

Refurbishment of the LECI

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Abstract

The LECI is a hot laboratory built in Saclay in the early sixties for examinations on fuel rods, with 25 hot cells. Around 1995, a refurbishment programme up to 2004 was decided and started. It includes the renovation of about half of the cells of the existing building and the construction of a new building with about twenty lead-shielded hot cells for mechanical testing. At mid 2001, this paper presents the status of the project and the perspectives for the next years.

These modifications aims:

- ◆ To increase sample preparation and examination capacities on nuclear metals: mainly zirconium, steel and aluminium alloys,
- ◆ To keep existing P.I.E. facilities on short P.W.R. fuel rod as support for ramp testing programmes in the nearby Osiris reactor and as support for new cladding development programmes,
- ◆ To gather in LECI mechanical testing facilities which are up to now located in another facility to be shut down at the end of 2003.

Concerning the existing building, most of the planned refurbishment has been performed and 10 cells have been cleaned and 8 of them will be reequipped at the end of 2001: a metallography line with new microscope, hardness testing, periscopes, TEM thin foil and EPMA preparation, two cells for tooling mechanical samples (milling machine, lathe, spark erosion), one cell for clad creep testing on long term storage conditions and a cell with a 250 kN tensile machine.

The new building is built, the lead cells will be installed in 2002 and most of the scientific equipments have been ordered. They include : wire erosion machining, 3 tensile machines with extensometry, 2 Charpy, different creep and internal pressure machines, autoclaves, EPMA and Raman analyses. The schedule is to open this building to irradiated materials (no fuel except on EPMA) at the end of 2003.

Some difficulties such as the public enquiries have been successfully overcome, some financial constraints have delayed the project of about one year, and technical difficulties have slightly modified the scientific equipments, but on the whole the objectives have been completed up to now.

In the next years, the challenge will be to successfully achieve in time the completion of the new building including a completely renewed set of safety reports, to refurbish a few other hot cells in the old building to comply with

always more stringent safety requirements, altogether with going on with the examinations for our customers.

Keywords: Hot laboratory, hot cell, refurbishment, post irradiation examination

1. Introduction

The LECI (French acronym for laboratory for irradiated fuel study) is a hot laboratory built in Saclay in the early sixties for examinations on fuel rods. It includes a main line of 11 concrete-shielded cells + 2 for metallographic examinations, a line of 9 lead shielded cells and 2 separate cells for SEM and XRD.

Mechanical testing on metallic samples is performed in another building (called LHA), also built some decades ago a few hundreds of meters away, and including several lead-shielded hot cells.

In the early nineties, some strategic decisions were taken: most of fuel examinations should be performed in Cadarache, at the LECA-STAR facility, whereas Saclay should concentrate on material studies, although some examinations on ramp tested fuel are still conducted in LECI.

Around 1995 [1], a refurbishment programme up to 2004 was decided and started. It includes the renovation of about half of the cells of the existing building and the construction of a new building with about twenty lead-shielded hot cells for mechanical testing. At mid 2001, this paper presents the status of the project and the perspectives for the next years.

These modifications aims:

- ◆ To increase sample preparation and examination capacities on nuclear metals: mainly zirconium, steel and aluminium alloys,
- ◆ To keep existing P.I.E. facilities on short P.W.R. fuel rod as support for ramp testing programmes in the nearby Osiris reactor and as support for new cladding development programmes,
- ◆ To gather in LECI mechanical testing facilities which are up to now located in the other facility to be shut down at the end of 2003.

2. Refurbishment of the main building

Concerning the existing building, most of the planned refurbishment has been performed: 10 cells have been cleaned and 8 of them will be reequipped at the end of 2001. Figure 1 shows the present status of the main building. The last refurbished cell before the present programme, around 1991, was K2, with a non destructive bench for LWR fuel, and puncturing equipment [2]. The refurbishment programme includes eleven cells (K1, K4, K6, K7, K8, I3 and I5 to I9), altogether with some improvements in the non nuclear part of the building. Usually, refurbishment starts with cleaning and decontamination of the cell. It includes changing the window, because most of the old windows were made of glass panels separated by oil, and oil is not appreciated by safety authorities in case of fire hazard, so new windows are without oil. Then new equipment is implemented in the cell.

2.1. Autoclaves (K1)

The K1 cell will be devoted to corrosion studies on metallic samples. It will include 3 autoclaves of 3 litres with water loop. One of the them will be equipped with a slow tensile system. Each autoclave will be able to work either in dynamic mode or in static mode. Electrochemical measurements will be possible. Nominal conditions will range from 360°C to 415°C and from 103 to 202 bars, depending of the type of corrosion test: with or without stress, in steam and / or water. A chemical treatment of the water will be

performed to create PWR conditions, with $0 < [B] < 2500$ ppm, $0 < [Li] < 5$ ppm and $0 < [H_2] < 50$ cm³/kg. Programmes will include PWR cladding and internal structure studies. Our planning of refurbishment leads to a commissioning of this cell at the end of 2002.

2.2. Mechanical sample preparation (K4, K7)

In order to provide samples to the mechanical testing part of the laboratory, two cells have been equipped with several machining equipments [3] :

- ◆ K4 includes a large metallic Kasto saw, a universal numeric drive milling machine (Figure 2), a numeric drive turning lathe and an engraving equipment.
- ◆ K7 is equipped with a large spark erosion machine, completely modified by the staff of the laboratory in order to operate under demineralised water instead of kerosene (Figure 3).

Both of these cells are in operation, as shown below:

2.3. Long term storage studies (K6)

To answer the needs of long term storage studies, initiated in 1991 by the French law on nuclear waste research, it was necessary to install long term creep facilities to test pressurized irradiated claddings. These include 5 ovens, under controlled atmosphere and carefully monitored temperature, where pressurized irradiated cladding tubes can be treated during several months or even a year. The preparation of the tubes will be performed first by end plug TIG welding in the K9 cell, then pressurised up to 200 bars in a special bell to be installed in this K6 cell. At the moment, both equipments: ovens and pressurization bell (Figure 4) are ready outside the cell, the safety report has been issued, and final commissioning is announced for the end of 2001.

2.4. 250 kN tensile machine (K8)

The cell has been cleaned, the window is new, and a 250 kN tensile machine has been ordered. Its delivery is due for next month. It is a static tensile machine with a displacement speed ranging from 1×10^{-3} to 100 mm/s, within a temperature range from -150°C to 1000°C. Final commissioning is now foreseen for September 2002.

2.5. Fuel cutting (I3)

One of the most stringent requirements from safety authorities was to improve our fuel cutting process, to avoid fuel contamination. So we moved from an old cell (K10) to a refurbished one (I3) including new window, booting on master slave manipulators, and we used Plexiglas boxes connected to a vacuum cleaner to avoid fuel contamination in the cell. This cell was equipped with a cutting machine and a combined lathe/milling machine.

2.6. Metallography zone (I5 to I9)

This was the most important feature in the refurbishment of the old building: five lead cells have been cleaned and four of them have been reequipped, with two periscopes, a new microscope including micro hardness capabilities (Figure 5), polishing and grinding equipment, a hardness machine, and preparation equipments for the EPMA and TEM. All this is detailed in another presentation during this meeting [4].

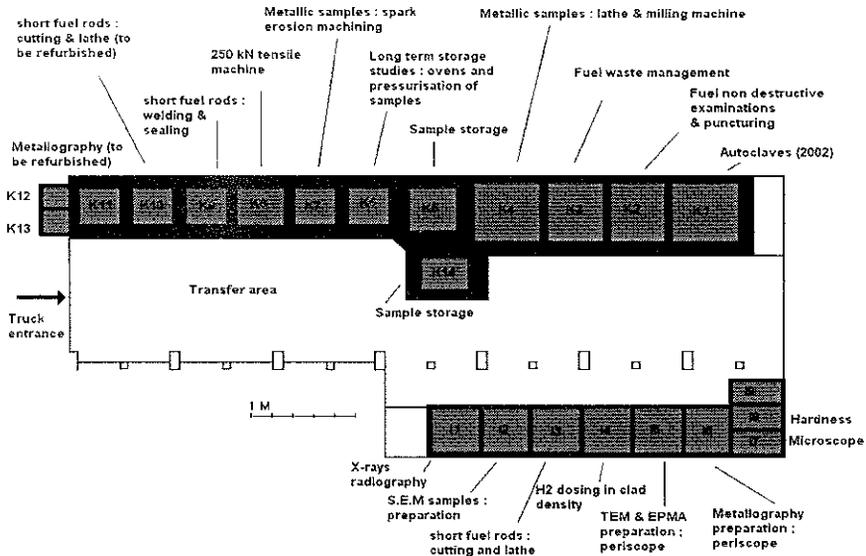


Figure 1 Present status of the two lines of hot cell in the LECI main building

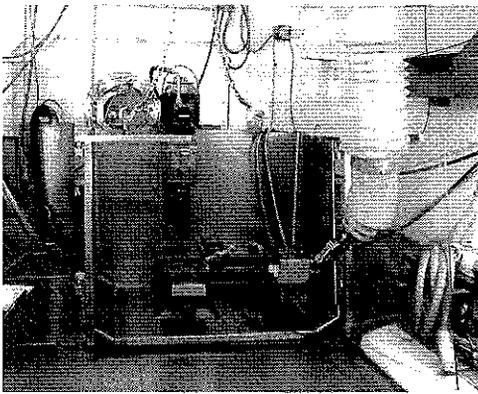


Figure 2 Milling machine in cell K4

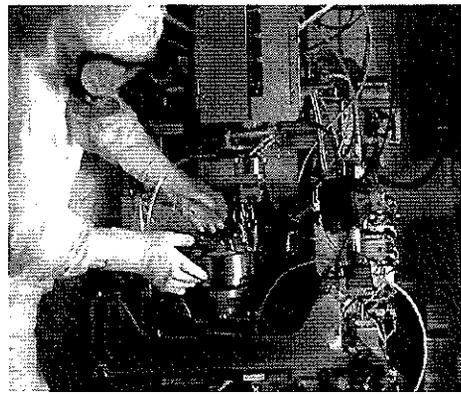


Figure 3 Spark erosion machine in cell K7 (right)

2.7. Non nuclear part of the building

Some emphasis was also done to improve the non nuclear part of the building, with creating or painting new offices, painting several halls and transfer area. In the north part of the building an area for conventional metallography (S.E.M., T.E.M., autoclaves) is nearly ready.

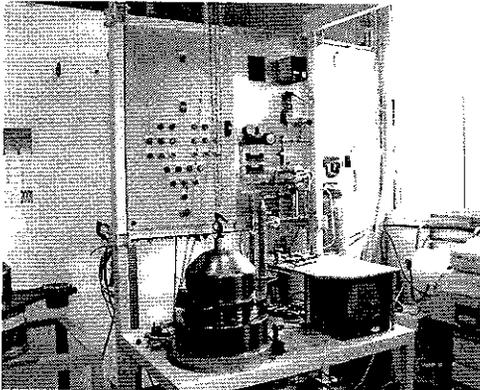


Figure 4 Pressurisation bell for long term storage creep tests (out of cell)

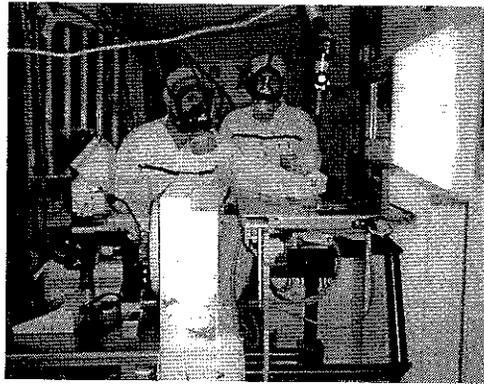


Figure 5 New microscope (during introduction inside the cell).

3. New building for mechanical testing

The new building is now ready (Figures 6 and 7) and waiting for its cells and its scientific tools : its general shape (see Figure 8) is similar to the older one, with two lines of cells around a transfer area, and two working lines. The lead cells will be installed in 2002 and most of the scientific equipments have been ordered. The schedule is to open this building to irradiated materials (no fuel except on EPMA) at the end of 2003.

3.1. Bases for the design of the cells

It was decided to separate protection and confinement functions :

- ◆ biological shielding is ensured through lead walls ranging from 15 cm for surface analysis

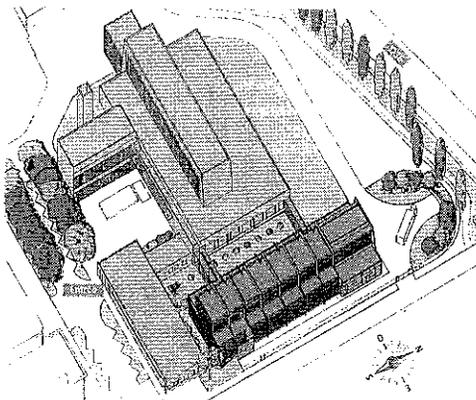


Figure 6 New building in blue

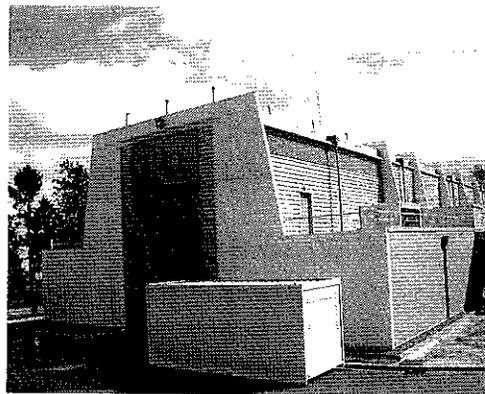


Figure 7 New building as realised on September 2001

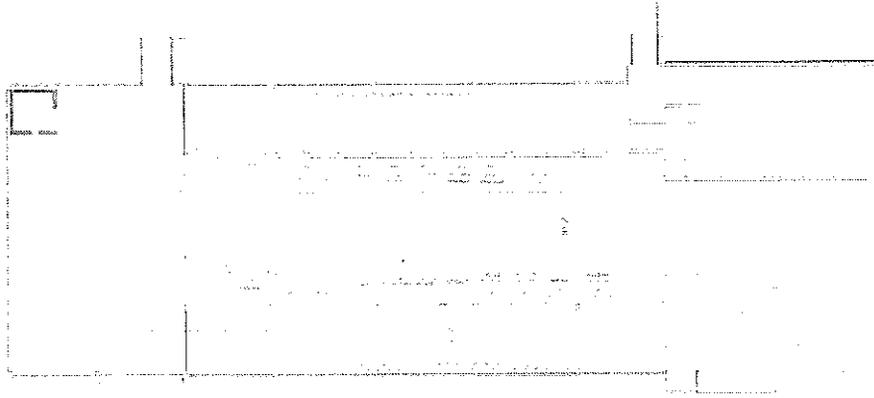


Figure 8 Scheme of the new building equipments

cells, to 23 cm for standard mechanical test cells, and to 26 cm for storage cell.

- ◆ Confinement is performed through a stainless steel box (class 4 level) inside the cell.

Standardisation was the rule as far as possible. Two types of casks were defined with regularly distributed hatches on the back side of the cell rows; another cask is defined for waste disposal through the top of the cells. When designing a new equipment in a cell, a 3D simulation is performed to check its implementation.

3.2. Scientific equipments in the new building

They can be divided according to their purpose.

- ◆ Sample preparation:

Cell M06	Spark erosion machining	For small samples
Cell M07	Tooling, oxide removing, mechanical preparation	

This is completed by the K4 & K7 cells in the old building.

- ◆ Mechanical testing :

Cell M05	50 kN static tensile machine with extensometer	2×10^{-4} to 500 mm/s -170°C to 1000°C
Cell M09	100 kN static tensile machine with extensometer (toughness)	1×10^{-3} to 100 mm/s -150°C to 1000°C
Cell M04	25 kN dynamic tensile machine with extensometer	15×10^{-6} to 500 mm/s 20°C to 1000°C
Cell M10	50 Joule impact Charpy	-180°C to 650°C
Cell M10	450 Joule impact Charpy	-180°C to 650°C
Cell M20	Axial creep test with extensometers	50 kN ; 60°C to 1000°C
Cell M23	Internal pressure creep test with extensometers	1000 bars ; 60°C to 1000°C
Cell M19	Creep under iodine atmosphere (SCC), with extensometer	1000 bars ; 100°C to 500°C
Cell M21	Fatigue & burst (oil internal pressure), with extensometers	50 kN, 2000 bars ; 0.001 to 1 m/min 80°C to 500°C
Cell M03	Small specimen static tensile test	1 kN, 20 to 500°C

This is completed by the 250 kN tensile machine in the old building.

♦ Surface analysis :

Cells M14, M15, room 22A	EPMA	Equipment transferred from LHA
Cell M16	Raman spectroscopy	With in- and out- of cell capabilities
Glove box room 26	TEM thin foil preparation	Final step for preparing samples

♦ Miscellaneous :

Cell M02	Metrology of samples	
Cell M08	Storage cell for metallic samples	With dose rate measurement
Cell M17	Thermoelectric power measurement	

3.3. Safety reports

In the first part of the project, after writing preliminary safety report in March 1997 (analysed in January 1998), the main administrative difficulty was to go through a public enquiry to obtain a building licence for the extension of our facility. This was obtained on February 1999. The decree for modification of the facility was published in May 2000. Now we are working on the final text for the decree of liquid and gaseous releases. The main following step is a complete rewriting of the safety report for the facility, including the provisory safety report for the new building.

4. Next steps of refurbishment in the main building

At the end of 2002, the first part of the refurbishment programme concerning the old building will be coming to an end with K1 (autoclaves) and K8 (250 kN tensile machine). So it was necessary to propose to the safety authorities a schedule to continue refurbishing. A decision was taken in April 2001 to start a second part of refurbishment (2002-2005) including the second metallography zone including K11 to K13 cells, together with cell K10 which will be devoted to high activity waste management.

5. Conclusion

Some difficulties such as the public enquiries have been successfully overcome, some financial constraints have delayed the project of about one year, and technical difficulties have slightly modified the scientific equipments, but on the whole the objectives have been completed up to now. In the next years, the challenge will be to successfully achieve on time the completion of the new building including a completely renewed set of safety reports, to refurbish a few other hot cells in the old building to comply with always more stringent safety requirements, altogether with going on with the examinations for our customers.

6. Bibliography

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