International Atomic Energy Agency

Evaluation of Results and Identification of Safety Measures

S. Thierfeldt, Germany

Workshop on Safety Assessment for Decommissioning of Research Reactors

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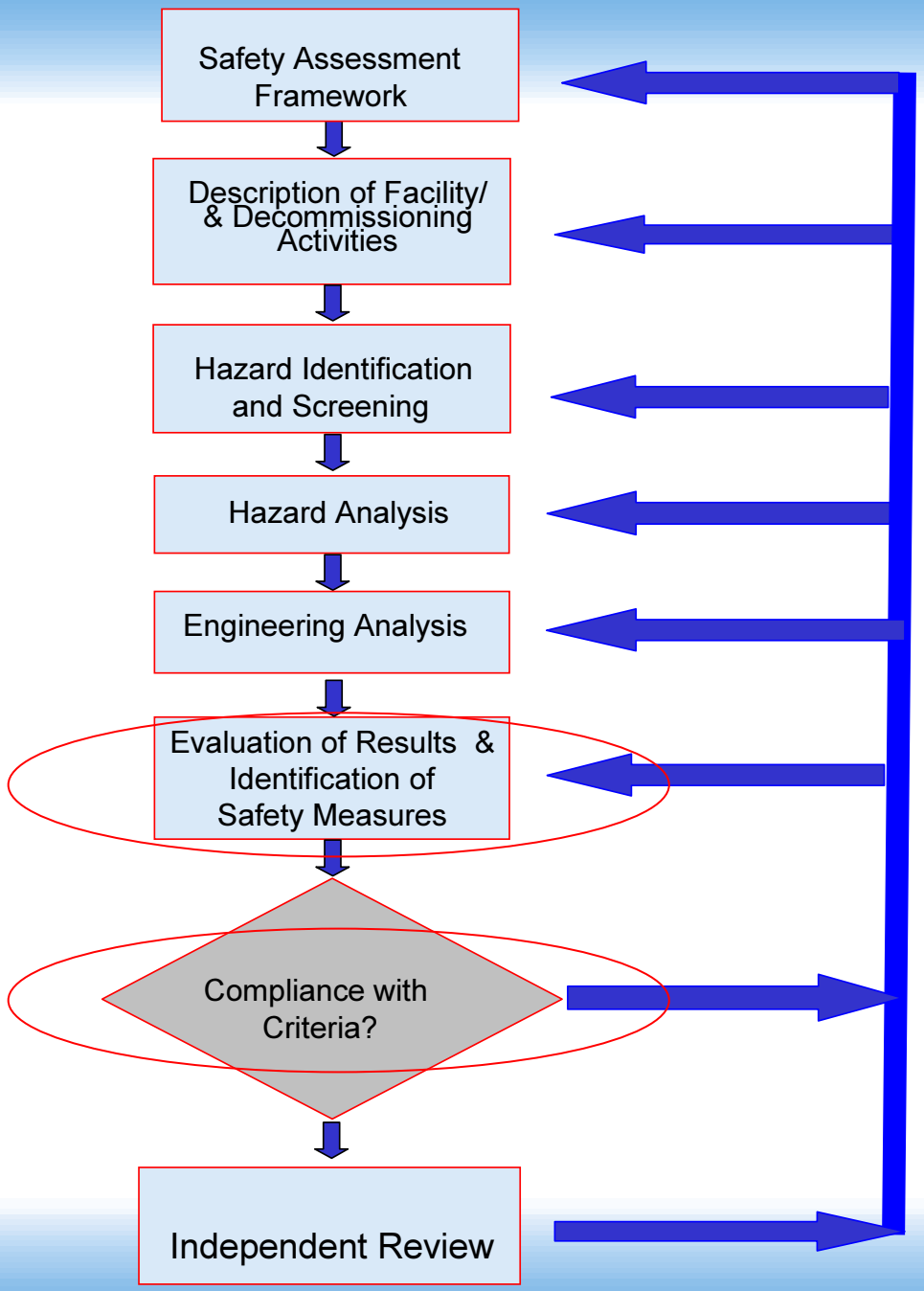
Safety Assessment Methodology



Evaluation of Results / Identification of SMs Basics

- Safety Assessment:
- demonstrate compliance with regulatory requirements and criteria

- Sensitivity analysis
  - identify and assess those parameters and values with highest impact on assessment results, possible consequence
  - further effort to reduce uncertainties & repetition of the safety assessment
- Demonstration that adequate safety measures are in place
  - Engineered measures
  - Procedural measures

Evaluation of Results / Identification of SMs Basics

- Assumptions and results need to be adequately documented, including:
  - Uncertainties or assumptions in case of data missing
  - Clear indication where assumption rely on provision of new safety measure or continuation of existing safety measures
  - Indication of level of confidence or results or of safety margins
  - Indication of future actions, if needed
- In case of non-compliance
  - Repetition of the Safety Assessment after appropriate adaptations
  - Use results of Safety Assessment to direct effort for updates and modifications

Evaluation of Results / Identification of SMs Basics

- In case of compliance
  - Safety Assessment becomes subject of independent review
    - conducted on behalf of the operator
    - prior to finalizing the Safety Assessment
    - before submission to regulatory body
    - reviewers shall be independent from those involved in decommissioning planning and from safety assessors
  - Objectives are to ensure that
    - input data and assumptions are valid
    - SA reflects actual state of facility and of planned activities
    - safety measures are adequate for decomm. activities
    - safety assessment is kept updated

Details – Comparison of Analysis Results

- Comparison of the Safety Assessment results with regulatory requirements and criteria
  - Basis: regulatory requirements and criteria as defined in the Assessment Framework
  - Analysis results need to be expressed in terms of the proposed assessment outputs, also defined in the Assessment Framework
  - Draw a clear conclusion on the compliance

Details – Comparison of Analysis Results Examples from DeSa Test Cases

- NPP Test Case – Excerpt of summary table

Criterion	Value	Assessment outcome
Normal decommissioning operations		
Worker dose	20mSv/a	14mSv/a.maximum identified
Public dose (constraint)	0.15mSv/a	Less than 2 10^{-6} mSv/a
Fault conditions		
Worker dose	20mSv/a	Maximum of 90mSv per event, if unmitigated. When mitigated - insignificant
Public dose	None set	Insignificant
Fault conditions		
Consequences – defence in depth requirement		
Worker fault protection – higher consequences	2 layers specified (i.e. number of independent complete safety measures)	3 layers identified in the most demanding scenario. This bounds the other scenarios discussed in detail in Appendix C.

Details – Comparison of Analysis Results Examples from DeSa Test Cases

- Research Reactor Test Case
  - Regulatory requirements and criteria are
    - dose limits
    - dose constraints
    - ALARA principle to be implemented
    - conditions for clearance of the reactor hall for release for unrestricted use
  - All regulatory requirements and criteria are met under normal scenarios and under accident scenarios

Details – Assumptions and Uncertainties

- Safety assessment needs to be conservative
  - but not over-conservative
  - conservatism in the assumptions allow to simplify the Safety Assessment (may allow easier implementation and interpretation of the results)
- In decommissioning projects, data / information required for the Safety Assessment may not be available
  - consequence: compensation by bounding assumptions or
  - strategies to gain necessary data / information by sampling, measurements, stocktaking, update of plans and drawings etc.

Details – Assumptions and Uncertainties

- Typical areas for assumptions are
  - on current conditions and existing construction details of building structures and systems / detailed plant knowledge due to inadequate design records
  - uncertainty in nuclear material inventory and location
  - volumes of different waste streams that will arise
  - activity levels and radionuclides in inaccessible areas
  - uncertainties in the analysis models and codes
- Typical sources for such assumptions:
  - similar decommissioning projects
    - e.g. activity inventory, activation calculations etc.
  - plausible assumptions on the basis of expert judgement

Details – Safety Measures

- Two classes of Safety Measures
  - Engineered
  - Administrative or procedural control
- Complementary categorization of Safety Measures:
  - General safety measures (controls) resulting from the safety management program of the operator (e.g. for conventional work safety)
  - Specific safety measures (controls) resulting form the Safety Assessment (e.g. a ventilation system)
  - Safety measures (controls) resulting from task-specific safety assessments of work packages (e.g. during a detailed work planning in the framework of the work described in the decommissioning plan) (e.g. personal protective equipment)

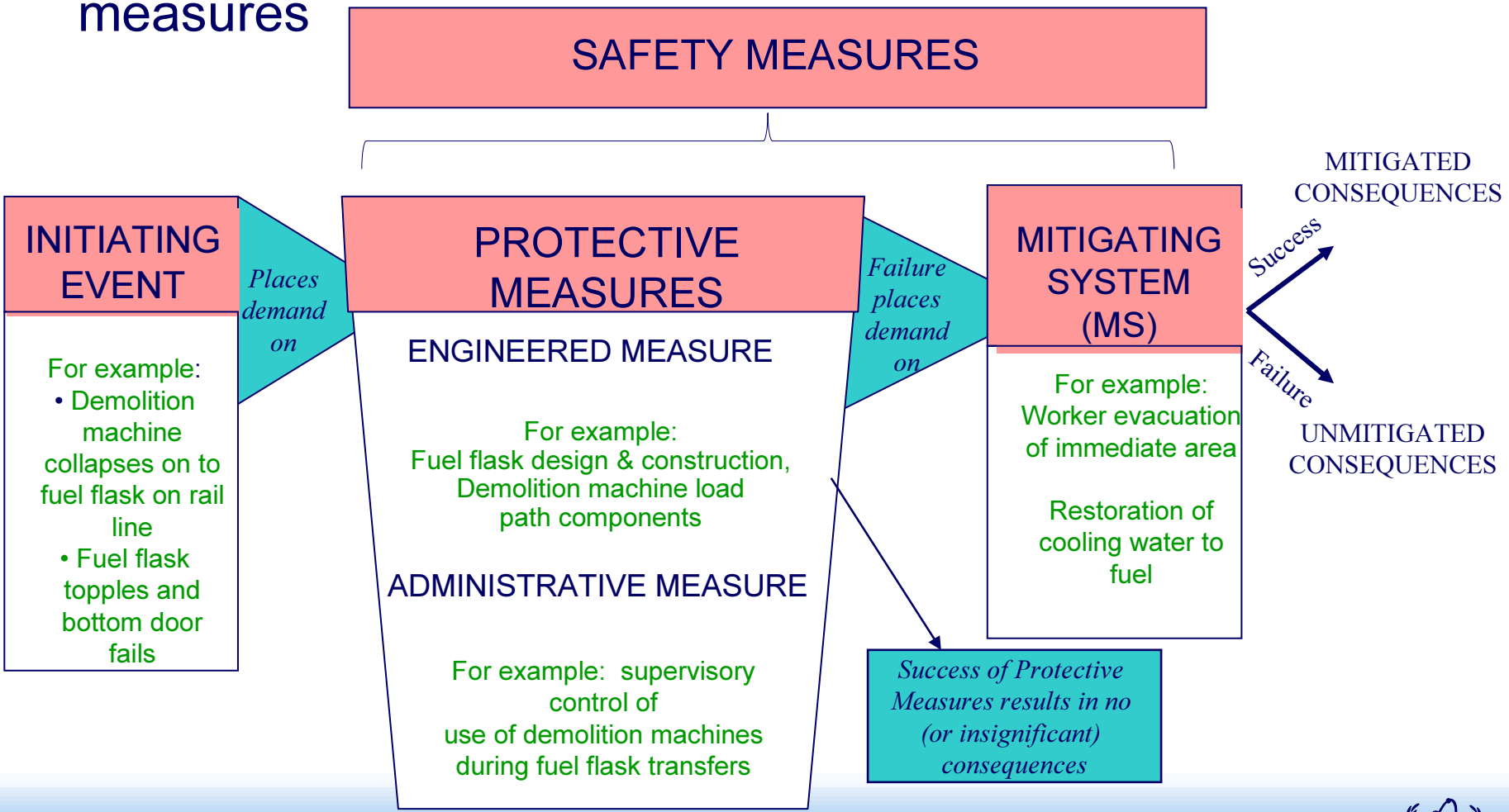
Details – Safety Measures

- 3 categories of administrative safety measures

	Degree of specificity of Administrative Controls→		
	General	***Specific***	***Task Specific***
Nature of administrative control	Compliance with the site safety management programme	Limits and conditions for safe operation arising from nuclear safety assessment	Safety controls resulting from task-specific safety assessment
When to apply	For all work whether the hazards are radiological or only conventional in nature	While the nuclear hazard potential requires 'limits and conditions' for safe operation	For all work whether the hazards are radiological or only conventional in nature
Level of importance of administrative control-	Important for legal and regulatory compliance to ensure general safety of workforce	Important for controlling nuclear and radiological hazards identified in safety assessment	Important for legal and regulatory compliance to ensure safety of workforce on specific tasks

Details – Safety Measures

- How Safety Measures "work" – combination of individual measures



Details – Safety Measures

- How Safety Measures “work” – reduction of consequences

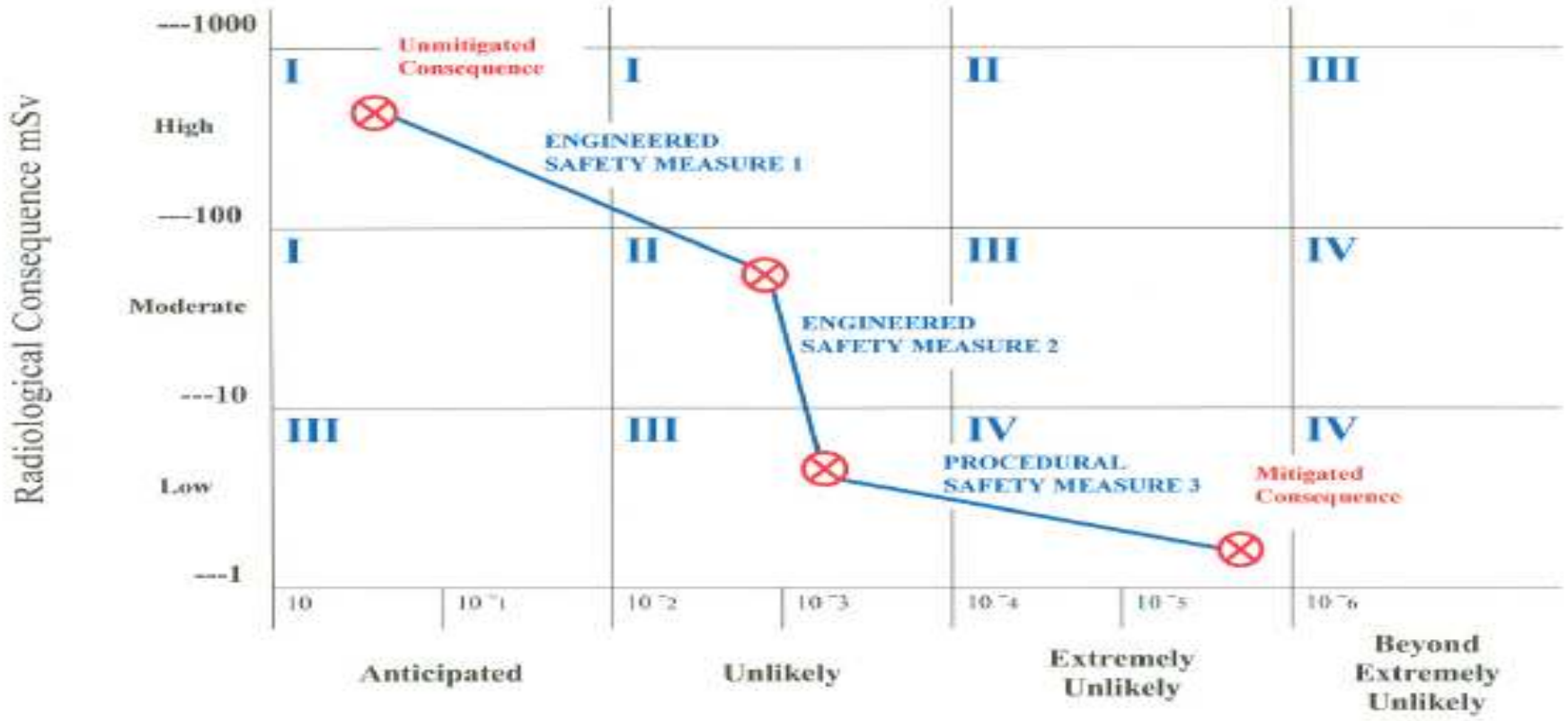


Figure: Risk Classification System For Accident Scenarios

Details – Safety Measures

- Safety Assessment has to demonstrate the conditions that must apply for the specific Safety Measures
- Safety Measures typically will change with progress of decommissioning, especially from phase to phase, consequence among others
  - Safety Assessment needs to include a clear discussion on the derivation of the safety measures proposed to provide a safe working envelope
- Engineered safety measures are considered preferable, but there will be more reliance on administrative safety measures with progress of the decommissioning activities
- At some point, specific safety measures are not more needed and the general and task specific safety measures are sufficient to ensure safety.

Details – Safety Measures
Examples from DeSa Test Cases

- NPP Test Case – Safety Measure (excerpt)

No. of SM	Engineered Safety Measures (SSCs)	Associated Administrative Safety Control Measures
1	Personal dose meters that incorporate an alarm on dose	System of calibration. System of control of issue and recording of results. System to relate recorded results to approved dosimetry records, and to engineering work packages. Adequate training to support the above. Adequate training to wearers of personal dose meters.
2	Ventilation extract for local enclosures, fitted with fans Temporary enclosure for cutting operations.	Standard for construction and testing of tented enclosures.
3	Alarm for failure of local ventilation extract	Carry out routine testing and maintenance of alarm before each work period. System of calibration.

Details – Safety Measures
Examples from DeSa Test Cases

- NPP Test Case – Specific Safety Measure (excerpt)

Description	**Safety Function**	**Internal Reference**
Procedures to be Implemented		
Systems 321 and 322 are isolated from water feeds. In particular, System 321 is isolated from the primary circuit by blanks inserted between the twin isolation valves (numbers xx1 and xx2).	This removes any interactions between the decommissioning of System 321 and the rest of the nuclear plant.	Section 1.2 in Part 1
High dose rate jobs are planned such that a target dose for each job must be defined.	To define the boundary of intended operations with respect to dose.	Scenario 01 in Part 2
Workers must be issued with personal dose meters that incorporate an alarm on dose, with the alarm level set at a lower dose than the target dose for the job	To enable workers to evacuate when the dose approaches the limits of intended operation.	Scenario 01 in Part 2

Details – Safety Measures
Examples from DeSa Test Cases

- Research Reactor Test Case
  - Engineering systems
    - Air monitoring systems
    - Fire detection systems of the reactor hall
    - Covering of the biological shield and local ventilation during dismantling
    - General ventilation in the reactor hall
  - Administrative / Procedural controls
    - Preparation of work activities
    - Control of work activities
    - Task specific controls (e.g. use of remote tools, dust & breathing masks, local ventilation system as pre-requisite for work conduct)
    - Ensure reliable protection of the workers by use of personal protective equipment
  - In addition: further procedural controls and measures to ensure conventional safety
  - Note: quality management ensures availability of Safety Measures

Summary/Conclusions

- Safety Measures and analysis results need to be evaluated:
  - role of the Safety Measures has to be clearly defined and described
  - Safety Measures have to be reliable available at the time needed

- Analysis results need to be expressed in terms of the Assessment Output to allow a comparison with regulatory requirements and criteria
  - If no compliance is achieved, the planning of the decommissioning activities, input parameters for the Safety Assessment or else need to be revised and updated
  - Only in case of compliance, the Safety Assessment may be submitted to the regulatory body