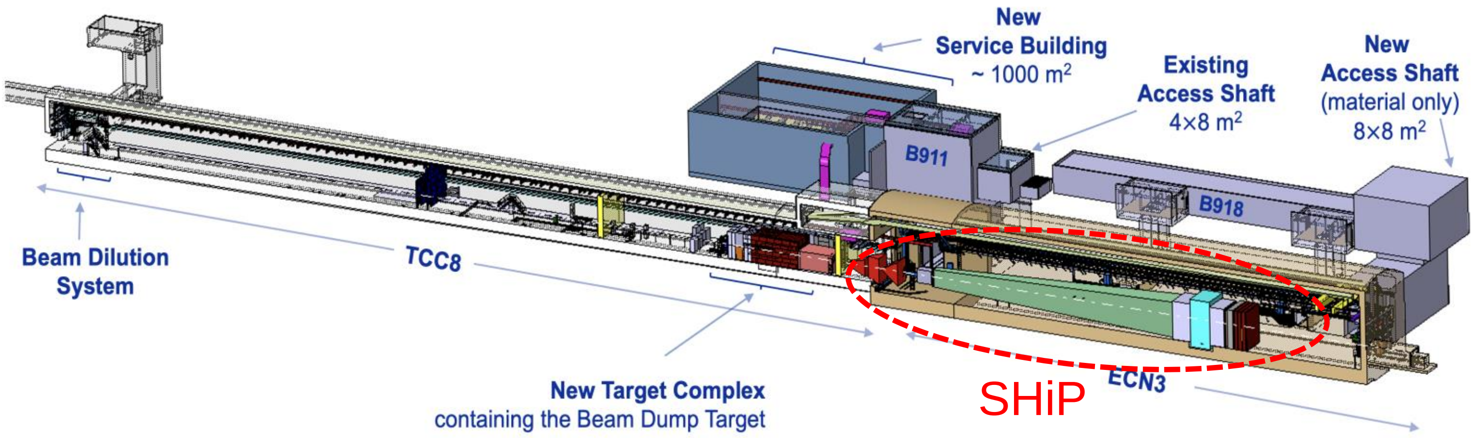
Facility Safety Requirement and Constraints

BDF Targetry Systems Advisory Committee – TSAC
4 - 6 March 2025

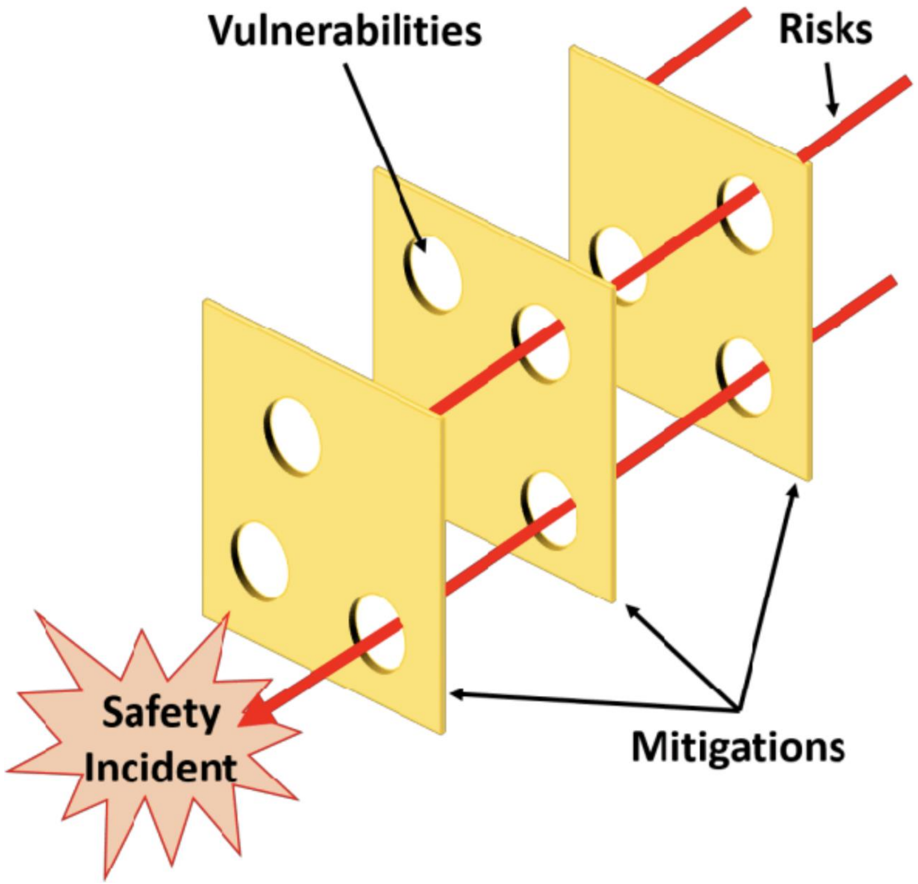
Melania Averna – Project Safety Officer

Table of Content

BDF facility Target & Complex



Facility Safety – scope and goals



Safety Lifecycle analysis: from design to decommissioning

- Aims
  - Hazard identification (General &Target System-Specific)
- Ensure
  - **Inherently safe** design
  - Risk management (vulnerabilities and protection layers)
  - Process Flow optimization
  - Safe handling and operation activities

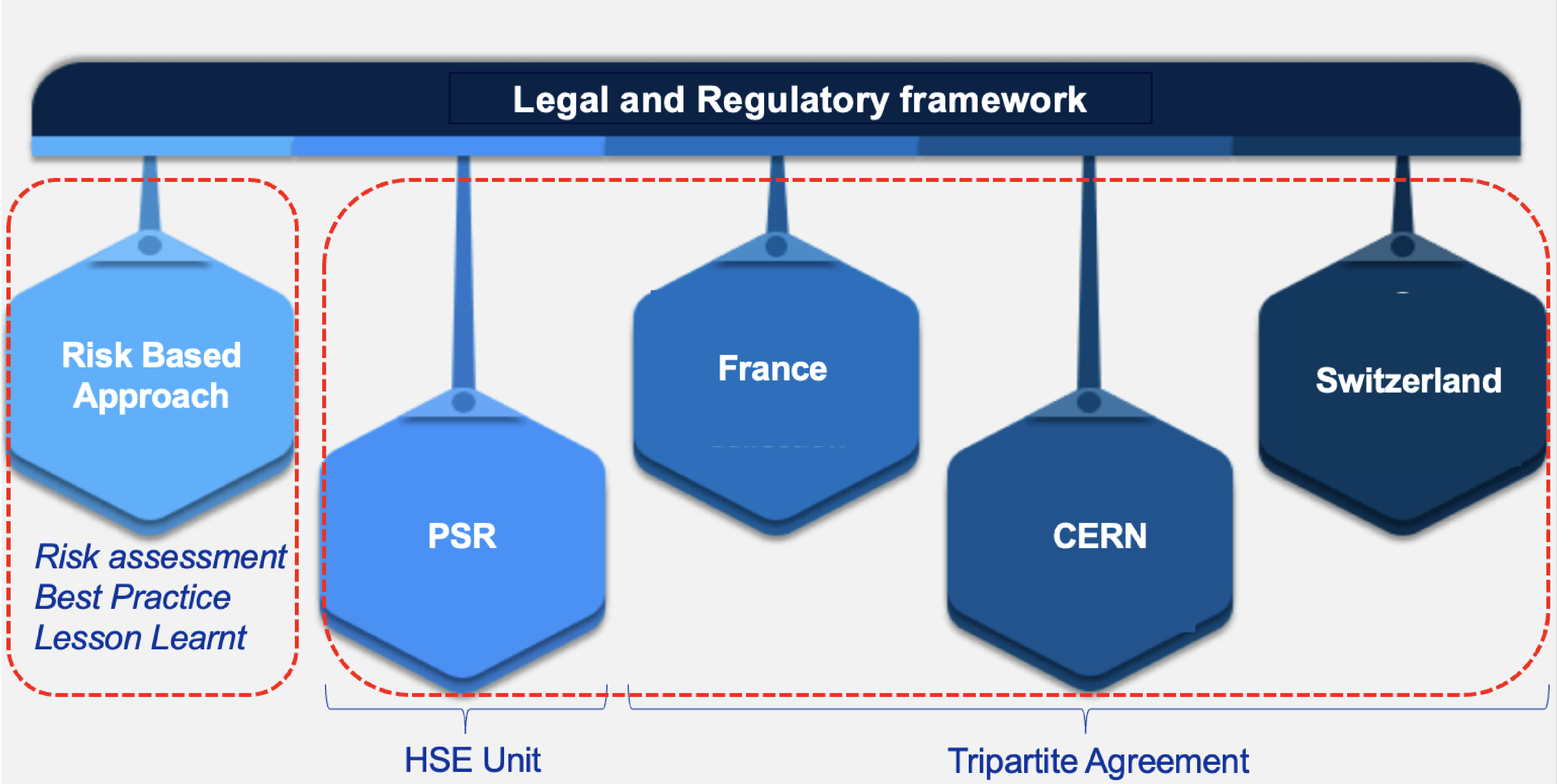
Facility Safety – scope and goals

*Safety Critical Systems

Goals:

- To minimize safety risks by implementing appropriate **engineering controls**, **safety protocols**, and **emergency response plans**
- To ensure compliance with local, national, and international **safety regulations** and **standards**
- To provide a **safe working environment** for all personnel, public and environment and protect the integrity of sensitive equipment

Constraints



Tripartite Agreement

- CERN and its Host State

- Entered into force in September 2011

- Legal framework to discuss how the common objective against ionizing radiation can best be achieved in the context of CERN of protecting people working on site and the public

Every year, CERN submit:

1. inventories of the radioactive sources held by CERN
2. list of labs where unsealed radioactive sources can be handled
3. location of unsealed radioactive sources at CERN
4. unsealed radioactive substances present on the ISOLDE, MEDICIS and n-TOF experiments at CERN

28 août 2011 JOURNAL OFFICIEL DE LA RÉPUBLIQUE FRANÇAISE Texte 6 sur 98

Décrets, arrêtés, circulaires

TEXTES GÉNÉRAUX

MINISTÈRE DES AFFAIRES ÉTRANGÈRES ET EUROPÉENNES

Décret n° 2011-1024 du 24 août 2011 portant publication de l'accord entre le Gouvernement de la République française, le Conseil fédéral suisse et l'Organisation européenne pour la recherche nucléaire relatif à la protection contre les rayonnements ionisants et à la sûreté des installations de l'Organisation européenne pour la recherche nucléaire (ensemble deux annexes), signé à Genève le 15 novembre 2010 (1)

NOR : *MAEJ1118489D*

Le Président de la République,

Sur le rapport du Premier ministre et du ministre d'Etat, ministre des affaires étrangères et européennes,

Vu la Constitution, notamment ses articles 52 à 55 ;

Vu le décret n° 53-192 du 14 mars 1953 modifié relatif à la ratification et à la publication des engagements internationaux souscrits par la France,

Décrète :

Art. 1er. – L'accord entre le Gouvernement de la République française, le Conseil fédéral suisse et l'Organisation européenne pour la recherche nucléaire relatif à la protection contre les rayonnements ionisants et à la sûreté des installations de l'Organisation européenne pour la recherche nucléaire (ensemble deux annexes), signé à Genève le 15 novembre 2010, sera publié au *Journal officiel* de la République française.

Art. 2. – Le Premier ministre et le ministre d'Etat, ministre des affaires étrangères et européennes, sont responsables, chacun en ce qui le concerne, de l'application du présent décret, qui sera publié au *Journal officiel* de la République française.

Fait le 24 août 2011.

NICOLAS SARKOZY

Par le Président de la République :

Le Premier ministre,
FRANÇOIS FILLON

Le ministre d'Etat, ministre des affaires étrangères et européennes,
ALAIN JUPPÉ

(1) Le présent accord entrera en vigueur le 16 septembre 2011.

Homologation Process – new installation


Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Division Radioprotection
Office Fédéral de la Santé Publique OFSP
Département Fédéral de l'Intérieur

CODEP-LYO-2017-016116

asn AUTORITÉ DE SÛRETÉ NUCLÉAIRE

Division de Lyon

République française

RECEIVED

Purpose: demonstrating and documenting that a facility is being or has been designed respecting Safety principles and that it can be constructed, operated and then dismantled safely

Tripartite meetings: ASN, OFSP, CERN

- Inform the authorities and submit **Safety Files** for comments
  - descriptive (facility/equipment/systems in terms of safety)
  - demonstrative (HazId, risk reduction measures)
  - radiation protection
  - it evolves across the installation lifecycle
- Prior commissioning (before introducing the hazard)
- **Joint visit** is organized
- Comments are received and addressed
- Upon comments implementation a homologation letter* is submitted to the DG

**This decision might be accompanied by additional technical requirements, defined in its appendix*

Physical and Environmental constraint

Geological conditions (soil types, rock stability, seismic activity risks) and how they influence design and safety

- ❖ Existing Underground facility:
  Ongoing safety assessment to validate modifications (structural, pollutants)

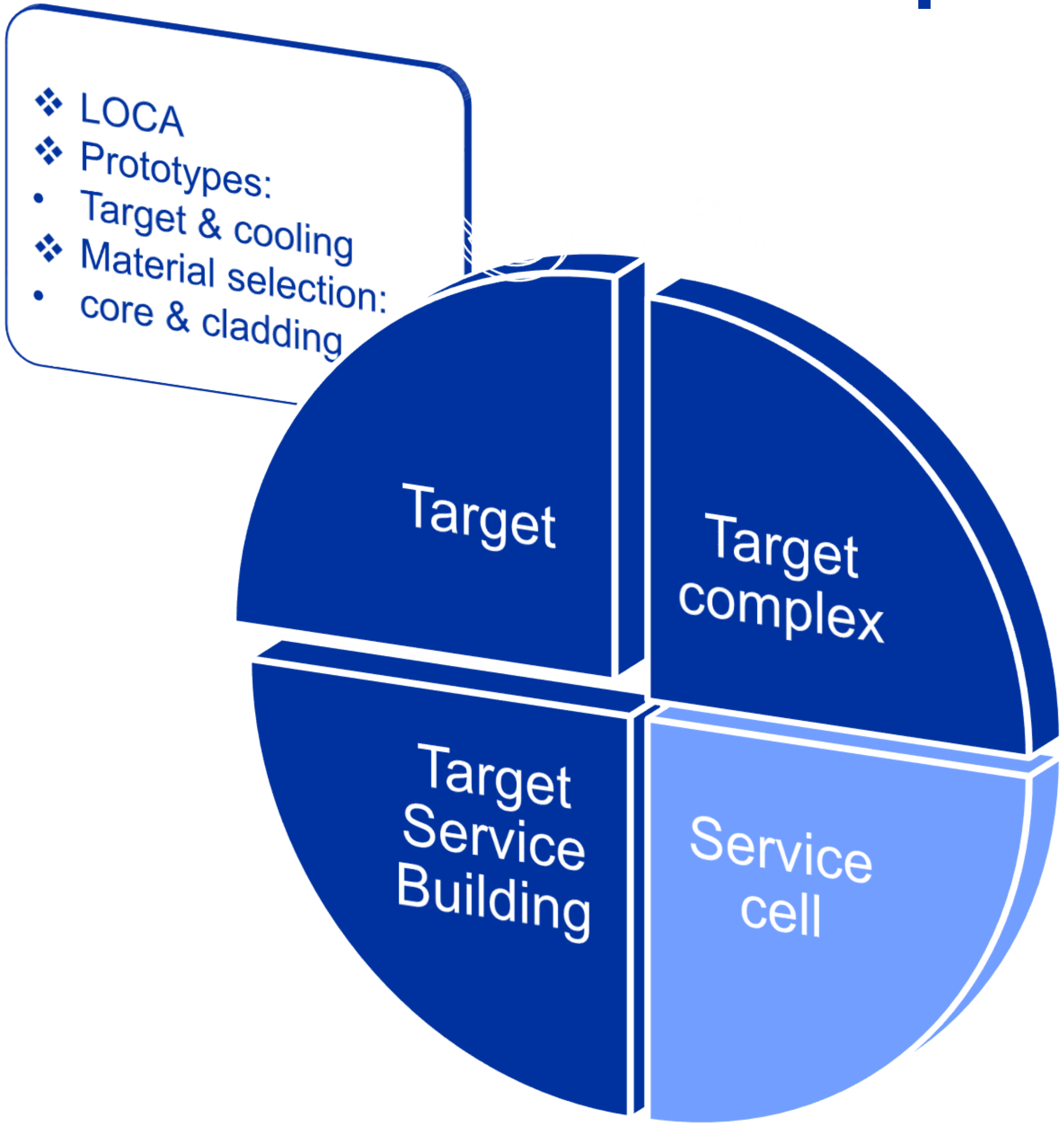
- ❖ Target Service Building
  Soil categorisation and seismic assessment in detailed design

- Pollutant diagnostics (asbestos, lead paint, etc)

Structural design:
limitations based on existing underground space, accessibility, and ventilation requirements
(confinement, smoke extraction, fire partitions etc -> FIRIA Study)

Environmental factors: temperature fluctuations, groundwater presence

Where we are – TDR phase



Target cooling:

Water– CDS

- Radiolysis: production hydrogen -> ATEX implications
- Erosion of target materials

Helium

- Pressurised gas
- Erosion of target materials (mostly tungsten)
- Diffusion (outgas) of spallation products: due to operational **temperatures**

Operation and maintenance

Upcoming prototyping phase

- to provide more insights
- indication of where to go next
- how to further develop our design
- risk reduction measures

LOCA Scenario

lost or insufficiently circulated due to:

- **leaks**
- **failures in the helium circula**
- **or mechanical failure of valv**

Mitigation measures:

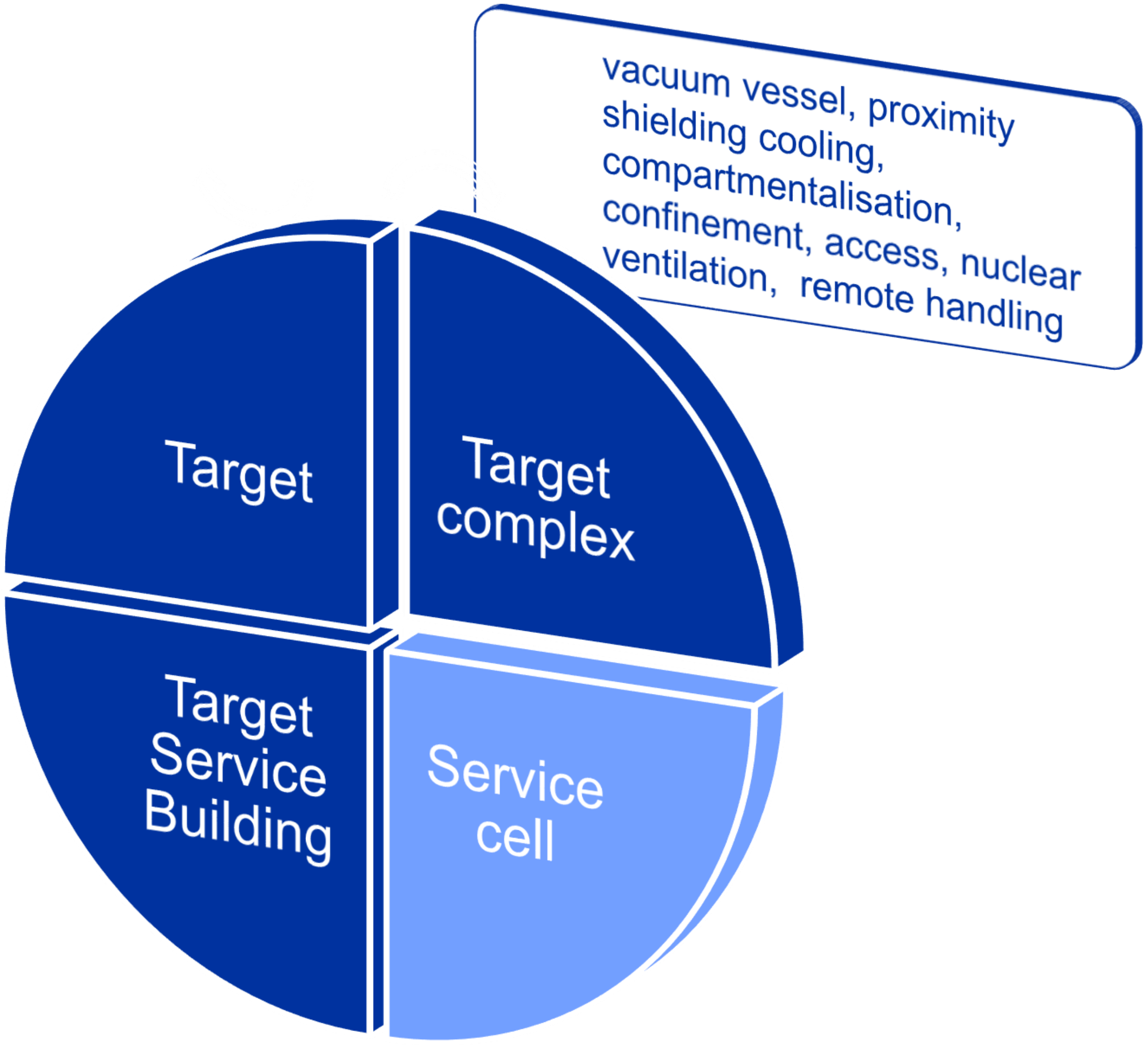
- Reduce leak points
- Double skin pipework
- Leak testing
- Build in redundancy - cooling system
- Monitoring and alarm (safety interlocks and safe shutdown)
- Design -> material safety limits
- Reduce Ta Cladding

Effects:

- **Uncontrolled temperature ar**
- **Potential risk of core damages (due to decay heat)**
- **Cladding rupture, release of radioactive material**

Talks from Luigi, Rui and Mike

Where we are – TDR phase



Target Complex - high risk areas

Independent layer of protections:
- Confinement
- Compartmentalisation
- access control
- remote handling and operation

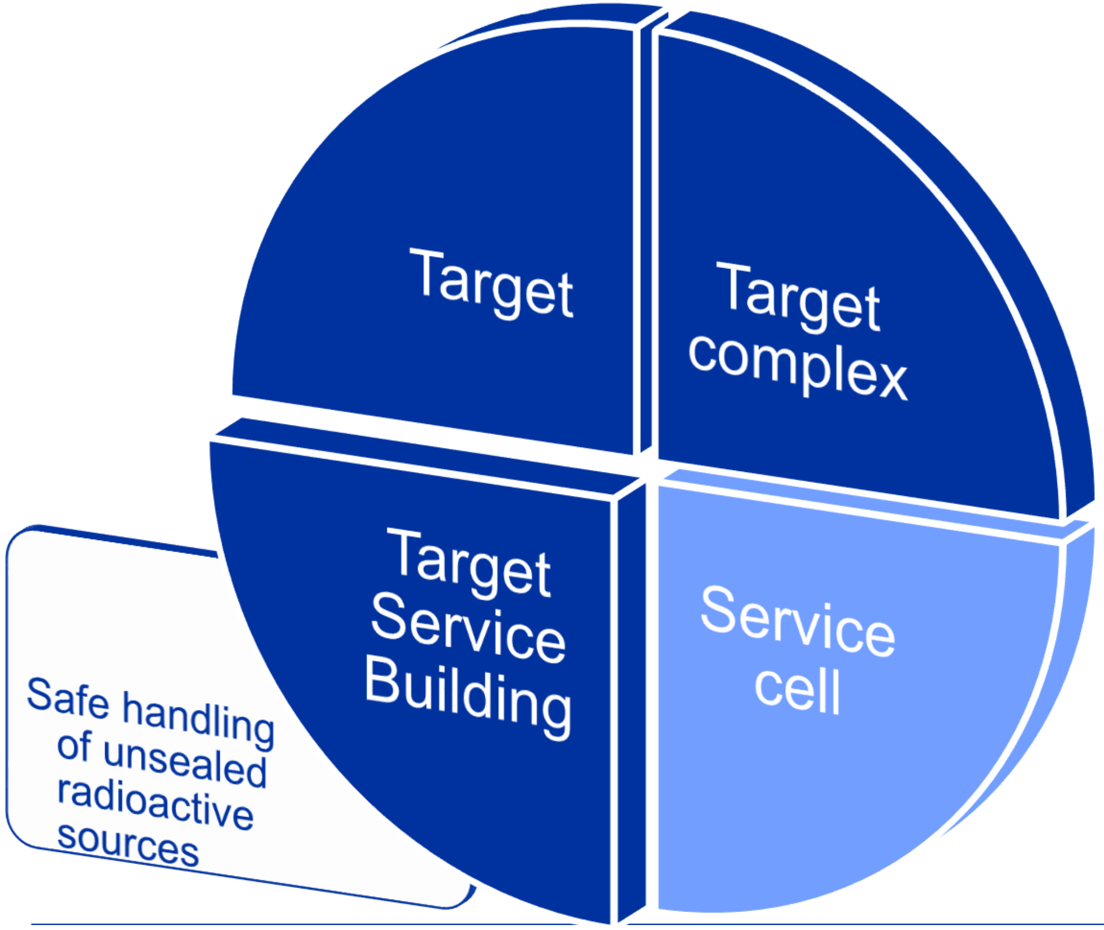
Separation between high and low risk area

Compartments (FIRIA)
- Access shaft
- Access tunnel
- Target complex

- Failure Scenario
- Redundancy (fault tolerancy)

Where we are – TDR phase

Infrastructure where technical and operational measures are in place to safely handle the risks of unsealed radioactive sources (Class A, B, C)



- Buffer Area – temporary storage
- Access and changing room
- Circulation
- Service corridor
- Handling Hall
- Cooling and Ventilation Technical Room
- *Service Cell*
- Electrical Room and Control Rack Room

Separation

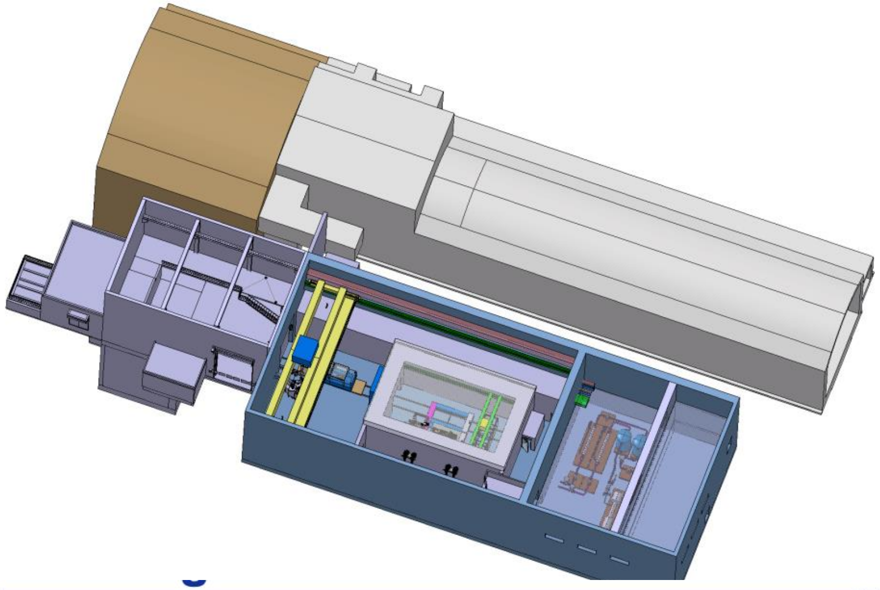
- high risk areas (radiological, electrical, fire)

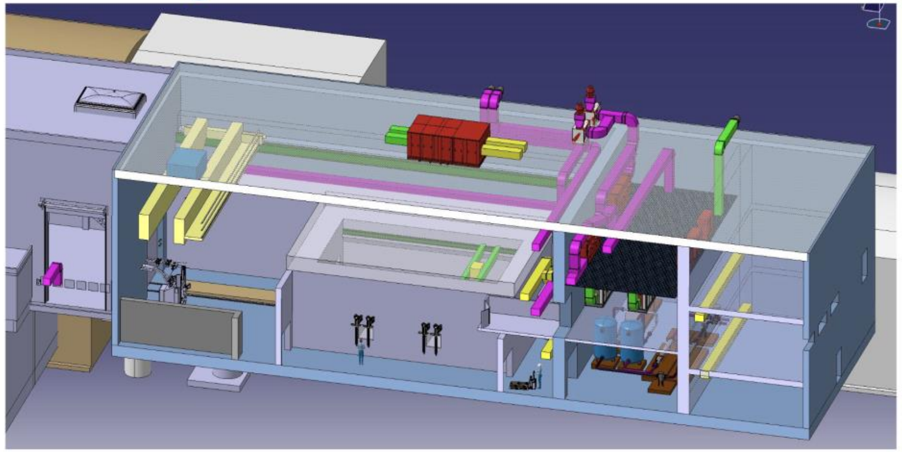
Compartments (FIRIA)
Safety Critical Systems

Operation and Maintenance

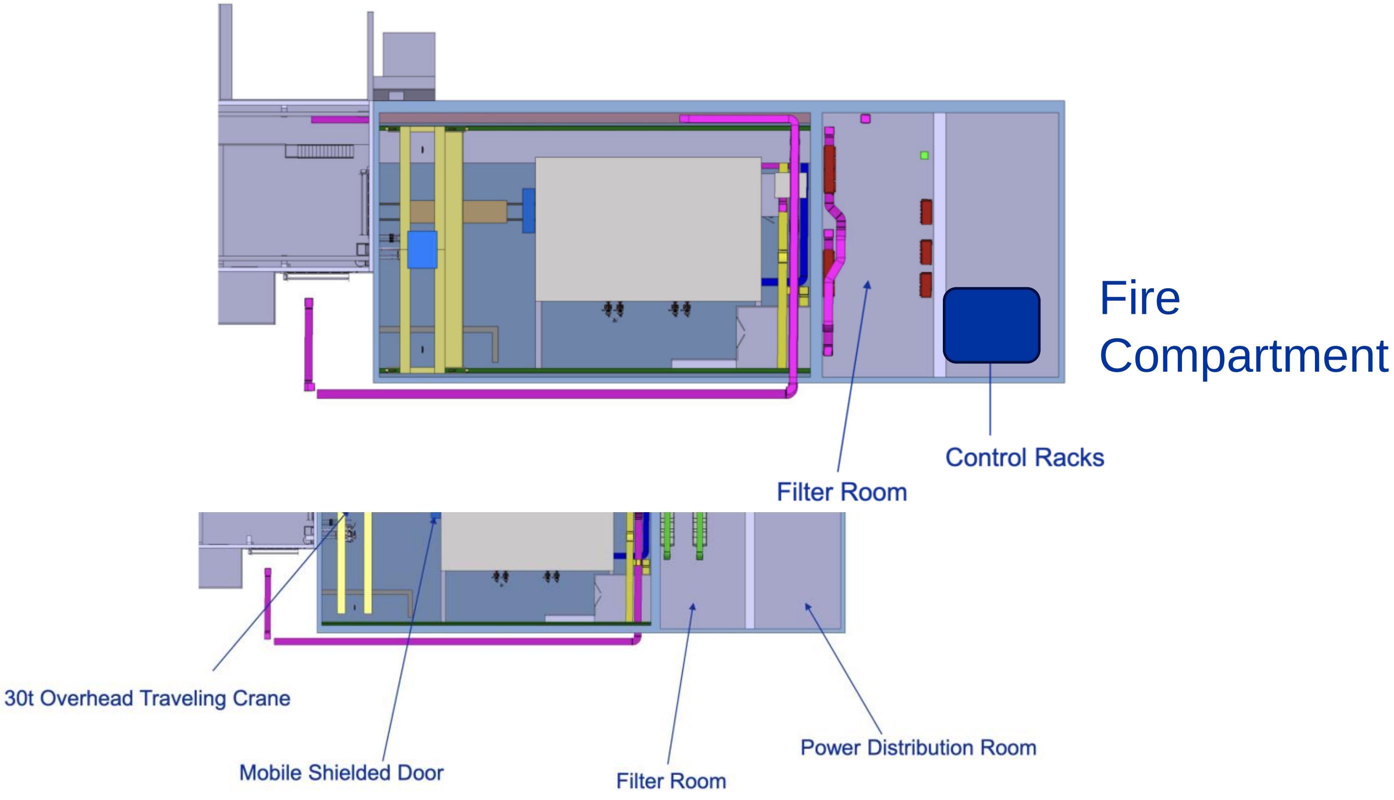
- Failure Scenario
- Redundancy (fault tolerancy)

Target service building



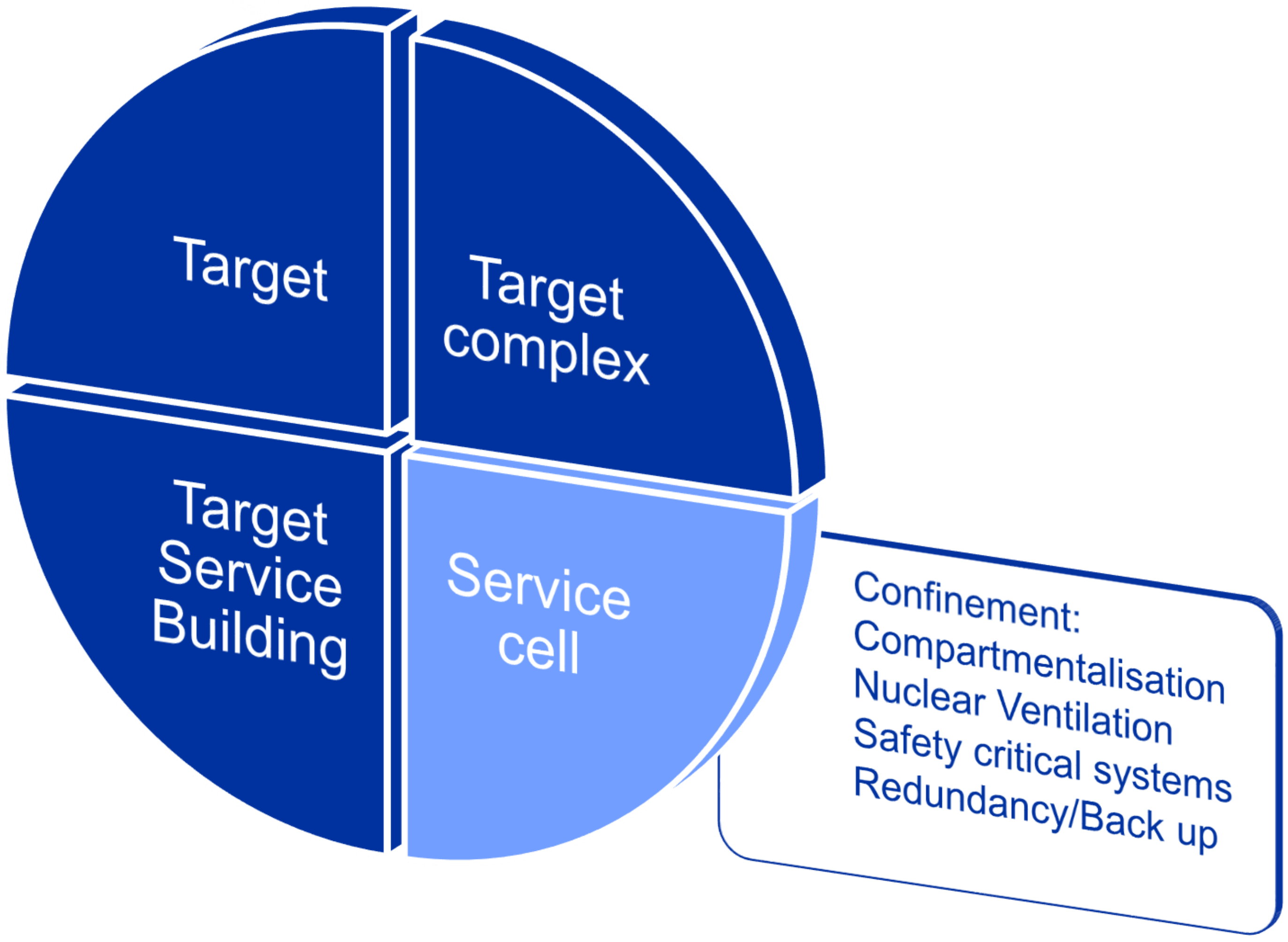


Service building – 2nd floor



Courtesy of Jean-Louis and Gemma

Where we are – TDR phase



High risk areas

Independent layer of protections:

- Dynamic Confinement and SAS
- Compartmentalisation
- access control
- remote handling and operation
  - Failure Scenario
  - Redundancy (fault tolerancy)
  - Recovery scenario

Separation between high and low risk area

Compartments (FIRIA)
Safety Critical Systems

FIRIA Study - ongoing

Fire Induced Radiological Integrated Assessment

- Impact of a fire within a radiological area on the public
- Powerful tool for assessing fire-induced conventional and radiological risks to life, the environment and property
- Accounts for the complexity and specific characteristics of each facility, typically experimental areas
- Assess potential fire hazards specific to underground operations and target systems
- Evaluation of flammable materials used in the target systems and underground areas
- Fire suppression system review, including coverage, redundancy, and response time

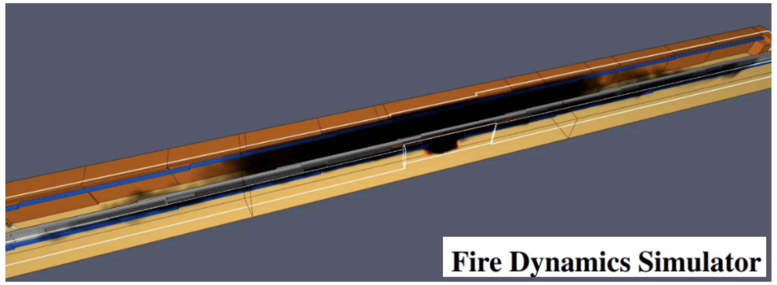
Outcome: iterative process

Risk reduction measures:

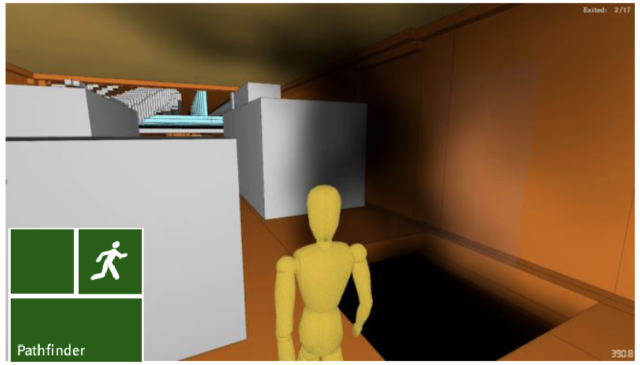
❖ Compartmentalisation
❖ Early detection
❖ Material selection
❖ Fire load limitation
❖ Intervention plan to be integrated in the design (equipment and organisational measures)

FIRIA Study - ongoing

Fire modelling / smoke transport

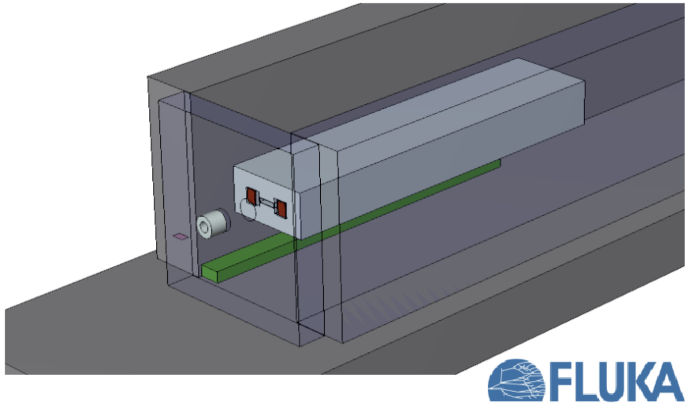


Life safety for occupants



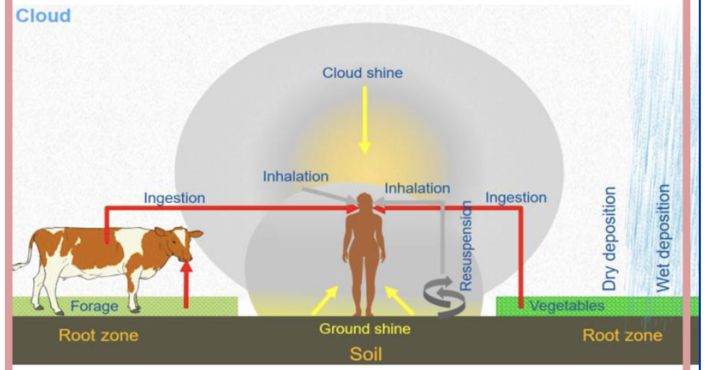
Input for fire intervention tactical plan

RP radionuclide inventory



Environmental dispersion

Radiological environmental impact assessment



Safety Systems

- ❖ Access control – not interlocked

- ❖ Personnel Protection System (TBC Cooling Room, target area, accelerators) – interlocked zone

- To limit access to only fully identified, trained and authorised personnel
- Importantly, to interlock of machine elements in case of dangerous situation
- Made up by access points and an interlock system with a rationalized number of safety chains (safety loops organised by zones)

- ❖ Fire safety
  - Fire detection and safety interlock
  - Sprinkler (access shafts and tunnels)
  - Compartmentalisation
  - Dry riser
  - Smoke extraction

- ❖ (Public Address) General Alarm

Look **ahead**

- Prototyping outcome to feed design
- Detailed System Failure modes analysis
- Accident scenarios definition
- Hazard and Operability study of PID (piping and instrumentation diagram) and PFD (process flow diagram)

Conclusions

While the need for safety systems has been identified, most of the mitigation measures will be defined once :

- Target and target complex material and process selection
- FIRIA Study recommendations
- System failure modes
- Accident scenarios

will be finalised and design can be integrated.

Specific risk reduction strategies will be better shaped once the project's design is more advanced (ventilation and ancillary system PID and PFD approved)

References

EDMS – 3094730 HI-ECN3 Facility Project Safety Requirements by J. Currie et al.

EDMS – 3214094 Fire Safety Concept - HI-ECN3 – Surface Building by R. K. Janardhan et O. Rios

home.cern

Thank you