

## **The INFODEM Information Centre at CEA Marcoule: A Unique Information Tool in Europe About Nuclear Decommissioning - 16217**

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### **ABSTRACT**

In September 2014, the French Alternative Energies and Atomic Energy Commission (CEA) inaugurated a unique information center focused on decommissioning of its nuclear facilities. This facility, named INFODEM information center, is inside the main building of the G1 nuclear reactor at Marcoule, a nuclear site in the south of France with world-recognized expertise in decommissioning. Constructed in the 1950s, the G1 reactor was the first industrial-scale reactor for plutonium production in France; it was also used to produce electricity. Operations ceased in 1968, and it was progressively dismantled (through removal of fuel and main components) and placed in monitoring status. In the 1980s, mockups of fuel cycle process equipment were built under a temporary mission to support development activities for the La Hague reprocessing plant. When that ended, further dismantling occurred, and during 1996 through 2010, the site established itself as a reference example for worldwide nuclear dismantling activities. In 2012, the project to establish an information center at the reactor began, targeting three main audiences: the public, agency personnel and politicians, and technical professionals. Considerable thought went into the facility design, to address the interests and information needs of these three audiences. The INFODEM concept extended over 800 square meters (about 960 square yards), to host an informative tour addressing several major themes: CEA's D&D strategy, programs, skills, tools and methodologies and "everyday life" on decommissioning projects. Illustrating its unique value and considerable success, INFODEM received the Public Information Prize from the French Nuclear Energy Society (SFEN) in June 2015.

### **INTRODUCTION**

In September 2014, the French Alternative Energies and Atomic Energy Commission (CEA) inaugurated a unique information center focused on decommissioning of its nuclear facilities. This facility, named INFODEM information center, is inside the main building of the G1 nuclear reactor at Marcoule, a nuclear site in the south of France with world-recognized expertise in decommissioning.

The INFODEM information center is operated by CEA and open every day for visits by non-specialists (such as local community members, students, and the media) and nuclear and energy professionals. Moreover, the INFODEM information center aims to become the technological showcase for the PVS1 economic cluster (Pôle de Valorisation des Sites Industriels, or recycle and recovery cluster for industrial sites) – an organization dedicated to promoting

decommissioning technologies among French companies involved in such projects.

In April 2015, in recognition of its high quality and contributions, the INFODEM was awarded the Public Information Prize by the French Nuclear Energy Society (SFEN) [1]. The history of the G1 facility is described below, from its early years to final shutdown and decommissioning, followed by an overview of how the reactor was transformed into a unique information center and showcase for decontamination and decommissioning (D&D) technologies.

## **THE G1 REACTOR: AN HISTORIC LANDMARK OF THE FRENCH NUCLEAR INDUSTRY**

France began developing the G1 reactor in the early 1950s, to become its first industrial-scale reactor for plutonium production. Construction of this reactor at Marcoule was completed in 1956. 1955, three years after the French parliament had voted the first national act on nuclear energy development, which urged the construction of such reactors.

The objective of G1 was mainly to produce plutonium for nuclear weapons and, to a lesser extent, to use the induced generated heat to produce electricity. At that time, two nuclear research centers were already being operated by CEA, Fontenay-aux-Roses and Saclay, both in Paris area. Marcoule center was to become the first production-scale center within the CEA.

Ground preparation for the construction of the G1 reactor began in May 1954, and only 18 months later it went critical. Although the initial divergence of G1 occurred January 5, 1956, the date reported in the history books [2] is January 7, which is when the top management of CEA was present. One year later, in January 1957, the industrial operation of G1 began, and in July 1958, the first spent fuel rods were transferred to UP1, a PUREX process-based reprocessing plant situated next to the reactor.

The design of the G1 reactor was very basic, although considering the state of the art of civil engineering in France in the 1950s, its construction can be considered innovative (e.g., its use of pre-stressed concrete). Regarding nuclear science, the technological choices were based on the use of natural uranium as the fuel and graphite as the moderator. One hundred metric tons of uranium were used in cartridges shaped with a magnesium-zirconium alloy cladding. These cartridges were to be inserted in the core horizontally, given the limited knowledge about vertically designed reactors; however, the 36 control rods were vertical. Operating the reactor required 69 technicians and 4 engineers, all working in rotating shifts. Air-cooled at atmospheric pressure, with only 46 megawatts of thermal power, G1 became the first French reactor to generate electricity using nuclear reaction. Connected to the grid, it was operated until October 1968, then progressively dismantled to reach Level 2 of the International Atomic Energy Agency (IAEA) decommissioning status (i.e., fuel and main components removed and evacuated).

The reactor's building then remained under permanent monitoring status until the facility was temporarily assigned a new mission in the 1980s. At that time,

CEA decided to build different mockups and demonstrators of fuel cycle process equipment, including a rotating dissolver for the La Hague reprocessing plant. Extraction technologies such as pulsed columns were also assembled at Marcoule, to support efforts for the La Hague facilities. Technically independent, without any links to the rest of the former core, these pilot components also illustrated Marcoule's ability to build readily available technology for its industrial clients. After that mission ended, these devices were progressively dismantled in the late 1990s. On July 19, 2003, the G1 chimney stack reached the end of its 47-year lifetime and was toppled, symbolically completing the first part of the G1 story.

Like the subsequent G2 and G3 reactors, G1 still contains graphite, which will be removed when a final storage facility becomes available in France. Thus the reactor can be considered as providing interim storage for its graphite elements, which represent long-lived low-activity waste. This explains why the reactor continues to be monitored to assure facility safety. Particular attention is paid to the following: residual tension in the pre-stressing cables, hygrometry of air inside the sheaths of the cables, state of the pre-stressed concrete, and the leak-tight barrier of the reactor units.

## **DECOMMISSIONING ERA AND OPPORTUNITY OF A NEW LIFE FOR G1**

In 1996, newly elected French President Jacques Chirac made strategic decisions for national nuclear deterrence, which signaled the end of weapons-grade plutonium production. In the meantime, the government ordered the dismantling program for the UP1 plant in Marcoule, with immediate shutdown of the production facilities including not only the reprocessing plant but also its numerous adjacent workshops (support facilities).

During 1996-2010, Marcoule became a highly regarded reference example for worldwide nuclear dismantling activities. With more than 300 million euros of annual expenses (more than roughly 220 to 230 million dollars), the dismantling programs covered a wide array of facilities, including six reactors (G1, G2, G3, plus in the future: Phenix, Celestins 1 and 2) plus two reprocessing plants (UP1 and APM). Combined with a comprehensive legacy waste retrieval program, the need for communication and public outreach on D&D issues logically emerged. It especially called for a technical solution to reach out to various audiences and explain the main challenges, questions and solutions.

When speaking about the nuclear industry in France, a country that has chosen to produce up to 78% of its electricity from nuclear fission, one can hardly imagine finding citizens aware of objectives and techniques involved in D&D programs. As a matter of fact, these activities can be considered most of the time as almost totally unknown. In 2011, an analysis of existing visits within the Marcoule facilities led to a very simple conclusion: trying to give the audience the opportunity to see "real" D&D operations did not allow visitors the chance to effectively discover them, due to safety and radioprotection rules. In fact, visitors are rarely admitted in buildings, laboratories, and other places where radioprotection and personal security concerns may be logically synonymous with strict and rigorous dressing procedures or the use of specific individual protection equipment. Moreover, most of these technical operations are often

conducted behind thick and blind concrete walls making them simply unadaptable for visits.

Finding a solution that could make the whole D&D topic available to the public soon became a necessity for three main reasons. First, CEA's D&D programs can largely be considered as funded by taxpayers. These programs represent significant amounts of money in the mind of citizens, especially in an economic recession period. The UP1 reprocessing plant for instance, represents an overall D&D budget of more than 5 billion euros, and that for the PHENIX reactor up to 0.9 billion euros (representing only two of the most emblematic D&D program activities at Marcoule).

Another reason for CEA to enhance its communication effort is linked to the management of environmental impacts of D&D projects, and especially the waste issue. With challenges focused on both current and legacy wastes, D&D programs do need comprehensive explanations - not just guidelines - to be readily available to the public. Typology and volume of waste, conditioning techniques, long-term behavior, and research and development options are all topics that need to be addressed with citizens who are supposed to be also involved, in France, in public debate procedures, especially in the perspective of the future deep geological storage national repository.

Ultimately, the capacity to valorize innovation and technologies developed for or around D&D programs also represents an opportunity for nuclear operators like CEA. With two decades of feedback, CEA Marcoule and its industrial, academic and training partners can now pretend to go upmarket and join their efforts for standardization of methodology, techniques, etc. A reflection about the creation of an economic cluster project, namely the PVSI, was started at the initiative of CEA in 2012. Launched in 2014 as an associative structure, the PVSI now gathers both R&D and industry actors involved in major decommissioning projects in France. A Marcoule-based organization with a nationwide ambition, PVSI could certainly benefit from a visitors center, a place where interested members of the public, technical experts, and others could discover and understand the skills and expertise developed in and around this nuclear site, as well as the potential markets in D&D, estimated at up to 220 billion dollars worldwide in the next 20 years.

All these reasons led CEA to start the INFODEM project, to develop a place that would be fully dedicated to information on D&D issues, and that would become both an information center and also a showcase for innovation in this field.

In preparing the project, it was determined that three main audiences would be targeted by INFODEM. First, this information center could address needs of the general public seeking information about the conditions of nuclear dismantling in the framework of the national energy transition policy. It could help address common questions such as: Why to dismantle? How to achieve it in safe conditions and technical and economic optimization? Who are the actors? How to manage the waste? Second, INFODEM appeared to be of great interest for managers and politicians, such as members of Parliament, governmental representatives, civil servants, decision-makers, representatives of regulatory agencies, and international visitors in the framework of existing agreements

with the CEA. The third audience includes professionals, such as members of industrial associations and corporate groups, professional education and training staff (e.g., in higher education nuclear science courses and other specific topics, e.g., in the areas of decommissioning, environmental, safety, security, and other related disciplines).

## **THE TRANSFORMATION OF G1 AND CONSTRUCTION OF THE INFORMATION CENTER**

In March 2012, a project team was established within the communication team of CEA Marcoule, which included the G1 facility head of operations and D&D experts. The project guidelines were presented to the CEA Marcoule Direction and to the Nuclear Energy Directorate. After formal validation, a commercial bid was organized, opened to European Union subcontractors.

Three basic design proposals were selected and analyzed. The project proposed by DECORAL studio, Paris, turned out to be the most appropriate one. The project team selected the final design and formally started the elaboration of the contents of the exhibition, while the studio started its detailed design layout. A three-dimensional (3D) virtual mockup was created to help create the distribution of information, data and objects that would likely be emplaced in the future information center. The DECORAL project put the stress on the necessity to symbolize transparency and neutrality in the communication process as well as accuracy and technical soundness. The white color chosen for the design, the graphic measurement patterns on the walls, the curved shapes of some furniture elements, and the painted taxiway on the ground, all these elements brought the requested balance.

Located in the main hall of the former nuclear reactor, the INFODEM concept extended over 800 square meters (about 900 square yards), to host an informative tour that could address several major themes, including: CEA's D&D strategy, programs, skills, tools and methodologies and "everyday life" on decommissioning projects.

At that stage, an important step was to prepare the site for previously unscheduled transformation. Fortunately, the hall itself was no longer a controlled zone in terms of radiological controls, and people could already go in and out without any specific precaution. However, the ground had to be reshaped; electricity lines for the exhibition needed to be set; and walls needed some painting to give G1 its new life. These work activities lasted for 6 months, from spring to autumn 2012. Security and safety files were managed and submitted at the appropriate levels, with information provided to the national regulator.

Storytelling and text contents were written by CEA, with the help of various experts within the D&D projects. Multimedia materials (photos and film) were gathered from CEA's archives or had to be produced specifically for the INFODEM, with video and photographic shootings organized in 2013. A dozen facility mockups were ordered and assembled. Numerous objects or artifacts were prepared for the exhibition, from an inactive fuel rod dating back to the

1950s, to a concrete piece saved from the demolition of the SILOE experimental reactor in Grenoble.

The tour within the INFODEM consists of three successive zones. The first zone is dedicated to the challenges and strategy of D&D programs. It provides visitors with basic information such as vocabulary definitions (including cleaning-up, dismantling, and decommissioning) and a description of the national framework for nuclear operators, as well as the regulator's doctrine. It also explains budgets, funding, expenses, and project management organization within CEA.

The second zone is a discovery of the D&D projects themselves, in five different CEA centers: Grenoble, Fontenay-aux-Roses, Saclay, Cadarache and of course Marcoule. This sector is the one where visitors can discover the majority of the mockups: reactors, reprocessing plants, and interim storage facilities.

The third and last zone of the visit explains everyday life on D&D projects. It shows how humans or robots can perform these operations, depending on selected scenes. Safety and radioprotection requirements are detailed, as well as dressing and security protection equipment. The methodology of the projects is pedagogically explained, and innovation and R&D production is detailed through examples, such as a gamma camera for radiological characterization, and a flotation foam sample for decontamination. After a specific area that provides a focus on waste management issues (e.g., dummy waste package concepts and new interim storage facility mockups), the visit ends spectacularly with a 3D immersive room inside which visitors are plunged to experience a full scenery of a robotics-based D&D project.

At the end of their tour, visitors have a locker room space that allows them to wear the safety equipment needed to explore real facilities, if scheduled by CEA.

The INFODEM visit requires from 30 to 60 minutes or more, depending on the type of visitor and information needs. The tour is guided and conducted by CEA teams: either D&D experts or communications and public relations (PR) specialists. Requests and registrations for tours are processed via a website ([www.infodem-marcoule.fr](http://www.infodem-marcoule.fr)) that offers only an introductory (interest-teasing) experience, as the full contents of the center are not unveiled until visitors arrive at Marcoule. Example of the views that can be experienced at INFODEM are illustrated in Figures 1 through 6.

After a smooth pre-opening period in early 2014, the INFODEM was officially inaugurated on September 19, 2014, by Dr. Bernard BIGOT, General Administrator of CEA, with two hundred visitors present. Attendees included MPs and local politicians, and members of the media and D&D companies. The media covered the event and "Midi Libre" regional newspaper wrote that "such a communication gem would definitely help in launching the French Dismantling team" [3] while specialized newsletters like "EnergyMed" [4] especially put the stress on the technological contents made available in that unique place.

The center began operating in spring 2015, and in late June of that year, the INFODEM project was awarded the Public Information Prize by the French Nuclear Energy Society, notably pointing out the uniqueness and interest of this place.



Fig. 1. View of the G1 Reactor Building.



Fig. 2. View of INFODEM Welcome Zone.



Fig. 3. View of the Marcoule D&D Projects Presentation Zone.



Fig. 4. View of a D&D Operation Scene.



Fig. 5. View of the PHENIX Fast Neutron Reactor D&D Project Booth.



Fig. 6. View of a Dismantling Robot Mockup.



## CONCLUSIONS

Repurposing a former nuclear reactor to create an information center provides a unique way to create valuable educational experiences for different types of audiences interested in learning about D&D activities. The INFODEM center that opened in 2014 has made it possible for members of the general public, agencies and politicians, and technical professionals to learn about the history of the first industrial-scale nuclear reactor in France and better understand dismantling technologies through guided tours, displays, and first-hand experiences. The INFODEM project serves as a valuable model for other former nuclear facilities that have been decommissioned sufficiently to serve as a potential educational resource that preserves historic information and provides engagement opportunities for multiple audiences.

## REFERENCES

- [1] SFEN AWARDS, Ceremony at « Cité des Sciences et de l'Industrie », Paris, France (June 24, 2015).
- [2] D. MAZZUCCHETTI, "From Divergence to Convergence: Marcoule, the First 50 years," CEA-COGEMA & Romain Pagès Editions, Sommières, France (2005).
- [3] H. AMIREAU, "Démantèlement, la filière se met en orbite à G1", Midi Libre (September 21, 2014).
- [4] ENERGYMED, the Energy Newsletter, "CEA's INFODEM opening" (September 29, 2014).