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Taking into account dismantling and decommissioning waste management in conception and operations phases

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AREVA

Summary

- Requirements
- Optimization Approaches
- Facts and examples
  - EPR & ASTRID,
  - Georges BESSE 2,
  - MELOX,
  - ECRIN (Malvesi)
  - RJH,
- Conclusion

General Requirements

First requirement for a plant is to be operable ….

But not only, there are also

- Radiological protection of operators
- Environmental care
- Nuclear safety of operations
- Waste management
- Dismantling operations

Required by

- Nuclear regulators
- Health protection
- Waste and dismantling regulators
- Sustainable development rules

Life cycle analysis

Lifecycle phases concerned by the impacts assessment

- Project implementation (engineering, procurement, construction)
- Facility operation for its whole life
- Cleanup and dismantling

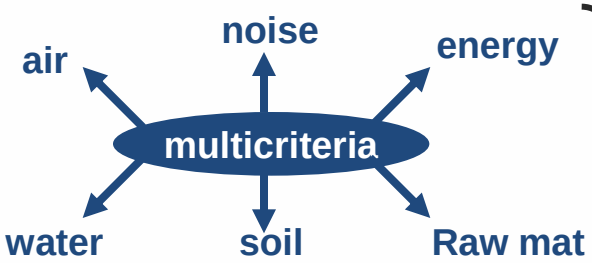
All impact must be taken in account

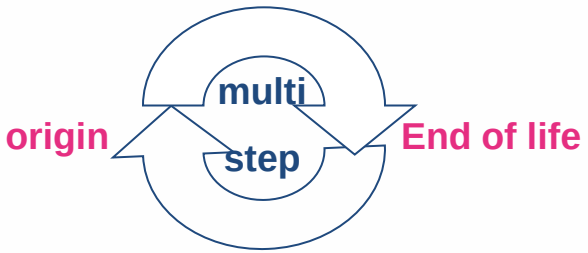
- Radio-toxical (occupational exposure)
- Environmental
- Societal
- Economic

Sustainable design

Scenarii and design options deriving from impacts assessment

Impacts assessment





Exhaustive approach

All criteria

All step of life cycle

Or

Selective approach

Specific issues

Design choice

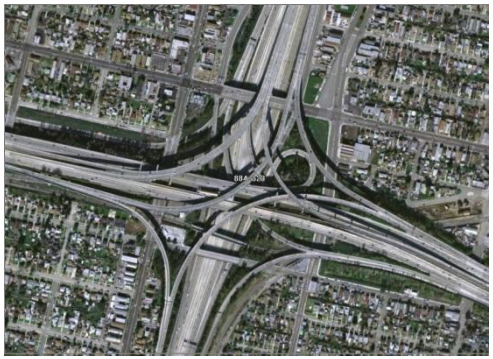
Check of non transfer of impact, from one action to an other one…

Adaptation of resources to needs

Mangement system without flow regulation

No adaptation to live operating states

= > unjustified expositions and impacts

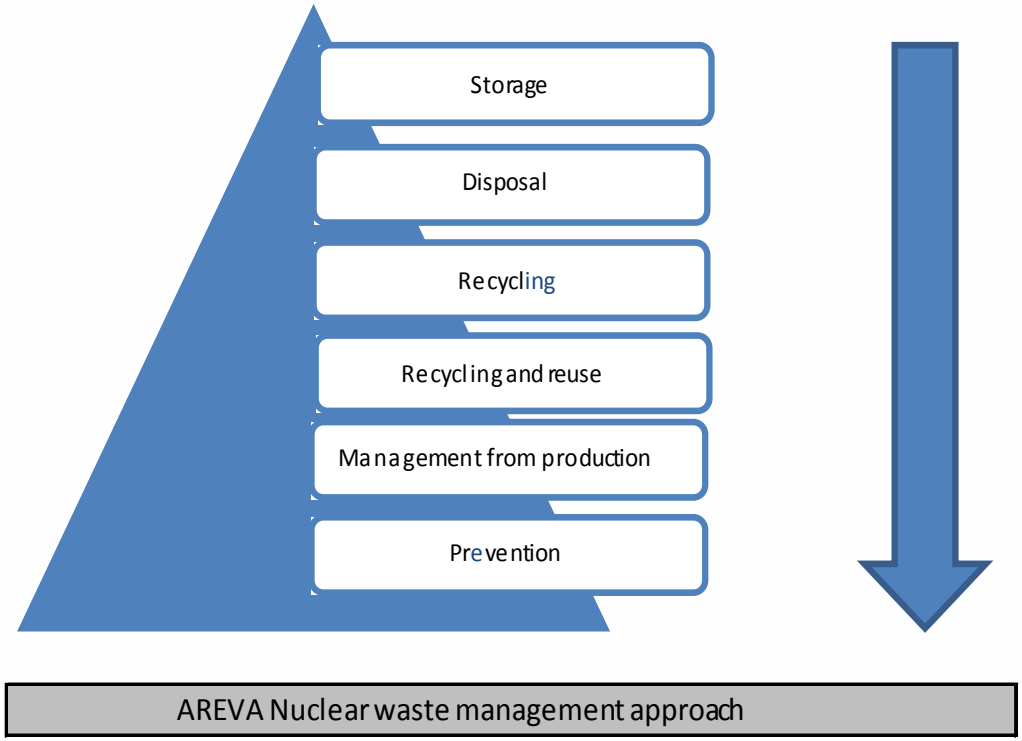


High fluidity for high Investment…

Expensive maintenance / upkeep and most difficulty for dismantling operations

All impact must be taken into account, and all steps of facility life cycle; from initial investment to final dismantling

AREVA global approach



AREVA Nuclear waste management approach

- **Optimisation must be achieved with respect to nuclear safety principles**
  - **Storage only as an interim strongly justified solution,**
  - **Disposal,**
  - **Recycling,**
  - **Initial management,**
  - **Prevention**

⇒ **The « ideal waste » is the waste which is avoided …**

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Waste area zoning principles

- Required by French BNI's (7 February 2012 decree) but WW principle…
- Identifies parts of facilities thus divided into two types of areas
  - Nuclear waste areas (NWA) in which the waste produced is likely to be contaminated or activated
  - Conventional waste areas (CWA) in which the waste produced is not likely to be contaminated or activated
- This zoning is
  - Established with consideration of
    - Facility process (way of contamination / activation)
    - Passed actions (regarding history)
  - Impact regarding
    - Safety
    - Operations management
    - Final license termination (end of nuclear control)
    - Waste management

Waste area zooning optimizations

Use classical and common sense tools…

During design, the Nuclear Waste Area classification should be limited to areas in which a continuous or recurring risk of contamination has been identified.
Other contaminating operations should be performed in an area zoned for operations (the reference zoning is "conventional").

Transitions and changes of areas (CWA / NWA) must be set up as close as possible to the source presenting the risk of contamination. Any extension of area thresholds from their theoretical positions (e.g. in terms of radiological monitoring) must be justified by a cost/benefit approach

Materials contamination modes must be characterized in nuclear waste areas (in France) or areas presenting a known risk of contamination. The means to be deployed to remove the nuclear part can be assessed with 3D zoning.

It is imperative to maintain the radiological cleanliness of the facilities; a poor dosimetry report can only postpone cleanup operations.

Ex: Dosimetric assessments Optimization / Organization

Operation and Dismantling approaches:

- Organize activities by integrating activity decay
  - Waiting for the high dose rate decline in RN

  Or,
  - Anticipation of activities to avoid appearance of RN (daughter products) high DeD
- Avoid activities if they do not bring a quantifiable benefit (and comparable) to the exposure they induce
- Integrated team approach for the development of operating methods
  - The staff (operator, maintenance, decommissioning)
  - An ergonomist ,
  - Knowledgeable people in FOH ,
  - Consideration of Lessons Learned (with respect to similar facilities)
- Checking an Training
  - Qualification testing of handling,
  - Balances with operational dosimetry

Ex: Management of Material Activation

Objective: minimization production of activated waste

Approach:

- Add shielding to reduce neutron radiation likely to activate material
- Material activation (alloys with a low cobalt content),
- Architecture of the facility and by the equipment, which should facilitate the most highly irradiating operations

Example:

- Simple, robust methods and techniques will optimize operations and minimize maintenance time, such as
  - quick disconnect couplings (e.g. Stäubli)
  - bypasses for maintenance preparations
  - siphon vacuum-breakers

Estimation of Induced Savings

	Waste			Operations			Environmental
	deep geological	subsurface	conventionnal	dificult to operate	nuclear conditions	conventional	CO2, natural ressources, water pollution, global,…
	25 K€/drum	1K€/drum	0,1K€/drum	5 h/op	1h/op	0,5h/op	
Radiological cleanless	= MELOX =>			= MELOX =>			
Zooning optimisation		= GB2 =>			= GB2 =>		Propotionnal with other impacts
Minimization activation	= EPR =>			= EPR =>			
Avoid mixt waste		= ECRIN =>			= ECRIN =>		

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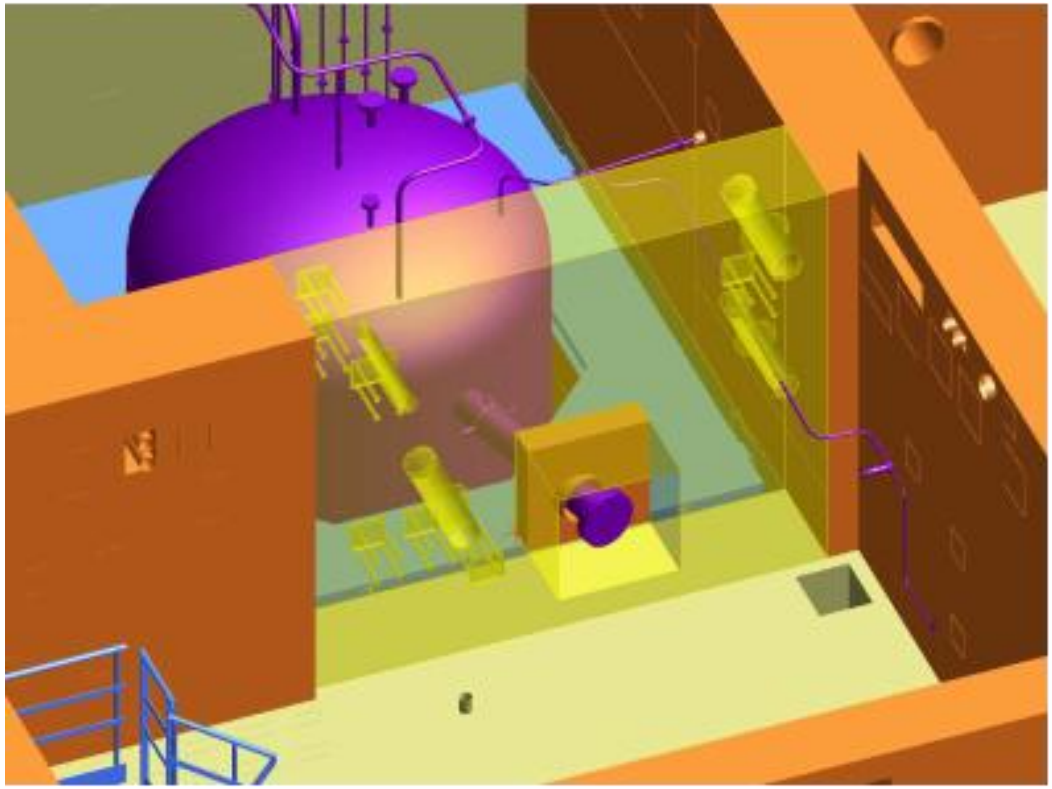
EPR & ASTRID *

- Minimization of radioactity exposure
  - Limitation of hard coatings based on cobalt (Stellite) on the primary circuit components and auxiliary systems ...
- Selection of material
  - Reduction of the cobalt content alloys (steel, nickel bases) used for the components of the primary circuit
  - Additional reduction for steel of the reactor vessel and internal materials under neutron flux
  - Limitation of the contents of silver and antimony in the components sealing of the auxiliary circuits
  - Use of low release rate materials exposed to the primary fluid chemistry
- Protection
  - Use of Zinc in the primary fluid to limit the deposition of cobalt -60 products
  - Use of screens sandwich easily removed before dismantling operations

ASTRID : (Advanced Sodium Technological Reactor for Industrial Démonstration), projet.

EPR

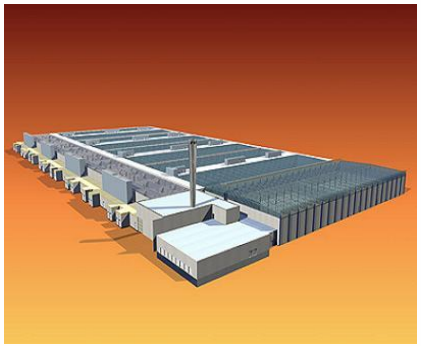
Operational design adapted for specific dismantling operations



Decontamination nozzle on the Volume Control Tank

Georges BESSE II enrichment plant

The Georges Besse II plant uses a new uranium enrichment process: centrifugation. With this technology, Georges Besse II offers the best guarantees in terms of competitiveness, energy conservation, technical reliability and environmental impact reduction. Deployed in two units at the Tricastin site, Georges Besse II plant began producing its first commercial separative work units (SWU) in 2011



Georges BESSE II enrichment plant
Sustainable design and adapted organization

The original design was adapted with

- Specific disposition of the UF6 management area (limiting the risk of contamination) and consequently, reducing the nuclear area.
- Relocation of most of the electric rooms in a non-nuclear area

Waste zooning

- Specific operations for management of room filtration, emptying post,…
- Re-arrangement of ventilation cascades
- More than 90% of areas classified as « conventional waste area » (CWA),
- Specific organization for « risk of contamination » area,
- Development of specific software for the management of waste zooning
  - Radiological information,
  - Operations,
  - Checks,
  - Recording data,
  - Traceability,

MELOX
Nuclear waste management optimization

MELOX: Minimization of the glove boxes radioactity

- Reduction of the residual activity inside the plutonium boxes
- Innovative ultrasonic decontamination process

⇒ Downgrading waste (from deep geological to subsurface)

⇒ Raw material recycling

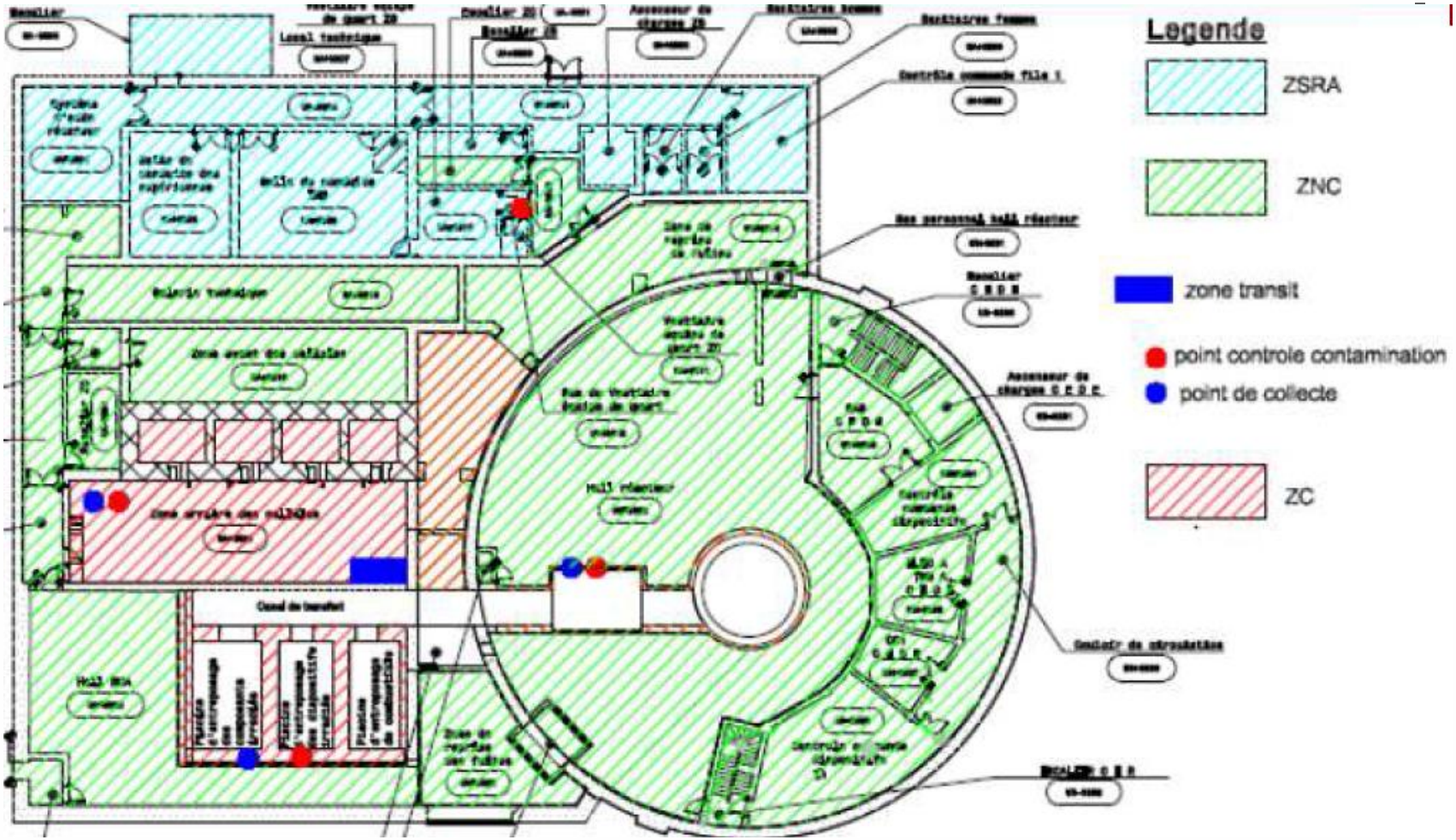
⇒ Facilitate management of dismantling

⇒ New BAT (best available technology) implemented, in accordance with BNI's decree (objective of BAT for waste management)

ECRIN (Malvesi): Blanketing of the nuclear waste storage

- Specific bitumen protection against rain water
- Prevents the generation of secondary nuclear waste. The bitumen protection contains chemical and nuclear material (mixed waste)
- This disposition will help AREVA to optimize the future management of nuclear waste and reduce the environmental impact

Jules HOROWITZ Research Reactor (JHR)



Jules HOROWITZ Reactor (JHR)

- Materials have been chosen (with RCCM-RX) with low level of impurity for minimization of activation under flux
- Specific spillage protection for
  - capacity which contain water,
  - hot cells;
- In the aim of waste saving in dismantling phase operations
- Waste zooning optimization (minimizing nuclear waste area)
- Specific attention on cleanness political and culture for futur operators
- Taking in account the well needed for nuclear waste storage, in the aim to avoid saturation
- Projection and specification of specific management (underwater) for all activated tools and material,

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Conclusion and prospects

- Taking in account dismantling operations in preliminary phases allow global impact minimization for :
  - technical stress,
  - waste management ,
  - radiological exposure balance

- Optimization opportunities
  - Validation of design scenario with life cycle analysis methodology
  - Systematizing life cycle analysis and eco-design
  - Promotion of work-experience sharing in different job (design, operation, dismantling)
    - factory history
    - Knowledge
    - Capitalization of dismantling operations experiences
  - Expend dismantling specifics tolls
    - Radiological characterization
    - Radiological measurement system
    - traceability (facilities modifications,…) .

Enable to manage all data and limit the investigation and intervention scenarios

<u>With Special attention to</u>

- balance between radiological impact and conventional one's
- link quick saving (during operations) with long term saving (dismantling) for help decision maker,

Thank you for your attention

BACKUP

Dismantling and nuclear waste management
External exposure risk

⇒ limiting integrated doses to workers and the public by the general layout of the facility and the placement of radiological shielding where necessary.

⇒ Studding the opportunity of transferring activated and/or contaminated equipment and structures to processing facilities (limitation of in situ work)

⇒ optimizing the position of personnel in relation to irradiating sources

⇒ reducing work time near radiation sources with an appropriate room layout. Need pre-installation of the means required for dismantling (anchoring of handling systems), of equipment dismantlability,

⇒ monitoring the operational dosimetry of personnel in all operating configurations by means of dosimetry forecasts and operational dosimetry

- And, always in connection with the ALARA principle :
  - avoid creating deposits of contamination and facilitate cleanup operations monitoring
  - Analyses of dosimetry feedback

Ex: Implementation of radiation protection aspects

Models help reducing exposure to ionizing radiation (for characterization of rooms and waste)

Mode of operation :

- Guarantee knowledge of history (hardened traceability)
- Enhanced radiological cleanliness

Technical tools

- Modelling of contamination transfers = optimization characterization measurements
- The over - classification can be justified by a limitation of costs and radiation exposure

Organisation :

- Highly dependent on the size of the facility , radionuclides implemented, and the " repetitive " activities character (reproducibility of work)
- Integration of skills and experiences of staff

Optimization during the operating Phase

Radiological cleanliness targets

- Promoting radiological operating cleanliness
- Sanitation favor the immediate temporary protection provided by a surface coating

Management of degraded situations and events

- Anticipating mobility barriers (movement of events)
- Integrating the experience feedback (operation / maintenance) for dismantling , adapting scenarios

Memory and traceability

- Identify all of the history of the radiological status and changes made during the operation of the
- Sustaining the archiving system

Georges BESSE II enrichment

Waste zooning operational arengement

Specific operation with specific risk need adapted organisation

NUCLEAIRES

ZONAGE TEMPORAIRE

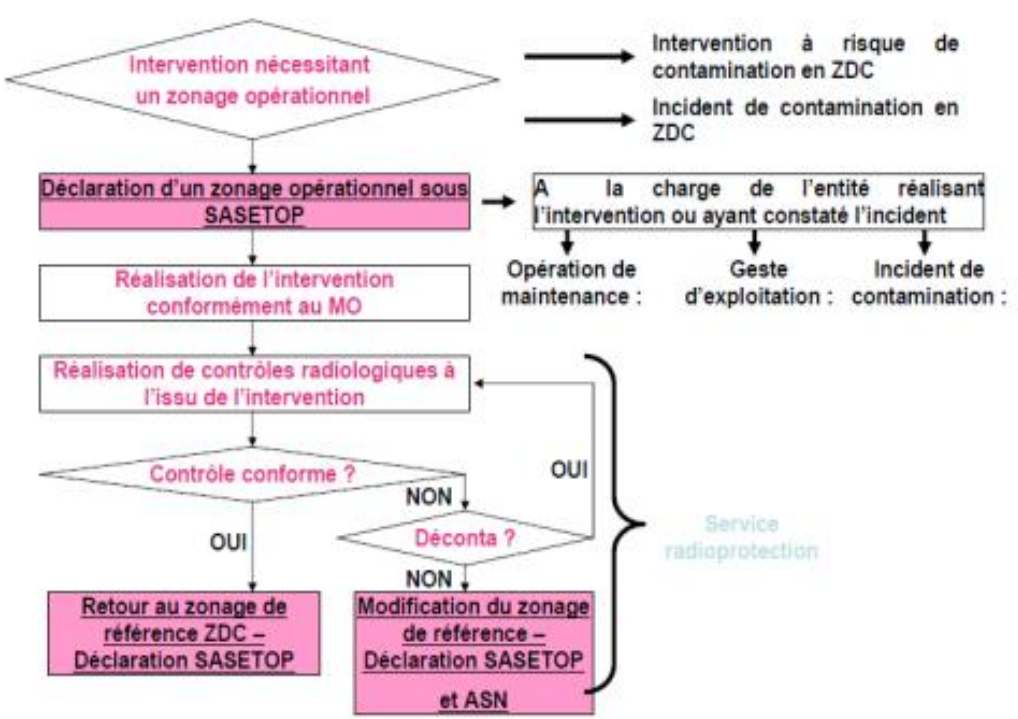
- **Containment and ventilation adapted for "risk of contamination" operations,**
- **Cheek of non scattering of contamination (or cleaning up)**
- **Return on "normal" organisation**

⇒ **Saving**

- ⇒ **Time**
- ⇒ **Energy**
- ⇒ **Nuclear waste**

⇒ **helping**

- ⇒ **operator risk sensitivity**
- ⇒ **Radiological neatness of the plant**
- ⇒ **Examplary and safety posture**



Design arrangement

- Industrial target
  - Essential for choice homologation !
  - Check if any other more relevant solution
  - Global assesment
- Design
  - Relevant sizing
  - Exhaustivity of the assesment
  - Architectural design
  - Possibility of maintenance & big operation in view of dismantling
  - Decomissionning of big equipement and material
  - Waste packaging (operation & dismantling)
- Equipments and tools
  - Choice of process
  - Choice of materials (regarding contamination and activation))
  - Care of chemical toxicity (regarding waste management)
- Feedback and lessons learned
  - Continual Improvement system, regarding dismantling and big maintenance operations, with care for new factory design and organisation of future Operations