# HALEU

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#### Orano: Ensuring excellence across the entire fuel cycle ...



Orano supplies customers throughout the global commercial nuclear market, offering products and services across the nuclear fuel cycle – from mining to decommissioning.

Orano is also pursuing nuclear medicine applications through its Orano Med subsidiary, developing targeted alpha therapies for hardto-treat cancers using Lead-212 processed from mining waste.



## A global leader in the nuclear energy industry

#### Orano key facts and figures



### Orano USA

- Front End Sales
- Orano Federal Services
- Orano Med
- Orano TN
- Orano Decommissioning Services





## The Nuclear Packages & Services Business Unit

An international player in nuclear logistics with an ambitious growth target and unique expertise

With more than 60 years experience, Orano provides global logistics solutions to its customers throughout the world, ranging from the design and approval of packages to the transport of nuclear materials.

Orano conducts more than 5,000 shipments around the world each year, in compliance with the most stringent international safety and security requirements.

Orano's unique expertise in nuclear logistics services encompasses engineering, licensing, packaging, transport and storage solutions for nuclear materials.

> Global leader in nuclear transport

#### Global leader in used fuel dry storage

#### Development of used fuel transportation

in Europe and the USA

Growth in business related to waste management from decommissioning nuclear reactors

Diversification of activities in the front end of the fuel cycle and into certain non-nuclear areas



## **Chemistry & Enrichment**

From the Malvési (Aude) and Tricastin (Drôme/Vaucluse) sites, Orano operates on an industrial platform which sets the standard for the front end of the cycle, deploying its expertise acquired from more than 60 years' experience in the conversion of uranium and the chemistry of fluorine.

- Georges Besse II (enrichment; 2011): Nominal capacity of 7.5 MSWUs reached in 2016; the most efficient technology worldwide
- Philippe Costes (conversion; 2016 & 2018) Nominal capacity of 15,000 tons of UF6 ; the only conversion industry with innovative processes
- Other activities

Defluorination and denitration plants, maintenance activity of our cylinders for our customers

Our customers' security of supply is guaranteed by fully modernized conversion and enrichment plants meeting the highest standards of safety and security with a reduced environmental footprint.





#### Our strengths

- About one hundred customers worldwide
- A strong order backlog
- 1<sup>st</sup> industry player in the world to have modernized its conversion production tools
- Security of supply for its customers over the long term thanks to a modernized industrial platform
- An 80% reduction in GHG emissions and 96% lower electricity consumption since 2004

# Tricastin-Malvési

## Platform

An expert in uranium transformation, purification, enrichment & fluorine chemistry

55+ years experience & expertise

~ \$1 Bn/yr ~ <sup>1</sup>⁄<sub>4</sub> of Orano sales revenue

**10 years Order book** 



more than 60 Customers **40 Partnerships** 

## Tricastin- Malvési platform

An expert in uranium transformation, purification, enrichment & fluorine chemistry



## HALEU Background & Context



#### Impact on front-end supply chain & Orano capabilities



#### HALEU - A promising market

Market Players Assay Chemical form **Commercial** 

Advanced reactors / fuel concept ~5%-19,75% UF6, Oxyde, metal, salt

#### Estimated Demand Forecast Nuclear Energy Institute



- $\Rightarrow$  Promising, but uncertain, demand driven by new concepts of advanced reactors / fuel and SMRs, mainly in North America
- The various chemical forms requested represent a technological challenge
- The expected initial needs for 2028-30 appears ambitious
- · Question marks around the concepts that will emerge





#### $\Rightarrow$ Modest but certain demand

- Although RTRs were historically using metal HEU, most of them have recently been transitioning to 19.75% HALEU metal fuel
- Hence, ensuring the availability and durability of metal HALEU supply is becoming critical to protect domestic and international interests of western countries

#### Potential requirement vs. impact on front-end markets



Order of magnitude

Note (1): Np: 19.75% - Nf: 0.711% - Nt: 0.2%

## Challenges: Completing the future nuclear fuel chain supply



Although securing the availability of HALEU appears critical, it is also a challenge

➔ Raising fuel enrichment above 5% 235U will directly impact many of the established fuel cycle steps and sub-steps, requiring infrastructure and logistics upgrades together with international regulation evolution

#### **HALEU facility: Key Requirements**

Technology and Industrial	<ul> <li><u>Enrichment</u>: A state-of-the-art enrichment technology for a highly competitive production</li> </ul>		
	<ul> <li><u>De-conversion</u>: industrial expertise and hands-on know-how to de-convert UF6 under the required chemical form</li> </ul>		
	<ul> <li>Industrial &amp; chemical know-how: expertise for an optimized operation</li> </ul>		
	<ul> <li><u>Appropriate designed and built installations</u> to account for the criticality of such assay level</li> </ul>		
Logistics	<ul> <li>An available transportation solution for HALEU:</li> </ul>		
	<ul> <li>Suitable for the requested chemical form</li> </ul>		
	<ul> <li>Compliant with the existing industrial facilities and international regulations</li> </ul>		
Regulatory	<ul> <li>Obtain appropriate regulatory approvals and authorizations</li> </ul>		
Economics	Appropriate financing solutions to finance the various studies and construction works		

### HALEU Supply Concerns

## Q41: What issues keep you up at night?

RankIssue	Score #	of cor	mpanies 2020
1 Availability of High Assay Low-Enriched Uranium	<mark>65%</mark>	11	<mark>#1</mark>
2 Ability to sell initial 10-20 commercial units (beyond initial demo unit)	<b>53%</b>	9	<mark>#2</mark>
<b>3</b> tie Current NRC reactor licensing process (other than Part 53)	<mark>47%</mark>	8	#7
<b>3</b> tie Sufficient government funding for the development of advanced			
reactor technologies	<mark>47%</mark>	8	#3
<b>3</b> tie Availability of financing for domestic deployment	<mark>47%</mark>	8	#4
6 <sub>tie</sub> Administration change (in 4-8 years) to one that is not supportive of nuclear			#5
6 <sub>tie</sub> Availability of financing for international deployment			#6
6tie Sufficient domestic manufacturing resources to produce your design		5	
9 Potential requirements for safeguards and security	24%	4	
10 Part 53 (based on NRC current language)	18%	3	United States
			NIC
Other Clear waste disposition policy, sufficient federal resources, etc.			Nuclear
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#### **Orano: A Proven Industry Partner**

#### Expertise + Access to Technology + Track Record of Delivery = Assured Supply

- Advanced nuclear power applications at commercial scale are essential to meeting U.S. and global industrial decarbonization goals
- Assured availability of HALEU is necessary for the commercialization of advanced reactors in the U.S. and throughout the world – there are no commercial HALEU producers outside Russia
- Orano is committed to fueling the future of nuclear energy through the development of commercial platforms that secure HALEU production capacity <u>and</u> the associated logistics infrastructure
- The initial diversity of OEM requirements requires a flexible platform for HALEU production including integrated advanced chemistry applications backed by Orano's expertise and delivered through industrial partnership
- Orano is focused on U.S. demand signals and emergent DOE and commercial OEM requirements pursuing greater clarity around commercial offtake commitments and the availability of policy tools that can accelerate investment in this critical infrastructure
- A commercially-committed, geopolitically stable supply chain will fuel expansion of advanced nuclear energy



# orano