European Commission

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The Finnish presidency

Status, requirements and way forward for the sustainable management of used nuclear fuel and radioactive waste from EU research reactors

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[1]UNF: Used Nuclear Fuel

[2]RR: Research Reactor(s)

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Orano
A strategic refocusing on nuclear fuel cycle business

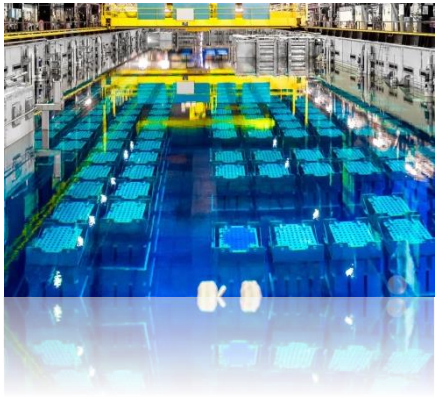
01

Sustainable Used Nuclear Fuel management
Introduction

Orano Used Nuclear Fuel management, a key asset addressing Back-End challenges for international nuclear operators

Used Nuclear Fuel management: the challenges

- Worldwide growing quantities
- Disposal facilities development



Orano Used Nuclear Fuel management, a key asset addressing Back-End challenges for international nuclear operators

Reprocessing

> 34,000 tHM LWR used fuel reprocessed since 1976

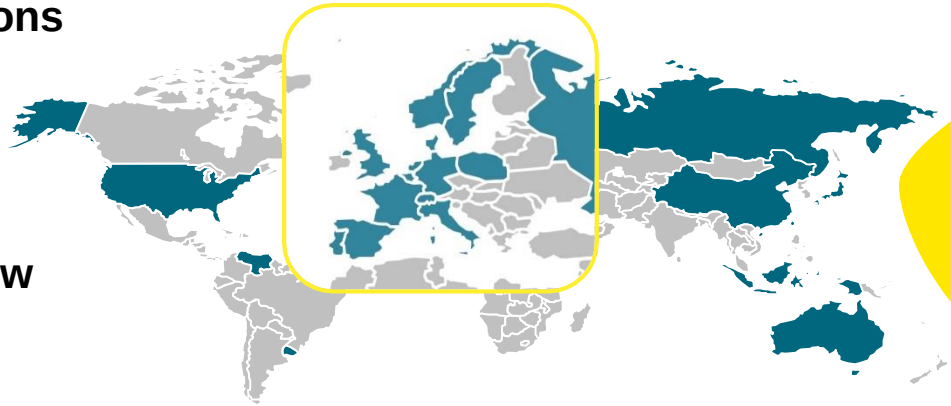
MOX Manufacturing

> 2,600 tHM MOX fuel produced since 1995

Logistics solutions

- *350 shipments /y for UNF management*
- *1,500 UNF dry storage systems loaded / licensed worldwide*

Industrial solutions with 40 years of experience & proven continuous adaptation to new requirements



+ Leading R&D efforts for supporting EU strategic industrial sectors while building next generation fuel cycle
➔ Valorization of elements currently found in the waste solutions from UNF reprocessing…

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02

Sustainable management of Used Nuclear Fuel from European Research Reactors
Challenges and options

Transportation of RRUNF

RRUNF reprocessing operations

Management of final waste from reprocessing

Research reactor Used Fuel management status

Specific feature
High variety of materials
in small quantities

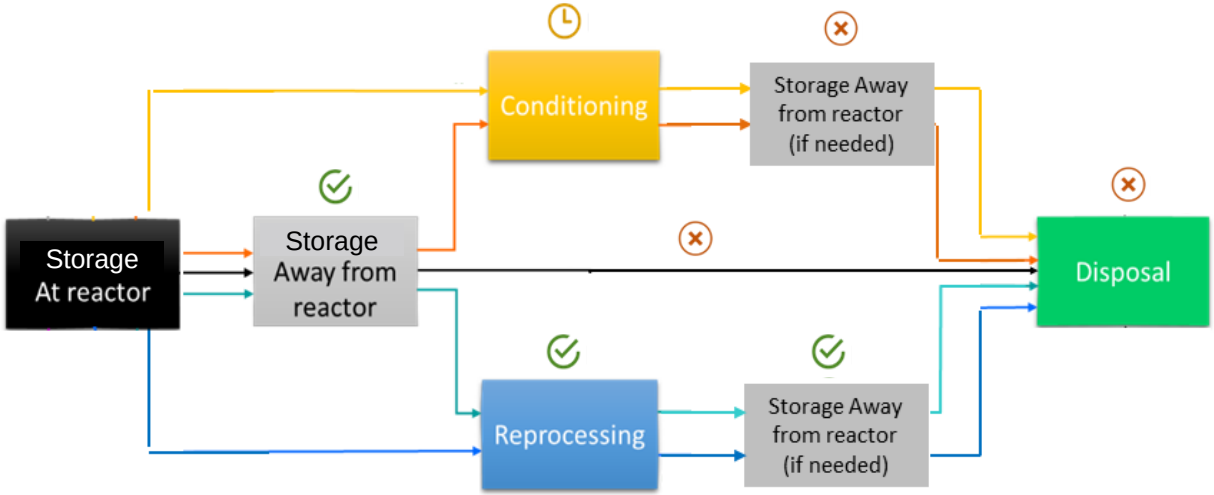
The Challenge
Build standardized and
industralized processes

Decision postoponed (storage)

Shipment back to the country of origin (outside Europe)

Define a sustainable strategy up to disposal

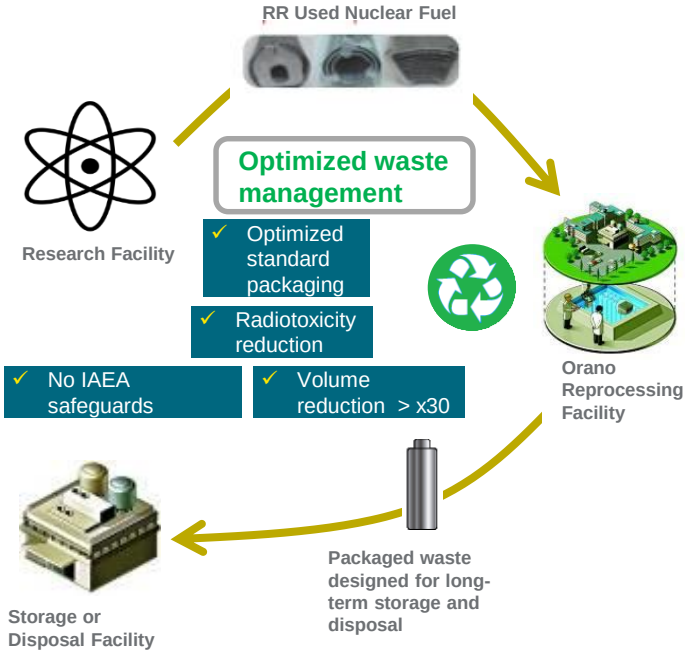
Available RRUNF management strategies



Technology Readiness Level

- High
- Medium
- Low
- Not ready

Reprocessing of RRUNF
Conditioning of final waste under optimized form



- **Non-proliferation**
  No IAEA safeguards
- **Risk reduction**
  with regard to long-term management of nuclear materials
- **Optimized disposal in terms of design / operations**
- **Clear predictability on Used Fuel management cost**

Transportation of Research Reactor Used Fuel

- **Since 1990's: ~150 MTR[1] type transportation casks transported to Orano La Hague reprocessing plant**

  MTR cask operated today: 'TN®-MTR' cask

  Especially for transport to:

  - **La Hague**
  - **US DOE Savannah River Site**

[1]MTR: Materials Testing Reactor with fuel element typically:
- made of U-Al alloy (possibly with Si)
- 6-10 kg of alloy, length ~1 m

- **A transport cask for large variety of fissile or non fissile radioactive materials: 'TN®-106' cask**

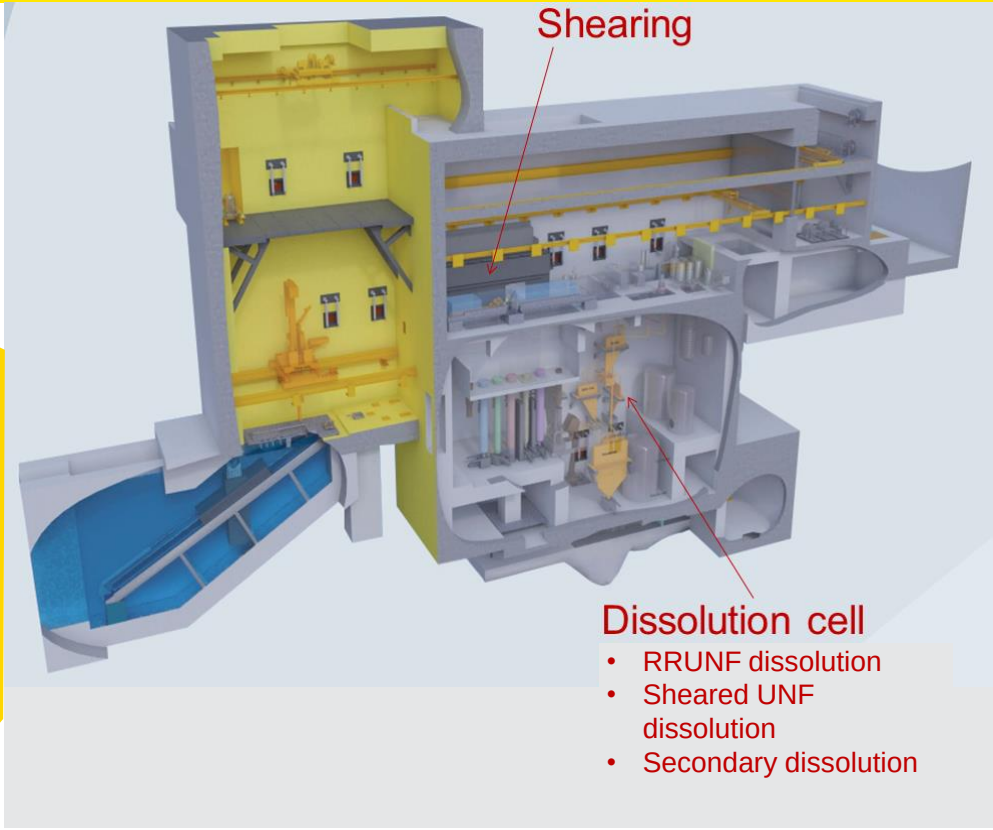
  For shipments between research reactors and laboratories

Reprocessing of RRUNF
Experience and future service

Orano La Hague facility RRUNF reprocessing experience

- From 2005 to early 2019:
  11+ tons of MTR UNF reprocessed
- Market expanding needs in terms of management of UNF from non-power applications

Future Special Fuel Treatment capabilities in existing plant: 'TCP'

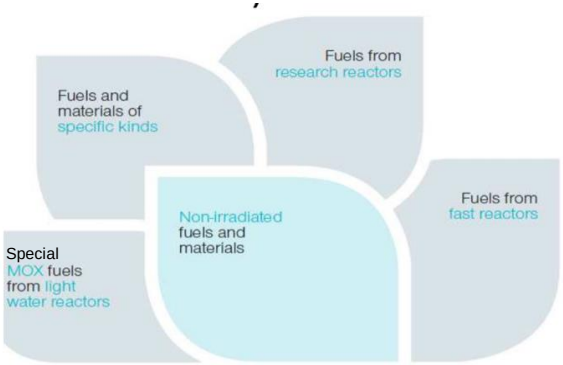


Reprocessing of RRUNF
TCP service

TCP technical assets

- Shearing tool modularity and operational flexibility
- A wide scale of dissolution conditions
  - ➔ Bringing more flexibility
  - ➔ Facilitating implementation of dedicated solutions for specific fuel features

TCP to be implemented in existing « hot » cell, which commissioning had been postponed during the global workshop construction



Special Fuel families identified as candidates for treatment *via* TCP

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Universal Canisters
Smooth final residues management

- **Universal Canisters - Vitrified**

Fission products and minor actinides vitrified in a homogeneous and stable glass matrix

- **Intermediate to High Level Waste**
- **Heat generating**

- **Universal Canisters - Compacted**

Compacted structural waste from non-soluble-parts of fuels

- **Intermediate level long-lived waste**
- **Not heat generating**

The TN®28 for transport / TN®81 for transport and storage of 20 to 28 UC

Vitrified and compacted waste are standard and durable

No IAEA safeguards

Standardization

Simplified transport and on-site handling

Volume saving in storage / disposal facilities

High stability of the residues for the very long term

Clear cost predictability

A universal waste management solution

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03

Sustainable management of **Radioactive Waste from Research Reactors**

Radioactive Waste management strategy

Radioactive Waste management options

Waste Management strategy

Managing waste routes in a sustainable, innovative and cost-effective manner in all the steps :

- **with a performance oriented approach**

INCREASING
safety, modularity, sustainability and acceptance, space availability

MINIMIZING
costs, volumes, toxicity, incremental investments, environmental impact

- **and innovative tools continuously developed**

Nanopix, CartoOnline, Riana, Iris, Collecte, Manuela

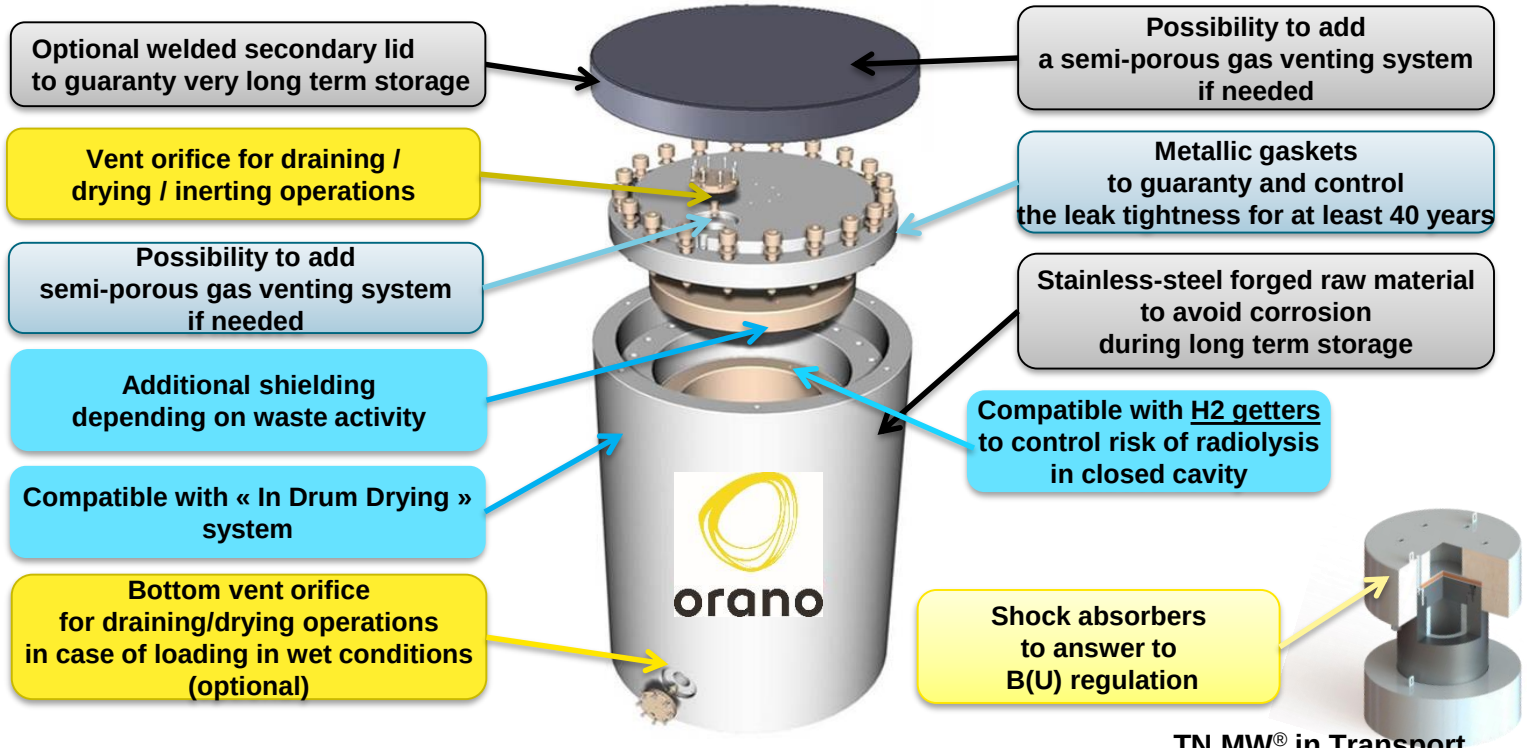
300,000+ m3
VLLW-SL-LILW conditioned, transported by Orano and disposed of in France

80% waste
to the French Ground Disposal facility conditioned by Orano

Waste management option: The TN MW® cask concept Adaptble according to the content and use

All kind of waste: liquid, solid, sludge, bulk loading

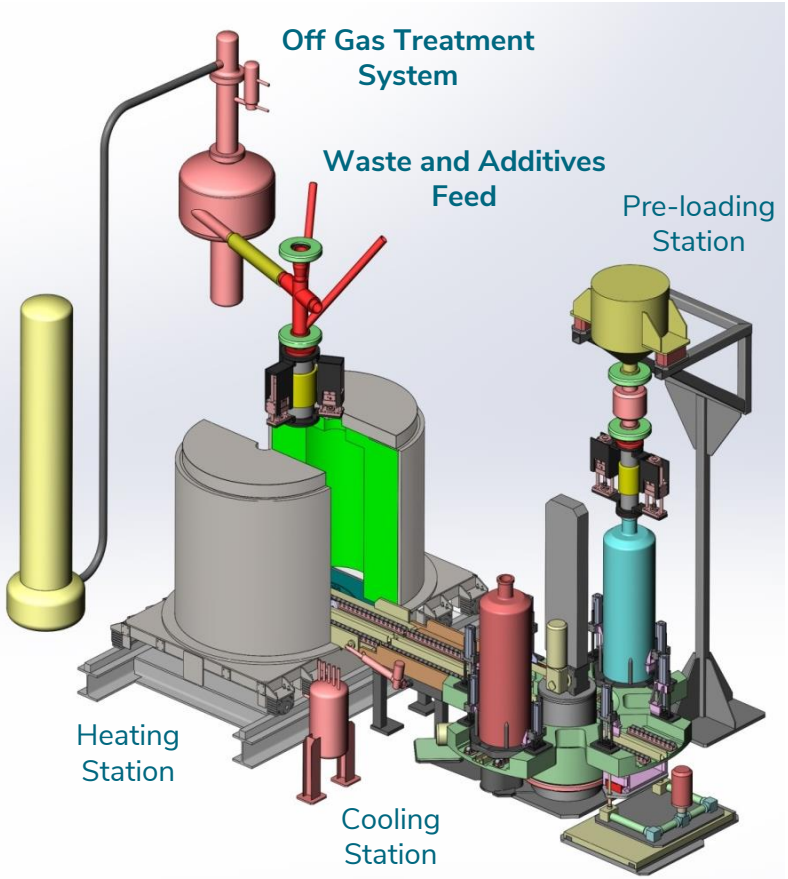
- B(U) package 2012 IAEA Regulations
- 10 t loaded, 8 t empty
- Activity up to 300 TBq for 60Co
- Wet or dry loading
- Max P: 300 W



TN MW® in Transport configuration

Content | In Operation | Transportation | Interim Storage | Final Disposal

Waste management option: Dem&Melt, an innovative in-can vitrification facility



An innovative solution for treating intermediate and high level waste arising from remediation and D&D

- can accommodate uncertainties in waste composition

Dem&Melt operates within a compact unit, ensuring:

- Significant volume reduction
- Safe containment of radionuclides
- Waste stabilization

An optimized waste treatment solution designed for a wide range of waste:
Zeolites, Liquids, Deposits, Solids, Sludges

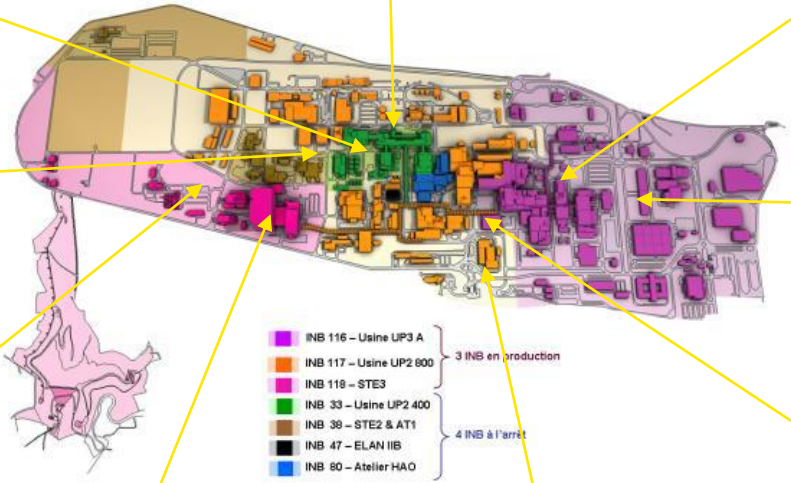
Radioactive Waste management options
Shipment to La Hague for conditioning

ACC
Metallic waste compacting unit

ACR
Resins cementation

UCD
Alpha waste treatment

AD1/BDH
Large tools decontamination



AD2
Cementation

STE3
Liquid waste treatment

R7/T7
Vitrification

MDSB
Solvant mineralisation and cementation

AMEC/AEC
Package decontamination

04

Conclusion

Management of Used Nuclear Fuel and Radioactive Waste from European Research Reactors

- Identification of Used Nuclear Fuel management sustainable strategy making use of available capacities
- Definition of Radioactive Waste management global and optimized approach

Orano supports EURR operators in their back-end operations based on

- ✓ **Long-term and international used nuclear fuel management experience**
- ✓ **Strong return of experience from multiple radioactive waste management programs with its own and also worldwide facilities**
- ✓ **Up-to-date and adapted services**

Ready to set up partnership with EURR operators for robustly managing back-end operations

THANK YOU FOR YOUR ATTENTION!

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