time, allowing co-activity without risk
- Dose rate measurement performed at adjustable distance (30 cm by default), and can be refined to contact via a raising/lowering mechanism



Supervision and traceability of data:

- Control of robot from 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 backup of data for each check performed
- Production of video during journey for visual investigation

SAFETY
Eliminates risk of falling from height and reduces dose

QUALITY
100% exhaustive traceable mapping

AUTONOMY
Robot designed to work in co-activity

REFERENCES

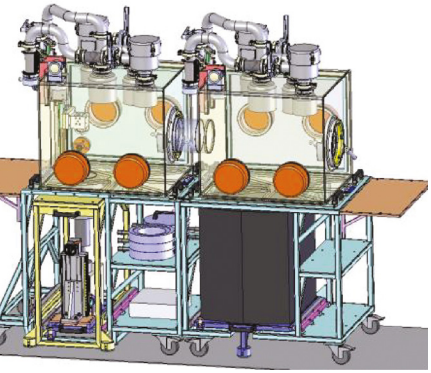
- **Orano DS ICPE Triade:** implementation of RIANA SC for the inspection of waste containers before shipment

In situ lab

In situ worksite analyses

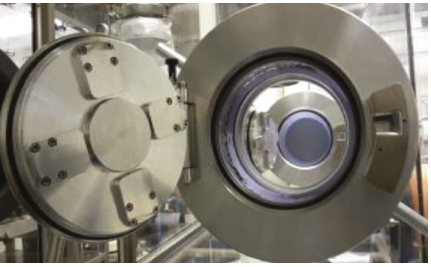
Radiological characterization of solid samples at the worksite:

- Totally modular, mobile installation, adaptable to the specific needs of the worksite, for example:
  - Gamma spectrometry measurement (samples protected by shielding so they can be measured in an environment with high background noise)
  - Sample water content measurement using a thermobalance



Optimization of sampling plans and schedules:

- Alternative to systematically sending samples to laboratory
- Targeted reference analyses continue to go to lab
- Potential to increase number of samples analyzed without any impact on worksite schedule
- Reduced number of samples transported to laboratory



Occupational / nuclear safety:

- Class 2 ventilated glove box as per ISO 10648-2 for containments

SAFETY
Airtight glove box system

QUALITY
More representative measurements

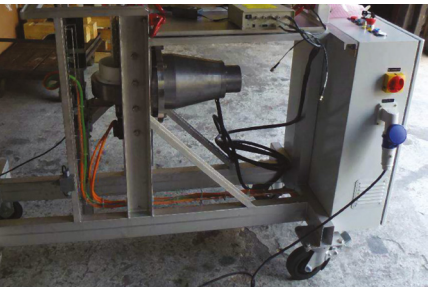
PERF'
Reduction in transportation and analysis times

REFERENCES

- **CEA Marcoule:** installation under way at UDH worksite

RODSY & RASCO²

Remote concrete core drilling and in situ measurement



Rover drilling systems for remote dry sampling of concrete in semi-automatic mode:

- **RODSY30:** single core 30 cm long
- **RODSY10+:** 5 cores 10 cm long in single operation

Facilitation and reliability of operations:

- Systems allowing remote coring operations in irradiated and/or contaminated zones
- Core drilling performed **dry**, removing need to manage contaminated effluents

Occupational and nuclear safety of operations:

- Core drills remotely operated eliminating integrated doses for operators
- Criticality risks in U/Pu environment reduced due to the lack of water

RASCO²: Mobile measurement station for in situ analysis

- Automated measurement system to determine the core contamination profile by gamma spectrometry
- Measurement processing software for visualizing the 3D distribution of contamination in civil engineering structures

OP

PATENTED

SAFETY
Eliminates risk of spreading contamination

SECURITY
Force measurement, remote restarting, EC certified

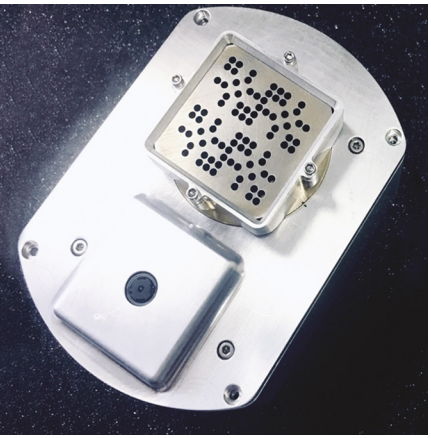
PERF'
In-situ analysis of cores

REFERENCES

- **CEA Marcoule:** supply of complete system for dismantling project at decladding U workshop

NanoPix

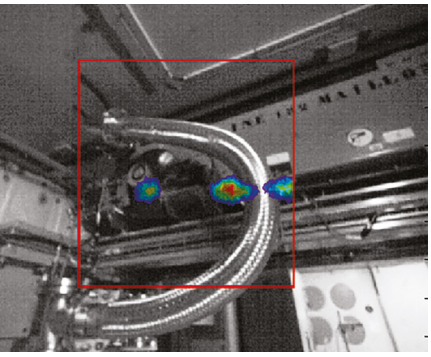
Miniature gamma camera



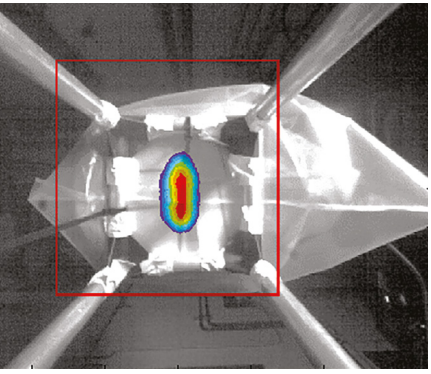
NanoPix: a gamma imager developed by CEA LIST in collaboration with Orano DS

Like any other gamma camera, NanoPix can:

- Superimpose a real image (photo) and a dose rate curve formally expressed by a colored patch
- Rapidly locate gamma sources that are hard to access and/or in highly radiological environments



Its main advantages: its small size and low weight, which enable it to be embedded on different supports (e.g. pole, robot, robot arm, drone, etc.)



Technical characteristics:

- Dimensions: 10 x 7 x 5.4 cm
- Weight: under 400 g
- Angular resolution: 6°
- Field of view: 50°

ALARA
Remote investigation ⇨ reduces operator dose

MINIATURE
Easily embedded

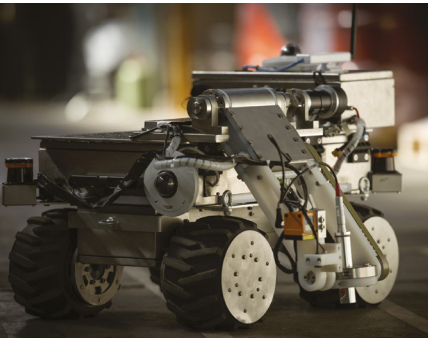
INNOVATIVE
Smallest camera on market

REFERENCES

- **Orano la Hague:** effluent filter measurements
- **Orano la Hague:** identification of hot spots on ventilation ducts
- **Orano la Hague:** identification of material precipitation at bottom of vessel
- **CEA Marcoule:** investigations of pit 7 and pools P and Q

RIANA

Multi-purpose carrier for investigations

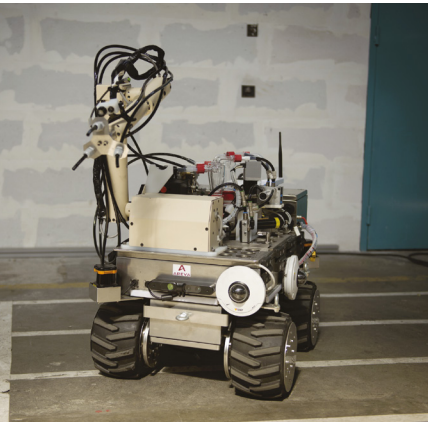


Ground-level radiological mapping module:

- Real-time 2D map construction and precise positioning of measurements
- Measurement of dose rate and surface contamination, and gamma spectrometry

Remotely controlled arm with 3 degrees of freedom:

- Gripping of objects, radiological mapping of walls and equipment
- Interchangeable grippers for moving objects and measuring probes



Module for taking liquid and powdery samples:

- Collection of 3 liquid or powdery samples (50 cm^3 max) and in situ dose rate measurement

ALARA
Measurements taken remotely

QUALITY
Precision and traceability of measurements

MODULARITY
Interchangeable measurement modules

REFERENCES

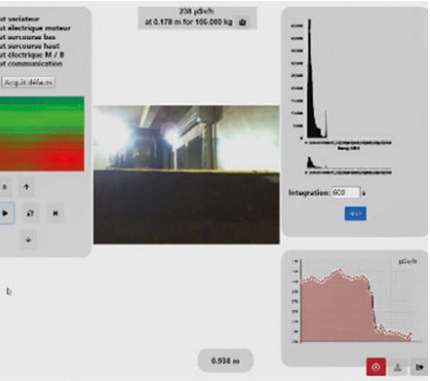
- **CEA Marcoule:** one set of equipment delivered as part of the Intervention Units pack
- **Orano's National Response Force (FINA):** one set of equipment delivered as part of crisis management operations

MINDE

Modular, scalable and customizable HMI

Modular, scalable and customizable HMI for instrumentation control:

- Ergonomic Human-Machine Interface (HMI) designed to make the control of nuclear instrumentation accessible to non-expert profiles
- Integration of all measurement elements necessary for operations in nuclear environments (e.g. dose rate, gamma ray spectrometry, cameras, distance, weighing, etc.)
- Customizable HMI allowing data to be both managed and viewed in real time



Investigation and characterization:

- System used for the remote control of nuclear investigation robots
- Integrated into nuclear characterization workstations

ADAPTABLE
to the constraints of each operation

ACCESSIBLE
to non-expert profiles

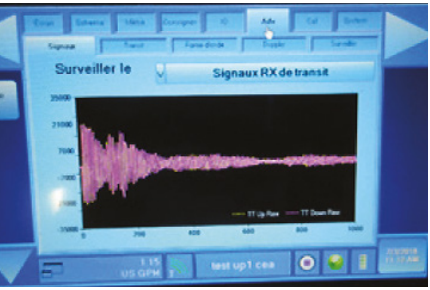
TRACEABILITY
and archiving of data

REFERENCES

- **Orano DS ICPE Triade:** control interface for RIANA SC container inspection robot
- **CEA Marcoule:** control interface for RIANA inspection robot
- **CEA Marcoule:** control interface for workstation for characterization of liquid effluent treatment station (STEL) drums

CACTUS

Active ultrasonic pipework inspection



Problem:

- Identifying the presence of residual liquid in pipework is an essential step that has to be carried out upstream of dismantling operations, given the risks to which operators are exposed
- Indeed, there can be significant consequences for the dismantling operator (e.g. contamination, chemical risks, etc.) and the site schedule

The ultrasonic detection solution:

- Implementation of an ultrasonic measurement technique with portable field instrument allowing measurements to be taken rapidly in most worksite configurations
- Adaptation of existing instruments to our operating constraints
- Passive (sourceless) and non-intrusive technique
- Reduction of risks related to residual liquid effluent in pipework when performing dismantling operations
- Elimination of worksite shutdowns due to suspected presence of residual liquid unforeseen in the dismantling scenario

SAFETY
Eliminates risk of spraying of liquids

RELIABILITY
Adapts a tried-and-tested system

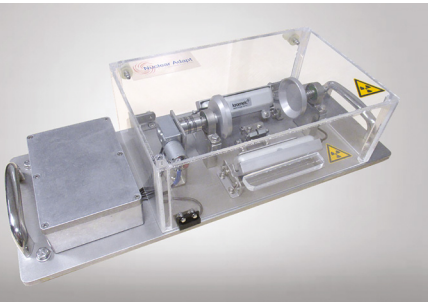
PERF'
Eliminates site hazards related to the discovery of residual liquid

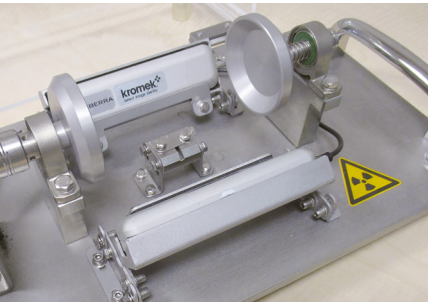
REFERENCES

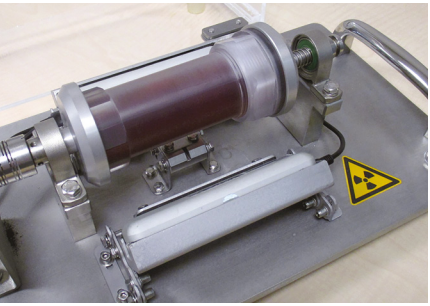
- **CEA Marcoule:** first industrial implementation at UP1 plant in 2018

MUNIC

Unitary neutronic measurement of vessels







Problem:

- The encapsulation of radioactive sludge in cement matrices according to Andra specifications requires knowledge of its physical, chemical and radiological characteristics
- The laboratory analysis of sludge sampling vessels makes operations very costly in terms of expense and time

MUNIC: a non-destructive, non-intrusive measurement system developed to determine the water content (and indirectly the quantity of dry solids) of radioactive sludge vessels, and thereby:

- Optimize the formulation of cemented packages (i.e. the mixture of sludge and cement)
- Limit the cost of analysis and reduce lead times for laboratory results

SAFETY
Non-intrusive measurement without opening vessels

SPEED
Results in 30 mins, instead of 1 week for laboratory

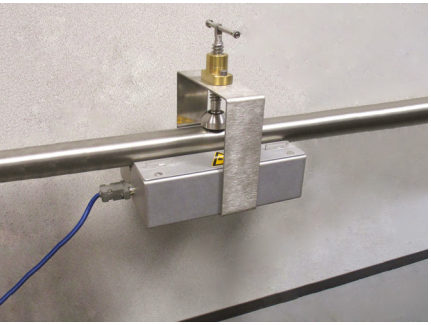
RELIABILITY
Making cemented packages secure

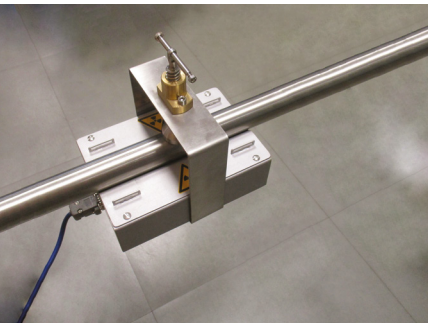
REFERENCES & PROSPECTS

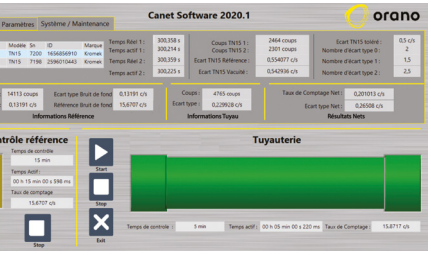
- **CEA Marcoule (UP1):** qualification tests on inactive vessels demonstrated that measurements had relative precision of <10%
- **CEA Marcoule (UDH):** 1st application of the system at UdH Marcoule is planned for 2022

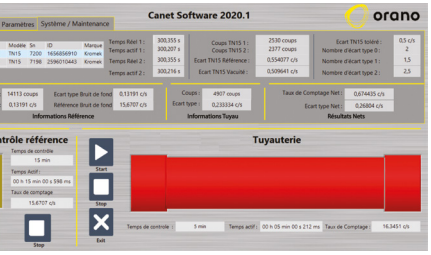
CANET

Active neutronic pipework inspection









Problem:

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- Indeed, there can be significant consequences for the dismantling operator (i.e. contamination, chemical risks, etc.) and the site schedule

CANET: a field device designed to

- Detect the presence of a liquid phase in a pipework element in a non-intrusive way
- Enable pipework dismantling in the safest, most appropriate way

Tool supplied with:

- A pole for reaching zones that are difficult to access
- Intuitive analysis software designed to give the operator an immediate diagnosis on the ground (i.e. presence/absence of a liquid)

SAFETY
Eliminates risk of spraying of liquids

QUALITY
Reliable, reproducible results

EXPERTISE
Results interpreted to guide the operator

REFERENCES

- **CEA Marcoule (UP1):** qualification tests performed in 2020 on a model with loaded liquids and solid deposits

ANEMONE

Recovery and sampling tool

A tool designed to grip any solid element, whether for sampling purposes or more generally for recovery and removal

Characteristics:

- Structure: rigid body and a flexible head equipped with tentacles designed to grip and trap any type of object or material
- Dimensions: 95 mm in diameter and 375/265 mm long (deployed/retracted)
- Gripping action: provided by retraction of the anemone

A universal, reproducible and scalable sampler:

- Dimensions and characteristics adaptable to needs
- Allows simultaneous recovery of several solid objects
- Allows recovery of various materials (e.g. lead, steel, corium, etc.)
- Can be deployed on different types of surface (e.g. water, sludge, sand)
- Radiation resistant

3D PRINTING
Reduced manufacturing time

RADIATION PROTECTION
Limited dosimetric impact

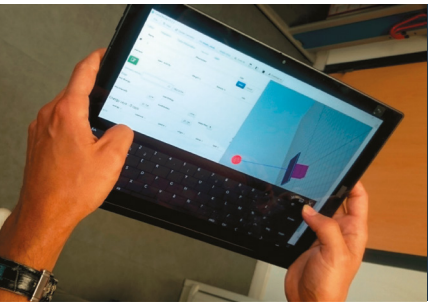
PERF'
Operations in challenging, irradiating and underwater environments

REFERENCES

- **Beaumont Hague - Orano Projects test all:** tests demonstrated that the tool can take samples of different types (e.g. metal, corium, plastic, etc.), densities, sizes and degrees of roughness, in different environments (e.g. air or water) and from different surfaces (e.g. sand, sludge, rubble)

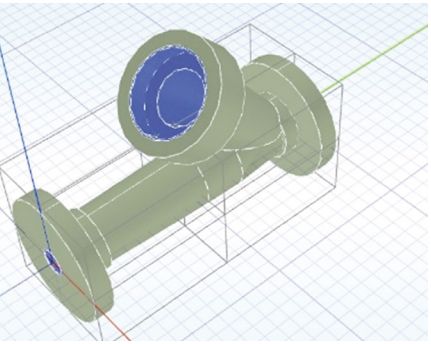
CartoOnline

Collaborative radiological modeling



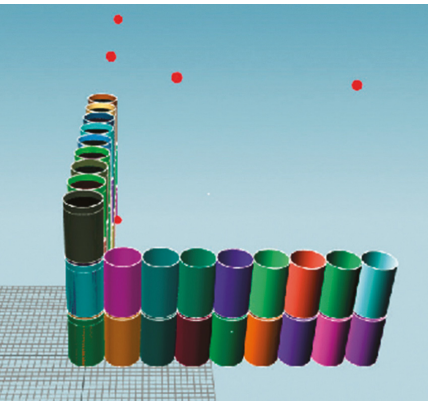
3D modeling software applied to radiological protection calculations and nuclear measurements:

- Configurable modeling of complex geometries
- Real-time modification of input data (e.g. container size, fill level, density, etc.)
- Creation of configurable transfer functions



Expert assessment and information sharing:

- Application available on tablet for use in situ
- Offline or online cloud tool allowing remote information sharing and simplified access to expert assessment
- Compatible with multi-purpose measurement workstation developed by Orano DS for fully automated waste characterization



Proven and qualified calculation codes:

- NARMER: qualified by Orano, CEA and EDF

SIMPLICITY
Can be used by beginner and expert profiles

QUALITY
Lower measurement uncertainty = optimized waste disposal channel

PERF'
Modeling time reduced by factor of 10

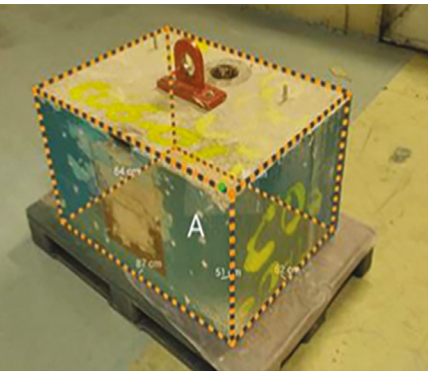
REFERENCES

- **CEA Marcoule:** modeling of pools P and Q upstream of dismantling operations
- **Orano Tricastin:** modeling of equipment for in situ characterization
- **Orano Malvési:** modeling of waste for final characterization
- **Orano la Hague:** in situ modeling for investigations

3D SCAN
3D digitization

Physical assessment of the environment:

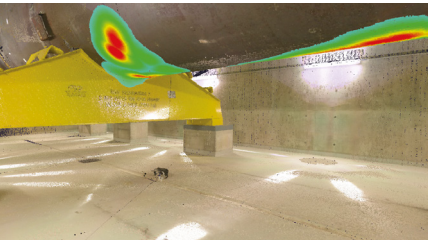
- 3D scanning of the environment for viewing at a given time
- All the measurements of a complex environment performed in one take, stored in a single file



Preparing operations:

- Integration of 3D elements (e.g. tools, robots, airlock, etc.) in the environment in order to validate the layout of the worksite and visualize any interferences
- Simulation of equipment replacement, connection checks, etc.

Sharing information:



- Navigate a 3D virtual model as though it were real
- Extract drawings and units: visualize overall dimensions and access points
- Present the worksite environment to operators, understand the risks and thereby make the operation more reliable

OP

8 & 10

SAFETY
Patented enclosure system for intervention in contaminated zones

QUALITY
Reliability, precision and traceability of data

ADAPTABLE
Scans can be conducted indoors or outdoors

REFERENCES

- **CEA Marcoule:** UP1 plant - Room 55, SPF/AVM, STEL
- **CEA Saclay:** ADEC, Ulysse, STEL, EDC, etc.
- **CEA Cadarache:** INB 54, AGATE, etc.
- **EDF Chinon NPP:** machine room, CEX system water chambers
- **Orano la Hague:** UP2-400 HAO

Polar crane driving simulator

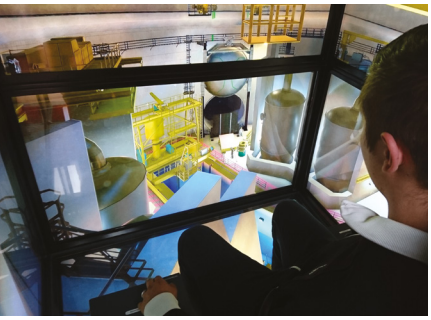
Immersion in a virtual environment

Reproduction of a polar crane cab:

- Immersion of crane operators in the reactor building environment
- Transportable, realistic crane cab

3D modeling and scenarios:

- 3D modeling of reactor building environments
- Integration of all typical unit outage scenarios
- Management of collisions with the environment and simulation of hazards



Incorporation of a foreman avatar with semi-artificial intelligence:

- Crane operator follows foreman's instructions
- Foreman adapts orders in real time according to the way in which the load is moved

Control tablet:

- Monitoring of activity in real time and direct interaction with the crane operator
- Possibility of viewing the complete maneuver again

AVAILABLE
Training accessible outside of unit outages

DYNAMIC
Simulation of scenarios on demand

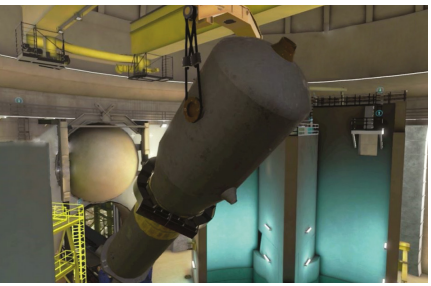
LEARNING
Post-training analysis and interaction

REFERENCES

- **Orano DS - EDF NPP site:** training provided upstream of unit outages (EDF Just in Time approach)
- **EDF Paluel NPP:** services/ training on removal of SG42 (steam generators) from unit 2 on 1,300 MW series reactor
- **Orano DS - EDF Creys Malville, Cattenom and Belleville NPPs sites:** training new operators and raising awareness among experienced crane operators upstream of unit outages

Handling/lifting simulator

Virtual reality training



Co-activity with a polar crane handling operation:

- Immersion of operators in an environment modeled in 3D
- Integration of co-activity on specific activities (crane operators/foreman/ monitors, etc.)
- Learning all regulatory and technical skills
- Preparation and training in the handling and use of specific tooling (e.g. lifting machine, negative pressure machine, steam generator, radioisotope thermoelectric generator, etc.)

Specific operations:

- Training in a virtual environment on risk activities
- Learning technical skills
- Risk awareness:
  - Radiological, stress, activity time management
  - Technical, mechanical or linked to co-activity
- Integration of unexpected events, exposing operators to exceptional situations without any risk

AVAILABLE
Training accessible at all times

DYNAMIC
Simulation of scenarios on demand

LEARNING
Post-training analysis and interaction

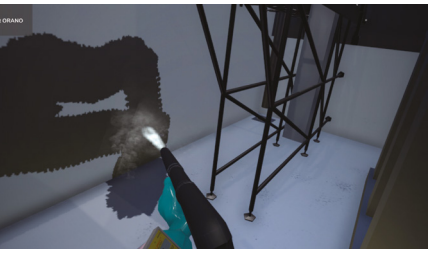
REFERENCES

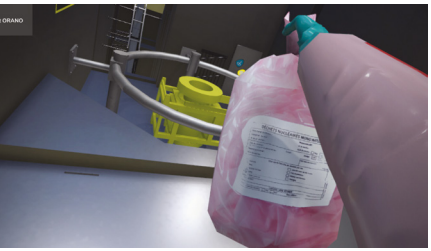
- **Framatome:** creation of VR training module on the introduction and removal of steam generators (SGs) on 1,300 MW series reactor

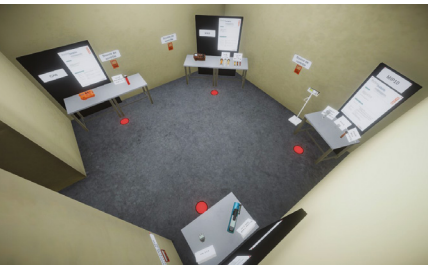
- **Orano DS:**
  - Training on the installation of the negative pressure machine (MEDCP)
  - Virtual tour for new operators

Simulator for sensitive activities

Virtual reality training







Development of specialist applications in virtual reality (e.g. decontamination (reactor/fuel building pool), waste, scaffolding, «jumping», etc.)
Scenarios created based on a real situations:

- Preparation and training for work in difficult environments (vessels, reactor building, etc.)
- Practice on recurrent activities (waste management, decontamination, containment airlock, etc.)
- Virtual tours and concrete practice on facilities

Learning and training:

- Risk prevention:
  - Radiological, stress, activity time management
  - Technical, mechanical or linked to co-activity
- Training of operators in a specific activity:
  - Learning technical skills
  - Feedback in real time with specialist experts
- Integration of unexpected events, exposing operators to exceptional situations without any risk

MODULAR
Dedicated development depending on constraints in the field

SAFETY
Identification of risks and impacts

LEARNING
Post-training analysis and interaction

REFERENCES

- **Orano DS:** training in pool decontamination operations, tour of a reactor building
- **EDF Belleville NPP:** introduction to reactor building for 30 new operators
- **EDF Penly:** preparation for scaffolding installation at bottom of pool

Jumper VR (SG nozzle dam work)

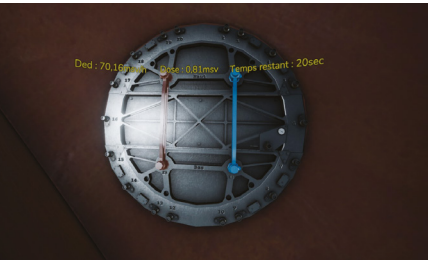
Step into the shoes of a jumper

Virtual reality in a confined environment:

- Immersion of jumper* learners into the bottom of a steam generator (SG)
- Learning technical skills for the installation and removal operations of the SG nozzle dam

A simulation close to reality:

- Simulation of absorbed dose
- Integration of hazards (e.g. torn suit, loss of air supply, dose rate alarm, etc.)
- Timed exercises to be completed within a set time (i.e. 60 seconds in the bottom of the SG)
- Pdf format reports to monitor learners' progress



Pro's:

- Ease of implementation
- Cost reduction
- Candidate aptitude test

*Operator who replaces the steam generator nozzle dam

CSR POLICY
Stimulating and supportive learning environment

SAFETY
Training in a secured environment

PERF'
Repetition of technical skills at a lower cost

PROSPECTS

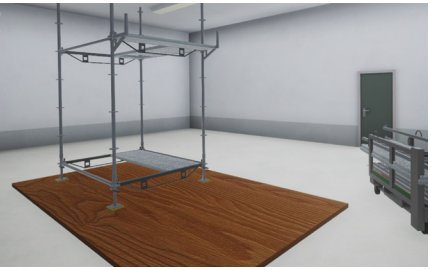
- **EDF Paluel NPP:** provide training to all Orano DS jumpers (Q1 2022)

Echaf VR

Training for carrying out work at height safely

Virtual reality (VR) for scaffolders:

- New operators: simple and fun access to the information needed to set up and approve a scaffold structure
- Experienced operators: updating and renewal of knowledge

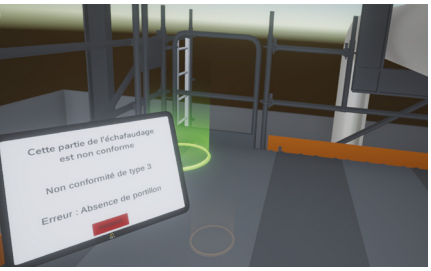


Application made of four modules:

- Choice of different types of PPE
- Setting up a scaffold using a plan
- Scaffold approval: identification of errors in more or less complex scaffolds
- Seismic countermeasures for scaffolds

→ Gradual adjustment of the difficulty of these modules to the learners level (i.e. beginner, intermediate and experienced)

Edition of a report after each training session



Solution available to train scaffolders working outside the nuclear industry

CSR POLICY
Stimulating and supportive learning environments

SAFETY
Scaffold safety awareness

PERF'
Repetition of technical skills at a lower cost

REFERENCES & PROSPECTS

- **EDF Penly NPP:** preparation for scaffolding installation at bottom of pool (June and September 2021) jumpers (Q1 2022)
- **Orano DS:** deployment planned for 2022 across the entire DOPN

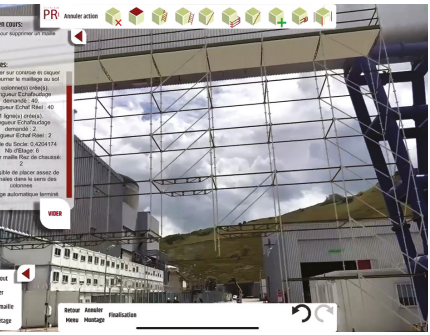
Echaf RA

A scaffold design tool

Augmented Reality (AR) scaffolds:

- Design scaffold adapted to site constraints and facilitate their three-dimensional (3D) visualizations within their environment using AR on a mobile device (tablet)

Two options are proposed:



- Option 1 - Scaffolds created in real-time and in-the-field using a tablet:
  - identification of the assembly area, design of a scaffold, visualization of the design in AR, save and send the structure to the design office for the design calculation

- Option 2 - Importing a 3D model from the design office
  - positioning of an approved scaffold in its real environment, check of the suitability of the scaffold before its assembly, validation of data with the customer in-the-field

Automatic report including:

- The list of the materials required to set up a scaffold
- Several views of the modeled scaffold

CSR POLICY
Stimulating and supportive environment

UNIVERSAL
Modeling of all scaffold brands used by ODS

PERF'
Technical validation with our customers prior assembly

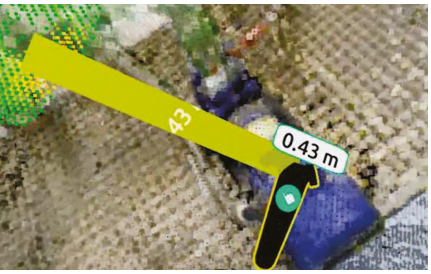
REFERENCES

- **EDF Chinon NPP:** Echaf RA was tested in August 2021 indoors and outdoors, under different light conditions and on the basis of the requests usually made by our customers

VR mapping
Immersion without exposure

Immersive and interactive environment for training workers

- Virtual reality immersion of operators in the work area
- Presentation of worksite environment to operators so they understand the risks, making the intervention more reliable
- Integration of interactive tools to improve immersion: virtual radiation meter, distance measurement, visualization of hot spots and radiation field, etc.
- Quickly deployable in any type of environment



Information transmission without exposure

- An effective, visual way to share the reality of the worksite with operators who are not intervening but still involved in the operation
- Avoids unnecessary exposure
- Can be obtained using **MANUELA™** and **PoStLAM**

ALARA
Visualizing the radioactive zone without exposure

SECURITY
Risk prevention through training

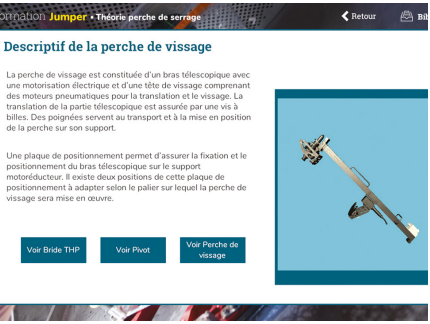
PERF'
Most effective way to reproduce environment

REFERENCES

- **EDF Cattenom NPP:** 3D maps for SGR ALARA study
- **EDF Fessenheim NPP:** contribution to ALARA studies for maintenance operations
- **Orano la Hague:** investigations prior to decontamination of facilities
- **Idaho National Laboratory:** preparatory investigations for maintenance operations

Serious Games

Fun learning for knowledge acquisition



New training methodology:

- Design of a 3D environment incorporating targeted activities
- Immersion of learners in a context close to reality
- Exposing learners to hazardous situations and developing behaviors and attitudes that can save lives
- Initiation into a relationship of shared vigilance

Development of dedicated scenarios:

- Welcoming new hires, Human Performance Tools, contamination management, specialized maintenance, operator safety, shared vigilance and «jumping»
- Subjects such as quality, occupational/ nuclear safety (fire, ionizing radiation, transportation of hazardous materials, wearing of PPE, travel by vehicle, RSI prevention, etc.)
- Specific topics (contamination management, logistics, handling, scaffolding, etc.)

Training adaptable according to needs:

- Classroom session with trainer
- Dedicated session on PC with generation of an individual report

EDUTAINMENT
Fun learning for knowledge acquisition

INTERACTIVE
Working environment faithful to reality

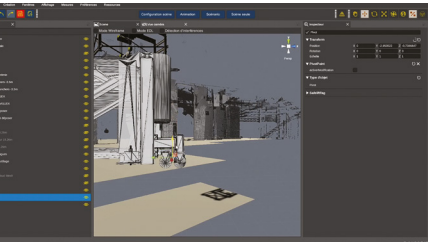
EXERGAMING
Learning to complete tasks correctly with practice

REFERENCES

- **Orano DS/EDF/UTO:** development of customized modules suited to the specific requirements of sites

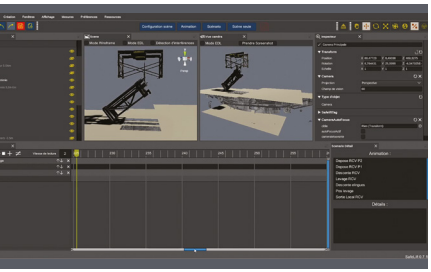
Safelift

Complex handling simulator



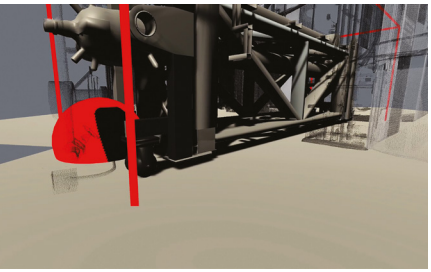
Safelift software:

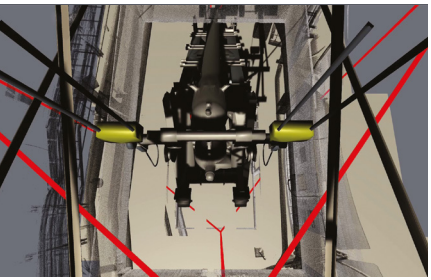
- Design, model and produce handling kinematics in a 3D database (point cloud, digitized meshes, etc.)



From the study to the analysis of a handling scenario:

- Create complex handling scenarios using point clouds (up to 50 million points)
- Calculate distances in real time to identify collision zones between the object being handled and its environment
- Establish the feasibility of a handling scenario using an interface for creating and managing animations
- Export kinematics choices
- Validate the methodology most suited to the real environment





Perspectives:

- Take into account the complexity of EDF facilities and lifting operations to rapidly generate lifting simulation scenarios (including load tipping, real-time modeling)
- Development for lifting professionals

SOLUTION
All-in-one simulation software

DYNAMIC
Simulation of operation scenarios on demand

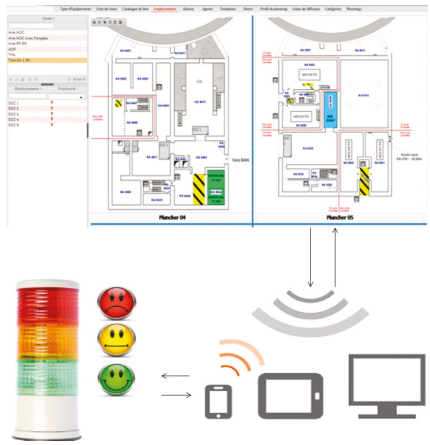
ADAPTABLE
Analysis and discussion on discipline-specific features

REFERENCES

- **UTO - EDF R&D:** Safelift (build 7.14) was implemented for UTO activities; the application was delivered to EDF R&D June 30 2021

Zone boundaries

Control box for monitoring zone boundaries



The Zone boundaries application:

- Locate, control and secure access to working sites

The actions:

- Localization and digital control of working sites on a web application
- Digital and synchronized control of the installation conformity using the mobile application
- Visual identification of compliances or deviations on sites with the zone jump box positioned on the site
- Ensure worksite compliance at all times
- Capitalize on operating experience feedback (e.g. photos of past marking of zone/room boundaries)

Optimized monitoring of zone boundary compliance:

- **Location:** the operator identifies the zones to inspect
- **Display:** the tracking form on the pillar is dematerialized and permanent

The system can be adapted for other applications (e.g. worksite compliance)

UNIQUE
Only zone boundary inspection application on the market

SAFETY
Worksite compliance can be guaranteed at all times

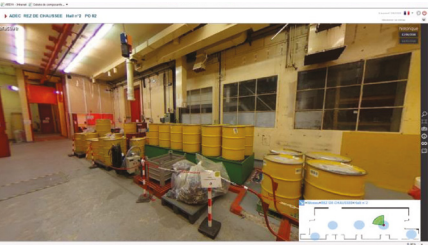
EFFICIENCY
Saves time and reduces paper tracking forms

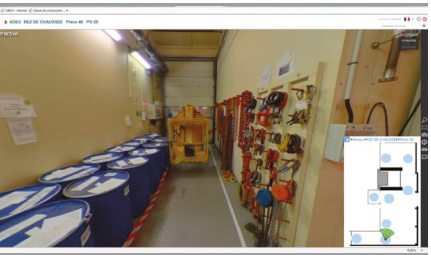
PERSPECTIVES

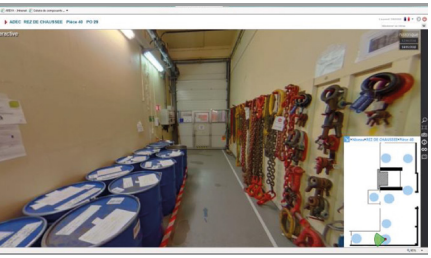
- **Orano DS - EDF Cattenom NPP:** deployment of pilot Q3 2021

Virtual inspection

Inspection and supervision of facilities







Giving as many people as possible access to information:

- **Training and immersion of operators:** immersion of operators and project participants in a new and sometimes physically inaccessible environment
- **Information management:** centralize and increase the reliability of all information gathered and necessary to prepare studies and operations
- **Operation of facilities:** catalog and track the numerous items of equipment within a facility

VIS-On solution:

- Use of a 360° camera allowing the environment to be captured rapidly in its entirety
- Coupling of 360° photos with specialist data to generate an enriched visual and digital environment
- Remote tours, guided tours, integration of annotations or inspection points, etc.

SIMPLICITY
Immediate operational implement-tation

ADAPTABLE
Integration of all types of information

DYNAMIC
File enriched throughout the life of the project or facility

REFERENCES

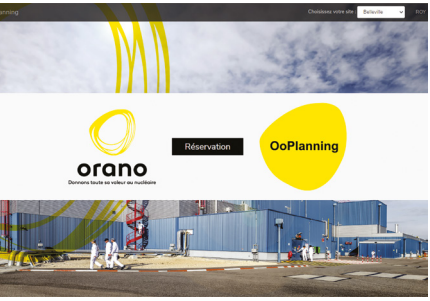
- **CEA Saclay:** creation of virtual tour of the decontamination workshop (ADEC) as part of operational and round tracking activities
- **TRIHOM Gravelines:** creation of virtual tour of the training workshop for integration into various training modules

OoPlanning

Interactive calendar for logistics specialists

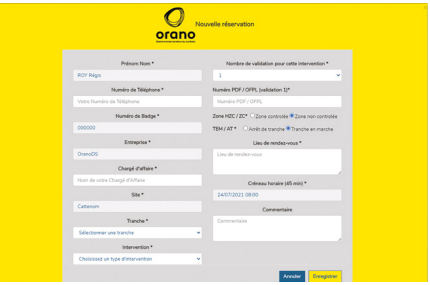
OoPlanning

- Management of activities on a digital schedule based on customers need (e.g. «fire permit», «floor opening and closing», etc.)

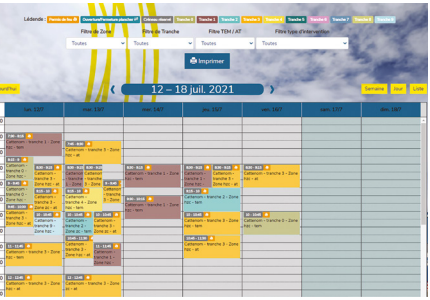


Simplified and diversified use

- An online address for multiple bookings
- An open access for internal use but also for external companies
- Smoothing activities and managed according to needs (e.g. no more than 2 reservations in the same time slot)
- Operator workload is steadier
- All intervention requests get a response



Application available to Orano users as well as external operators via a webpage on a dedicated portal



UNIVERSAL
Customizable tool meeting several needs

QUALITY
Reservation requests recorded

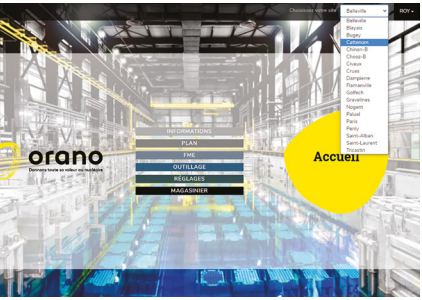
PERF'
Technical intervention requests controlled

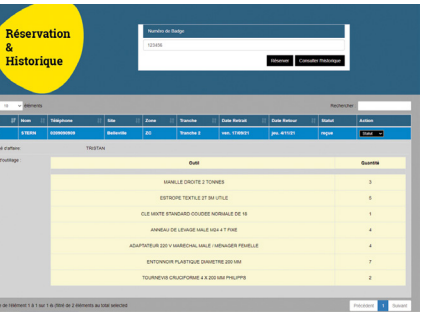
PERSPECTIVES & PROSPECTS

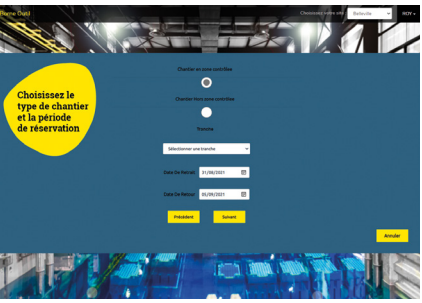
- **Orano DS - EDF Cattenom NPP:** application tested during unit outage (Q2 2021)
- **Orano DS - EDF Cattenom NPP:** the application is being updated to be deployed on all DOPN sites, la Hague and Tricastin (Q1 2022)

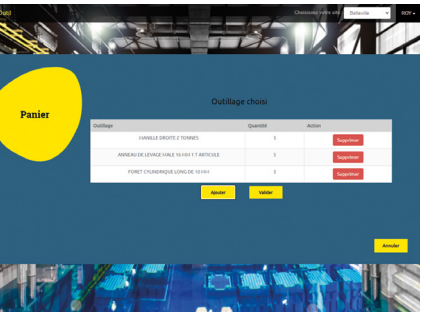
Tooling reservation terminal

Optimized information management









Facilitate tooling reservation and withdrawal:

- Anticipate requests on an e-commerce type platform:
  - Access by the requesting party with online tracking of the request
  - Access by the warehouse keeper with inventory management and tracking of tooling requests

Manage flows:

- Limit waiting times at equipment withdrawal desks
- Optimize management of tooling inventories and anticipation of tooling stock shortages

Tracking and traceability:

- Grouping data together on a single platform ensures equipment history is traceable
- Possibility of organizing work ahead of time
- Warehouse keeper has access to all user contact details (e.g. company, contract manager, phone number, etc.)

QUALITY
Improvement in information reliability and traceability

SIMPLICITY
Intuitive interface

PERF'
Reduction in waiting times at warehouse

REFERENCES

- **EDF Belleville NPP:** deployment of the tool at the Belleville NPP tooling warehouse, managed by Orano DS

Single-component peelable resins

Decontamination/protection with sprayable resin

Protection of equipment and premises:

- Protect equipment before entry into contamination risk zone
- Protect work chambers and worksite zones using one or more separable layers of resin
- Protect ventilation equipment and premises to maintain dynamic confinement

Confinement of contamination:

- Confinement of contaminated surfaces (e.g. work tents, walls, ventilation ducts, equipment, etc.)
- Confinement of contamination between two layers of resin

Decontamination:

- Treatment of contaminated surfaces: spray, dry, then peel off the resin to remove fixed surface contamination

OP

WASTE
Compatible with nuclear waste disposal channels

SIMPLICITY
Applied from a distance with airless spray gun

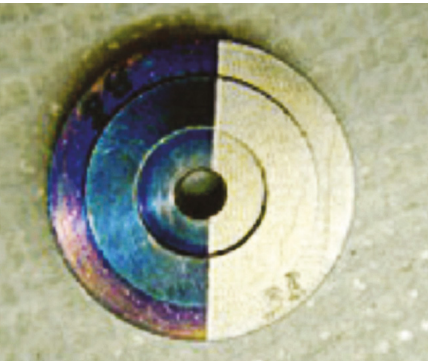
ADAPTABLE
Can be used on all types of surfaces

REFERENCES

- **CEA Saclay:** protection of cutting airlock at the liquid effluent treatment station (STEL)
- **Orano la Hague:** protection and decontamination of cutting airlocks on dismantling worksites
- **Orano la Hague:** restoration of dynamic confinement of supply units
- **Orano la Hague:** decontamination of CBFK container (factor of 8)

Decontamination laser

Metal surface decontamination



Principle:

- Laser decontamination is a dry process based on the interaction of laser radiation with the surface of a structure (e.g. oxide layer, coating, paint, etc.)

Preparation of surfaces prior to non-destructive testing (NDT):

- Removal of oxides or paints to allow use of inspection equipment
- No damage to weld seams (an advantage over conventional mechanical methods)

Decontamination:

- Treatment of non-fixed, fixed (including hot-formed oxides) and greasy contamination
- Treatment of parts with complex geometry
- Patented laser head system to allow use in the nuclear zone without contaminating parts in contact with elements to be treated or impacting the performance of the laser

OP

PATENTED

EFFICIENCY
Up to 10 m² per hour in automated mode

WASTE
No production of liquid effluents

SAFETY
Compatible with nuclear building ventilation systems

REFERENCES

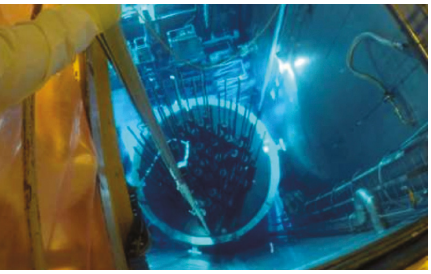
- **Orano la Hague:** decontamination test on ECE cask
- **EDF Belleville NPP:** removal of paint on reactor coolant system piping
- **EDF Blayais NPP:** removal of paint on SG support ring
- **CEA DAM:** decontamination of metal equipment

ICLAREC II

Pool water clarification tool

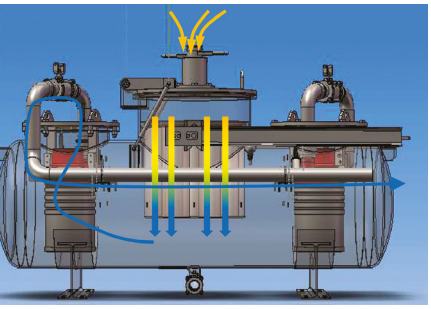
ICLAREC II was designed for use in maintenance operations during unit outages and ahead of fuel unloading/reloading phases, when:

- Underwater vision is limited due to turbidity
- There is high radiological activity
- Foreign bodies or loose parts are present in the water



The system enables:

- Suction and filtration of particles in suspension
- Surface skimming: reduction of supernatants by suction and filtration of particles in suspension
- Suction of particles
- Recovery of objects at the bottom of pools (option): elimination of loose parts in the pool bottom by suction and trapping of the parts (e.g. bolts, tape, miscellaneous objects, etc.)



OP

PATENTED

ADAPTABLE
Suitable for many types of pools/ ponds

SIMPLICITY
Ease of handling and maintenance

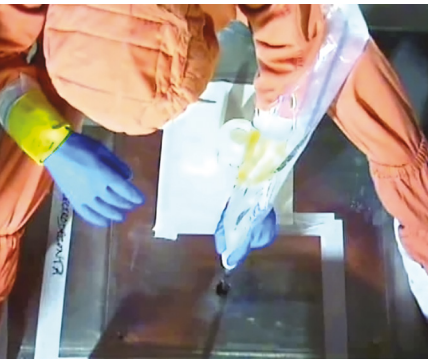
MULTI-FUNCTIONAL
1 single tool for 3 applications

REFERENCES

- **EDF Bugey NPP:** deployed for the first time in Q3 2017 for cleaning fuel pools

Portable electrochemical decontamination

Metal surface decontamination solution



Tried-and-tested process for the nuclear industry

- Process consisting of disintegration of the oxide layer and the base metal
- Application via brush (or multi-brush system) comprising several hundred thousand carbon fibers that fit the shape of the targeted part
- Applicable to maintenance and dismantling operations, this process allows processing of non-fixed and fixed contamination

Decontamination of tools and small surfaces

- Pickling of oxide layer and erosion of the base metal, using brush previously soaked in an electrolyte (HNO_3, H_3PO_4, etc.)
- Improves the final surface condition to reduce the risk of subsequent contamination

Decontamination of large surfaces

- Tools adapted to the processing of large surfaces (multi-brush, «telescopic» sweeper)

COSTS
Effective decontamination at low cost

PORTABLE
For more efficient pooling of resources

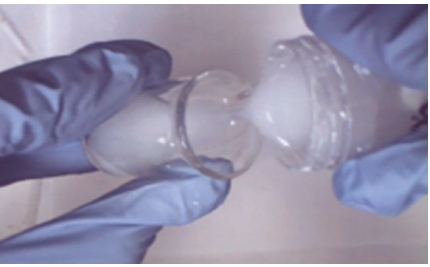
EFFICIENCY
Removes several µm of material in less than a minute

REFERENCES AND PROSPECTS

- **CEA Marcoule:** thorough (additional) decontamination of room 115, used for cementing drums of sludge
- **Orano la Hague:** upcoming decontamination tests at cell 904 - HAO South

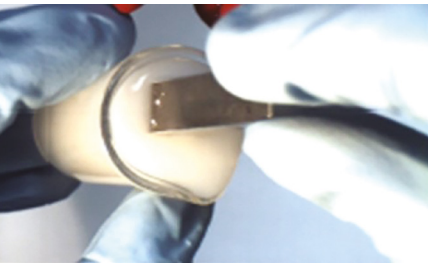
Coating gel

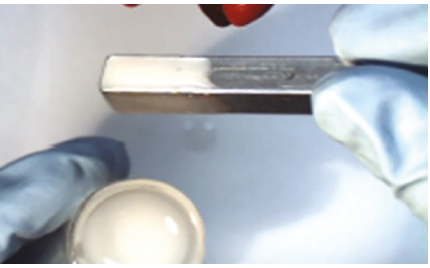
The advantages of a bath with fewer effluents



A combination of bath and dry gel

- The principle of this new process is based on the properties of decontaminating baths and dry gels
- Unlike vacuumable gels, coating gels are used in a similar way to baths:
  - The part being treated is dipped into a liquid solution
  - During dipping or coating, the solution turns into a gel
  - Once dry, the gel flakes off, similarly to dry gels
  - These flakes are the only waste generated - they are treated as dry waste





The process of choice for workshops

- Due to their ease of use, coating gels represent the solution of choice for decontamination workshops
- The best process for small and medium parts
- This process makes it possible to avoid contamination of the base solution, unlike with baths
- There are 3 different possible formulations of gel (basic, acidic and oxidizing) depending on the desired treatment

EFFICIENCY
Process efficiency similar todry gels

SIMPLICITY
Very simple application by dipping

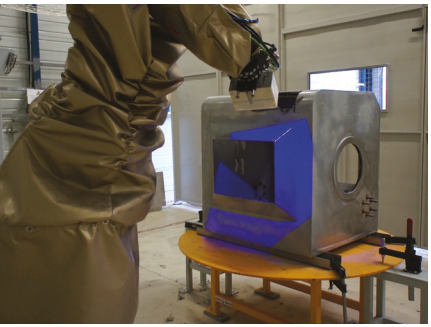
WASTE
No effluents generated: dry waste only

PROSPECTS

- **Solution under development:** implementation planned for T4 2021

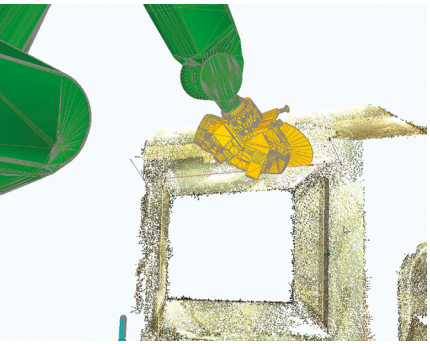
DEROSA

Semi-automatic robotic cutting



3D scanning for precise knowledge of the working environment

- 3D scanning of the equipment to be cut and its environment
- Reproduction of the environment «as exists» in real time in the form of a point cloud



Risk-free cutting sequence

- Simulation of robot cutting trajectory to confirm accessibility of both the equipment to be cut and the built-in tool
- Detection and management of robot's collisions with its environment

Automatic, optimized cutting

- Cutting in automatic mode following the trajectory set by the operator and confirmed by the anti-collision and accessibility calculation
- Robot speed controlled by cutting force measurement

OP

PATENTED

STANDARD
Robust, reliable industrial roboticarms

ADAPTABLE
Caters for interventions with «unknowns» in any situations

PERF'
Around 50% saved on consumables

PROSPECTS

- **CEA Valduc:** technological bricks from development of DEROSA (anti-collision management) are offered as part of tender
- **Orano la Hague:** DEROSA is being studied for use with laser cutting

Spark arrester-protected filtration unit

Stainless steel inline cleanable filtration device

Filtration system for hot work cutting operations: grinder, plasma and laser

- Simplification and improvement of cutting conditions by combining three conventional units into a single tool

Secure filtration system:

- Arrests all incandescent particles emitted by the cutting process
- Eliminates the risk of error when assembling conventional components (spark arresting screen, baffle box, HE filter, etc.)

Optimization of performance and maintenance:

- 100% stainless steel intrinsically fireproof filter for stopping incandescent particles
- Automatic, inline cleaning device to extend the duration of the cutting operation and reduce the amount of waste generated

SAFETY
Improves safety conditions for cutting operations

SIMPLICITY
Easy to install and maintain

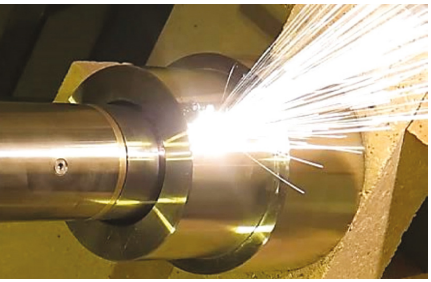
COSTS
Extend service life and reduce waste

REFERENCES

- **Orano DS Triade ICPE:** cutting test on ISO 20-foot container using plasma torch

Orbital laser cutting head

Tool for internal pipework cutting



Technical principle:

- The cutting head comprises a fixed part with the drive motor and a mobile (rotating) part with the blast nozzle and optical module

Performance:

- Enables vertical and horizontal cutting of pipework from inside
- Compatible with pipework measuring 80 mm to 1800 mm
- Capable of cutting stainless steel thicknesses up to 30 mm in one pass
- Laser sources with up to 6 kW power

Advantages:

- Compact head (64 mm diameter)
- Air cooling: simplified waste management and reduced criticality risk

OP

PATENTED

WASTE
No effluent generated during cutting

SAFETY
Air cooling

PERF'
Ease of cutting in difficult-to-access environments

REFERENCES

- **EDF Creys-Malville NPP:** used at Creys-Malville NPP to cut up sodium containment tanks located under the slab

Inflatable arm

Investigations in challenging environments

Investigations in nuclear zones:

- Investigations in difficult-to-access areas (e.g. at height, obstructed areas, etc.)
- Access and deployment through an endoscope sleeve
- Possibility of fitting an instrument at the end of the arm (e.g. measurement probe, camera, lidar, etc.)
- Can be «made to measure» if necessary (i.e. length, diameter, degrees of freedom)

Remote control:

- Axis-by-axis control by the operator via a dedicated interface
- Precision control allowing access to very obstructed zones

Technical characteristics:

- Deployment at up to 5 meters for a diameter of 100 mm
- Low inflation pressure:
  - 2 bar (1st generation arm)
  - 5–7 bar (2nd generation arm)
- Structure and actuators are 100% textile
- Diameter: varies between 100 and 500 mm depending on load and length of arm

WASTE
Very small volume of waste generated

SAFETY
Remote investigation with no risk to the operator

PERF'
Rapid deployment for different types of investigation

PROSPECTS

- **Orano la Hague:** investigations in cell 904 - HAO South planned for 2021

5-minute airlock

Reusable airlock that is quick to deploy on the worksite

Applications :

- Applicable for any operation where there is a risk of spreading contamination

Quick and easy to set up:

- Freestanding, one-piece structure
- Light and maneuverable for rapid deployment (<5 minutes)
- Possibility of combining structures to build a larger airlock adapted to the configuration of the worksite

Reusable airlock:

- Structure situated outside the potentially contaminated zone

Characteristics:

- Available dimensions: 1 x 1 m; 2 x 2 m; 2 x 3 m
- Materials compatible with Andra disposal channels
- M2 fire classification

Marketing:

- The 5-minute airlock is marketed by Amtech

OP

PATENTED

SAFETY
Technology tried and tested in nuclear zones

FLEXIBILITY
Modular depending on needs

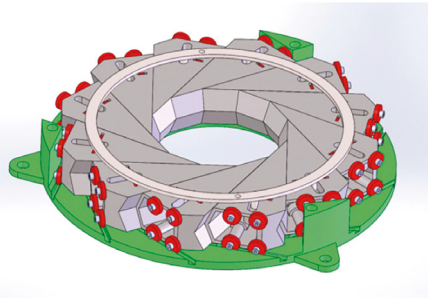
PERF'
Saves time on assembly/ disassembly of airlocks

REFERENCES

- **Orano la Hague:** implementation on numerous dismantling worksites (changing room airlocks, mobile or one-off worksites, etc.)
- **Orano DS Triade ICPE:** implementation in the reconditioning of waste
- **EDF Belleville NPP:** deployment on unit outage activities performed by Orano DS

IRIS

Biological shielding that can be adjusted to tool size

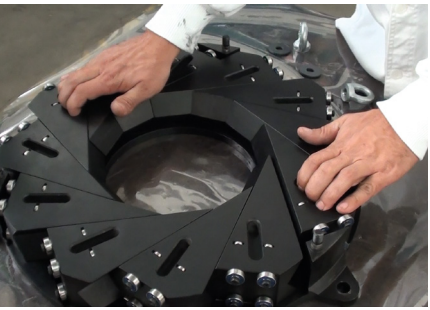


Design:

- Mechanical assembly of several elements easily erected on the worksite

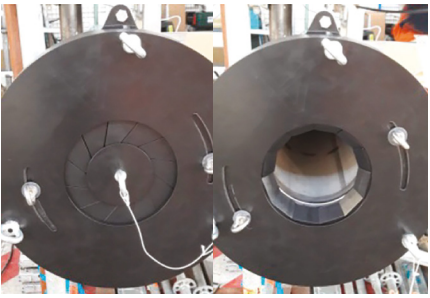
Adapts to needs:

- Adjustable opening for precise adaptation to the element being introduced (probe, boom, robot arm, etc.)
- Total closure to make worksite safe and guarantee dynamic confinement



Operational implementation:

- Easy handling and assembly for rapid installation directly at the worksite
- Fully manual system handling



OP

PATENTED

ALARA
Dose rate optimized at the workstation

ADAPTABLE
Bespoke development according to needs

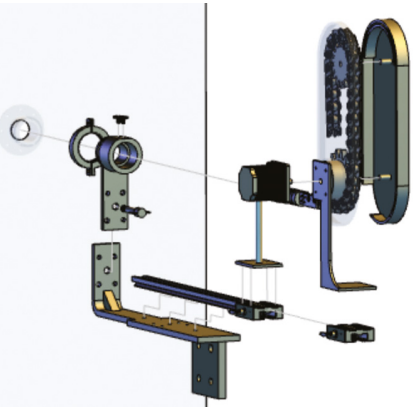
PERF'
Set up biological shielding in just a few minutes

REFERENCES

- **CEA Marcoule:** invasive investigation of evaporators in room 71 of the UP1 plant at CEA Marcoule

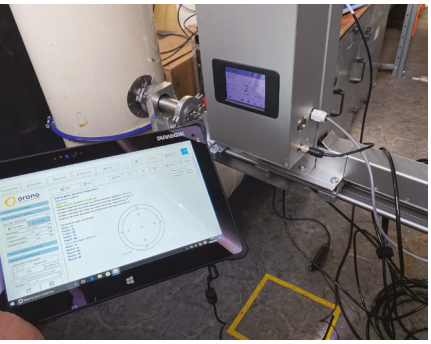
Gas and particle tracing

Automated measurement in ventilation ducts



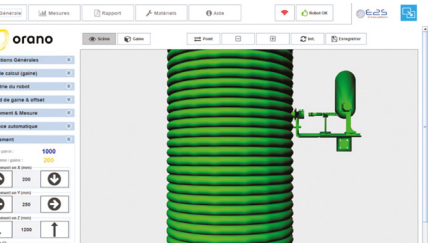
Issues:

- Strict requirements of the Safety Authority concerning the qualification of sampling points for the **monitoring of discharges and very high-efficiency filtration/iodine trap equipment**
- Qualification of sampling points in ducts requires numerous time-consuming measurements that are hard to reproduce
- Considerable uncertainties related to operator actions
- Complex, time-consuming data processing



Automated duct measurement solution:

- Adaptable device on a Pneurop DN40 connector, linked to a measurement and sampling system
- Simultaneous measurement of air speed, tracer gas concentration and temperature (concentration of tracer particles to be added in future)
- Automatic calculation of measurement point locations according to standards or customer specifications
- Automated data processing and compliance status in relation to standards



TR

SAFETY
Limits difficulty of operations and risk of musculo-skeletal disorders

QUALITY
Standardization of methods

PERF'
Intervention time halved and report time quartered

REFERENCES

- **EDF NPPs:** deployment for very-high efficiency filter inspection operations planned for 2022

Audio / video system

A headset for improving communication

Monitor and hear in difficult environments:

- Secure communications on sensitive activities
  - Ensure secure transmissions between workers and supervisors
  - Facilitate the control of the technical gesture compliance
- Improve the traceability
  - Record the operations (photos, videos, etc.)

Solution :

- Microphone coupled to a 4K camera, both installed on a rugby helmet
- Set connected by a single and resistant cable to a control box allowing sound adjustment (incoming / outgoing) and video feedback on a remote screen
- Photos can be taken by a third person to release the operator from this task

OP

SAFETY
Improved communication between operators

CSR POLICY
Reduced operator stress

PERF'
Video recording of operator gestures for return of experience

PROSPECTS

- **EDF Flamanville and/ or Cattenom NPP:** the camera and microphone kit will be deployed the first half of 2022

Acidic waste

Confinement matrix

Issue of managing acidic waste and effluents:

- Legacy or operating waste/effluent
- Significant pH difference between Portland cements and acidic waste:
  - Makes it impossible to directly incorporate solid waste into a hydraulic binder, or necessary to neutralize it prior to cement encapsulation (which increases the costs and quantity of waste)

Proposed solution:

- Direct cement encapsulation of acidic waste in hydraulic binder adapted to the acidic pH of the waste

Advantages:

- Successful formulations for immobilizing different types of acidic waste and effluent
- Reduction in water/cement ratio to maximize incorporation of effluents
- This cement could potentially be used to immobilize species containing phosphates, ammoniums, borates, etc.

QUALITY
Established, qualified formulation

EVOLUTION
Adaptation of formulation to other waste types

PERF'
Processing of legacy waste

QUALIFICATION

- **Orano DS - IFSTTAR:** feasibility validated with HCl, HF, HNO_3 and H_2SO_4 acidic effluents up to pH = 0

Metallic mercury (Hg)

Dry process treatment

D-CINNABAR: a process for small volumes

OP

- Patented reference process:
  - Decontamination: reduction of final activity of waste and removal of impurities that could affect the stabilization phase
  - Stabilization of metallic mercury with flower of sulfur
- Treatment of 1 kg of Hg per workstation with 1 set of equipment (i.e. equivalent to 15 liters of Hg per year per set of equipment)
- Solution suitable for small amounts (i.e. several liters) with the possibility of using several reactors in parallel

D-CINNABAR^{Max}: an industrial process for large volumes

T

- Single unit with target processing capacity of **12 kg Hg/workstation** per set of equipment (i.e. the equivalent of 180 liters of Hg per year per set of equipment)
- Processing time per batch compatible with industrial implementation
- **Stable, insoluble final waste that is accepted at Andra disposal centers** (CSA and CIRES)

QUALITY
Compliance with Andra acceptability criteria

SAFETY
Stabilization of toxic waste awaiting disposal route

PERF'
Treatment of 1 batch of Hg per workstation

REFERENCES AND PROSPECTS

- **SICN:** processing of 0.4 liters of metallic mercury and acceptance at CIRES
- **Orano DS ICPE Triade:** processing of Tricastin Hg

Radioactive organic liquids

Conditioning of radioactive organic liquids

Issue - Current situation:

- Significant source of radioactive organic liquids (VLLW and LILW-SL) not compatible with CENTRACO incineration channel, stored at production sites
- Need to offer optimized, appropriate management solutions (chemical and radioactive characteristics, possible diversity of mixtures or volumes of radioactive organic liquids, etc.)

Solutions:

- Immobilization of radioactive organic liquids using Nochar polymer N910 (directly in drums and/or immobilized at core in cement matrix)
- Encapsulation of radioactive organic liquids in geopolymer matrix

Advantages:

- Generic Nochar process for «target» families will facilitate the integration of this solution as the preferred treatment for radioactive organic liquids in radioactive waste disposal channels (working with Andra)
- Geopolymer matrix: alternative solution to Nochar immobilization, of particular interest given the chemical variability of radioactive organic liquids.
  N.B.: Andra's requirements changed in 2020; additional demonstrations regarding durability are required

INNOVATION
Optimization of conditioning process

ADAPTABLE
Conditioning according to radioactive families

PERF'
Ease of implementation of both solutions

REFERENCES

- **CEA Cadarache:** conditioning of oils and TBP/dodecane solidified by Nochar in 7A packages in 2015/2016
- **CEA Marcoule:** organic residue immobilization tests in 2018
- **CEA Marcoule:** R&D program on immobilization of radioactive organic liquids in geopolymer matrices in partnership with CEA

Stabilization of waste and effluents

Radioactive waste cement encapsulation laboratory

Development of new processes:

- Facility for development of cement formulations or treatment processes based on non-radioactive simulants and/or real waste and effluent

Modular adaptable laboratory:

- Operations: mixing (5 L), molding of test pieces, Vicat setting tests, mechanical strength tests, dimensional variation tests, fluidity tests, etc. (other operations available upon request)
- Ventilated hood and containment chamber in the cell for handling/ preparation of samples and reagents, and testing
- Operations on real Very Low-Level Waste (VLLW) or Low- and Intermediate-Level Short-Lived Waste (LILW-SL), performed in hot cell by qualified technicians

Located in a suitable facility

- Laboratory located at Triade classified facility (ICPE) (operated by Orano DS)
- Possibility of tests on an industrial scale (200 L)

COSTS
Risk reduction by validation on realwaste

SCALABLE
Add equipment according to need

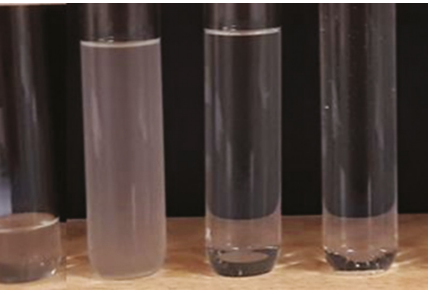
QUALITY
High-performance equipment and competent personnel

REFERENCES

- **Orano DS ICPE Triade:** laboratory currently in operation at Triade facilities

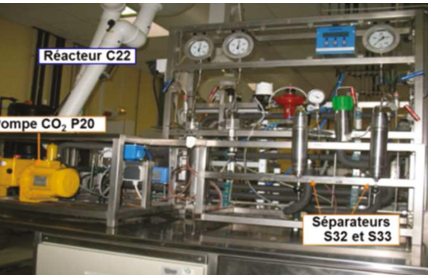
Perfluoropolyether (PFPE) lubricants

Purification process for reuse



Context:

- Waste awaiting disposal route
- PFPE soluble in supercritical CO_2



Reusing perfluorinated PFPE oils after purification:

- Turn used PFPE oil into a reusable lubricant
- Minimize new PFPE supply needs and resulting waste production

Purification:

- Demonstration of purification efficiency (pollutants, uranium)
- Operational parameters consolidated
- Change of scale consolidated and purified PFPE produced under satisfactory conditions

Reuse

- No change in structural composition of oil
- Performance similar to new lubricants

QUALITY
Lubrication performance of preserved oils

WASTE
Reuse of waste awaiting disposal route

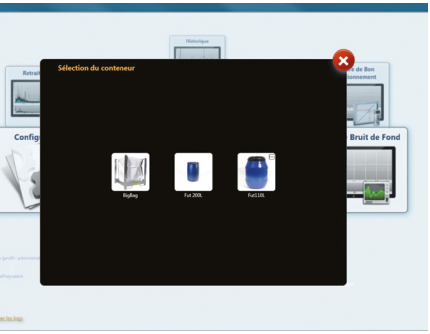
IMAGE
Sustainable, green solution

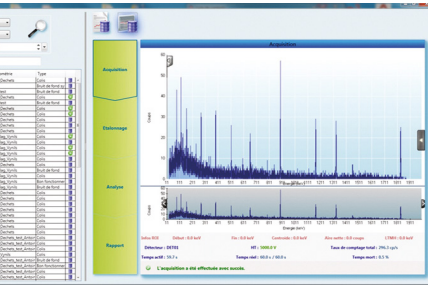
REFERENCES AND PROSPECTS

- **Orano Tricastin:** endurance tests under way since January 2020 with purified PFPE in real pump; industrialization of process under way

Universal software

Configurable solution for waste characterization





Modular, scalable platform:

- Waste measurement software that is versatile, modular, scalable and quickly operational
- Human/Machine Interface (HMI) for configuring a measurement station (detector, package, nature of waste, standard spectrum, processing and export of results, etc.)
- Single, intuitive interface in operating mode
- Possibility of upgrading an existing station

Optimization of waste disposal channel:

- Characterization of all types of package, waste matrix and standard spectrum, with all types of measurement sensor
- Makes it possible to open/optimize disposal channels for specific waste from dismantling operations with an adapted radiological characterization system

Expertise and production:

- Setup of an automated station for carrying out measurements, without any need for support from an expert
- Expert assessment can be performed on a measurement and/or its interpretation

STANDARD
Single soft package for all measurement workstations

FLEXIBLE
Adaptable to the existing environment

SIMPLICITY
Accessible to non-expert profiles

REFERENCES

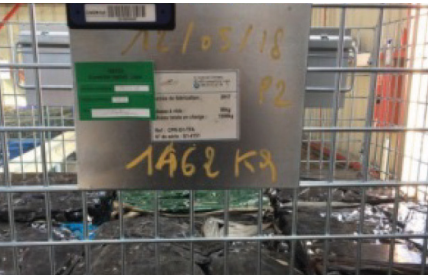
- **Orano Malvési:** tool used since 2018 in response to issue of radiological characterization of waste packages

COLLECTE

RFID application for waste package tracking

Tracking and traceability of waste packages:

- Recording of waste package information on RFID tags: package number, Andra barcode, physical/chemical/radiological data, etc.
- Real-time location of packages
- Sharing of information by LAN and/or on a secure cloud
- Consolidation of package information and lifecycle in a configurable final report



Sequencing:

- Configuration and monitoring of waste package lifecycle
- Operator guided step by step through custom-designed user interface
- Management of co-activity with chronological sequencing of actions
- Remote activity monitoring and automated reports

QUALITY
Reduced risk of data entry errors

TRACEABILITY
Eliminates risk of dataloss

PERF'
Time saving across the wholeprocess

REFERENCES

- **Orano Malvési:** COLLECTE introduced for monitoring nuclear waste packages from production and dismantling activities

Treatment of rubble and dust

Supercompaction process

Issue - Current situation:

- Clean-up work and civil engineering surface removal operations can result in significant volumes of Intermediate-Level Long-Lived Waste (ILW-LL) surface removal residues
- Production of this waste can generate major costs (management and disposal of N3S packages, which are not suitable for above-ground disposal)

Proposed solution: supercompaction of surface removal residues

- 50% volume reduction for compacted rubble and surface removal residues
- Homogenous, non-dispersible block of concrete rubble produced by supercompaction
- Possibility of compacting drums filled with inert materials only or a mixture of different particle sizes

Advantages:

- Significant industrial interest in volume reduction given Cigéo* disposal costs
- Surface removal residues are no longer powdery, offering new possibilities for conditioning Intermediate-Level Short-Lived Waste (LILW-SL) residues
- Potential to diversify supercompaction applications

*Cigéo: The Industrial Centre for Geological Disposal

COSTS
Reduced storage and disposal costs

WASTE
Eliminates powdery nature of treated waste

PERF'
Reduces volume of waste to be storedby 50%

REFERENCES AND PROSPECTS

- **Conclusive tests performed at facilities of press manufacturer**
- **Orano la Hague:** study in progress for use of supercompaction equipment on UP2-400 dismantling worksites

TWISTER

Drying damp textile waste by centrifugation

Issue of managing wet textile waste:

- Non-industrial on-site treatment practices (wipes in airlocks or glove boxes squeezed out by hand and dried individually, etc.)
- Wet textiles squeezed out by hand incompatible with waste disposal channels at producer sites
- Limited and costly interim storage of waste awaiting treatment

An industrialized drying solution:

- Drying process using high-speed centrifugation, adapted to the nuclear/ occupational safety requirements of nuclear sites
- Mobile and autonomous unit enabling optimum rate of treatment
- Continuous recovery and removal of effluents

Performance characteristics compatible with outlet requirements

- Treated waste compatible with «dry waste» disposal channels at producer sites: CENTRACO incineration, Very Low-Level Waste (VLLW) compactors, mid- to high-capacity Low- and Intermediate-Level Waste (LILW) drum presses depending on textile type

SIMPLICITY
Robust «zero maintenance» system

WASTE OPTIMIZATION
Final waste compatible with «dry waste» channel

PERF'
Significant reduction in operating times

REFERENCES AND PROSPECTS

- **Orano Tricastin:** treatment of 80 legacy wet wipe drums
- **EDF Saint-Laurent and Chinon:** treatment of wet textile waste from operations
- **Orano la Hague:** treatment of legacy wet textile drums (deployment in progress)

As a recognized international operator in the field of nuclear materials, Orano delivers solutions to address present and future global energy and health challenges.

Its expertise and mastery of cutting-edge technologies enable Orano to offer its customers high value-added products and services throughout the entire fuel cycle.

Every day, the Orano group's 16,500 employees draw on their skills, unwavering dedication to safety and constant quest for innovation, with the commitment to develop know-how in the transformation and control of nuclear materials, for the climate and for a healthy and resource-efficient world, now and tomorrow.

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