Shielded cells design and periodic safety review

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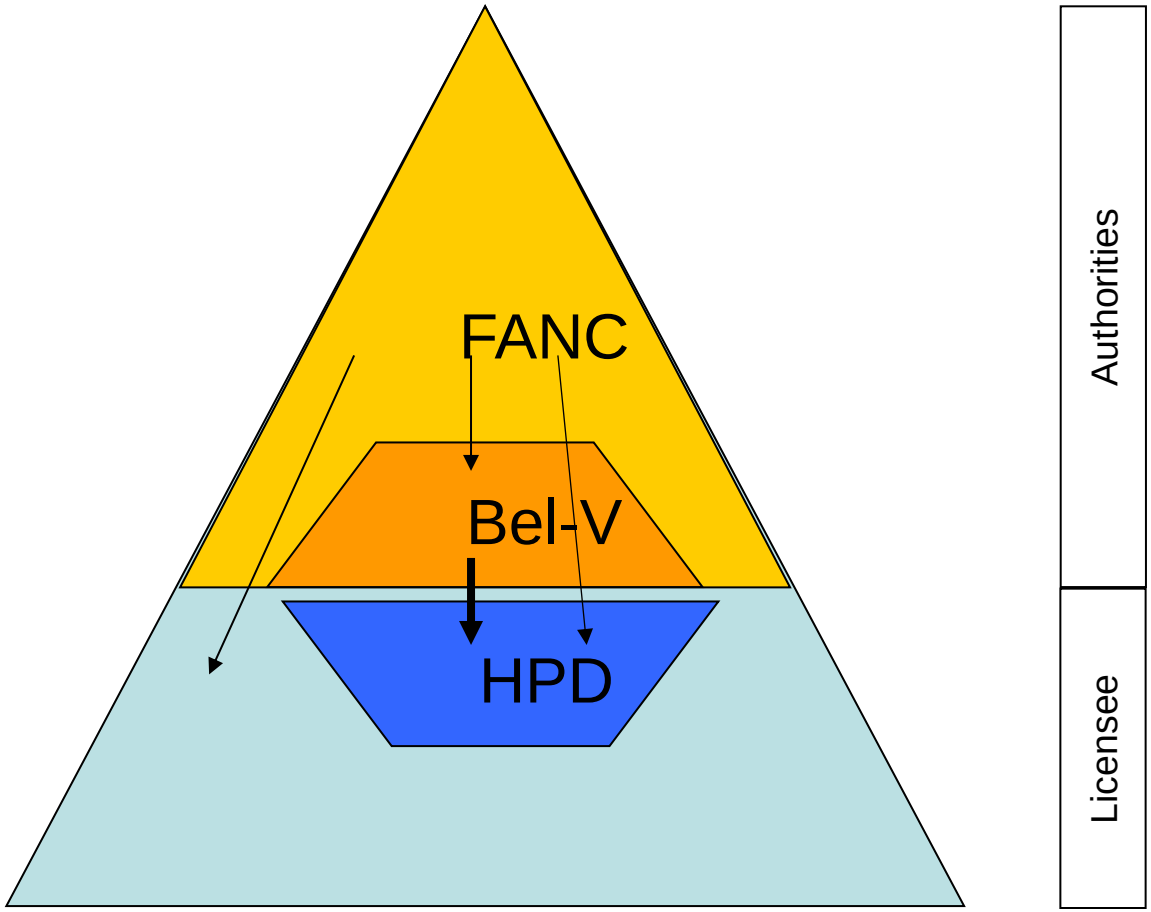
Contents

- Introduction
  - Belgium regulatory body structure
  - Belgian sites (non NPP)
  - Safety functions
- Periodic safety review
- Methodology
- Old shielded cells design improvement a few examples
  - Instrumentation
  - Fire safety
  - Internal filtration
  - Leak tight box (alpha box)
  - Inflatable rubber seals
- Conclusion
- References

Belgium regulatory body structure



Belgian sites (non NPP)

- 7 NPP's (Doel & Tihange)
- **Research Centre at Mol (SCK•CEN)**
- **Waste (Belgoprocess)**
- **Medical isotope production (IRE)**
- Research reactor Thetis (UG)
- Fuel production (FBFC)
- MOX fuel (Belgonucléaire)
- Universities
- Hospitals

Periodic safety review

The periodic safety review consists in a systematic reassessment of the safety of a facility carried out at regular intervals to deal with the cumulative effects of :

- **ageing,**
- **modifications,**
- **operating experience,**
- **technical developments,**
- **new regulation and guidelines comparison**
- **siting aspects,**

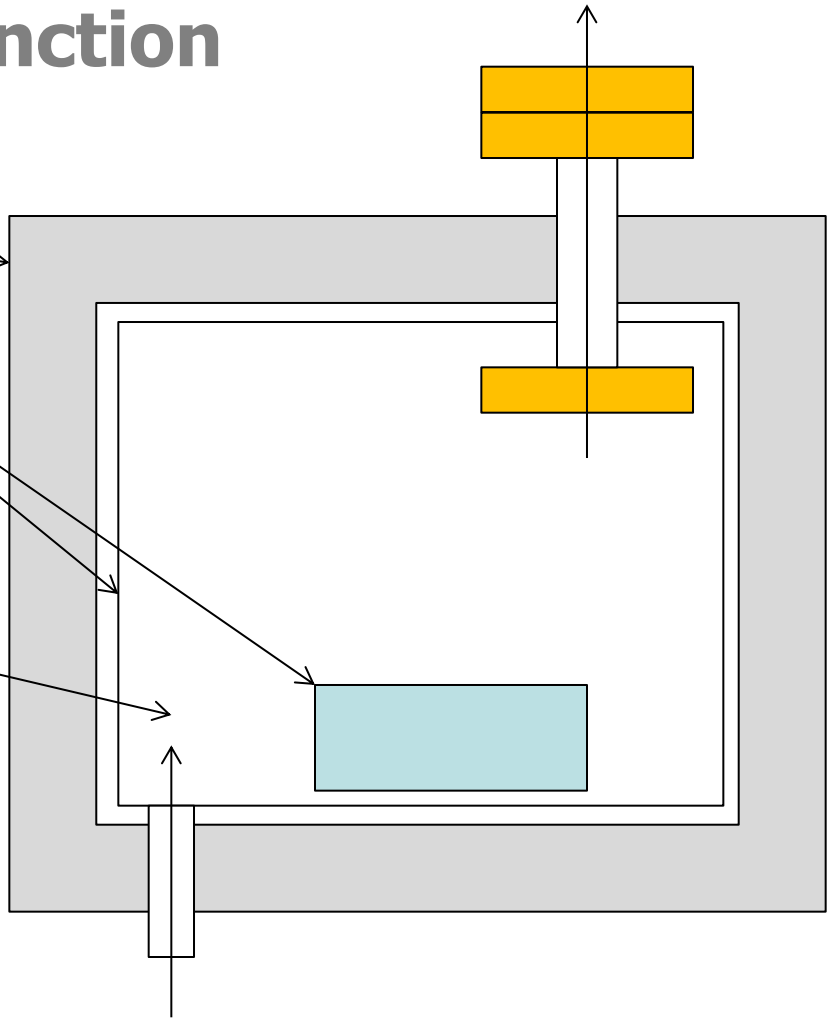
and is aimed at ensuring a high level of safety throughout the operating lifetime of the plant (IAEA SSG 25 for NPP).

Methodology followed by the licensee

- Safety factors analysis (about 15 themes - 3 years)
  - Human factors;
  - Emergency prepardness;
  - Ageing;
  - Equipment qualification, …
- One report per safety factor
- Interaction with the regulatory body
- Actions plan and setting-up of actions (7 years)
- Shielded cells design, safety factor 1 : « Design »
  - Shielding;
  - Static confinement;
  - Dynamic confinement;
  - Process

Safety function

- **Shielding**
- **Static confinement**
  - **Leak tightness of the process;**
  - **Leak tightness of the alpha box;**
- **Dynamic confinement**
  - **Under pressure cascade;**
  - **Air renewal;**
  - **Filtration (internal and external);**
- **Fire protection (and detection)**
- **Monitoring**



Engineering re-evaluation

- Archiving plan « As built » and as it stands now (digitalization);
- Identification of the legal framework;
- Under-pressure cascade re-evaluation;
- Re-evaluation of the source term within the shielded cell;
- Re-evaluation of the process hosted by the leak tight box
  - Hydrogen generation;
  - Chemicals and chemicals fluxes management;
  - Process inside the shielded cells v.s. fire risk, …
- Re-evaluation of hot cells resistance against external hazard :
  - Seismic event (lead glass on a vibration table);
  - Plane crash;
  - Extreme weather conditions (tornadoes, …)

Shielding

- < 5 µSv/h at the workplace
- Additional shielding around hot cell subsystems :
  - Ventilation ducts;
  - Transport systems;
  - Transport containers;
  - …
- Very few shielding design weaknesses are identified

Instrumentation

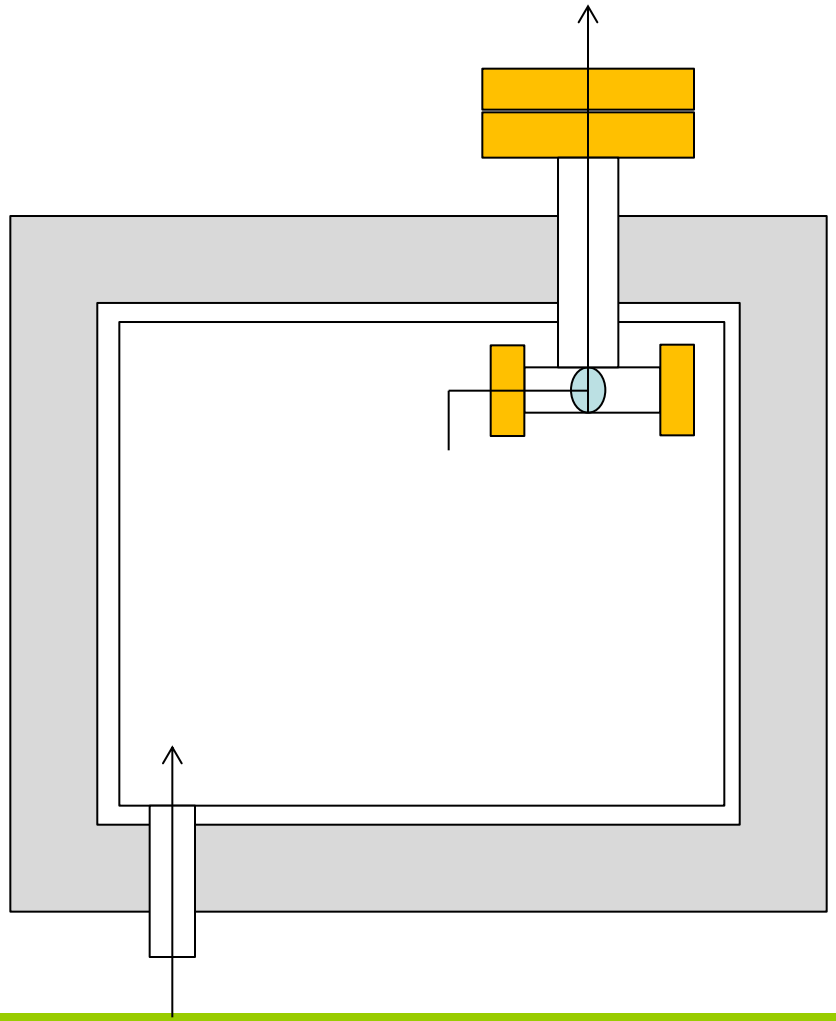
- Visibility through lead glass (replacement);
- Lighting (replacement by led);
- Dose rate measurement;
- Humidity;
- Temperature;
- Ventilation debit;
- Under-pressure;
- Airlocks set-up;
- Protection against unwanted actions (door opening);
- Alarming.

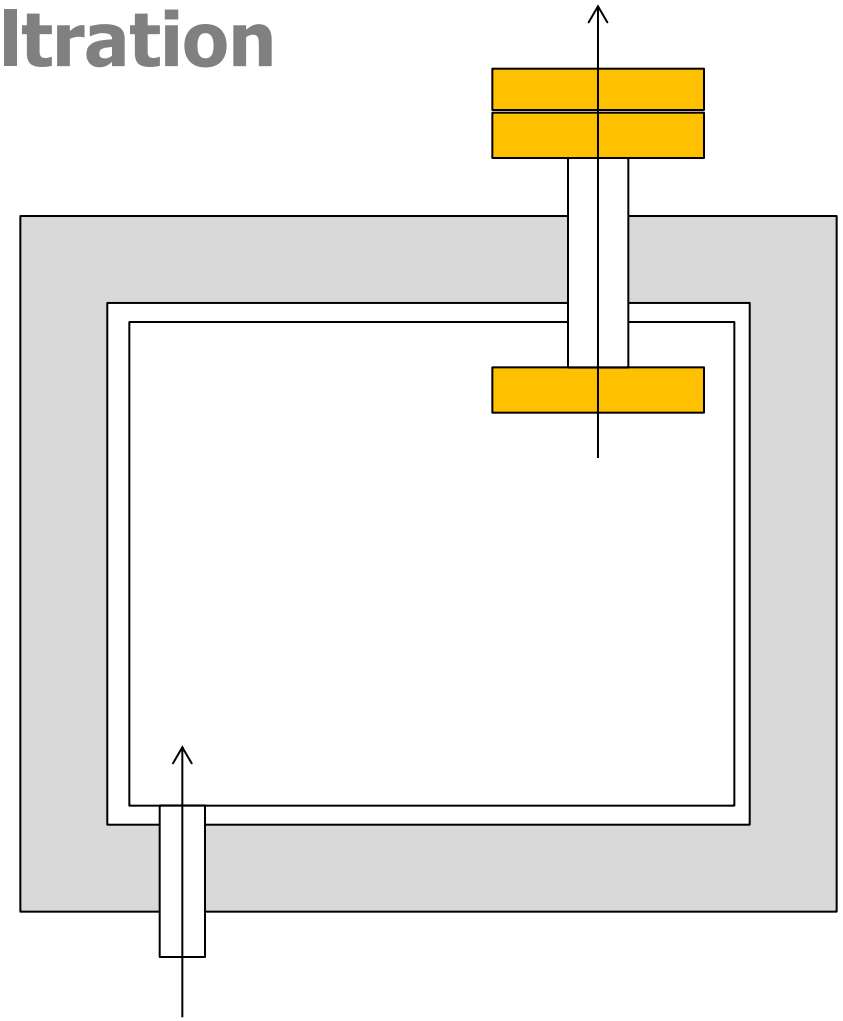
- Continuous recording and archiving of these parameters

Fire safety

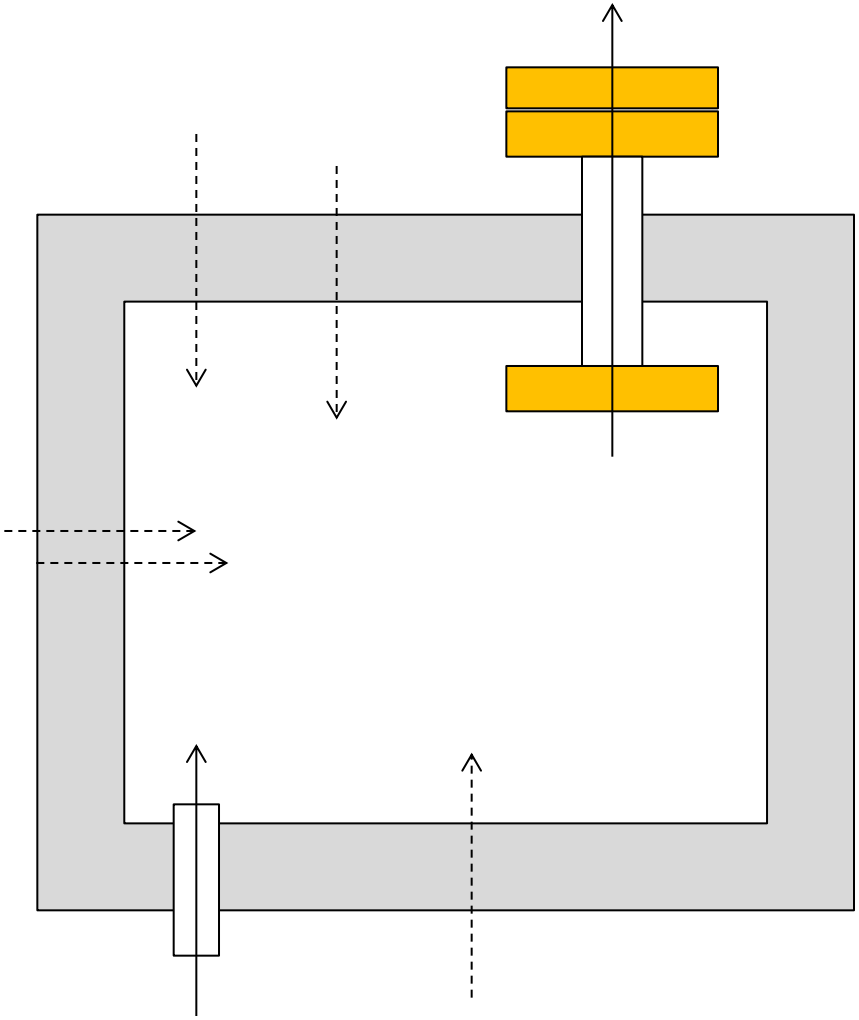
- **Reduction of the fire load;**
- **Redundancy and diversity at the level of the fire detection system;**
- **Alternative solution for the gaseous suppression systems in the hot cells (under-pressure loss)**

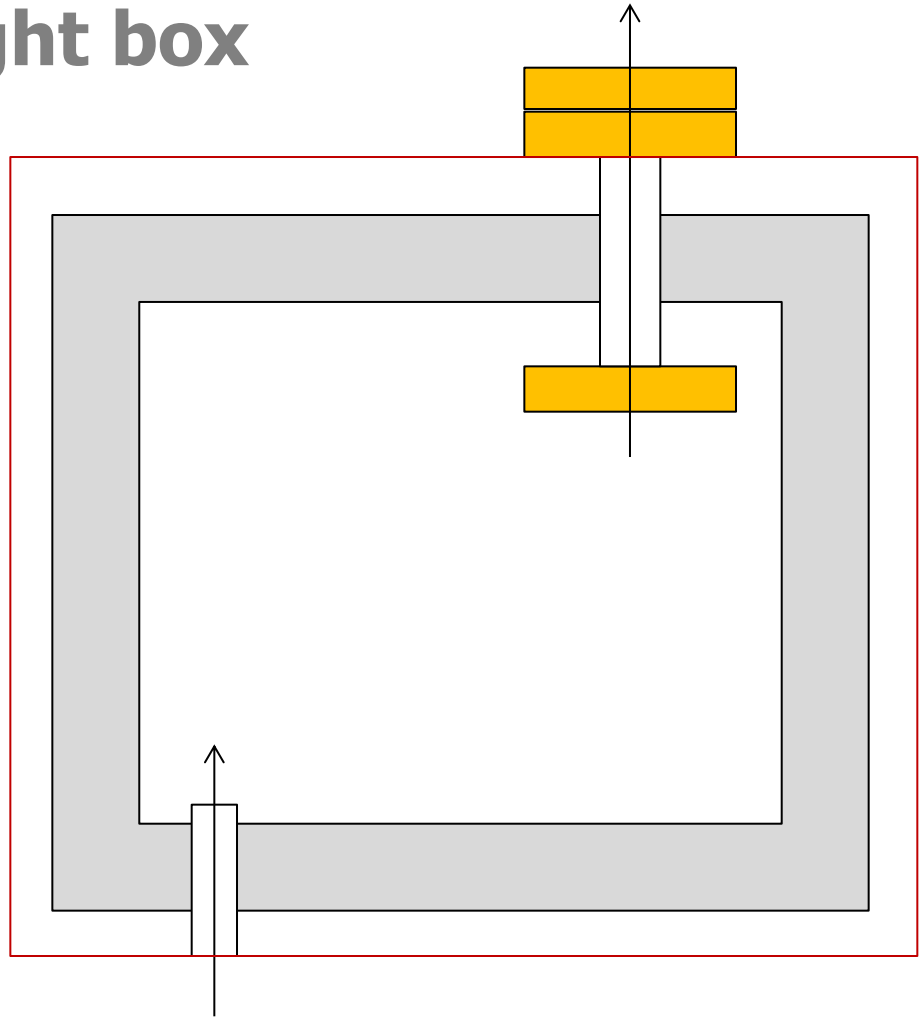
Internal filtration





Leak tight box





Inflatable rubber seals

- Guillotine doors between shielded cells sealed by compressed air in the interface;
- Interfaces between hot cells to transfer products or materials;
- Interfaces between shielded cells and working area (doors);
- Setting-up of interlocks;
- Reduce the use of inflatable rubber seal;

Process

- **Identification of material**
  - **Glass;**
  - **Metal;**
  - **Polymers;**
  - **…**

- **Material adequation**
  - **Physical useful range : temperature, pressure, …)**
  - **Chemical resistance (acid, base, …)**
  - **Radiation resistance : dose debit**

Conclusion

The periodic safety review of the old shielded cells allows the identification of weakness design.

The list of the weaknesses is discussed between the regulator and the licensee.

Corrective actions discussed between the regulator and the licensee make it possible to reduce the gap between current references and guidelines and an old design.

References

- IAEA SSG25, Periodic Safety Review of Nuclear Power Plant.
- ISO 11933-1 : Components for containment enclosures-Part 1: Glove/bag ports, bungs for glove/bag ports, enclosure rings and interchangeable units.
- ISO 11933-2 : Components for containment enclosures-Part 2: Gloves, welded bags, gaiters for remote handling tongs and for manipulators.
- ISO 11933-3 : Components for containment enclosures-Part 3: Transfer systems such as plain doors, airlock chambers, double door transfer systems, leaktight connections for waste drums.
- ISO 11933-5 : Components for containment enclosures-Part 5: Penetrations for electrical and fluid circuits.
- ISO 10648-1 : Containment enclosures-Design Principles.
- ISO 10648-2 : Containment enclosures-Classification according to leak tightness and associated checking methods.
- ISO 17873 : Nuclear facilities - Criteria for the design and operation of ventilation systems for nuclear installations other than nuclear reactors.
- ISO 11933-4 : Components for containment enclosures-Part 4: Ventilation and gas-cleaning systems such as filters, traps, safety and regulation valves, control and protection devices.

Thanks for your attention

Any question ?