RESUMPTION OF OPERATION OF THE PHENIX HOT CELLS: THE SAWING LINE REFURBISHMENT

JL. PAUL, C. PUGNERE, P. BRUGUIER, M. MASSON

Alternative Energies and Atomic Energy Commission (CEA),
Marcoule Nuclear Installations Operation Department, Phenix Nuclear Power Plant
BP 17171 – 30207 Bagnols-sur-Cèze Cedex – France
1973/1981 - 1 cell (Irradiated Elements Cell, IEC) for 3 main activities:
- Sub-assembly/capsule dismantling,
- Post-Irradiated non destructive Examinations,
- Experimental Irradiation Capsule/Sub-assembly re-fabrication.

1981 - New Annexe Cell (AC) commissionning to host the mechanical treatment processes of the sub-assembly dismantling line:
- Sawing bench,
- Milling bench,
- Extraction bench.
Focus on the sawing bench

Two main observations after 35 years of original sawing bench operation:
  - A decrease of its reliability (i.e. safety issue),
  - An increase of the difficulties to perform an efficient corrective maintenance programme on the saws by hand.

Saws refurbishment decided at the beginning of 2008
1. Fuel sub-assembly dismantling process overview

2. Old sawing bench description and reliability issue

3. Sawing bench refurbishment requirements and new design

4. Hot Cell setting-up of the new sawing bench and first operation feedback
1. Sub-assembly transfer from the storage drum to the washing pit in the IEC

2. Washing operation

3. Na-free sub-assembly transfer to the AC
4 Sub-assembly handling from a vertical to an horizontal final position

5 Sub-assembly sawing

Cutting locations:
- Breeder fuel (1 pins bundle)
- Fissile fuel (2 pins bundles)

6 Hexagonal wrappper (fissile pins bundle) milling

7 Opening enlargement and pins extraction
8. Pins basket transfer to the conditionning workstation (IEC)

9. Pins conditionning in stainless steel sheath

10. Cap / sheath airtight welding

11. Sheath storage in the transport basket
Stock of 5 saws:

- 3 were always in the Annexe Cell
- 2 were being undergoing corrective maintenance in a low level activity workshop

Saw main features:

- Hydraulic power hacksaw based on a model commercially available in the 80’s,
- Remote handling and operating modifications made by the supplier, for example:
  - 2 V-shape cutouts on the baseplate for the positioning and the tightening on the bench
  - 1 pin force fitted at the rear and an hex-head screw in the front of the blade for its positioning and stretching
  - Handle compatible with the overhead crane hook
  - Capstan-head screw to adjust the cutting force
  - …
- Cutting resulting of 2 synchronised motions:
  ✓ Backward and forward motion of the blade (arm) driven by an electrical gear motor for tearing the material and removing the chips on the backward stroke
  ✓ Downward motion of the blade (arm) driven by a hydraulic pump.
- Dry cutting (no coolant) due to a criticality risk requirement.

Reliability issue:
- Inexorable obsolescence of the saws after 35 years of operation (c.a. 800 cuttings per saw) and despite the curative maintenance policy reinforced during the last decade
- Increase decontamination difficulties over time (higher quantities of sticky aggregates made of a mixture of grease and activated steel chips) leading to some replacement with spare parts available on the shelf but not commercially available anymore

Decision-making to refurbish the sawing bench in 2008
Specifications:

1. A higher reliability of the blade guidance (deflection of the cutting not tolerated because of the closeness of the pins),
2. A performance of more than 1000 cuttings to avoid a preventive and to limit a corrective maintenance programme,
3. A modular design compatible with the top and bottom openings to limit the decontamination operations to the broken part only,
4. The compatibility with the remote handling apparatus of the operational organs: valves, electrical and pneumatic connectors, blade, motors, …
5. The compatibility with the unchanged existing baseplate fixing system,
6. The necessary outline dimensions to put up two saws side by side for the fissile cutting configuration,
7. The consideration of several years of corrective maintenance feedback,
8. The use of a maximum standard spare parts available at retail,
9. The limitation of the hydraulic fluid quantity according to the criticality rules of the cell.
New design after 2 years of development and inactive remote handling validation tests:

- Similar to the first-generation but taller (consequence of specifications n° 3 and 6)
- Same hydraulic unit.
Main challenge being taken up is related to:

- The technical solution to keep an absolute control of the blade during the cutting operation based on this analysis:
  ✓ The misalignment of the blade increases when its penetration into the material is progressing,
  ✓ The cutting forces highly stress the two linear guidance systems (backward and forward, downward motions)
- The hot cell environment constraints: no lubrication, no radiation-sensitive materials.
Technical solutions:

- The improvement of the blade linear guidance stiffness results of:
  ✓ A well design dimensioning of the bearing structure (base frame, vice and arm guidance columns, and top flange plate)
  ✓ The use of special steel grades with high elastic and mechanical resistance properties (for ex. arm: 40CMD8) for the parts exposed to a high mechanical stress,
  ✓ Parts perfectly fitted (i.e. less than few hundredth millimeter plays).

- The « traditional » lubrication is replaced by:
  ✓ A dry lubrication with carbide inserts bronze plates screwed on the rubbing surface areas
  ✓ Ball-bearings equipped the moving parts of the guidance axes particularly exposed to high bending stresses
New design of the sawing bench:
New saws setting-up in the Annexe Cell:

- Evacuation of the old highly contaminated saws in a waste container
- Last inactive functionning tests of each saw
- Saws handling into the cell
- Final commissioning tests (i.e. qualification hot tests)

Ready for start-up on Dec. 20, 2013 (experimental capsule holder dismantling)

Positive feedback but some unexpected events occurred:

- The cutting time was higher than expected according to the reference cutting times recorded during the endurance tests,
- The arm of one of the three saws jammed during the cutting.

Improvements need to be made and additional operating tools need to be designed
Thank you for your attention!