Status Report - JIMMY (France)

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1. Overview

- ☐ **In Operation**
- ☐ **Under Construction**
- ☐ **Described in**

Link to PRIS	--

- ☑ **New Concept**

Number of Units	--
Year	2026

Reference Plant

Name of Site	--
Link to PRIS	--
Net Power Output (MWe)	20
Gross Power Output (MWe)	--

1.1 Introduction

Jimmy is a high-temperature gas-cooled reactor with a thermal power of 10 to 20MW(t), designed to provide competitive, low-carbon industrial process heat. The reactor is based on UCO TRISO particles, a graphite moderator and a helium coolant (primary loop). A CO2 secondary loop allows to deliver heat up to 550°C to industrial processes, selecting the secondary heat exchanger according to industrial needs. Valuing the existing HTGR return of experience, the approach consists in delivering a simple, safe and robust heat generator. As a result, the design relies mostly on well-tested solutions, as well on a passive safety demonstration, to optimize the time- and cost-to-market. A first official application has been submitted (April 2024), for a first generator project, with a first client site already identified (France).

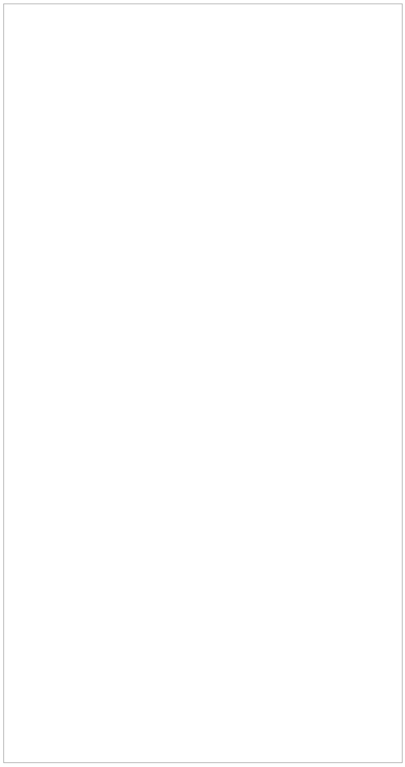


Figure 1. JIMMY's concept

Target Application

Jimmy targets the industrial heat market, where industrial suffer from both economic and environmental pressure to reduce their use of fossil fuels, while no alternative solution available. Jimmy will allow to replace industrial gas-burners and provide competitive, low-carbon industrial process heat. The design and small reactor footprint and limited capacity (up to 20MWt) allows to integrate into most industrial sites, with one or several generators in a row. The primary target is the French market, especially steam-consumers such as the Agro or Chemistry industry, with needs for steam up to 550°C. After massive deployment to process heat applications in and outside of France, the main applications are district heating (offices, residential buildings…) and hydrogen production.

1.2 Development Milestones

2020	Creation of Jimmy Energy
2022	Conceptual design completed
2024	Start of pre-licencing vendor design review (in France)
2026	Start a 9-month construction of first full-scale NPP in France towards commercial operation

1.3 Design organization or vendor company

contact@jimmy-energy.eu

1.4 Links to designer/vendor website

1.5 Design Description

Design Philosophy

The main goal of the design is to provide a simple, safe and financially viable alternative to industrial heat gas-burners. This goal is achieved by using HTGR well-tested solutions (especially regarding safety) and then optimizing the design to optimize safety, reduce cost, and allow easy manufacturing, transportation and assembly. For instance, the use of a secondary CO2 loop allows to distinctly separate the nuclear perimeter from the industrial zone in terms of safety. Furthermore, the manufacturing and assembly aspects have been taken into account since the beginning of the detailed design: design teams are in contact with presented suppliers to screen commercially available components and integrate them in the design. It ensures that a viable industrial scheme is available and to anticipate the orders of long-lead items, as well as to optimize instruction time by safety authorities.

1.6 Licensing Application Support Documents

Most Recent Licensing Application Support Document:

- **Preliminary Safety Analysis Report (PSAR) 2024**

1.7 Reactor Unit in PRIS

2. Category Fields

Table 1: ARIS Category Fields

ARIS Category	Value	Units of Examples
Current/Intended Purpose	Prototype/FOAK	e.g. Commercial – Electric/Non-electric, Prototype/FOAK, Demonstration, Experimental
Main Intended Application (once commercial)	Non-electric (Industrial heat)	e.g. Baseload, Dispatchable, Off-grid/Remote, Mobile/Propulsion, Non-electric (specify)
Reference Location	On Coast, Inland	e.g. On Coast, Inland, Below-Ground, Floating-Fixed, Marine-Mobile, Submerged-Fixed (Other-specify)
Reference Site Design (reactor units per site)	Single Unit	e.g. Single Unit, Dual Unit, Multiple Unit (# units)
Core Coolant	He	H2O, D2O, He, CO2, Na, Pb, PbBi, Molten Salts, (Other-specify)

Reactor Core Size (1 core)	Thermal Power < 30 MWth	e.g. Thermal Power < 30 MWth, 30 MWth ≤ Thermal power < 1000 MWth, 1000 MWth ≤ Thermal power ≤ 3000 MWth, Thermal power > 3000 MWth
Reactor Type	GCR	e.g. PWR, BWR, HWR, SCWR, GCR, GFR, SFR, LFR, MSR, ADS
Reactor Size	Microreactor	e.g. PWR, SMR
Neutron Moderator	Graphite	e.g. H2O, D2O, He, CO2, Na, Pb, PbBi, Molten Salts, (Other-specify)
NSSS Layout	Loop-type	e.g. Loop-type (# loops), Direct-cycle, Semi-integral, Integral, Pool-type
Primary Circulation	Forced (1 pumps)	e.g. Forced (# pumps), Natural
Thermodynamic Cycle		e.g. Rankine, Brayton, Combined-Cycle (direct/indirect)
Secondary Side Fluid	CO2	e.g. H2O, He, CO2, Na, Pb, PbBi, Molten Salts, (Other-specify)
Fuel Form	Coated Sphere	e.g. Fuel Assembly/Bundle, Coated Sphere, Plate, Prismatic, Contained Liquid, Liquid Fuel/Coolant
Fuel Lattice Shape	Hexagonal	e.g. Square, Hexagonal, Triangular, Cylindrical, Spherical, Other, n/a
Rods/Pins per Fuel Assembly/Bundle		e.g. #, n/a
Fuel Material Type	Oxide	e.g. Oxide, Nitride, Carbide, Metal, Molten Salt, (Other-specify)
Design Status	Detailed Design	e.g. Conceptual, Detailed, Final (with secure suppliers)
Licensing Status	PSAR	e.g. DCR, GDR, PSAR, FSAR, Design Licensed (in Country), Under Construction (# units), In Operation (# units)
Neutron Spectrum	Thermal	e.g. Fast, Thermal

3. Parameter Fields

Table 2: ARIS Parameter Fields

ARIS Parameter	Value	Units of Examples
Plant Infrastructure		
Design Life	20	Years
Lifetime Capacity Factor	95	%, defined as Lifetime MWe-yrs delivered / (MWe capacity * Design Life), incl. outages
Major Planned Outages	11 days every years for maintenance and 6 months every 10 years for refuelling	# days every # months (specify purpose, including refuelling)
Operation / Maintenance Human Resources	1	# Staff in Operation / Maintenance Crew during Normal Operation
Reference Site Design	1	n Units/Modules
Capacity to Electric Grid	0	MWe (net to grid)
Non-electric Capacity	18.8 MWth heat at 450°C	e.g. MW(th) heat at x °C, m3/day desalinated water, kg/day hydrogen, etc.
In-House Plant Consumption	0.8-1.2	MWe
Plant Footprint	400	m2 (rectangular building envelope)
Site Footprint	1500	m2 (fenced area)
Emergency Planning Zone		km (radius)
Releases during Normal Operation		TBq/yr (Noble Gases / Tritium Gas / Liquids)
Load Following Range and Speed	None	x – 100%, % per minute
Seismic Design (SSE)		g (Safe-Shutdown Earthquake)
NSSS Operating Pressure (primary side)		MPa(abs), i.e. MPa(g)+0.1, at core outlet
NSSS Operating Pressure (secondary side)		MPa(abs), i.e. MPa(g)+0.1, at secondary side outlet
Primary Coolant Inventory (incl. pressurizer)		kg
Nominal Coolant Flow Rate (primary)		kg/s

Nominal Coolant Flow Rate (secondary)		kg/s
Core Inlet Coolant Temperature	550	ºC
Core Outlet Coolant Temperature	200	ºC
Available Tempeature as Process Heat Source	480	ºC
NSSS Largest Component		e.g. RPV (empty), SG, Core Module (empty/fuelled), etc.
- NSSS Largest Component Length		mm
- NSSS Largest Component Diameter		mm
- NSSS Largest Component Thickness		mm
- NSSS Largest Component Weight		tonne
Reactor Vessel Material		e.g. SS304, SS316, SA508, 800H, Hastelloy N
Steam Generator Design		e.g. Vertical/Horizontal, U-Tube/ Straight/Helical, cross/counter flow
Secondary Coolant Inventory		kg
Pressurizer Design		e.g. separate vessel, integral, steam or gas pressurised, etc.
Pressurizer Volume		m3 / m3 (total / liquid)
Containment Type		Dry (single/double), Dry/Wet Well, Inerted, etc.
Containment Volume		m3
Spent Fuel Pool Capacity and Total Volume		Years of full-power operation / m3
Non Electric Application		-
Core Delta Temperature		ºC
Fuel/Core		
Single Core Thermal Power	20	MW(th)
Refuelling Cycle	120	months or “continuous”

Fuel Material	UCO	e.g. UO2, MOX, UF4, UCO
Enrichment (avg./max.)	19.75	%
Average Neutron Energy		eV
Fuel Cladding Material		e.g. Zr-4, SS, TRISO, E-110, none
Number of Fuel “Units”	N/A	Specify as Assembly, Bundle, Plate, Sphere, or n/a
Weight of one Fuel Unit		kg
Total Fissile Loading (initial)		kg fissile material (specify isotopic and chemical composition)
% of fuel outside core during normal operation	0	Applicable to online refuelling and molten salt reactors
Fraction of fresh-fuel fissile material used up at discharge		%
Core Discharge Burnup		MWd/kgHM (heavy metal, eg U, Pu, Th)
Pin Burnup (max.)		MWd/kgHM
Breeding/Conversion Ratio		Fraction of fissile material bred in-situ over one fuel cycle or at equilibrium core
Reprocessing		e.g. None, Batch, Continuous (FP polishing/actinide removal), etc.
Main Reactivity Control	Boron rods	e.g. Rods, Boron Solution, Fuel Load, Temperature, Flow Rate, Reflectors
Solid Burnable Absorber		e.g. Gd2O3
Core Volume (active)		m3 (used to calculate power density)
Fast Neutron Flux at Core Pressure Boundary		n/(cm²*s)
Max. Fast Neutron Flux		n/(cm²*s)
Core Control Rod Absorber		-
Core Soluble Neutron Absorber		-
Safety Systems		

Number of Safety Trains	Active / Passive	% capacity of each train to fulfil safety function
- reactor shutdown	Active/Passive	- / - / -
- core injection	Active	- / - / -
- decay heat removal	Passive	- /- / -
- containment isolation and cooling	Passive	- / - / -
- emergency AC supply (e.g. diesels)	N/A	- / - / -
DC Power Capacity (e.g. batteries)		Hours
Events in which Immediate Operator Action is required	None	e.g. any internal/external initiating events, none
Limiting (shortest) Subsequent Operator Action Time		Hours (that are assumed when following EOPs)
Severe Accident Core Provisions	No core melt	e.g. no core melt, IVMR, Core Catcher, Core Dump Tank, MCCI
Core Damage Frequency (CDF)		x/reactor-year (based on reference site and location)
Severe Accident Containment Provisions	N/A	e.g., H2 ignitors, PARs, filtered venting etc.
Large Release Frequency (LRF)	N/A	x/reactor-year (based on reference site and location)
Overall Build Project Costs Estimate or Range (excluding Licensing, based on the Reference Design Site and Location)		
Construction Time (nth of a kind)	8	Months from first concrete to criticality
Design, Project Mgmt. and Procurement Effort		Person-years (PY) [DP&P]
Construction and Commissioning Effort		PY [C&C]
Material and Equipment Overnight Capital Cost		Million US$(2015) [M&E], if built in USA
Cost Breakdown	%[C&C]/%[M&E]	
- Site Development before first concrete		(e.g. 25/10) (30/40)
- Nuclear Island (NSSS)		

- Conventional Island (Turbine and Cooling)		(20/25) (20/10) (5/15) (----------) (to add up to 100/100)
- Balance of Plant (BOP)		
- Commissioning and First Fuel Loading		
Factory / On-Site split in [C&C] effort		%/% of total [C&C] effort in PY (e.g., 60/40)
Nuclear System		
System Steam Flow Rate		kg/s
System Steam Pressure		MPa
System Steam Temperature		ºC
System Feedwater Flow Rate		kg/s
System Feedwater Temperature		ºC
Reactor Core		
Active Core Height		m
Equivalent Core Diameter		m
Average Linear Heat Rate		kW/m
Average Fuel Power Density		kW/kgU
Average Core Power Density		MW/m3
Outer Diameter Of Fuel Rods		mm

4. Plant Layout, Site Environment and Grid Integration

SUMMARY FOR BOOKLET

The layout of Jimmy's reactor is a building of w: 25m * l: 25m * h: 25 m. For security reasons, walls are thick to prevent aggression and only few systems go through the wall (mainly the RCCS and the secondary system that reaches the industrial line). All the access for maintenance and installation are on the roof to stay out of an easy reach.

4.1 Site Requirements during Construction

- Sample site plans, e.g. on-coast, inland, etc
- Acceptable soil conditions (soft, medium, rock)

- Site access needs for major equipment and special services
- Buildings and structures (reactor, turbine and other buildings)
- Containment layout and structure (separation of radiation areas, accessible areas, etc.)
- Spent fuel facilities
- Manpower during construction

4.2 Site Considerations during Operation

- Water usage needs for all plant systems
- Maximum acceptable ambient air temperature, humidity, and heat sink temperature for full-power operation
- Cooling options / requirements; effect of heat sink temperature
- Manpower during operation
- On-line and outage maintenance activities
- Normal and abnormal emissions
- Thermal discharges
- Required infrastructure and support systems during operation and maintenance, special equipment/tooling needs
- Emergency planning and response
- Design provisions for decommissioning after major accident and at planned end-of-life

4.3 Grid Integration

- Grid interface/code requirements (power (MWe), voltage (kV), frequency (Hz))
- Load following capability, experience, and effect on waste generation
- Ability of plant to operate on house load
- Ability to load reject without shutdown
- Extend of electrical systems reliance on grid Class IV power
- Plant needs from the grid (availability, stability, etc.) during normal and off-normal operation

5. Technical NSSS/Power Conversion System Designn

SUMMARY FOR BOOKLET

Power Conversion

The Jimmy generator is designed to provide heat only, i.e., there is no energy conversion into electricity. A primary exchanger allows to transfer heat from the primary helium-based loop to the secondary CO2-based loop. The CO2-based loop pressure is 3.0 MPa and temperature is 600°C. A secondary exchanger is then selected, according to each industrial site's specific needs (fluid, temperature, pressure, etc.).

Reactor Core

The reactor core consists of fuel assemblies inside a graphite reflector. Theses fuel assemblies are designed to be assembled in a factory and transportable inside existing fuel transportation packages.

Fuel Characteristics

The fuel are pellets of HALEU TRISO particles that are conformed to the AGR program envelope to reach the expected burnup.

Reactivity Control

Reactivity control is made with 24 independent B4C control rods and B4C neutronic poisons that cross the core or the reflector.

Reactor Pressure Vessel and Internals

The Jimmy reactor does not feature a pressure vessel but pressure tubes that constitute the core. This whole core is then contained into a containment vessel. This geometry facilitates the transport and assembly of the reactor on its installation site.

Reactor Coolant System

The primary coolant is a helium pressurized circuit, whose circulation is forced on the cold branch by a helium blower. The circuit divides and reunites before and after the pressure tubes of the core.

Secondary System

The secondary circuit connects to the primary circuit through a plate heat exchanger. It contains pressurized carbon dioxide whose circulation is also forced.

Steam Generator

Jimmy's generator does not directly produce steam, but its industrial client may produce steam based on the heat it gets from the secondary system through a secondary exchanger.

Instrumentation and Control System

The I&C system is under design and does not contain any major disruption.

5.1 Primary Circuit
5.2 Reactor Core and Fuel
5.3 Fuel Handling
5.4 Reactor Protection
5.5 Secondary Side
5.6 Containment/Confinement
5.7 Electrical, I&C and Human Interface
5.8 Unique Technical Design Features (if any)

6. Technology Readiness

SUMMARY FOR BOOKLET

Testing Conducted for Design Verification and Validation

Jimmy's philosophy is to use already tested technologies. Thus, most of the required tests are validation tests on the behaviour on well modelled pieces. Jimmy does not plan to conduct a specific test program.

Design and Licensing Status

Interaction with Nuclear Safety Authority – Formal licensing process under way;

(Launch of licensing procedure with the first regulatory application (Dossier d'Options de Sûreté) in April 2020, allowing the French Safety Authority to start the instruction)

Site permit for FOAK plant – To be developed.

(Application to be submitted in June 2023 – First site for FOAK has already been identified, with seismic and other environmental studies underway)

6.1 Deployed Reactors
6.2 Reactors under Licensing Review
6.3 Reactors in the Design Stage

7. Safety Concepts

SUMMARY FOR BOOKLET

Engineered Safety System Approach and Configuration

Jimmy's safety is mainly based on the leverage of three properties that the HTR can achieve: passive decay heat removal, TRISO particles robustness and high reactivity coefficients. Based on these intrinsic properties, most of the safety systems are around redundant and highly independent control rods.

Decay Heat Removal System / Reactor Cooling Philosophy

During normal operation, the reactor is cooled thanks to the industrial site that use the transferred heat for its process.

During accidental operation, the graphite plays the role of a thermal absorber. The low power density of the reactor easily ensure that the fuel remains below the limit temperature that it can endure.

Spent Fuel Cooling Safety Approach / System

Calculations and modelling show that spent fuel from a Jimmy's reactor cools passively and does not require temporary on-site storage in a spent fuel pool.

Containment System

The design's containment system is based on the "defence in depth" philosophy and includes a set of technical measures aimed at preventing environmental exposure to radiation and radioactive substances from the reactor.

The set of barriers includes:

- The coating layers of TRISO particles;
- The graphite of the core
- The primary system
- The containment of the building

Chemical Control

The main chemical control is a helium purification system that supplies a highly pure helium and monitor the health of the core.

Plant Safety and Operational Performances

he goal of Jimmy is to ensure that large radioactivity release frequency is less than 1E-7/reactor year.

7.1 Safety Philosophy and Implementation
7.2 Transient/Accident Behaviour

8. Fuel and Fuel Cycle

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Fuel Cycle Approach

In order to simplify the design and the operation, and to maximize safety, no refuelling will be done. After the 10-to-20-year life (depending on the nominal power chosen by the client), the entire vessel is extracted from the generator and replaced. Jimmy has a long-term strategy to foster fuel recycling between its systems.

Waste Management and Disposal Plan

By design, the Jimmy reactor does not release any waste during normal operation. The only possible source of waste would be the leaks from the helium loop, which is filtered and stored.

At the end of reactor lifetime, the reactor produces waste that can be collected and disposed of in accordance with applicable regulation, relying on existing French waste management infrastructures with minimal adaptations.

8.1 Fuel Cycle Options
8.2 Resource Use Optimization
8.3 Unique Fuel/Fuel Cycle Design Features

9. Safeguard & Physical Security

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9.1 Safeguards
9.2 Security
9.3 Unique Safeguards and/or Security Features

10. Project Delivery & Economics

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10.1 Project Preparation and Negotiation
10.2 Construction and Commissioning
10.3 Operation and Maintenance