STATUS REPORT

2024

Jules Horowitz Reactor

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Please refer to pages 72/73 to find the meaning of the acronyms underlined in yellow

Jonathan HYDE
JHR Governing Board Chairman

In 2023, the French state endorsed the revised roadmap developed by CEA and reconfirmed their support to enable completion of the Jules Horowitz Reactor in the early 2030s (first criticality is planned for late 2032). In 2024, focus was on delivering the in-year milestones and implementing an improved methodology to assess construction progress. Over 100,000 key milestones were defined, of which approximately 50% are now complete. The increase in site activity has been apparent, with manpower increasing from approximately 150 in September 2023 to around 210 in April 2024. Safety remains the CEA's overriding priority and therefore a prime concern for the board. The conditions that led to two lost-time accidents were properly assessed, providing an immediate response that included enhanced safety training to minimize risk as activities on site continue to increase. This positive outcome is a good reflection of the site's safety culture.

The progress made during the course of the year has kept us on track to obtaining the operating license. There were several technical meetings between CEA and ASN with its technical support, IRSN. Feedback on site safety, cleanliness and responses to questions raised has been very positive.

Initial discussions have begun with the intention of updating the consortium agreement in preparation for the operating phase. During 2024, CEA visited several consortium members to discuss the rationale for updating the agreement. These visits will continue in 2025, leading up to discussions by the JHR management board in June 2025.

The three JHR working groups (fuels, materials and technology) met twice during the year; just before the board meeting in June (at Cadarache) and then in November (hosted by VTT in Finland). The level of engagement has been exceptional. Discussions covered a wide range of activities, including fuel testing requirements and the potential development of a fuel capsule irradiation rig, not to mention the use of standard materials for cross-comparison of different reactor environments. Progress has already been made in the irradiation activities within the OECD FIDES-II framework.

In 2025, the JHR International Advisory Group (IAG) will be tasked with refining the experimental weighting factors associated with each of the experimental devices. This is an important task to deliver in tandem with the amendments to the consortium agreement.

Finally, it gives me great pleasure to thank Petri Kinnunen for his outstanding leadership of the JHR Governing board over the last 8 years. I am equally thankful that he has agreed to continue serving on the board as Finland's representative and to chair the IAG.

David EMOND
JHR Project Director

In 2024, the construction pace of the Jules Horowitz reactor significantly advanced. Electromechanical erection activities increased on most levels of the buildings, and dozens of workers joined the site. Unfortunately, the number of accidents increased with this trend, with the accident frequency rate returning to its 2022 level, reversing the positive trend initiated in 2023. Additionally, the proportion of lost-time accidents increased.

Safety remains the utmost priority. To turn this negative trend around, we organized a one-day 'stop work' initiative, leading to a remedial action plan and strengthening our safety culture within our teams and those of our sub-contractors.

The construction site is now very active from dawn to dusk. We achieved some major milestones in 2024, such as: assembly of the cooling systems on the building ground level, completion of the stainless steel casing in the reactor pools, disassembly of the heat exchangers and their expedition for repair, supply of the lifting units for the hot cells, detailed design reviews of the MADISON and ADELINE experimental loops, and implementation of two mock-ups in the TOTEM facility (a hot cell and the MADISON out-of-pile experimental loop).

Although more than 1,500 km of cables and 40 km of piping have already been installed, there is still much to do. However, strong progress will be made in 2025, taking yet another step towards completion of the JHR facility. In 2025, the 3D implementation of the experimental devices will be finalized, their detailed designs will be reviewed, and the bidding process will be launched for the manufacturing of the experimental components.

In 2029, the reactor will move into its commissioning phase with first criticality scheduled for 2032. Thanks to the daily commitment of the project team, together with our industry partners and consortium members, the Jules Horowitz reactor is now progressing at a steady pace, on its path to completion and start-up.

As Gandhi pointed out, "*the future depends on what you do today*". Every day, more than 1,000 people working at the construction site are helping to build the future of the Jules Horowitz reactor.


csti

2 TOWARD A ZERO ACCIDENT CONSTRUCTION SITE

Guillaume VILLARD
Safety and Construction
Site Manager

The JHR Project team values the health and safety of its employees, contractors and third parties involved in the JHR construction and commissioning activities. Preventing accidents, injuries and ill health while protecting the environment is JHR Project's primary concern. This is why all the work during construction and commissioning has and will continue to be carried out under the safest possible conditions. All the project's contractors, including CEA, have signed the occupational safety policy and are committed to making occupational safety their main concern.

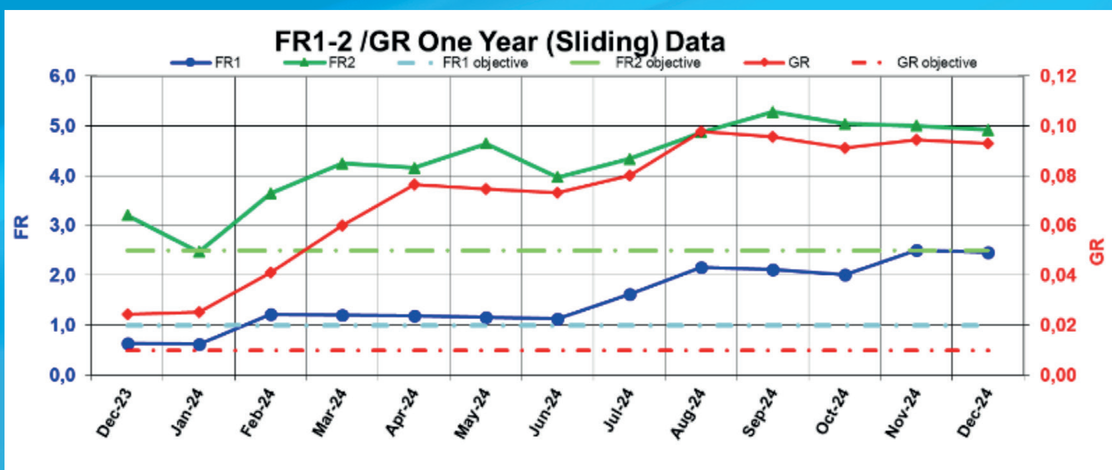
The JHR Project strives to provide a safe and healthy working environment for employees and contractors alike; its managers, supervisors, engineers and operatives, as well as its contractors, are all encouraged and expected to proactively contribute to improving JHR health and occupational safety indicators.

All health, safety and environmental risks are systematically managed as an integral part of the project; accordingly, the behaviour of employees and contractors must reflect the highest occupational safety standards when going about their daily activities.

2.1 OCCUPATIONAL SAFETY

2.1.1 Indicators

The table hereafter shows the main safety key performance indicators for 2024



- *TF1 (frequency rate 1) defines the number of occupational accidents with lost time over a 12-month period per million hours worked.*
- *TF2 (frequency rate 2) defines the number of occupational accidents with and without lost time over a 12-month period per million hours worked.*
- *TG (severity rate) defines the ratio between the number of days lost multiplied by 1,000 and divided by the number of hours worked over a 12-month period.*

EHS KPI

	Results	Objectives
TF1	2	<1
TF2	4,4	<2,5
TG	0,07	<0,01

The number of occupational accidents in 2024 significantly increased compared with previous years, and it is above the JHR Project objectives.

The following table describes all lost-time accidents (LTA) and without-lost-time accidents (WLTA) for 2024.

22 November	LTA | a worker suffered occupational stress
14 November	LTA | A worker fell over at ground level while moving. Her foot got caught in the deteriorated floor covering.
06 September	WLTA | A worker was performing a bush hammering operation when the jackhammer slipped. As he tried to rectify the situation, the worker felt pain in his shoulder.
04 September	WLTA | A worker was cutting a metal part with a saw when the tool slipped and cut the worker's thumb, which required stitches. He was not wearing safety gloves.
12 August	LTA | A scaffolder was preparing equipment in the storage area. He was handling sleeved scaffolding tubes when a lower tube felt on his foot and another tube hurt his shoulder.
16 July	LTA | A worker slipped on the stairs inside a building and twisted his ankle. As he was holding the handrail, he did not fall.
27 May	WLTA | During a drilling activity, a worker got a metal shard in his eye. He was wearing protective googles but they did not fit his face properly.
14 March	WLTA | During a tightening operation, the wrench slipped and the worker's hand struck the lifting basket guardrail.
28 February	WLTA | Worker (A) was working on scaffolding when Worker (B), on the level below, opened the hatch. The leg of Worker (A) went through the open hatch and struck the ladder.
02 February	LTA | While looking for a nut that he dropped, a worker fell from a height of 4.5 m after having passed through the scaffolding system in place.

2.1.2. Actions

❖ *Stop work safety moments*

The lost-time accident in February 2024 could have resulted in a fatality as the contractor fell from a height of 4.5 m. Because of the severity of the accident, the JHR Project team decided to hold a "stop work" safety moment, gathering all the workers, including office workers. The aim was to summarise the accident and introduce the action plan to prevent this accident from happening again. This action plan was deployed on site. CEA produced a dedicated movie to share the accident and learn from it.

Despite this action plan, other accident and events occurred thereafter, including events with HIgh POtential severity (HiPO). For this reason, the JHR Project team conducted another "stop of work" safety day on 3 October during which on-site construction activities were halted. Each contractor organised a meeting with its employees in the morning to define the ways to improve safety in the field. In the afternoon, the JHR Project team organised a round-table meeting with all contractor managers to share ideas and agree on a joint action plan. During this time, the site workers cleaned the construction site area. Many actions were identified, such as: improve the project's safety procedures, reinforce construction site markings, and make field supervisors aware of their safety role and legal responsibilities.

Occupational safety field visits

The JHR project has implemented safety field visits to observe the occupational safety behaviour in the workplace. This involves observing employees (JHR project personnel and contractors) in the field to find solutions that can improve occupational safety and working conditions. Employees are asked to think about the situation themselves so they can identify ways to resolve their own occupational safety issues and improve their workplace conditions. This approach actively engages employees in the implementation of actions that have been decided together.

A total of 103 visits were carried out in 2024 (74 visits in 2023), with more than 200 good practices observed and 100 hazardous behaviours corrected.

Occupational Safety Day

The Occupational Safety Day took place on 1 October 2024 at the JHR construction site. This day was dedicated to occupational safety training and risk awareness, including a very impactful conference on lost-time accidents with severe injuries hosted by a former worker who lost his leg at work several years ago. All the project contractors were invited to participate in this event, some of which led workshops, e.g. scaffolding team or electrical maintenance team.

The following workshops were held:

- **Conference on the consequences of a severe accident: >400 participants**
- Climate fresco awareness: 65 participants
- How to use a fire extinguisher: 80 participants
  Lifting activities: 47 participants
- **When and how do the police conduct work accident investigations: 101 participants**
- Resitting the driving theory test: 87 participants
- Slip and trip hazards: 45 participants
- Stress management: 52 participants
- Electrical risks: 55 participants
- Scaffolding safety: 45 participants
- Work-at-height risks: 68 participants
- Test your reflexes: 36 participants
- Forklift driver with virtual reality simulation: >30 participants
- Rollover car: 106 participants
- First aid actions training 140 participants

❖ *Back-to-work journey*

Every January, the JHR Project organizes a back-to-work site visit to ensure that workers will start the New Year with safety as their top priority. Together with their managers, workers walk around the construction site to specific spots where safety information is provided, such as:

- 2024 safety events
- Work-at-height hazard awareness
- Risk-hunting in the offices
- Electrical hazard awareness
- Risk-hunting on the construction site

2.2 SITE SAFETY COMMUNITY

2.2.1 Company industrial safety award

At the annual general meeting in 2024, the JHR Project awarded three companies for their implementation of good practices, deployment of new occupational safety initiatives, and ownership of occupational safety issues.

The following companies were rewarded:

- Q1/2024: NUVIA ACCESS
- Q2/2024: FRAMATOME ARC
- Q3/2024: NUVIA STRUCTURE
- Q4/2024: None

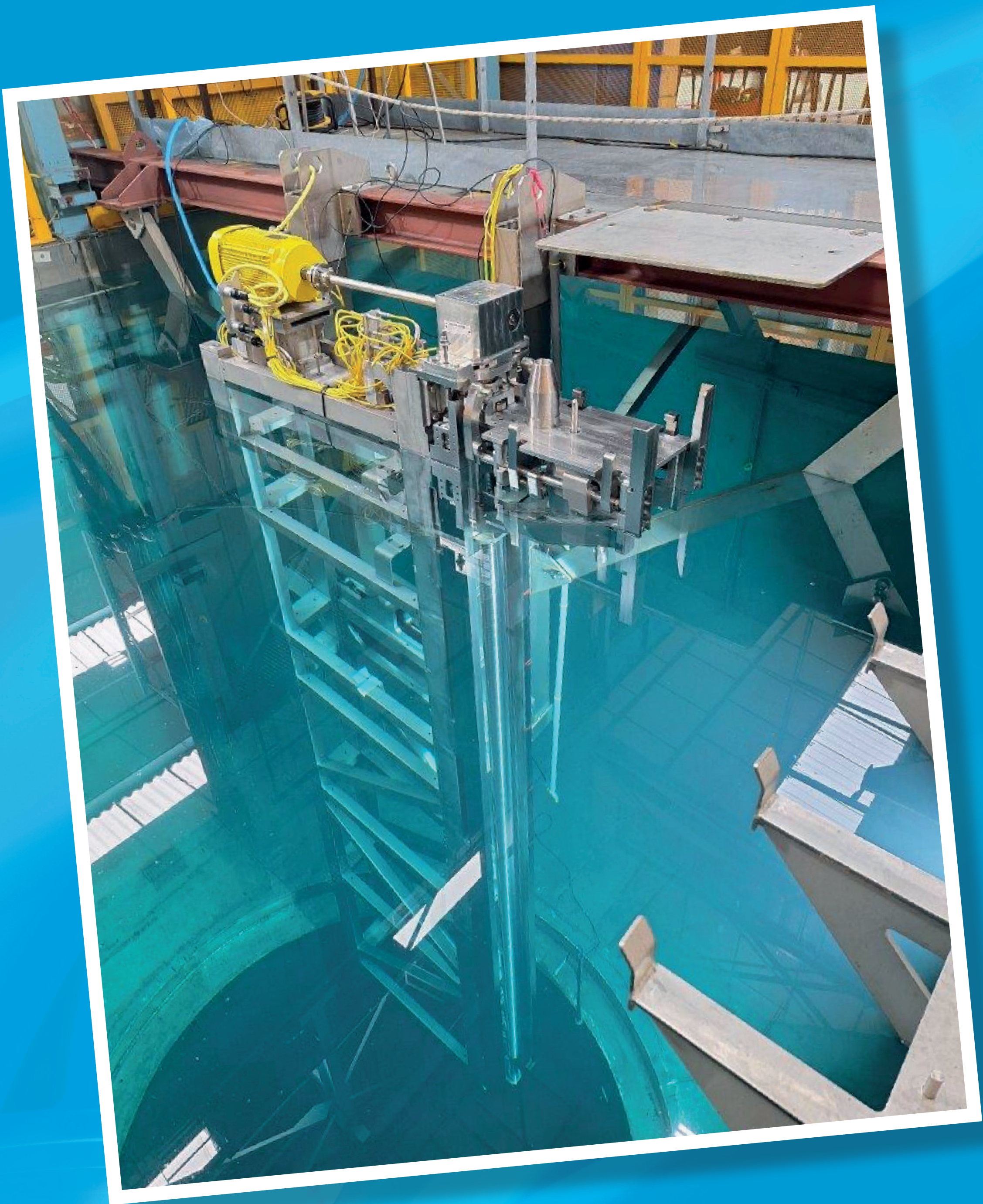
2.2.2 Employee of the month

In 2024, eleven staff members were given the 'safety employee of the month' award for the following reasons:

- Zero occupational safety non-conformity events over a period of 3 months (compliance with the JHR safety fundamentals)
- Model behaviour with respect to the occupational safety rules (wearing safety equipment, following procedures, etc.)
- Good safety initiatives and safety proposals
- Polite and open communication in safety and environmental matters
- Proactive warnings about hazardous situations

2.2.3 Emergency drills

A total of 21 emergency drills were organised in 2024 to train staff to react correctly in the case of an accident and to benefit from lessons learnt. Hazardous situations were analysed and 'victims' were evacuated from areas considered difficult to access in order to test the emergency response procedure in place. Many visits were organised with the CEA emergency response team to make sure they were able to find their way into buildings and reach difficult areas during working and non-working hours



Gilles BIGNAN – Eric HANUS
International Affairs Manager
Consortium Manager

Mid-2024, Eric Hanus joined the JHR project as Manager of JHR Consortium Affairs (both domestic and international).

3.1 CONSORTIUM ORGANISATION

The JHR Consortium gathers 14 partners. The European Commission is associated to the consortium activites. The consortium agreement states the rights and obligations of each member, providing a model for governance during both the construction and operation phases. The consortium is managed by a governing board. Each member of the Consortium appoints a representative to attend the governing board meetings.

Jonathan HYDE
JHR Governing Board Chairman

The governing board is responsible for defining the policy and strategic orientations of the consortium. Its members appoint a chairperson to manage the meetings and duties for a period of four years. After 8 years of chairing this governing board, Petri Kinnunen from the Technical Research Centre of Finland (VTT) has left the position. At the last meeting in June 2024, the board endorsed Jonathan Hyde from the UK NNL for the next 4 years

David EMOND
JHR Project Leader

Appointed by the CEA and approved by the governing board, the project leader is responsible for the construction phase. David Emond manages the day-to-day activities associated with JHR construction.

CONSORTIUM ORGANISATIONAL CHART

The last governing board meeting was held at Cadarache (JHR site) on 6 & 7 June during which its members were given updated information on the project.

3.2 GOVERNING BOARD AND CONSORTIUM ACTIVITIES

3.2.1 New consortium members

The CEA is mandated by the governing board to further develop the JHR international consortium by accepting new members. In 2024, the CEA continued to exchange with potential stakeholders/ customers having shown interest in joining the JHR international consortium. Following the important decision made by the French Nuclear Policy Council in July 2023, the CEA is now in a position to offer certain countries the possibility to join the JHR consortium. So far, the CEA is focusing its efforts on Japan and South Korea.

3.2.2 JHR working groups

The three JHR working groups, i.e. fuel (FWG), material (MWG) and technology (TWG), met twice in 2024:

- At the 13th scientific and technical seminar in Aix-en-Provence (France) in June.
- During dedicated meetings in Espoo (Finland) organised by our colleagues at VTT, who also organised visits of their hot laboratories and underground laboratory

In 2024, the main activities of the three working groups were:

- Provide information to update the expected performance levels of the experimental devices under development (fleet 1 and fleet 2)
- Exchange on several key topics strongly linked to the JHR experimental devices, e.g. LOCA tests for the FWG, JAM samples for the MWG, and the IFE laboratory for sensor studies for the TWG.

Note: *following approval from the governing board in autumn 2023, participation in these three working groups was extended to non-members of the consortium such as the US NRC, the US DOE, NRG in the Netherlands, NCBJ in Poland, and JAEA-CRIEPI in Japan. The Working Group members consider these additional participants as very beneficial and will continue their collaboration.*

Their activities also underpin the importance of launching the 'pre-JHR' phase through several joint research programmes in operating MTRs (see OECD/NEA FIDES framework, EURATOM framework, etc.) in order to collect feedback and optimise the experiments to be performed in the JHR.

3.2.3 JHR archive material (JAM)

The MWG is currently focusing on an important topic linked to the specific neutron spectrum in the JHR. The group is studying the behaviour of reference materials in different neutron spectra. Firstly, it is conducting research in operating MTRs such as the HFR in the Netherlands and LVR15 in the Czech Republic. Later, it will continue research in the JHR to build a data bank on reference materials (stainless steel) that will be used for the entire service life of the JHR.

Significant progress was made in 2024 with respect to the detailed characterisation of cold samples stored and managed by the CEA Saclay centre. The MWG is now ready to initiate a round robin on cold reference samples with its members.

Thanks to NNL, it was possible to start an irradiation experiment on the first JAM samples in the high-flux isotope reactor (HFIR) at the Oak Ridge National Laboratory (ORNL) in the US. In the coming years, these samples will be sent back to the UK for Post-Irradiation Examinations (PIE).

At the same time, JAM samples will also be irradiated in both the MIT reactor (MITR) at the Massachusetts Institute of Technology (US) and in the HFR in Petten (Netherlands), giving us access to Post Irradiation Examinations PIE) data from different test reactors. These irradiation programmes are part of the INCREASE joint programme under the FIDES-II framework.

3.2.4 OECD FIDES framework

After the phase-out of the Halden reactor (mid-2018), the OECD decided to launch a new initiative called FIDES. This initiative federates a broad scientific community around material test reactors to propose several joint R&D programmes on fuel and material behaviour studies under irradiation.

The CEA and its partners from the JHR consortium have been actively working on the FIDES legal framework agreement, as well as preparing the first joint experimental programmes based on topics proposed by the JHR working groups. The CEA has also confirmed that once the JHR starts operating, the OECD-NEA community will be able to perform important research programmes on innovative fuels and structural materials. The FIDES legal framework came into force in March 2021 with 27 organisations representing nuclear operators, fuel manufacturers, R&D organisations, and transmission system operators.

The year 2022 saw an overall increase in the number of activities led by the FIDES joint research project. Nevertheless, due to the international context and the fact that the OECD council suspended its Russian members from taking part in all activities in May 2022, a new framework called FIDES-II was created. The new framework for FIDES-II with 24 organisations was officially endorsed at the governing board meeting in October 2022, and there has been no impact on the progress of the R&D projects thanks to the excellent responsiveness of all members.

The governing board meeting in autumn 2022 endorsed a new joint R&D project (called JEEP) in addition to the four on-going projects: it is called INCREASE and will study the behaviour of structural materials (excluding cladding materials), first under neutron irradiation in the MITR (US) and then in the HFR in the Netherlands. This INCREASE joint project will be testing samples from the JAM initiative, with strong support from the Material working group.

The United Kingdom entered officially the FIDES-II framework as a new member in October 2023 and South Korea did the same in March 2024. The second triennial of FIDES-II was officially launched in April 2024 with 28 organisations and a total budget for the experiments of around €30 million for the 3 years. Nine joint programmes have been endorsed, doubling the number of programmes compared with the first triennial.

Hence, the JHR consortium members are particularly involved in three projects:

- The 'Power-to-Melt and Manoeuvrability' (P2M) project that sets out to perform slow-power transients to reach partial fuel melting led by the CEA and SCK CEN
- The 'In-Core Creep studies of Accident-Tolerant Fuel cladding' (INCA) project led by CVR
- The INCREASE project led by the Idaho National Laboratory in the USA for the first phase, and by NRG in the Netherlands for the second phase

3.2.5 JHR school

The three working groups have endorsed the organisation of the 2nd JHR 'school' that will be co-organised by the Aix-Marseille University, Bologna University, the CONNECT-NM framework (European Commission) and the CEA. It will be held in October 2025 at the Aix-Marseille University with participation open to non-members. This year, the target is 30 young fellows, with half of them from consortium members.

3.3 JHR AN INTERNATIONAL FACILITY

3.3.1 IAEA ICERR

The CEA was named ICERR by the IAEA in 2015 for 5 years, with the label renewed in 2020 for another 5-year period ending in December 2025. Such international recognition has led to successful collaborative actions with several IAEA member states. In late 2019, the CEA decided to submit its application for the next 5 years with a new scope that includes the CABRI research reactor, the MADERE dosimetry platform, and the JHR. After a rigorous assessment process carried out by the IAEA in 2020, the CEA and its partner IRSN were chosen in December 2020 to be an ICERR for the next 5 years.

The main highlights with respect to work completed under the ICERR framework were:

- Preparation of practical training sessions for staff specialised in fuel and material science from the UAE Federal Authority for Nuclear Regulation
- Organisation of a 'Research Reactor school' from 18 to 27 November for 15 participants from developing countries under the auspices of the IAEA. Lectures were given at the National Institute for Nuclear Science and Technology (INSTN) on the Saclay centre, the Institut Laue–Langevin (ILL) in Grenoble, and the CEA Cadarache centre. They focused on the subjects of 1) operation & maintenance, 2) safety reviews, and 3) safety of experiments. In addition, the group had the opportunity to visit several reactors: high flux reactor, CABRI and JHR

Participants of the Research Reactor School during their visit to JHR construction site and the TOTEM facility

3.3.2 Scientific seminar

The 13th scientific and technical seminar on the JHR experimental capacity was held from 3 to 5 June 2024 in Aix-en-Provence, with the possibility of remote participation through videoconferences for colleagues who were unable to travel.

As indicated above, the seminar was open to certain non-members (US-NRC, US-DOE, NRG, JAEA, CRIEPI, Aix Marseille University, Bologna University, IRSN, etc.).

Around 100 people attended the seminar (around 60 in person, the other half remotely), during which the JHR community was given a progress report on:

- JHR project
- Design of the experimental devices (fleet 1 and fleet 2&3)
- In-kind contributions for experimental devices (e.g. the CLOE loop from BARC), but also experimental devices developed by JHR partners (e.g. the RISHI loop from IGCAR and the Pb-Bi capsule from CGN)
- Work completed by secondees from VTT, BARC and UKAEA
- Preparation of international joint programmes: OECD/NEA/FIDES, EURATOM framework via the CONNECT-NM initiative which got funding from EURATOM in 2024, etc.

Half a day was dedicated to separate sessions organised for each working group.

A technical visit of the JHR building site was organised and greatly appreciated by the participants.

3.3.3 French Decision makers visits

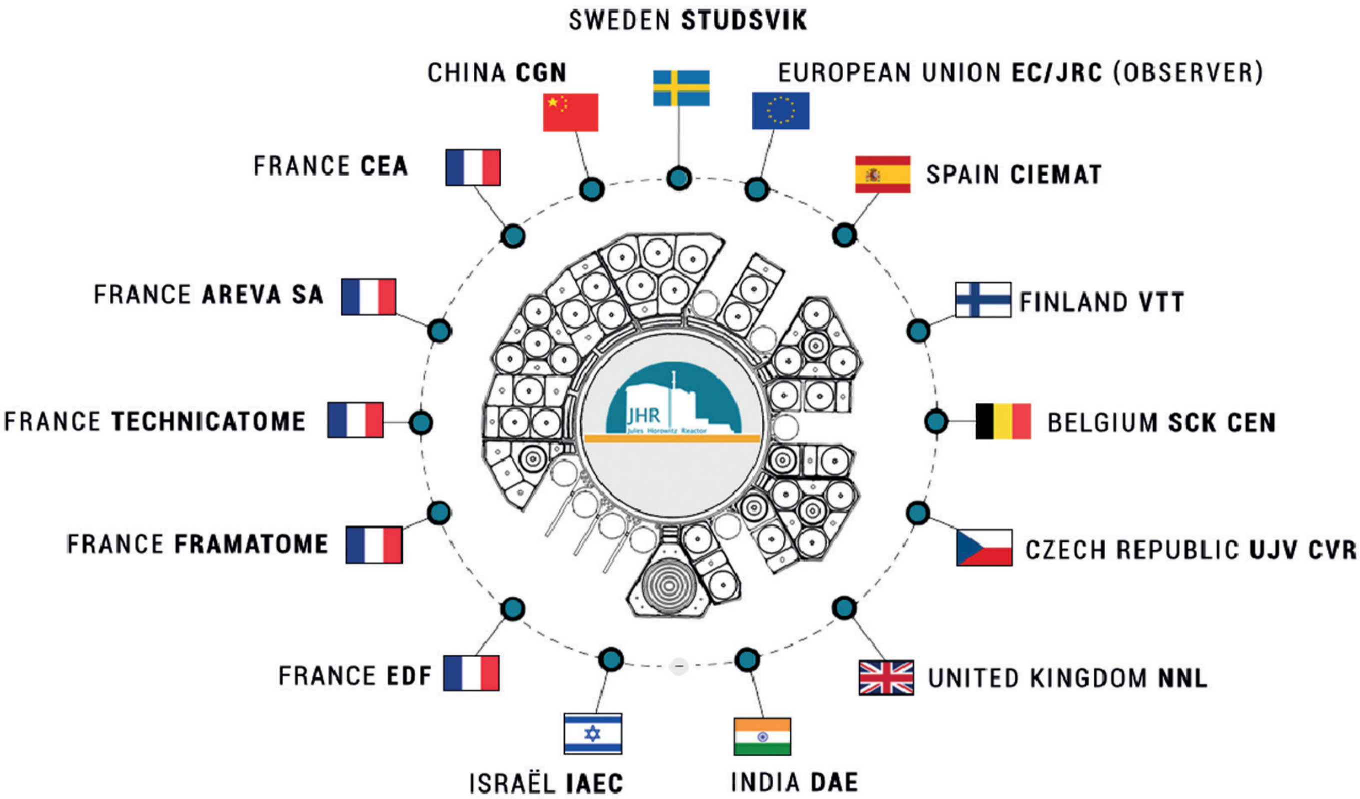
In order to support the roadmap proposed by CEA to the French State for the JHR completion, this year, JHR Direction organised a JHR visits with 7 French parliamentarian.

3.3.4 Conferences

The JHR and CEA teams have attended several international and European events on fuel and material experiments, as well as on material and test reactors. During these events, they have given presentations on the JHR project and its progress, in the preparation for operation and the experimental devices under development:

- European research reactor conference (RRFM)
- IAEA International conference on research reactors (ICRR)

The CEA also participated in many events around the production of medical radioisotopes, during which it was able to communicate on the JHR construction progress.



David EMOND
JHR Project Director

4.1 PROJECT ROADMAP AND OVERALL SCHEDULE

During the Nuclear Policy Council on 19 July 2023, the French government decided to continue investing in the project with the objective of finishing reactor construction by 2032-2034. To do so, the CEA is following the validated roadmap that focuses on the following areas:

- Maintaining good results in occupational safety
- Erecting, installing, commissioning and starting up the reactor according to schedule and in line with quality and safety objectives
- Signing variation orders and new purchase orders to meet site needs
- Planning ahead to ensure a smooth licensing process
- Continuing to deploy best project management standards
- Securing resources
- Preparing for technical and commercial operation

Regarding the project completion schedule, the project management team and its contractors are working to reach JHR start-up by the end of 2032.

The main milestones of this new schedule are as follows:

2025	End of the detailed preliminary design phase for the first fleet of experimental devices, and ramp-up of electromechanical assembly in the Reactor Building
2026	Start of assembly activities in the experimental area
2027	End of assembly activities in the Annex Building
2028	End of primary system assembly
2029	Commissioning of electrical distribution system and start of functional tests
2030	Filling of the BUA pools
2031	Filling of the BUR pools
2032	Fuel loading and first criticality (start-up)

Valentin DALLAPORTA
Technical Director

Sarah FRANCKE
Engineering Director

4.2 TECNICAL DESIGN

In 2024, work on the digital mock-up of the JHR continued with the convergence of the BUA roof. The layout has now reached 90% convergence, with only the CEDE area in the BUR to be finalised.

At the same time, 50% of the terminal electrical routes have been installed in rooms with very complex layouts, without coming up against any significant difficulties. This was one of the actions resulting from the 2022 design review (maturity of construction/manufacturing readiness).

The year 2024 also saw significant progress on the conceptual design studies of systems still to be designed. The following remain to be completed:

- Basic design of the building containing the hardened safety core equipment (BND)
- Basic design of the cooling system for the pools in the BUA in the event of a hardened safety core situation
- Basic design of the gaseous effluent system
- Intermediate design review milestone for the part of the MOLFI system in the pool
- Mid-basic design review of the effluent treatment system (ELT). This system is used to:
  - Recover effluents from the ADELINE loop (and potentially from MADISON/ FUICA/ LORELEI in incidental conditions)
  - Filter very-high-level effluents so they are compatible with liquid effluent treatment plants: STEL[1] at Marcoule or AGATE[2] at Cadarache
- Specify the requirements associated with extending the truck access airlock and the contaminated equipment storage building.
- Carry out the basic design studies for the experimental devices (see Chapter 4.4.2)

KEY MILESTONES IN 2025

- Configure the CEDE area as a mock-up for convergence of the lower levels
- Carry out the final design review of the MOLFI system
- Carry out the preliminary design of the Electrical Auxiliary Building (BAE) and the truck access airlock extension
- Continue the basic design of the effluent treatment system; the basic design is scheduled for completion in early 2026
- Complete the fire stability studies for the engineered structures of the nuclear unit, finalise the fire compartmentation strategy, and define the additional fire extinguishing means

1/ *STEL: A liquid effluent treatment plant that filters effluents before their discharge*

2/ *AGATE: A facility that treats radioactive liquid effluents, concentrating the radioactivity in a smaller volume (reduced by a factor 10) before their transfer to another facility for final treatment and packaging*

4.3 CONSTRUCTION STATUS AND PERSPECTIVES

Remy POMMIER
Delivery Manager

To summarise the work to be completed in 2025:

- Efforts will focus on preparation for the cabling activities, which are due to start in mid-2026
- Major progress will be made in the field of electromechanical installation
- The key challenge will be to manage the on-time delivery of components needed to maintain the pace of construction

4.3.1 Site activities

Guillaume VILLARD
Safety and Construction
Site Manager

MAIN ACHIEVEMENTS IN 2024

In 2024, 91% of the on-time delivery milestones related to the preparation of site activities and construction were achieved, including the removal of the three heat exchangers and their transport to the factory for repairs, and installation of the BMR+0 systems.

Installation of the pool liner was also completed during this period.

All of these milestones were met thanks to the strong commitment of the CEA and contractor site teams, including tight follow-up of the schedule, and several technical and organisational improvements.

Extra support was assigned to the elaboration of the JHR project's 6-month schedule and the follow-up of procurement needs. This was needed to enhance our capacity to plan ahead and to manage site erection activities in line with the project schedule.

The entire JHR project team works hard to ensure that all installation activities comply with the occupational safety and quality requirements.

KEY MILESTONES IN 2025

In 2025, eleven on-time delivery milestones concern site activities.
These milestones reflect five objectives:

- Finish the preparation of civil works in the BUA
- Be ready to start cable-pulling operations in 2026 (first semester)
- Install the equipment on the Reactor Building's critical path (primary cubicles), including the primary pumps
- Coordinate movement of people and activities in the BUR hall
- Increase our site storage capacity

The main issues involved in reaching the schedule objectives are:

- Maintaining high safety standards and reinforcement of task preparation
- Maintain a high level of installation follow-up to ensure quality at each step and to foresee any site hazards
- Strengthen the project's capacity to ensure equipment supply and manpower staffing in line with the operational schedule

Pascal PIERRE
Reactor Block and MOLFI
System Manager

4.3.2 Reactor block and radioisotope production

The main activities completed within the scope of the reactor block project are detailed in the sections below.

❖ *MOLFI displacement system*

The MOLFI system refers to the four devices involved in the production of molybdenum. The new configuration of the MOLFI cooling system was validated during the intermediate design review. The tender process has been launched for the supply of system equipment. Some of the in-core equipment has been received. The equipment impacted by changes to the system configuration had to be modified. An intermediate design review validated the changes and gave the green light to continue with the preparation of the tender documents for a call for tender scheduled for 2025.

❖ *Pile block unit*

MAIN ACHIEVEMENTS IN 2024

Factory activities

In 2024, the factory activities concerning the pile block equipment progressed according to plan. The only issue encountered was with the displacement system where a flaw was identified during qualification tests on a mock-up.

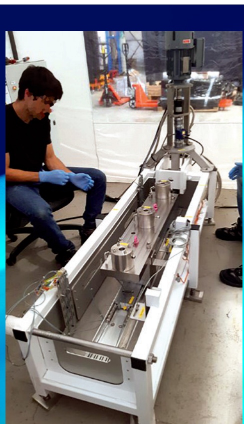
Monitoring mechanisms

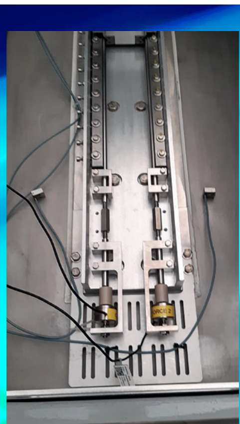
Factory acceptance for the jacks of the safety and shutdown absorber rods was granted in October 2024

Displacement system mock up

After the displacement system mock-up was damaged during tests in water, a new design for the slide rail and roller cage was developed. Tests were then performed in June to analyse the torque and realignment force of these new roller cages.

Test of new slide rail design for the displacement system





Torque and realignment force of the new displacement system's slide rail design

Frame for the ex-core measurement systems

A prototype was designed to validate the deep holes to be drilled in the frame of the ex-core neutronic measurement systems where the probes will be inserted. The machining operations comply with requirements. Tests were performed to validate the size of the ex-core measurement systems in the prototype frames

Machining of the frame for the ex-core measurement system

Classified equipment

In 2024, the factory manufacturing of classified equipment for the reactor core contract continued, e.g. the assembly of DN 400 non-return valves for the primary system and the butterfly valve delivered onsite).

DN400 non-return valve

Butterfly valve

In-pool equipment

In 2024, the following equipment was accepted and delivered onsite

- Rack for experimental devices in the core and reflector
- Rack for cooling tubes
- Support structure for the storage pool

Onsite activities

Conditioning for the long-term storage of the vessel cover lifting beam in 20-foot ISO containers.

Vessel cover lifting beam

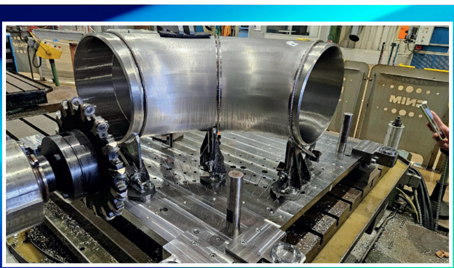
Conditioning of the vessel cover lifting beam in 20-foot containers

Primary system pumps

The three pumps were successfully re-tested, with the last pump completed at the end of 2024. Pump Nos 1 and 2 were disassembled to check all components and then cleaned in preparation for shipping to the JHR construction site at the beginning of 2025. Pump No. 3 is currently being removed and disassembled to check all its components.

Primary system

In 2024, some N1-classified and non-classified DN400 elbows on the JHR primary system had to be machined again after a dimensional non-conformity was detected. The machining and cleaning were completed in November 2024.



Machining

Machining

Cleaning

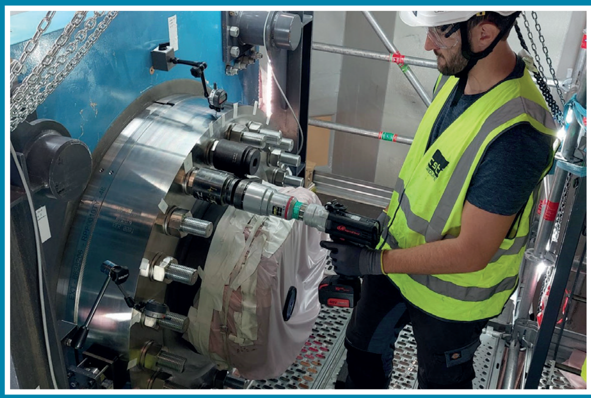
Procurement of N2-classified and non-classified DN400 elbows has been renewed.

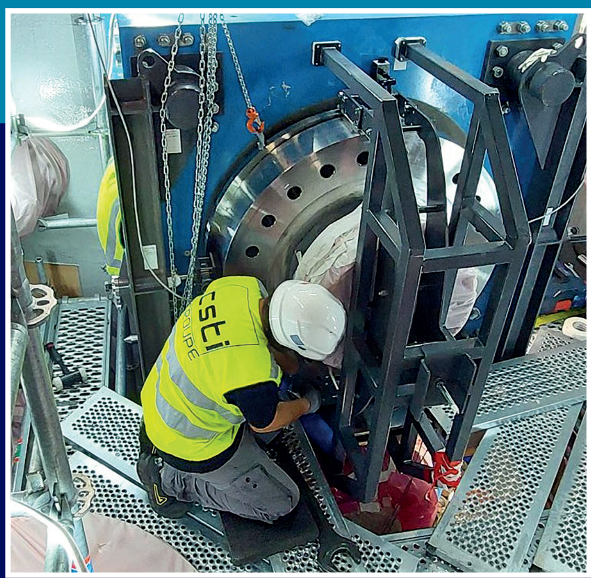
Procurement of N2-classified elbows

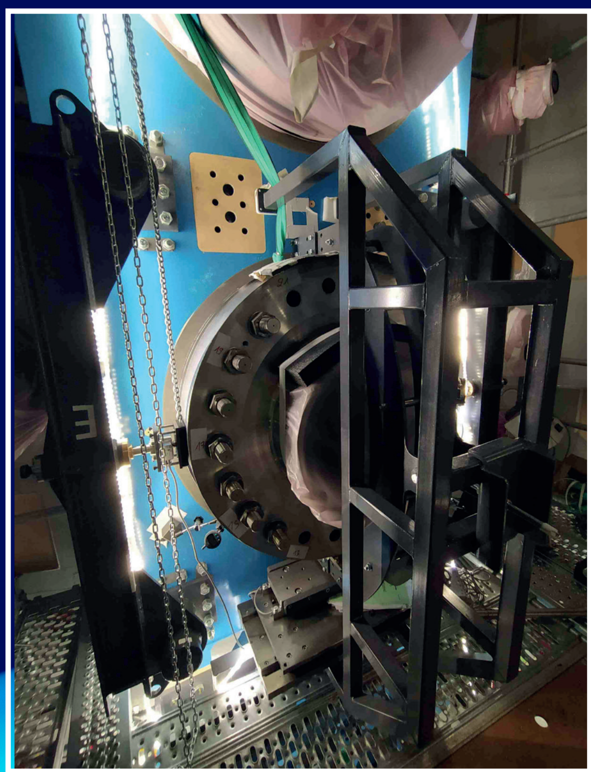
The primary system frames were partially dismantled to be able to remove the primary system heat exchangers and to install the motor pump assembly. These operations were completed in May 2024

Frames

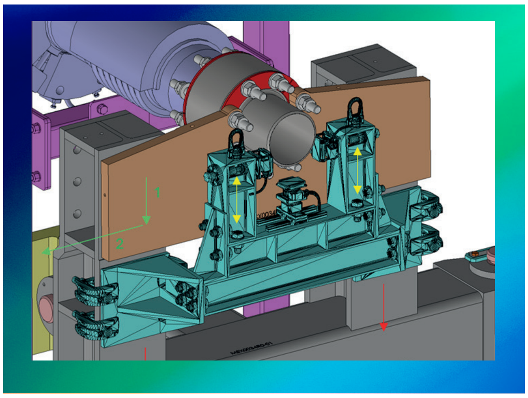
The penetrations between the reactor pool and the primary system cubicle have been attached using flanges to the central fixed point, placing them in their neutral position called 'zero load'. This position ensures primary system assembly without exerting any additional loads on the penetrations.







Flanging to the central fixed point



To attach the penetrations to the right and left fixed points between the reactor pool and the penetration cubicle, special tools were designed to make optimal adjustments for each relevant penetration.

Tools

Safety systems

The activities completed in this field in 2024 were:

- Design studies: Design of tools to adjust the penetrations
- Factory activities: Factory welding of non-classified penetrations

- Site activities: Preparatory work for the assembly and adjustment of penetrations

Heat exchangers (Spanish in-kind contribution)

After having removed the tubes of the primary system heat exchangers at the end of 2023, the results of the assessment of corrosion phenomena led to the decision to factory-repair the heat exchangers by replacing all the internals and keeping only the shell and water boxes.

Four contracts were initiated in 2024:

- Removal of the three primary heat exchangers onsite
- Procurement of new tubes for the primary system
- Procurement of forged components for the tube plates of the primary/ secondary heat exchangers
- Factory repair of the primary/secondary heat exchangers

The three heat exchangers were removed in July 2024 and sent to the contractor for repair under contract. This contract has been completed.

Removal of the heat exchangers

The pre-production tubes have been manufactured and shipped. The tubes are now being produced in series; the hot-rolling was completed by the end of 2024.

Pre-production tubes

The forged components for tube plates have been manufactured and gone through factory acceptance.

Forged components

The heat exchangers have been cut open and the internals removed.

Cutting the heat exchangers

The year 2024 ended with an assessment of the parts that were not replaced, making it possible to define the work required to restore compliance (mainly pickling).

Antoine DEWAVRIN
Building, Pools & Cells Manager

4.3.3 Buildings, pools and cells

MAIN ACHIEVEMENTS IN 2024

- Civil works: creation of openings and preparation of these openings for the assembly of the HVAC and electrical systems in the BUR, in the BUA and in BAS
- Erection of the underwater transfer conveyor system between the BUA and BUR pools

Underwater conveyor

Delivery of a hot cell lifting unit

- Finalisation of all BUA pool liners:

- Liner repairs (section limited to 3 metres) in the reactor pool after local stress corrosion cracking was found
- Site delivery of all hot cell lifting units and start of installation of these units on site

Engineering activities

- Continuation of design studies on the tools required to install and remove the bypass pipes for fission product analysis
- Continuation of design studies on the tilting frame for the isolation doors
- Incorporation of changes made to the interlocking device on the isolation doors:
- Review of the electrical I&C design studies
- Review of the drawings for the isolation doors.
- Manufacturing of the I&C system for the isolation doors and conveyor (still in progress)
- Continuation of design studies on the conveyors for the mechanical dewatering prevention system (safety level 2)
- Design and layout of additional anchors in the hot cells to provide better mechanical support
- Design of hot cell and hatch doors adjustments according to as-built features

Factory activities

- Fabrication of the 9 lifting units for the hot cells (Czech in-kind contribution):

- Acceptance of the underwater conveyor.
- End of tests on the mechanical assembly of the polar crane bridge and the winding telescopic extension arm system:

- Tests on the underwater conveyors and main channel structures
- Factory acceptance of the heavy doors to be installed in rear area of the large hot cells. Factory acceptance of fluid skids and cable trays for cranes. Ongoing factory manufacturing for some the trapdoors providing access to channels, the biological shielding plugs, the ventilation systems, etc.

Onsite activities and acceptance procedures

- Civil works: creation of openings and preparation of these openings for the assembly of the HVAC and electrical systems in the BUA and BUR buildings
- Hot cells (Czech in-kind contribution): installation of the ECR floor and doors in the transfer channel pools. Door installation operations continued in the hot cells and hatches (mechanical adjustments, wiring, etc.)
- Hot cell equipment: installation of the operation platform in the front area of the large hot cells and installation of fluid skids and cable trays for cranes
- JHR pools:
  - Finalisation of all BUA pool liners
  - Erection of the underwater transfer conveyor between the BUA and BUR pools
  - Liner repairs (section limited to 3 metres) in the reactor pool after local stress corrosion cracking (SCC) was found

David DELESVAUX
Fluids Manager

4.3.4 Fluid systems

❖ *Engineering*

MAIN ACHIEVEMENTS IN 2024

The main engineering activity in 2024 involved finalising the detailed design of the fluid systems in the BUA and BMR buildings in assembly configuration, which was validated during the design maturity reviews in late 2022, supplemented by changes made in 2023.

KEY MILESTONES IN 2025

The main engineering milestones identified for 2025 are:

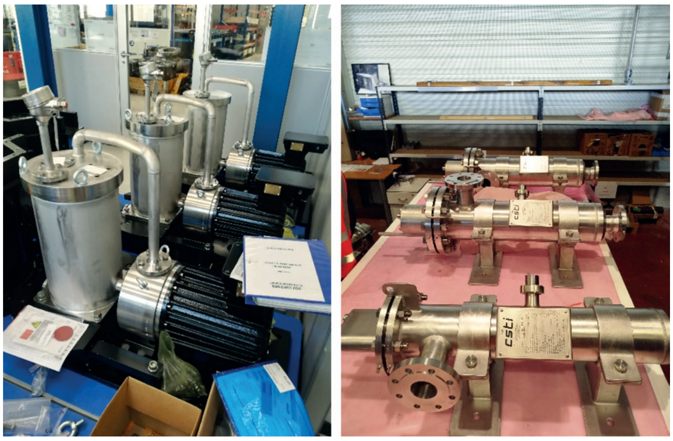
- Finalisation of the detailed design for the fluid systems on the different levels of the BUR building in assembly configuration, which was validated during the design maturity reviews in late 2022 and supplemented by changes in 2023-2024
- Finalisation of the functional design of the gaseous effluent circuits in the CEDE zone

❖ *Manufacturing*

MAIN ACHIEVEMENTS IN 2024

The main component fabrications for the fluid systems were:

- Key components for the BUA, i.e. pumps, fabricated equipment and valves, which were delivered
- Prefabricated piping and support structures for the BUA and the BMR



Photos of embedded rotor pumps/ biocides to treat the pool water

KEY MILESTONES IN 2025

- Continue the delivery of key components and equipment for the BUR
- Ensure the prefabrication of piping and support structures for the BUR

Assembly

MAIN ACHIEVEMENTS IN 2024

The year 2024 for onsite assembly operations was marked by:

- Significant progress in the installation of pipes on levels -2 and -3 of the BUA
- Full installation of the reactor's secondary and tertiary cooling systems, installed on level 0 of the BMR and in the technical gallery connecting to the reactor unit

KEY MILESTONES IN 2025

In 2025, the key milestones for the fluid systems are:

- Functional tests on the compressed air system, the demineralised water system, and the mains water system on level +1 of the BMR building
- Full installation of the systems for the two BAS and the galleries connecting to the nuclear unit
- Assembly of the metal platforms for the fluid systems of the BUR pools
- Finalisation of system equipment installation on levels -2 and -3 of the BUA

BMR level

Jean-Pierre MUNOZ
HVAC Manager

4.3.4 Fluid system

❖ *Engineering*

MAIN ACHIEVEMENTS IN 2024

HVAC (excluding the emergency diesel generator building, BAS)

The main achievement for the HVAC systems is the final confirmation of the erection references for the JHR 3D model on all levels of the BUA and the BUR. Production of the detailed design documentation was launched accordingly.

HVAC safeguard building (BAS)

For the HVAC BAS, the completed design review allowed us to finalise the 3D model arrangements.

The final confirmation of the erection reference for the 3D model made it possible to launch the production of the detailed design documentation.

KEY MILESTONES IN 2025

For HVAC (excluding the emergency diesel generator building, BAS), the following main tasks have been planned for the coming year:

- Updating the functional system files and 3D model for CEDE
- Producing the detailed design documentation to secure the erection phases schedule

The main activities will involve finalising the design to move to the phase of on-site installation.

❖ *Manufacturing*

MAIN ACHIEVEMENTS IN 2024

HVAC (except the emergency diesel generator building)

The main manufacturing achievements of the year were:

- Manufacturing of components and equipment to be installed on the lower floors (level -1, -2 and -3) of the BUA building, the BMR and the mezzanine floor of the BUR reactor hall

Factory acceptance of the exhaust fans

Delivery of ducts for the BUR hall

Delivery of ducts for the BUR hall

- Launch of prototype manufacturing for the most important safety-related equipment in order to start the qualification and in-series manufacturing processes

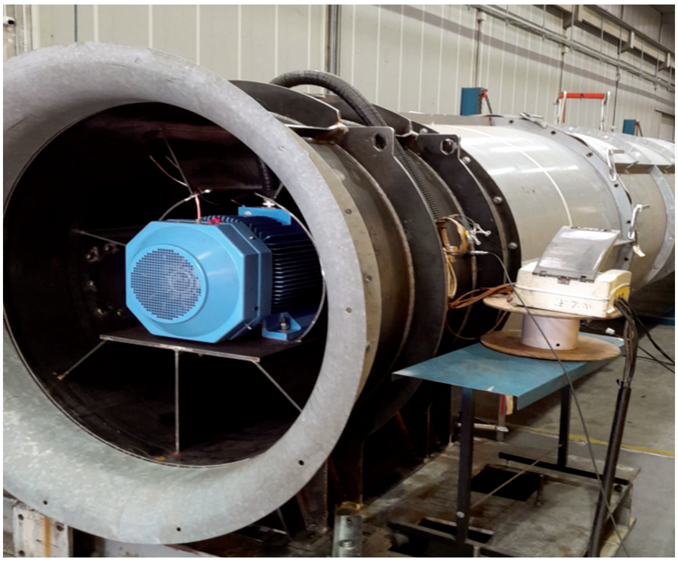
Prototype of the classified cooling unit

Prototype of the air handling unit

HVAC safeguard building (BAS)

MAIN ACHIEVEMENTS IN 2024

The main manufacturing achievements included some major components such as the fans.



Successful performance tests on the fans at the supplier site

KEY MILESTONES IN 2025

The key milestone for 2025 will be to continue delivering key components and equipment for the auxiliary cooling and utility building, as well as components for the BUA and BUR buildings.

The year 2025 will see the finalisation of all major equipment qualifications and site deliveries of components and equipment according to the erection schedule requirements.

❖ *Assembly*

MAIN ACHIEVEMENTS IN 2024

HVAC (except the BAS buildings)

In 2024, installation work was concentrated in the BUA (level -1) and the BMR, as well as on the mezzanine floor of the BUR reactor hall where duct installation was completed.


Installation of filter box and connectors

Installation of the network

Installation work in the BMR.

Exhaust

Sound attenuator

Duct

HVAC safeguard building (BAS)

MAIN ACHIEVEMENTS IN 2024

In 2024, installation of the pre-sealed inserts in the BAS building was completed, and the detection/ tracing/ drilling activities for installation of support structures were started.

Installation of the pre-sealed inserts in BAS A and B

KEY MILESTONES IN 2025

In 2025, the team will focus on:

- Starting the ventilation tests in the auxiliary cooling and utility building.
- Completing the ventilation and air-conditioning systems on levels -2 and -3 in the BUA, starting installation of the ventilation and air-conditioning systems on levels +1 in the BUA, and continuing installation work in the BUR reactor hall

In 2025, the main key milestone for 2025 will be installing the components and equipment according to the erection schedule requirements.

Pierre Yves BOIVIN
Electrical Systems Manager

4.3.6 Electrical systems

❖ *Engineering*

MAIN ACHIEVEMENTS IN 2024

Equipment design

In 2024, the containment penetration design studies were revised to integrate equipped spaces for future configurations.

The design reviews for classified and non-classified UPS have been finalised. These latest reviews have provided a stable set of documents on the reactor electrical systems, making it possible to start qualification, manufacturing and assembly.

Cable routing and mock-up

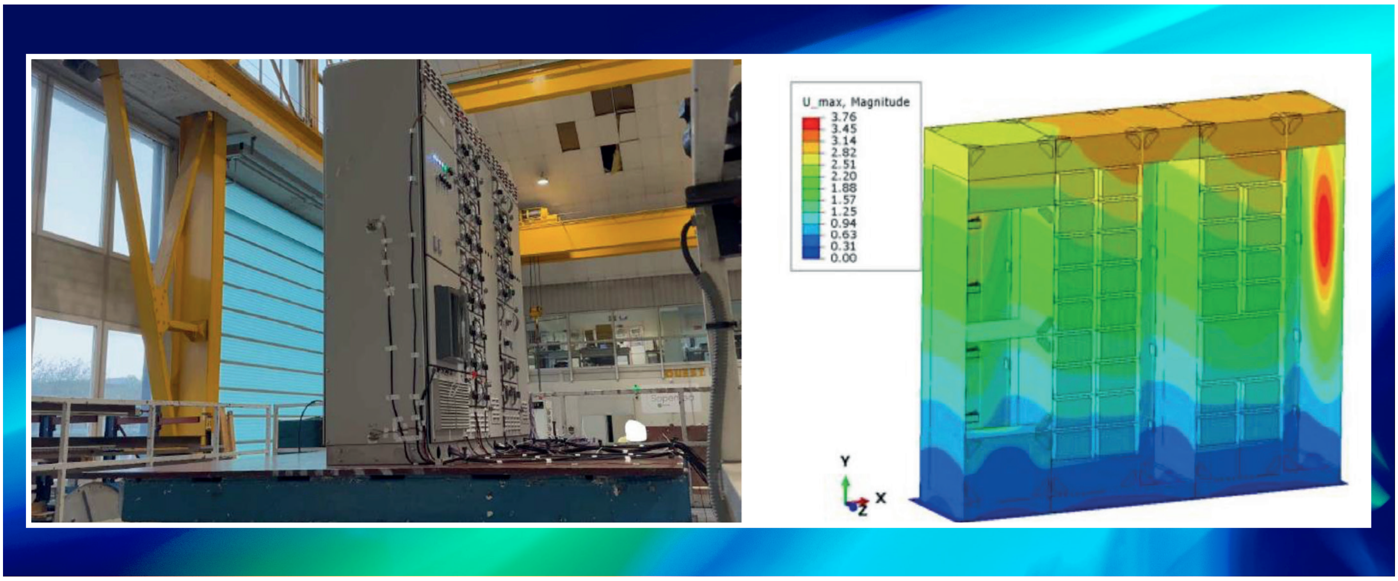
The digital mock-up, outside the CEDE area, has been updated to include a series of changes. The impact on the existing mock-up has been minimised.

A preliminary study conducted in several 'test' rooms in the CEDE area confirmed the feasibility of the high-voltage architecture changes, such as the I&C system.

Equipment qualification

Qualification studies were continued on the classified UPSs, fire detection systems, and transformers.

With regard to the safeguard electrical distribution boards, we used digital modelling combined with instrumented seismic tests to reduce the number of test specimens required for seismic qualification.



The qualification tests for the cameras used in the hot cells have been finalised.

KEY MILESTONES IN 2025

Equipment design

The major objectives for 2025 are:

- Launching the design studies for the electrical systems in the hardened safety core building.
- Upgrading the systems powering the equipment for the experimental devices

Cable routing

In addition to the design work on the experimental device systems, layout work in the lower CEDE area is scheduled for 2025.

Qualification

Following the manufacturing of the first-in-series equipment, qualification tests (including seismic tests) have been scheduled for the UPS, and the classified transformers.

Underwater cable tests have also been planned for 2025.

❖ *Fabrication*

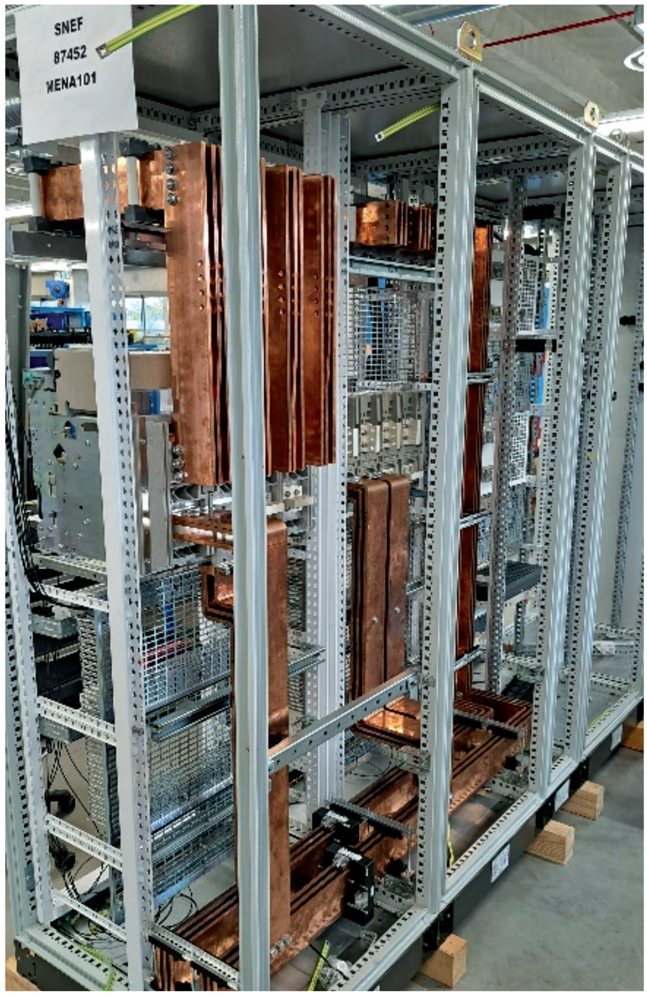
MAIN ACHIEVEMENTS IN 2024

In total, 178 tonnes of seismic supports were delivered in 2024, as well as 370 km of cables.

Several first-in-series components were manufactured, including emergency UPSs, classified transformers and load-breaking switch units.

Emergency UPS

370 km of cables



Electrical cabinets

The manufacturing of 29 non-classified electrical cabinets has also started, which will be mostly installed in the BAV and BMR buildings.

KEY MILESTONES IN 2025

In 2025, we expect the delivery of:

- First electrical penetrations for the containment
- Non-classified cabinets currently being manufactured

Other components are scheduled for manufacturing, such as:

- Low-current system cabinets and racks
- Classified UPSs
- Seismic-rated raised floors for the BAS
- Back-up electrical distribution boards

❖ *Construction*

MAIN ACHIEVEMENTS IN 2024

Assembly work increased in the BUA building in 2024, with more than 1500 holes drilled in the upper BUA levels.

Machining on the penetration sleeves was completed so the first penetrations can be assembled in 2025.

KEY MILESTONES IN 2025

The main objectives in assembly for 2025 are:

- Adapting the routes already set up in the BMR/BAV buildings
- Continuing to install equipment in the BUA
- Installing the 8 first penetrations for the containment
- Starting cable pulling in the BMR building

Michel TREVISIOL
Instrumentation & Control Systems Manager (Including emergency diesel generators)

4.3.7 Instrumentation and control systems

❖ *Engineering*

MAIN ACHIEVEMENTS IN 2024

The main achievement in the field of instrumentation and control (I&C) engineering was the factory acceptance of the V1.0 software standard (safety classes C1 and C3 according to electrical I&C 61513 norm and industrial I&C software). The completion of this milestone allows us to start validating the main JHR circuits on the simulator/emulator.

KEY MILESTONES IN 2025

The year 2025 will also present many challenges:

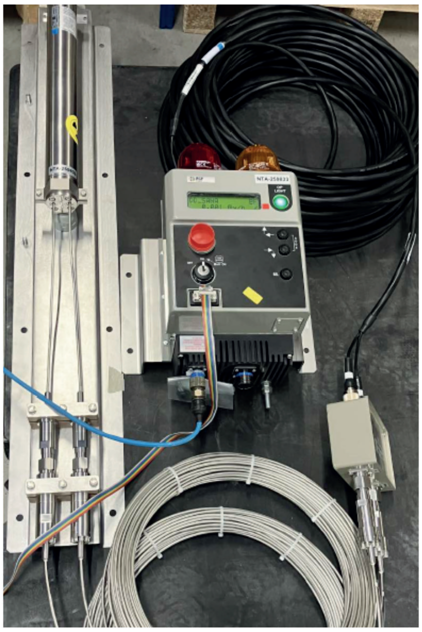
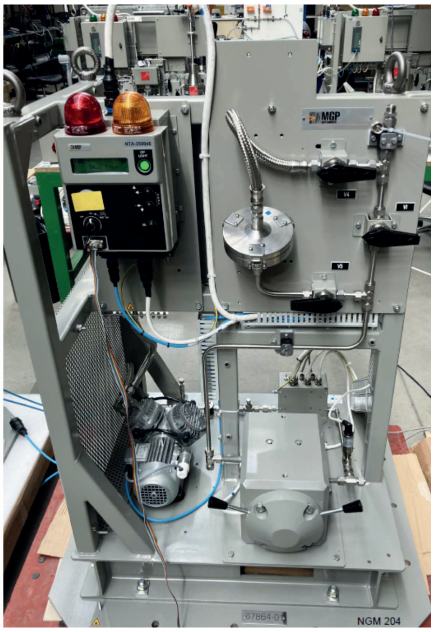
- Acceptance of the V1.1 JHR simulator coupled with the instrumentation and control emulator. The simulator will be used to model the physical phenomena of main circuits, to define reactor operating procedures, and to train future operators
- Initiation of I&C (hardware and software) 3.2F project configuration studies
- Preparation of the ex-core neutron detectors and gamma detector tests in an experimental reactor
- Qualification of the ultimate emergency diesel generator

❖ *Manufacturing*

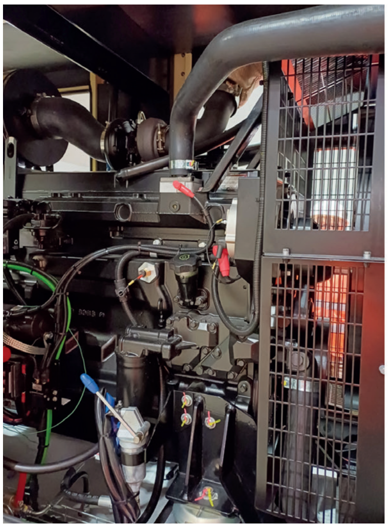
MAIN ACHIEVEMENTS IN 2024

The year 2024 saw the completion of the following I&C manufacturing activities:

- Factory acceptance of the radiation monitoring systems. A beta/gamma radiation detection system has been developed to sample air in discharge stacks and ventilation ducts

- Manufacturing of the ultimate emergency diesel generator, which is now ready for qualification




KEY MILESTONES IN 2025

The keys milestones for 2025 will include manufacturing non-radiological equipment (electrical and connexion boxes and cabinets) and delivering the temperature sensors.

❖ *Installation*

MAIN ACHIEVEMENTS IN 2024

A key milestone achieved in 2024 was the installation of cable tray supports and radiation protection equipment (1,485 supports installed).

KEY MILESTONES IN 2025

The main key milestone for 2025 will be installing the non-radiological equipment (electrical and connexion boxes and cabinets).

Jean-François VILLARD
Experimental Domain Manager

4.4 EXPERIMENTAL DOMAIN AND DEVICES

4.4.1 Experimental domain

In order to strengthen supervision during the preparation of future experiments in JHR reactor, the project has appointed an experimental domain manager for the JHR experimental domain.

Jean-François VILLARD joined the JHR project management in June 2024. Among others skills, he has twenty years of experience in innovative experimental devices for the OSIRIS reactor and the development of advanced instrumentation for material testing reactors.

His main tasks within the project are:

1. To check that the JHR experimental domain reflects the scientific and industrial needs, ensuring consistency between requirements, high-level specifications and projected experimental performance. He therefore works closely with the teams in charge of designing, procuring and commissioning experimental devices.

2. To anticipate the future organization of experimentation in JHR. This includes defining the necessary skills and workforce needed to prepare and conduct experiments, but also the strategy to reinforce and maintain these skills at the CEA, building links between experimentalists, reactor operators and experts. The experimental domain must be fully operational at the time of JHR start-up, taking into account all the associated resources with experimentation (from hot labs to reactor and service facilities).

Raphaël PALHIER
Experimental Devices
Project Manager 2024

Arnaud DOUVENAU
Experimental Devices
Project Manager 2025

4.4.2 Experimental devices

The year 2024 was mainly devoted to the detailed design studies for the experimental devices (irradiation loops and capsules, measurement benches, I&C equipment, mechanical equipment, start-up equipment for the JHR), the aim being the completion of these design studies in 2025 so the tender processes can be started. Nearly a hundred people are involved in these studies, divided between the JHR project team on the construction site at the CEA Cadarache centre, the CEA laboratories at the Cadarache and Saclay centres, and partners involved in the design studies for irradiation facilities.

The designs of the ADELINE, MADISON, OCCITANE and MICA devices have now been finalised, though some items still need to be validated through further studies and tests on mock-ups or prototypes to validate design options. The CEA facilities at Cadarache (TOTEM & HRT platforms) and Saclay (TAXY loop) will continue to be used to carry out the tests required to validate the studies. These facilities have already produced significant results this year, including:

- Fatigue tests in the HRT hall for the underwater lines
- Hydraulic qualification on the TAXY loop for the source-holder mandrel dedicated to the JHR start-up neutron source
- Hydraulic qualification of the components for the ADELINE and PROSPERO devices on the CORAIL loop in the TOTEM facility

Other test programmes in irradiation conditions are currently underway to qualify the measuring cell for CARMEN in BR2 and to characterise NaK and water reactions for the MICA device in a CEA Cadarache facility (VAUTOUR cell).

The year 2025 will remain a transitional period between the end of the detailed studies and the launch of the first contracts to manufacture the experimental devices.

❖ *Development of devices and tools for radioisotope production*

According to prospective feedback, the demand for artificial radioisotopes is expected to increase in the coming years, especially for nuclear medicine where radioisotopes are used for examination purposes (diagnosis) and cancer treatment (therapy).

The JHR has the following objectives:

- Produce radioisotopes for industrial and R&D purposes (e.g. non-destructive testing, sterilisation of equipment, etc.)
- Produce radioisotopes for medical applications with a commitment to secure between 25% to 50% of the yearly European needs for molybdenum-99 (about two to four million patients diagnosed). This also concerns the production of radioisotopes to sustain R&D in the medical field (for pre-clinical and clinical trials), i.e. therapeutic radioisotopes such as for vectorised internal radiation therapy. Securing this medical production for the next fifty years is a key issue across the world. This is why JHR is looking to use the most versatile industrial production approaches. This activity is important in securing the worldwide supply of medical radioisotopes, ensuring French and European sovereignty, and helping balance the JHR business model

The main achievement in 2024 was the consolidation of the reactor kinematics for the radioisotope production system, defining the optimal method for managing the daily production of relatively short-lived radioisotopes such as lutetium-177.

Feasibility has been acquired for installing a specific shielded box for radioisotopes in a room of the nuclear unit.

ONGOING WORK IN 2024-2025

The engineering design studies are in progress. Priority is focused on radioisotopes that can be managed in the shielded box after irradiation, such as lutetium-177. The main objective is to design the devices and all the tools associated with this production process, including the studies for the shielded box.

❖ *MADISON*

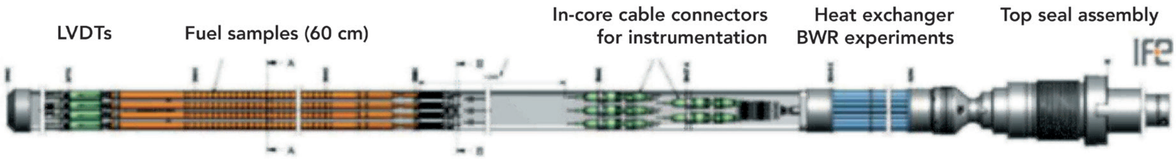
The MADISON[3] device will provide the nuclear industry (utilities, research institutes, fuel vendors, etc.) with the means to test LWR fuel samples under normal operating conditions like those existing in nuclear power plants:

- An in-core part located on a displacement system in the JHR reflector will provide the neutron flux conditions required for any type of experimental programme. The fuel linear power and transient scenarios will be representative of conditions that do not lead to cladding failure.
- A water loop in the JHR reactor building will supply the in-core part with the thermohydraulics and chemical conditions required by customers

The CEA plans to have this device available immediately after JHR start-up as a part of the first fleet of experimental devices.

The MADISON device incorporates feedback from both the CEA-OSIRIS reactor (France) and IFE-Halden reactor (Norway). This experimental device will ensure the continuous use of most experimental devices existing in these experimental reactors: OSIRIS experiments performed in the GRIFFONOS and ISABELLE4 test devices, Halden experiments performed in an IFA irradiation device with a single or multi-rod irradiation rig. The first MADISON device will use most instruments currently employed in these two reactors, and specific changes to the MADISON irradiation rig will make it possible to use all of them (counter-pressure sensors, diameter gauge, etc.).

CEA has already sub-contracted a mock-up of the first irradiation rig and loop which is now installed in the TOTEM facility.



Madison design inspired from the IFE model

3/ *Multirod Adaptable Device for the Irradiation of LWR Fuel Samples Operating in Normal conditions*

MAIN ACHIEVEMENTS IN 2024

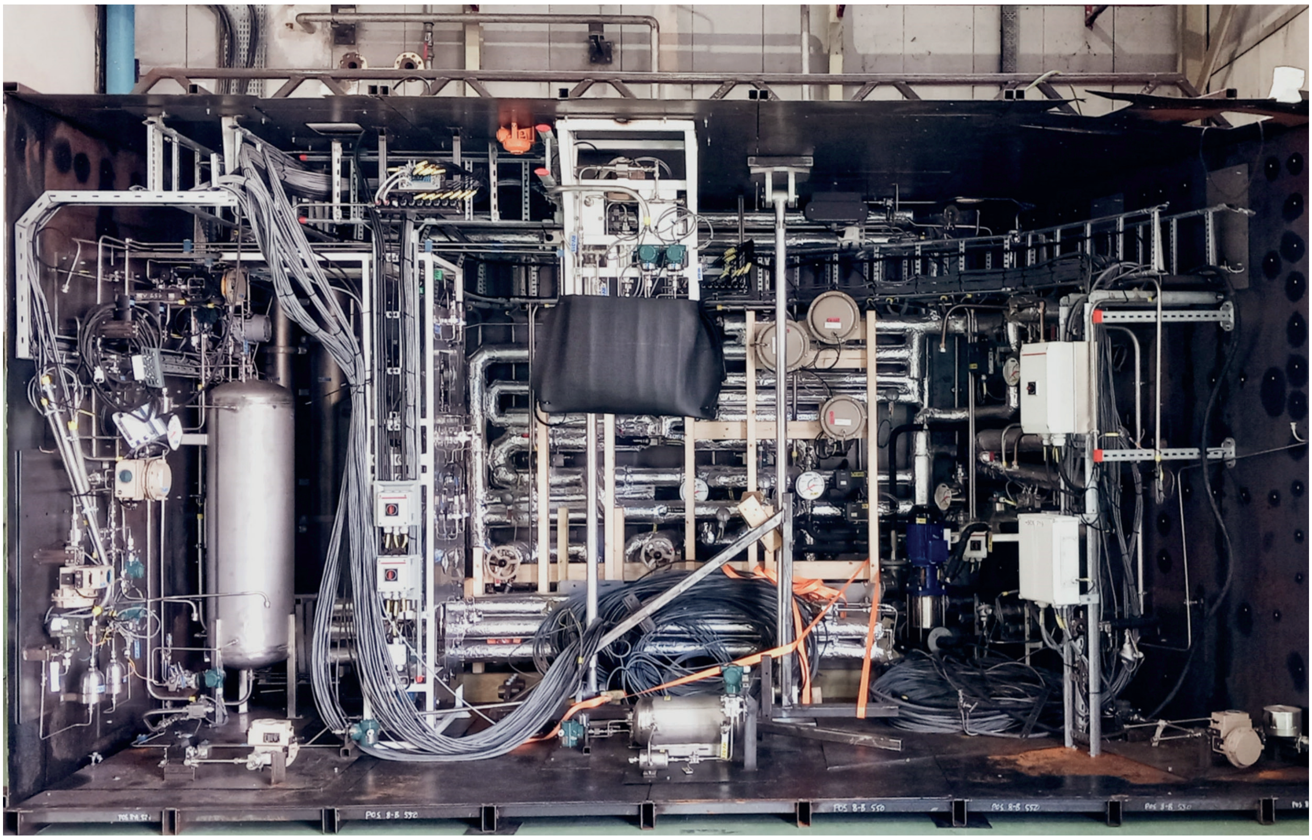
With support from an engineering company, the CEA completed the basic design studies to provide the specifications needed to manufacture the final loop and MADISON device. Engineering provided the basic design studies for the main components of the loop and the experimental device. The design is up to date in accordance with French regulatory rules.

This year, a design review on the in-core part of the device was completed and considered satisfactory contingent on the implementation of some non-critical design actions required to reduce any risk associated with the call for tender process.

THELIA experimental loop

THELIA[4] is a mock-up that reproduces the thermohydraulics (PWR conditions) of the future JHR. Initially under IFE Halden ownership (Norway), this loop was transferred to Cadarache in summer 2023 and installed in the TOTEM facility in the first quarter of 2024. After the first commissioning tests in 2025, the objective is to operate the loop in 2026.

The JHR project teams will use this loop to perform multiple thermohydraulic characterisations of components during the design phase, before using it during the manufacturing phase of the MADISON loop, e.g. to check the loop's operating range under normal operating conditions and for different other scenarios in order to demonstrate its robustness.



View of the THELIA loop (IFE Halden) integrated into the TOTEM test hall at Cadarache in 2024

4/ Thermal-Hydraulic Experimental Loop to test Instrumented Assembling

The experimental results collected during the first campaign at IFE Halden before 2023 have already provided us with valuable insights for the design and operation of the MADISON loop.

Operating this loop onsite at Cadarache will provide useful data for safety, reliability, efficiency, and pre-design validation. We will be able to test future experimental components not only for the MADISON loop, but also for other loops like ADELINE.

Sample holder

The first experimental rig (dummy rig) was manufactured by the IFE workshop teams. The CEA has already performed the first tests on this dummy rig in the UO2 laboratory facility at Cadarache. These tests aimed to collect feedback on the handling and design of the sample holder. The results of these tests are being used to update the design. As planned for, the specifications of the MADISON sample holders were updated and the sample holder design was defined.

Underwater flexible hoses/ connections

The tests to validate flexible hoses on the full-scale test bench have shown their good behaviour. The objective is to experimentally demonstrate that the fatigue of these components largely exceeds the number of cycles expected during their lifetime. The first campaign included a number of iterative tests to validate the expected lifetime of these flexible hoses.

After the tests, additional mechanical failure analyses were carried out in 2024. These analyses were used as a basis to elaborate the technical specifications for manufacturing. The tender process is on route for delivery some time in 2025.

MADISON cubicle

MAIN ACHIEVEMENTS IN 2024

Installation of the cubicle in the JHR facility scheduled in 2023 has been stopped for two main reasons. First, difficulties have been encountered with the cubicle structure linked to the steel inserts in the concrete floor. Second, new requirements related to internal situations, such as fire conditions, implies a more complex design After examination, it appeared that updating the design up has been update to fulfil the requirements, was more complicated than realizing a new cubicle that were significant. The strategy is now to include the cubicle realization in the future call for tenders of the out of pile part.

KEY MILESTONES IN 2025

The work to be carried out in 2025:

- Achieve the detailed design studies of the experimental device and of the MADISON loop and its components
- Proceed on the call for tenders in 2025 for the manufacturing
- Continue the validation test program for the underwater flexible houses

❖ *ADELINE*

The ADELINE experimental device is designed for single fuel rod studies in LWR conditions. It aims at investigating the fuel behaviour under off-normal irradiation conditions up to cladding failure and/or partial fuel melting.

To do so, the device is placed on a displacement system that moves through the reflector towards the reactor core so the samples can be subjected to different power ramps. The main components of the device are given below.

MAIN ACHIEVEMENTS IN 2024

ADELINE in-core rig: detailed design review

A detailed design review was successfully performed in 2024. To do so, a large panel of CEA senior and fellow experts was selected from outside the JHR project. They extensively analysed the detailed design of the ADELINE in-core rig over a period of several months. At the end of their review, they had identified no sticking points, but highlighted a few design improvements to be made. This successful stage gives us the green light to start the tender process.

Flexible line fatigue tests for both ADELINE and MADISON

Metal flexible hoses are used to connect the out-of-pool parts with the ADELINE and MADISON devices. This is to accommodate for the kinematics of the devices inside the reactor pool on the displacement systems, as well as to ensure the displacement of the devices in the reactor pool, before and after the irradiation phases.

The underwater lines of the ADELINE device are composed of small-diameter metal tubes. The inlet flow rate is 50 to 100 g/s from the out-of-pool part.

The underwater lines of the MADISON device are corrugated metal hoses. The maximum inlet flow rate is about 1 kg/s. Fatigue tests were performed to simulate the operating cycles of the underwater lines during their operational phases in the reactor.

A specific fatigue test bench was used for these verifications. The operating conditions of this bench were: room temperature, inlet pressure of 300 bar.

After the results obtained in 2023[5], new tests were performed in 2024. The fatigue test bench was used with mini-tubes to represent the hydraulic lines, including pressure sensors located between the in-core device and the out-of-core system.

The objective of these tests was to check the behaviour of the metal mini tubes over 2000 cycles at room temperature with an internal gas pressure of 180 bar. This scenario corresponds to the kinematics of the lines over a period of 10 years of operation in the reactor pool.

These tests were completed successfully, without any leak or break in the lines. These experimental results were an important milestone for the JHR in 2024.

Fatigue test bench equipped with mini tubes

KEY MILESTONES IN 2025

The year 2025 will be devoted to completing tender processes and launching the manufacture of ADELINE. Two main calls for tender are planned:

- Shielded cubicle and process loop: June 2025
- In-core device including underwater lines and pool plugs: December 2025

5/ *2600 (vs 400) cycles carried out without any observed degradation for the ADELINE (vs MADISON) lines*

❖ MICA

Water-NaK interactions if a MICA device is dropped during handling

The MICA experimental device is designed to irradiate structural materials inside a fuel element in the JHR core. This sample holder is immersed in liquid metal (NaK eutectic), which ensures optimal thermal homogeneity thanks to its high thermal conductivity. The mechanical strength of a MICA device must be guaranteed in the event it is dropped during a handling operation. This scenario must be studied to take into account the consequences of reactions between NaK and the pool water, including the risk of damaging nearby safety-classified components.

In order to precisely define the loads to be In order to precisely define the loads to be considered to analyse the mechanical behaviour of nearby structures, it was decided to carry out an experimental test campaign representative of the conditions existing during such a scenario. The CEA is in charge of designing and manufacturing the test bench needed to study these reactions. Equipped with fast cameras and pressure sensors, the objective is to monitor the pressure wave during the reactions and to determine its kinetics. Different volumes of NaK will be used to determine the effect of such parameters.

This new experimental system is called NaKRE and is located in the VAUTOUR facility at the CEA Cadarache centre. After delivery of the test bench equipped with its instrumentation in late 2024, some technological tests were performed to check the experimental process.

MAIN ACHIEVEMENTS IN 2024

The main achievements for the MICA device were:

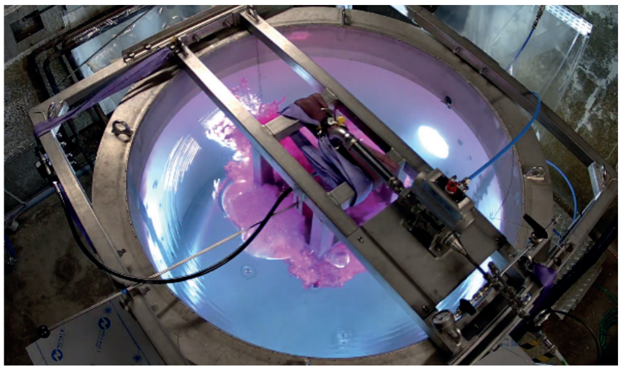
- Production of the MICA preliminary drawings
- Validation of the design changes by the safety group
- Manufacturing of the reaction bench for NaK-water interaction studies
- Integration of the bench in CEA Cadarache VAUTOUR cell facility
- Carrying out technological tests at the end of 2024

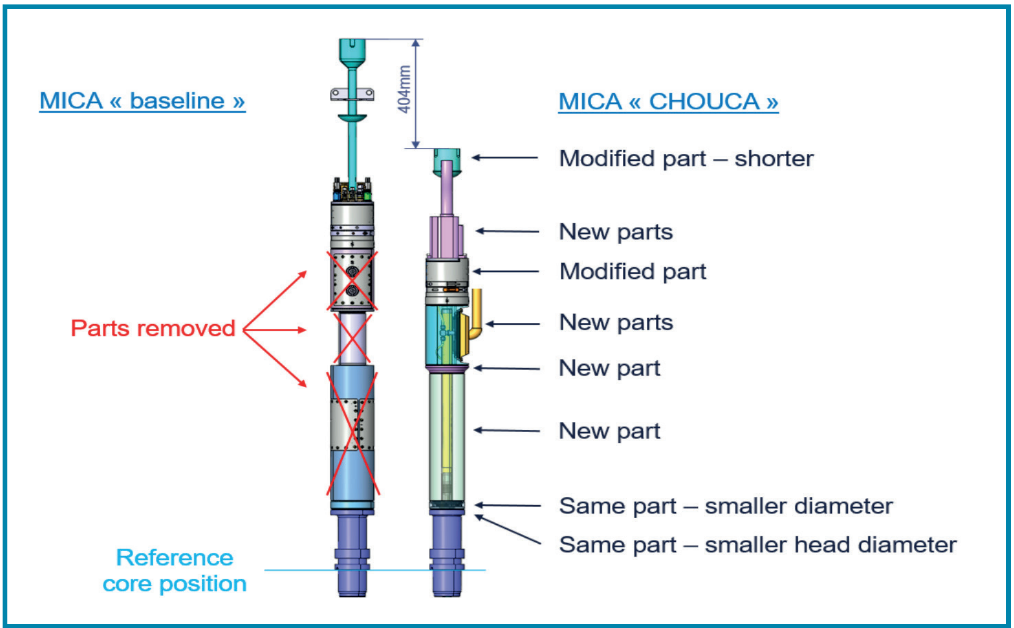
NaKRe experiment: First technological tests using a fluorescent product performed in late 2024

KEY MILESTONES IN 2025

The main activities to be completed in 2025 are:

- Real tests with NaK & water
- Call for tender for the fabrication of the MICA furnace mock-up
- Manufacture of the MICA mock-up
- Detailed design review at the end of 2025





❖ *CARMEN*

CARMEN is a multi-detector measuring device able to acquire the neutron and photon fluxes and the specific power deposited by nuclear heating over the full height of the core and in different experimental locations of the JHR.

MAIN ACHIEVEMENTS IN 2024

The main achievements of the year for the CARMEN device were:

- Validation of the calorimeter for high nuclear heating in BR2. The detailed design studies were submitted to the SCK CEN experiment study committee. To obtain approval from this committee, an additional thermohydraulic topic study be added. The tender process has been launched to find a contractor to manufacture the device:
- Mock-up of the device head and testing:
  - The mock-up was assembled and subjected to leak tests
- Rad-resistant motors:
  - The call for tender was published and the ensuing contract was signed for the development and production of rad-resistant motors which will be integrated into the CARMEN head

KEY MILESTONES IN 2025

The main milestones for 2025 are:

- Manufacturing of the device so an irradiation test can be performed in 2026 to validate the calorimeter for high nuclear heating in the BR2
- Signal transmission tests to validate the choice of cables and connectors on the mock-up of the device head.
- Delivery of the rad-resistant motor prototypes

❖ *Non-destructive examination devices (Finnish in-kind contribution)*

Gamma and X-ray examinations systems will be implemented in the JHR to examine experimental samples by quantitatively measuring the spatial distribution of gamma emitters and by high-resolution X-ray imaging.

Three benches were manufactured and commissioned:

- 2 UGXR for the examination of samples in an integral device: one for the reactor pool, and one for the storage pool.
- 1 hot cell gamma and X-ray scanning system (HGXR) for in-air examinations of samples in a hot cell.

In parallel to this in-kind contribution, the CEA has signed a contract with a French company to design and manufacture a 6 MeV linear accelerator, and another contract with a British company to design and manufacture a prototype of a high-resolution X-ray camera

MAIN ACHIEVEMENTS IN 2024

UGXR benches

After delivery, the UGXR benches were installed in the TOTEM facility (one bench in the pool and one bench on an in-air test tower) and final acceptance was validated in late 2022, starting a 2-year warranty period.

After the replacement of some components and the resolution of some non-conformities in 2023, additional tests were carried out in 2024 to repeat the site acceptance tests after modifications to the benches. As these tests were not fully satisfactory, an extension of warranty is being prepared. This will enable the necessary modifications to be made, and the bench tests and performance qualifications to be finalised under representative conditions (e.g. endurance tests).

In parallel, preparations are underway to install the benches in the JHR, with assembly of the bench support structures in the reactor pool and storage pool scheduled for 2025.

UGXR bench in the TOTEM pool

HGXR bench

The design and manufacturing of a hot cell mock-up was initiated by the CEA in 2022 to address the specific nature of the remote handling operations required. It was installed in 2023 in the TOTEM facility at the CEA Cadarache centre. In 2024, it was equipped with the same remote handling systems as those to be used in the JHR hot cells, as well as with various operational equipment (cameras, video systems, etc).

At the same time, the different parts of the HGXR bench were installed and electrically wired in the mock-up, the in-cell part, the airlock and the feed-throughs. The security analysis has been completed and authorisation to operate the HGXR bench in the mock-up should be granted in early 2025.

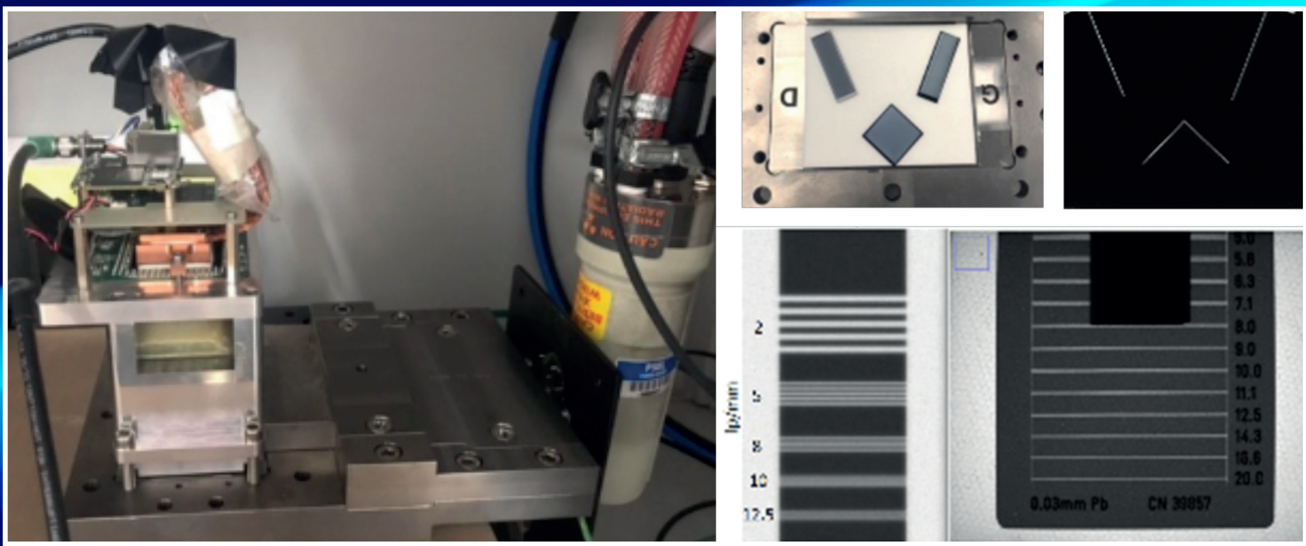
Installation of the HGXR bench inside the mock-up of JHR hot cell in TOTEM facility

Accelerator support and X-ray imaging system

Factory acceptance of the accelerator was completed in late 2022 and it was delivered to the TOTEM facility in 2023.

A specific structure (SAX) is required to support the accelerator and to align, collimate and shield the X-ray beam. The CEA launched a call for tender in 2023 and a Spanish company was entrusted with the design and manufacturing of this structure in 2024. The design is well advanced and its manufacturing is due to start in 2025.

The prototype of the high-resolution X-ray camera has been designed and manufactured. Factory tests using a low-energy source produced some encouraging results in 2024, and these tests will be continued in 2025.



Factory tests on the prototype X-ray camera

KEY MILESTONES IN 2025

The main milestones programmed for 2025 are:

- Extension of warranty, and finalisation of the tests and the performance qualifications for the UGXR benches
- Assembly of the support structures for the UGXR benches in the JHR pools
- Remote handling tests on the HGXR bench inside the JHR hot cell mock-up installed in the TOTEM facility
- Manufacturing of the support device for the accelerator
- Finalisation of factory tests for the prototype X-ray camera

❖ OCCITANE

In the field of vessel steels for PWRs, irradiation experiments are carried out to substantiate the safety case of the second containment barrier (made from stainless steel) and to improve its lifetime, thus the lifetime of the reactor itself. This is the objective of OCCITANE.

The multi-zone furnace controls the required irradiation temperature and compensates the axial thermal gradient due to the neutron flux axial gradients.

A mock-up of the OCCITANE furnace is being manufactured to demonstrate its manufacturability. In 2025, this prototype will be tested at the CEA to verify its operability.

MAIN ACHIEVEMENTS IN 2024

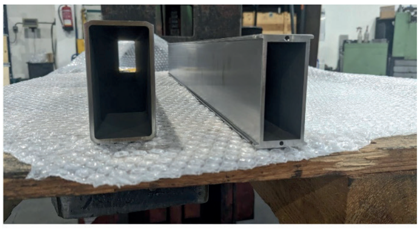
The main achievements for the OCCITANE device were:

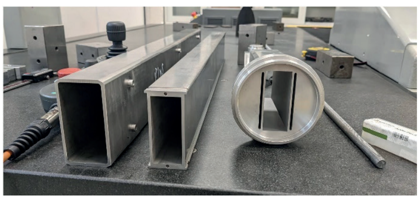
- Manufacturing of the furnace structure with an electric discharge machine (~700 mm high)
- Finalisation of the mock-up design
- Start of the mock-up assembly.

KEY MILESTONES IN 2025

The milestones planned for OCCITANE are:

- Completion of mock-up manufacturing
- Re-commissioning of the CORALIE test bench (CEA - TOTEM)
- Operability tests of the OCCITANE furnace





❖ CLOE (Indian in-kind contribution)

Following the successful completion of the preliminary design for the CLOE loop, our BARC colleagues in India have spent the past few years working on the detailed design studies and on drafting several engineering documents. This work is closely related to the experimental qualification of key components (e.g. the pump), which has been carried out at the BARC premises in Mumbai.

MAIN ACHIEVEMENTS IN 2024

The documentation is currently being reviewed by the CEA and its engineering subcontractor. Within the scope of this work, the CEA hosted a secondee from BARC for 3 months and whose main activities were to perform thermohydraulic calculations using the CATHARE code (a CEA reference code used for safety cases) considering several scenarios in normal, incident and accident conditions. This work is invaluable for the safety case on the CLOE loop.

The annual steering committee between Indian Departement of Atomic Energy (DAE) and CEA was held in December 2024 in India. It allowed in-depth technical exchanges on different topics of collaboration:

- RISHI loop developed for sodium environments (IGCAR)
- Innovative sample holder for material capsules (BARC)
- Development of a specific device for measuring the smart properties of fuel (BARC)

KEY MILESTONES IN 2025

The progress made on the CLOE detailed design phase has been acknowledged by the CEA, with an intermediate review planned for the second term of 2025 before the final in autumn 2025.

4.5 QUALITY CONTROL

Thierry KARA
Quality Manager

In 2024, the JHR site saw an improvement in its quality standards. Specifically, the frequency rate of quality non-conformities experienced a decrease of 22%.

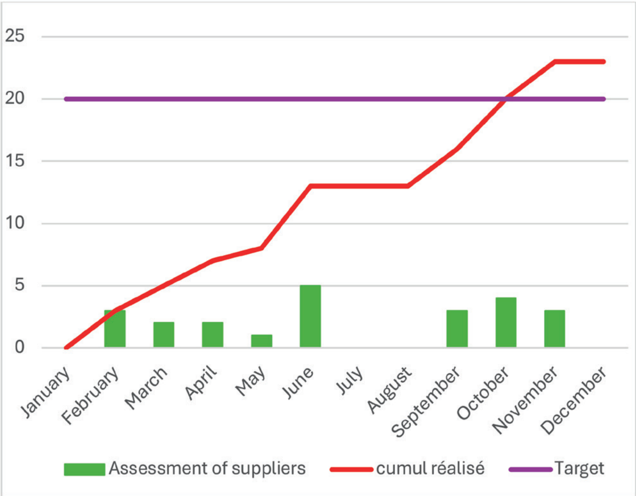
The increase in our onsite inspections also resulted in a 38% increase in our checkpoints (hold points and witness points hereafter).

KPI	2023	2024	Evolution
Hold / witness points	1513	2094	+38%
Hold points at factory	546	883	+62%
Witness points at factory	215	217	+1%
Hold points at JHR site	648	853	+32%
Witness points at JHR site	104	141	+36%

Our pre-2023 non-conformity backlog is also down by 66%.

The 2024 annual internal audit and process review programme has been completed.

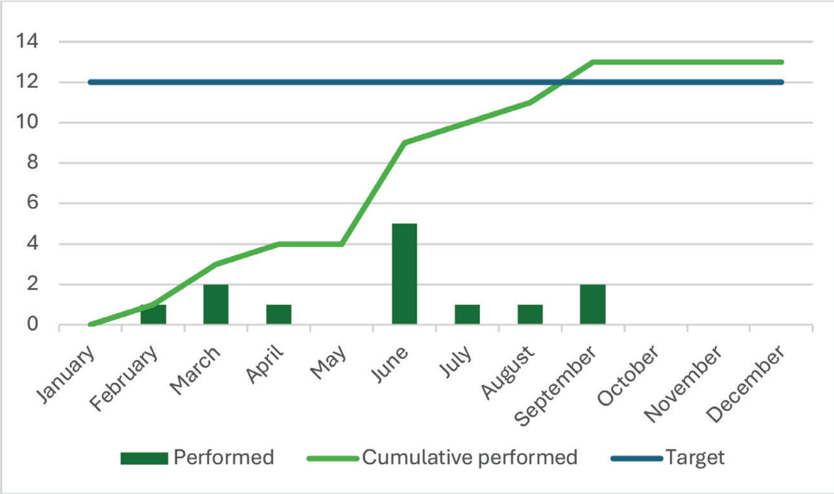
In 2024, a comprehensive assessment of 24 suppliers was conducted, resulting in the definition of confidence indices. These indices will facilitate the adaptation of our inspection programmes to their respective appropriate levels.



Assessment of 24 suppliers

The current monitoring system was reinforced by specific technical visits of equipment deemed 'critical'. Critical equipment was chosen on the basis of a technical and quality analysis taking into account their lifecycle, and then comparing the results with the defined and expected technical requirements. Priority was given to equipment for which a non-conformity discovered onsite would have an impact on the project (repair issues, long procurements times, safety-related classifications such as ESPN N1, etc.).

These technical visits were carried out by a group of project engineers, designers, quality engineers and inspectors. The reviews were carried out onsite and with the contractor or sub-contractor to assess the equipment in situ (condition of equipment, storage conditions, etc.). Thirteen technical visits were carried out in 2024.



Technical inspections

In the field of CFSI, a CFSI leader has been appointed and a specific reporting (whistleblower system) interface has been added to the JHR Intranet network. Awareness-raising and training actions were also carried out in this field.

The annual review of the IMS is scheduled in January 2025 with the JHR Project Director as chairman.

This review will include presentations of improvement actions issued after the 2024 internal audits and process reviews. An IMS improvement action plan has been defined and is to be reviewed at the 2025 annual review. The plan for the 2025 internal audits and process reviews has been defined

The evaluation of suppliers is scheduled to be completed by the end of 2025.

Nathalie VEDRENNE

Nuclear Safety
and Licensing Manager

The Safety and Licensing Department works closely with the DSSN and other CEA/Cadarache units. It has been tasked with the following responsibilities:

- Defining and implementing the JHR nuclear safety policy
- Elaborating regulatory files for assessment by the IRSN before submission to the ASN for authorisation to commission the JHR
- Liaising with the ASN and IRSN

5.1 NUCLEAR SAFETY LICENSING

In order to obtain regulatory approval to load nuclear fuel, an application for an operating agreement must

be submitted to the ASN. This application includes the JHR project's nuclear safety standard and associated documents.

A request to update the DAC was submitted to the Ministry of Energy Transition, as stipulated in the DAC Roadmap.

In application of the nuclear safety licensing roadmap discussed with the ASN and IRSN in 2022, an early assessment of the JHR Safety Report was proposed by ASN based on four successive series of assessments.

The ASN performed four inspections on the JHR site which lasted one day each.

ASN inspection

The ASN was satisfied with the safety and cleanliness of the construction site and the JHR project, as evidenced by the ASN 2023 Report published in 2024.

Jules Horowitz Reactor project

CEA centre

The Jules Horowitz Reactor (JHR – INB 172), under construction since 2009, is a pressurised-water research reactor designed to study the behaviour of materials under irradiation and power reactor fuels. It will also allow the production of artificial radionuclides for nuclear medicine. Its power is limited to 100 MWth.

The equipment construction and manufacturing activities continued in 2023, particularly in the reactor building and the nuclear auxiliary building. The defects observed on the primary/secondary heat exchanges are undergoing expert assessments. The corrective action plan is to be submitted in early 2024.

The ASN conducted four inspections in 2023. They focused in particular on the primary cooling system of the reactor for the aspects relating to correction of the deviations detected on the heat exchangers and taking into account the risk of migrating bodies, on the water-proofing of the floors and walls, and correcting the deviation concerning the severing of several rein forcing bars of a slab in the leak collection zone. The assembly of the reactor equipment and of the fluid circuits, the lining of the pools, the treatment of the corrosion at the bottom of the reactor pool and the fire protection of the nuclear buildings also underwent verifications.

Following the submittal in late 2021 of a revision of the facility's safety analysis report taking into account the changes and modifications introduced since the start of construction, the ASN – assisted by the Institute of Radiation Protection and Nuclear Safety (IRSN) – continued the technical examination of various themes in 2023 in preparation for the future commissioning.

ASN notes the rigour of the organisation put in place the construction of the JHR and underlines the effective and satisfactory handling of the main deviations detected on the worksite.

A project completion road map has been produced by the CEA, with a new reference schedule for the construction and commissioning of the facility. The Nuclear Policy Council meeting of 19 July 2023 endorsed the continuation of the investments by the State and the nuclear sector to finalise construction of the JHR, with commissioning expected around 2032-2034.

In September 2023, the CEA submitted a new request to modify DAC 2009-1219 of 12 October 2009, to set the commissioning date to 14 October 2037 at the latest, taking into account margins for the project.

5.2 NUCLEAR PRESSURE EQUIPMENT

Safety-related measurement control and regulation accessories

The French pressure regulation contains the definition and implementation of safety accessories in piping to protect against excessive pressure. There are different types of safety accessories, including passive accessories (e.g. safety valves or rupture discs) and active accessories (e.g. Safety Instrumented Systems (SIF). In 2024, the JHR project engineering conducted a study to identify potential SIF containing pressure equipment and nuclear pressure equipment. Additional automation and operating procedures were defined and will be processed from 2025.

Heat exchangers and ESPN Order

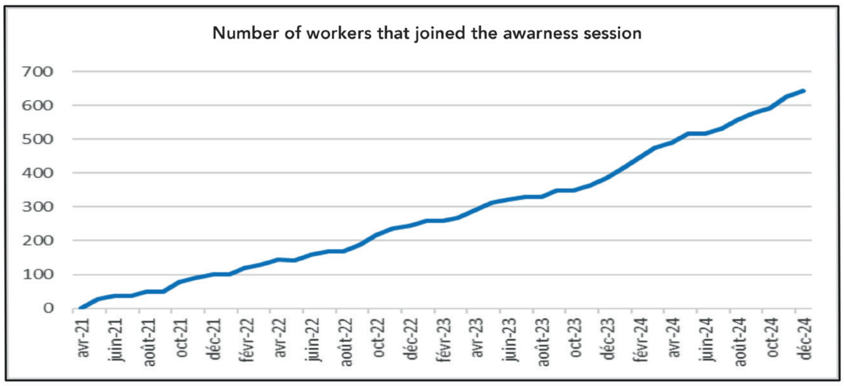
In order to rectify corrosion non-conformities detected in the primary heat exchangers, the replacement of all their internal components was deemed necessary. Given that this equipment is classified ESPN N2, the regulatory impact of these repairs had to be analysed in depth. The study concluded that the primary heat exchangers were not subject to any specific requirements stipulated under Part III of the French Ministerial Order of 30/12/2015 amended (ESPN Order).

MADISON and ADELINE – the CEA becomes a nuclear pressure equipment manufacturer

As experimental devices, MADISON and ADELINE represent a high level of risk and significant technical complexity. For this reason, the CEA decided to qualify as a 'regulatory manufacturer' for some nuclear pressure equipment in 2024. Accordingly, the CEA will be implementing an internal regulatory manufacturing process.

5.3 NUCLEAR SAFETY CULTURE

During the 2021–2024 period, monthly nuclear safety culture sessions were implemented to raise awareness of nuclear safety culture across the project in accordance with World Association of Nuclear Operators principles.



Franck PILLOT
Manager in charge of preparing
JHR operation

6.1 FUEL MANUFACTURING

In 2024, the JHR contractor Framatome-CERCA started manufacturing the inert fuel element mock-ups. These mock-ups will be used for drop and kinematic tests. The contract signed with Framatome-CERCA also allows this company to maintain its skills and know-how in specific JHR fuel assembly manufacturing activities.

Additional measurements were carried out on 10 fuel sections of the pre-production batch to analyse the possibility of optimising manufacturing tolerances.

6.2 OPERATION PREPARATION

In 2024, the future Operator analysed several operating models already in place at other research reactor sites. Operating experience was analysed in order to propose an optimised organization for the future operation unit.

The future Operator contributed its expertise in the field of thermohydraulics and neutron physics within the scope of studies supporting the design of several experimental devices such as MADISON, ADELINE and MICA.

Hydraulic tests were performed with the CORALIE loop to characterise the experimental devices PROSPERO SUPPORT and SAFETY. The objective is to monitor the mechanical properties of reactor vessels under neutron irradiation.

Operability and maintainability tests were carried out on several mock-ups to check the design of the MICA device head and the OCCITANE device.

Tests performed on mock-ups in the TOTEM facility

6.2.1 Operation documentation

The JHR General Operating Rules had been undergoing revision since 2023. The updated rules were recently completed and submitted to several experts for analysis within the framework of an internal safety commission at the end of 2024. Feedback from these experts will be incorporated in 2025, before submitting the final version of the General Operating Rules to the ASN.

6.2.2 Operating activities

When a completed system is delivered to the construction site, the future Operator becomes responsible for keeping it in good working order until reactor start-up.

In 2024, the future Operator prepared the transfer of the reactor building's pre-stressed cable system, the seismic pads, the district substation and the annex building cranes. The main polar crane, already under the responsibility of the future Operator, has been re-qualified to 360 kN to meet the high demands during the assembly phase.

The JHR project's operational cybersecurity has been assessed and the trust tag system has been tested on some systems.

A mechanical workshop was created and equipped to make modifications/ adaptations to machine parts.

Similarly, a room has been reserved in the future building containing the hardened safety core equipment; it will replicate the JHR control room. This room will house a simulator that will be used as a training tool for reactor control room operators.

6.2.3 Training

The elaboration of the training baseline continued with the analysis of each operating workstation, the identification of the necessary skills and behaviours, their translation into training objectives, and the development of training material.

Polar crane re-qualification in the Reactor building
Simulator room under construction in the BMX

Laurent ANTONEL
JHR Project Deputy Director

7.1 PROJECT ORGANISATION

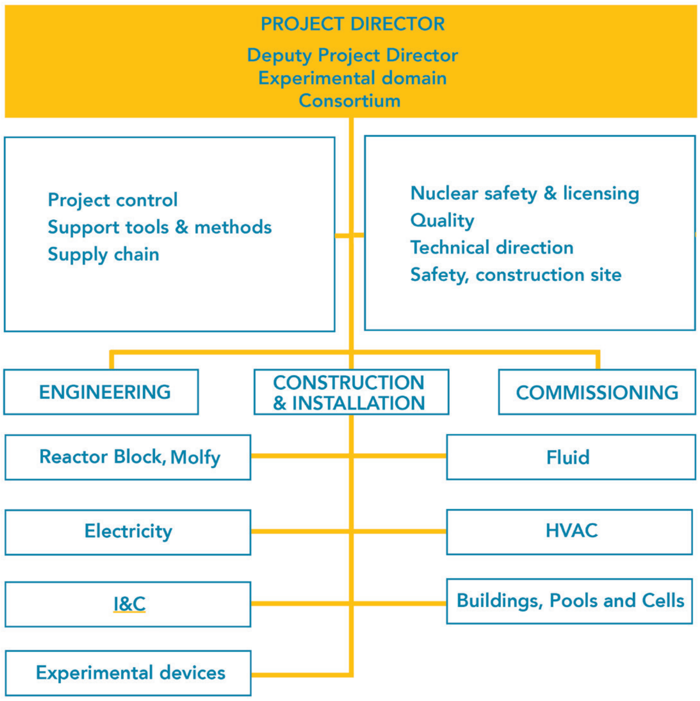
To strengthen the project's ability to meet current and future challenges, the Safety, Quality and Licensing Department and the Customer-Consortium Department underwent organisational changes in 2024.

On 4 November 2024, the Safety, Quality and Licensing Department was divided into two entities to create a Quality Department on the one hand, and a Safety and Licensing Department on the other hand. The aim of this organizational change is to create a "Quality" department dedicated to the definition and implementation of an operational quality policy, focused on monitoring the quality of production at the plant and on the worksite. The Safety and Licensing Department will remain responsible for regulatory instructions and authorization processes.

Since 2020, the Customer-Consortium department has been working with the Consortium and future users to refine customer needs with regard to the JHR. However, this task cannot be taken much further insofar as the players are not in a position to commit to activities to be carried out in more than 8 years. Nevertheless, it has become clear that we need to strengthen the steering and coordination of user needs under the project management of the experimental domain.

For this reason, the Client and Consortium Directorate (DCC) has been replaced by an experimental domain manager and a consortium manager.

Both these positions report directly to the JHR Project Director.



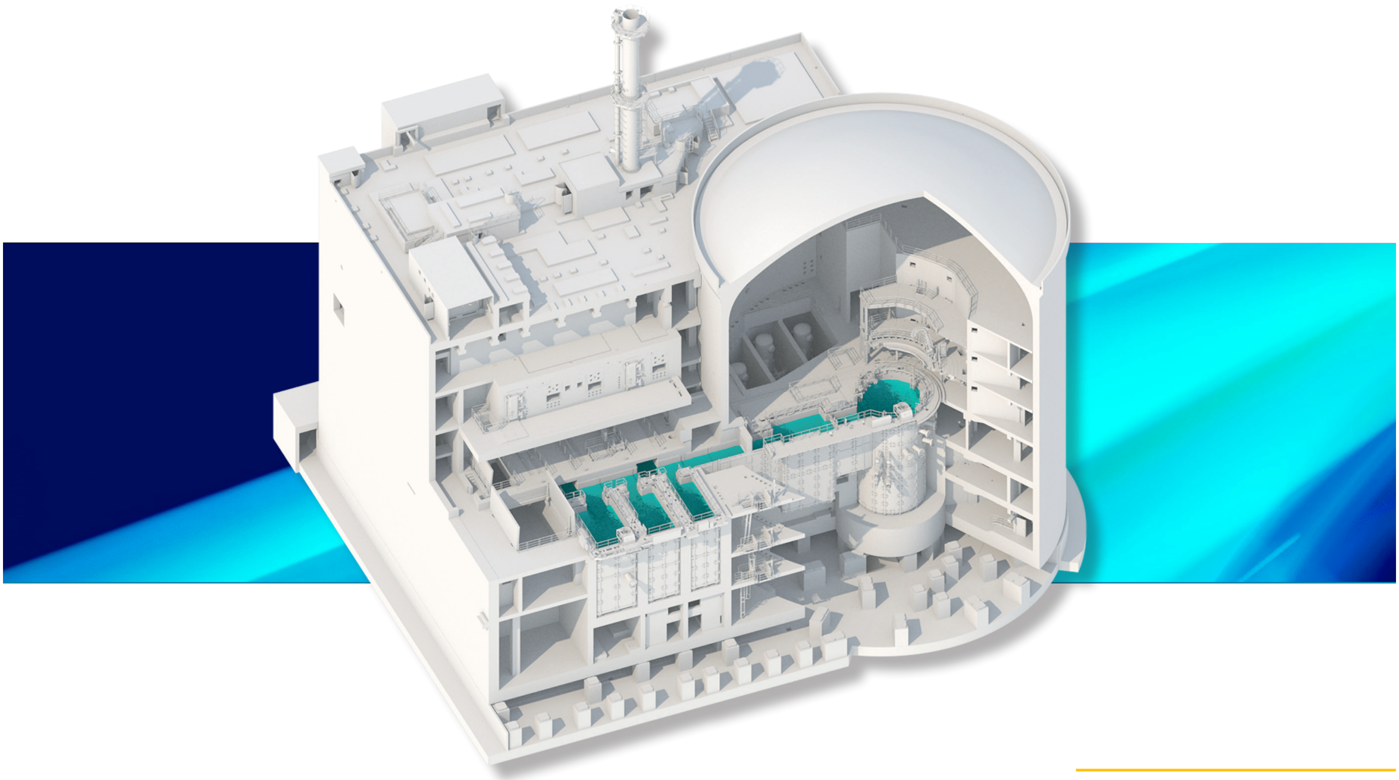
7.2 RISK MANAGEMENT

Philippe GAÏ
Project Control Manager

Risk and opportunity management is at the heart of project control, making it possible to anticipate key issues and implement mitigation actions in due time.

Key risks and opportunities for the JHR project have been compiled into a single portfolio that is managed at project level, improving the resolution of cross-disciplinary issues, and identifying risks and opportunities at each level of the organisation.

The status of actions is monitored on a monthly basis. A shared Risk Management integrated system tool has been implemented to facilitate updates and reporting.



7.3 DEPLOYING PROJECT STANDARDS

Remy POMMIER
Delivery Manager

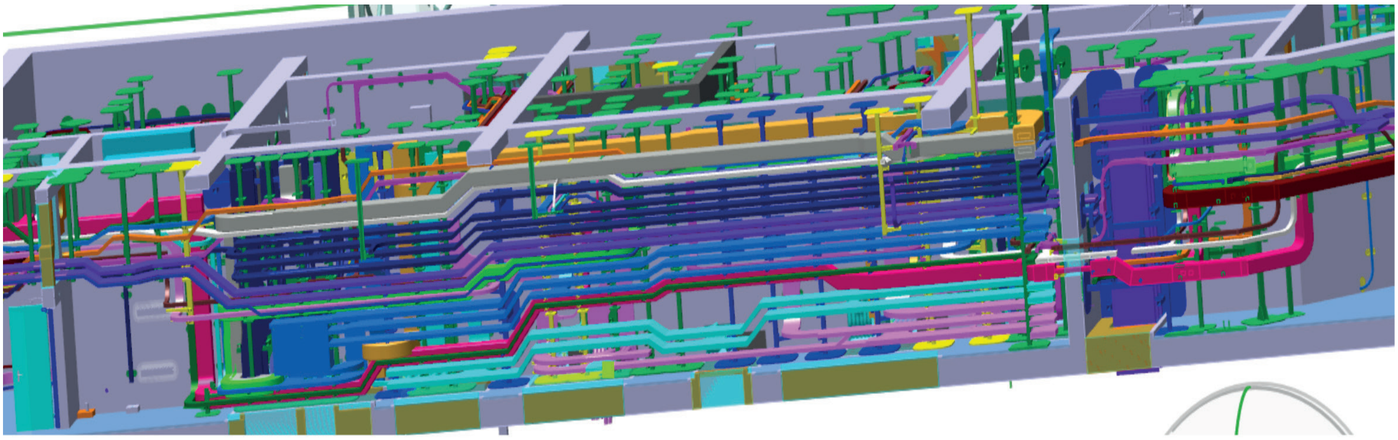
MAIN ACHIEVEMENTS IN 2024

The year 2024 saw the rapid acceleration of the installation phase for the project. Our newly updated integrated project platform (PPI) has demonstrated its ability to manage the challenges faced:

- **Schedule management:** the partial schedules for functional area[6] level-3 were reviewed and were closely monitored on both aspects of completeness and performance. Schedule management was enforced to keep the refined baseline aligned with the date of December 2032 for first nuclear reaction.
- **Field design unit:** the unit is composed of CEA and contractor representatives and its task is to manage the erection reference of the 3D model. Two main tasks were carried out in parallel in 2024:

    1) Resolution of issues arising during the assembly phase: the organisation proved to be efficient with timely analysis so to allow activities to resume quickly

    2) Completion of tasks remaining from the previous integrated technical platform to confirm the construction readiness of the model areas. A configuration update was implemented to ensure that the electrical contractor was aligned with the reference used by the mechanical contractors. During 11 months, the 3D models of all buildings were updated. While the project erection references were being updated, impact mitigation solutions were implemented to ensure that the JHR Project schedule would be able to meet its projected construction ramp-up milestones.



Electrical design in the BUA+1 technical gallery

6/ *A functional area consists in organising the building erection in order to manage the functional system for the transfer to commissioning*

- **Interface management:** the interface management team contributed to the smooth installation sequence onsite. It also started working on the electrical connection interfaces of the cooling building.

- **Problem resolution:** In 2024, working groups were set up to resolve difficult design issues affecting some rooms or building levels. This was mostly the case in the electrical/computer rooms for the experimental systems. This is because the current configuration (updated to take into account the higher level of functional design maturity) has increased the complexity of the cable routes.

KEY MILESTONES IN 2025

The year 2025 will focus on consolidating the activity level of contractors having led the ramp-up in 2024, and supporting new major contractors in their site activities in the reactor building. Our integrated project platform will be invaluable to the project by:

- Driving the project **schedule** efficiently
- Managing the erection reference of the 3D model though the **field design unit**
- Reviewing and validating the different **interfaces**
- Organising and driving task forces to **resolve problems** quickly. The first priority will be to finalise the initial 3D model erection reference for the different levels of experimental system areas
- Securing the on-time delivery of contractors since the beginning of one operation is conditioned by the completion of the previous operation. This will be the main challenge for our **process optimisation approach**
- Finalising the **handover after commissioning of the first process systems** (tap water, compressed air and demineralised water systems)

Philippe GAÏ
Project Control Manager

The main objectives of the JHR project in 2025 are to:

- Reinforce occupational safety practices in a context of increased erection activity
- Finalise the technical configuration (3D implementation) in the area hosting the experimental devices (CEDE)
- Strengthen the monitoring of equipment manufacturing to ensure its timely site delivery before installation
- Complete the detailed design reviews for the experimental devices and prepare the tender process for component manufacturing
- Launch tests on the BMR building
- Continue discussions with the ASN on the updated JHR safety report (batch 2)

JHR Jules Horowitz Reactor
SAFETY HONESTY GET RESULTS TEAM MINDSET

9 ACRONYMS

ADELINE	JHR Advanced Device for Experimenting up to the Limits of the Nuclear fuel Element
ASN	French Nuclear Safety Authority (now the ASNR)
BAS	Safeguard building
BAV	Auxiliary Changing Room building
BARC	Indian consortium member
BMR	Auxiliary cooling and utility building
BND	Building containing the ultimate emergency equipment (hardened safety core)
BORAX	Severe reactivity insertion accident
BUA	Nuclear auxiliary building
BUR	Nuclear unit reactor building
BR2	Belgian Reactor
CABRI	CEA research reactor dedicated to safety tests
CARMEN	JHR device to measure neutron and gamma fluxes, and to provide gamma heating to precisely characterise irradiation locations in order to improve modelling and experimental results
CEA	French Alternative Energies and Nuclear Energy Commission, JHR Host and French consortium member
CEDE	Experimental shielded cubicle room
CFSI	Counterfeit, fraudulent, and suspect items
CGN	China General Nuclear Power Corporation – Chinese partner in the JHR Material Test Reactor international consortium
CLOE	JHR Corrosion Loop Experiment
CORAIL	Thermohydraulic loop in the TOTEM facility
CORALIE	CEA loop in the TOTEM facility to measure the hydraulic characteristics of the experimental devices (in-core and reflector areas)
DAC	Decree authorising the construction of a nuclear facility (licensing process)
DSSN	CEA division for nuclear safety and occupational safety
ECR	Large hot cell used to condition and remove radioisotope targets
ESPN	French ministerial order governing nuclear pressure equipment
EURATOM	European Atomic Energy Community supporting the development of the European nuclear industry
FIDES & FIDES-II	Framework for Irradiation Experiments
FWG	Fuel Working Group
HFR	High Flux Reactor of Netherlands
HVAC	Heating, Ventilation and Air-Conditioning
I&C	Instrumentation & Control
IAEA	International Atomic Energy Agency
ICERR	International Centre based on Research Reactors
IFE	Institute For Energy technology, Halden
IGCAR	Indira Ghandi Centre for Atomic Research

IMS	Integrated Management System
INB	Licensed nuclear facility
IRSN	Institute for Radiation Protection and Nuclear Safety (now merged with the ASN)
JAM	JHR Archive Material project
JHR	Jules Horowitz Reactor
HGXR	Finnish In-Kind Hot cell Gamma and X-Ray scanning system
HRT	Research and Technology Hall (CEA Cadarache)
INCREASE	In-Core Real-Time Mechanical Testing of Structural Materials of the FIDES-II Joint European Experimental Programme
LOCA	Loss-Of-Coolant Accident
LTA	Lost Time Accident
LWR	Light Water Reactor
MADISON	JHR Multi rod Adaptable Device for Irradiation of LWR Fuel Samples Operating in Normal conditions
MICA	JHR Material Irradiation Capsule
MIT-R	Massachusetts Institute of Technology Reactor (USA)
MOLFI	Displacement system used in the production of molybdenum
MTR	Material Test Reactor
MWG	Material Working Group
NEA	OECD Nuclear Energy Agency
NNL	Nuclear National Laboratory, a British consortium member
NRC	US Nuclear Regulatory Commission
OCCITANE	Out-of-Core Capsule for Irradiation Testing of Ageing by Neutrons JHR device
OECD	International Organisation for Economic Co-operation and Development
OSIRIS	Previous CEA Material Test Reactor (phase-out 2015)
PROSPERO	JHR device to monitor beginning-of-life changes in reactor materials and vessel material behaviour under irradiation during its lifetime
PWR	Pressurised Water Reactor
RISHI	Research facility for Irradiation studies in Sodium at High temperature (sodium loop designed and built by IGCAR)
R&D	Research and development
SCK CEN	Belgian consortium member
TAXY	CEA Saclay loop for the hydraulic characterisation of JHR components (ex: flow measurements, pressure drop) and fatigue tests
TOTEM	CEA cold test facility
TWG	Technical Working Group
UGXR	Finnish in-kind of an Underwater Gamma and X-ray scanning systems
UPS	Uninterruptible Power Supplies
VAUTOUR	CEA Cadarache cubicle designed to resist to explosion from NaK/water reactions
VTT	Finnish consortium member

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Jules Horowitz Reactor

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