DISMANTLING AND REPLACEMENT OF A LIFTING UNIT IN A HOT CELL

Nuclear power plant of Phénix stopped in 2009
The Lifting Unit for Cell 50kN (LU50) of irradiated fuel elements at Phénix, a French nuclear power plant, broke down in 2009 after 40 years of service.

The PHENIX hot cell allows the reconditioning of fuel elements. This cell is the main piece of equipment for dismantling the PHENIX power plant. Nearly all means of remote operations in this cell were lost. This LU50 failure leads to block the evacuation of fuel elements.

The Commissariat à l’Energie Atomique (CEA) operates PHENIX.

This operation was conducted by the CEA (PHENIX and Decommissioning Department), with the project management being carried out by AREVA R&S. The manufacturer is REEL company.
SCHEME OF THE CELL

- Transfer to an other cell
- Transfer to washing wells
- Output of fuel elements

LU50
The LU50 was installed at the end of the erection of the cell without providing possibilities for removal or remote intervention. It is linked to the rails of translation by two rack gears engaged under the rails and also linked to the cell by the wiring of power supply.

Problems:

- Human intervention inside the cell is impossible because of ambient radiation, despite the evacuation of the main radiation sources,
- The crane frame is inter-dependent on the rails of translation,
- There are no remote tools to repair LU50.
LIFTING UNIT OF THE CELL 50 kN

Rack gears engaged under the rails without possible removal
Adopted strategy: Replacement rather than repair

✔ Considerable risk of failure of other elements in the lifting unit,

✔ Intensive use of LU50 in the future,

✔ Improvement of operational maintenance, reliability and nuclear safety.
Preparation studies of the intervention have selected the following principles:

- Development of a new concept of LU50 to allow maintenance and subsequent dismantling,
- Intervention by the roof of the cell through the slabs used in the first implementation of the LU50,
- Establishment of an adapted working airlock with means for integrated remote handling devices for 30-ton slabs and tools,
- Development of remote specialized tools for cutting gears of translation and the power supply cable chain,
- Development of a specific process for creating new penetrations sealed in the cell walls of 1.2 meter of concrete, maintaining containment and without any internal access.
For easy maintenance and subsequent dismantling:

- A crane frame driven in translation by two motorized pusher chains stored outside the cell with the possibility of manual recovery,
- Power supply by two wires on the pusher chains stored in drums outside,
- A trolley running on the crane frame, extractable, and with two winding drums of hoisting cables fully redundant,
- The establishment of two extractable power supply cable chains on the crane frame, these units making the electrical connection between the trolley (direction and vertical movements) and the cables from the outside,
- An emergency mechanical system from outside the cell to perform the direction movement.

Aim:

- Return to a safe situation for fuel elements,
- To be able to repair all crane elements in the event of failure.
MODELING OF LU50

- Crane frame
- Trolley
- Wall of the cell
- Pusher chain
  - Pusher chain penetration
  - Pusher chain storage
- Biological protection
- Inside the cell
- Winding drums of cables
DEVELOPMENT OF A NEW LIFTING UNIT DESIGN

- Winding drums of cables
- Pusher chain storage
TROLLEY MODELING

Two winding drums: East and West

Two drive motors: South and North

Two hoisting motors: East and West (hidden)

Two weight lifting converters: East and West
TROLLEY
INTERVENTION MEANS THROUGH THE ROOF OF THE CELL

The roof of the cell has had an access closed with concrete slabs 30 tons in place since 40 years.

- Establishment of an adapted working airlock,
- Development of a hydraulic gantry handling unit on rails inside the working airlock to:
  - Extract the slabs for opening
  - Maintain a slab raised to achieve biological protection (limiting waste)
  - Achieve a function of opening/closing and sealing between each intervention by lateral displacement,
  - Extract and put in equipment and specific tool with side brackets which are automatically positioned over the opening.

All operations were carried out from outside the working airlock with remote-controlled video camera because of the ambient radiation.
WORKING AIRLOCK

Top of the cell

Working airlock
2 mobile side brackets to:

- Introduce specialized tools,
- Lift out hold equipment,
- Introduce new equipment.

Hydraulic gantry inside the working airlock
HYDRAULIC GANTRY WITH A SLAB

Opening of the cell, concrete slab moving
Specific tools were developed for the cutting of gears of translation and power supply cable chain:

- Development of a reciprocating saw (1) mounted on a motorized bridge to cut the gears,
- Development of a specific tool (2) to attach the cable chain to the cell.
DEVELOPING REMOTE SPECIALIZED TOOLS

- Development of a shear-type (3) “auto extrication” used by firefighters to cut the cable chain. This cutter was mounted on an adjustable arm connected to the mobile side brackets,

- Development of a lifting beam (4) for the old and the new lifting unit.
DEVELOPING REMOTE SPECIALIZED TOOLS

Extraction of the old LU50 from the cell
Development of a Specific Process for creating new Sealed penetrations

The implementation of pusher chains and emergency mechanical system required the development of penetrations in the cell walls of concrete 1,2 meter maintaining containment.

The developed method is based on the following principles:

- Drilling of concrete to the steel undercoat sealing cell,
- Trepanning the steel undercoat,
- Implementation of a steel sleeve with a system of locking pins which secures the expandable sleeve with steel undercoat (innovative system),
- Injecting of expandable seal and sealing with concrete.

All interventions were carried out from outside the cell.
NEW SEALED PENETRATIONS

Concrete drilling

Steel undercoat trepanning

Mechanical guide for drilling
NEW SEALED PENETRATIONS

Mechanical penetration

Expansion system
The procedure of replacing LU50 was carried out between March 2011 and March 2012. The new LU50 was set up in January, followed by commissioning.

The investment cost of the operation is more than €10M ($12,5M).

THANK YOU FOR YOUR ATTENTION