

**International Atomic Energy Agency**

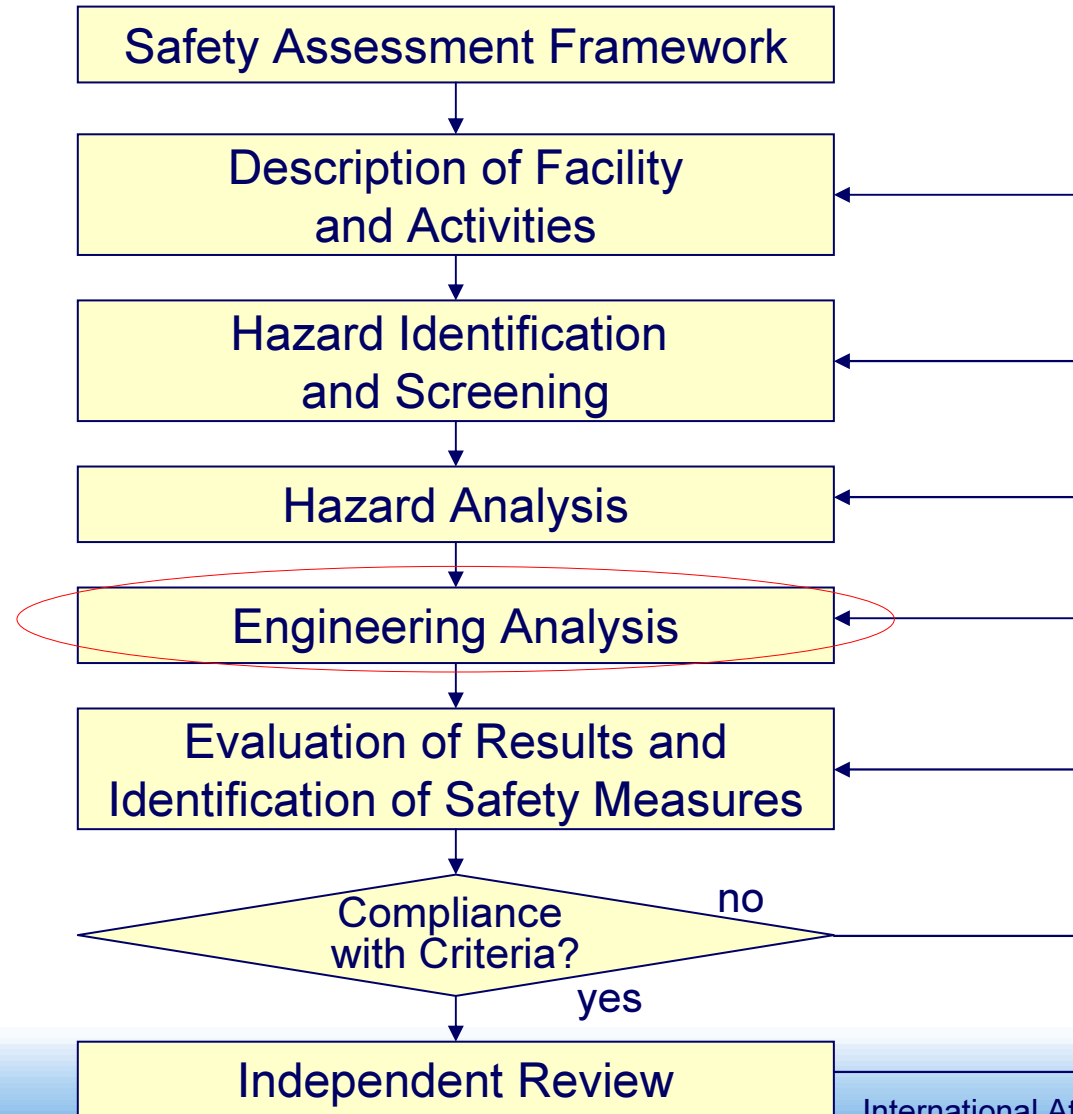
# **Engineering analysis**

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Workshop on Safety Assessment for  
Decommissioning of Research Reactors

4 – 8 October 2010, Risø (Denmark)

# Safety Assessment Methodology



# ENGINEERING ANALYSIS

- Safety Guide on Safety assessment for decommissioning (WS-G.5.2.) from 4.39 to 4.42
- Aim of safety assessment:
  - identify the safety functions related to decommissioning activities and associated structures, systems and components (SSCs)
- Safety assessment should determine whether the SSCs
  - are suitable and sufficient to achieve all functions assumed in hazard analysis
  - will achieve the required reduction of doses and risks with an appropriate level of confidence



# ENGINEERING ANALYSIS

- The safety assessment should demonstrate that existing SSCs will continue to ensure associated safety functions as long as it is required by the decommissioning plan, taking into account:
  - ageing and other degradation mechanisms
  - implementation of the decommissioning activities
    - demolition of supporting walls,
    - creation of a dusty environment, etc.



# ENGINEERING ANALYSIS

- The safety assessment should
  - identify any safety functions that require new engineered SSCs and
  - confirm that these will be suitable and sufficient to meet the relevant safety requirements and criteria
- The safety assessment should also identify any ongoing engineering requirements that need to be applied during decommissioning:
  - requirements for the inspection and controls
  - maintenance
  - testing of SSCs

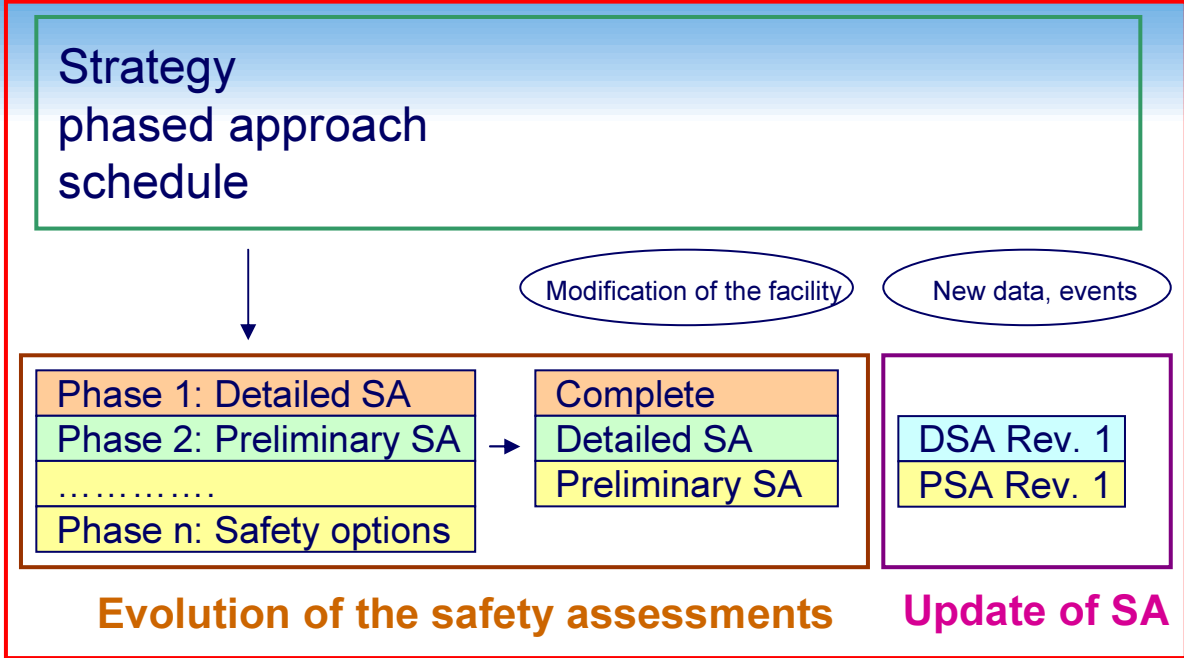


Overarching safety report

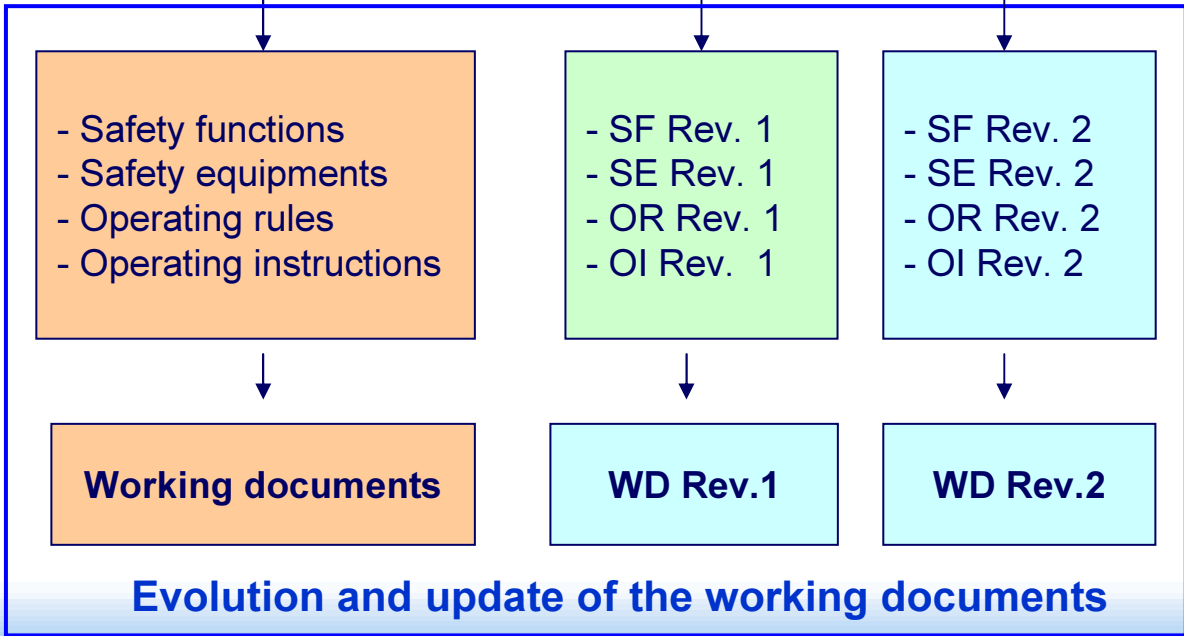
Safety assessments

Operating limits and conditions

Working procedures



Decommissioning conduct



Implementation of safety assessment results



# **Identification of Safety Related Systems, Structures and Components (SSCs)**



# What are SSCs and Why Identify Them?

- SSCs are all the engineered systems, structures and components that will have a safety related role during preparatory phase and implementation of decommissioning
- SSCs are identified to help ensure worker and public safety during decommissioning
  - often significantly different from 'operational' SSCs
  - provision of safety functions and associated SSCs should be performed by applying appropriate engineering codes and standards, commensurate with importance of safety function
- SSCs will often change as plant state changes
  - accurate change management will be required





# Hierarchy of Safety Controls

- Preferred types of Safety Control Measures:
  - 1. Inherent Safety Features
  - 2. Passive Safety Features
  - 3. Engineered Safety Controls
  - 4. Administrative Controls
  - 5. Use of Personal Protective Equipment
- However: breach of containment at some stage of decommissioning becomes inevitable
  - dependence on administrative controls will become dominant



# DeSa project: Research reactor test case

- Safety functions to be ensured during the conduct of the decommissioning activities of the research reactor are:
  - limitation of exposure to workers and the public
  - enclosure of radioactive material and avoidance of uncontrolled and unplanned release of radioactive material
- Safety related SSCs needed during decommissioning of the research reactor:
  - existing ventilation system,
  - existing fire detection system,
  - radiological monitoring system of the reactor hall
  - new storage cell to temporarily store radioactive waste
  - the existing reactor hall crane



# Use of SSC Categories and Risk Classes

- SSCs to support specific decommissioning activities will be derived from detailed safety assessments.
- Classification and Categorisation of activities and SSCs is fundamental to a graded approach and minimisation of assessment work.
- Approach to safety and engineering assessment: essentially deterministic
  - categorisation and classification systems are used to define 'Grading' in the level of assessment required
  - simple probabilistic tools can be used to good effect



# Risk classification

Consequence Level	Beyond Extremely and Unlikely $<10^{-6}$ pa	Extremely Unlikely $10^{-4}$ to $10^{-6}$ pa	Unlikely $10^{-3}$ to $10^{-4}$ pa	Anticipated $10^{-1}$ to $10^{-3}$ pa
High Consequence	3	2 SAR	1 SAR	1 SAR
Moderate Consequence	4	3	2 SAR	1 SAR
Low Consequence	4	4	3	3



# Engineering Schedule

## Classification of SSCs:

- **SSC Category 1** – Those SSCs that are principle means for the prevention/mitigation of significant public exposure and major worker exposure. Typically applied for Risk Class I accident scenarios.
  - **Requirement** – *Engineering assessment to be supported by detailed engineering investigations and calculations, assessment against national engineering codes and standards, review of operational experience, specification of surveillance programme requirements and a demonstration of fitness for purpose in meeting functional requirements under accident conditions.*
- Category 1 SSCs are not usually to be expected in a decommissioning safety assessment.



# Engineering Schedule

## Classification of SSCs:

- **SSC Category 2** – Those SSCs that make a significant contribution to the prevention/mitigation of decommissioning worker exposure, other workers on the site but a lesser public risk, where the risk is commensurate with Risk Class II accident scenarios.
  - **Requirement** – *The requirement is similar to SSC Category 1 items, but with an appropriately lesser level of detail in the engineering assessment.*
- Category 2 SSCs may be required in decommissioning safety assessments, but will not be commonly found in decommissioning applications.



# Engineering Schedule

## Classification of SSCs:

- **SSC Category 3** – Those that have only a minor contribution in the prevention/mitigation of worker exposure. Typically applied to Risk Class III accident scenarios.
  - *Requirement* – The requirement will be to demonstrate adequate functionality and performance only based on records or/and a structured plant walkdown to demonstrate that the facility is in good condition and in accordance with engineering drawings.
- This will be the category of SSC often found in decommissioning safety assessments.



# Engineering Schedule

## Classification of SSCs:

- **SSC Category 4** – Those that make only slight contribution to the prevention/mitigation of worker exposure. Category 4 SSCs may be applied in Risk Class IV accident scenarios.
  - **Requirement** – *The only requirement is to register the SSCs in the facility surveillance programme, and may only be required to be considered for response when they become not functional.*





# Alternative categorization

- Alternative categorization for engineered barrier providing mitigation of potential consequences
  - Category 1 –  $> 250\text{mSv}$  to workers or  $>10\text{mSv}$  to the public
  - Category 2 – range of  $20 - 250\text{mSv}$  to workers or  $0.1 - 10\text{mSv}$  to the public
  - Category 3 – range of  $2-20\text{ mSv}$  to worker or  $0.01 - 0.1\text{mSv}$  to the public, i.e. minor consequences
  - Category 4 –  $< 2\text{mSv}$  to worker or  $<0.01\text{mSv}$  to the public, i.e. insignificant consequences
- For a typical decommissioning project:
  - none of the SSCs in category 1
  - few SSCs would be in Category 2 (e.g. ventilation failure alarm, respiratory protective equipment etc.)

