SMR development in Europe: spotlight on the French AMR developers

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Oakridge presentation

A UNIQUE MULTIDISCIPLINARY **CONSULTING & ENGINEERING** COMPANY, SUPPORTING NUCLEAR PROJECTS, WORLDWIDE.



Company founded in Oct. 2002 - family owned Constant and assumed <u>single-sector positioning : Nuclear 100%</u> Involved both in New build projects and in Installed Base

✓ Safety oriented
✓ Skilled Management
✓ Expertise in Nuclear
✓ Global footprint
✓ Partnership policy
✓ RELIABLE and FAIR



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The European and French contexts

-EUROPEAN INDUSTRIAL ALLIANCE ON SMR

-FRANCE 2030

European Industrial Alliance on **SMALL** MODULAR REACTORS





Founded in February 2024

Objectives

Aims to expedite SMR projects in Europe by early 2030s









France 2030 Investment Plan

President Macron – October 12th, 2021 :

- Addressing the major challenges of our time
- With a focus on the green transition, technological advancements and industrial innovations
- €54 billion investment

Part of the nuclear sector in France 2030 :

- Supporting the development of Small Modular Reactor (SMR) technologies
- Developing innovative solutions for the management of radioactive materials and waste



FRANCE



FRANCE 2030: 11 projects awarded





SMR Development in France

THORIZON AND NEWCLEO

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FRANCE

Thorizon One Reactor by Thorizon

Technology: Wasteburner Molten Salt Fast Reactor



Reactor operation target: 2030

Туре	Fast Neutron
Fuel	Thorium
Fuel life cycle	5-10 Years
Power output	250 MWTh or 100MWe
Total funds raised	€42.5 M
Market	Electricity, hydrogen production & Heating





OAKRIDGE and Thorizon, France 2030 "Innovative Nuclear Reactor" winners

- Thorizon is part of a consortium with OAKRIDGE and the University of Lille.
- OAKRIDGE is involved in several projects related to the Thorizon reactor development:
 - Nuclear reactor core design: Responsible for core design and core optimization to burn minor actinides.
 - Nuclear fuel storage criticality-safety: Establishing a subcritical configuration for the storage of the nuclear fuel cartridges. The study analyses the interactions between the cartridges, with variations of the relevant parameters (pitch, reflectors, humidity, materials, fuel...) for the storage facility subcritical in all cases.



Double

Connection to secondary salt system

The patented cartridge concept

- Core consists of several cartridges containing their own molten salt inventory + a pump + a heat exchanger
- Salt is circulated in each cartridges by a pump
- Criticality of the fission chain reaction occurs only when the pump is operational and there is salt at the top side of all cartridges
- When the pump shuts down, the salt drops and the nuclear reaction stops > "Walk-away safe" design



Thorizon One: a modular design



- Replacement of the cartridges every 5-10 years
- Cartridge system solves material degradation issues for the containment material
- Enables continuous improvement and adjustment to need
- Reduces cost through standardization and off-site series production of the primary system
- Facilitates and accelerates design qualification

Lead Fast Reactor: Newcleo

- Newcleo: European Startup launched in September 2021
- **3 Projects:** building a LFR30 demonstrator reactor and a LFR200 production reactor
 - + a FR-MOX fuel manufacturing plant

Reactor type	Fast neutron reactor
Fuel	MOX
Coolant type Pressure	Lead Atmospheric
Core inlet temperature Core outlet temperature	420 °C 530 °C
Prototype operation target	2031



newc

Futurable Energy

Our references in SMR/AMR development : Newcleo



Criticality calculations support for the fresh and spent fuel storage

- Criticality calculations, using Monte-Carlo N-Particle Transport code, for storage of fresh and spent fuel assemblies.
- Optimization of the fuel storage configuration sizes and delivery of calculation notes.
- Definition of the pitch between fuel assemblies in storage (center to center distance).

Support for radioprotection studies related to the reactor vessel

- Preparation of OpenMC/MCNP datasets : Geometry, materials, calculation parameters.
- Source term calculations used as input data for subsequent calculations (vessel and surroundings).

Contributing to the development of the general operation of the LFR models

• Producing a concise documentation of the requirements associated with the "Grid Requirement".

Thank you!