The Use of the IAEA Safety Case Concept in Management of Near-Surface Disposal

PRISM components and Approaches

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International Atomic Energy Agency

Overview

- The concept of Safety Case in the IAEA
- The concept of Safety Case for Near Surface disposal: PRISM components and Approaches
- Focus on Task 1: Understanding the Safety Case
- Link with other tasks

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The concept of Safety Case in the IAEA

- The concept of Safety Case has been circulated for many years now.
- The NEA defines the Safety Case as : “The synthesis of evidence, analyses and arguments that quantify and substantiate a claim that the repository will be safe after closure and beyond the time when active control of the facility can be relied on”.
- IAEA defines it as the collection of arguments and evidence to demonstrate the safety of a facility.
- The SC has to be developed in the early phases of the development of a project. For the operator as a basis for internal decisions (R&D, site selection and evaluation, design conceptualization…) as well as for dialogue with the regulator

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The concept of Safety Case in the IAEA

- IAEA approach of the SC for disposal is mainly given in:
  - Safety requirements (SSR -5) on Disposal of Radioactive Waste addressing SC
  - Specific Safety Guide on SC and SA (DS355) in final process of development
  - These documents cover all types of radioactive waste that require specialized disposal facilities
  - In addition, one safety guide on near surface disposal facilities in development

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The concept of Safety Case in the IAEA

- **Requirement 12: Preparation, Approval and use of the safety case and safety assessment for a disposal facility**

"A safety case and supporting safety assessment shall be prepared and updated by the operator, as necessary, at each step in the development of a disposal facility, in operation and after closure. The safety case and supporting safety assessment shall be submitted to the regulatory body for approval. The safety case and supporting safety assessment shall be sufficiently detailed and comprehensive to provide the necessary technical input for informing the regulatory body and for informing the decisions necessary at each step"

- **Requirement 13: scope of the Safety Case and safety assessment**

The safety case for a disposal facility shall describe all safety relevant aspects of the site, the design of the facility, and the managerial control measures and regulatory controls. The safety case and supporting safety assessment shall demonstrate the level of protection of people and the environment provided and shall provide assurance to the regulatory body and other interested parties that safety requirements will be met"

- **Requirement 14: Scope of the Safety Case and Safety Assessment**

The safety case and supporting safety assessment for a disposal facility shall be documented to a level of detail and quality sufficient to inform and support the decision to be made at each step and to allow for independent review of the safety case and supporting safety assessment"

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The concept of Safety Case in the IAEA

- Number of member states questioned themselves on the real significance of safety case as well as safety assessment, the linkage and differences between both concepts.

- Terminology used for Safety Case can differ from country to country (“Dossier de Sûreté” i.e. “Safety File”, Safety Report, Performance assessment report…)

- This can create confusion

- In practice, the SC is a collection of different reports related to the disposal project (including the documentation related to the basic data (geology, hydrogeology, chemistry, waste inventory…), the design, the safety approach, the evolution scenarios…) that substantiate the demonstration of safety of the disposal

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Components of the safety case

- Safety case Context:
  - Purpose of the safety case
  - Demonstration of safety
    - Safety objectives
    - Safety principles
  - Graded approach
- Safety Strategy
- Description of the disposal system

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Components of the safety case

- Safety Assessment
  - Radiological impact assessment
  - Site and engineering aspects
    - Passive safety
    - Robustness
    - Scientific and engineering principles
    - Quality of the site characterization
  - Operational Safety Aspects
  - Non-radiological environmental aspects
  - Management system
- Management of uncertainties
- Iteration and design optimization
- Limits, controls and conditions

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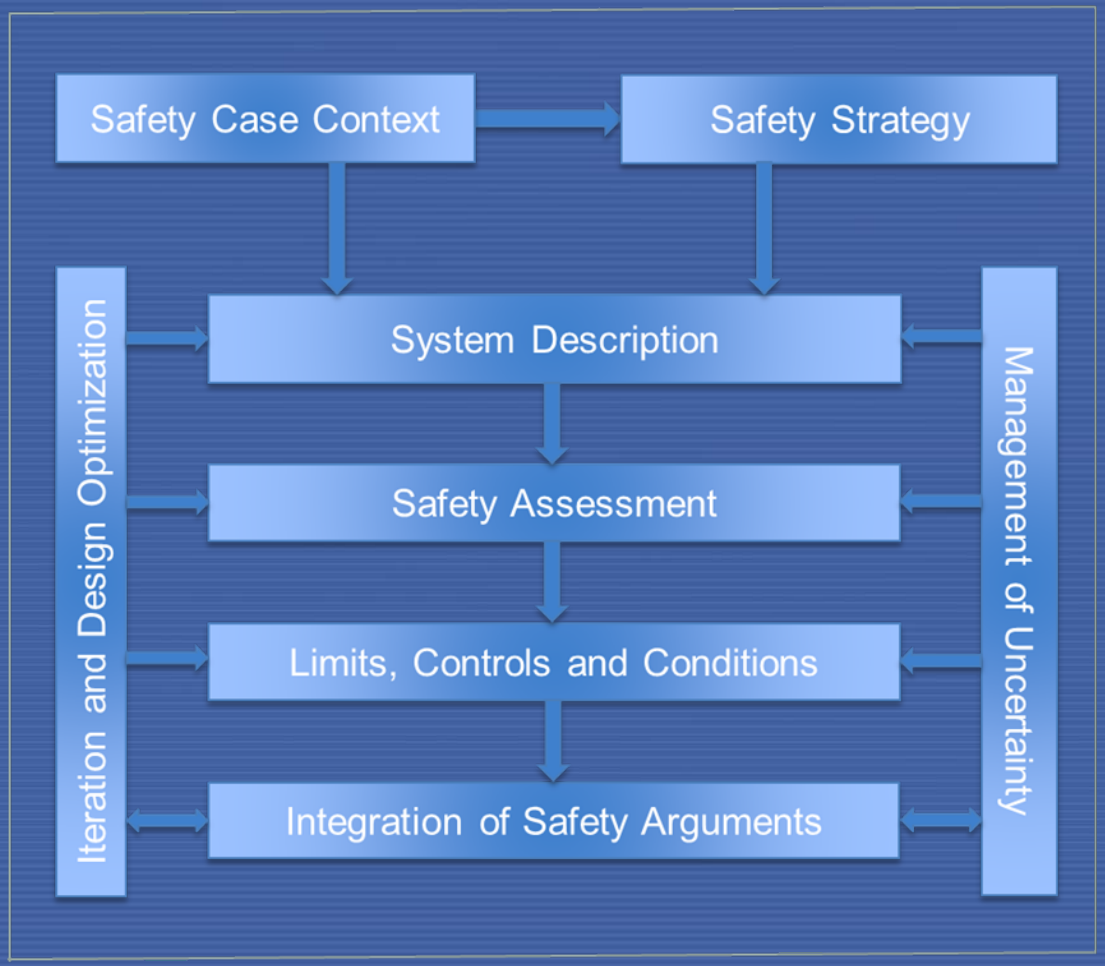
Components of the safety case

- Integration of safety arguments
  - Comparison with safety criteria
  - Complementary safety indicators and performance indicators
  - Multiple lines of reasoning
  - Plans for addressing unresolved issues
- Interacting processes
  - Involvement of interested parties
  - Independent review
  - Management system

Components of the safety case



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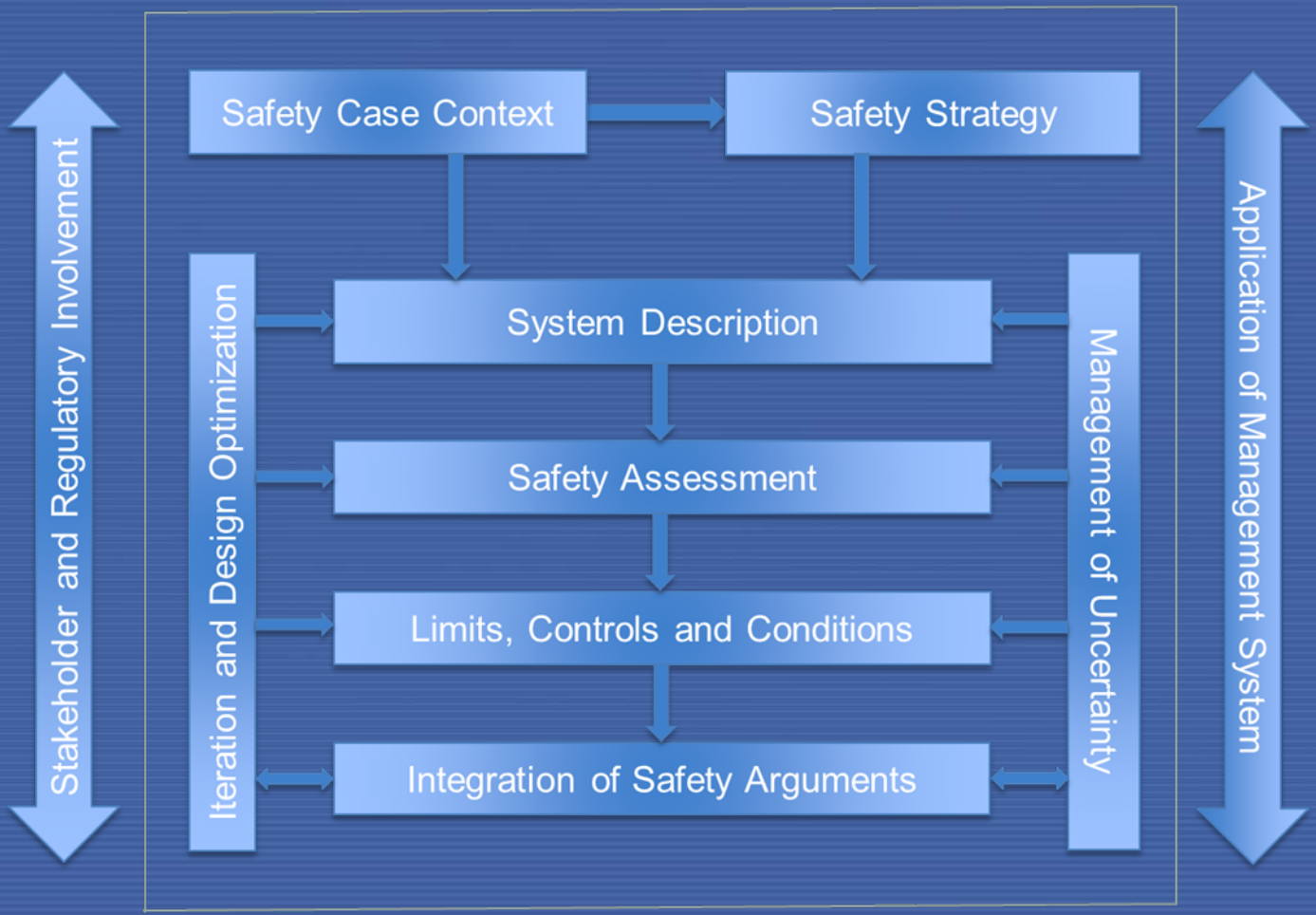
Management system - Regulatory and Stakeholder involvement processes



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Safety Assessment

Aims at:

- evaluating the soundness of the safety strategy
- verifying that the disposal performs such as adequate levels of protection of man and environment are reached
- During this step the « global » performance of the disposal project is evaluated against plausible situations (scenarios).
- Provide an input for the treatment of uncertainties
- Contribute to provide a hierarchy of the studies deserving particular attention and that should be implemented in the next stage of project development.

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SA: component of the SC

- Safety assessment relies to qualitative and quantitative assessment of elements relevant for the safety of the development, operation and closure of the disposal facility.
- Safety assessment is part of the safety case
- Radiological impact calculation is an important component of the safety assessment.
- Safety assessment also covers the evaluation of the qualitative and quantitative performances of the disposal project.

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SA: component of the SC

For example, calculations should address:

- the verification of the favourable behaviour of the disposal components when no interactions are expected, individually and globally
- the evaluation of the disturbances caused by the interactions between the different disposal components and the assessment of the consequences of those disturbances on safety functions
- the modelling of the future behaviour of the repository for specific scenarios
- checking that individual exposure is acceptable.
- The results can be presented in terms of various indicators of the performances of the disposal as activity fluxes, concentrations, ratios, or doses if needed.

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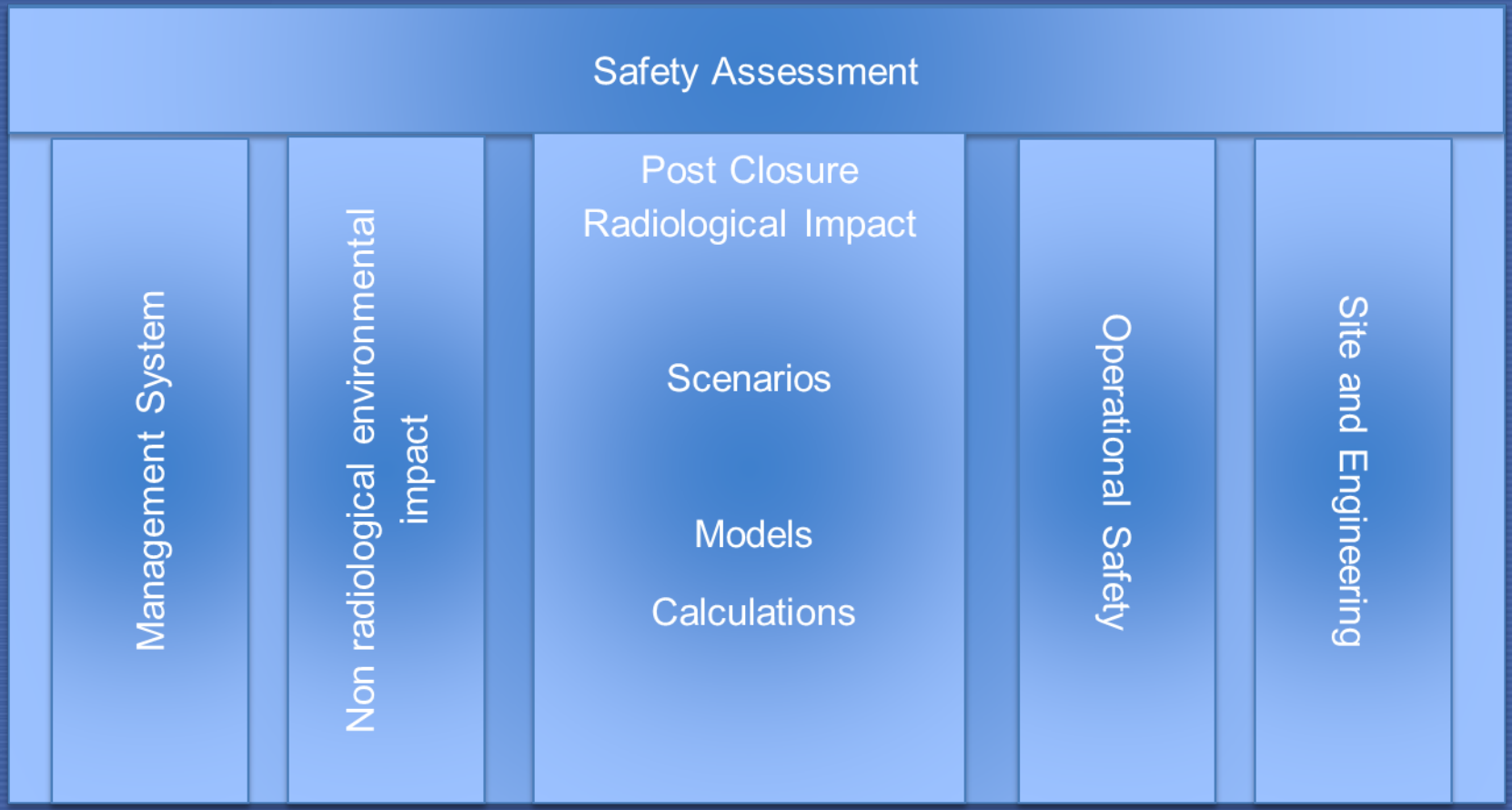
Safety Assessment Aspects



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The IAEA concept of SC

- Not specific to Near Surface disposal
- Valid for all types radioactive waste that requires specialized disposal facilities
- However there are specificities for near surface disposal facilities
- PRISM specifically addresses the concept of SC for Near Surface disposal facilities

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PRISM Task 1 – Understanding the Safety Case

- **Requirement 14: Scope of the Safety Case and Safety Assessment**

  The safety case and supporting safety assessment for a disposal facility shall be documented to a level of detail and quality sufficient to inform and **support the decision to be made at each step** *and to allow for independent review of the safety case and supporting safety assessment"*

➔ Questions

1. Which "decision step" are concerns by the requirement 14?
2. Who are the decision-makers?
3. What are the relevant safety case argument in relation with the decision step?

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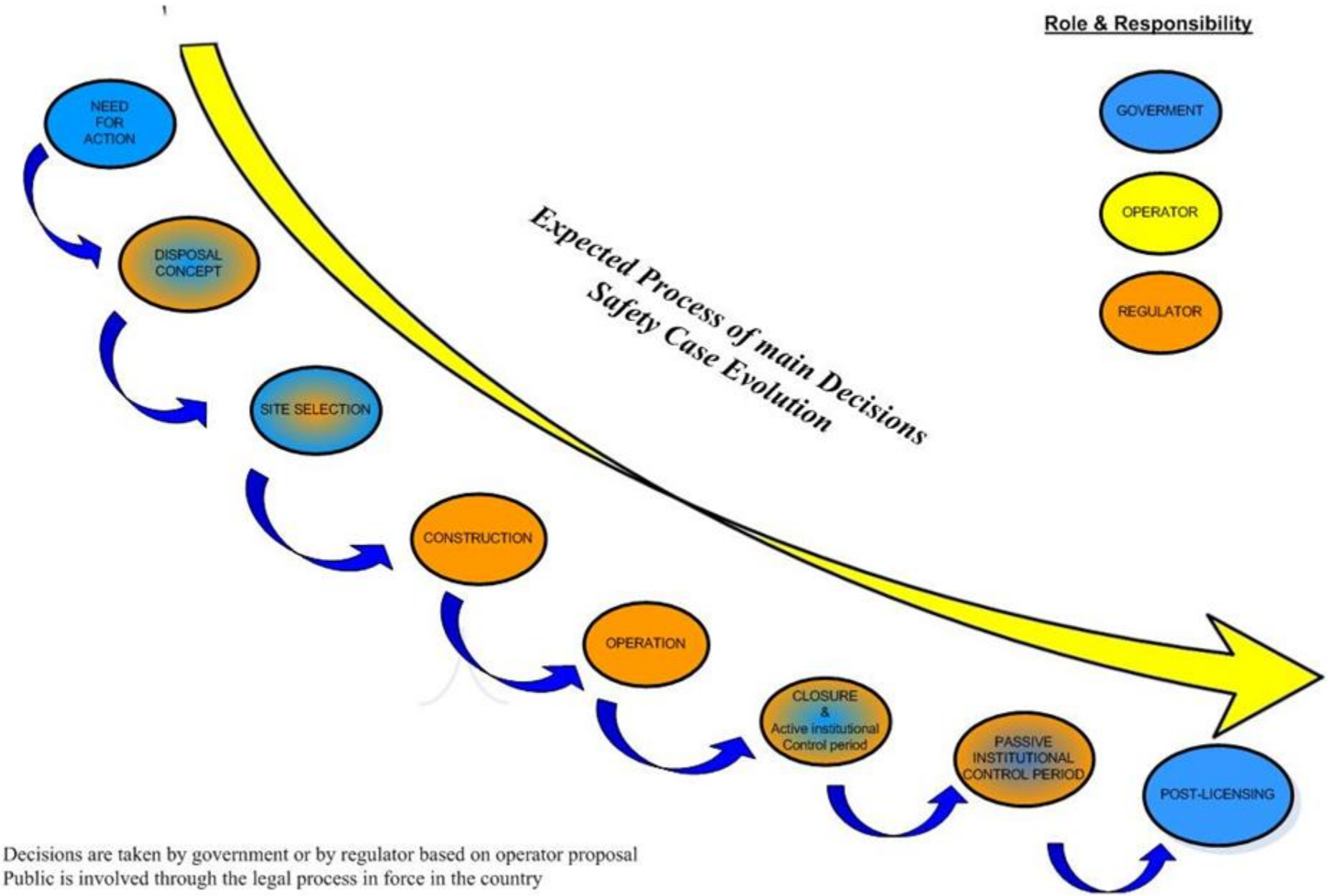
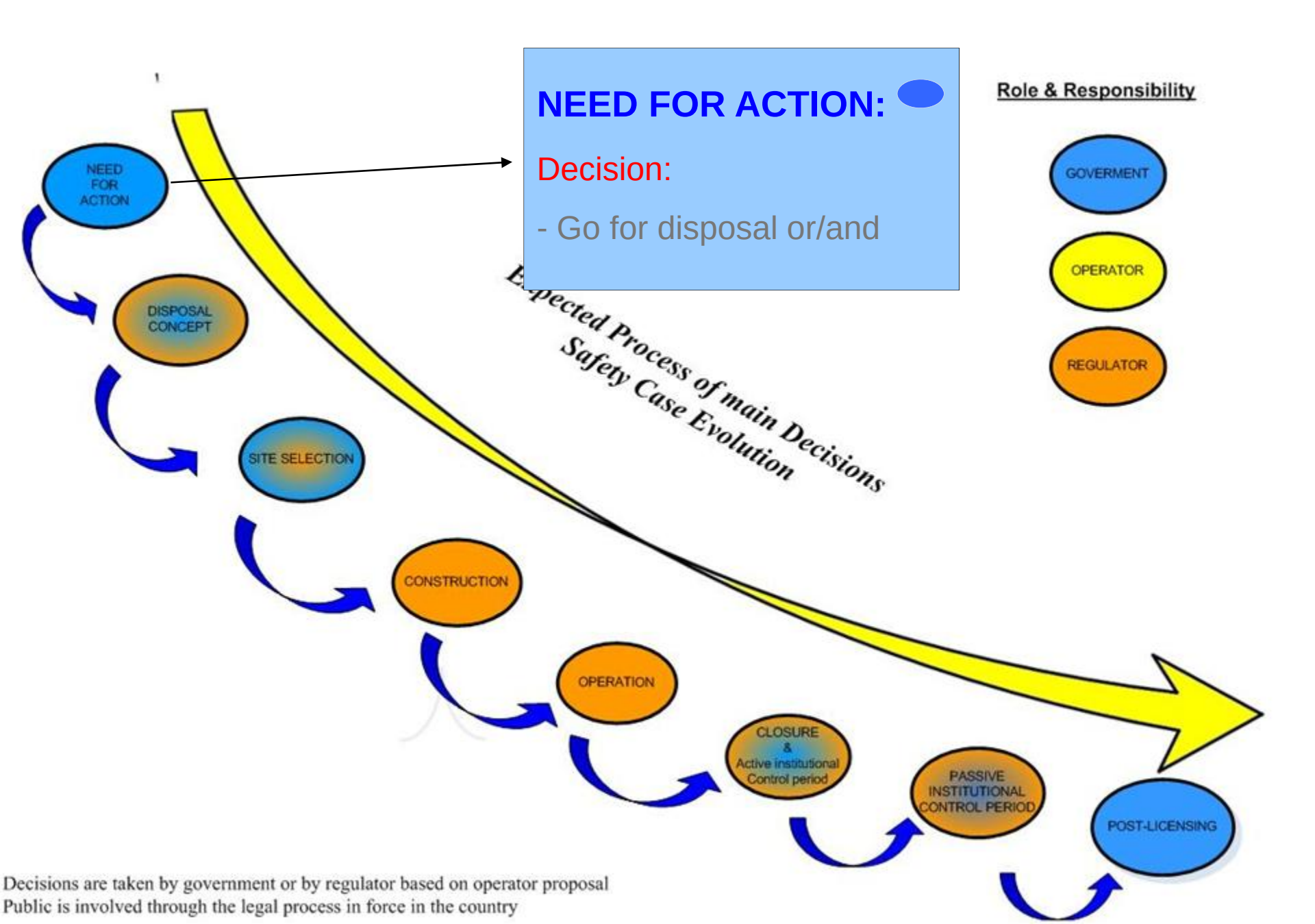
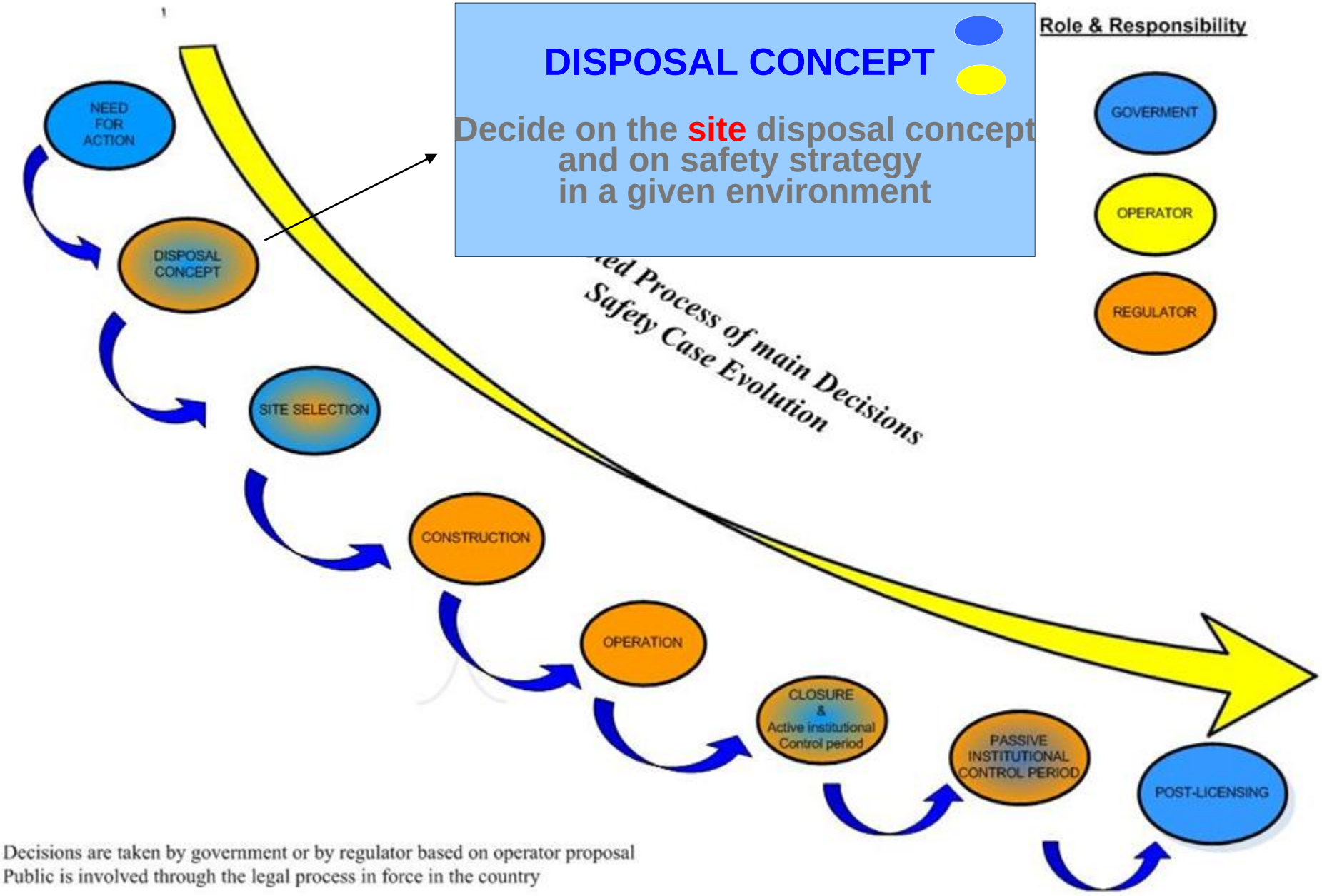


Decisions are taken by government or by regulator based on operator proposal
Public is involved through the legal process in force in the country


NEED FOR ACTION:
Decision:
- Go for disposal or/and
Role & Responsibility
GOVERMENT
OPERATOR
REGULATOR
NEED FOR ACTION
DISPOSAL CONCEPT
SITE SELECTION
CONSTRUCTION
OPERATION
CLOSURE & Active institutional Control period
PASSIVE INSTITUTIONAL CONTROL PERIOD
POST-LICENSING
Expected Process of main Decisions
Safety Case Evolution
Decisions are taken by government or by regulator based on operator proposal
Public is involved through the legal process in force in the country


DISPOSAL CONCEPT
Decide on the site disposal concept
and on safety strategy
in a given environment
Role & Responsibility
GOVERMENT
OPERATOR
REGULATOR
NEED FOR ACTION
DISPOSAL CONCEPT
SITE SELECTION
CONSTRUCTION
OPERATION
CLOSURE & Active institutional Control period
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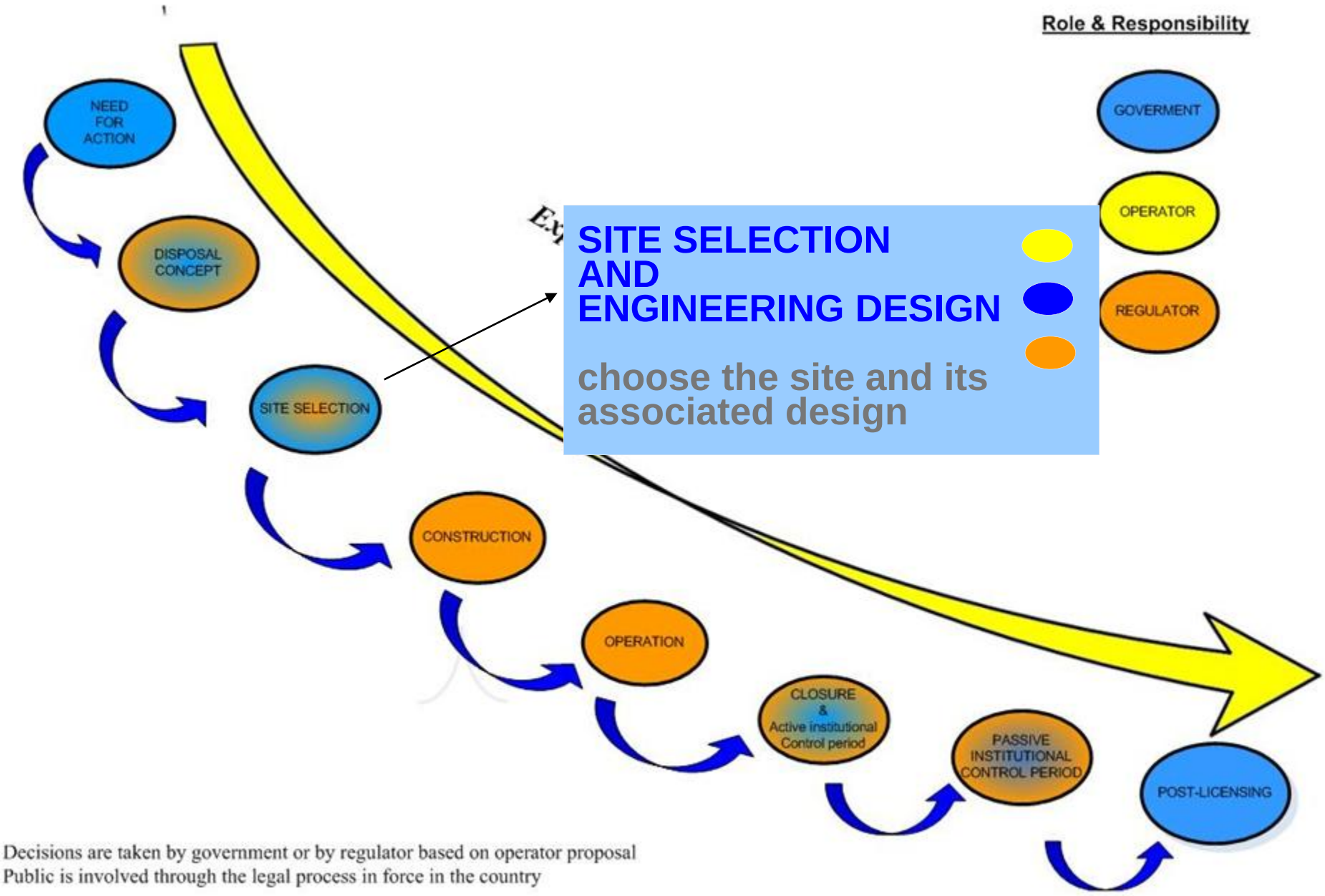

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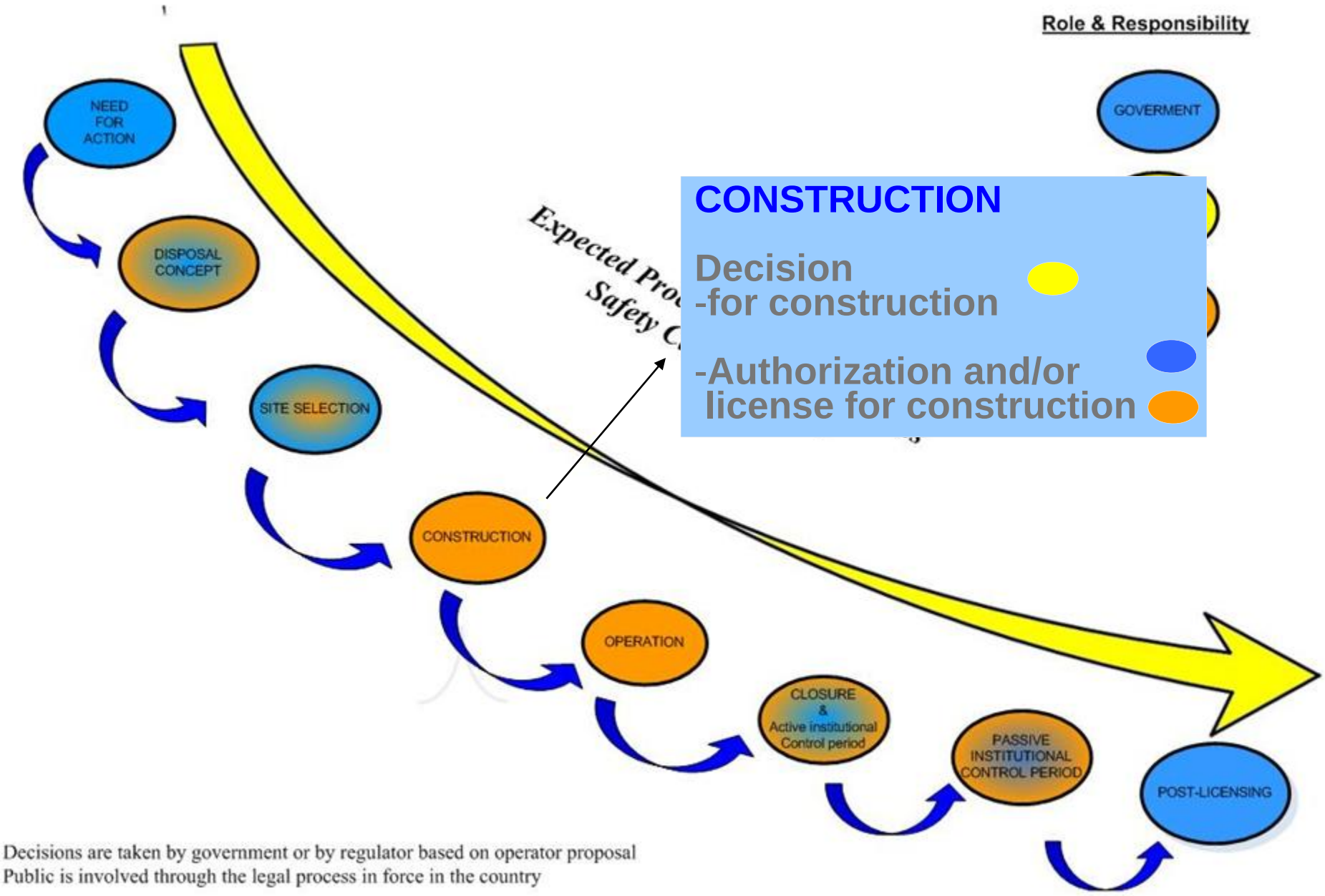

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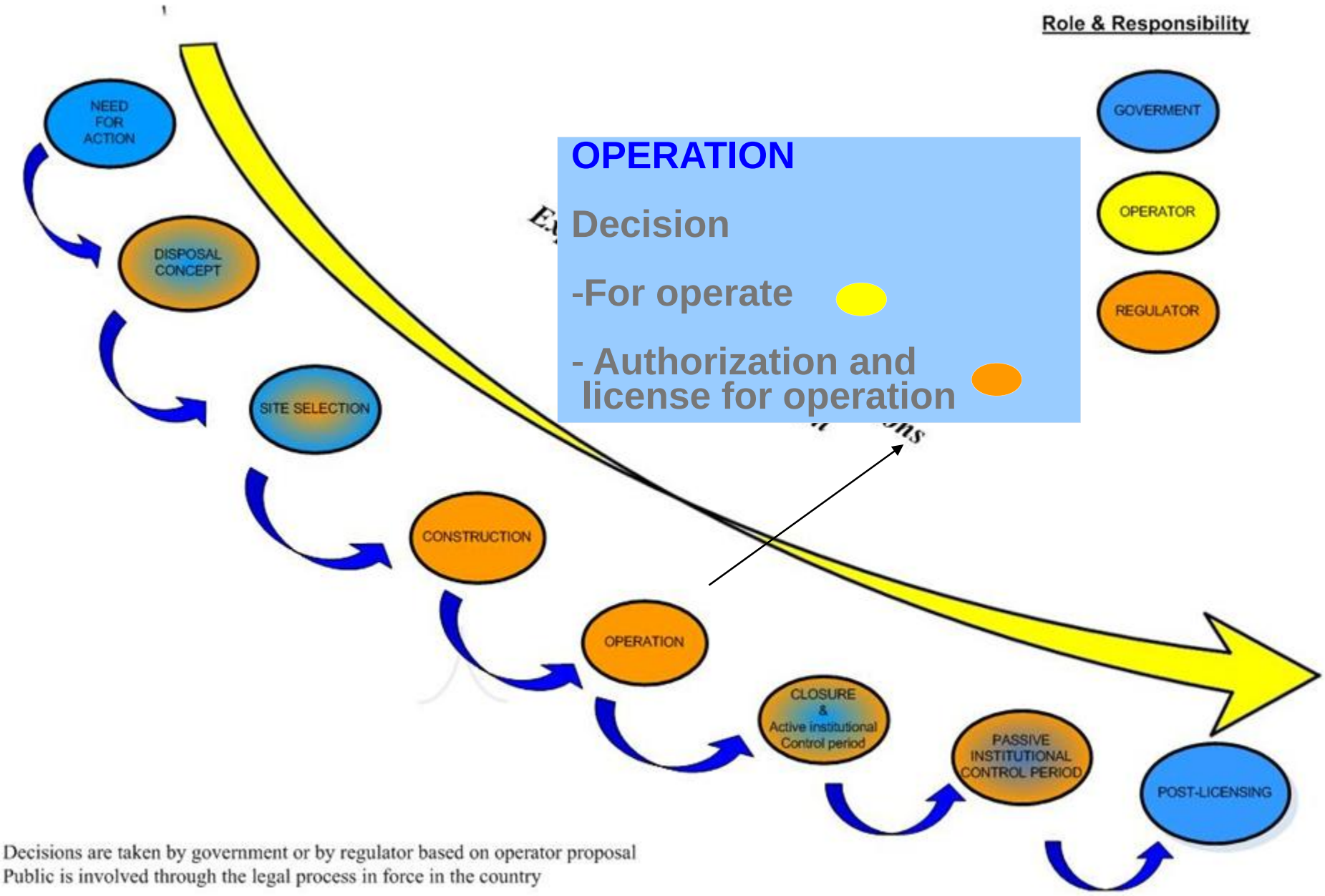
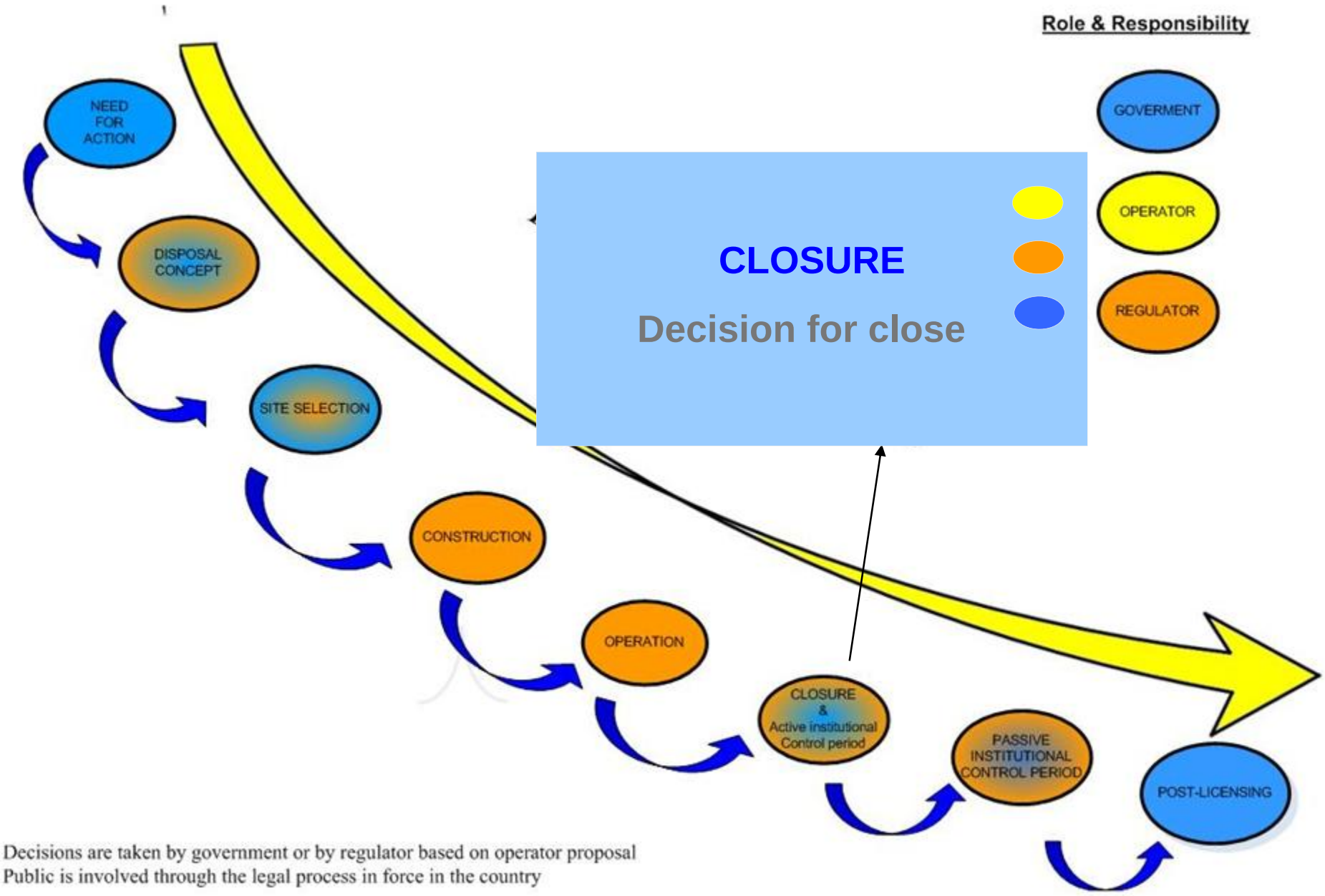

Role & Responsibility
NEED FOR ACTION
DISPOSAL CONCEPT
SITE SELECTION
CONSTRUCTION
OPERATION
CLOSURE & Active institutional Control period
PASSIVE INSTITUTIONAL CONTROL PERIOD
POST-LICENSING
GOVERMENT
OPERATOR
REGULATOR
OPERATION
Decision
-For operate
- Authorization and license for operation
Decisions are taken by government or by regulator based on operator proposal
Public is involved through the legal process in force in the country



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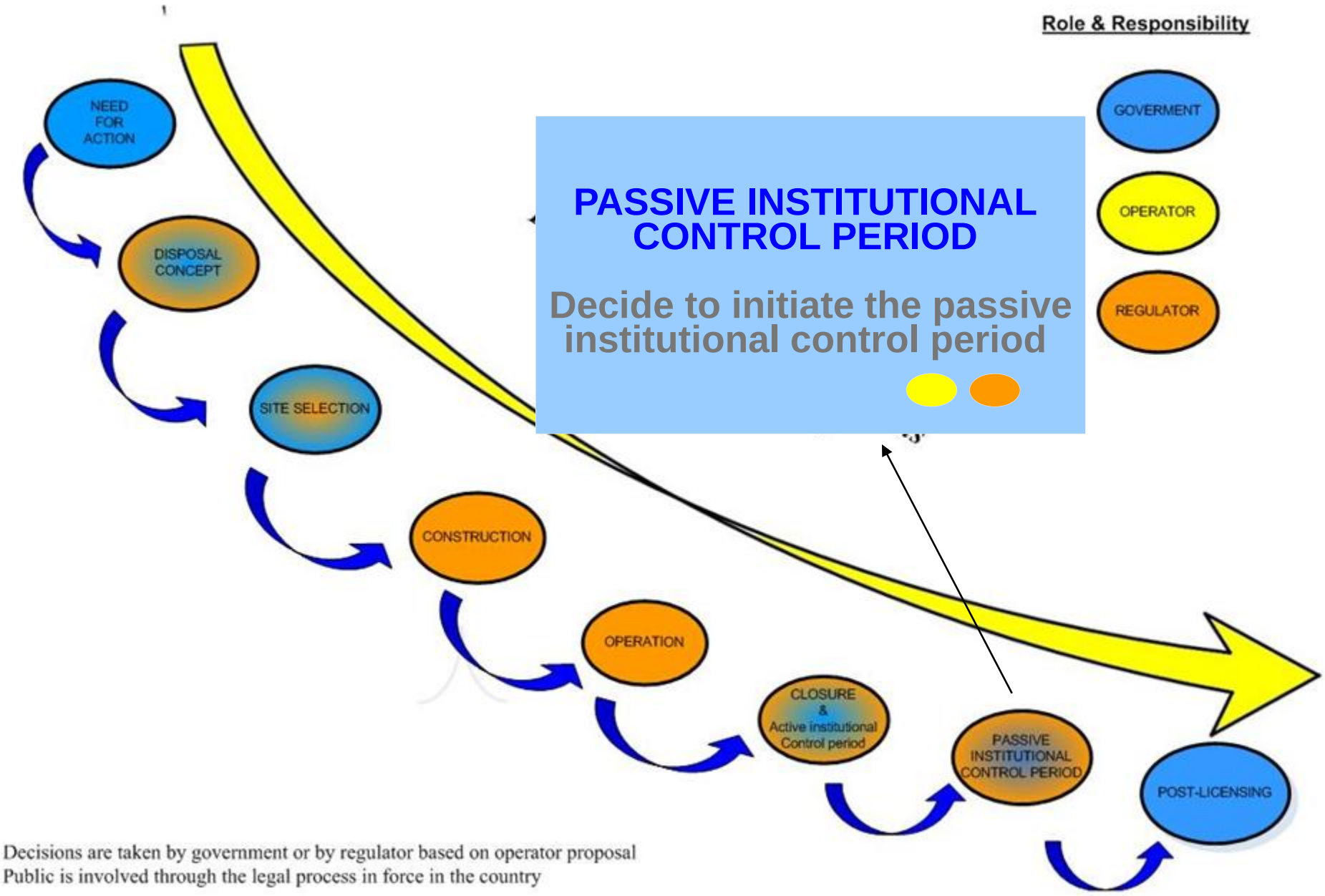

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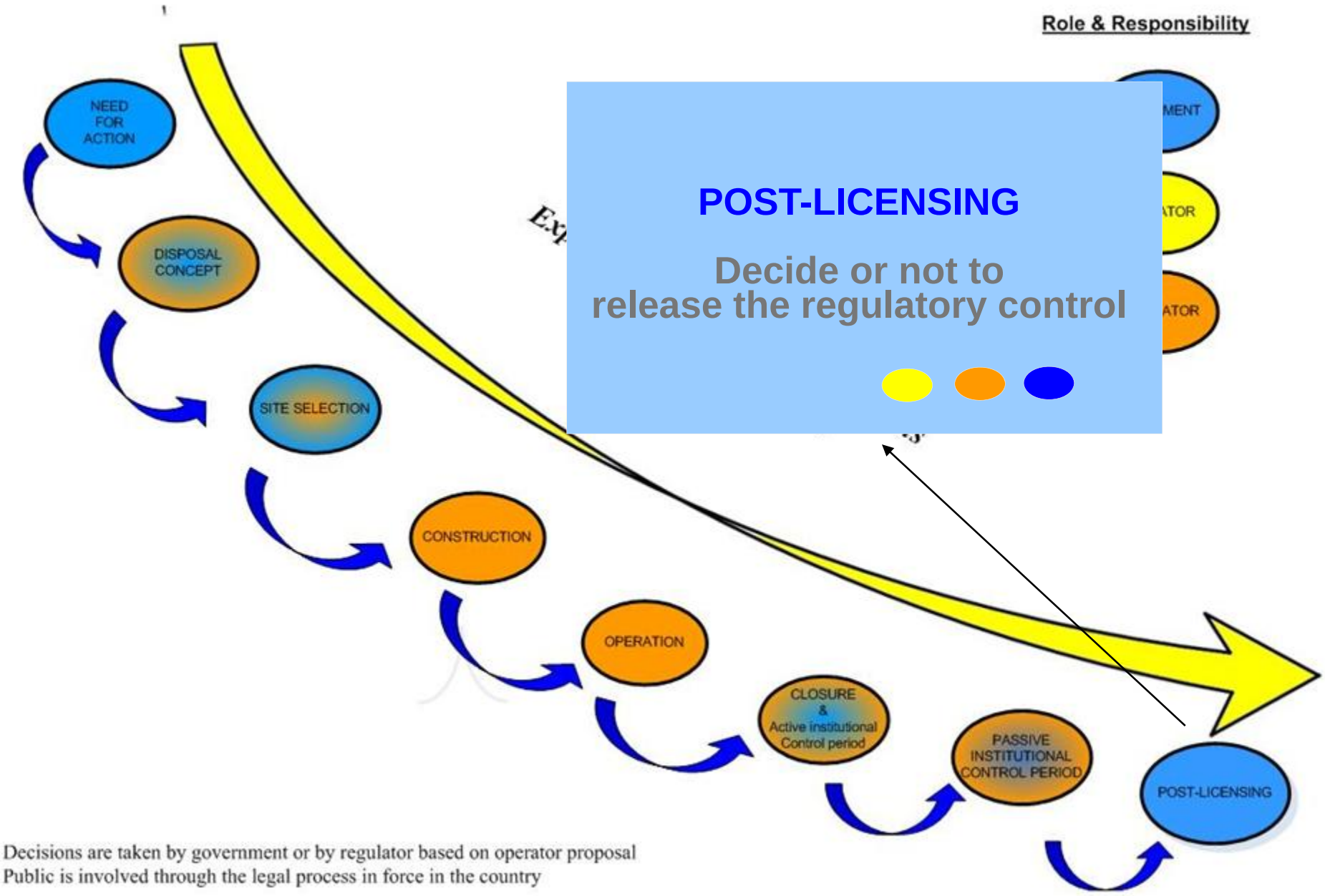
Role & Responsibility
NEED FOR ACTION
DISPOSAL CONCEPT
SITE SELECTION
CONSTRUCTION
OPERATION
CLOSURE & Active institutional Control period
PASSIVE INSTITUTIONAL CONTROL PERIOD
POST-LICENSING
POST-LICENSING
Decide or not to release the regulatory control
Decisions are taken by government or by regulator based on operator proposal
Public is involved through the legal process in force in the country

Safety Arguments

Safety Case Arguments **could be gathered in the following themes:**

- **Safety Case Context**
- **Management and Stakeholders**
- **Safety Strategy**
- **System Description**
- **Safety Assessment**
- **Surveillance**
- **Integration of safety arguments**
- **Limits, Control & Conditions**

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Safety Arguments

Safety Case Context **includ**

- ✓ **NATIONAL STRATEGY**
- ✓ **REGULATIONS**
- ✓ **INTERNATIONAL GUIDANCE A DUTIES/COMMITMENTS**
- ✓ **FINANCIAL CONSIDERATIONS**
- ✓ **…**

Includes
- the description of the responsibilities at the national level;
- the national waste management plan;
- ..

Financial considerations over the guaranties that the financial resources for conceive, construct, operate, close and monitor the facility, will be available when needed.
Finance for R&D activities are included.

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Safety Arguments

Management and Stakeholders i

Management systems have to provide for assurance of the quality of all safety related activities, systems and components throughout all steps of the development, operation and closure of a disposal facility.

- ✓ **INVOLVMENT OF STAKE**
- ✓ **MANAGEMENT SYSTEM**
  - **Organization**
  - **Staff competence**
  - **Q/A**
  - **record keeping / traceability**
- ✓ **REGULATORY PROCESS**
  - **Management system**
  - **Licensing process**
  - **Early and continuous involvement**
- ✓ **…**

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Safety Arguments

Safety Strategy **includes amongst others, considerations on how the following topics will taken into account :**

- ✓ **Graded approach**
- ✓ **Optimization**
- ✓ **Robustness**
- ✓ **Demonstrability**
- ✓ **Multiple Safety Functions**
- ✓ **Passive Safety**
- ✓ **Good engineering/scientific practices**
- ✓ **Management of uncertainties**
- ✓ **…**

The safety strategy is defined as the high-level integrated approach adopted for achieving safe disposal.

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Safety Argumen

- Radionuclide inventory,
- Physical and chemical form,
- Volume,
- Content of chemical substances such as complexing agents, hazardous substances etc.;

System description is based on the level of knowledge available at the considered stage.

System Description **includes amo wing topics will be taken into account**

- ✓ **WASTE CHARACERISTICS**
- ✓ **SITE CHARACTERISTICS**
- ✓ **DESIGN**
- ✓ **Identification of the safety functions, theirs allocation to the system components and their evolution**
- ✓ **…**

System description should be considered as an internal process (intern iterative loop) of the safety case. Its outcomes is the safety concept.

The safety concept should provide the need information arguing why the disposal system could be considered as safe. It's included the description of the waste to be disposed of, the engineered and natural components, their respective role in the safety and their evolution. Argumentation of the robustness of the disposal system could also be presented at this stage.

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Safety Arguments

It addresses the non-radiological hazards generated by the facility through its different lifecycle

Safety Assessments **includes amongst others**

- ✓ **ENVIRONMENTAL IMPACTS ASSESSMENT**
- ✓ **RADIOLOGICAL IMPACT AND PERFORMANCE ASSESSMENT**
- ✓ **OPERATIONAL SAFETY**
- ✓ **…**

Safety Assessment (DS355): The safety assessment, a systematic assessment of radiation hazards, is an important component of the safety case. It involves the quantification of radiation dose and risk that may arise from the disposal facility for comparison with dose and risk criteria, and provides an understanding of the behaviour of the disposal facility under normal and disruptive conditions, considering the timeframes over which the radioactive waste remains hazardous.

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Safety Arguments

Surveillance **includes amongst others:**

- ✓ **MONITORING**
- ✓ **SECURITY**
- ✓ **…**

Surveillance and monitoring programmes should be developed and implemented to provide evidence for a certain period of time that the disposal facility will be performing as predicted and that components have the required level of performance (safety function).

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Safety Arguments

Integration of safety arguments **includes amongst others:**

- ✓ **ARGUE (Multiple lines of reasoning)**
  - the robustness
  - the defense in depth,
  - the system understanding,
  - the monitoring, etc
- ✓ **COMPARISON OF OPTIONS**
  - Comparison between different sites for new disposal facilities;
  - Comparison of different disposal facility types, design,..;
  - Comparison of different risk management and remediation options for existing facilities
- ✓ **ADDITIONAL MEASURES TO INCREASE CONFIDENCE**
  - Independent review;
  - Complementary Safety indicators;
  - Multiples lines of reasoning
- ✓ **R&D**

  Any R&D activities that are needed in order to support the knowledge and the understanding of the phenomenology and also plans for addressing unresolved issues
- ✓ **…**

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Safety Arguments

Limits, Controls & Conditions **includes amongst others:**

- ✓ **Limits: dose/risk limits; activity limits per waste package; per disposal unit and for the site**
- ✓ **Controls: active and passive institutional controls; control for waste acceptance; conformity control; compliance with design criteria and with operational procedures, etc.**
- ✓ **Conditions: quality management, format and nature of facility description, licensing conditions for operation, closure, etc.**
- ✓ **…**

The fundamental bases for such limits, controls and conditions are the safety requirements and on the licensed conditions. They generally are derived from formalized safety assessment, both operational and post-closure.

Limits, Controls and Conditions contribute to the demonstration of the overall safety.

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Link between the Safety Case argument and the Decision Steps

Main decision-making steps:	NEED FOR ACTION	DISPOSAL CONCEPT	SITE SELECTION AND ENGINEERING DESIGN	CONSTRUCTION		OPERATION		CLOSURE	PASSIVE INSTITUTIONAL CONTROL PERIOD	POST-LICENSING
	- Decision: Go for disposal or/and Decision for reassessment of an existing facility	- Decide on the disposal concept and the Safety Strategy in a given environment (conditions)	- Decision: choose the site and associated design	- Decision for construction (operator)	Decision: Authorization and/or license for construction (authorities)	Decision to operate (operator)	Decision: Authorization and license for operation (authorities)	- Decision to close	- Decide to initiate the passive institutional control period	Decide or not to release the regulatory control
Safety Case Context	2	3	3	2	3	2	3	3	2	2
Management	1	2	3	3	3	3	3	3	3	3
Stakeholder & Regulatory Process	1	2	3	3	3	3	3	3	3	3
Optimisation	0	2	3	2	3	2	3	3	0	0
Uncertainties	2	3	3	2	3	3	3	3	2	2
Safety Strategy	1	3	3	2	3	2	3	3	1	1
System Description	1	3	3	3	3	1	3	3	1	2
Safety assessment	1	2	3	3	3	3	3	3	1	1
Integration of Safety Arguments	2	2	2	2	2	2	2	2	1	1
Limits, Control & Conditions	1	1	3	3	3	3	3	3	3	0

==> not relevant to the decision at hand
==> of value but is not significant
==> significant
==> mandatory

For each safety case argument, a prioritisation has been performed taking into account the decision step

These estimation have been summarized for each main topic and are illustrated in the above table➔ Full MASC results

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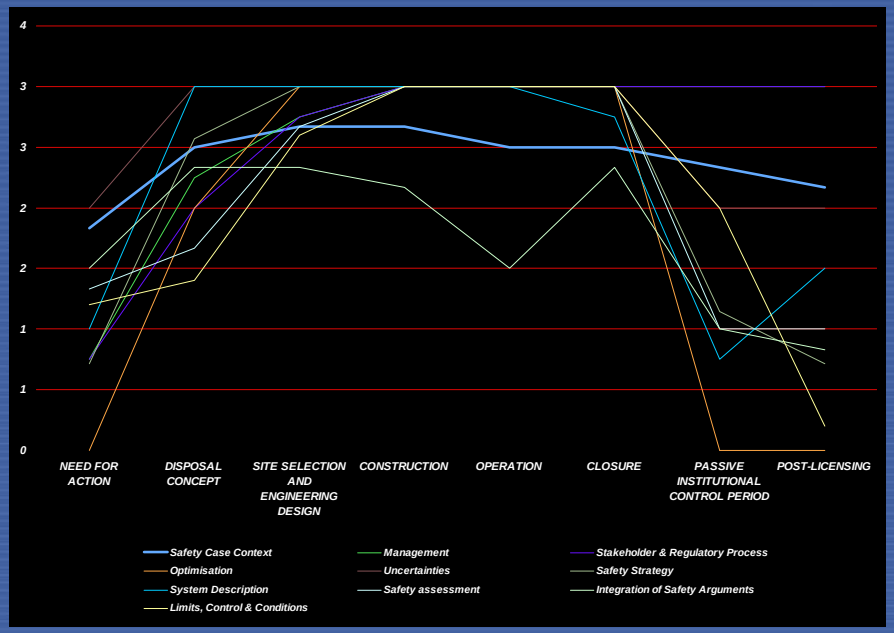
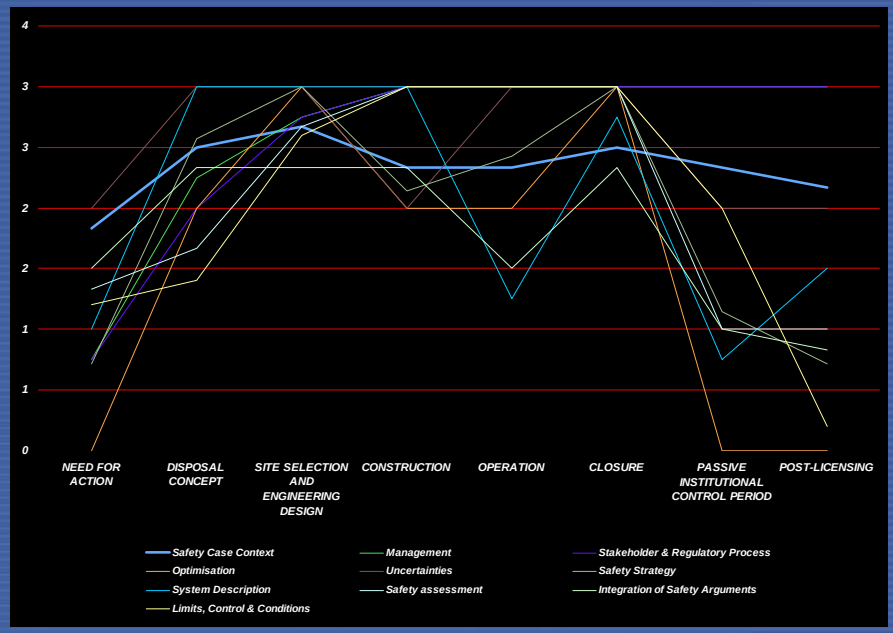
Time dependence of the Safety Case Argument





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Safety Case Arguments

System Description

How Safety Case Arguments interact together?

Management System

Limits, controls and conditions

Integration of Safety Arguments

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Safety Case Arguments

These two sets of arguments should be applied whatever the safety case argument considered or under development

System Description

Safety Case Context

Stakeholder & Regulatory Involvement

Safety Assessment

Safety Strategy

Management System

Limits, controls and conditions

Integration of Safety Arguments

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Safety Case Arguments

System Description

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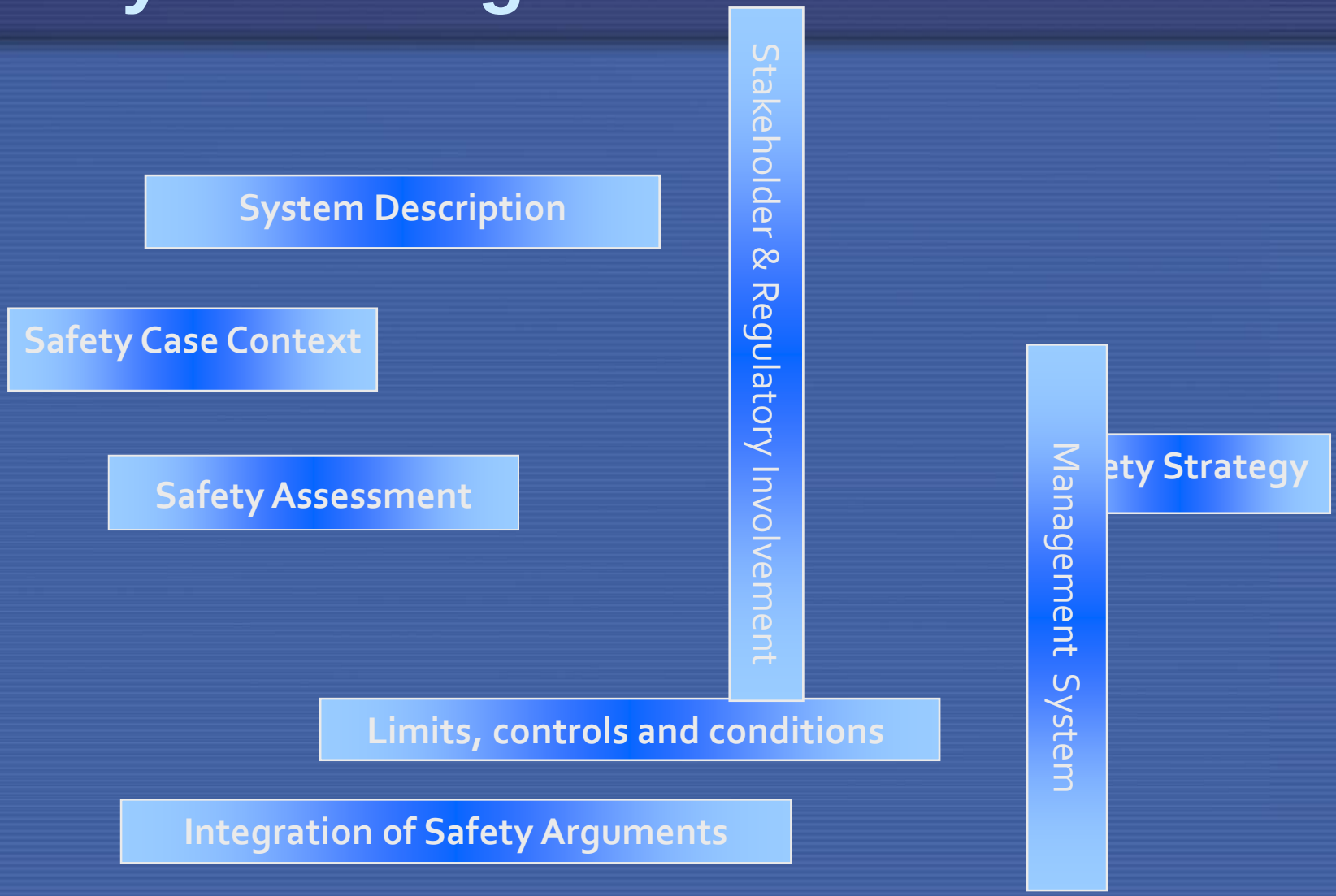
Safety Case Arguments



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Safety Case Arguments

Stakeholder & Regulatory Involvement

Before any development, the safety case context has to be set and the safety strategy has to be known

System Description

Safety Case Context

Safety Assessment

Safety Strategy

Management System

Limits, controls and **conditions**

Integration of Safety Arguments

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Safety Case Arguments

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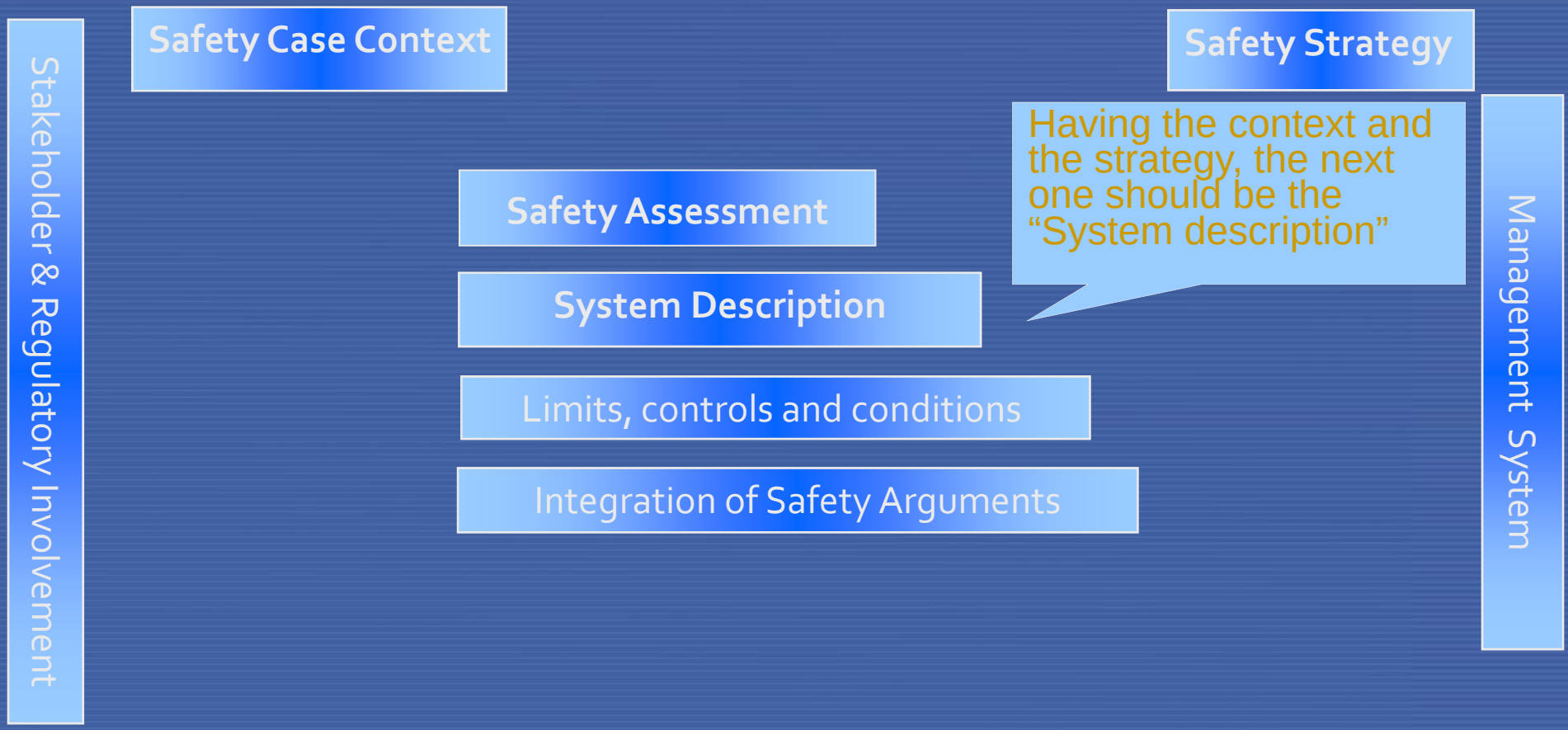
Safety Case Arguments



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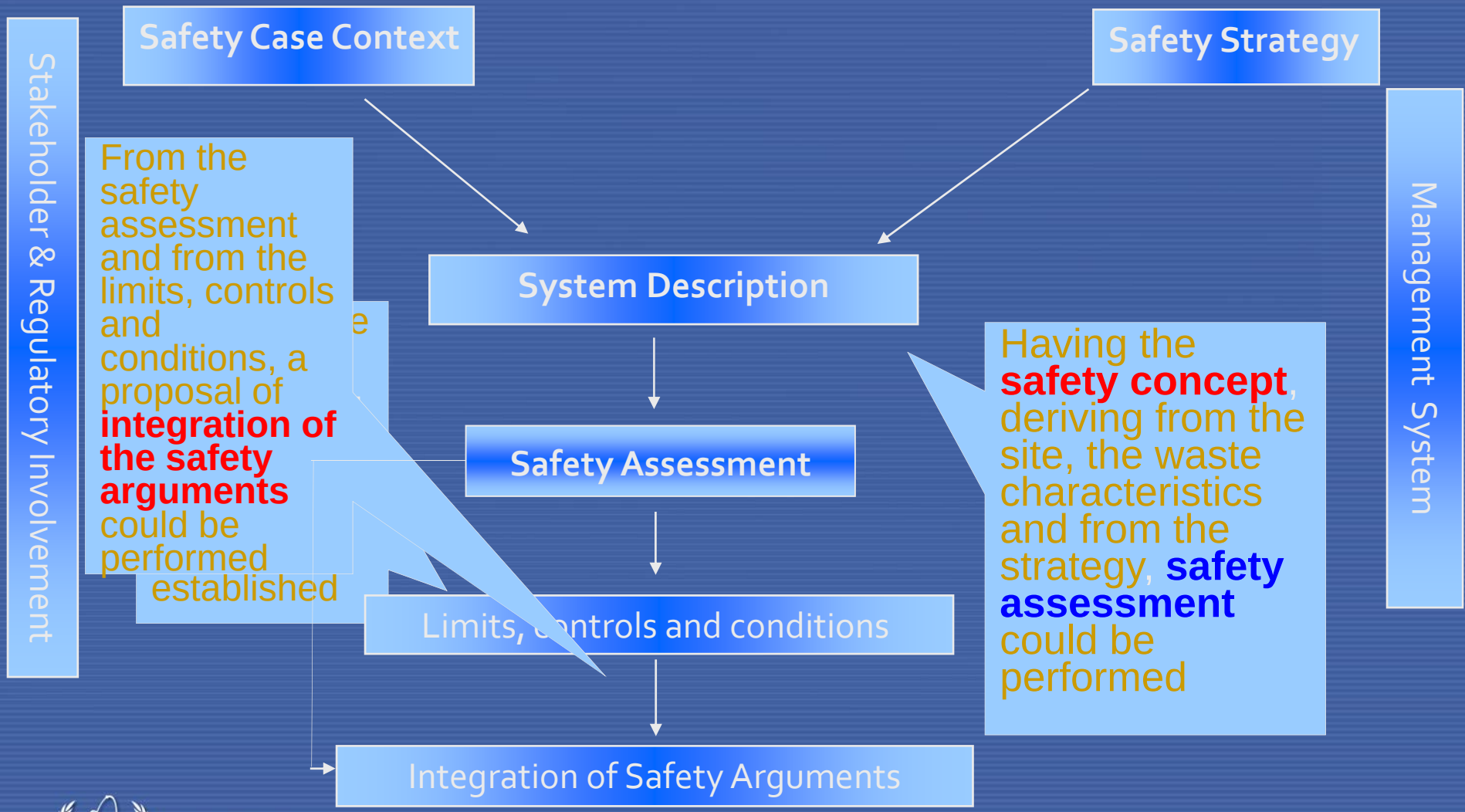
Safety Case Arguments



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This way of structuring the relationship between the safety case components we call it “safety approach”

This safety approach could be organized as followed:

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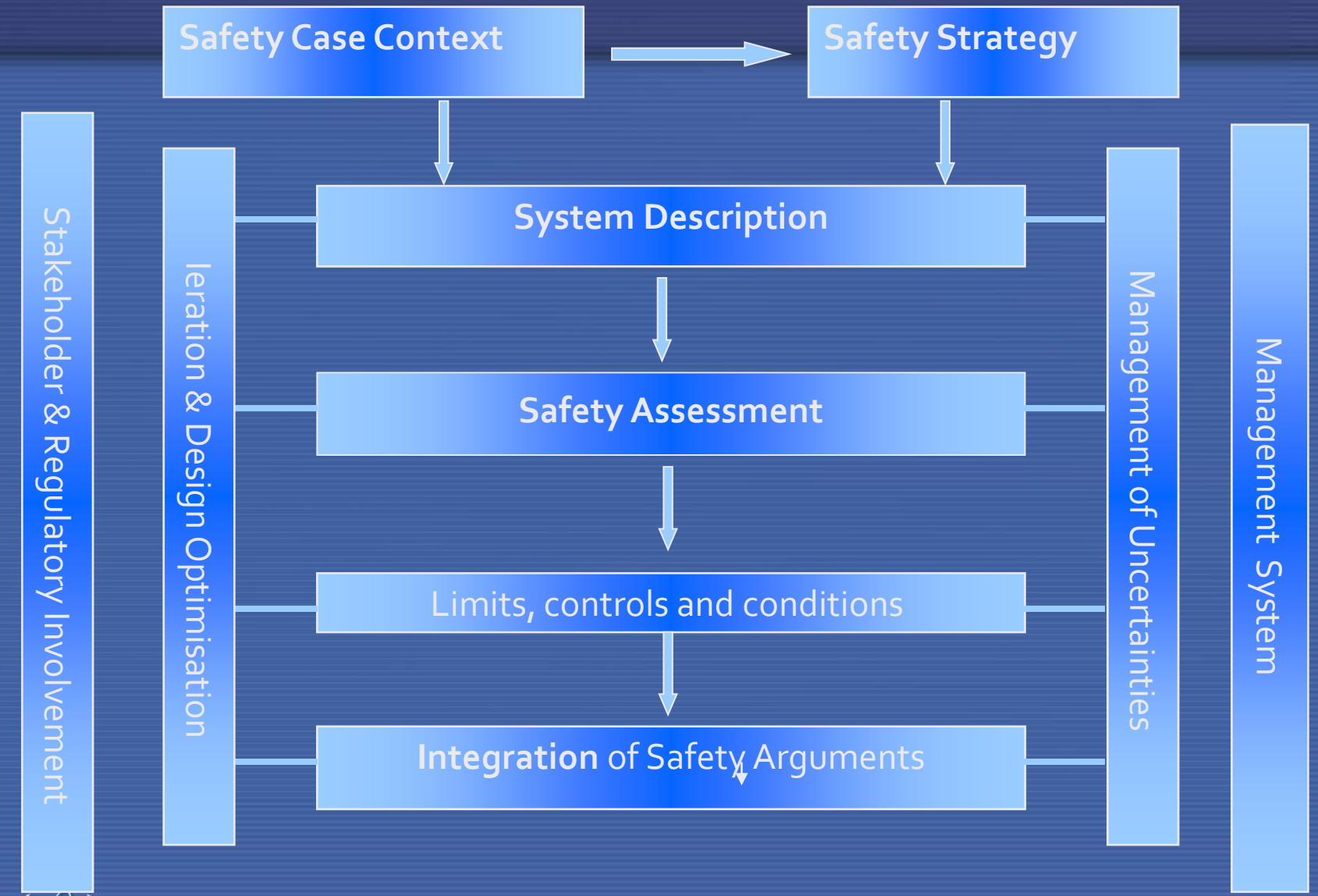
Safety Case Context
Safety Strategy
Stakeholder & Regulatory Involvement
Iteration & Design Optimisation
System Description
Safety Assessment
Limits, controls and conditions
Integration of Safety Arguments
Management of Uncertainties
Management System

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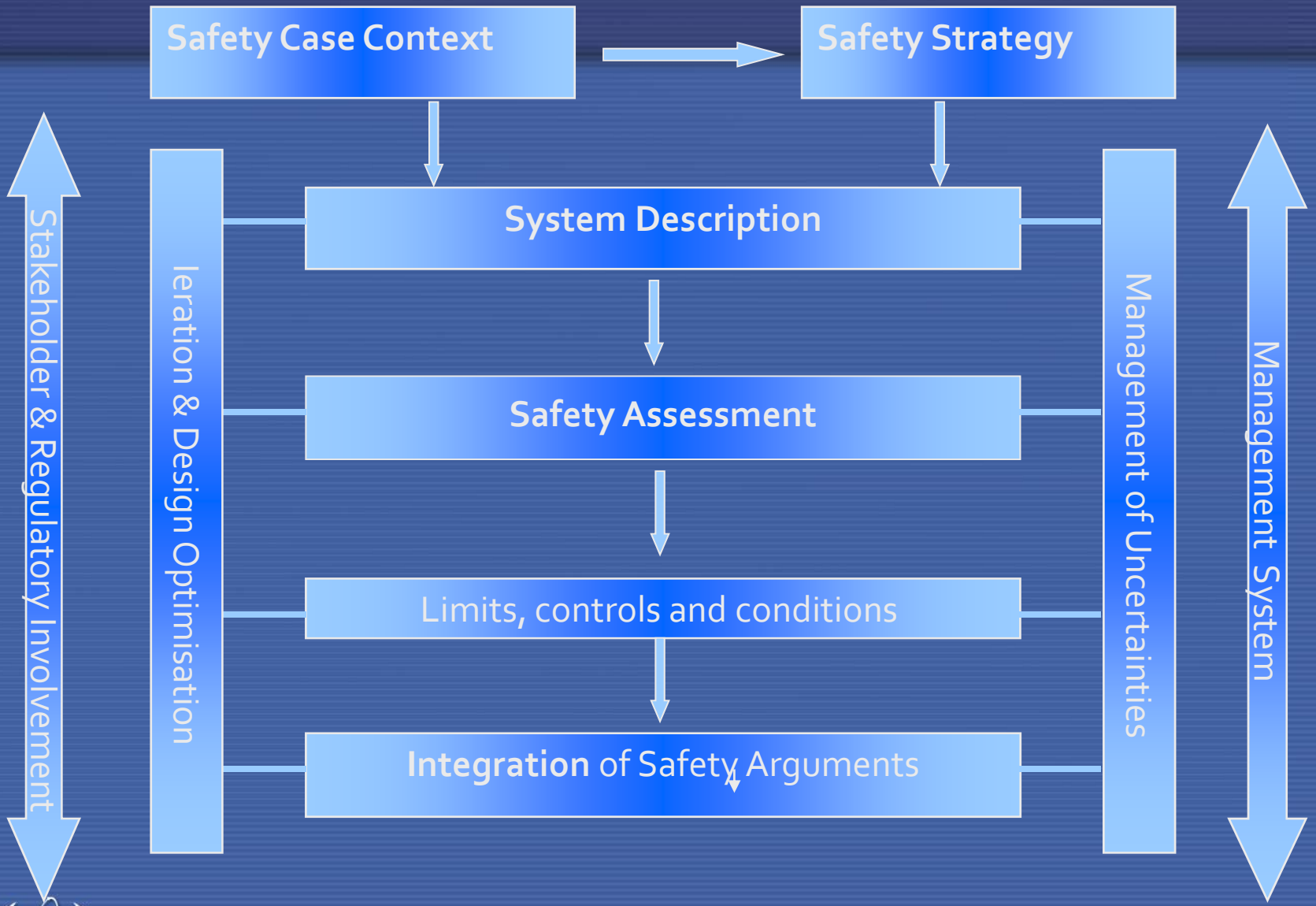
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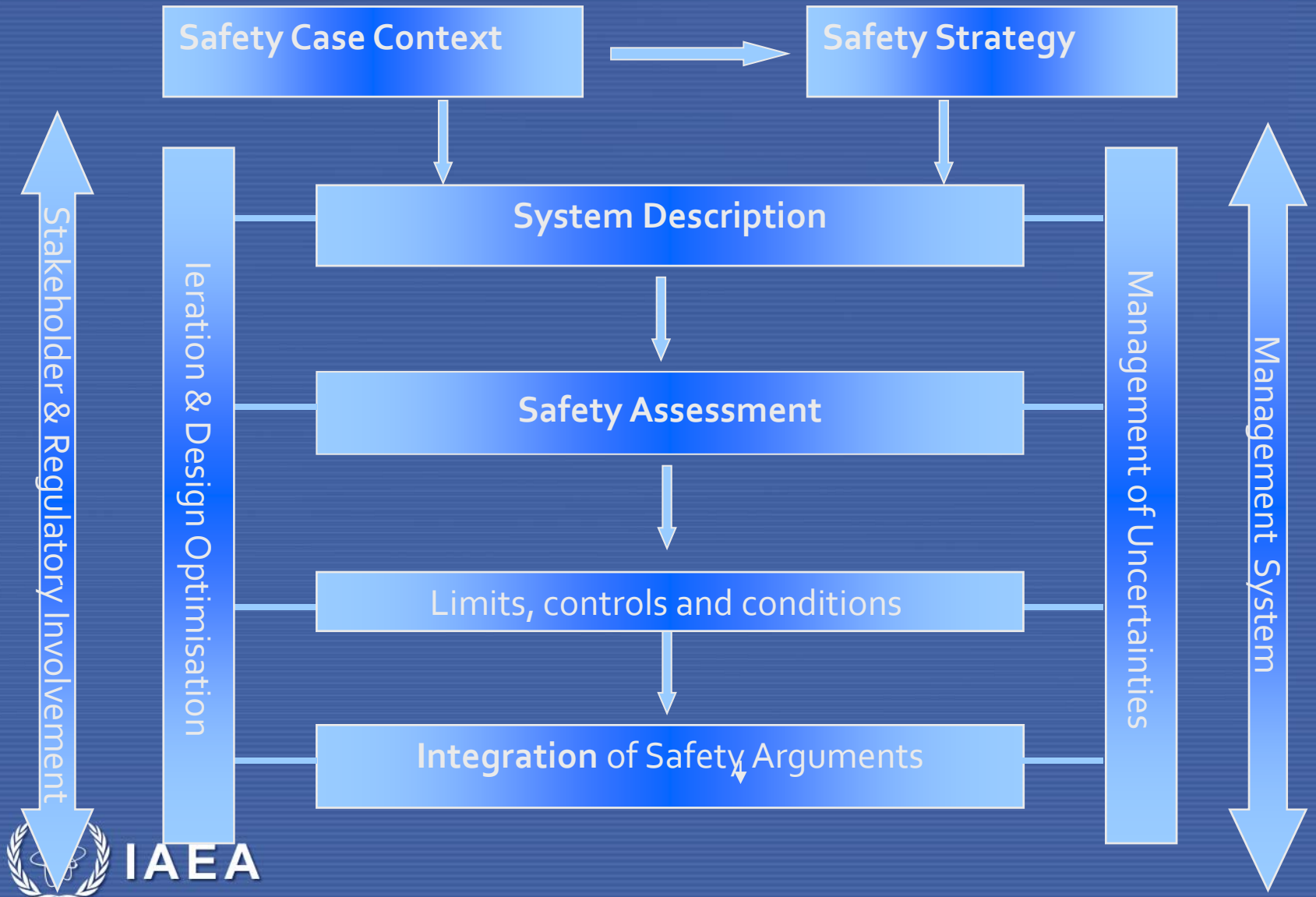
Link with other PRISM Tasks



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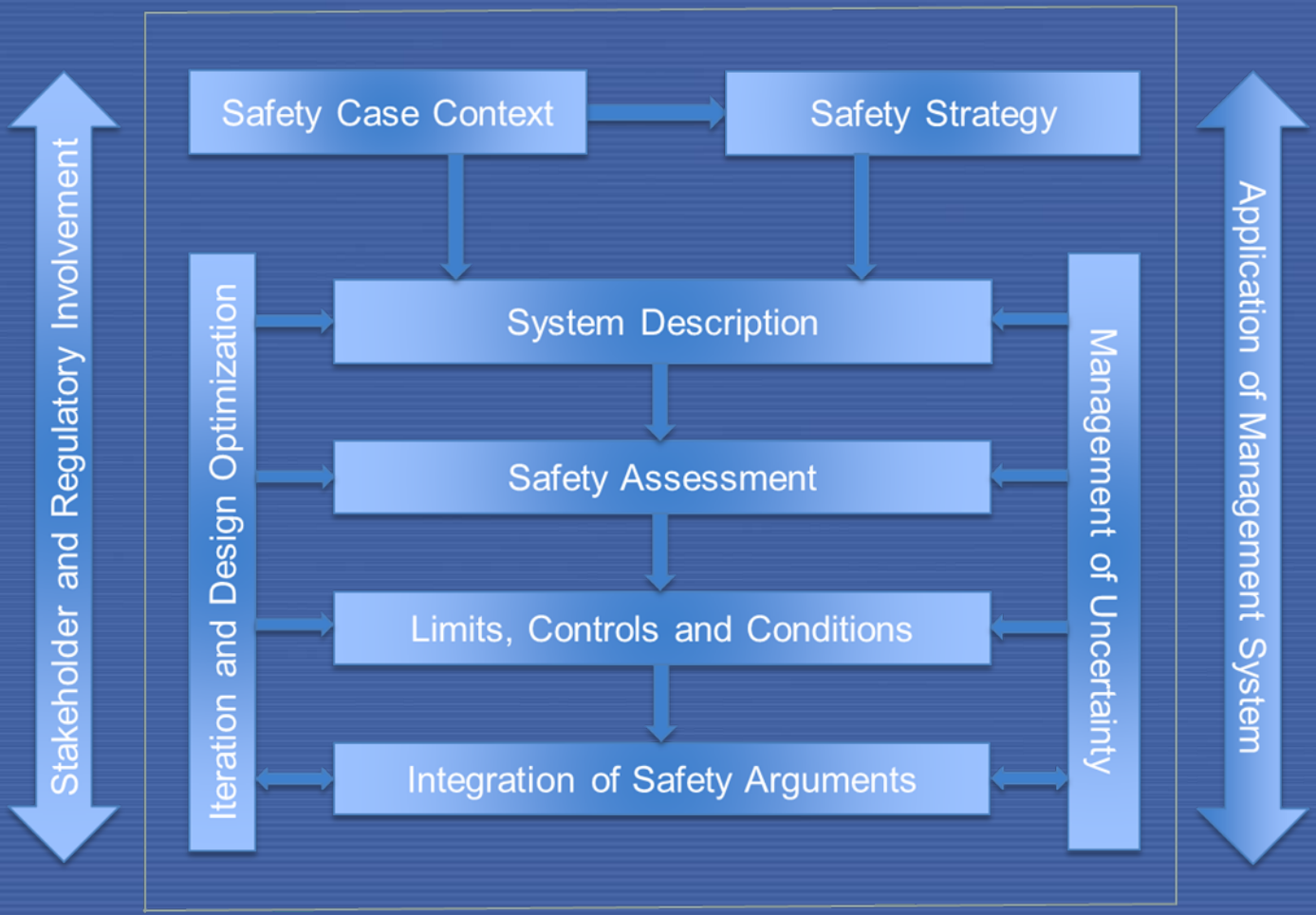
IAEA Safety Case and Safety Assessment: main figure



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Conclusions

- PRISM has been elaborated to put safety assessment in the perspective of the safety case
- Specific to Near Surface Disposal
- In parallel GEOSAF exists for geological disposal
- All elements to the concept of the safety case are valid for both types of facilities
- PRISM was a strong input for DS355 in its final step of development
- Contributes to the understanding of the safety case concept

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