

CONTINUATION OF CONSTRUCTION OF HOT CELL FACILIT IN CVR

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Abstract

Paper presents the continuation of construction of hot cell facility within the project SUSEN (Sustainable Energy) at CVR (Research centre Rez) [1]. The cells will be used for preparation and testing of irradiated structural materials. The project uses existing building converted for the purpose of placement of new hot cells. New design is used – heavy shielding with airtight steel box.

Paper is focus on constructional difficulties that come out from new layout of hot cells. Constructional solution of these difficulties will be discussed, namely airtight steel box, material transfer device, temporary sample storage and pre-chamber. All solution must be safe, functional and stable for long time, with low maintenance and all automatic manipulation replaceable with manual force.

The project SUSEN is fully funded by the European Union. Most components must be purchased on the basis of competitive tendering or competitive dialogue.

Introduction

The Sustainable Energy Project (SUSustainable ENergy, SUSEN) [2] is implemented as a regional R&D center in Priority Axis 2 and its objective is to act as a relevant research partner for cooperation within the sphere of application including the establishment of partnerships and cooperation with important European research centers.

Within this project a new complex of 10 hot cells and one semi-hot cell will be build. They are divided to 8 gamma hot cells and 2 alpha hot cells. The cells will be equipped with experimental devices for diagnostics and testing for admittance of radioactive samples entering the hot cells, technologies for a complex samples processing (cutting, welding machining) and set of equipment for carrying out mechanical tests (sample preparation area, stress testing machine, fatigue machine, etc.) as well as to study material microstructure (microhardness and nanohardness tester, SEM).

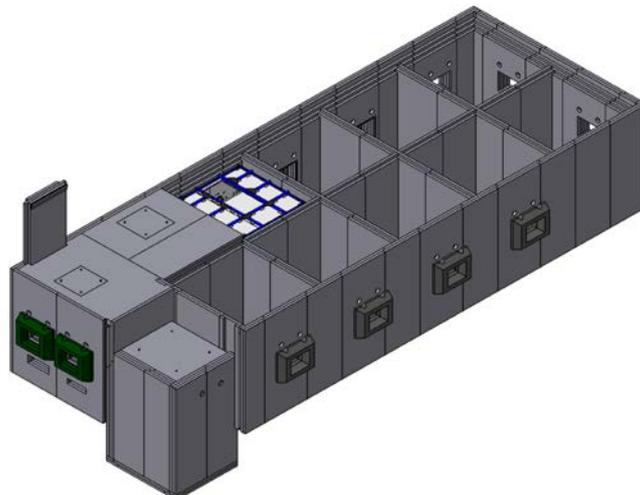


Fig. 1 Layout of the hot cells

Basic information

The main limitation for the design of the hot cells is the existing building. Limited space inside the building gives no other alternative than to build the hot cells in two lines (fig. 1) with their back together (fig.2). All shielding is made from a stainless steel, the outer wall shielding has thickness of 500 mm, internal wall between hot cells 300 mm with the possibility to make it wider up to 500 mm. The ceiling shielding has thickness of 400 mm and the floor shielding of hot cells is 300 mm wide. The detail design of the shielding has been decided by the supplier of the shielding. All block are made from steel plates (100 cm wide), every wall have 5 steps to prevent the gamma ray shots through the shielding (fig 3).

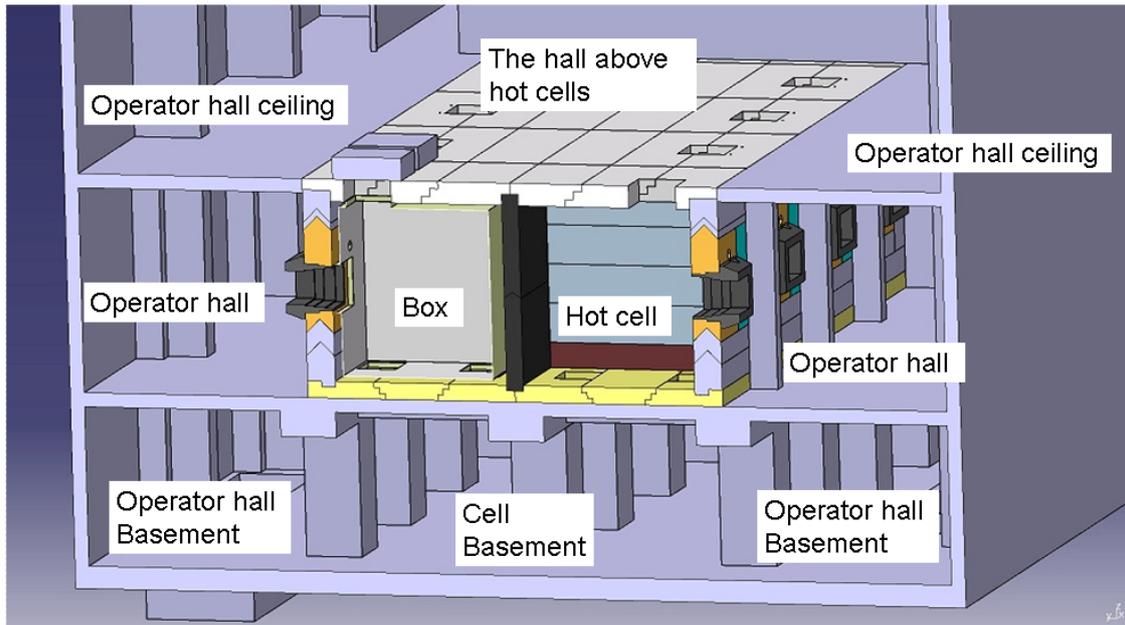


Fig. 2 Cross section of the hot cells

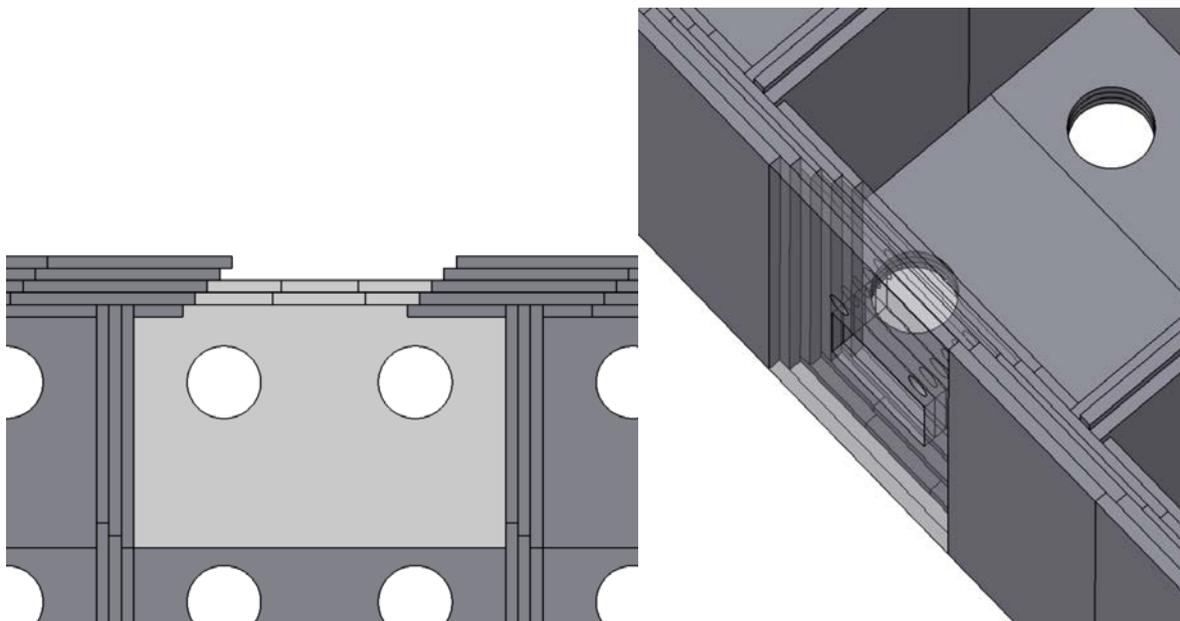


Fig. 3 Detail of the design of outer wall shielding

In each hot cell will be a hermetic, removable box from stainless steel (fig. 4), different type of devices will be installed inside these boxes. This approach to the hermetic properties of the hot cells allowed us maintain the condition inside very easily and if we have a reason to

change the instrumentation inside the box, we simply pull out the box and put new inside with the new instrumentation without delay.

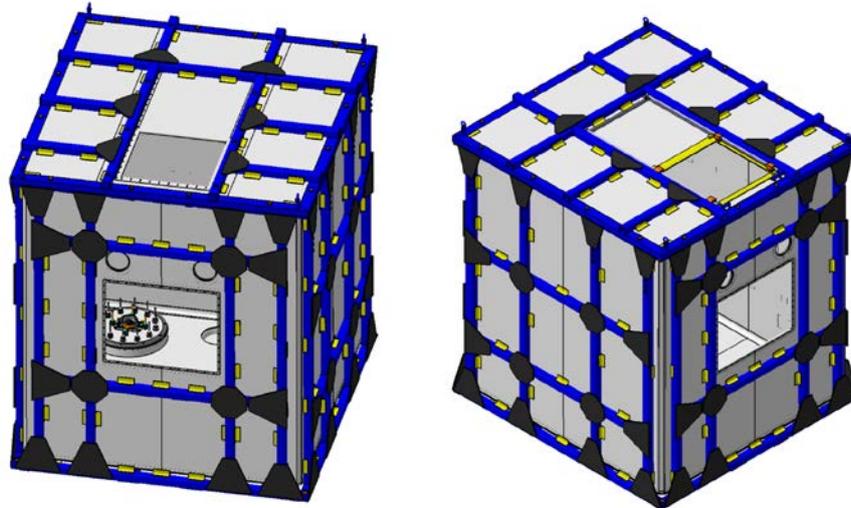


Fig. 4 Hermetic steel Box with holes for window and entrance for the workers

Detail of technical solution

Hermetic steel Box is first and only barrier for radioactive aerosols. Some part of the building are connected to the active ventilation, but not all. For that reason it is very important to maintain airtightness of the Box. Some leaking will solve under-pressure in the Box. In the gamma-cells will be pressure -150 Pa to surroundings and in alpha-cells -500 Pa. If this under-pressure would not be sufficient (malfunction or accident), emergency state will be announce and active ventilation will works on full power (approximately -1 kPa in Gamma and -3 kPa in alpha). Due to this feature all connection to the box are very problematic. Each Box have 4 plates full of airtight interconnection which will support everything in the Box (fig. 5).

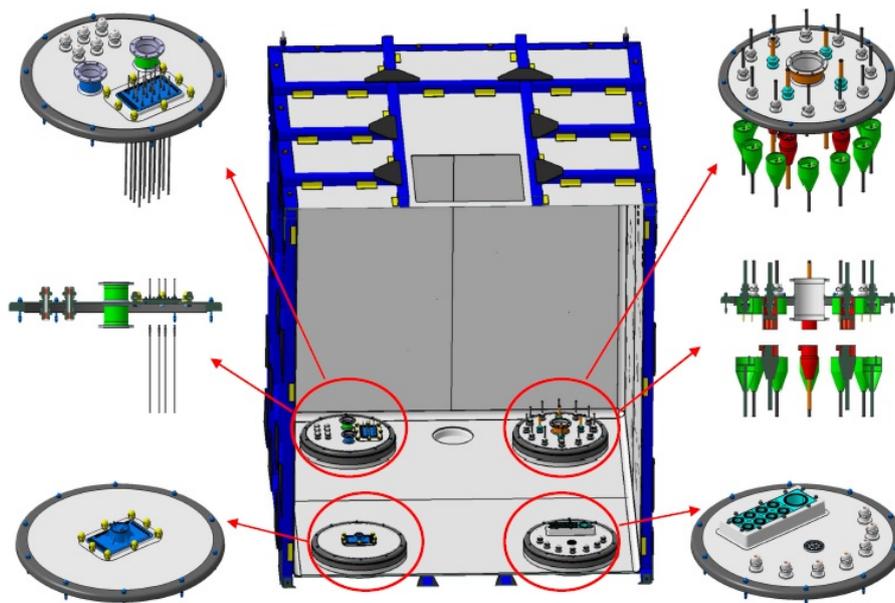


Fig. 5 airtight interconnection for all technologies

This interconnection must be accessible, airtight, easily disconnected and shielded. This has been solved by the airtight plates, connectors based on bayonet connector and additional

movable shielding with the same thickness as the floor shielding of the hot cells. This requirements prolong the need of very long connection (10 meter, fig 6) between technologies inside and technologies and control units outside. Every box (without instrumentation device) has active ventilation with filters, active waste piping and LED light system for illumination of the work space. Inside the box will be numerous sensors (temperature, pressure, radiation level, etc.) and cameras for better control of the device inside.

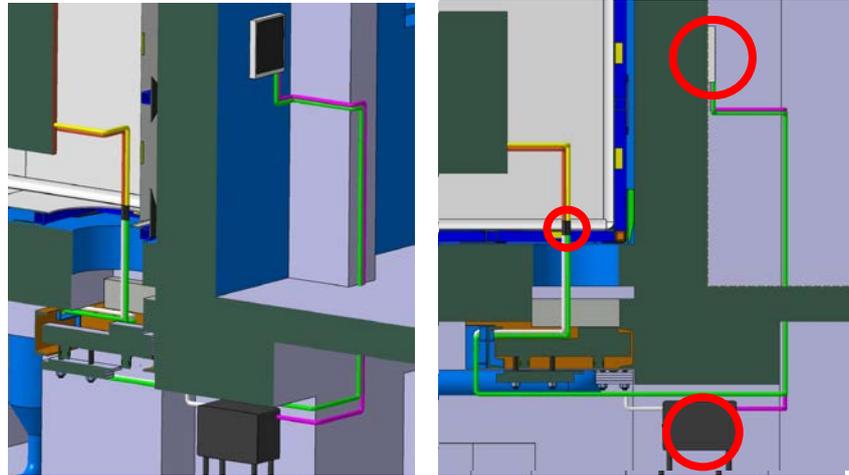


Fig 6 Detail of interconnection

Thanks to removable feature of the Box it can be reactivated (prepare for another experiment) outside hot-cell. This is achievable by docking bay which allowed us to simulate all conditions which will be in the hot cell (fig 7). Thereby all boxes (chambers) could be prepare and tested outside hot cells and then when the shielding or the future place of the box is ready all will be transport and easily reconnected and immediately operational.

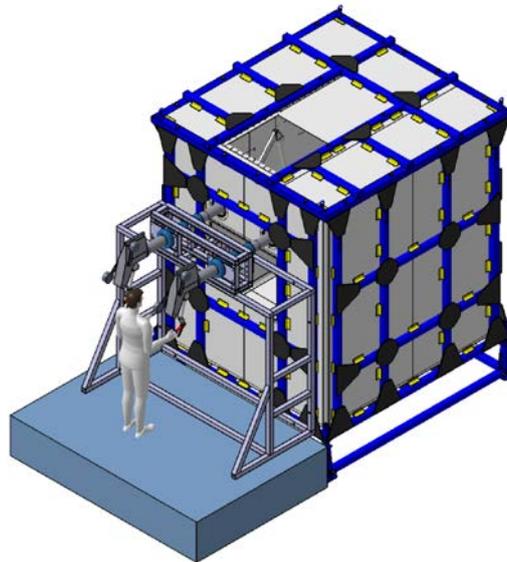


Fig. 7 Box in docking bay

Key system for every hot cells is transport of samples and materials. For that purpose special transportation device for the specimens is been constructed. Despite some difficulties basic design is finished and it will be used for public tender. Transportation device have to work even with open ceiling and pre-chamber as obstacle in trajectory. For that reason container

part of device will be manipulated by suspension crane (fig. 8). All electrical system will be replaceable with manual force if something false.

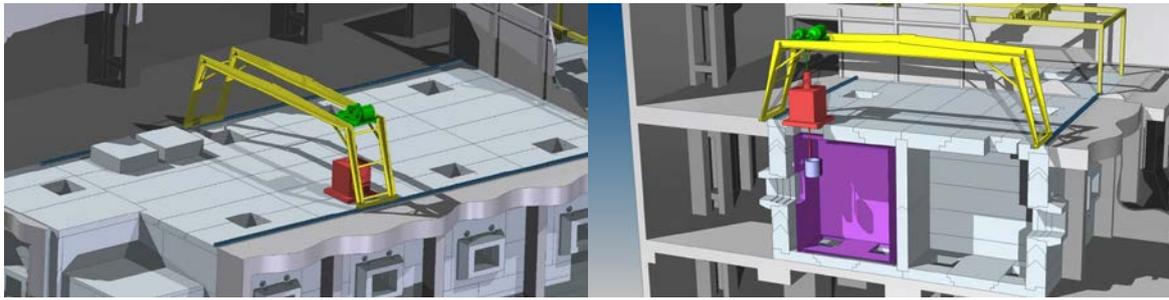


Fig.8 Transportation device for the specimens

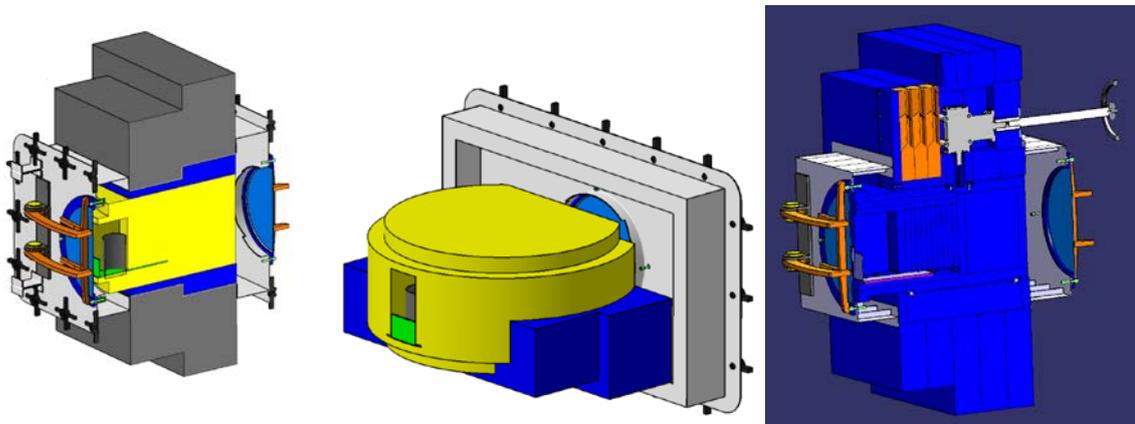


Fig 9 Material transfer device

Another way how to move samples between chambers is material transfer device. Design of all three devices is based on “Lazy Susan” (fig. 9). Its design has to be modified for removable hermetic box. From each side a steel collar will connect box and transfer device (fig. 9, left and fig 10). Mobile part could be powered by manual force (fig. 9, right) or electrical engine. The entire device could be also remove from wall into the box and repaired.

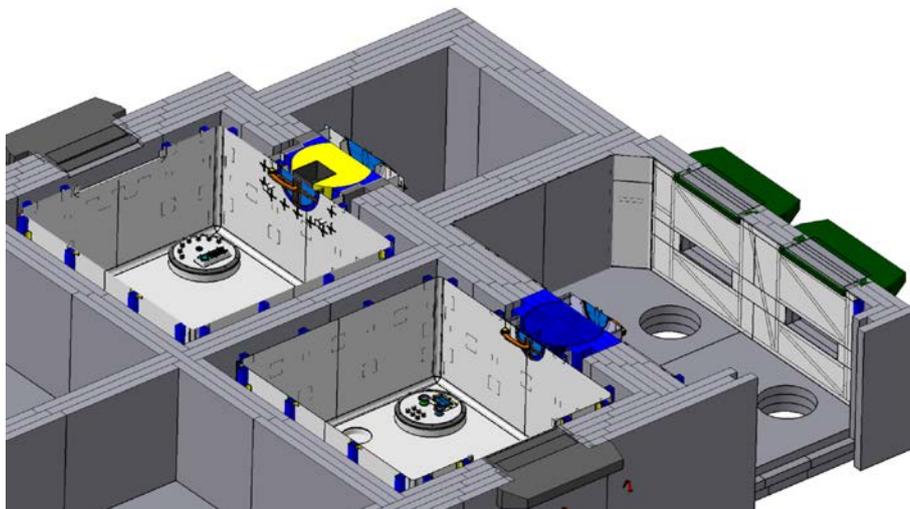


Fig. 10 Material transfer device with collar

Building where hot cells facility is been constructed did not allowed to build sufficient storage for samples. Everything will be transported from another building. To solve this problem

temporary sample storage for 34 storage can will be built in one chamber (fig. 11). Every chamber will also have small vault for samples.

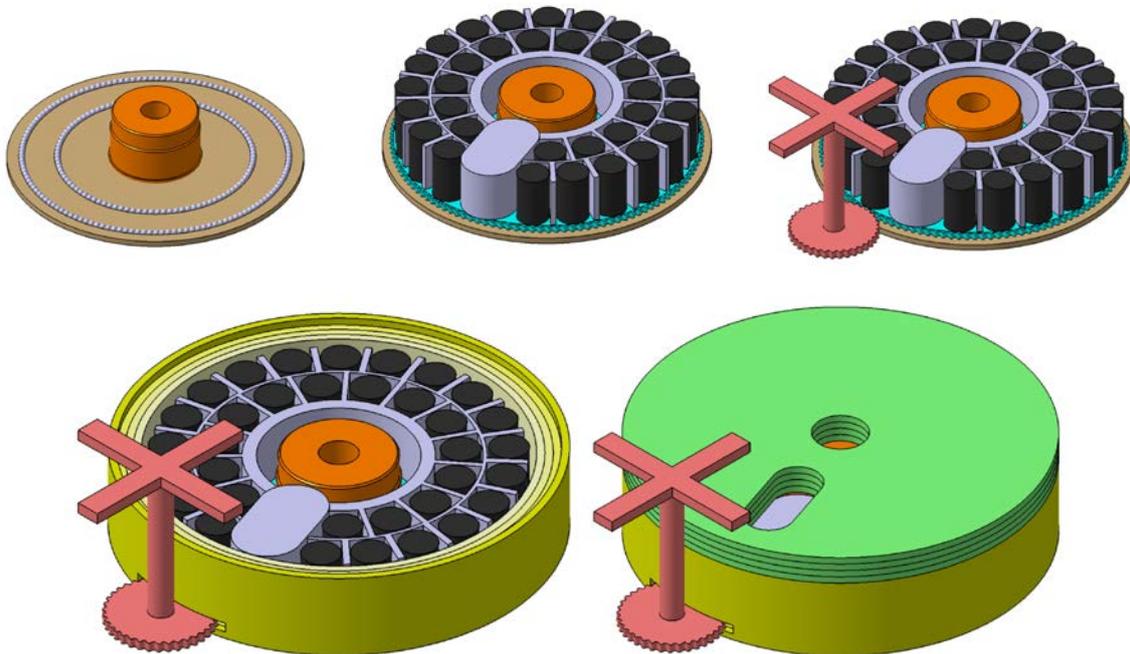


Fig. 11 Temporary sample storage

Limited space in the building did not allow to create a pre-chambers, therefore was a mobile pre-chamber developed. It is used for entry to a hot cell for workers. The pre-chamber has its own electrical circuit, ventilation, connector for the fresh air (for the protective suits) and entrance doors (fig 12, left). Door in the floor is for access to a hot cell. Pre-chamber will be equipped with shelves for tools, overhead crane and protective suits. It will be moved via the indoor crane and it has its swap space on the ceiling of operator halls. During operation on hot-cell (fig. 12, right) all communication of all workers will be cared out by open communication channel. Visual control of workers and work will be done by shielded window in hot-cell, pre-chamber and set of cameras.

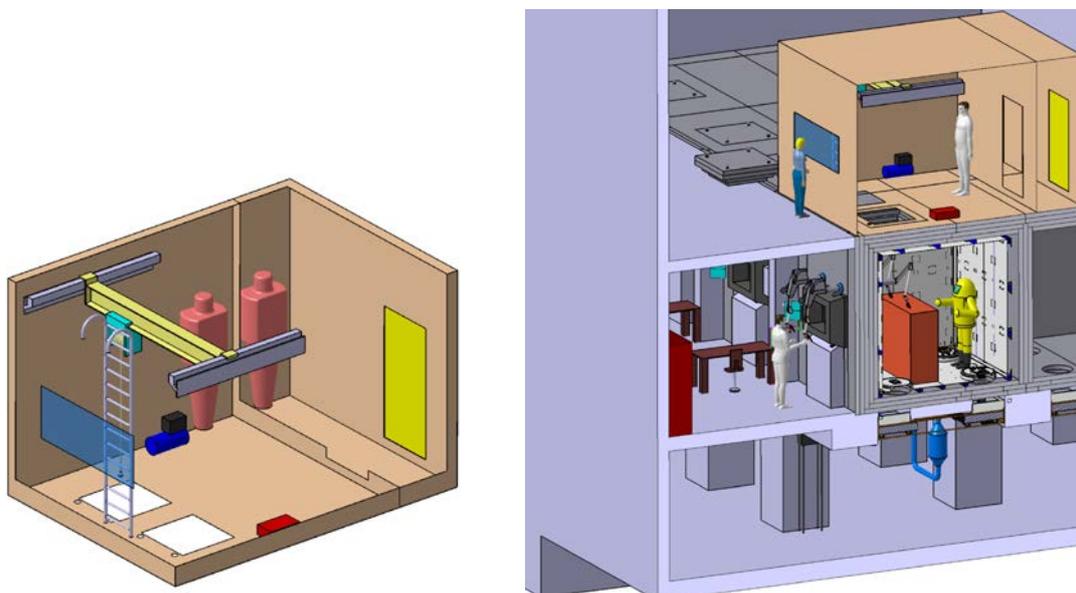


Fig. 12 Pre-chamber (left), Pre-chamber on the top of hot cell during operation (right)

Instrumentation part

The hot cells will be equipped for manufacturing of the specimens (cutting, welding, drilling, machining) with:

- Electrical discharge machine (EDM)
- CNC machining center
- Electron beam welding machine (EBW)

The hot cells will be equipped for mechanical testing with:

- Universal test machine for combined axial-torsional loading up to 250kN
- High frequency resonance pulsator up to 50kN
- Electromechanical creep machine up to 50kN
- Fatigue machine
- Autoclave with water loop

The microscopes (SEM, LOM) will be placed in the semi-hot cell also with nanoindentation device. All the technological and experimental devices will be purchase by public tender.

Conclusions

New hot cells complex will be ready and operational in 2016. The whole system will cover all process: receiving of the material, samples preparing, mechanical testing and microstructure observation. New design of hot cells have some very interesting and useful features and also difficulties. Due to high shielding we will be prepare for material from decommission NPP as well as highly irradiated materials for fusion applications. Our hot cells are close to research nuclear reactor LVR-15 and new irradiation facility (high irradiation by cobalt source in high and low temperatures also vacuum) which will be built in project SUSEN. This allowed us to cover everything for R&D of materials for Gen II NPP, future NPP Gen IV, fusion reactors and space programs.

Acknowledgements

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References

- [1] <http://cvrez.cz>
- [2] <http://susen2020.cz>