Status Report - XAMR (France)

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1. Overview

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

Link to PRIS	--

- ☑ **New Concept**

Number of Units	--
Year	--

Reference Plant

Name of Site	--
Link to PRIS	--
Net Power Output (MWe)	40
Gross Power Output (MWe)	--

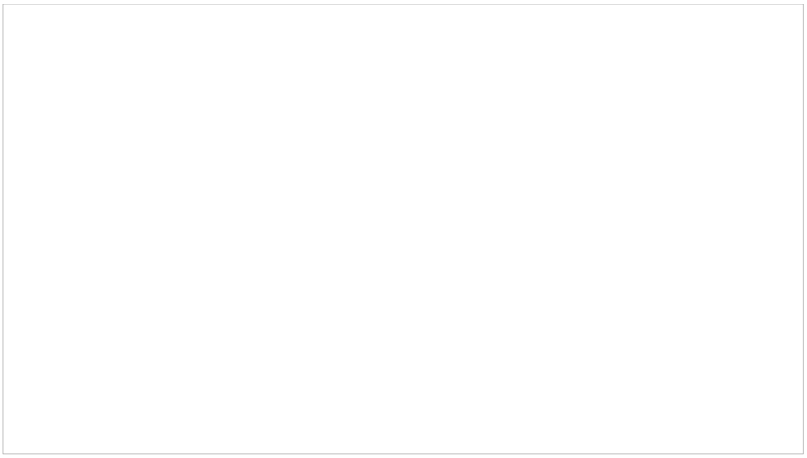
1.1 Introduction

The XAMR is a fast spectrum molten salt reactor with a power of 80 MWth operating close to the atmospheric pressure.

The reactor operating point is around 750°C for the fuel salt, 670°C for the coolant salt and 650°C tertiary salt. This point may evolve depending on the application design studies.

The core of the reactor is made up of a plate heat exchanger made of silicon carbide, a material chosen for its good resistance to temperature, irradiation and corrosion in a chloride environment.

NAAREA's strategy is to sell ”energy as a service” for industrial purposes while ensuring the design, manufacturing, installation, commissioning, operation, maintenance and decommissioning of its fleet of reactors.



1.2 Development Milestones

2021	Start concept design phase
2024	Start prototype basic design and pre-licensing phases
2028	Prototype commissioning
2030	Begin commercial operation

1.3 Design organization or vendor company

1.4 Links to designer/vendor website

https://www.naarea.fr/en

1.5 Design Description

1.6 Licensing Application Support Documents

Start of pre-licensing phase: Sept.2024

1.7 Reactor Unit in PRIS

2. Category Fields

Table 1: ARIS Category Fields

ARIS Category	Value	Units of Examples
Current/Intended Purpose	Commercial – Electric/Non-Electric	e.g. Commercial – Electric/Non-electric, Prototype/FOAK, Demonstration, Experimental

Main Intended Application (once commercial)	Dispatchable, Non-electric	e.g. Baseload, Dispatchable, Off-grid/Remote, Mobile/Propulsion, Non-electric (specify)
Reference Location	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	Molten Salts	H2O, D2O, He, CO2, Na, Pb, PbBi, Molten Salts, (Other-specify)
Reactor Core Size (1 core)	30 MWth <= Thermal power < 1000 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	MSR	e.g. PWR, BWR, HWR, SCWR, GCR, GFR, SFR, LFR, MSR, ADS
Reactor Size	SMR	e.g. PWR, SMR
Neutron Moderator	None	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	e.g. Forced (# pumps), Natural
Thermodynamic Cycle	Brayton	e.g. Rankine, Brayton, Combined-Cycle (direct/indirect)
Secondary Side Fluid	Molten Salts	e.g. H2O, He, CO2, Na, Pb, PbBi, Molten Salts, (Other-specify)
Fuel Form		e.g. Fuel Assembly/Bundle, Coated Sphere, Plate, Prismatic, Contained Liquid, Liquid Fuel/Coolant
Fuel Lattice Shape	n/a	e.g. Square, Hexagonal, Triangular, Cylindrical, Spherical, Other, n/a
Rods/Pins per Fuel Assembly/Bundle	N/A	e.g. #, n/a

Fuel Material Type	Molten Salt	e.g. Oxide, Nitride, Carbide, Metal, Molten Salt, (Other-specify)
Design Status	Basic Design	e.g. Conceptual, Detailed, Final (with secure suppliers)
Licensing Status		e.g. DCR, GDR, PSAR, FSAR, Design Licensed (in Country), Under Construction (# units), In Operation (# units)
Neutron Spectrum	Fast	e.g. Fast, Thermal

3. Parameter Fields

Table 2: ARIS Parameter Fields

ARIS Parameter	Value	Units of Examples
Plant Infrastructure		
Design Life	40	Years
Lifetime Capacity Factor	95	%, defined as Lifetime MWe-yrs delivered / (MWe capacity * Design Life), incl. outages
Major Planned Outages	Target for conventional island and nuclear island: 2 weeks/year	# days every # months (specify purpose, including refuelling)
Operation / Maintenance Human Resources	undisclosed	# Staff in Operation / Maintenance Crew during Normal Operation
Reference Site Design	Single Unit or Multiple Unit depending on customer requirements	n Units/Modules
Capacity to Electric Grid	Up to 40MWe	MWe (net to grid)
Non-electric Capacity	Up to 80MWth (from 100°C to 600°C heat)	e.g. MW(th) heat at x °C, m3/day desalinated water, kg/day hydrogen, etc.
In-House Plant Consumption	undisclosed	MWe
Plant Footprint	undisclosed	m2 (rectangular building envelope)
Site Footprint	10000	m2 (fenced area)
Emergency Planning Zone	undisclosed	km (radius)
Releases during Normal Operation	undisclosed	TBq/yr (Noble Gases / Tritium Gas / Liquids)

Load Following Range and Speed	100% NP per minute	x – 100%, % per minute
Seismic Design (SSE)	undisclosed	g (Safe-Shutdown Earthquake)
NSSS Operating Pressure (primary side)	0.101325	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)	undisclosed	kg
Nominal Coolant Flow Rate (primary)		kg/s
Nominal Coolant Flow Rate (secondary)		kg/s
Core Inlet Coolant Temperature		ºC
Core Outlet Coolant Temperature		ºC
Available Tempeature as Process Heat Source	650	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	Silicon Carbide	e.g. SS304, SS316, SA508, 800H, Hastelloy N
Steam Generator Design	N/A	e.g. Vertical/Horizontal, U-Tube/ Straight/Helical, cross/counter flow
Secondary Coolant Inventory	undisclosed	kg
Pressurizer Design	N/A	e.g. separate vessel, integral, steam or gas pressurised, etc.
Pressurizer Volume	N/A	m3 / m3 (total / liquid)

Containment Type	Dry	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	80	MW(th)
Refuelling Cycle	38	months or “continuous”
Fuel Material	undisclosed	e.g. UO2, MOX, UF4, UCO
Enrichment (avg./max.)	undisclosed	%
Average Neutron Energy	undisclosed	eV
Fuel Cladding Material	N/A	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	undisclosed	kg
Total Fissile Loading (initial)	undisclosed	kg fissile material (specify isotopic and chemical composition)
% of fuel outside core during normal operation	undisclosed	Applicable to online refuelling and molten salt reactors
Fraction of fresh-fuel fissile material used up at discharge	undisclosed	%
Core Discharge Burnup	undisclosed	MWd/kgHM (heavy metal, eg U, Pu, Th)
Pin Burnup (max.)	N/A	MWd/kgHM
Breeding/Conversion Ratio	N/A	Fraction of fissile material bred in-situ over one fuel cycle or at equilibrium core
Reprocessing	Batch, off-site	e.g. None, Batch, Continuous (FP polishing/actinide removal), etc.
Main Reactivity Control	B4C	e.g. Rods, Boron Solution, Fuel Load, Temperature, Flow Rate, Reflectors

Solid Burnable Absorber	N/A	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	N/A	- / - / -
- decay heat removal	Active/Passive	- /- / -
- containment isolation and cooling	Active/Passive	- / - / -
- emergency AC supply (e.g. diesels)	Active	- / - / -
DC Power Capacity (e.g. batteries)	72	Hours
Events in which Immediate Operator Action is required	None	e.g. any internal/external initiating events, none
Limiting (shortest) Subsequent Operator Action Time	undisclosed	Hours (that are assumed when following EOPs)
Severe Accident Core Provisions	Salt spread inside steel-clad reactor containment, static containment	e.g. no core melt, IVMR, Core Catcher, Core Dump Tank, MCCI
Core Damage Frequency (CDF)	1e-6	x/reactor-year (based on reference site and location)
Severe Accident Containment Provisions	Static containment	e.g., H2 ignitors, PARs, filtered venting etc.
Large Release Frequency (LRF)	< 1e-6	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)	6	Months from first concrete to criticality

Design, Project Mgmt. and Procurement Effort	undisclosed	Person-years (PY) [DP&P]
Construction and Commissioning Effort	undisclosed	PY [C&C]
Material and Equipment Overnight Capital Cost	undisclosed	Million US$(2015) [M&E], if built in USA
Cost Breakdown	%[C&C]/%[M&E]	
- Site Development before first concrete	undisclosed	(e.g. 25/10) (30/40) (20/25) (20/10) (5/15) (----------) (to add up to 100/100)
- Nuclear Island (NSSS)	undisclosed	
- Conventional Island (Turbine and Cooling)	undisclosed	
- Balance of Plant (BOP)	undisclosed	
- 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

4.1 Site Requirements during Construction
4.2 Site Considerations during Operation
4.3 Grid Integration

5. Technical NSSS/Power Conversion System Designn

SUMMARY FOR BOOKLET

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

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

7. Safety Concepts

SUMMARY FOR BOOKLET

7.1 Safety Philosophy and Implementation
7.2 Transient/Accident Behaviour

8. Fuel and Fuel Cycle

SUMMARY FOR BOOKLET

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

9. Safeguard & Physical Security

SUMMARY FOR BOOKLET

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

10. Project Delivery & Economics

SUMMARY FOR BOOKLET

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