Operating feedback gained during development of benches for use in hot cells.

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Based at Cadarache Center (France), the LECA-STAR Facility has been carrying out for many years high-quality programs on fuel in hot cells in various technical fields:

- R & D on irradiated fuel: metallography, annealing tests, micro / nanoscale examination,
- Manufacturing of experimental rods,
- Spent fuels processing and packaging (conditioning, chemical stabilization, ...),

To design and build all the necessary equipment for these activities, the LECA-STAR has chosen an organization to centralize the skills necessary for the development and realization of equipment usable in hot cells,

These skills are gathered within the LECA-STAR Engineering Laboratory.
The laboratory’s project managers are in charge of test bench development, managing the process of development from the statement of requirement to acceptance of the equipment.

The laboratory therefore offers a wide range of cross-functional competencies to meet the typical technical requirements of the projects it handles:

- project management,
- Mechanical design (CAD),
- Electrical and I&C system design,
- seismic, thermal and fluid calculations,
- Radiation protection calculations,…
Although all equipment developed at the laboratory are different, the LECA-STAR facility has implemented a “standard” organisational structure which allows projects to be managed in such a way as to limit the risks involved.

A project involves two main parties: the applicant (end-user of the equipment) and the project manager.

This organization allows to gather complementary skills: scientific and using experience for the applicant, project management and technical skills for the project manager. This organization will be kept until the operating of the equipment.
General standard organization of a Project

LECA-STAR

 Responsibilities

Project Manager
- End user
- Supplier
- CAD Design
- I&C design
- Calculation

Safety/security

End-user

Operators

Supplier
- Detailed studies
- realization
- Factory tests
- Technic documentation

End-user

Operators

CAD Design

I&C design

Calculation

Responsibilities
Once the requirements are defined by the applicant, main parts of process of development are generally as follows:

• A first stage of preliminary studies, made by the project manager to insure feasibility of the equipment,
• This first stage is highly recommended. Feedback shows that specification made with purely functional requirement may lead to tenders with wide range of solutions and price and/or infeasibilities or significant degradation of desired performance during the project,
• This stage generally ends with a specification requirement for a tender process. This specification gathers requirement of functions, performances, safety, in cell operating and maintainability, …
• it is recommended that the specification remains functional, the preliminary study is given as an example and can be adapted/modified by the supplier (which may have good ideas too!),
At the end of detailed studies made by the supplier, it’s recommended to set a project review (stopping point) to make a examination of the performances before manufacturing.

Before entering the cell, a complete cold qualification is performed on a mock-up to guarantee remote operability and maintainability. Feedback shows that remote operability is improved at several stage: CAD studies, factory acceptance and cold qualification.

All these steps has to be followed carefully by the Project Manager, to limit the risk of mistakes or forgetting.
In order to standardize technical content that is common to different projects, the laboratory has set up a technical specification editing programme.

These specifications are designed to be applied to all projects handled by the laboratory.

It gathers the feedback of reliable solutions usable in hot cell/nuclear environment.
CAD drawings and design guidelines

describes the architecture for the CAD models to be followed.
- logistical hierarchy of the various components,
- numbering rules for files and CAD model assemblies,
- plant classification rules,
- masks and layers to use, etc.

This ensures that all CAD models are standardized and can be incorporated easily into an overall design for a particular cell for instance.

Mechanical manufacturing rules

Describe the manufacturing rules for mechanical equipment
- reference standards applicable to the steel supplies,
- welding requirements (operator and process qualification, welding inspection, permissible defects, etc.),
- dimensional check requirements,
- surface treatments and cleanliness grades to be applied.
Seismic design hypothesis and methodology applies to all seismic calculations for new equipment. It specifies:

- the acceptable calculation method(s) and the accepted software,
- the seismic spectrums to be taken into account,
- the applicable mechanical criteria according to safety requirement: stability, integrity, tightness, …
- the anchoring principles and the bolt design calculation methods,
- the mandatory information that must appear in the calculation document.
Radiation protection calculation guidelines

This specification applies to the radiation protection design calculations. It defines:

- the source term to be used for the LECA-STAR facility,
- the permissible calculation methods (deterministic or probabilistic),
- the dose rate criteria depending on whether the source is present constantly, whether there is a workstation, etc.
- the mandatory information that must appear in the calculation sheet,

Dose rate of a wall plug with leakage
Construction guidelines for biological shielding penetrations defines criteria for wall penetrations (fluid or electrical circuits). It defines:

- the different authorized electrical or fluid connectors or valve glands allowed,
- the penetration construction principles (drawings, dimensional tolerances, surface condition, coating, etc.),
- the biological protection filling criteria required prior to installation of the facility (weighing),
- the tests to be conducted after the penetration has been installed (tightness, biological shielding).

LECA electrical crossing
Guidelines for the use of electrical and fluid connectors in hot cells:

- **For electrical connectors**, LECA-STAR uses mainly SOURIAU or LEMO remote handling sockets,
- This specification also defines the in-cell socket identification, mounting and wiring principles.
- **For fluid connectors**, LECA-STAR uses STAUBLI remote handling sockets,
- The specification defines which connectors should be used according to their application in the cell (gas, pressure, vacuum, etc.) and the mounting principles.

Guidelines for seals and plastic materials useable in hot cells

- The specification gives the different types of polymer and their resistance to irradiation, chemical compounds and temperature, to be able to find the best solution for hot cell use.
Rods cutting machine (spent fuel)

- Designed to cut spent fuel rods, to be repackaged in waste disposal containers.
- Two high power shears driven by ball screws for cutting solid fuel rods easily,
- Automatic feed and clamping system,
- A collection system for the cut end pieces.
Recent realization

Fuel plate measuring bench

- Two main function: dimensional measurement of a fuel plate and spectrometry.
- Thickness measurement along the plate (profile) by using LVDT sensors, set face to face (0.01 mm accuracy).
- Fuel plate spectrometry gamma scanning through a dedicated penetration.
Micro sampling bench

- Bench designed to collect core samples from fuel pellets.
- Core diameters are between 1 mm and 4 mm.
- Motor rotation speed up to 50,000 rpm, with Ethanol cooling.
- Once collected, the core sample is placed carefully in a crucible to be taken away for analysis.
Fuel plate cutting bench

designed for cutting fuel plates to isolate and collect the fuel zones,

- The plate is cut using a 0.5 mm thick diamond cutting disc,

- fuel space detection system based on an eddy current probe,

- Automatic alignment of the cutting disc with the gap between the fuel plates, with 0.1 mm accuracy,
Thank you for your attention