

JULES HOROWITZ REACTOR (JHR) OPERATING PREPARATION: STATUS AS OF MID-2023 FOLLOWING REASSESSMENT OF THE PROJECT

A. FARDEAU, F. PILLOT, JP. CHAUVIN, D. EMOND

*French Atomic and Alternatives Energies commission (CEA)
Cadarache Research Center
Reactor studies department
13108 Saint-Paul-lez-Durance – France*

The Jules Horowitz Reactor (JHR) is a new 100 MW Material Testing Reactor (MTR) currently under construction at CEA Cadarache research center in southern France. Its ambition is to become one of the major research infrastructures for industrial qualifications and scientific studies dealing with nuclear materials and fuels behavior under irradiation.

Following a Project schedule reassessment, CEA updated its roadmap for recruiting the future operator staff. This roadmap is used as an opportunity to work on the missions of the future operator's team during this construction phase, in order to train and qualify operators ready for the reactor start up, thanks to their deeper involvement in the Project. The following paragraphs provide detailed information on the missions of the operating section, their up-to-date status, and the work program from now up to the criticality of the reactor.

1. Introduction

A change in JHR Project organization, and a schedule reassessment lead to adapt the missions of the operating division (also named future operator in the following text), and to review the corresponding roadmap.

2. Organization change

2.1. Previous organization

Before 2020, JHR Project gathered several teams:

- the prime contractor, TechnicAtome, responsible of the JHR design, manufacture and commissioning tests,
- the CEA, as the owner and future operator, with 3 teams :
 - one responsible of the project coordination, notably in charge of supervising the prime contractor,
 - one in charge of the design and manufacture of the first fleet of experimental devices and associated equipments (non-destructive examination benches, laboratories...),
 - the future operator.

2.2. Current organization

In 2020, the project was reassessed, and there are now 2 teams:

- a Project team, working on an “integrated program platform”, made up of CEA staff, and employees from Technicatome and Framatome, made available to CEA. This team is responsible for project's management, dealing with the design and the manufacture of the reactor and the first fleet of experimental devices and associated equipment, and preparing the commissioning tests and the safety report of the facility.
- the future operator, whose missions are described below.

3. Missions of the future operator

3.1. Tasks

To be ready to operate JHR reactor, CEA needs to deal with several topics, particularly:

- staffing and organizational structuring for the commissioning test phases and for operation,
- elaboration of the documentation to operate the reactor (general operating rules, procedures, instructions...),
- writing of maintenance and periodic test programs,
- staff training by using dedicated tools (simulator, remote manipulators...),
- achieving calculations and studies in support of the reactor (start up core) and experimental devices (operation, experimental capacities in reactor), in the fields of neutron physic and thermo-hydraulic,
- verifying the JHR safety report, written by JHR project team, from an operator point of view,
- performing commissioning test programs to ensure that the layout of systems and subcomponents fulfill the design requirements, the specification performances and the safety criteria.
- testing the design of the first fleet of experimental devices in support to the Project team, regarding kinematics, handling, interfaces, hydraulics characteristics... To do this, the future operator uses models (of experimental devices, hot cell, ...), a 3D viewing room based on CATIA multi-platform 3D modeling software, tools made available by the Project (such as remote manipulators, pool storage holders, ...) and an hydraulic loop named CORALIE. This activity is carried on in a specific facility of Cadarache CEA site named TOTEM, owning 2 pools and handling tools, helping to do representative tests.

3.2. Up-to-date status

- Regarding staffing, 47 people are currently working in the operation team today; the need is to reach 120 people at the criticality (shift teams and normal operation teams) to operate the JHR reactor, and around 40 people for the experimental operation. A human resource mobilization plan was carried out, with connection to the need of operators for the commissioning tests and with the necessity to train people before being operational.

- All the documentation to operate the reactor have been scheduled, in order to be ready, completed and used, during the commissioning tests. Almost 1/3rd of this documentation is already drafted, mainly on:
 - Reactor normal operation procedures :
 - general instructions (to manage each status of the reactor, and the status changes, criticality, power changes...),
 - some instructions for specific activities regarding reactor (fuel loading, realization of a fuel-cladding failure detection map, underwater transfer...),
 - most of systems instructions, and their operation forms,
 - Reactor accidental conditions procedures (in case of loss of coolant, pool leak, break on the primary system...).

This year, the elaboration of incident condition procedures is on-going (for example in case of chemical pollution of pools water, under-voltage, load fall...).

- Some chapters of general operating rules are currently being written, particularly the one about periodic test programs, which is a 2023 milestone for the future operator, such as the one regarding nuclear waste management. The necessary periodic tests are now identified, and their feasibility assessed.
- Staff training is a 5 phases process :
 - The first phase, consisting in analyzing each working position of the future operation team, in order to identify the knowledge, and the necessary skills and attitudes, is completed for all the JHR operating working position.
 - The second phase, which converts competences into training objectives is completed for the JHR shift teams (shift supervisor, reactor operator, shift electrician and shift mechanic), for the operation engineer, and the day electrician and mechanic.

The work is ongoing for the safety engineer, the handling operator, the team supervising the operation jobs (such as nuclear waste manager, nuclear material manager, transportation manager, the core loading and unloading manager...) and the nuclear facility manager.
 - The 3rd phase, consisting in identifying/creating all training materials (specific to JHR or not) or actions needed to implement the training plans, is ongoing. In addition to theoretical training, the participation to tests (factory, commissioning, inter connection), the use of dedicated tools (simulator, remote manipulators...), and the writing of operation documentation are all meanings to train operators.
 - The implementation phase (4th phase) is already ongoing with a combination of several methods (classroom instruction, self-study, simulator...). The trainees' progress will gradually be assessed through written examinations or oral questioning.
 - At the 5th phase, which is the end of the training program, operating staff will be certified by a specific commission under the responsibility of the reactor manager.
- Depending on the Project priorities, the operating section performs calculations and studies in support of the reactor and experimental devices, in the fields of neutron physic and thermo-hydraulic, such as, for example, the definition of operating conditions of ADELIN and MADISON experimental devices, the study of cooling performance in core and reflector of CARMEN device, fuel management studies, average discharge burn-up, assessment of criticality safety margins.

- The future operator is also deeply implied on the construction project management, through:
 - participation to all the tests useful for operation, maintenance, assembly, disassembling,
 - analysis of constructors' documentation (user manual, maintenance instructions, periodic test feasibility...),
 - analysis of the safety report from an operator point of view
 - testing the design of the first fleet of experimental devices in support to the Project team, regarding kinematics, handling...

In the last few years, after some modifications in the facility (TOTEM) used to perform these tests, the future operator team designed a tipper for experimental devices, participated to the design and setup of a test-loop aimed to check hydraulic characteristics of experimental devices before their introduction in reactor, perform some handling tests...

When the Projects takes delivery of completed systems, the future operator takes them over (for maintenance and operation activities) to keep them in well operation conditions before the JHR start-up. At the current time, the future operator is in charge of the building where the experimental devices will be assembled, the main power supply building, the operator office building, several handling equipment, such as the main polar crane.

4. Work program up to criticality

- In order to allow the continuously growth of the team up to 160 people, it will be necessary to anticipate, and to take into account the important need of skilled labor of nuclear industry foreseen at the beginning of the next decade. In addition to the resource mobilization plan mentioned above, the education system has to be implied, in order to increase the amount of skilled labor qualified to work in nuclear industry.
- The work referring to staff training must continue, with :
 - the extension of the design phase to obtain training plans for all the JHR operating jobs,
 - a work with schools, training organisms to identify/create missing training materials,
 - the training of JHR staff and its assessment. In average, training to specific JHR operation lasted about one full-year. It is important to note that the current staff will not necessarily be the one who will operate JHR. So, the future operator will have to deal with maintaining the competences (train the trainers); that needs the implication of existing nuclear facilities (reactors, labs or factories).
- Up to now, a lot of procedures written are about the reactor operation, all the other documents procedures, referring to systems such as hot cells, pools, handling, experimental devices operation, transportation, nuclear materials, waste and transportation management..., have to be elaborated, taking into account the requirements date for each document.

3 main milestones are scheduled to plan the documentation writing : the filling of pools with water (which implies to put the control room in operation, such as HVAC, and other systems...), the inter-connecting tests, and the beginning of nuclear operation after first criticality.
- The periodic tests procedures have to be ready before to set up the beginning of nuclear operation after first criticality.

The maintenance procedures must be drafted when the equipment is integrated to a maintenance process (carried out by CEA or a subcontractor).

- It is agreed that the future operator will manage the following items :
 - procurement of generic tools or appliances, needed for the labs, the workshops, consignment systems,
 - adaptations to be considered in order to simplify and to optimize operation,
 - extension of the operator office building, and layout of the welcome area,
 - softwares necessary for operation (nuclear materials management, interventions management, ...).

5. Conclusion

The Project schedule reassessment and the deeper implication in the construction project offered the opportunity to help the future operator in its tasks accomplishment.

Indeed, by contributing to constructors documentation analysis, attendance to factory or onsite tests, performing calculations or tests on experimental devices, the future operator will get in advance appropriation of the whole functioning principle of the reactor.

However, special attention must be paid to the fact that the current team will not be necessarily the one that will operate the reactor, and all activities of future operator must be carried on, taking care of this.

References

- [1] O. Marcille and al., “The Jules Horowitz Reactor: Preparation of the commissioning phase and normal operation”. Research Reactor Fuel Management 2020, RRFM 22-26 March,
- [2] G. Bignan and al., “Jules Horowitz Reactor (JHR) project : status as of mid-2023 following major reassessment of the project and setting-up of « pre-JHR » phase before start-up of the reactor”, International Group on Research Reactors, IGORR 2023, 18-23 June, USA