

LEFCA RENOVATION PROJECT: INNOVATION IN RENOVATION

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ABSTRACT

Built in 1981, LEFCA is a licensed nuclear facility in which experimental actinides and plutonium-based fuels are elaborated in order to be physically and chemically characterised. It is also used to perform experimental irradiations and to condition exotic nuclear materials.

Following the safety assessment conducted by the French Nuclear Safety Authority (ASN) in December 2003, the CEA was asked to improve the facility's fire protection system, static containment and seismic resistance. This refurbishment work is being carried out while the laboratory remains operational (experimental activities, maintenance, etc.). This has generated a considerable amount of coactivity which needs to be taken into account as early as the design phase and planned in the facility's daily schedule.

A poster describes the following items:

Technical work completed in 2008:

- Fire protection through the replacement of windows and doors,
- Containment improvement through the replacement of windows and doors.

Seismic strengthening work completed in 2009:

- External LEFCA structures: classic process using reinforced concrete
- Internal LEFCA structures: an **innovative process using carbon fibre fabric to minimise coactivity in the nuclear environment**
- Replacement of the heavy concrete stack by lighter metal stack
- Removal of polystyrene between concrete blocks.

1. Introduction

The LEFCA facility (advanced fuel design and fabrication laboratory) was commissioned in 1984 and underwent a safety reassessment a few years ago which was validated by a standing group in December 2003. This group gave the go-ahead to pursue operations without a limit on the facility's lifespan, provided that a refurbishment programme was launched. This programme focuses on strengthening equipment and certain engineered structures to resist a safe shutdown earthquake, as well as on managing the risk of subsoil liquefaction in the event of an earthquake and on improving fire compartmentation and post-seismic containment.

This article first describes the renovation work that has already been completed. It then highlights the value of using innovative materials such as carbon fibre fabric (TFC[®]) by FREYSSINET (cf. [1]) to strengthen part of the engineered structures against earthquakes. The article concludes by describing various other operations programmed for 2010 and designed to strengthen engineered structures, particularly through the use of standard reinforced concrete materials.

2. Work achieved

Work required to strengthen equipment and structures so as to resist a safe shutdown earthquake (SSE) has been carried out, as has work to improve the fire compartmentation and post-seismic containment of the facility.

2.1 Work-related constraints

Carrying out strengthening work in a licensed nuclear facility *in service* puts high constraints on operation, particularly when it comes to moving equipment and monitoring safety levels (radiation protection, fire, etc.). Furthermore, areas where the strengthening work is being performed become temporarily unavailable. These coactivity issues are carefully planned and reassessed on a daily basis.

2.2 Seismic strengthening of equipment

One of the main safety objectives of the renovation work is to guarantee the containment of radioactive materials in the event of an earthquake. Under post-seismic conditions, containment is ensured by a series of static barriers, particularly those represented by the equipment (material storage racks and glove boxes) seeing that the ventilation system is automatically cut off and no longer operational during this time.

Maintaining equipment containment under post-seismic conditions means that the equipment must retain both its integrity and stability. This requirement has led to implementing the following measures:

- Strengthening the glove box structural framework,
- Anchoring the base of glove boxes to the floor,
- Reinforcing the containment box and its support structure,
- Anchoring components representing a potential missile threat to glove box glass panels in the event of an earthquake.



Fig 1 : Anchoring the glove base to the floor and interlocking its framework with the containment box



Fig 2 : Anchoring an electrical cabinet that represents a potential missile threat to a glove box

2.3 Improvement of fire compartmentation

Fire compartmentation of the facility has been guaranteed since its construction by the masonry, fire dampers and fire doors in each of the cells containing radioactive material. These measures are no longer sufficient in light of the current regulations. The renovation programme therefore mainly involves replacing the fire doors in all 13 cells and the waste drum storage room with 2-hour rated fire doors. A total of 27 fire doors were installed. It was

also necessary to install 2-hour rated fire glass panels in place of all cell glass panels not qualified to resist fire (12 panels).

Furthermore, all doors within the limits of the containment compartment next to the fire zone had to be upgraded to improve their leaktightness (16 doors).



Fig 3 : Cell doors and glass panels were replaced with fire doors and panels to prevent any loss of leaktightness

Another series of glass panels and doors were also installed to ensure additional containment of the LEFCA facility in the event of an earthquake.



Fig 4: Installation of glass panels on the south façade of the building to prevent any gaping holes in the case of an earthquake

3. An innovative approach for the CEA: using a new material for seismic strengthening

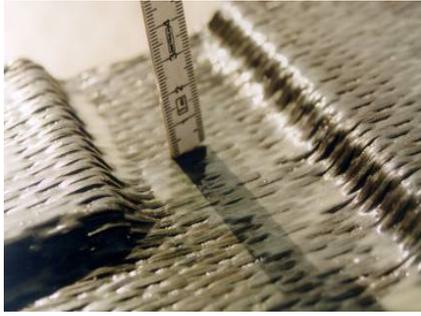
3.1 Background

Carbon fibre fabric (TFC[®]) was developed by FREYSSINET and is used by the CEA to strengthen the facility's seismic resistance in complex environments e.g. difficult areas to access, systems, presence of components important for safety, radiological conditions, etc. It can be installed under better conditions in terms of safety, deadlines and costs compared with standard processes such as reinforced concrete. These are the main reasons behind choosing this carbon fibre fabric solution for the LEFCA renovation project, which must guarantee the stability of the building in a safe shutdown earthquake.

The CEA submitted its first reports to the French Nuclear Safety Authority (ASN) in 2002. However, it was only in 2007 that ASN gave the green light to employ this innovative material for all cases cited in the project, i.e. strengthening of walls, vertical supporting structures and floors.

3.2 Description of material

TFC[®] is a composite material comprising a carbon fibre matrix with a synthetic binder. The bidirectional carbon fibre matrix has 70% of its fibres running in one direction (warp) and 30% running in the other (weft). The synthetic binder is a dual-component epoxy resin which is used to bind the carbon fibres and adhere to the supporting material after hardening.



Carbon fibre matrix



TFC® in place

The TFC® process stems from the bonded steel sheet technique and has helped to improve a number of characteristics:

- Improved resistance: a 0.48 mm layer of TFC® is equivalent to a 3 mm layer of steel,
- Lighter weight: 500 g of TFC® is equivalent to 25 kg of steel,
- Improved process durability since there are no constraints in terms of corrosion, thermal cycles, UV, etc.,
- Additional and improved installation possibilities thanks to fabric flexibility.

TFC® strengthening is suited to all types of loads (bending moments, shearing forces, seismic loads, etc.), geometries (floors, walls or beams) and materials (masonry, reinforced concrete, pre-stressed concrete and steel). Its ease-of-installation makes TFC® a very interesting solution for buildings and structures in service.

3.3 Initial installation of carbon fibre fabric

NUVIA TRAVAUX SPECIAUX (cf. [2]) – a subsidiary of FREYSSINET – was put in charge of design and installation which started in December 2008, with the **first sheet of TFC® installed on 14 May 2009**. The LEFCA facility is therefore the first CEA licensed nuclear facility to employ this innovative strengthening material in a nuclear environment. TFC® will continue to be installed throughout the facility up until December 2009. The pioneering use of this material therefore confirms the future possibility of using it in other licensed nuclear facilities, especially in those requiring refurbishment.

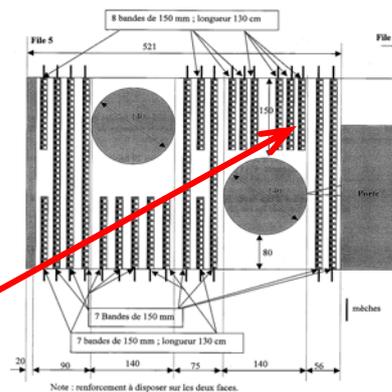


Fig 4, 5 & 6 : Work completed and working drawings for TFC® Strengthening of structures

4. Studies underway, operations programmed for 2010 and conclusion

Other engineered structures will also be strengthened in 2010 using standard processes (repairs to reinforcing steel and reinforced concrete). A number of walls and floors will be strengthened and additional edge reinforcement will be provided on the ground floor in part of the building. However, one of the most impressive operations will involve cutting up and replacing the current stack which weighs about 50 tonnes and is about 10 metres high. It will be replaced by a lighter metal stack.



Fig 8 : Current LEFCA stack

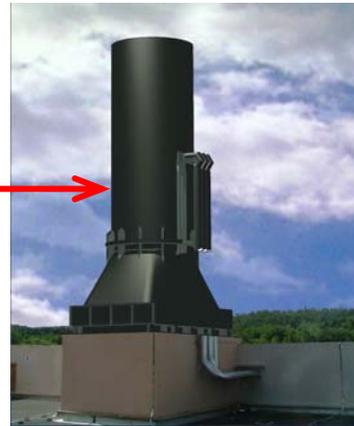


Fig 9 : 3D image of the future stack

To prevent any interaction between the different blocks composing the LEFCA facility in the event of an earthquake, the polystyrene installed between these blocks at the time of construction will be removed. Approximately 1,000 m² of polystyrene installed between level 0 and the building roof will be removed. The polystyrene is installed over a height of 4.5 m and lengths of 60 m for two rows of blocks and 40 m each for the remaining two rows. Figure 8 below shows the blocks composing the building which require polystyrene removal.

The pioneering use of TFC in LEFCA confirms the future possibility of using it in other licensed nuclear facilities, especially in those requiring refurbishment.

5. References

[1] FREYSSINET : 1 bis Rue du Petit Clamart 78148 VELIZY – France

[2] NUVIA TRAVAUX SPECIAUX : 85, Avenue Archimède – 13857 AIX-EN-PROVENCE CEDE3 - FRANCE

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