**Profile LFR-28**

**MASURCA**

**FRANCE**

## GENERAL INFORMATION

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|---|---|
| NAME OF THE FACILITY | MASURCA |
| ACRONYM | MASURCA ( |
| COOLANT(S) OF THE FACILITY | air |
| LOCATION (address): | CEA Cadarache,<br>13108 Saint Paul Lez Durance<br>FRANCE |
| OPERATOR | CEA |
| CONTACT PERSON (name, address, institute, function, telephone, email): | O. GASTALDI<br>CEA Cadarache<br>Building 710,<br>13108 Saint Paul Lez Durance, FRANCE<br>Sodium Technology and Components Project Manager<br>+33 4 42 25 37 87<br>Olivier.gastaldi@cea.fr |

| | |
|---|---|
| **STATUS OF THE FACILITY** | In activity from the 60th until 2006. |
| Re-Start of operation (date): | 2019 |

**MAIN RESEARCH FIELD(S)**

- ☒ Zero power facility for V&V and licensing purposes
- ☐ Design Basis Accidents (DBA) and Design Extended Conditions (DEC)
- ☐ Thermal-hydraulics
- ☐ Coolant chemistry
- ☐ Materials
- ☐ Systems and components
- ☐ Instrumentation & ISI&R

## TECHNICAL DESCRIPTION

### Description of the facility

MASURCA (Fig. 1) is one of the critical facilities operated by the CEA at the Cadarache Research Centre, France. This “zero power” nuclear reactor is mainly used for physics studies of fast spectrum lattices. The maximum authorised power, 5 kW, corresponds to a neutron flux of approximately $10^{11}$ n/cm$^2$/s, a level high enough to perform measurements in good conditions, while sufficiently low to consider that the fuel composition does not evolve with time.

The core is cooled by forced air extraction and blowing, and is surrounded by a biological shield in heavy concrete. The core inlet temperature can be adjusted between 20°C and 35°C, and the air flow is such that the temperature increase across the core is always less than 10°C. The core and the surrounding biological shielding are located in a reactor building where the air pressure is maintained below atmospheric pressure.

The MASURCA building area (Fig. 1 left) has a total surface of about 6000 m$^2$. It is a high-security fenced area made of four main buildings:

- the containment building (26 m in height, 18 m in diameter, partially underground)
- the control and measurement room building,
- the storage and handling building that contains in particular all fissile and non-fissile elements which can be loaded in the core
- an auxiliary building that notably includes the core cooling system as well as workshops.

A dosimetry lab, located in the vicinity of the MASURCA zone, complements this experimental platform.

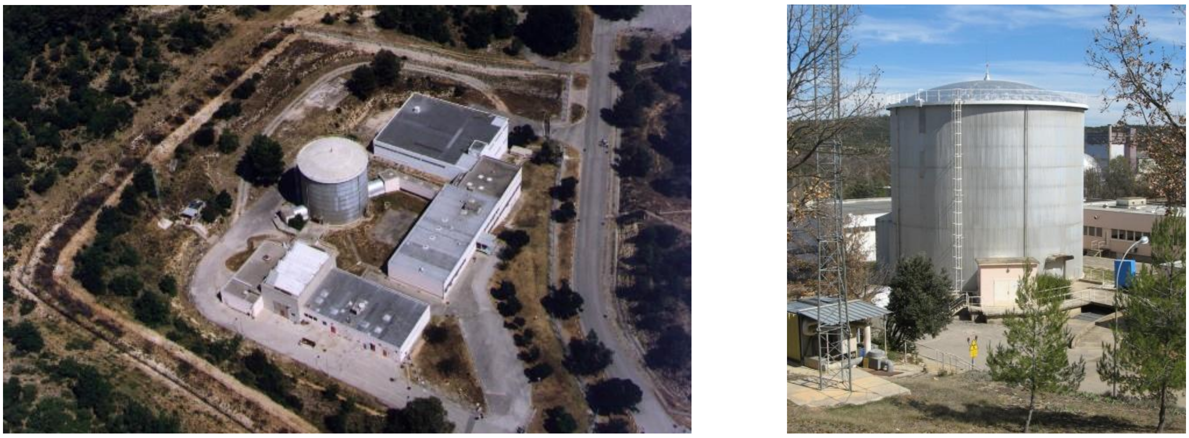

*FIG 1._The MASURCA zone (left) and the reactor building (right)*

The materials used in the MASURCA subassemblies, called “tubes”, are contained in cylindrical or square rodlets, or else in square platelets. These rodlets or platelets are loaded (Fig. 2 and 3) into wrapper tubes made of stainless steel, having a square section (~10.5 x 10.5 cm) and a total length of about 3.8 meters. The nuclear materials currently available at MASURCA, and stored in an adjacent storage building, include oxide of thorium, metallic uranium with up to 35% of $^{235}$U, oxides of uranium (natural, depleted and enriched with 30% of $^{235}$U) and several plutonium fuels with various $^{240}$Pu contents (8 ➔44%) that include:

metallic plutonium, oxide of plutonium and mixed oxides of plutonium and uranium. Large amounts of inert materials – metallic sodium, $Fe_2O_3$, stainless steel, graphite, lead, etc. - are also available to simulate the coolant, the blankets, the reflectors as well as the structure materials.

*FIG. 2. Building of a fissile tube*

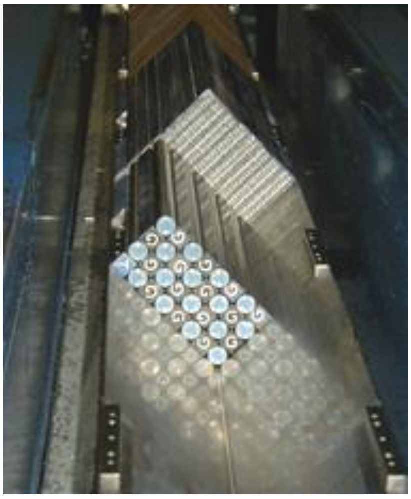

*FIG. 3. Example of a loading pattern*

Once built, the tubes are transferred horizontally from the loading room to the reactor building. There, they are lifted vertically and hanged to a horizontal upper plate supported by a concrete structure. Up to 400 fissile tubes can be loaded (diameter of the core 1.4 m, height of the fissile column up to 1.2 m).

Safety rods are positioned in the core ; their number and position depend on core type and size. These safety rods (CR) are composed of $B_4C$ in the upper part and fissile materials in the lower part. In normal operation, the safety rods are withdrawn so that the core is homogeneous. To make the core critical and adjust the power, a pilot rod (PR) with a reactivity worth of less than half a delayed neutron fraction is used. It is composed of a fuel tube containing a mobile part made of a $^{235}U$ enriched pin surrounded by stainless steel in the upper part and moderator material in the lower part.

To perform various local reaction rate measurements, special axial channels can be built in the MASURCA tubes in which different devices can be introduced: fission chambers, monitors, fissile or inert activation foils, neutron sources. In addition, two horizontal radial channels, at 90° of each other, can be set up near the mid-plane. Dosimeters can be also inserted between the rodlets.

**Acceptance of radioactive material**
No

**Scheme/diagram**
See description

**3D drawing/photo**

**Parameters table**

| | |
|---|---|
| Coolant inventory | air |
| Power | 5 kW |
| Test sections | |
| TS #1 | *Characteristic dimensions*<br>Diameter : 18 m<br>Height : 26 m |
| | *Static/dynamic experiment*<br>static experiments |
| | *Temperature range in the test section (Delta T)*<br>Until 35°C |
| | *Operating pressure and design pressure*<br>**Operating pressure : no pressure** |
| | *Flow range*<br>Neutron flux : $10^{11}$ n/cm$^2$/s |
| Instrumentation | Thermocouples<br>Neutron measurement |

## COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

In a first period, till the middle of the 70's, programs were focused on the homogeneous cores and parametric studies in function of U and Pu content. The RZ and PLUTO programs thus contributed to the development of calculation tools used for PHENIX and SUPERPHENIX design. Then, the PRE-RACINE and RACINE programs extended the study area to heterogeneous cores and allowed to validate the method adopted for the loading of SUPERPHENIX core. The program that followed, BALZAC, completed the knowledge in the field of control rods and experimental techniques for the assessment of their reactivity worth. Last, in the perspective of the deployment of FNR's, the CONRAD program aimed to investigate large axial heterogeneous cores within the frame of the European Fast Reactor project. The more recent programs have been carried out under the terms of the French law of 1991 on the management of long lived radioactive wastes (the "Bataille" act). They were essentially conducted within the axis 1 "Partitioning and Transmutation" :

- the CIRANO program (1994-1997) first contributed to the study of Pu burner reactors within the frame of the CAPRA project,
- from 1998 to 1999, based on the ECRIX experiments in the PHENIX reactor, the COSMO program investigated the principle of transmutation in moderated targets located in a FNR,
- Last, from 2000 to 2004, the behaviour of accelerator driven systems (ADS) has been deeply studied during the MUSE-4 project.

In the same way than the IRMA (1987) and BERENICE (1994) exercises, which intended to compare experimental techniques for the measurement of the delayed neutron fraction and spectral indices, the MUSE-4 program have been achieved within a large international collaboration and benefited of the support of the European Commission and the OCDE. These unique experiments, carried out in a close collaboration with the National Centre for Scientific Research, once more demonstrated the capability of MASURCA to simulate innovative systems.

During 2006, the loading of a "gas" cooled configuration, in view to validate the new neutronic control system of the facility, pointed out the start of a new experiments cycle; this time, for systems of the 4th generation. After an important refurbishment work that will include the construction of a new nuclear material storage building, the next programs will be conducted in support of the ASTRID prototype and innovative sodium cooled reactors.

**PLANNED EXPERIMENTS (including time schedule)**

**TRAINING ACTIVITIES**

**REFERENCES (*specification of availability and language*)**