The construction stage in the RA-10 Reactor Project

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Abstract. The RA-10 is a new multipurpose research reactor that is under construction in Argentina. It is a 30 MW thermal power reactor and it is designed to achieve high performance neutrons production to fulfil the stakeholder's requirements in compliance with stringent safety regulations. The principal objectives of the facility are to consolidate and increase the radioisotope production in order to cover future demands, to provide fuel and material testing irradiation facilities in order to support national technology development in this field, to offer new applications in the field of science and technology based on modern neutron techniques.
The project is supported by the National Administration and is conducted by the National Atomic Energy Commission (CNEA).
The construction stage was begun last year. Previously, the construction license and the environmental aptitude certificate were obtained and a social perception study was performed. The first concrete was built on last May 6. The reactor is planned to be operative in 2020.
The main ongoing activities developed during this stage involve the civil work construction, the industrial components manufacturing and mounting, the nuclear supplies and component provision and the development of the operation team. The plant documentation elaboration and preoperational tests preparation are planned for the next year. Regarding licensing, beside the upgrade of the Preliminary Safety Report and the commissioning preparation, the main objective is to assure and demonstrate that the licensee, and all safety and regulatory requirements, are correctly implemented.
According to the chosen model for the project organization, responsibilities were assigned to in-house groups and external companies within the frame of a few main contracts and internal agreements. The project organization had to be adapted for this stage reinforcing capabilities related to coordination, integration and controlling. CNEA has updated the project management system with specific procedures, modifying the corresponding quality system for handling this stage. The contractor´s quality systems had to be reviewed and adapted. Specific schedules had to be integrated. The commitment with safety culture was reinforced by assuming that, beside the contractors' participation, the responsibility for implementing the license relies on the operating organization.
This paper describes the experience of managing the construction stage, particularly for the different involved activities, with emphasis on their interactions and the application of control tools.

1. Introduction

The RA-10 Research Reactor is a 30 MW multi-purpose open-pool type facility, with a compact square array core containing 6 internal irradiation positions and 19 MTR fuel assemblies. A heavy water reflector tank surrounds the core and houses the ex-core irradiation facilities. The core and the heavy water reflector tank are both placed in an open pool containing the light water coolant that flows upward. The irradiation rigs are independently cooled by means of the pools cooling system. Reactor shut down can be achieved by two independent means, which are the insertion of the six control rods into the core, or the partial drainage of the heavy water from the Reflector Vessel.
The reactor is designed for the accomplishment of two main purposes:

- The continuous production of several radioisotopes, such as ^{99}Molybdenum, and ^{192}Iridium, among others; and Neutron Transmutation Doping in Silicon ingots.
- Perform several types of experiments, involving thermal and fast neutrons in-core Irradiation Facilities, Pneumatic Rigs with a wide range of neutron fluxes, two Cold Neutron Beams provided by a Cold Neutron Source, two Thermal Neutron Beams, one

particular Beam for an underwater Neutron radiography facility, one Power Reactor Fuel Rods testing Loop and a MTR Fuel Elements testing position.

Technical and safety requirements have been early established, based on the safety objectives, concepts and principles presented in the IAEA Safety Standards. Technical requirements are based on the utilization related requirements and in consistent reactor availability for the intended use.

The reactor is under construction in the Ezeiza Atomic Center, located at 60 km from Buenos Aires city.

2. The RA-10 Reactor

The requirements provided for the user related to utilization were consolidated and restricted, resulting in the following utilization related design features: neutron activation analysis, radioisotopes production, neutron transmutation doping, neutron beam applications for material structure studies and neutron radiography.

The six in-core irradiation positions are focused on material testing such as neutron damage and corrosion studies. The two central positions (F1, F2) present an intense fast neutron flux, while the four positions placed at the corners (T1-T4), a reactor spectrum flux.

The ex-core irradiation facilities include radioisotopes production, silicon doping, pneumatic tubes, a fuel-testing pressurized loop, an in-pool neutron radiography and beam extraction. The irradiation facilities distribution inside the reflector tank is shown in Figure 1.

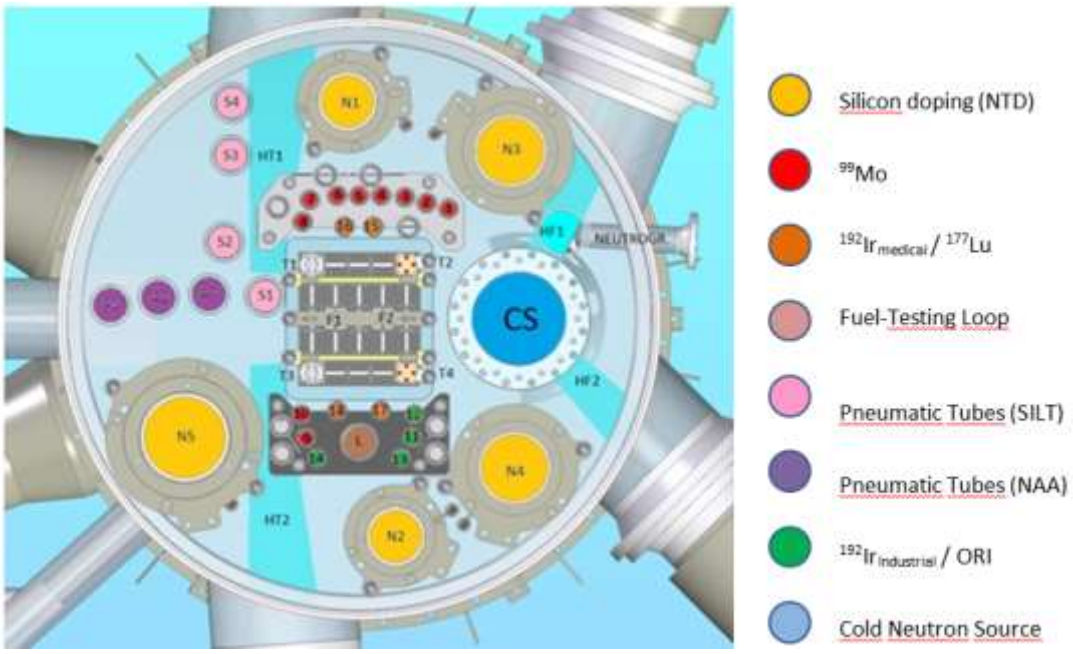

FIG. 1. Facilities distribution in the reflector tank.

3. The RA-10 Project

The scope of the project not only includes the reactor design, construction and commissioning; but also the operation team licensing and the user´s development for the specified applications. Besides, there are others associated projects focused on the radioisotopes production capability, the neutron beams development and exploitation and the post irradiation experiment facilities.
The project schedule is shown in Figure 2. The commissioning is planned to start on March 2020.

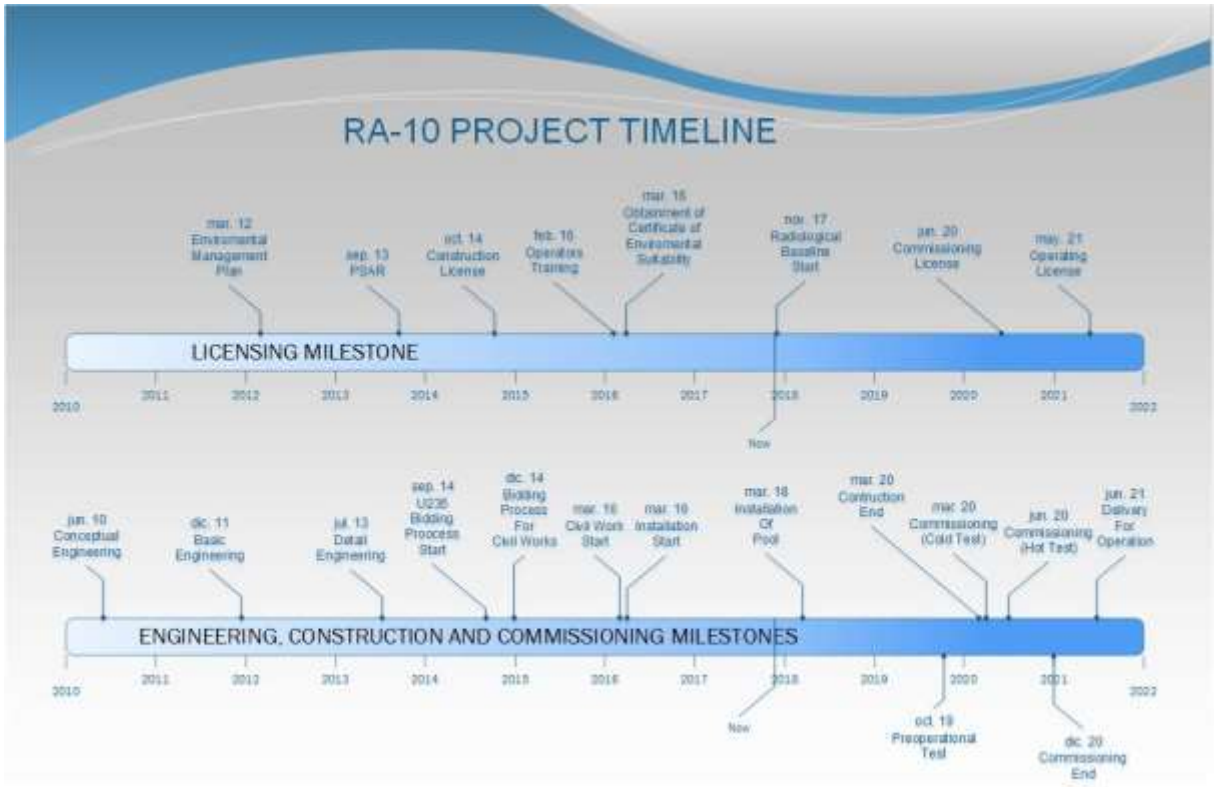

FIG. 2. RA-10 Project schedule

The commercial strategy adopted by the CNEA for the procurement was to appoint only a few general contracts; even with internal sectors considered also as suppliers.
The project execution is based on less than 10 relevant independent contracts, indicated in Table I, which are coordinated and controlled by a project team.

TABLE I: Relevant contracts (internal and external)

Object	**Contractor**
Design	CNEA & Invap S. E.
Civil work	Caputo S. A.
Supplying and mounting	Invap S. E.
Heavy water supplying	ENSI S. E.
Uranium supplying	B&W Y-12

Electric infrastructure	To be defined
Fuel elements manufacturing	CNEA
Nucleonic instrumentation	CNEA
Reactor protection system	CNEA

In order to have an appropriate organizational structure, the management of the project is based on a project team of about 60 persons that was conformed for covering all the relevant project areas, fixing its dependence at the highest-level authority of the CNEA.

4. The Construction Stage

The construction stage began on May 6 with the first concrete of the Reactor Building. During this stage, the main developed activities are related to the construction, licensing, the operation team conformation and training, the stakeholder´s handling.

According to the chosen model for the project organization, responsibilities were assigned to in-house groups and external companies within the frame of a few main contracts and internal agreements. The project organization had to be adapted for this stage reinforcing capabilities related to coordination, integration and controlling. CNEA has updated the project management system with specific procedures, modifying the corresponding quality system for handling this stage. The contractor´s quality systems had to be reviewed and adapted. Specific schedules had to be integrated. The commitment with safety culture was reinforced by assuming that, beside the contractors' participation, the responsibility for implementing the license requirements relies on the operating organization. [1]

4.1. Construction

It includes the Civil Work of four buildings and the Supplying and Mounting of all the Structures Systems and Components of the reactor.
Being executed through two separates contracts, it took more than one year to have a compatible and updated integrated schedule. The maintenance of this schedule is one of the most relevant and permanent tasks for the construction team.
Among the initial activities, it was also very relevant to supervise the adaptation of the QA systems of the main contractors to the RA-10 Project requirements.
Specific coordination of daily activities concerning their execution at different levels of the construction is one of the most demanding activity.
A general procedure for conducting all related activities was implemented.
The execution of the relevant activities is controlled by specific inspection and testing plans. According to the Quality Level assigned to each system or component, graded detail, protocols and registers (final documentation package related to each activity) are established for the following operations:

- manufacturing applied documentation specification
- materials reception
- inspection and testing controls
- production process controls
- special process controls
- final control and packaging
- quality review

4.3 Operation team training

The organization chart for conducting the operation of the RA-10 Reactor was developed and the functions and requirements for the license positions were established and approved by the regulatory body, as it is shown in Figure 3.
About 55 licensed positions are considered that will have to be occupied by professionals (20) and technicians (35).
A total of 95 positions are planned for covering the reactor operation.
A training plan for the reactor operation staff was developed and approved by the regulatory body. It was begun on February 2016 by the recruitment of 20 professionals that received a theoretical training in the fields of reactor engineering, radiation protection, nuclear safety and regulations, as well as quality management and safety culture. Then, a six-month practical training in the RA-6 and RA-3 Argentinian research reactors was implemented in order to develop the specific capacities for the licensed positions. After getting their individual licenses, a specific training on the RA-10 Reactor has already begun. It will be completed by the training in a full scope simulator. This team will be involved in the elaboration of the plant documentation and in the preoperational tests.
In addition, 36 technicians have been already recruited and they are now receiving their theoretical training for covering the corresponding licensed positions.

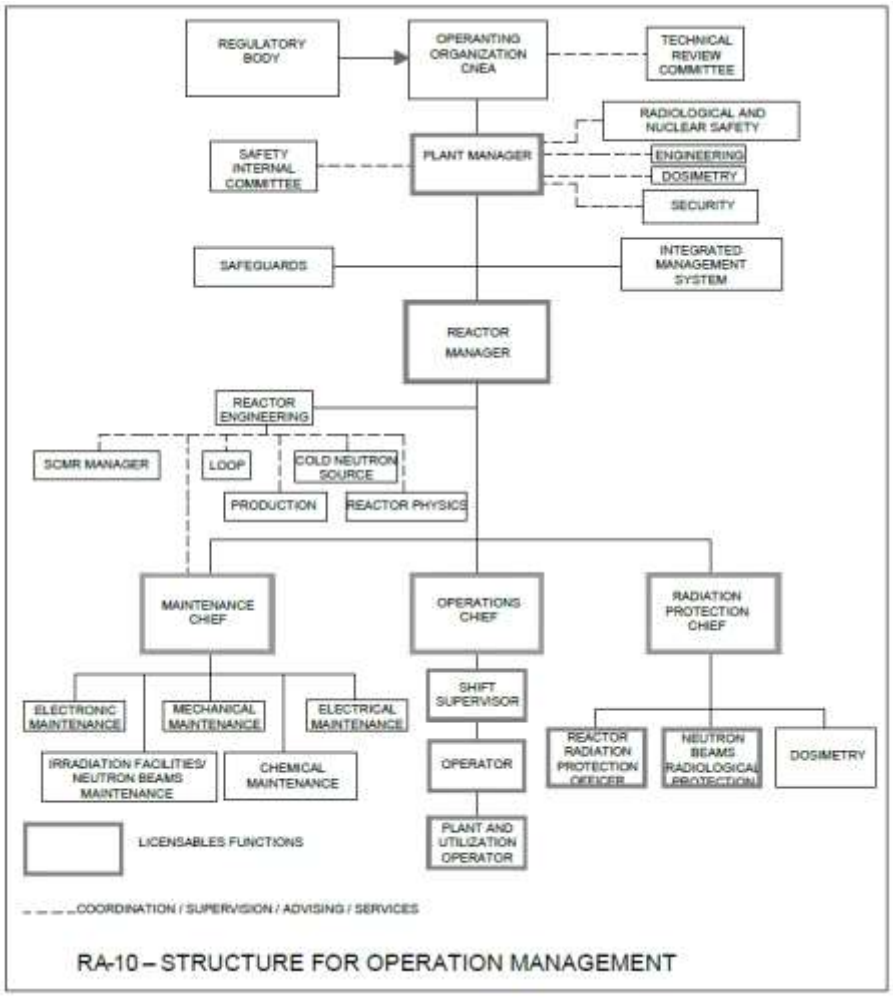

FIG. 3. Organization chart for the RA-10 Reactor operation

4.4 Stakeholders

Stakeholders' involvement in a research reactor project is especially important from two different but key perspectives that relate to two separate interests: public and users.
A social impact assessment study was implemented at the very beginning and the results expressed the community approval about the project. The results also reflected that people required further information about nuclear activities developed by the CNEA, so a communicational plan is being prepared.
In order to assure that the reactor and its auxiliary facilities were adequately utilized over its lifetime, several project related to its planned applications were promoted. Even there were experienced stakeholders related to the reactor-planned utilizations, in some cases there were not well-consolidated groups and auxiliary facilities were not available. So, an application development programme was implemented, focused in the following projects, involving new facilities and also human resources consolidation:

- a new radioisotopes plant for increasing molybdenum production
- a neutron beams laboratory
- a post irradiation experiment plant

In order to manage the relationship with these associated projects and follow up its execution, a user´s committee was created with the commitment of the highest-level authority of the CNEA.

4.5 Licensing

In order to manage the requirements related to the Construction License, regular communications are implemented between the project and the regulatory body:

- Monthly reports including the evolution of fixed relevant topics
- Monthly reports including the foreseen milestones for the civil work, the main component manufacturing process tests and the operation team licensing.
- Monthly meetings for presenting the project advance

In addition, a configuration management system was implemented following the recommendations indicated in [2].
Its main objective is to provide assurance that the plant is designed and built in accordance with the actual license and design basis, as stated in the Preliminary Safety Report, and in conformity with the requirements of the Construction License, granted by the national regulatory body in 2014.
In this sense, the concept of configuration equilibrium was established (see Figure 4) and the following management tools implemented to establish this equilibrium and manage deviations:

- Non-conformances management
- Configuration changes management
- Requirements management
- Testing and inspection plans
- Safety evaluation plans
- Commissioning and pre-commissioning plans

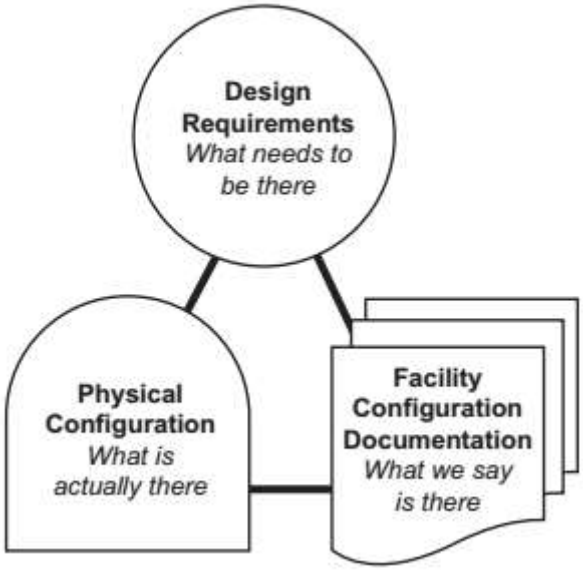

FIG. 4. Configuration management equilibrium model

5. Final Remarks

The construction stage development implies the appropriate management of relevant activities related to the construction itself, the operation team training, the stakeholders' handling and licensing.
CNEA has implemented these activities in a planned and structured organization and by developing specified procedures, resulting in the current advance of the RA-10 Project, which is about 40% and according to the planned schedule.

6. References

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Construction for Nuclear Installations, IAEA Safety Standards, Specific Safety Guides No. SSG-38, Vienna (2015).
[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Application of Configuration Management in Nuclear Power Plants, Safety Reports Series No. 65, Vienna (2010).