# WASTE MANAGEMENT 2011

## SESSION 101

### LOW-LEVEL WASTE PERFORMANCE ASSESSMENT, THE SAFETY CASE (PRISM) AND LONG-TERM MONITORING

### OPENING REMARKS
### (101-12)

L. CAMPER (US NRC) & C. GELLES (US DOE)

# Technical Basis of the 10 CFR Part 61 Classification System

Matthew W. Kozak
INTERA, Inc.
Denver
mkozak@intera.com

# Scope

- The 10 CFR Part 61.55 Waste Classification System
- The IMPACTS Methodology
- IMPACTS Methodological Approaches
- Concepts and Precedents
- Subsequent Developments

# Waste Classification System

- Identifies concentrations of radionuclides generally acceptable for near-surface disposal
- Derived from the IMPACTS Analysis Methodology
  - Detailed evaluation of waste streams of concern
  - Evaluation of disposal in trenches
  - Reflects waste management experience in the 1970s
- Based on the idea that LLW would decay to innocuous levels within a few hundred years

# The Impacts Methodology
## (A Short History)

- Database and Impacts Methodology for 10 CFR 61 Oztunali *et al*. (1981) NUREG/CR-1759
- Update of Part 61 Impacts Methodology: Oztunali and Roles (1986) NUREG/CR-4370
- De Minimis Impacts Oztunali and Roles, 1984
- IMPACTS-BRC 1.0 Forstom and Goode, 1986
- IMPACTS-BRC 2.0 O'Neal and Lee, 1990
- IMPACTS-BRC 2.1 Rao *et al*., 1992

# Methodological Approaches

- Intrusion Scenarios (concentration limiting)
  - Intruder-Construction
  - Intruder-Discovery
  - Intruder-Agriculture
  - Intruder-Well
- Offsite Scenarios (activity limiting)
  - Boundary well
  - 500 m well
  - Release to stream
  - Bathtubbing

# Intruder Modeling Approach

- Assumed facility design
  - Trench
  - Specified trench dimensions (180 m x 30 m x 8 m deep)
  - Assumed packing efficiency (50%)
  - 1 m thick cap
- Assumed construction behavior
  - Dimensions of house foundation (3 m deep)
  - Time onsite, breathing rate, etc
  - All obviously speculative
  - After that, a straightforward dose calculation
- Same basic approach used today

# Groundwater Modeling Approach

$$H_2 = \sum_{i} \sum_{n} \frac{f_o \, C_{ni} \, f_i \, V_L \, M_o \, t_c \, 10^{(1-IA)} \, f_{2n} \, PDCF\text{-}7}{Q} \quad (5)$$

Leach Fraction

Fraction of year that leachate contacts waste

Accessibility Index

Retention Factor

Not Retardation

Actually Fractional Saturation

# Protection of Intruders (DEIS)

- Controlling the disposal of specific waste-streams
- Waste form and packaging
- Use of engineered or natural barriers to intrusion
- Institutional controls
  - Limited to assumed 100 year control
  - Assumption used for the purposes of limiting wastes
  - No intention for release at that time
  - Presumption that earlier doses are worse than later

# Use of Modeling Results for Waste Classification

- Limitation of intrusion doses to 500 mrem/y
  - Dose higher than 25 mrem/y based on lower likelihood
  - Considered an accidental event
- Waste concentrations to limit dose = Class A
- Requires improved waste form = Class B
- Use of waste form and depth to limit the likelihood of intrusion = Class C
- Waste that does not meet these criteria = Greater Than Class C (GTCC)

# Classification by Radionuclide Type

- Long Lived: Only differentiates Classes A and C
  - Concentrations in Class A x 10 = Class C
  - Likelihood and consequence of this
  - Implications for GTCC
- Short Lived: Differentiates all classes
  - Class A x factors of 40 – 4000 ( or unlimited)= Class B
  - Class B x 10 = Class C; except Sr-90 x 50
- Mixed Short and Long Lived: Use of sum-of-fractions rule

# Concepts and Precedents

- Intrusion analysis identifies waste concentrations appropriate for near surface disposal
  - Generically derived values for generic application
  - Site specific and design specific values as needed
- Values for long lived alpha activity have seen wide propagation
  - From OECD/NEA -> Many national programs
  - Class A 10 nCi/g = 366 Bq/g ~ 400 Bq/g
  - Generally found reasonable, with some issues
- Normal Residential Intrusion Zone

# Subsequent Developments (1)

- State of Illinois (1990-1992) tried using the IMPACTS code for licensing the Martinsville site
  - Generic approaches intended for rulemaking
  - Site and design specific application
- Evolutionary change in design and safety concepts
  - Move to greater use of vaults and high integrity systems
  - Move from "dilute and disperse" to "concentrate and contain"
  - Move to greater disposal depths and thicker covers
  - Understanding that low dose constraints require long-term performance assessments even for low activities of long-lived species

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# Subsequent Developments (2)

- Proposed disposal of large amounts of depleted uranium in the Central Interstate Compact site (1992)
  - Uranium not in the waste classification system
  - Part 61: If waste does not contain any listed nuclides, it is Class A.
  - But it was analyzed
- Analysis including long times suggested that it should not be Class A waste

Table 4.5 Waste Classification Limits Assumed for the Part 61 Case

| Isotope | Class Limits (μCi/cm³) Class A | Class B | Class C |
|---|---|---|---|
| H-3 | 4.0E+1* | ** | ** |
| C-14# | 8.0E-1 | 8.0E-1 | 8.0E+0 |
| Fe-55 | 7.0E+2 | ** | ** |
| Ni-59# | 2.2E+0 | 2.2E+0 | 2.2E+1 |
| Co-60 | 7.0E+2 | ** | ** |
| Ni-63# | 3.5E+0 | 7.0E+1 | 7.0E+2 |
| Nb-94# | 2.0E-3 | 2.0E-3 | 7.0E+2 |
| Sr-90 | 4.0E-2 | 1.5E+2 | 7.0E+3 |
| Tc-99 | 3.0E-1 | 3.0E-1 | 3.0E+0 |
| I-129 | 8.0E-3 | 8.0E-3 | 8.0E-2 |
| Cs-135 | 8.4E+1 | 8.4E+1 | 8.4E+2 |
| Cs-137 | 1.0E+1 | 4.4E+1 | 4.6E+3 |
| U-235 | 4.0E-2 | 4.0E-2 | 4.0E-1 |
| U-238 | 5.0E-2 | 5.0E-2 | 5.0E-1 |
| TRU | 1.0E+1## | 1.0E+1## | 1.0E+2## |
| Pu-241 | 3.5E+2## | 3.5E+2## | 3.5E+3## |

*The notation 4.0E+1 means $4.0 \times 10^1$.
**No limit is set for these isotopes and classes.
#For activated metals, the limits for these isotopes are raised by a factor of 10.
##The limits for these isotopes are given in units of nCi/gm rather than μCi/cm³

Excerpt from FEIS NUREG-0945

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# Summary

- IMPACTS methodology for offsite releases is generic and not up to modern standards
  - Various nonphysical parameters
  - Does not affect the waste classification system
- The IMPACTS methodology for intruders is consistent with modern approaches
- Changes in designs and safety concepts mean that modern designs are not consistent with the original development of the waste classification system
- But it is flexible enough to accommodate these changes
- The basic idea that concentrations appropriate for  the near surface are limited by intrusion remains important

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# NRC Recommended Approach for Performance Assessment Methodology for Low-Level Radioactive Waste Disposal

## WM2011 Session 101

**Boby Abu-Eid, Ph.D.**
**Division of Waste Management and Environmental Protection**
**Office of Federal and State Materials and Environmental Management Programs**

**March 3, 2011**

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# Topics

- 10 CFR Part 61 disposal concepts and performance objectives
- Performance assessment (PA) overview
- PA LLW recommended approach & methodology – NUREG-1573
- Summary of PA approach related to DOE Waste Determination – NUREG-1854
- Current PA issues
- Concluding remarks and path forward

# PA Overview
# NRC Guidance on PA Approaches

- **NUREG-1573** ***(A Performance Assessment Methodology for Low-Level Radioactive Waste Disposal Facilities)***
- **NUREG-1854** ***(NRC Staff Guidance for Activities Related to U.S. DOE Waste Determinations)***
- **Comprehensive PA review guidance reflecting updated methods & approaches (planned)**

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# 10 CFR Part 61 LLW Disposal Concept

**Near-surface (<30 m depth) land disposal with specific technical requirements, performance objectives, and procedural requirements**

- **Cornerstone of safe disposal is stability:**
  - **Stable wastes, design**
  - **Reliance natural system isolation**
  - **Reduced exposure to intruders**
  - **Stability of waste form & packaging**

**Graded stability requirements using waste classes A, B, and C**

**Limit on maximum inventory for mobile long half-life radionuclides to limit potential radiation exposure**

# 10 CFR Part 61 LLW Disposal Concept (Cont'd)

**Inadvertent intruder dose limit not to exceed 5 mSv/yr**

**Greater than class C waste unsuitable for near- surface disposal**

**Site closure and stabilization (a 5-year post-closure period for observation, monitoring, and maintenance)**

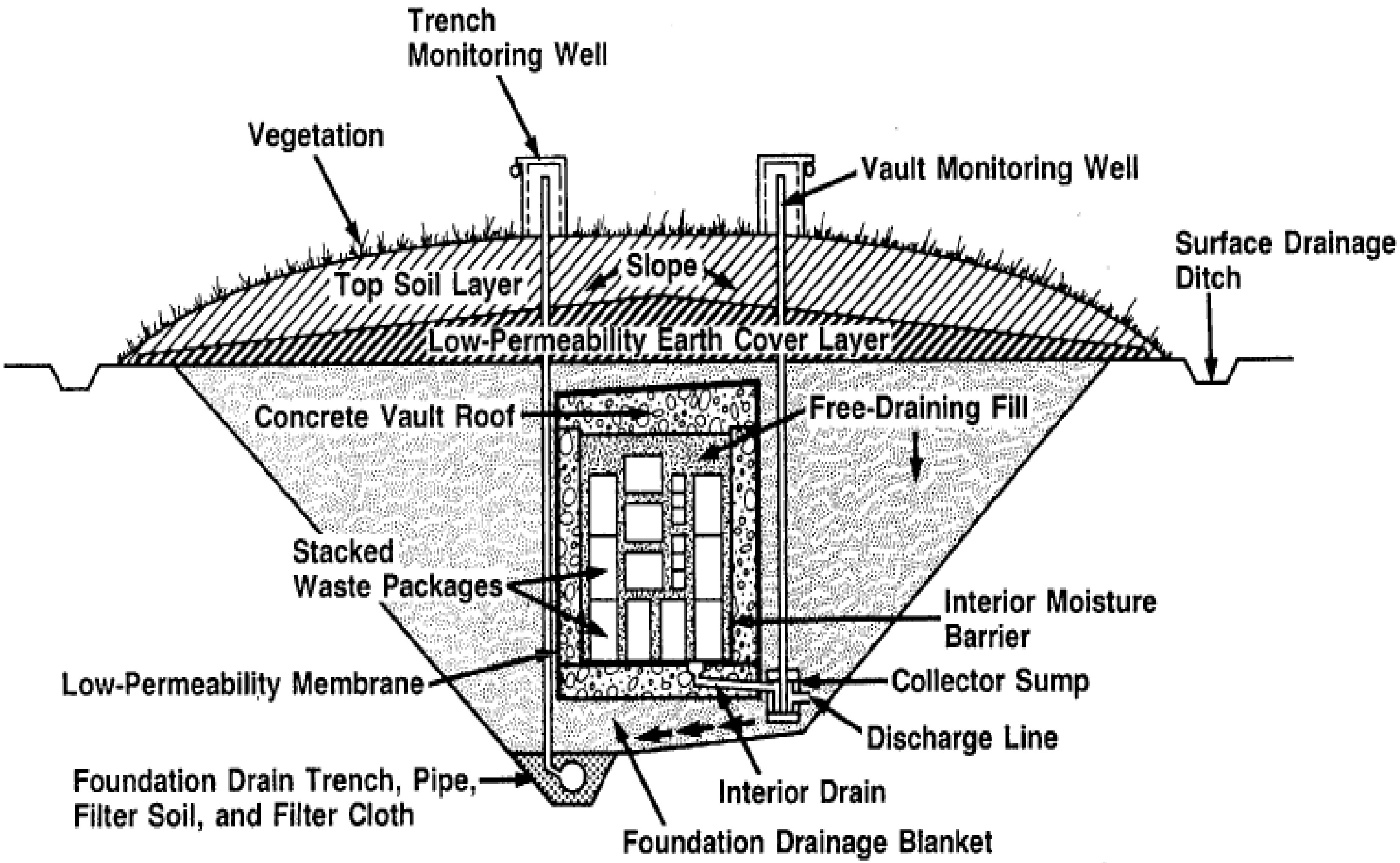
**Monitoring, access restrictions, and custodial activities after license transferred to the State or Federal agency for 100 year of institutional control period**

**State or federal government ownership of land assuring custodial care during institutional control period**

# 10 CFR Part 61 Subpart C Performance Objectives

- **Protection of the general public *(annual doses not to exceed 0.25 mSV/yr to the whole body, 0.75 mSv/yr to the thyroid, and 0.25 mSv/yr to any other organ and maintain effluent releases ALARA)***
- **Protection of individuals from inadvertent intrusion *(< 5 mSv/yr)***
- **Protection of individuals during operations**
- **Stability of disposal site after closure (the LLW facility must be sited, designed, operated, and closed to achieve long-term stability)**
- **Only surveillance, monitoring, or minor custodial care are required**

# A LLW Disposal Design Concept



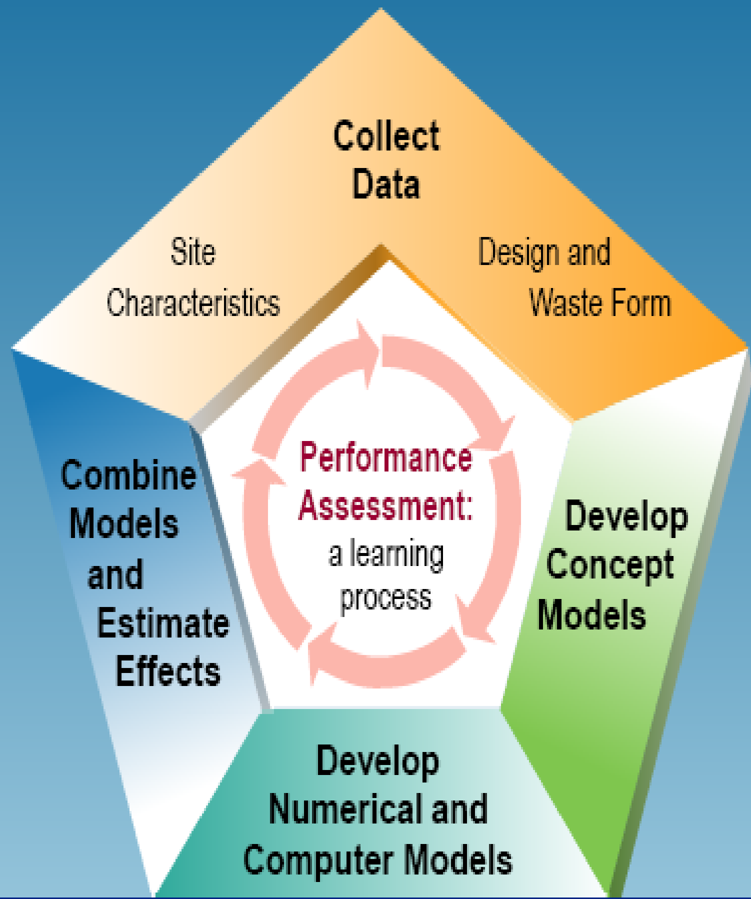
# Overview of Performance Assessment

## What is Performance Assessment?

- Systematic analysis of what could happen at a site

## Why use it?

- Complex system
- Systematic way to evaluate data
- Internationally accepted approach




## What is assessed?

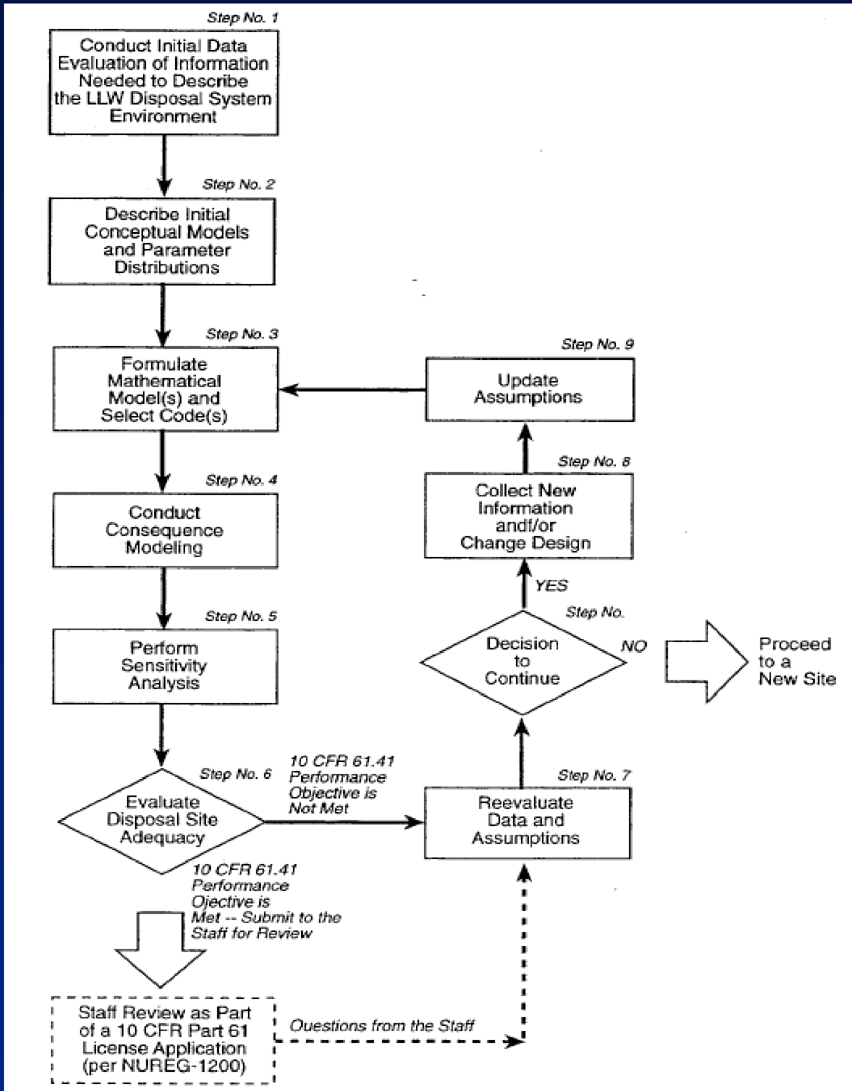
- What can happen?
- How likely is it?
- What can result?

## How is it conducted?

- Collect data
- Develop scientific models
- Develop computer code
- Analyze results

# Steps in NRC NUREG-1573 PA Methodology Reviews

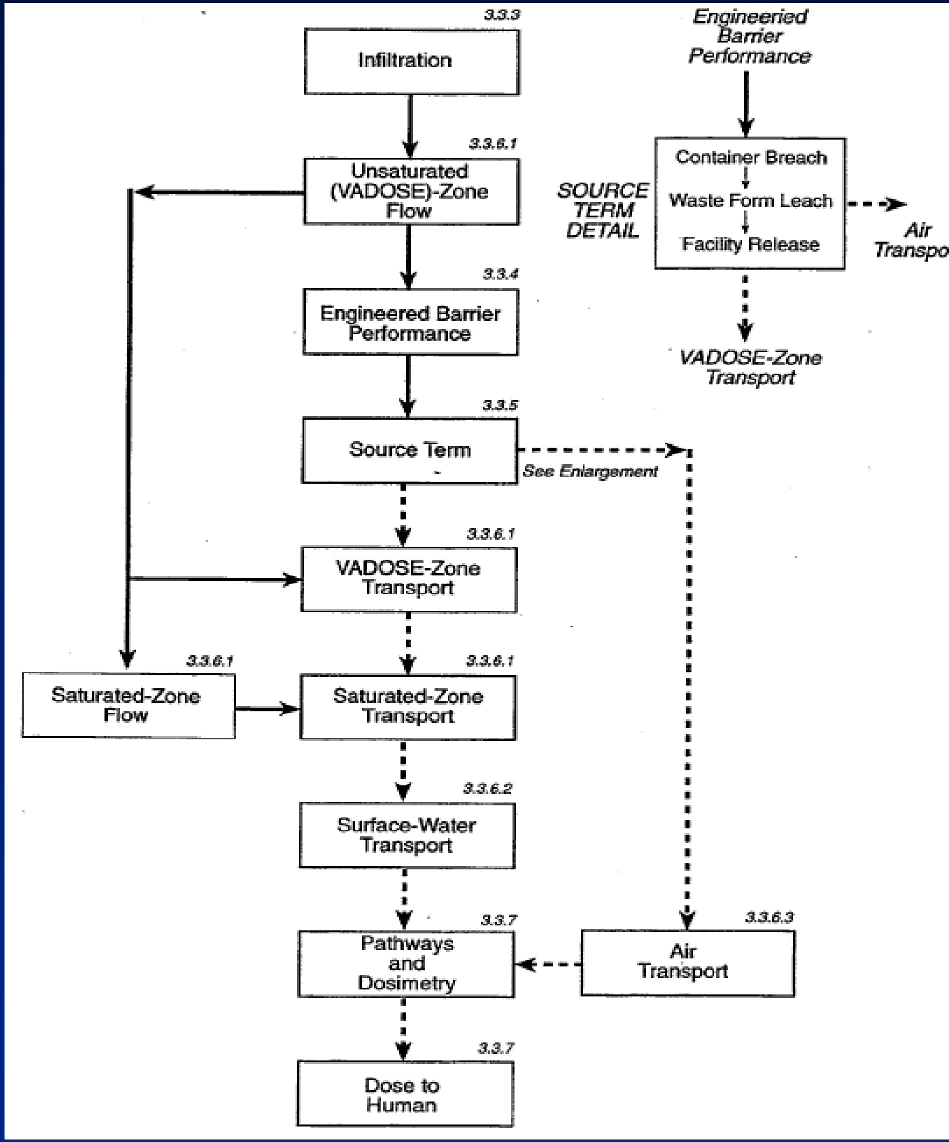
- Data evaluation
- Conceptual models
- Parameter distributions
- Mathematical models & codes
- Consequence modeling & analysis
- Sensitivity & uncertainty analysis
- Initial evaluation of site performance
- R-evaluation of data & assumptions
- Assessment of compliance with 10 CFR 61.41



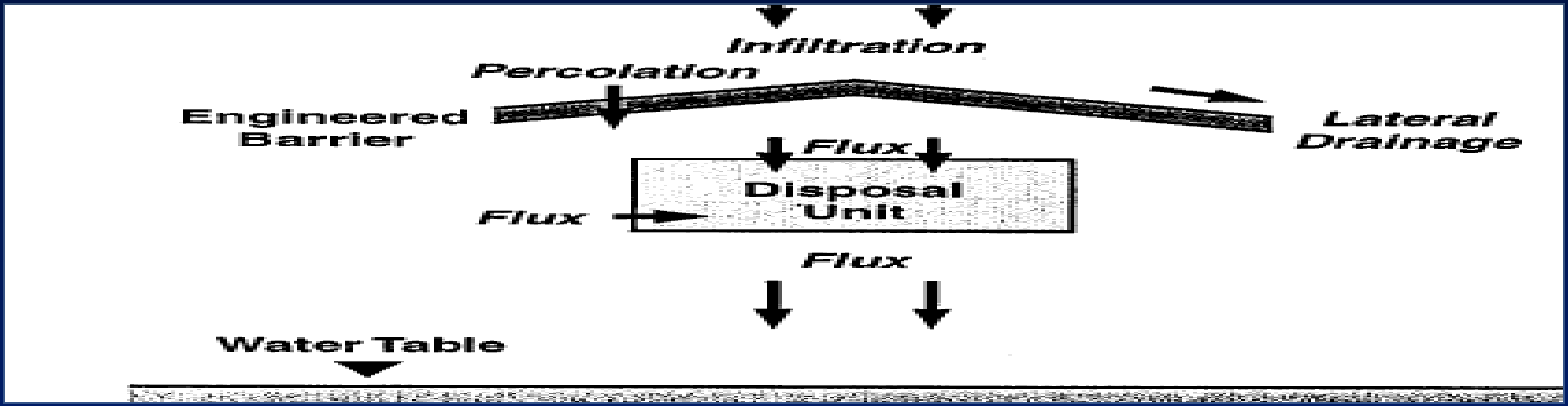
# Specific Processes Considered in NRC LLW PA

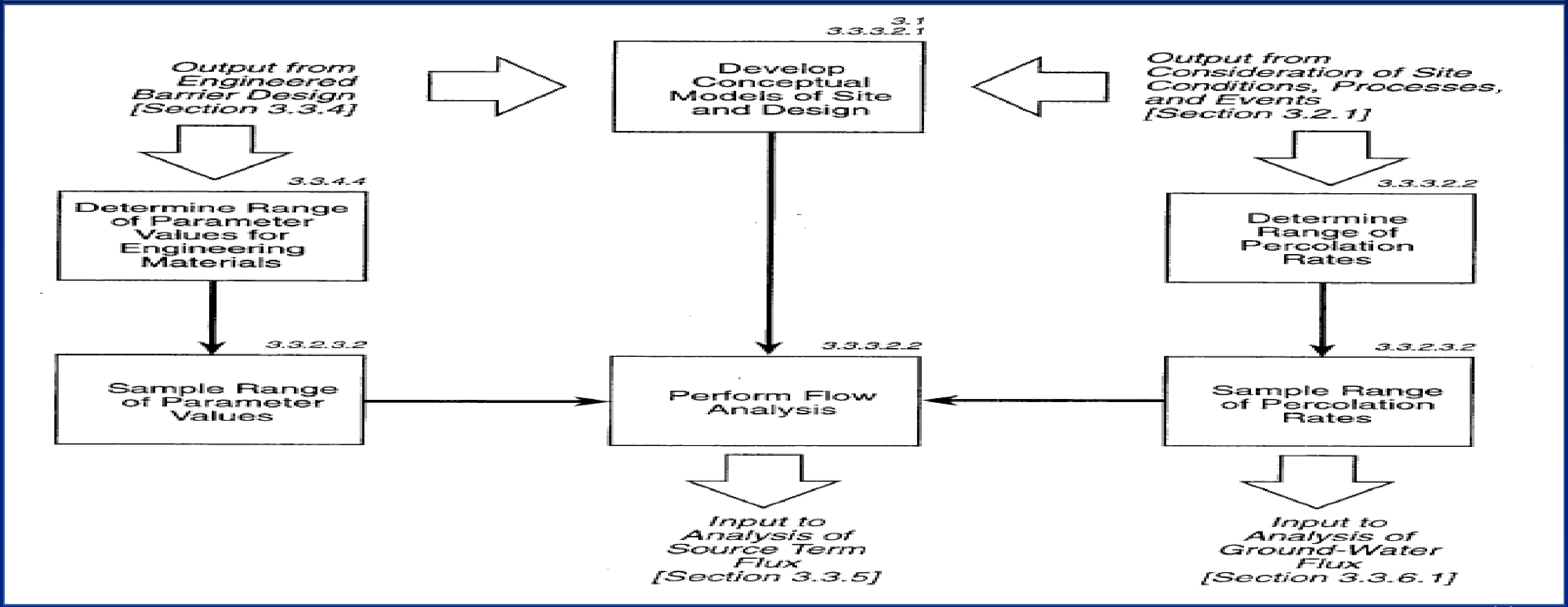
- Infiltration
- UZ Flow
- Eng. Barrier Performance
  - Container Breach
  - Waste Form Leach
  - Source term releases
- VZ Transport
- SZ flow & Transport
- Surface water transport
- Exposure pathways transport
- Dose to human

NUREG-1573

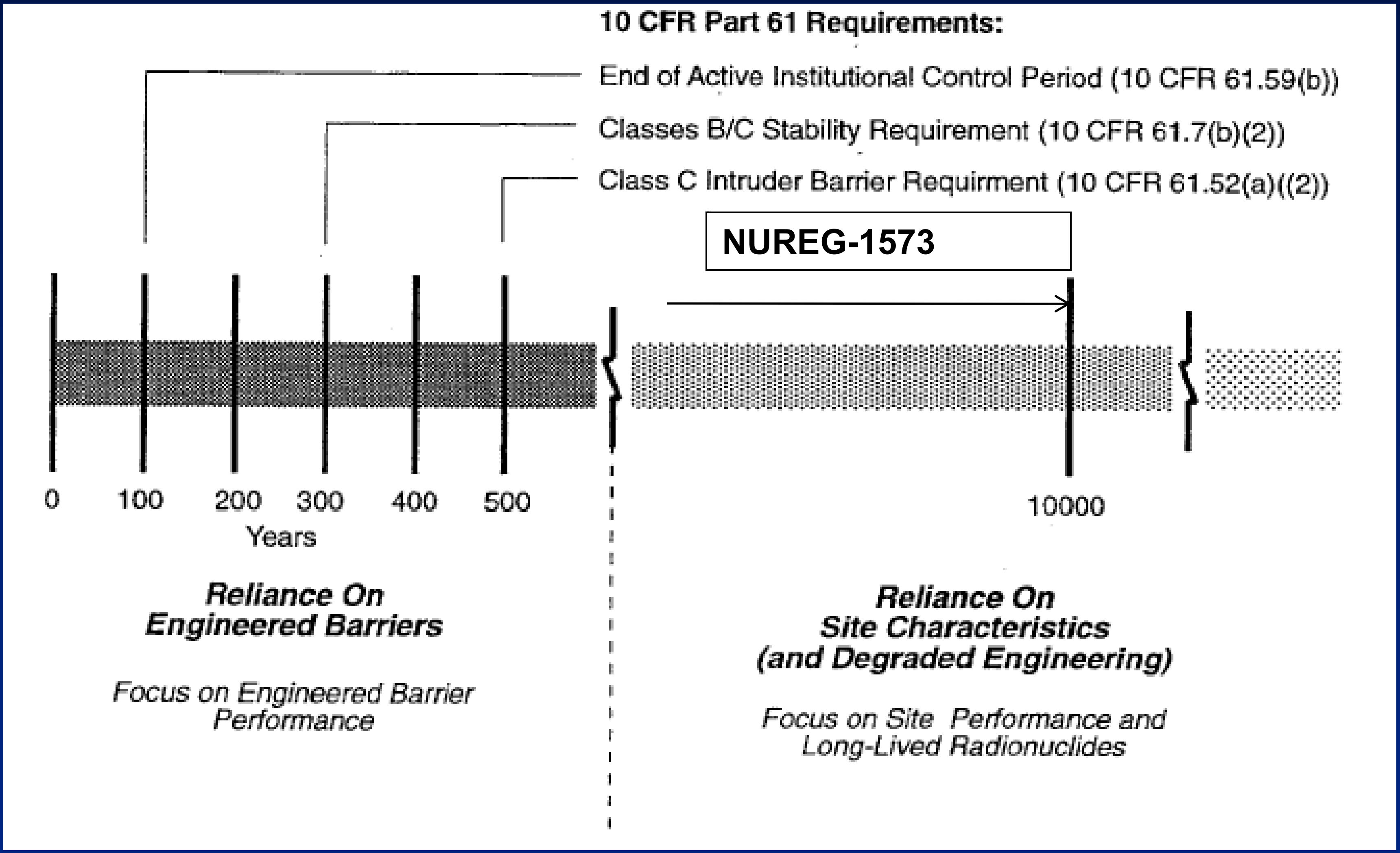


## Infiltration Process and Recommended Approach for LLW PA Analysis

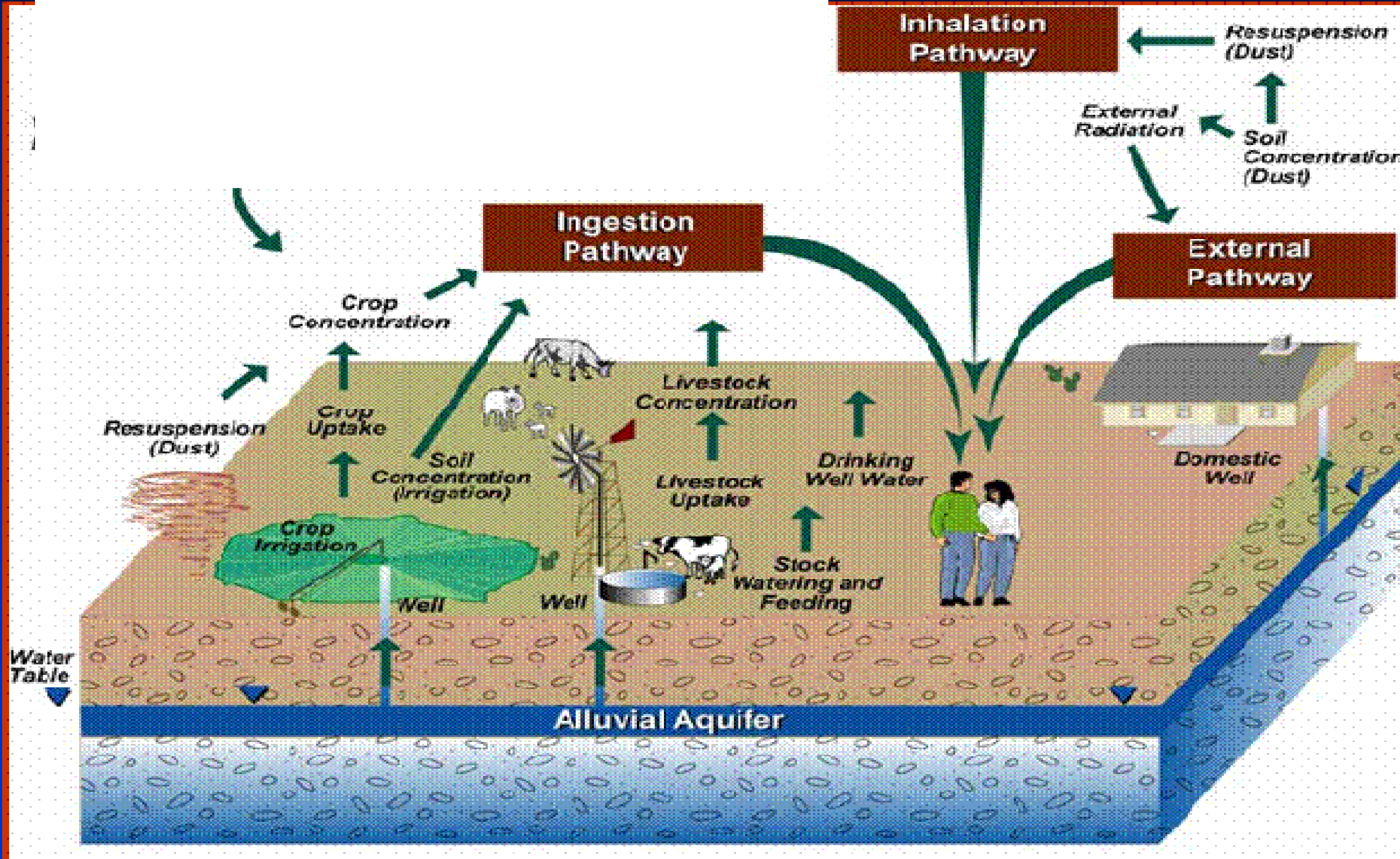


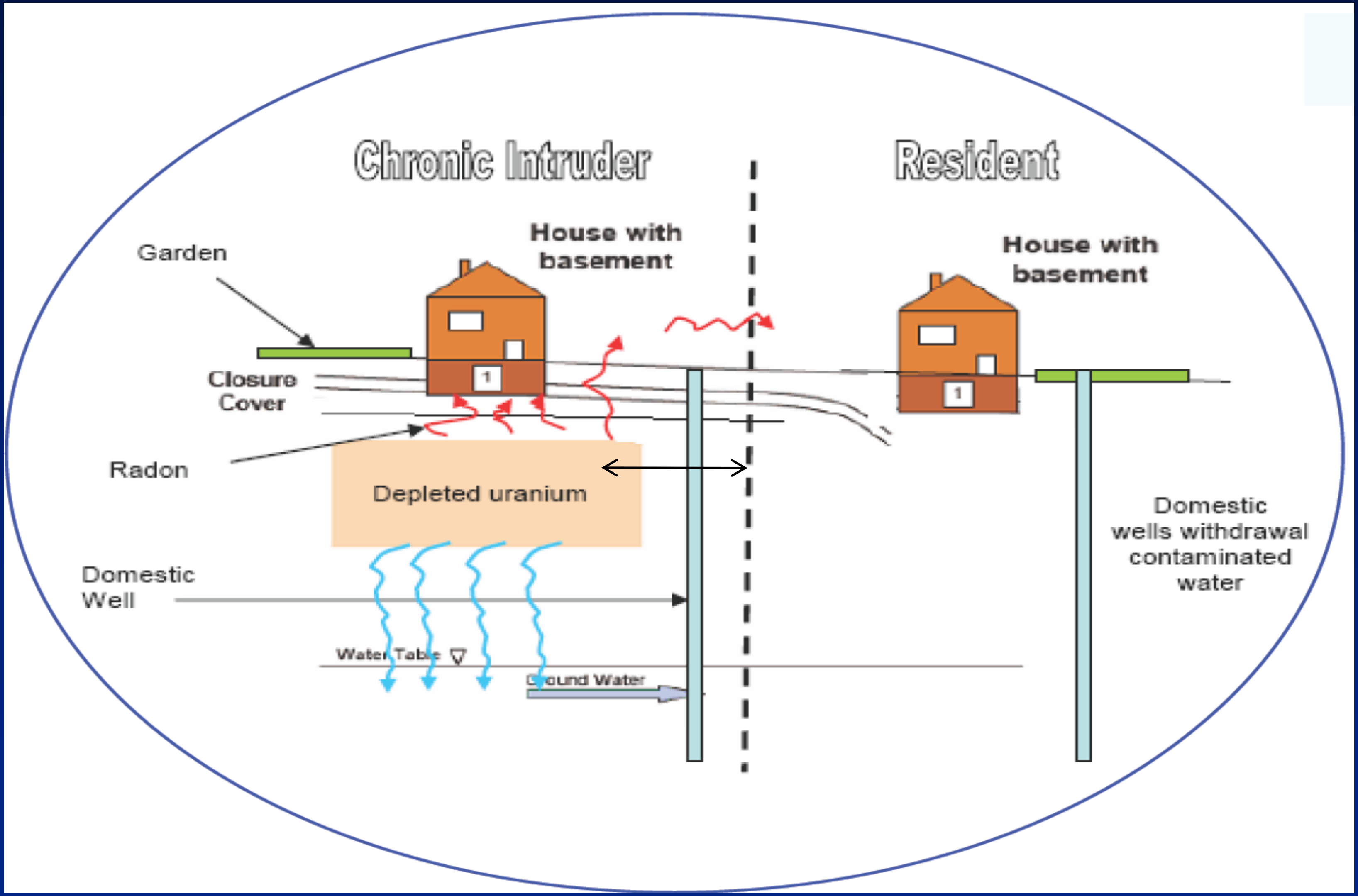
# LLW Timeframe and Performance Period



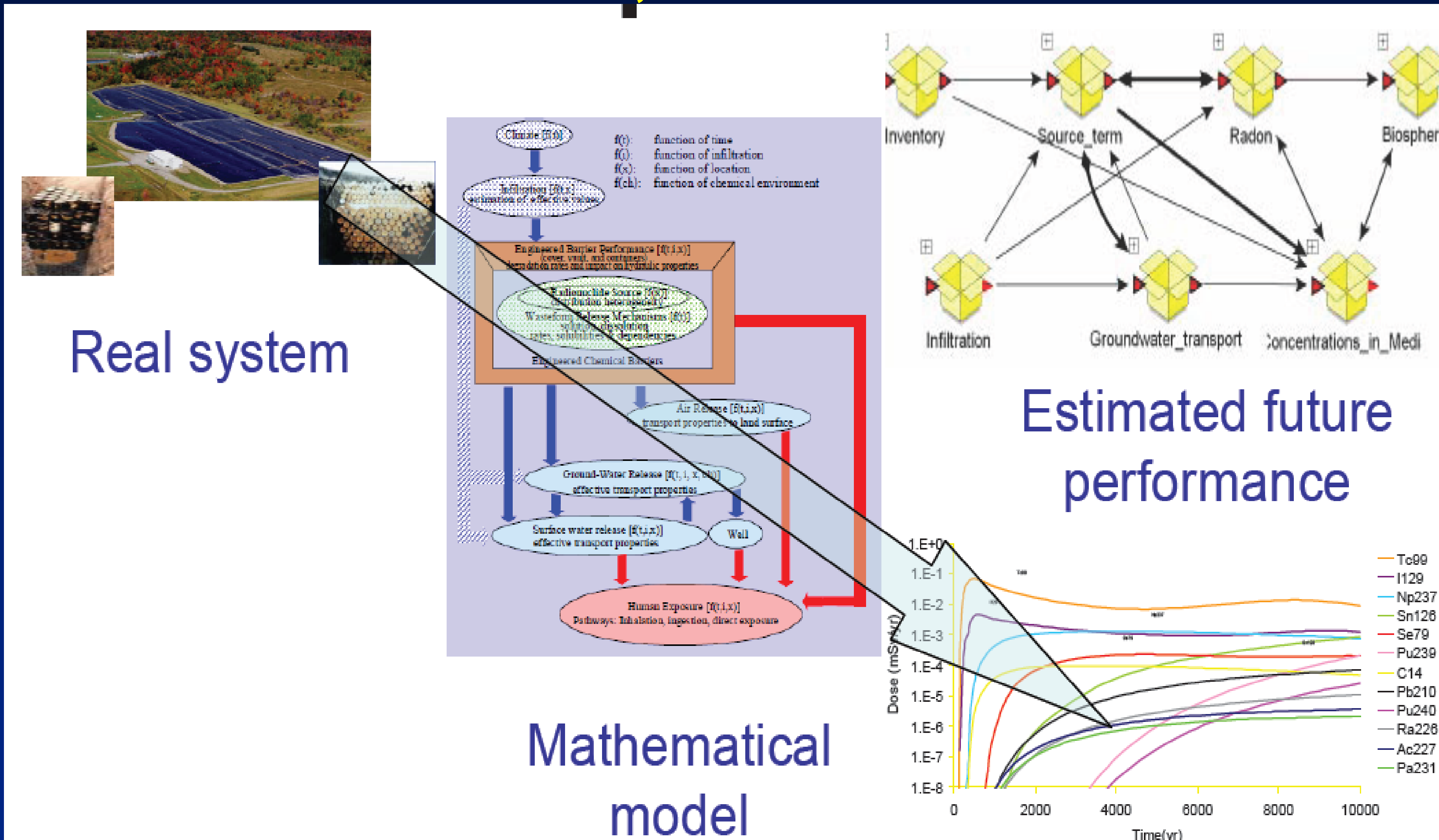
# Schematic Illustration of Potential Exposure Pathways



# Schematic Illustration of Examples of Exposure Scenarios



# PA Approach: Representation of LLW System, Conceptual & Mathematical Models, and Estimated Performance



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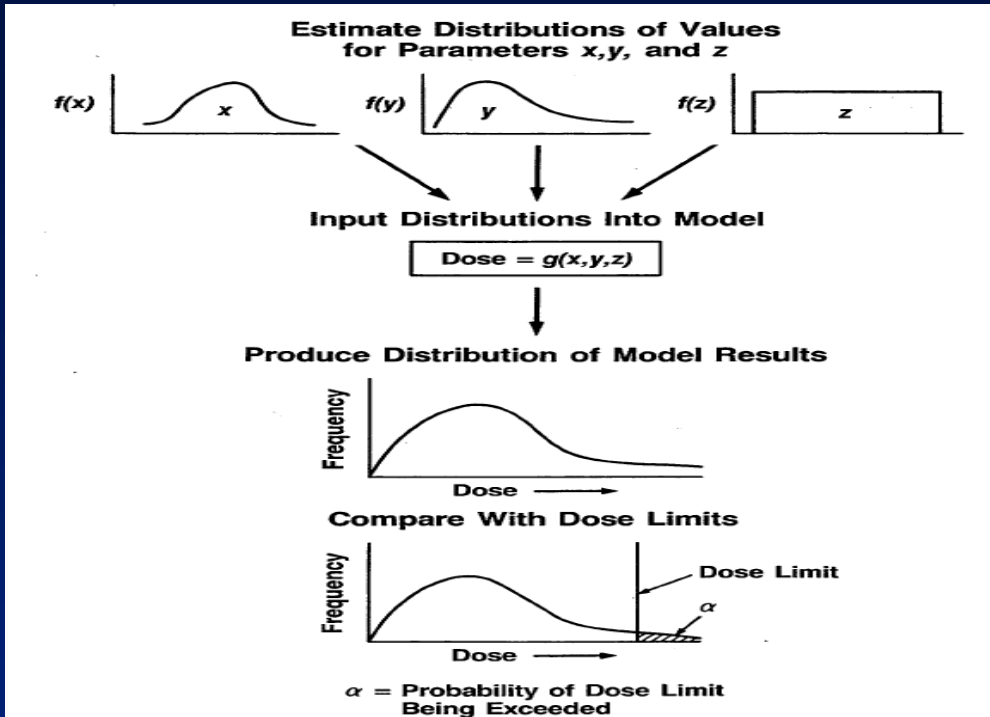
# An Approach to Uncertainty Analysis




$$\mathrm{Max}[\mathrm{Mean}(t)] \le \textit{Regulatory Limit}$$

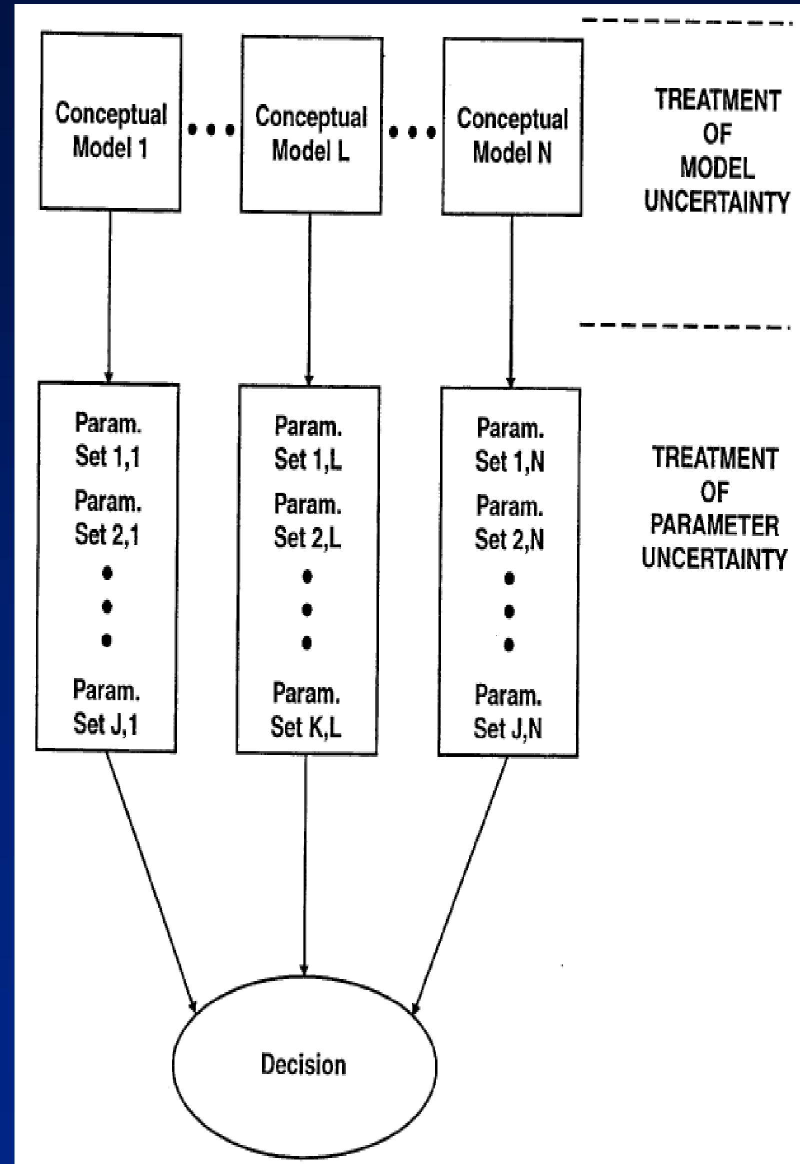
*where:*

$$\mathit{Mean}(t) = \frac{\sum_{k=1}^{N} \mathit{Dose}_k(t)}{N}$$

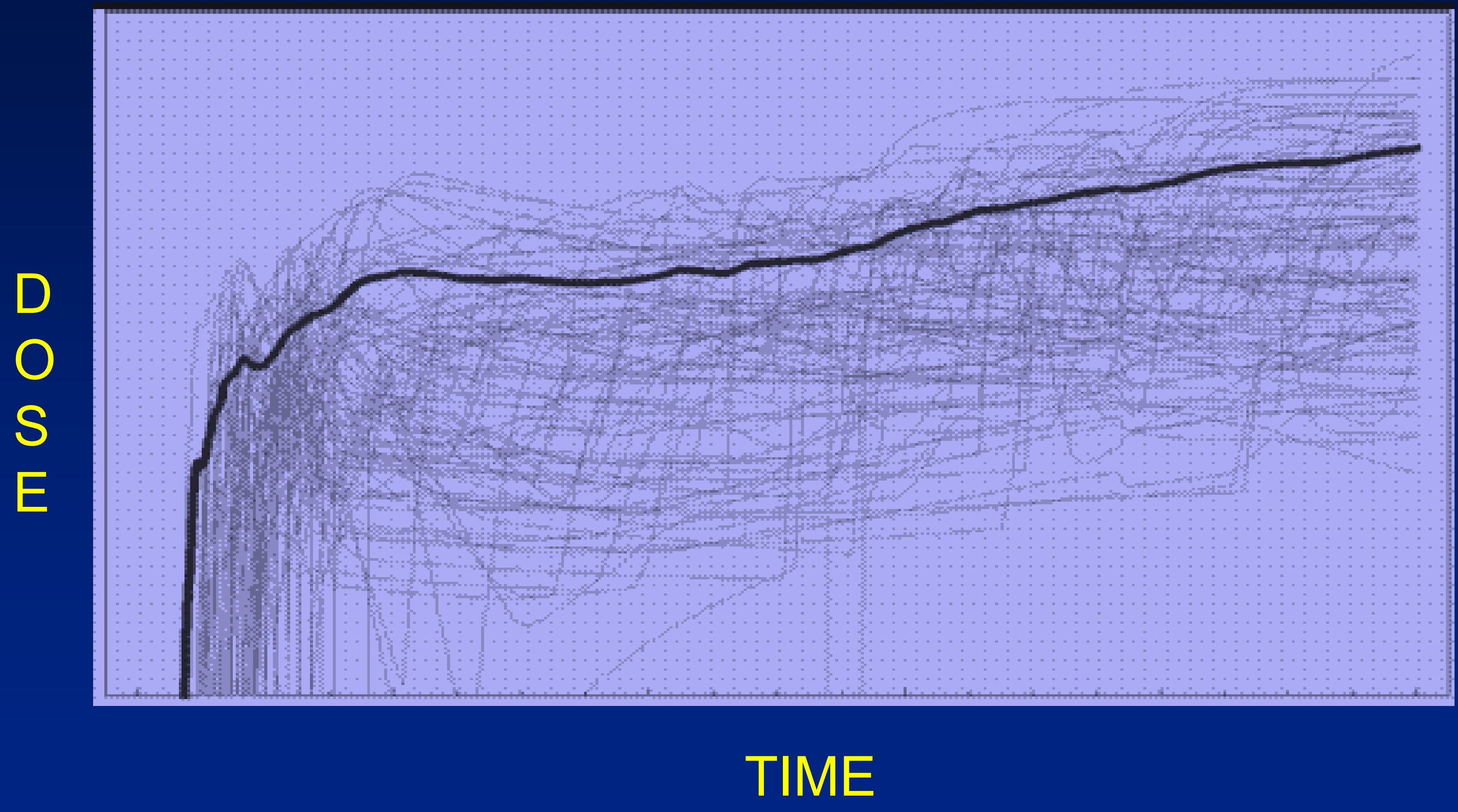
$\mathit{Dose}_k(t)$ = *doses at time t, for run k*

$N$ = *number of Monte Carlo runs*

$t$ = *time*



# Dose - Time PA Outputs



# NUREG-1854 - *PA Guidance for Activities Related to U.S. DOE Waste Determinations*

- Discusses the main areas that should be addressed during a WIR review
- Applies to all four WIR sites (SRS, INL, Hanford, West Valley)
- Is risk-informed and performance-based
- Is based on existing NRC guidance (e.g., NUREG-1573, NUREG-1757) as well as staff experience

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# NUREG-1854 Areas of PA Review Guidance

PA Review areas include:

- Scenario Selection and Receptors
- General Technical Review Procedures
- Specific Technical Review Procedures
  - Climate and Infiltration
  - Engineered Barriers
  - Source Term/Near Field Release
  - Radionuclide Transport
  - Biosphere Characteristics and Dose Assessment
- Models and Codes
- Uncertainty/Sensitivity Analyses
- Evaluating Model Results
- ALARA Analysis

# NUREG-1854 PA Reviews Generic Approaches

- The guidance emphasizes the need for adequate model to support its stability
- The amount of model support is to be commensurate with the risk significance of the model
- Model support may entail multiple lines of evidence
- The guidance recognizes that traditional validation may not be possible for some PA models
- Technical basis is needed for the performance of intruder protection systems
- Types of scenarios envisioned: residential, agricultural, recreational, hunting & fishing, well-driller, construction, or others
- Site stability PA includes:
  - Natural stability of the site (e.g., effects of floods, erosion)
  - Stability of the waste (e.g., potential for differential settling)
  - Stability of the engineered facility (e.g., vault degradation)

# Examples of Key Elements and Parameters in PA Analysis

- **Key PA Elements:**
  - Period of performance, disposal depth, receptor scenario (pathways and location), correlation of parameters, integration and consistencies of sub-models particularly and transport and dose impact calculations, and bench-marking and QA/QC
- **Examples of Parameters**
  - Hydraulic: conductivity, gradient of aquifer, infiltration rate
  - Chemical & Geochemical: solubility, liquid saturation, retardation
  - Exposure Scenario: sources of exposure, and occupancy time, residence parameters, location of receptor, and intake parameters

# PA Regulatory Issues

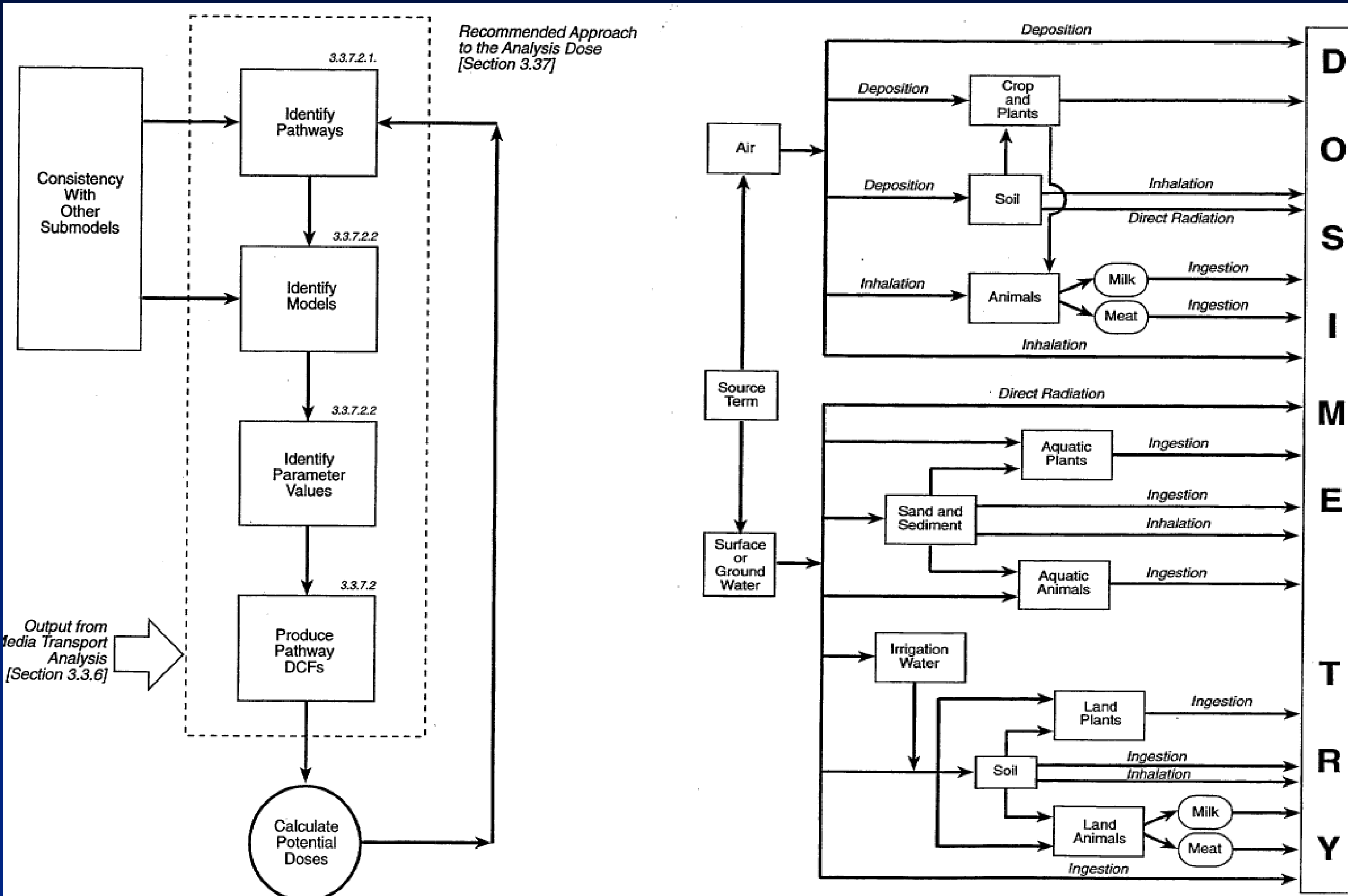
- How to treat future site conditions, processes, events, and climate change
- Exposure scenarios & compliance dose criteria
- Performance of engineered barriers
- Timeframe for LLW performance assessment
- Treatment of sensitivity and uncertainty
- Role of performance assessment during operational and post-closure periods
- Overall integration of site characterization, facility design performance assessment, and safety analysis
- Bench-marking and QA/QC issues
- Stakeholders Inputs

# Summary, Conclusion, and Path Forward

- Basic approaches and methodologies of generic NRC LLW PA, addressing 10 CFR Part 61 performance objectives, are well established in NUREG-1573
- PA analysis for LLW evaluation of specific sites, or specific waste streams, can be developed as necessary based on a case-by-case basis
- PA regulatory issues are typically addressed through coordination of PA analysts and decision-makers, as directed by the Commission and in consideration of stakeholders inputs
- PA analysis and management decisions will continue to be based on “Risk-Informed Performance Based Approach and Realistic Conservatism”
- NRC staff welcome international PA collaboration and exchange of information

# Backup Slide

# NRC's Recommended Approach to Dose Impact Analysis Calculations



# Computational Tools Used by NRC Staff for LLW Risk Analysis

David Esh (and PA staff)
US Nuclear Regulatory Commission
david.esh@nrc.gov

March 3, 2011 WM2011

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# Overview

- Role of NRC
- Independent modeling and analysis
- Tools/products
- Examples
- Conclusions

# Role of NRC

- All currently operating LLW disposal facilities are located in Agreement States
- NRC does not perform independent modeling of facilities located in Agreement States
- NRC performs technical analysis of many analogous programs:
  - Incidental waste (DOE)
  - Decommissioning
  - Uranium recovery

# Independent Modeling and Analysis

- Independent modeling has many benefits:
  - Better understanding
  - Ability to risk-inform the review
  - Shortens review time
  - Better identify critical issues in complex systems

# LLW Modeling–
# Do's and Don'ts

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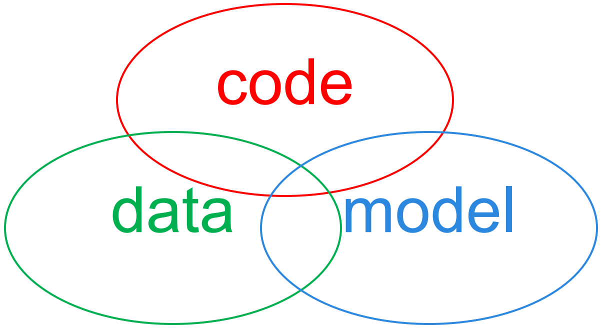
<u>**Do's**</u>

- Select code for problem
- Improve code if needed
- Ensure QA
- Provide model support
- Account for uncertainty and variability




<u>**Don'ts**</u>

- Force code to fit problem
- Limit analysis to scope of code
- Use codes without QA
- Use sophisticated codes when you have little data
- Select codes based solely on familiarity

# Codes Used by NRC PA Staff*

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GoldSim (GTG), RESRAD (ANL), D&D (ANL)

HELP (US COE)
Siberia (Telluric Research)

GENII (PNNL)
BDOSE (CNWRA)

4SIGHT (NIST)
BLT (BNL)
PHREEQC (USGS)
DUST-MS (BNL)
Geochemist's Workbench (Rockware)

UNSAT-H (PNNL)
PORFLOW (ACRi)
TOUGH2 (LBNL)
GMS (AquaVeo)
MODFLOW/MT3DMS (USGS)

Others – Microshield (Grove Software)
Mathematica (Wolfram)
Neuralworks Predict (NeuralWare)
ArcGIS (ESRI)
MVS (Ctech)
Earthvision (Dynamic Graphics)
MCNP (LANL)
SADA (U of Tenn)



*NRC general usage of codes is not an endorsement of any specific code for a specific site

# NRC Code Usage – Example #1

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- Using GIS to generate information for a performance assessment model
- West Valley Demonstration Project site near Buffalo, NY (decommissioning)
- Combined ArcView and GoldSim (eventually added Siberia and BDOSE)
- Esh and Gross (WM06)

# NRC Code Usage – Example #1

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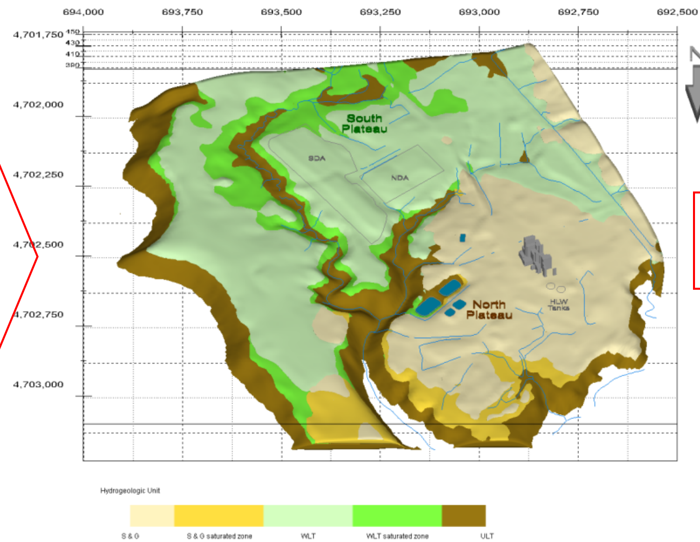


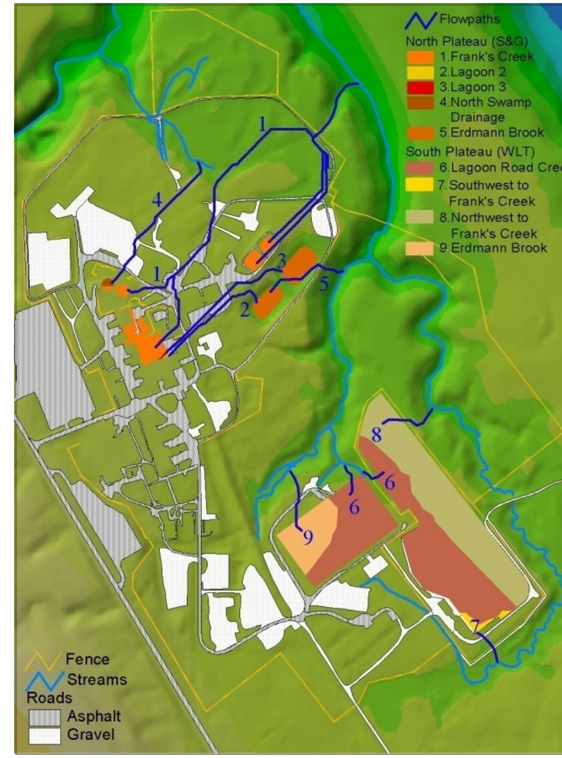


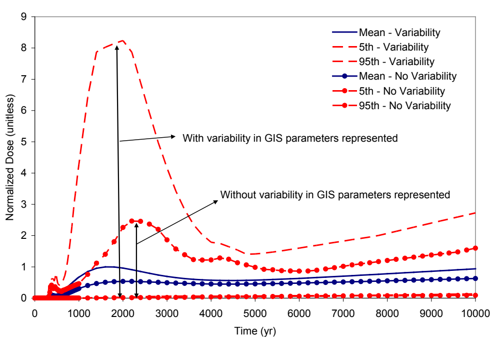


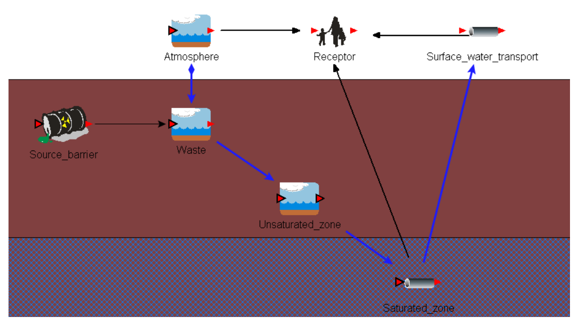

# NRC Code Usage – Example #2

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- Developed a performance assessment model to perform independent modeling of a waste disposal facility
- Savannah River Site Saltstone Disposal Facility near Aiken, SC
- Developed completely in GoldSim
- Esh, Ridge, Thaggard (WM06)

# NRC Code Usage – Example #2

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- GoldSim® software
- Probabilistic assessment
- Specialized elements facilitate radionuclide transport modeling
- 2,600 GoldSim elements, more than 300 stochastic elements
- Numerous submodels
  - Degradation of engineered cap
  - Oxidation of cementitious waste
  - Physical degradation of cementitious waste
  - Advective and diffusive releases
  - Transport in unsaturated and saturated zones
  - Dose assessment
- Modeling used abstractions

# NRC Code Usage – Example #2

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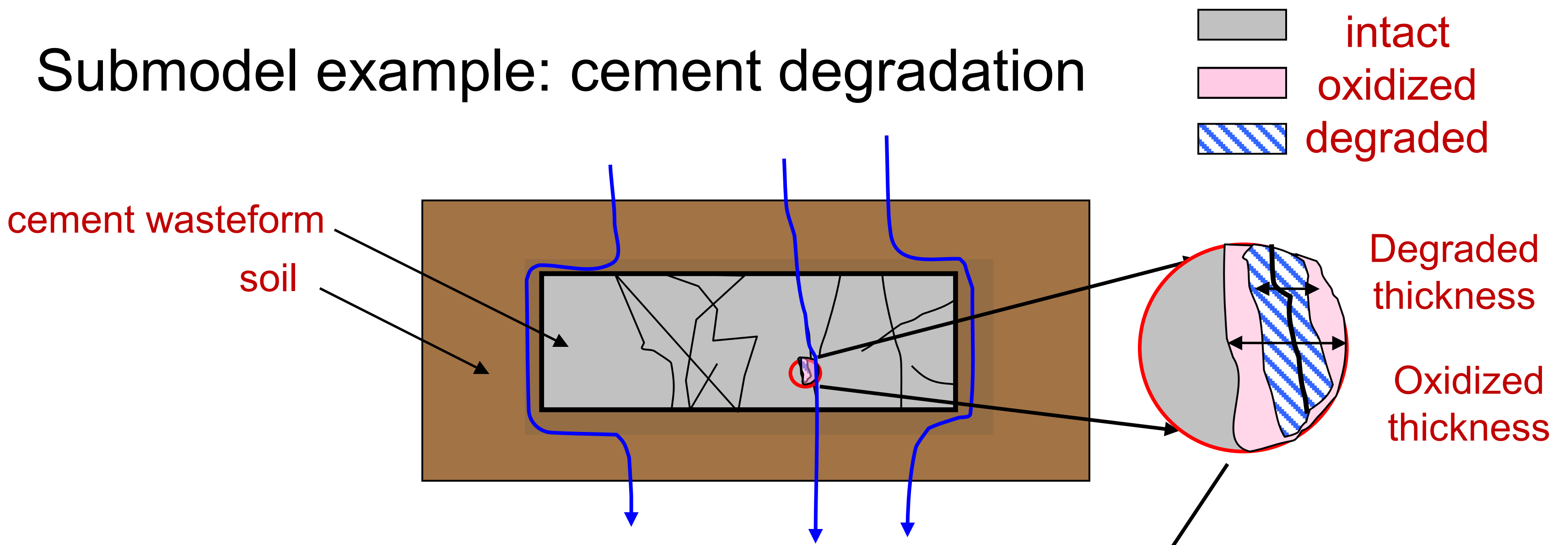
## Submodel example: cement degradation




Number of half cells modeled depends on user-defined fracture spacing

# NRC Code Usage – Example #2 (Uncertainty Analysis with Neuralworks Predict)

| Variable | Description | Importance Factor |
|---|---|---|
| Grout_deg_start | Time at which degradation of the wasteform can begin | 0.98 |
| Nm | MacMullin number. The effective diffusion coefficient is a product of Nm and the molecular diffusion coefficient. | 0.93 |
| Degraded_grout_Kh | Hydraulic conductivity for degraded region of the wasteform. | 0.36 |
| TransFactor_indoor | Factor to account for shielding of radiation when an individual is inside a residence. | 0.29 |
| Se_solubility | Solubility of Se in the pore fluid of the wasteform. | 0.21 |
| Kd_waste_Sr_ox | Distribution coefficient for Sr in the oxidized region of wasteform. | 0.11 |
| Vent_light_activity | Breathing rate for an individual during light activity. | 0.11 |
| SZ_dispersivity_factor | Used with the transport length in the saturated zone to develop the saturated zone dispersivity. | 0.10 |
| Kd_Waste_Eu | Distribution coefficient for Eu in the intact portion of the wasteform. | 0.08 |

# NRC Code Usage – Example #3



- PORFLOW was used as one submodel in a performance assessment model (DOE)
- Staff independently ran PORFLOW to test assumptions
- Staff identified key assumptions and uncertainties
- Without independent modeling, it would have been very difficult to risk-inform the review

# NRC Code Usage – Example #3

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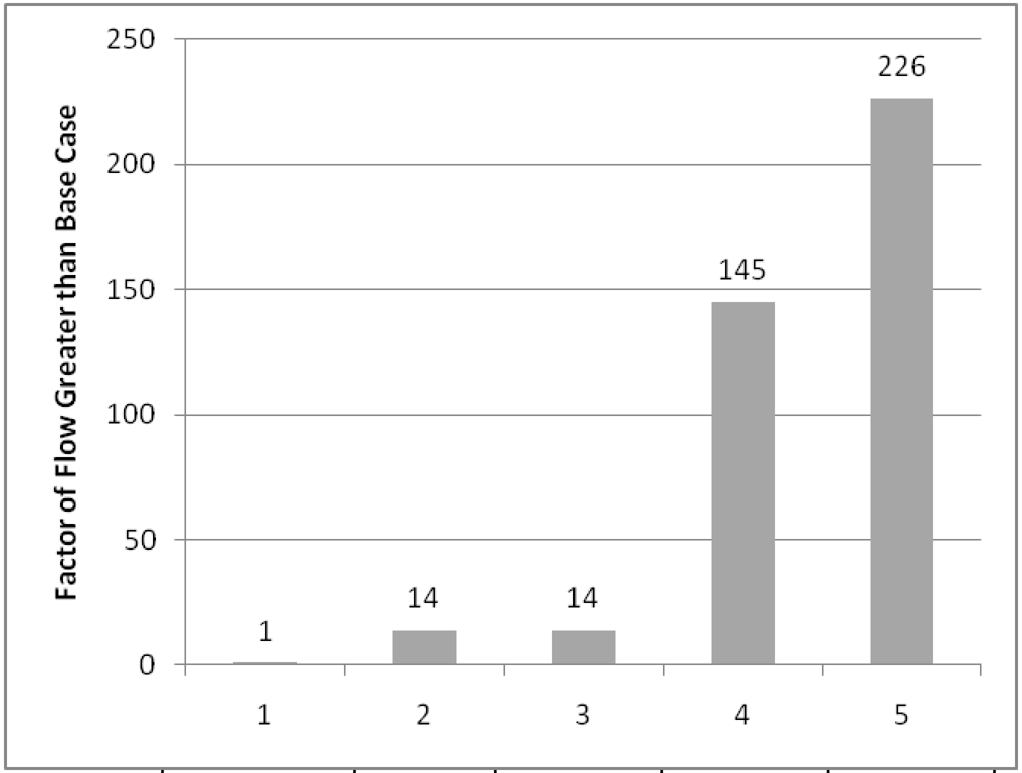


| Base Case | Revised: MCC for Saltstone and Clean Grout | Revised: LDL | Revised: K for Saltstone and Clean Grout | Revised: LDL; K and MCC for Saltstone and Clean Grout |
|---|---|---|---|---|

# Conclusions

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- NRC uses a toolbox of products to perform independent modeling
- Products must be selected for the specific problem being evaluated
- QA and model support are essential to successful LLW modeling
- It can be difficult to risk-inform a review without performing independent modeling

# Risk-Informed LLW Management

**WM 2011 Session 101**
**Thursday 1:00 PM**

**Michael T. Ryan Ph.D., C.H.P.**
**March 3, 2011**

# LLW Rules:

- **61.41 Principle Protection Criteria**

- **61.55 Waste Classification Tables (Deterministic Result for a Generic Site)**

- **61.58 Alternative Requirements for Waste Classification**

# Main Risk Metrics for Waste

- **Concentration – Best used as a metric for operational risks**
- **Quantity – Best used as a metric for disposal risks**
- **Half-life: long-term risk, transport, and environmental impacts**

# Concentration

- **Radiation Protection**
  - **Worker protection to external exposure**
- **Shipping Cask Operations**
  - **Compliance with dose rate limits**

# Quantity

- **For Disposed Radioactive Materials**
  - **Local concentration does not drive the risks**
  - **Total quantities released from the inventory in a site drive the risks**

# Half-Life

- Distinguishing short-term from long-term risk & waste acceptance criteria
- Considering long-term risk from progeny
- Considering long-term transport and potential environmental impacts

# Areas for Improvements

- Greater emphasis on Risk-Informed Approach to LLW management

- Focus on radionuclide content (inventory ) rather than waste origins or concentrations
- Address intermediate level waste category (ILW) – GTCC
- Address clearance issue

# Areas for Improvements

- **Need to focus on Extended Storage of Class B and Class C LLW**

- **RCRA Subtitle–C and Subtitle–D Sites: Are they suitable for certain types of LLW and LAW?**

# Approaches for Improvements

- **Specify the calculational methods and perform a risk-informed assessment**

- **Use the result to specify site-specific quantities/limits for the expected wastes within the bounds of the risk assessment**
- **Develop site-specific waste acceptance criteria**

# Approaches for Improvements

- **Risk-inform the characteristics of:**
  - **Waste**
  - **Waste Package**
  - **Disposal Technology Below Grade (Vaults and barriers**
  - **Cover Technology At and Above Grade**
  - **Update performance assessment approaches and methodologies**
  - **Geohydrology and Geology**

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

# PRISM components and Approaches

Gerard  BRUNO, IAEA/WES/NSRW

&

Vincent NYS, FANC Belgium

IAEA

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

# 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"

# 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

# 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

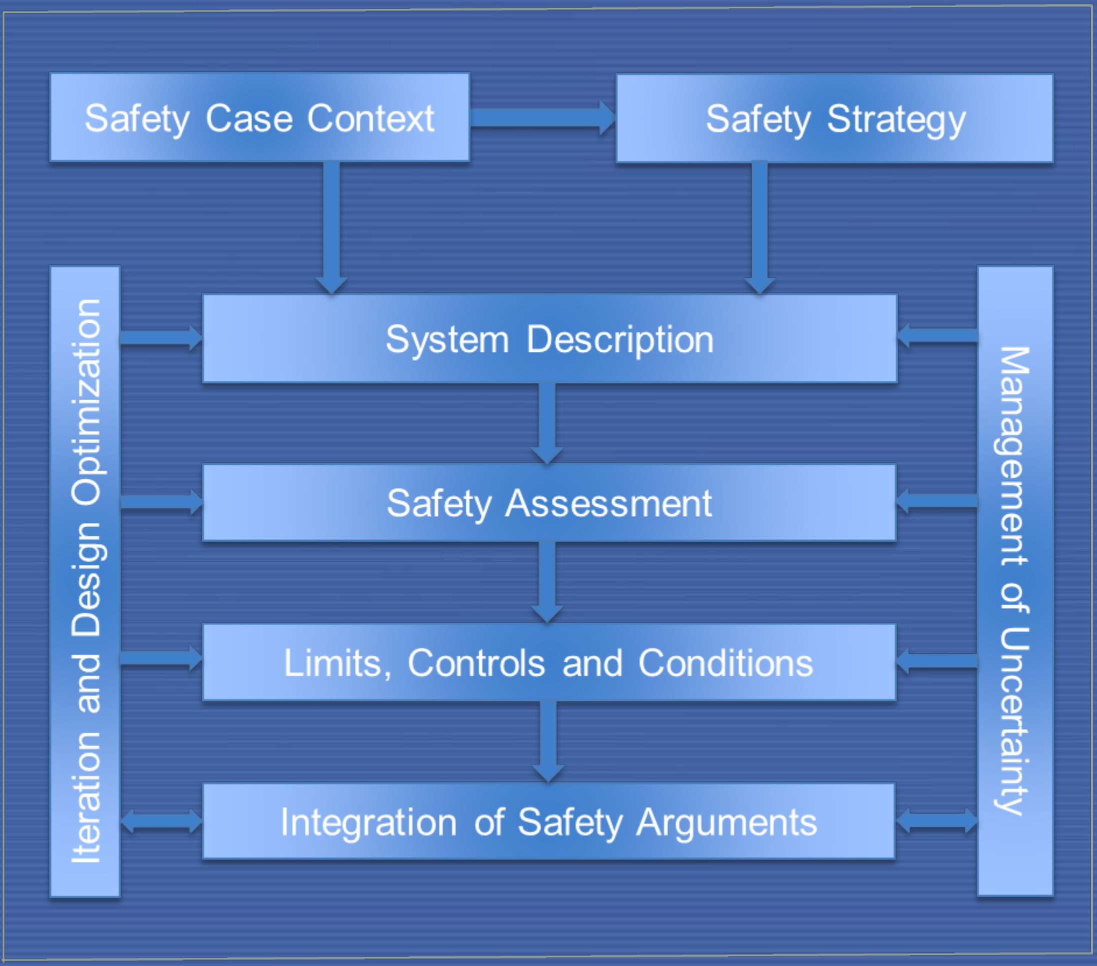
# Components of the safety case

- 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

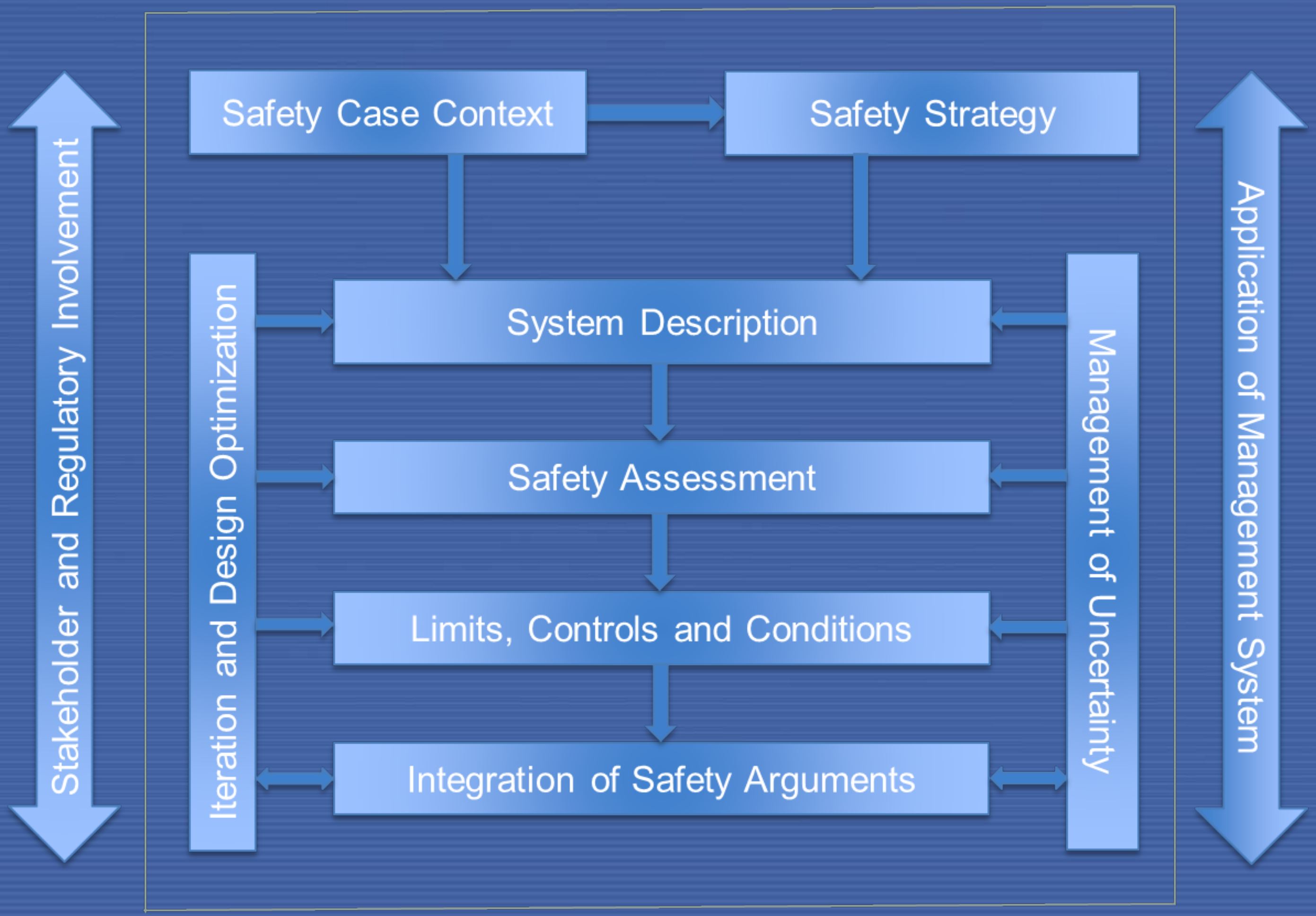
# Components of the safety case

- 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



# 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.

# 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.

# Safety Assessment Aspects

Safety Assessment

- Management System
- Non radiological environmental impact
- Post Closure Radiological Impact
  - Scenarios
  - Models
  - Calculations
- Operational Safety
- Site and Engineering

# 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

# 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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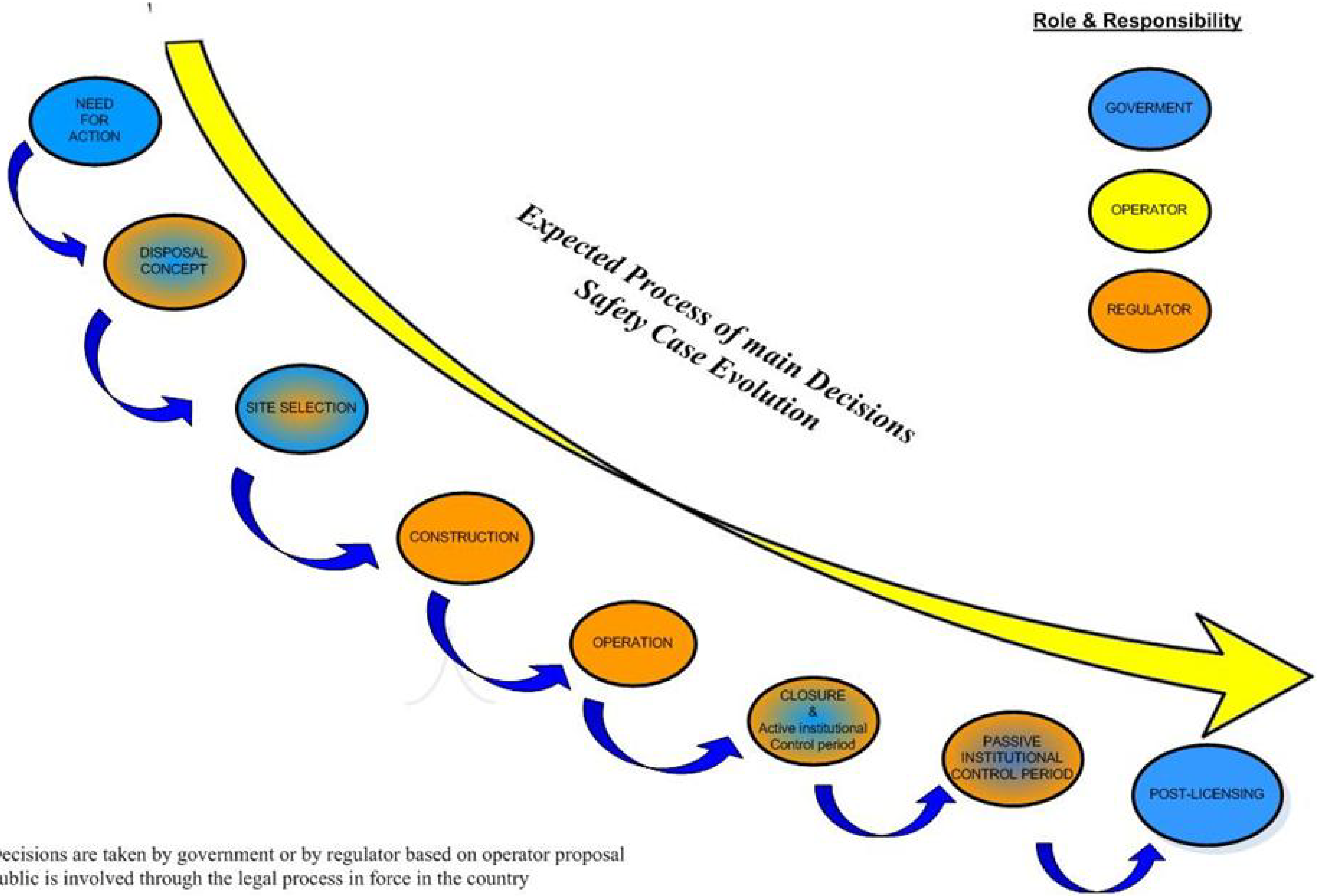
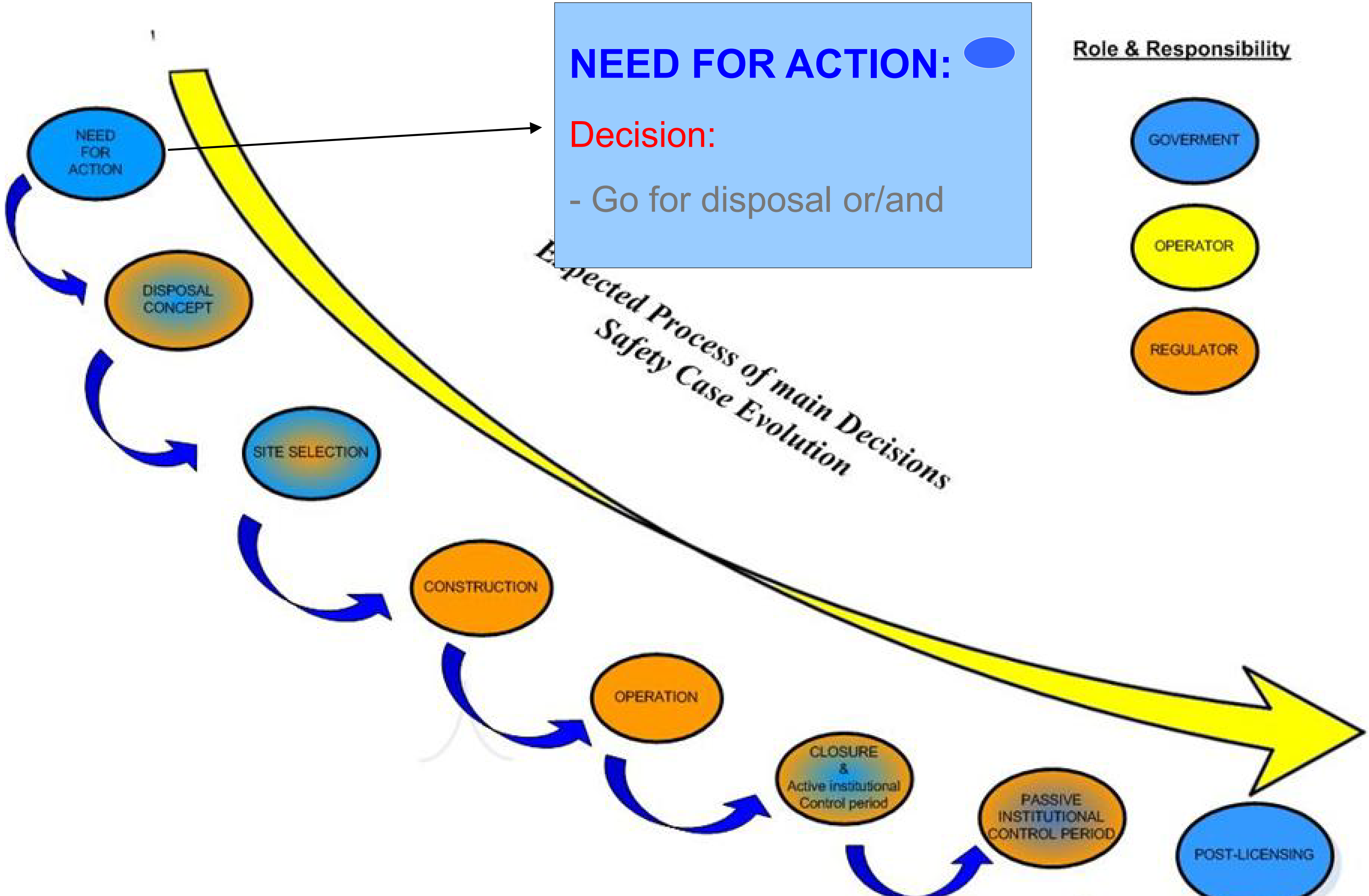



Decisions are taken by government or by regulator based on operator proposal
Public is involved through the legal process in force in the country

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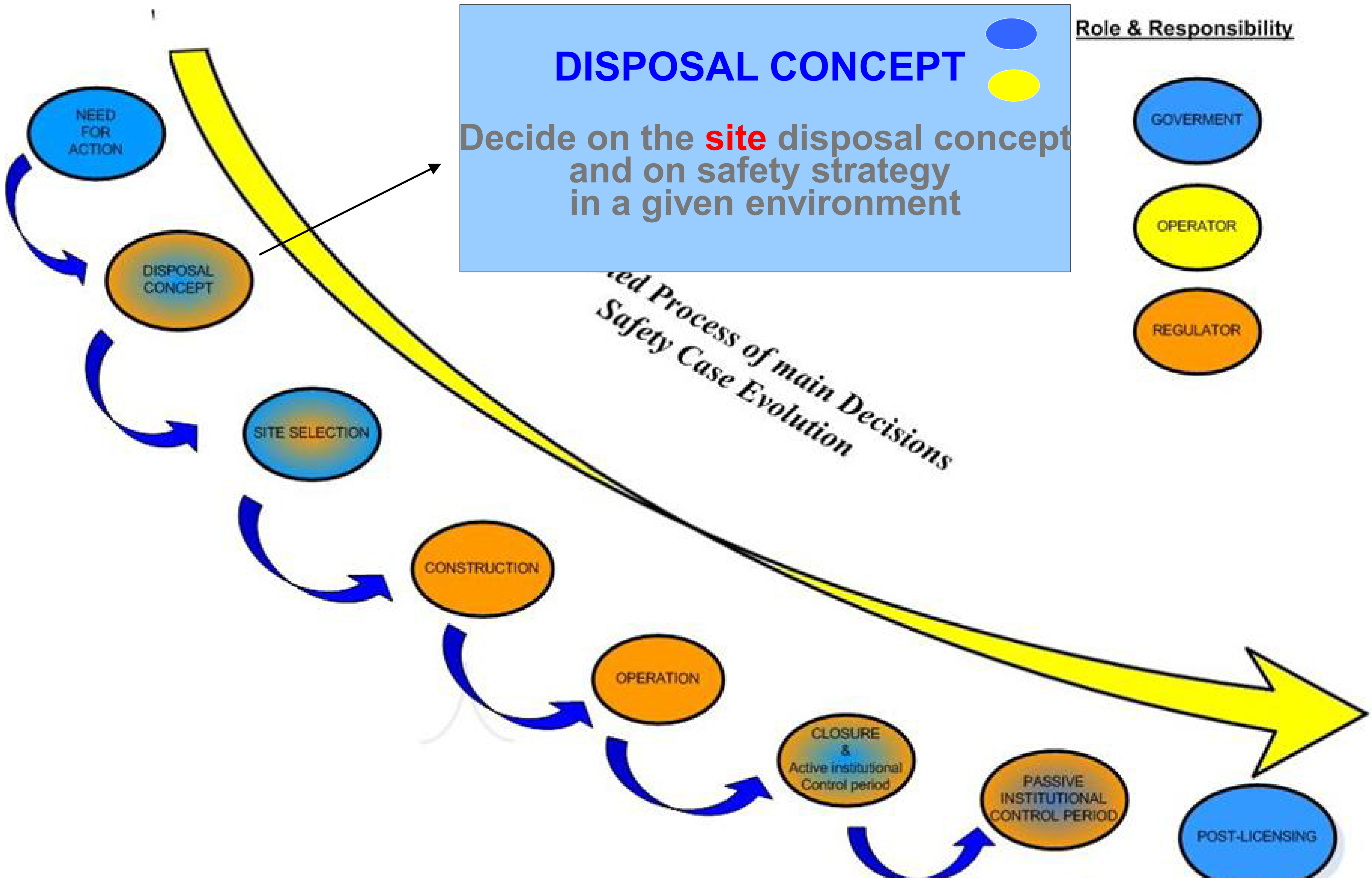
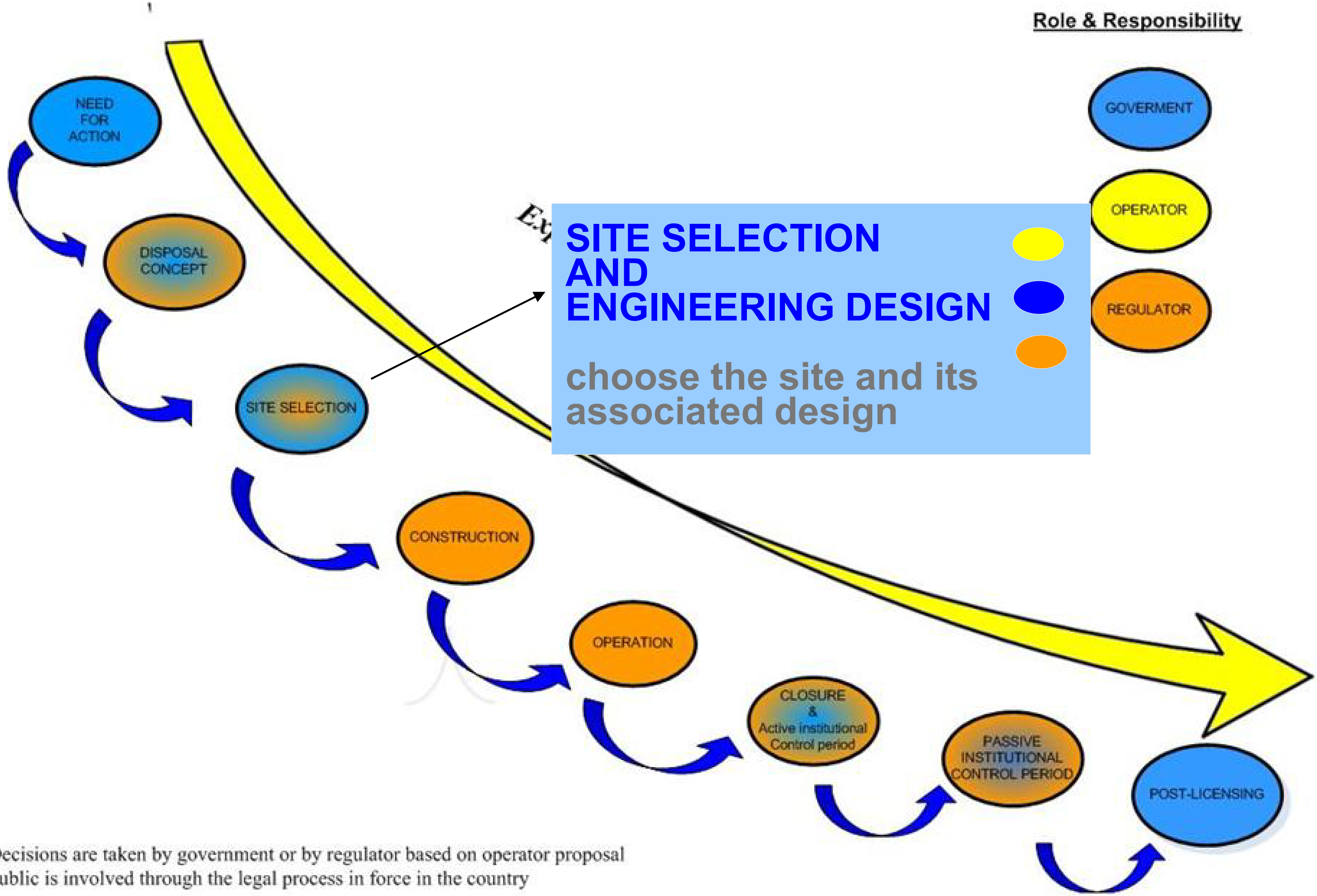



Decisions are taken by government or by regulator based on operator proposal
Public is involved through the legal process in force in the country

## SITE SELECTION AND ENGINEERING DESIGN

**choose the site and its associated design**

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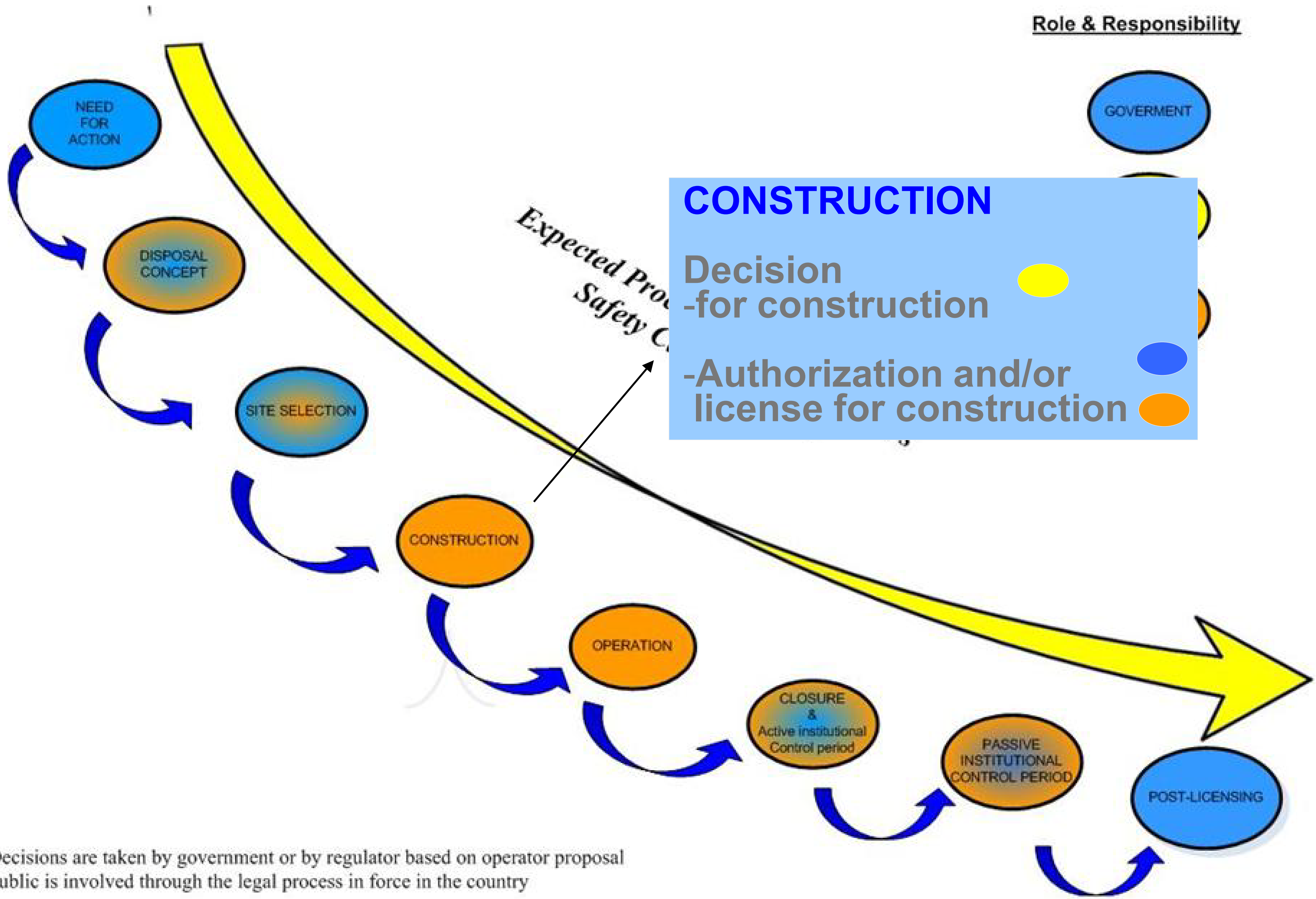


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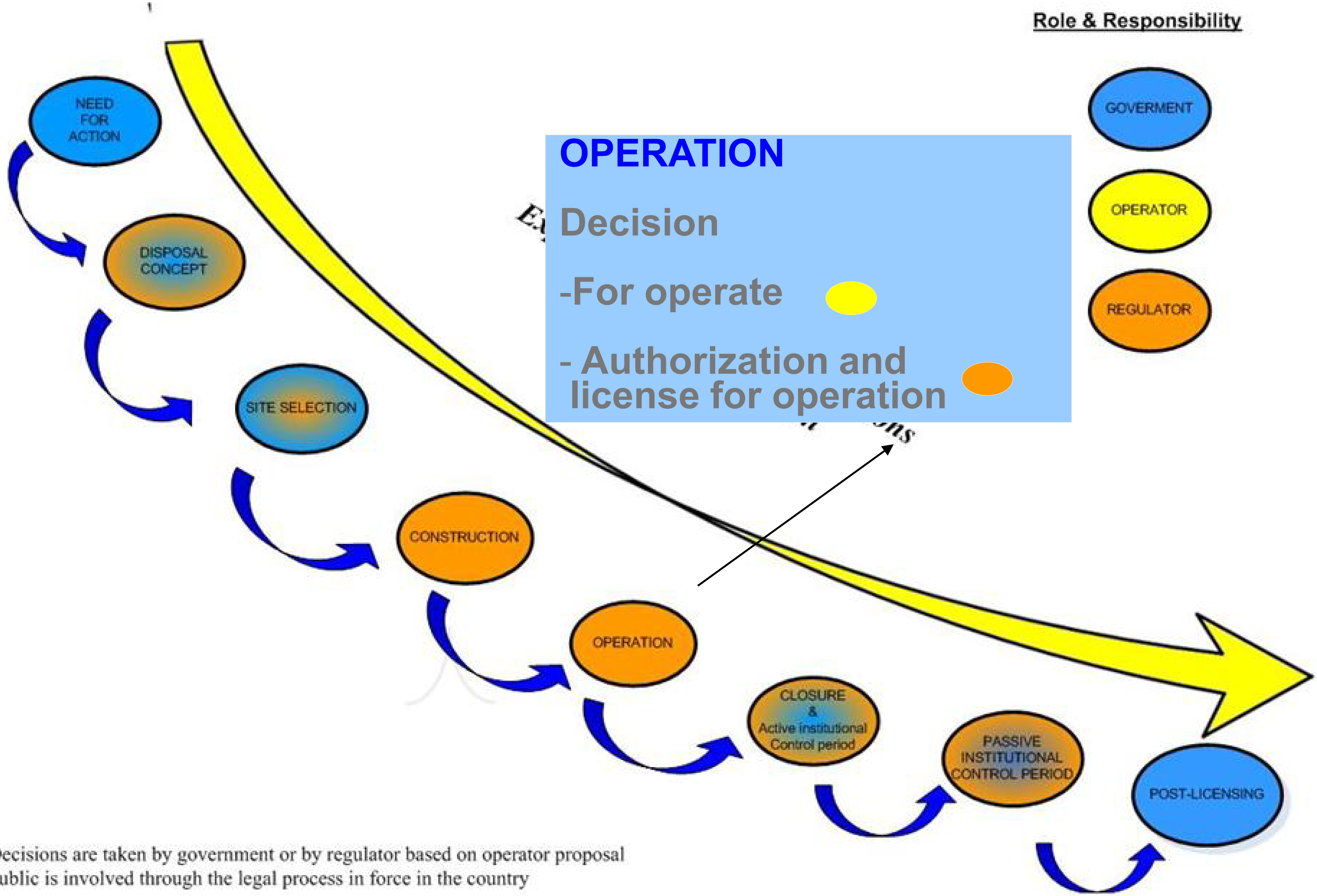


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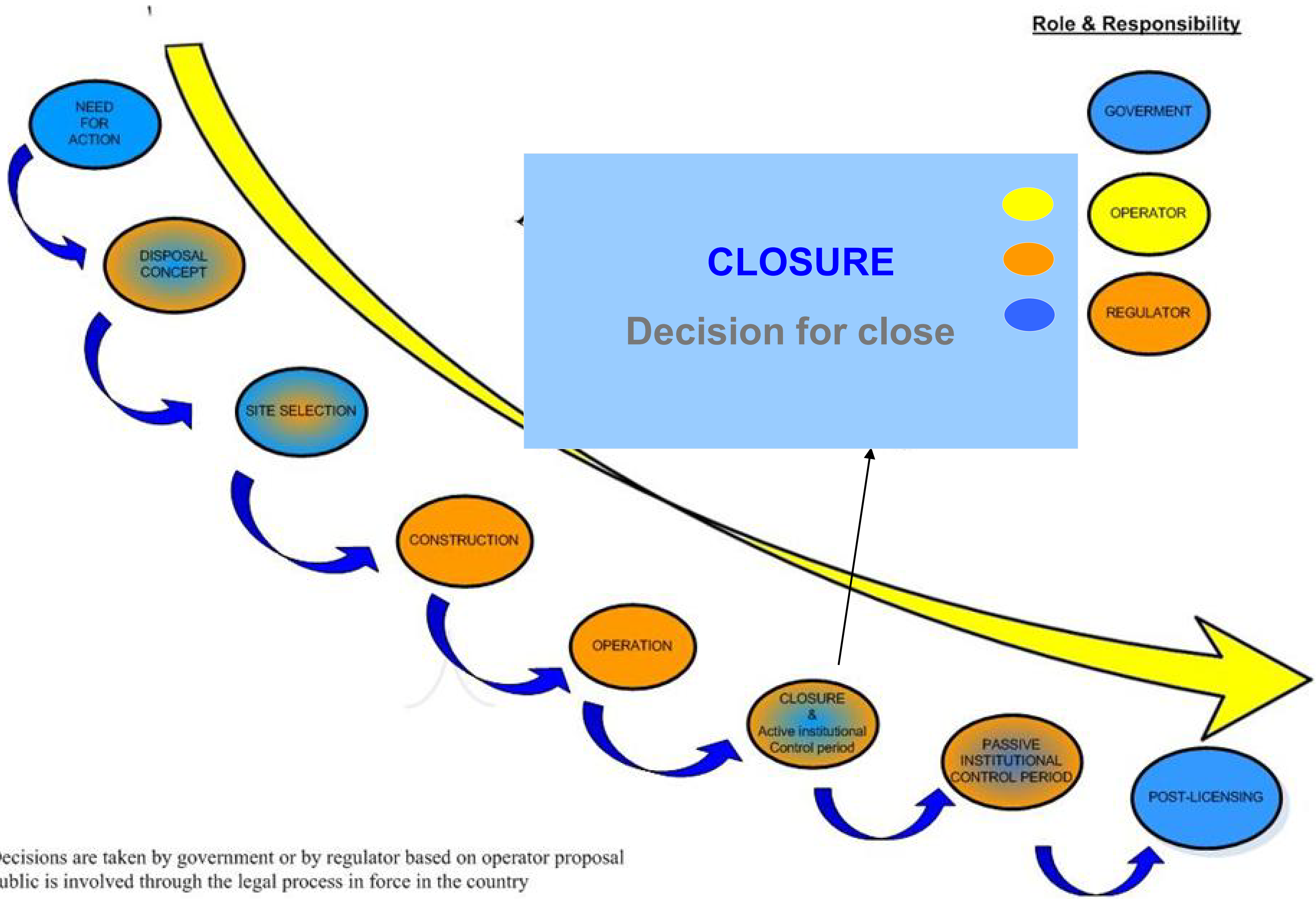


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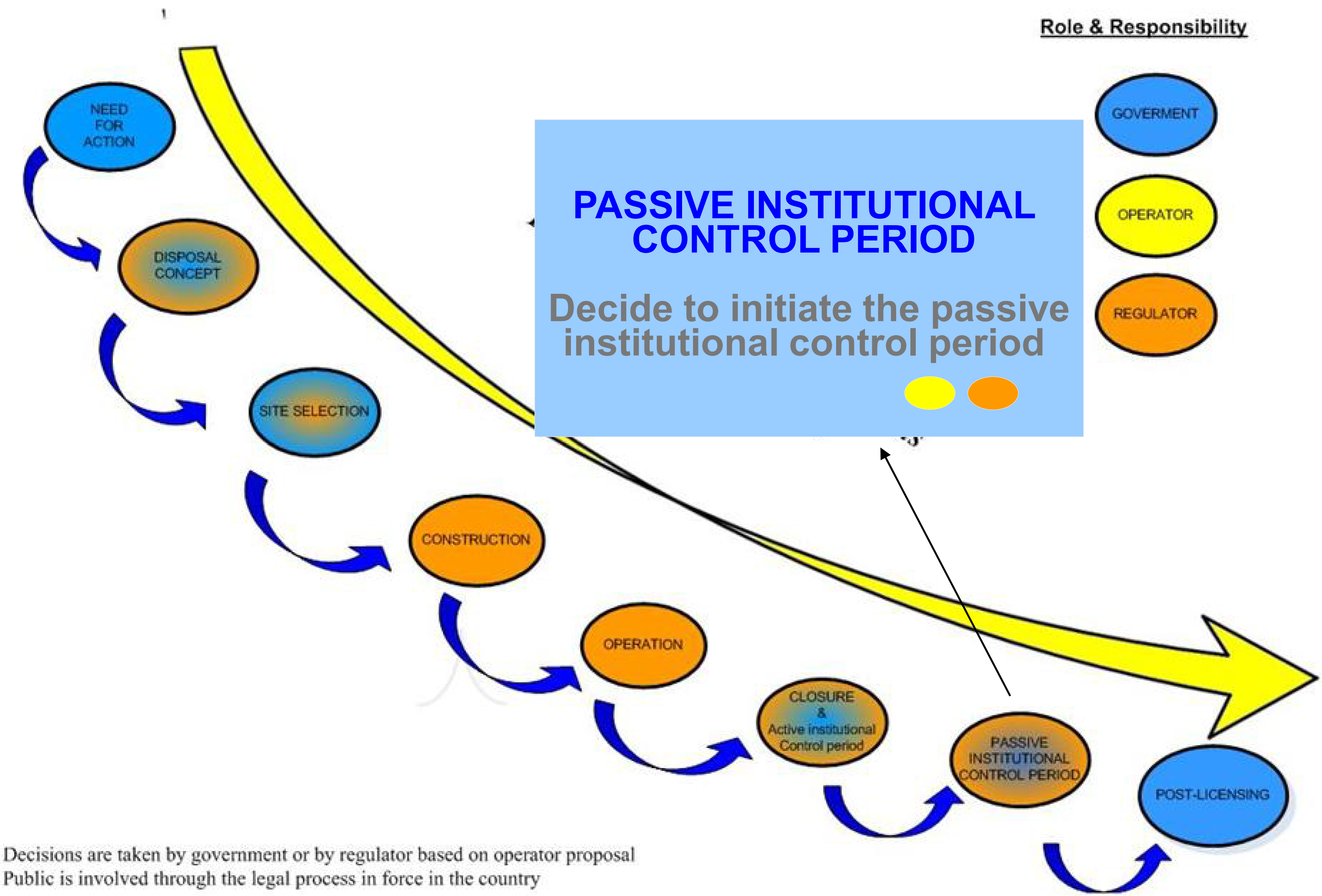
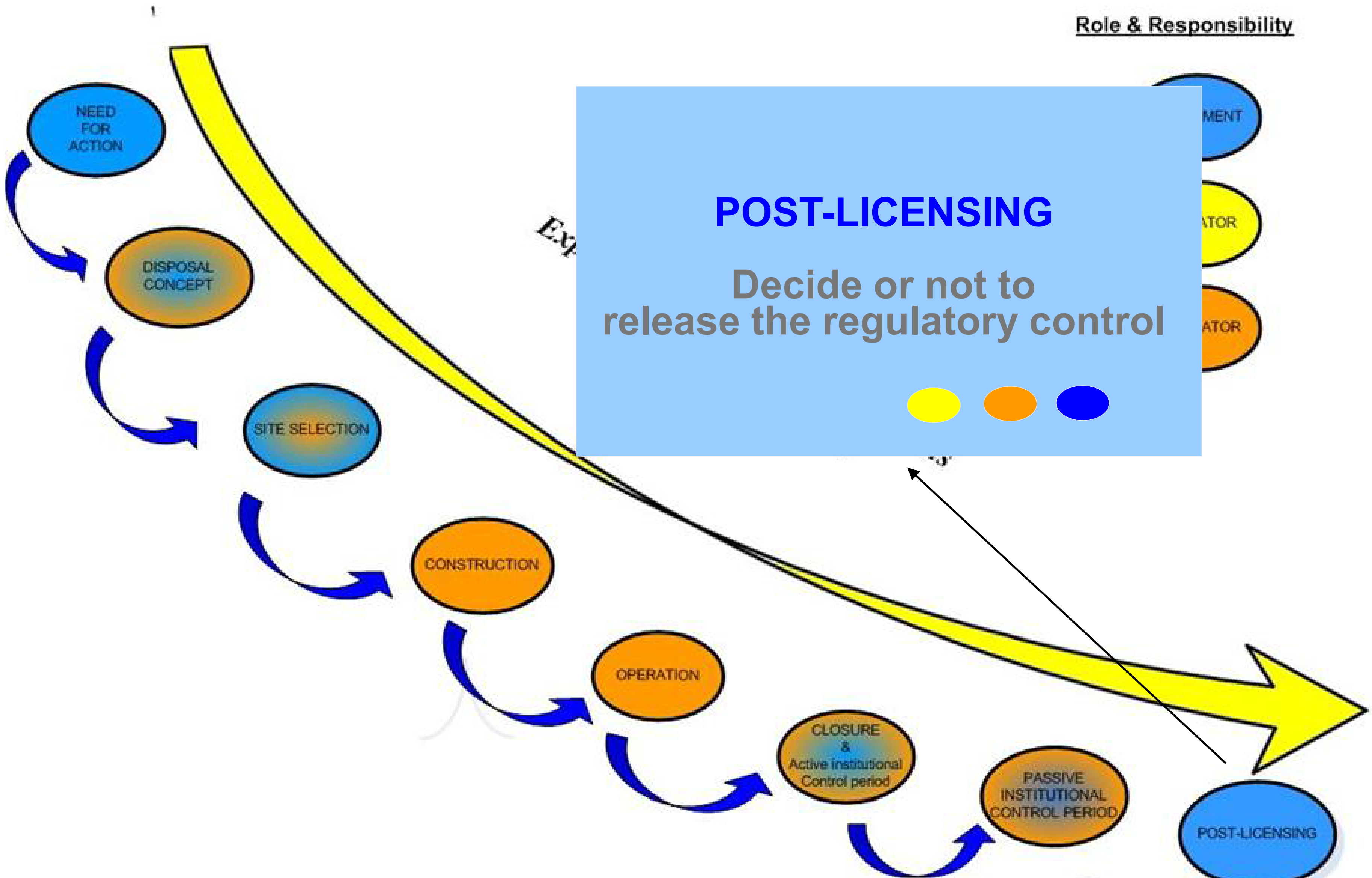

Role & Responsibility
GOVERMENT
OPERATOR
REGULATOR
PASSIVE INSTITUTIONAL CONTROL PERIOD
Decide to initiate the passive institutional control period
NEED FOR ACTION
DISPOSAL CONCEPT
SITE SELECTION
CONSTRUCTION
OPERATION
CLOSURE & Active institutional Control period
PASSIVE INSTITUTIONAL CONTROL PERIOD
POST-LICENSING
Decisions are taken by government or by regulator based on operator proposal
Public is involved through the legal process in force in the country




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**

# 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 **includes amo** … **wing topics will be taken into account**

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

- ✓ **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 <u>why the disposal system could be considered as safe</u>. 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.**

# 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.**

# 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**

✓ **…**

# 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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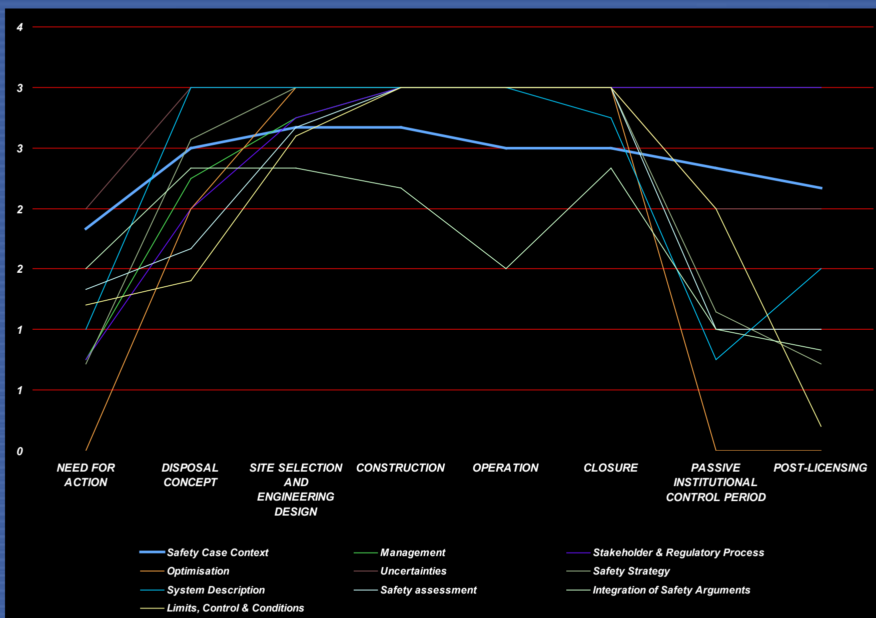
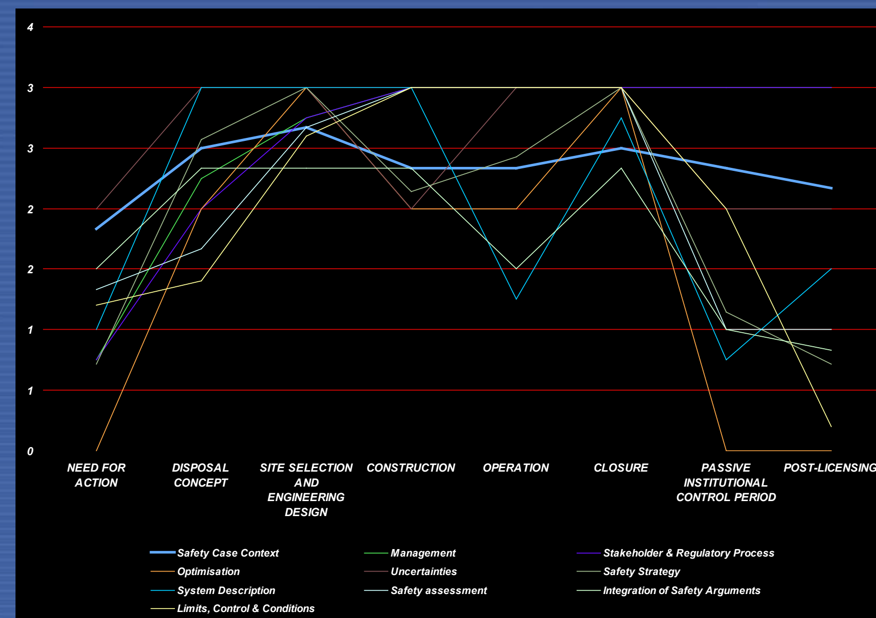
# Time dependence of the Safety Case Argument

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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

# 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

# Safety Case Arguments

System Description

Safety Case Context

Stakeholder & Regulatory Involvement

Safety Strategy

Safety Assessment

Management System

Limits, controls and conditions

Integration of Safety Arguments

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# Safety Case Arguments

Stakeholder & Regulatory Involvement

System Description

Safety Case Context

Management System

ety Strategy

Safety Assessment

Limits, controls and conditions

Integration of Safety Arguments

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# Safety Case Arguments

Stakeholder & Regulatory Involvement

System Description

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

Safety Case Context

Safety Strategy

Management System

Safety Assessment

**Limits**, controls and **conditions**

Integration of Safety Arguments

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# Safety Case Arguments

Stakeholder & Regulatory Involvement

Safety Case Context

Safety Strategy

Management System

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# Safety Case Arguments

Stakeholder & Regulatory Involvement

Safety Case Context

Safety Strategy

Having the context and the strategy, the next one should be the "System description"

Safety Assessment

System Description

Limits, controls and conditions

Integration of Safety Arguments

Management System

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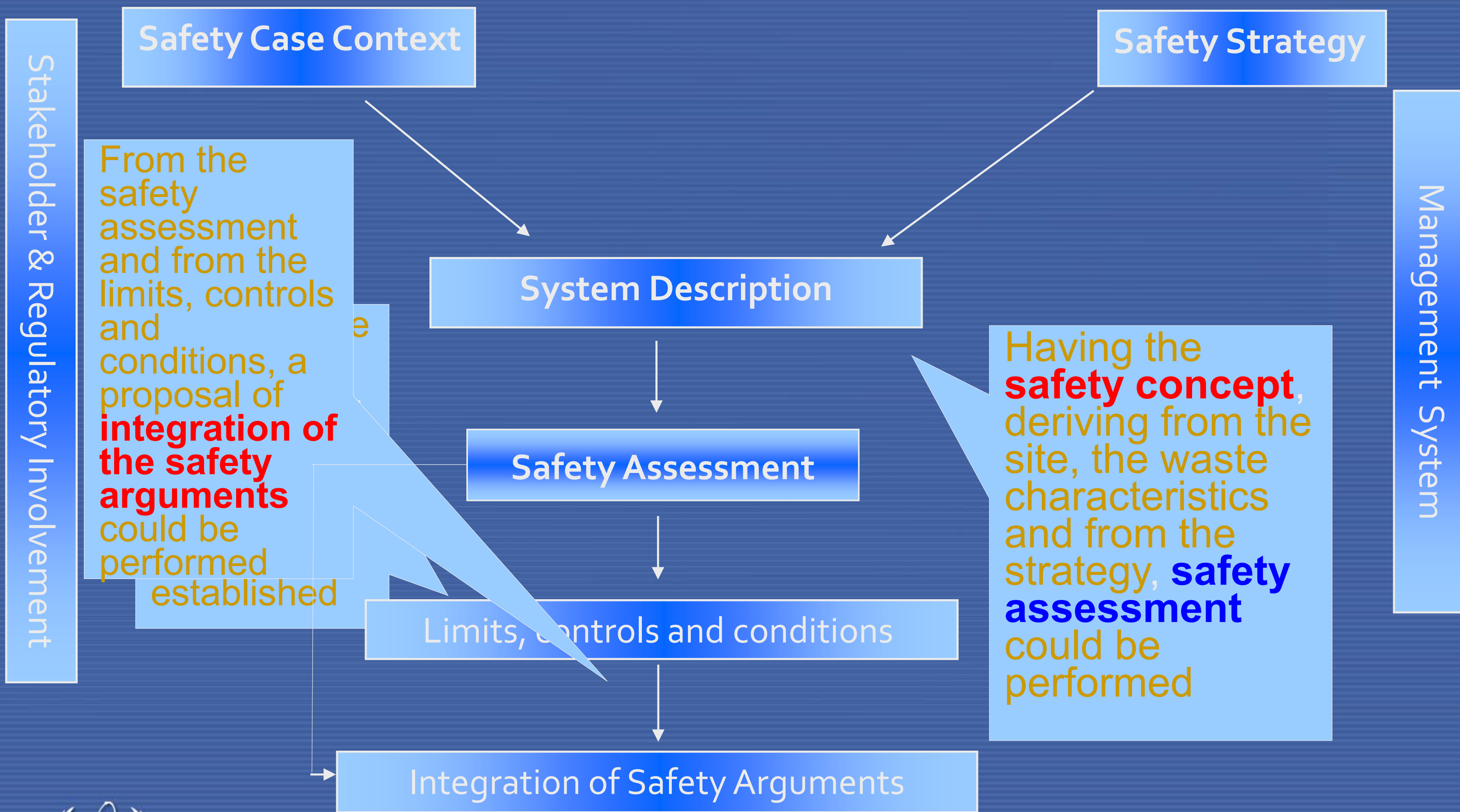
# Safety Case Arguments

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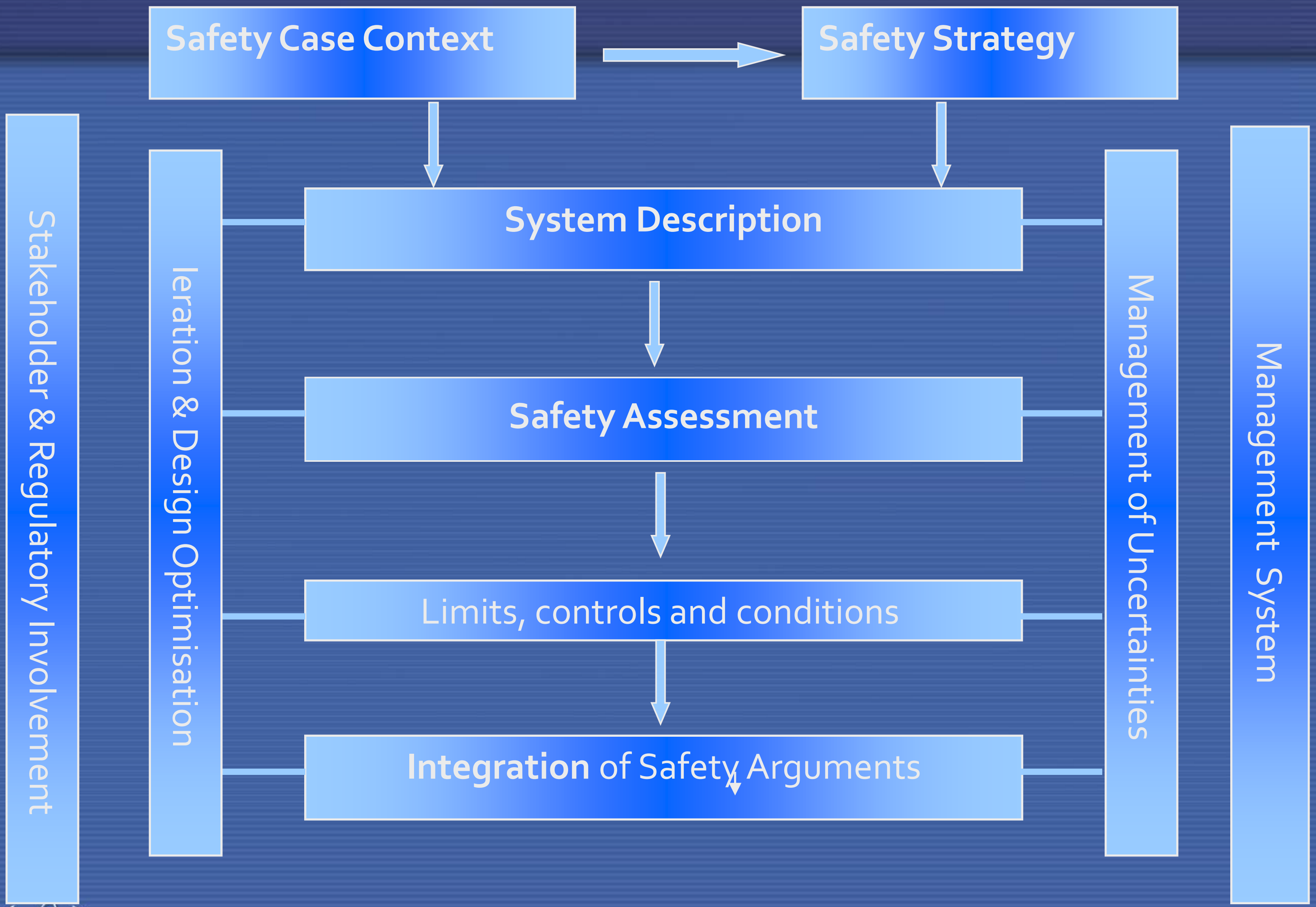
This way of structuring the relationship between the safety case components we call it “safety approach”

This safety approach could be organized as followed:


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

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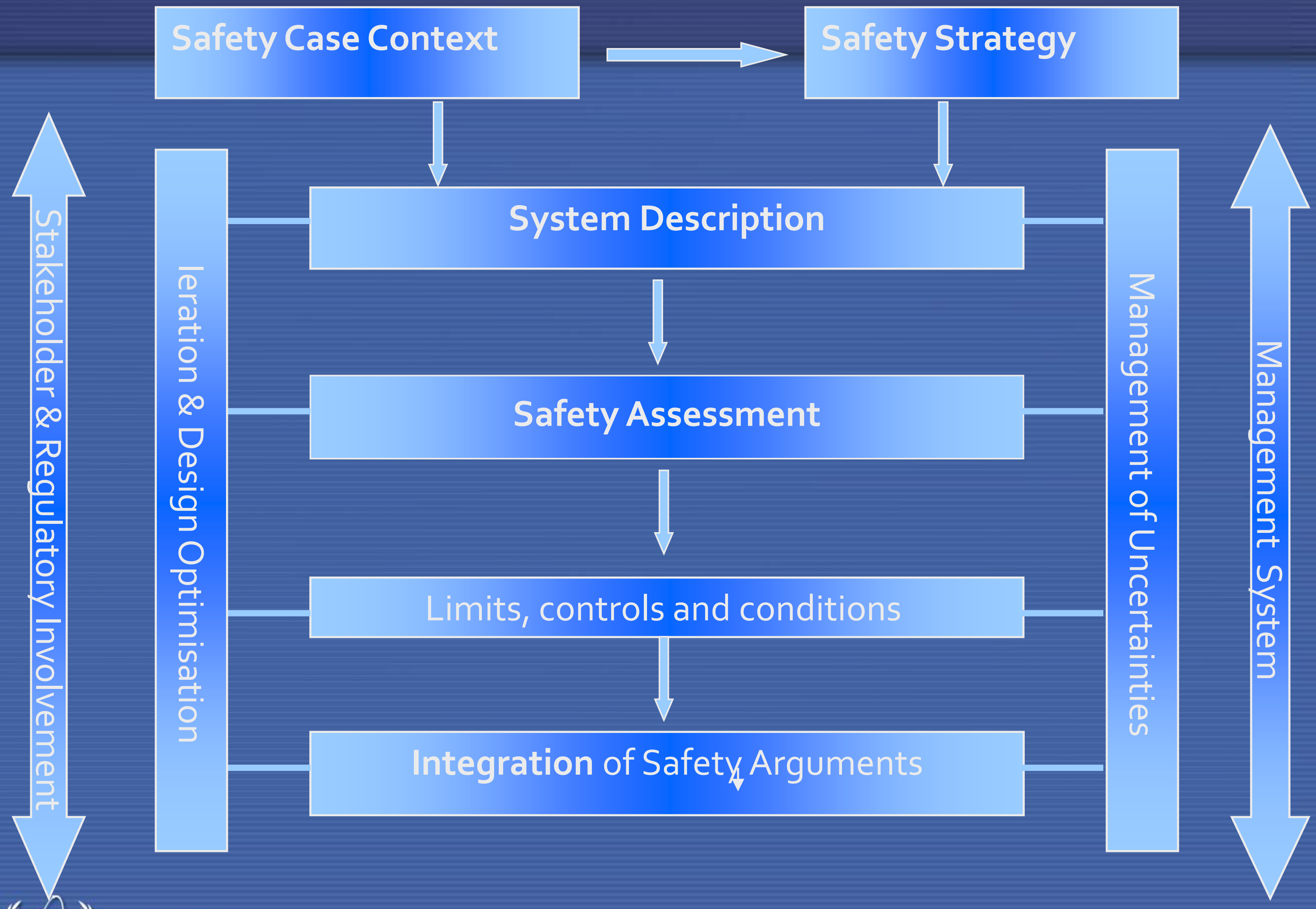

Safety Case Context
Safety Strategy
System Description
Safety Assessment
Limits, controls and conditions
Integration of Safety Arguments
Stakeholder & Regulatory Involvement
Ieration & Design Optimisation
Management of Uncertainties
Management System
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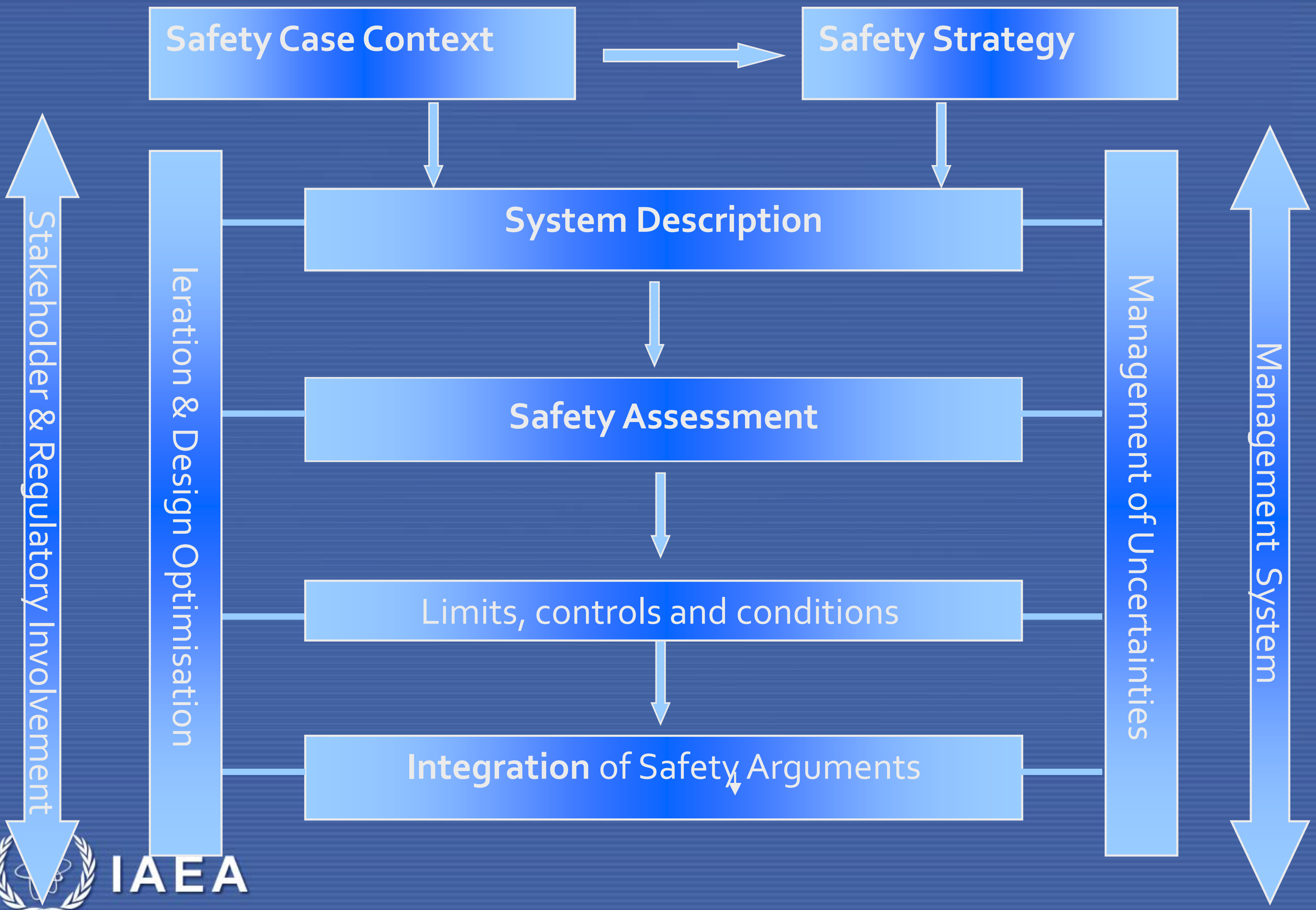
# Link with other PRISM Tasks

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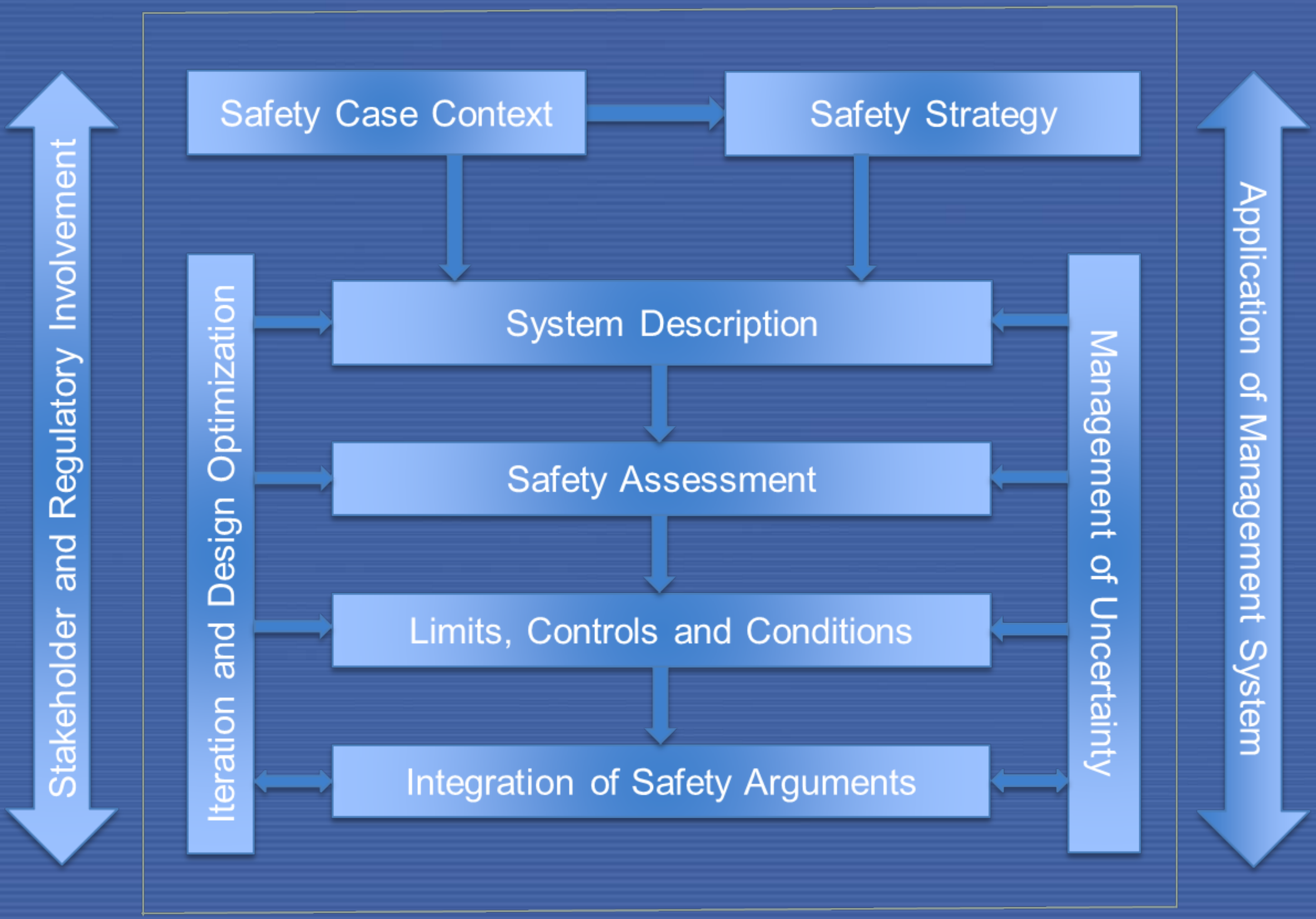
# IAEA Safety Case and Safety Assessment: main figure

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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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# Performance Assessment and LLW Disposal – EPRI Perspective


**Lisa Edwards**
EPRI Program Manager
David James
DW James Consulting, LLC


**WM 2011**
February, 2011
Session 101

# EPRI LLW Management Program

**Objective:**

- Address the Loss of Class B/C Disposal
- Provide Positive Public & Regulatory Assurance

**Description:**

- R&D Program Elements:
  - Improve LLW Management (B/C Waste Minimization)
  - Assure Safe Storage of LLRW
  - Develop New Disposal Options

**R&D Disposal Approach**

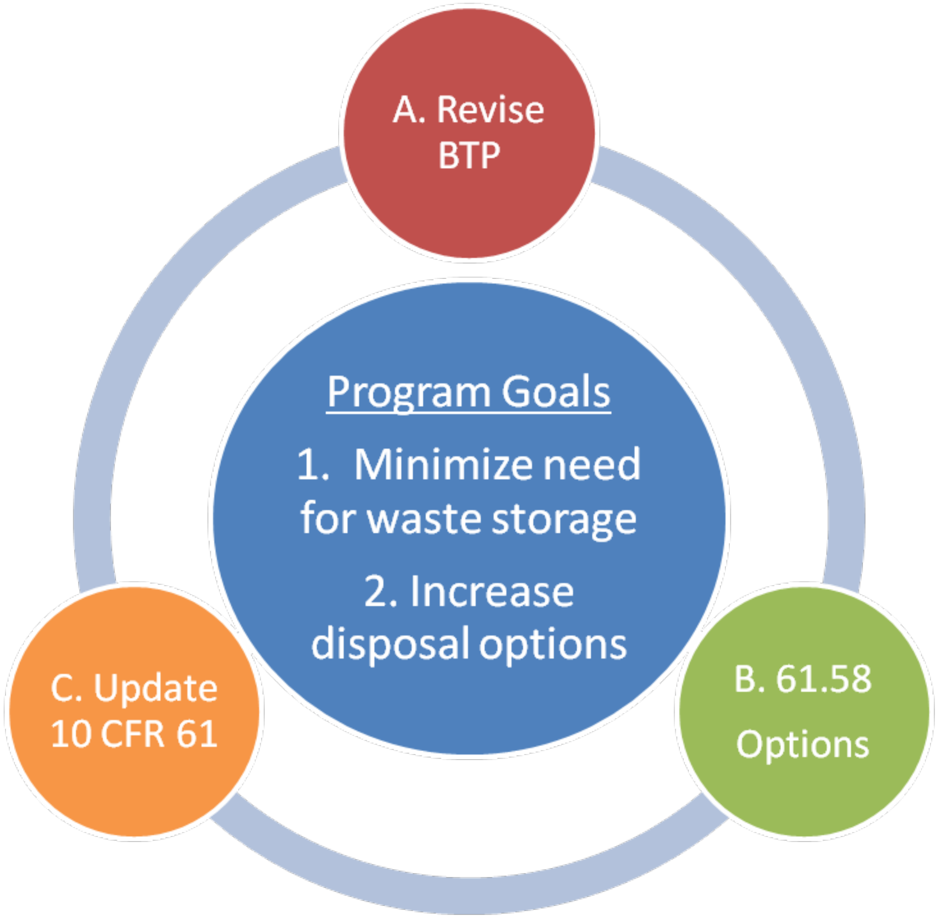
- Expand utility of Branch Technical Position (BTP) on Concentration Averaging [2006-2008]
- Develop alternative, conceptual disposal models to accommodate most/all utility waste
  - Use updated ICRP & disposal practices (via 61.58) [2009-2010]
  - Update 10 CFR 61 (redefine LLW) [2011+]

**Benefits:**

- Minimize orphaning of waste (provide waste assurance)
- Minimize waste storage requirements

# EPRI LLW Disposal R&D

- **Proposed Technical Basis for BTP Modifications**
- **10 CFR 61.58 is the NRC Mechanism for Review of Alternative Disposal Criteria**
- **Work Performed via 61.58 Leads Directly to Risk-Informing Part 61**
- **Update of 10 CFR 61 Provide Technical Basis for Risk Informed Regulations**



# EPRI Approach for Using 61.58

***§ 61.58 Alternative requirements for waste classification and characteristics.***

*The Commission may, upon request or on its own initiative, authorize other provisions for the classification and characteristics of waste on a specific basis, if, after evaluation, of the specific characteristics of the waste, disposal site, and method of disposal, it finds reasonable assurance of compliance with the performance objectives in subpart C of this part. (1)*

EPRI Objective: Determine if more appropriate disposal limits could be developed based on 1) radiological risk of the current and projected waste inventory, 2) current ICRP recommendations, and 3) modern disposal practices



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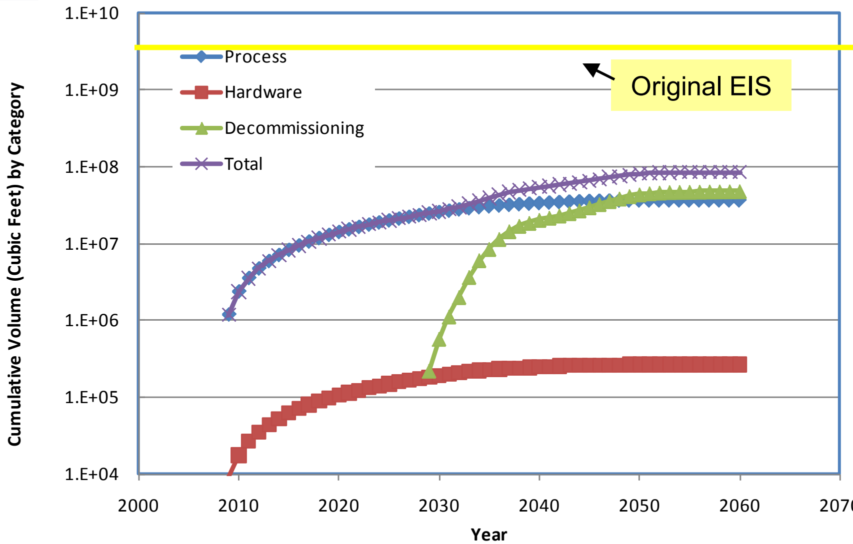
# Updated Low Level Waste Source Term

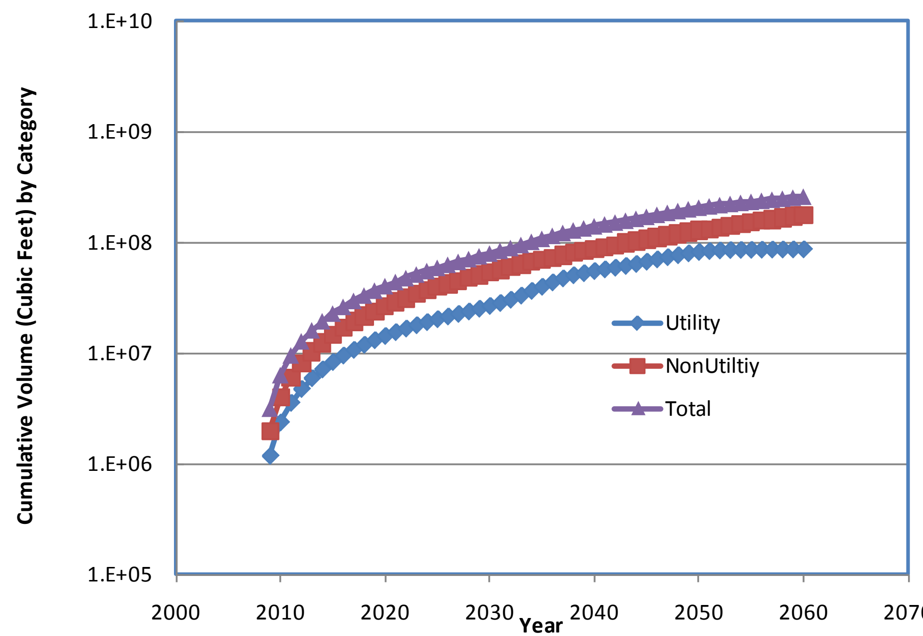



**Cumulative LLW Volumes – Commercial Nuclear Power Plants, All Sources**

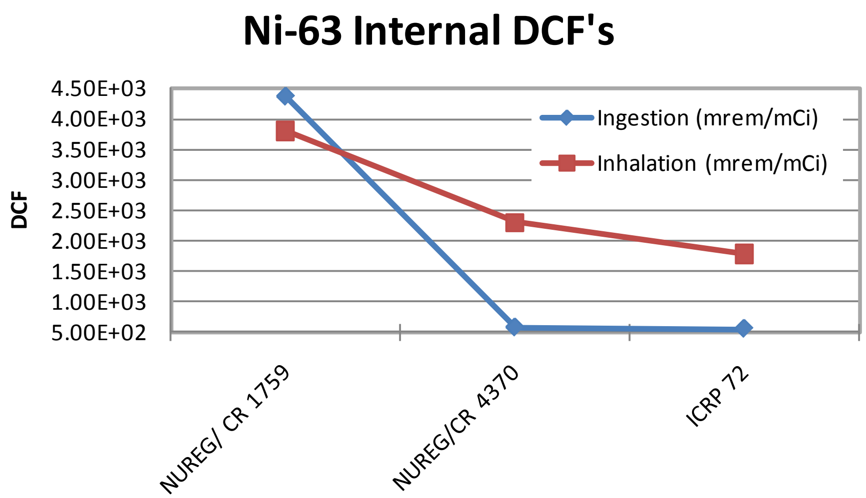
Total volumes are much lower than what was assumed in the original EIS for 10 CFR 61 (~3.53 x $10^9$ $ft^3$)

**Cumulative Volume Generation - All Waste Sources**

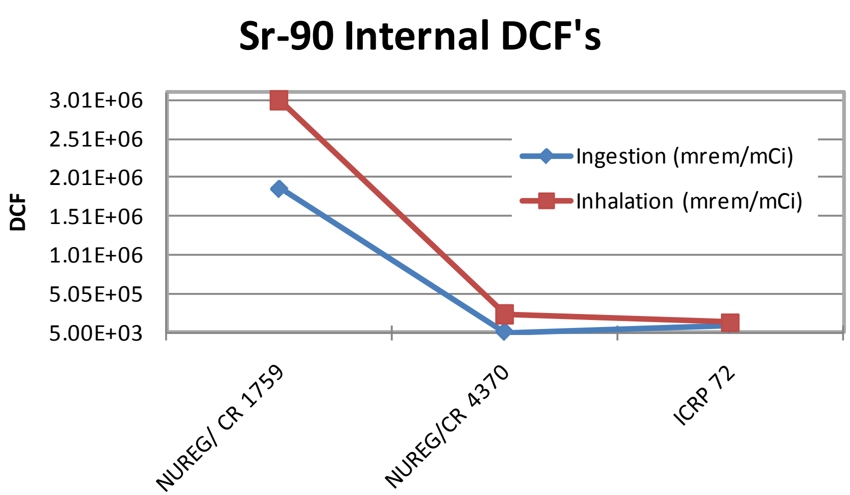
Non-utility waste is just as important a contributor as Utility waste

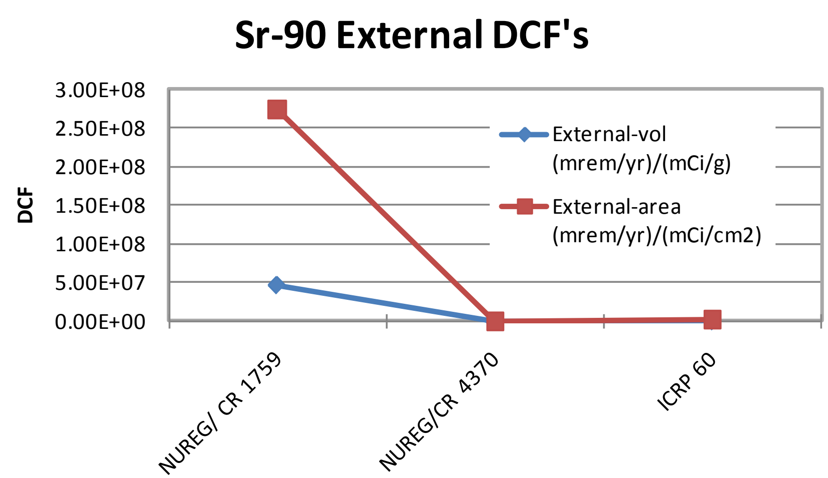


# Impact from Using Updated Science (More Recent ICRP Recommendations)




- Decreasing DCFs → decrease in dose → higher waste concentration limits
  - Ni-63 decrease by 15
  - Sr-90 decrease by 7



# Risk Assessment of Key Radionuclides

| | Why is it a concern? | Impact on Disposal Site Performance | Regulatory Consideration |
|---|---|---|---|
| Cs-137 | Most dominant | • Generally controls classification of LLW in the short term | • Defines institutional control period |
| Ni-63 | Classification limiting<br>10 CFR 61 | • Impact due to averaging restriction (BTP) on mechanical filters and ion exchange resins | • Use current ICRP DCFs (limits will increase by factor of 15)<br>• Activity should be averaged across disposal cell since activity is contained in a stable waste form |
| Sr-90 | 10 CFR 61 | • No significant impact on intruder scenarios or long term risk<br>• Over-reported generation rate | • Use current ICRP DCFs should be used (limits will increase by factor of 7) |
| Nb-94 | long half-life, Relative abundance<br>10 CFR 61 | • Subordinate to Co-60 and Cs-137 in leading exposure scenarios<br>•Becomes a prominent source of exposure following control periods | •Disposal limits should assume Nb-94 is dispersed due to disintegration (will no longer be discrete). |
| Ni-59 | Relative abundance<br>10 CFR 61 | • weak emission, never classification limiting<br>•Not a significant long term risk | • Disposal limits should assume Ni-59 is dispersed due to disintegration (will no longer be discrete). |





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# Risk Assessment of Key Radionuclides: "Phantom Four"

| | Why is it a concern? | Impact on Disposal Site Performance | Regulatory Consideration |
|---|---|---|---|
| H-3 | Mobility<br>10 CFR 20 | • No significant impact on intruder scenarios or long term risk<br>• Min. dose<br>• Not a classification determinant | Potential exist for non-utility tritium rich waste so maintain reporting requirements |
| C-14 | Mobility<br>Long half-life<br>10 CFR 20 | • No significant impact on intruder scenarios or long term risk<br>• Over-reported generation rate | • Actual generation <1% of Class A limits; thus should be considered "insignificant"<br>• Consider removing reporting requirement (costly & unnecessary) |
| Tc-99 | Mobility<br>Long half-life<br>10 CFR 20 | • No significant impact on intruder scenarios or long term risk<br>•Over-reported generation rate of 100 to 1000 times | •Actual generation <1% of Class A limits; thus should be considered "insignificant"<br>• Consider removing reporting requirement (costly & unnecessary) |
| I-129 | Mobility<br>Long half-life<br>10 CFR 20 | • Low dose contribution to intruder scenario (dose over-estimated by factor of 3 because used whole body instead of organ)<br>• Over-reported generation rate of ~1000 times | •Actual generation <1% of Class A limits; thus should be considered "insignificant"<br>• Consider removing reporting requirement (costly & unnecessary) |

# Site Specific Characteristics- "Natural Barriers"

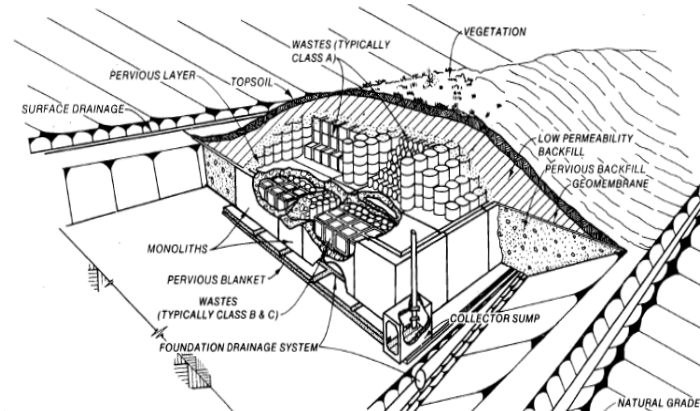
- Four Regional Areas
- Most Constraining Parameters Used for 10 CFR 61 Basis
- Not Reflective of Characteristics of Any Actual Site

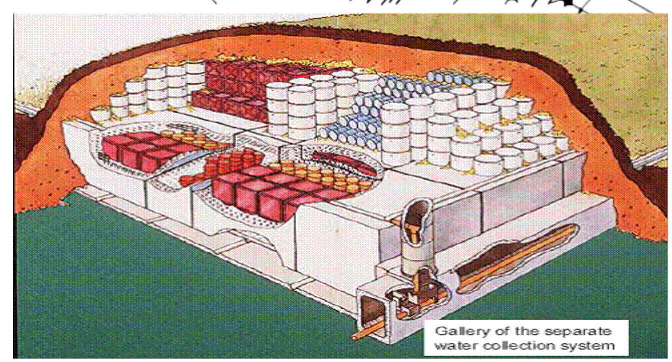
# Current Classification Criteria are Marginally Relevant to Today's Disposal Practices

**Original Bases for 10 CFR 61**

**"Kick And Roll" – 2 m Soil Cover**

**Actual Disposal Designs**




**Engineered Barriers Not Credited In 10 CFR 61 Protection Analysis**





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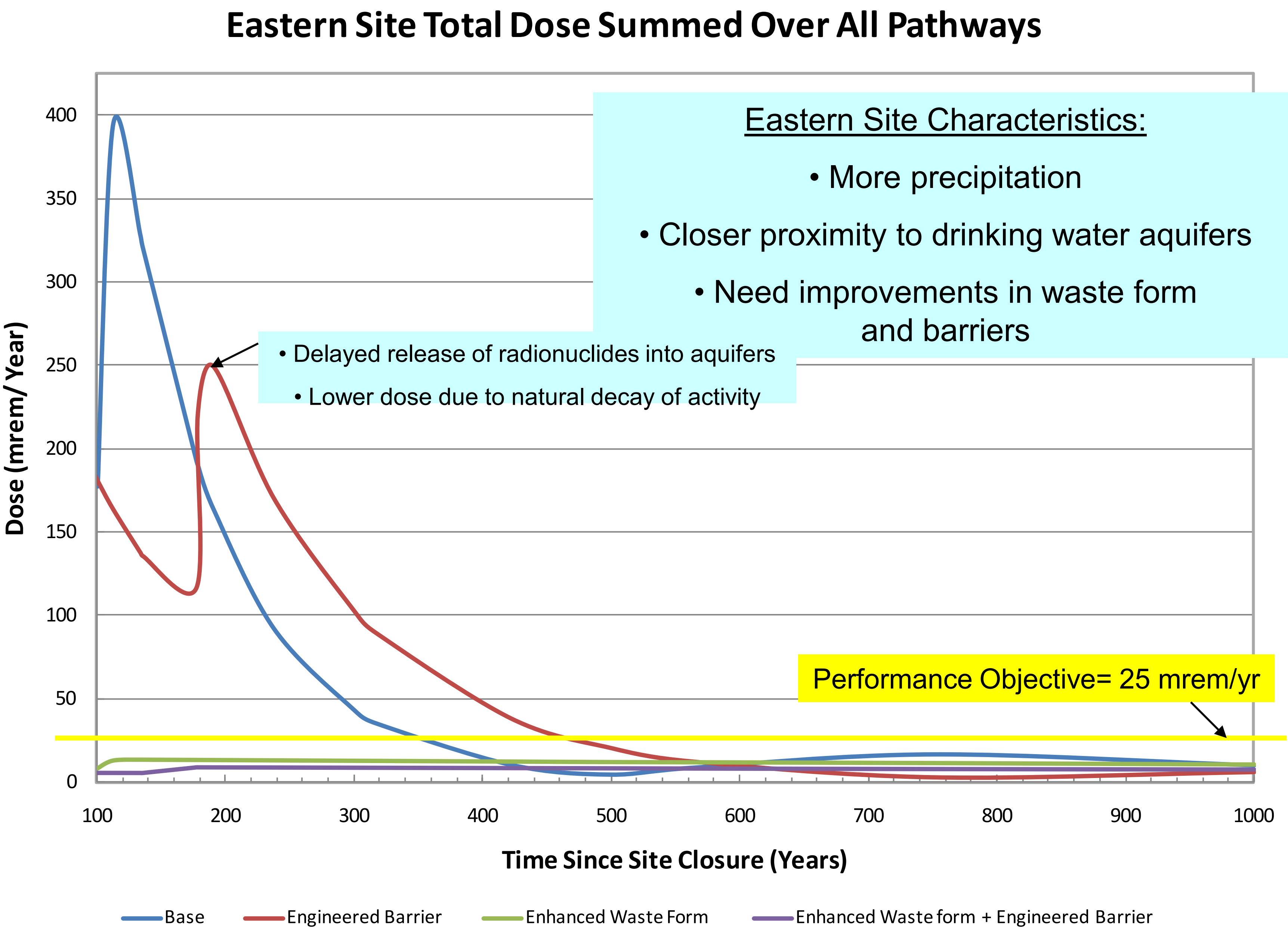






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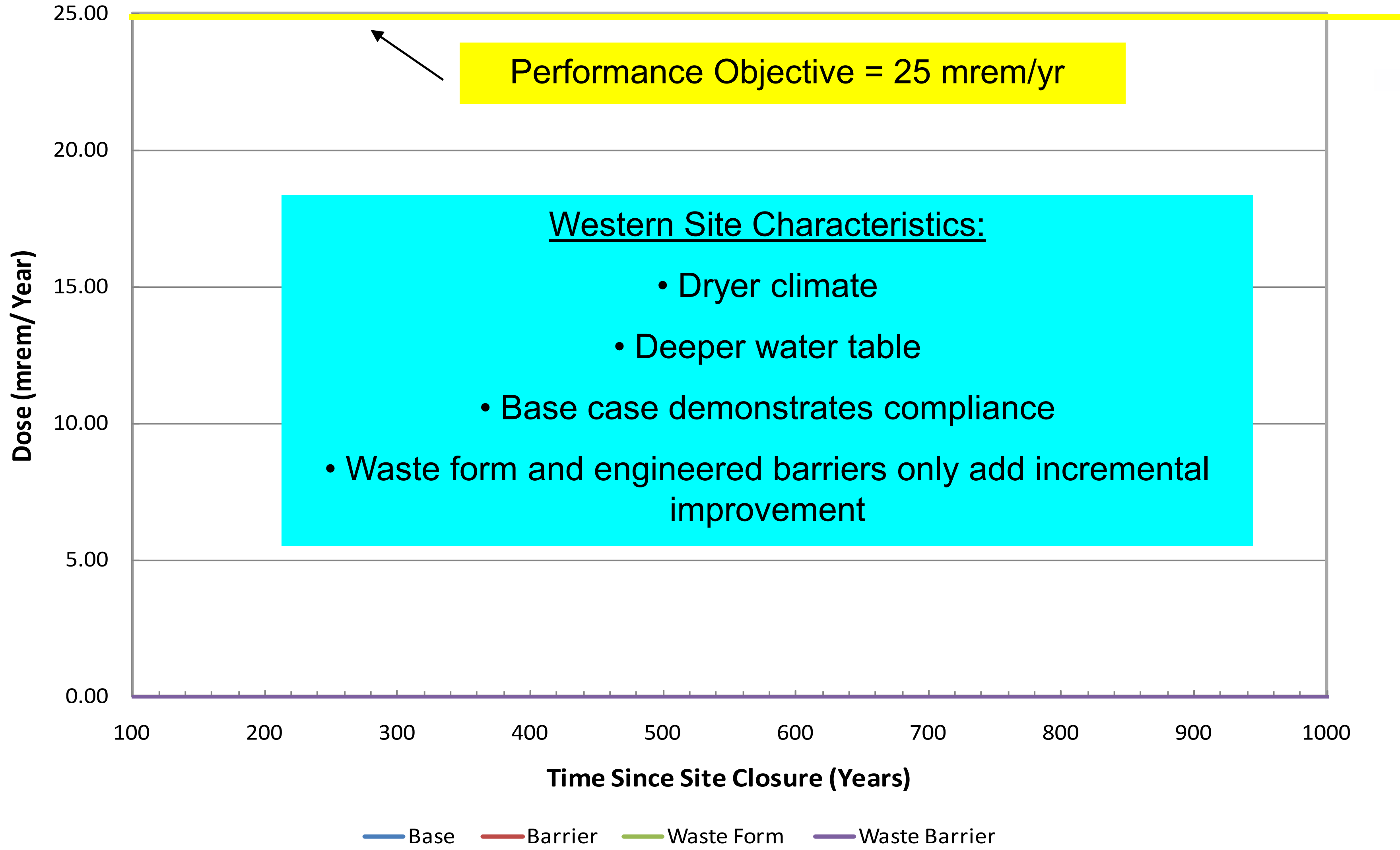
# Western Site Total Dose Summed Over All Pathways





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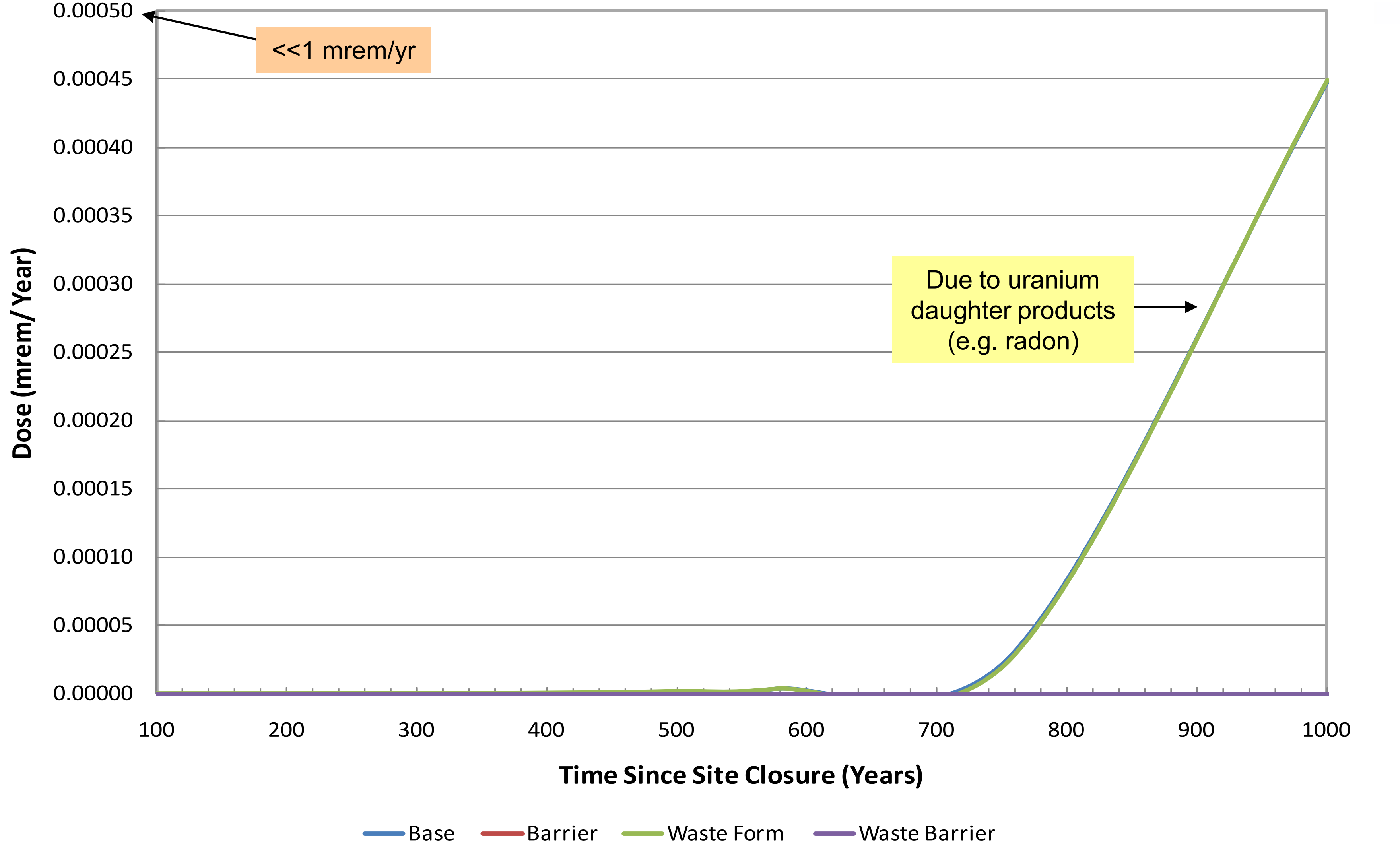
# Western Site Total Dose Summed Over All Pathways





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# Conclusions

- Inventory limits should be evaluated on a more site-specific basis than was implemented in 10CFR61.
- Site conditions, waste form and disposal facility design interact to achieve the performance objectives.
- A single LLRW disposal site in a dry climate location could be sufficient to accommodate all LLRW generated in the United States for the time period evaluated in this study.

# Together…Shaping the Future of Electricity

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SAVANNAH RIVER NATIONAL LABORATORY
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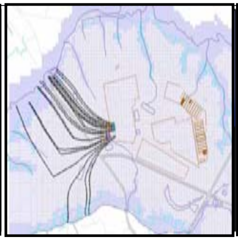
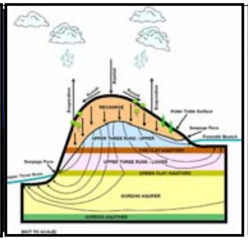
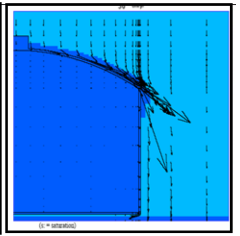
We Put Science To Work

# Overview of DOE's Performance Assessment Methodology for LLW Disposal

**Roger Seitz**
**Savannah River National Laboratory**
**3 March 2011**

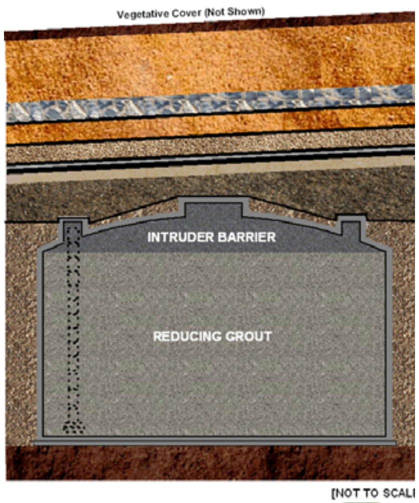
WM '11 – Phoenix, AZ

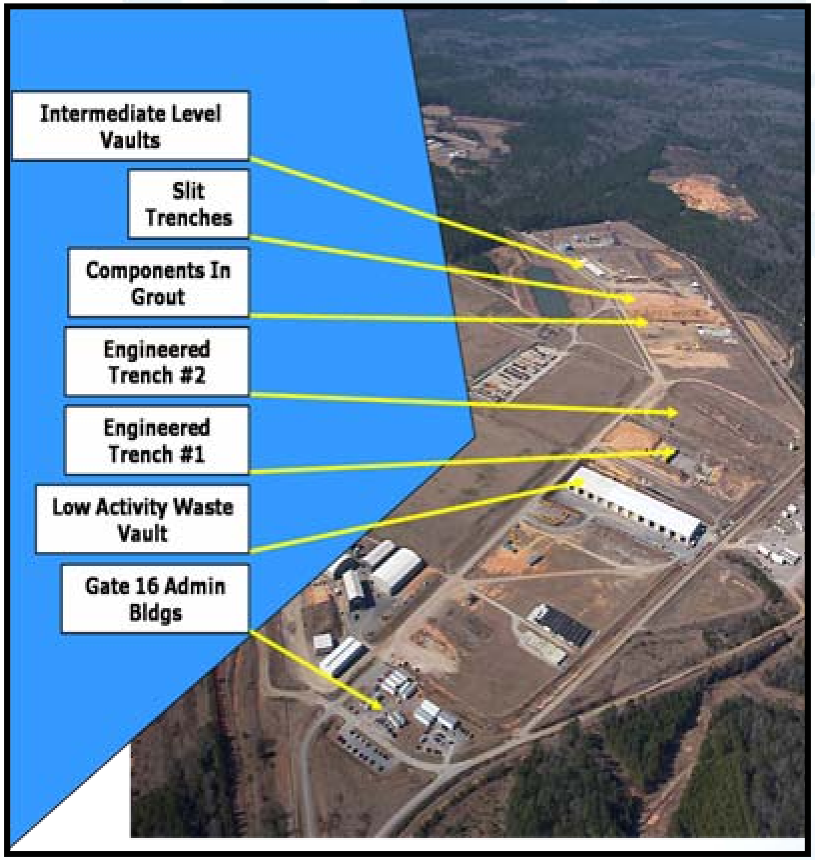
SRNL-MS-2011-00047

EM Office of Environmental Management
safety ❖ performance ❖ cleanup ❖ closure

# DOE Performance Assessment Activities

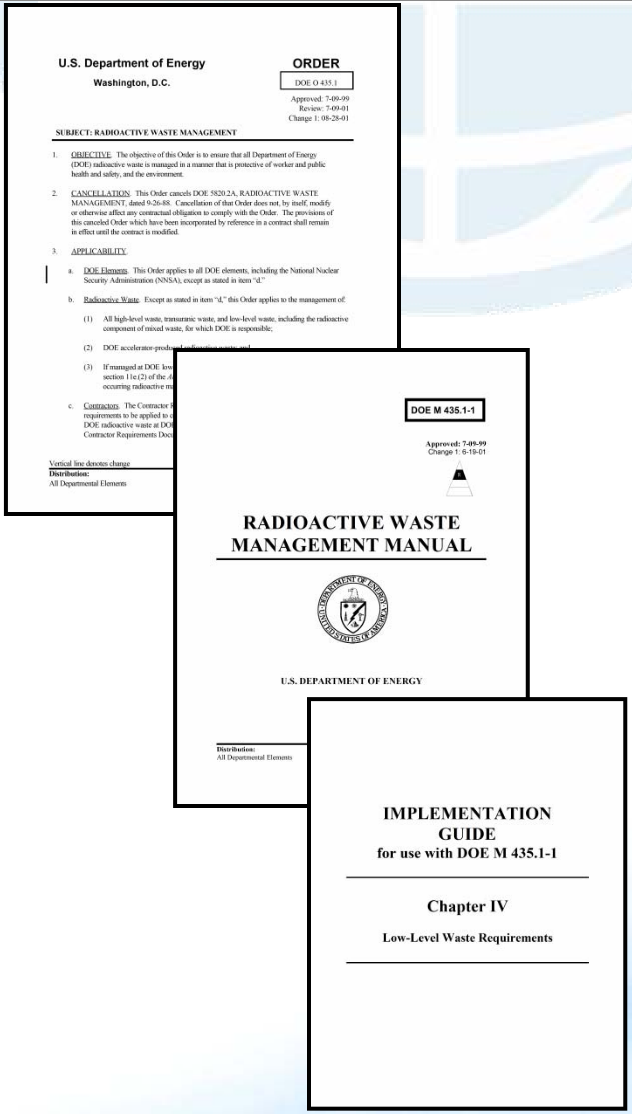
- **Multiple disposal facilities and tank closures in different climates and environments**
- **Multiple possible regulators depending on the situation**
- **Systems approach and safety case concept are used**



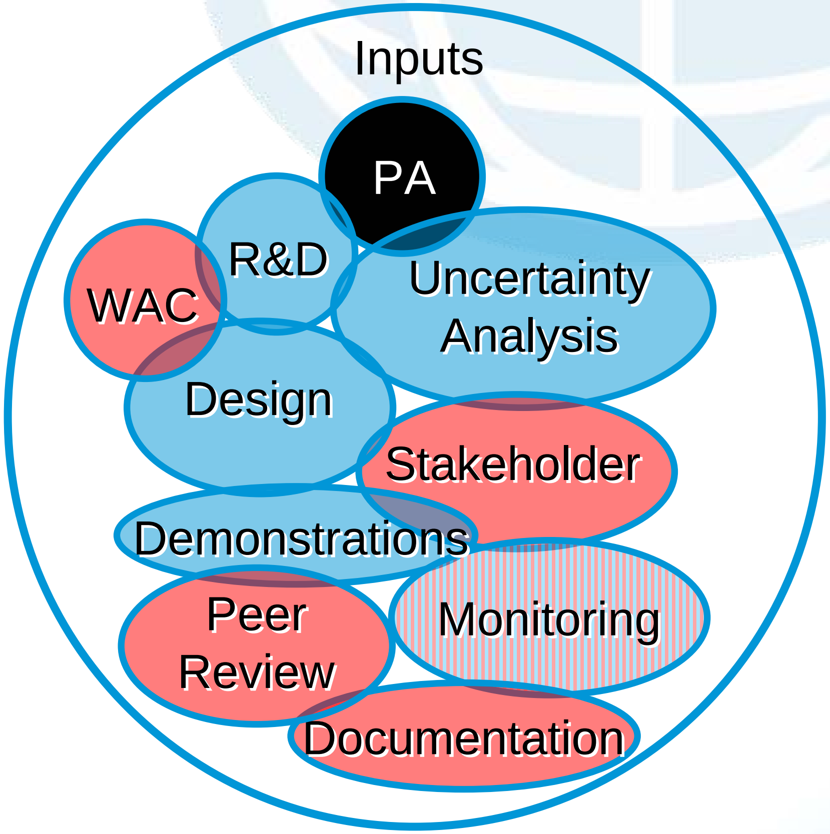
# DOE Order 435.1, Radioactive Waste Management

- **Issued final in 1999, currently working on an update (Manuals and Guides are used in practice)**
- **Establishes DOE HQ/Site responsibilities**
  - Low-Level Waste Disposal Facility Federal Review Group (LFRG)
- **Establishes performance objectives and requirements governing disposal actions**
- **Radioactive Waste Management Basis and Disposal Authorization Statement**



# DOE Approach for Performance Assessment

- **Holistic, systems approach**
  - *“The purpose of computing is insight, not numbers”*
    – Richard Hamming
- **Graded and Iterative**
- **Hybrid modeling (deterministic and probabilistic)**
- **Uncertainty quantification (UQ) with sensitivity analysis**
- **Questioning Attitude**



# Requirements for Authorization for Disposal

- **Disposal Authorization Statement (DAS)**
- **Performance Assessment (PA)**
- **Composite Analysis (CA)**
- **Preliminary Closure Plan**
- **Monitoring Plan**
- **PA/CA Maintenance Plan**
- **Annual Summaries**
- **Radioactive Waste Management Basis (Safety Case)**
  - Safety basis, procedures, design, WAC, and documents above

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# Systems Approach to Design and Assessment

Enhanced screening?

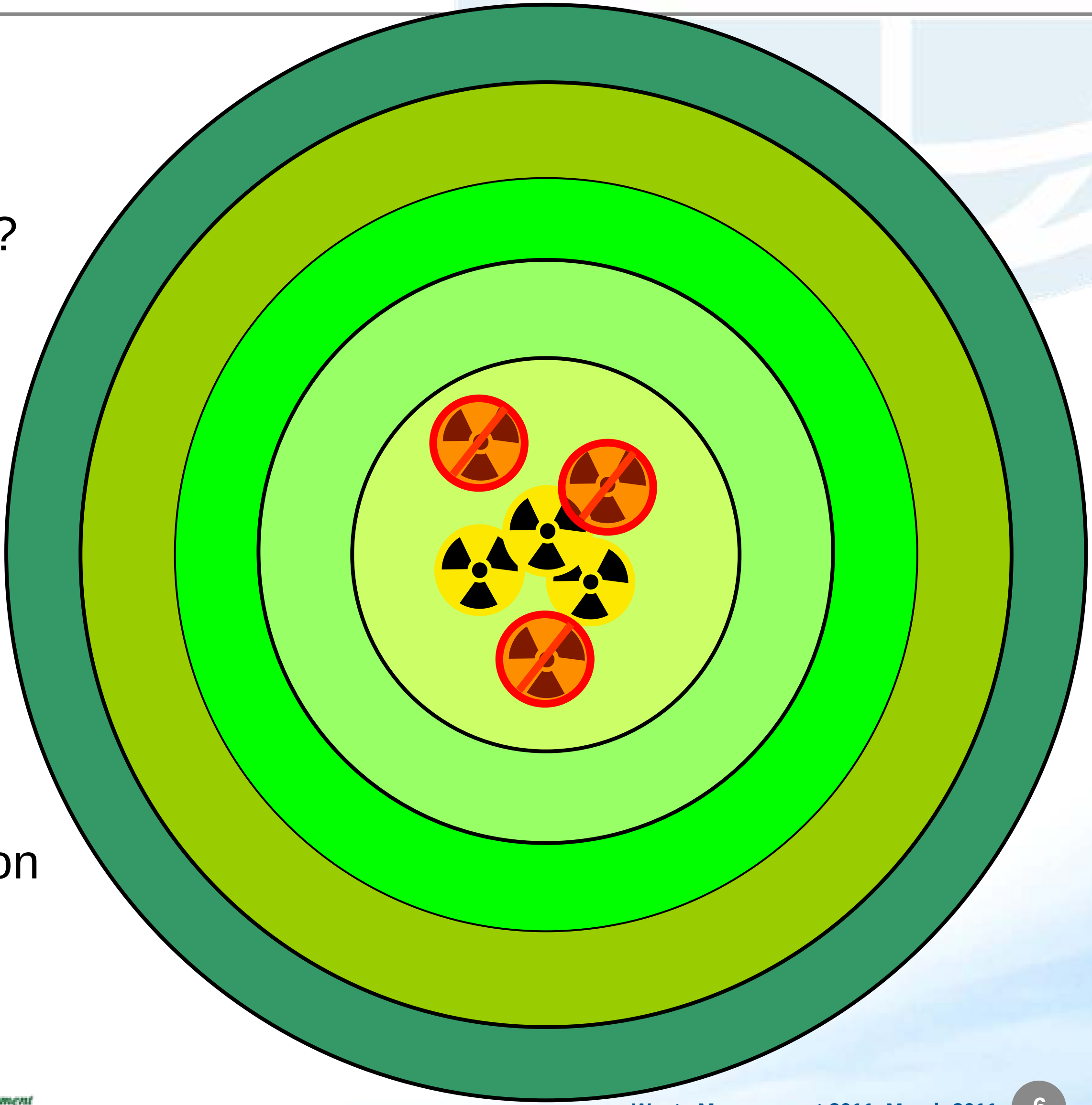
Improved cover representation?

Account for waste form (physical/chemical)?

Account for container (physical/chemical)?

Account for barriers (physical/chemical)?

More detailed site representation (physical/chemical)?



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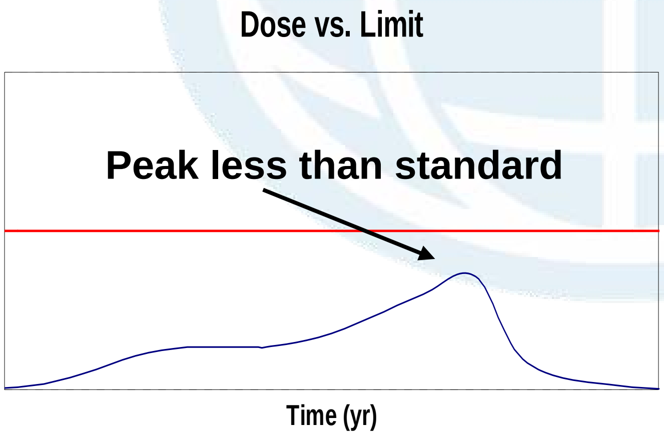
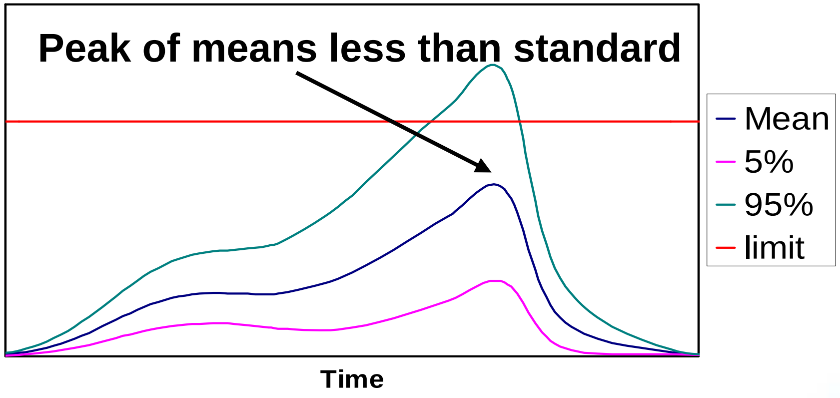
# DOE PA Modeling (Hybrid Approach)

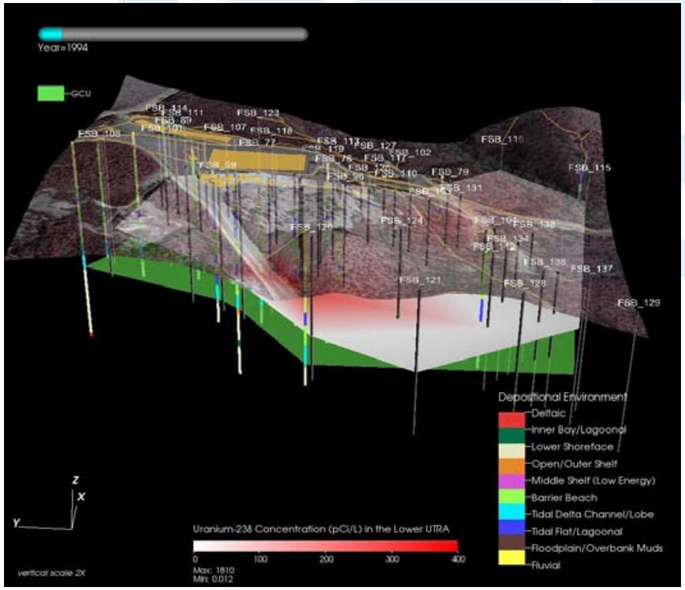
- Agree on deterministic baseline case(s) to compare with deterministic standard (add sensitivity "what-if" cases)
- Use probabilistic approach to more completely capture "what-if" questions and uncertainty analysis (abstraction)
- Multiple lines of reasoning, self checking
- UQ and Sensitivity Analysis
- Variety of different computer codes are used

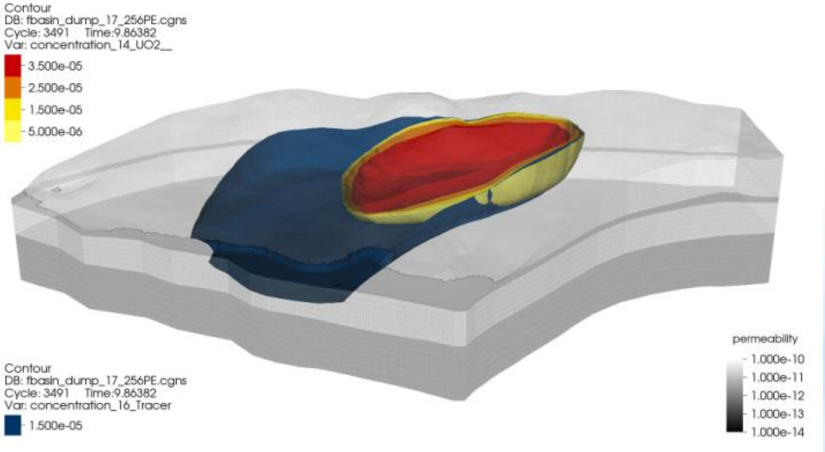


# Advanced Simulation Capability for Environmental Management

- **A state-of-the-art tool for predicting contaminant fate and transport through natural and engineered systems**
- **The modular and open source design will**
  - facilitate a new approach for integrated modeling and site characterization
  - enable robust and standardized future performance and risk assessments for EM cleanup and closure
- **www.ascemdoe.org**

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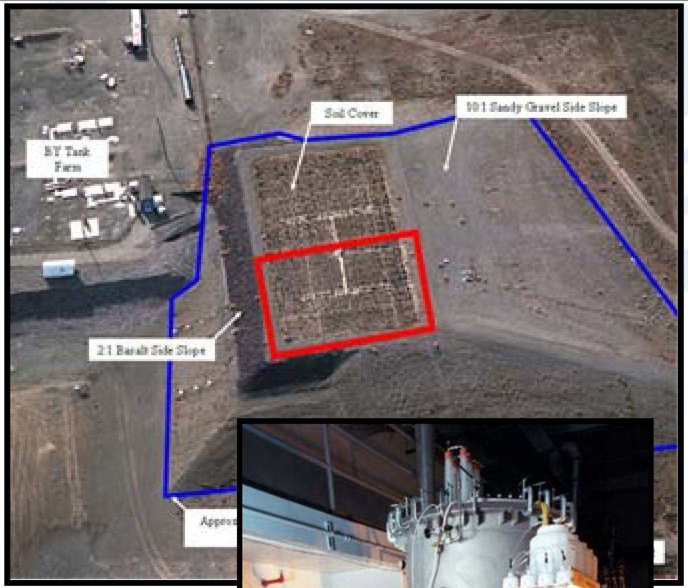
# PA/CA Maintenance Concept

- **Confidence building for assumptions in assessment calculations, addressing unforeseen circumstances, etc.:**
  - Demonstrations
  - Field studies
  - Compliance and Performance Monitoring (air, vadose zone, aquifer)
  - Annual summaries
  - Unreviewed Disposal Question Evaluations (e.g., design, container, waste form or inventory changes, new data)



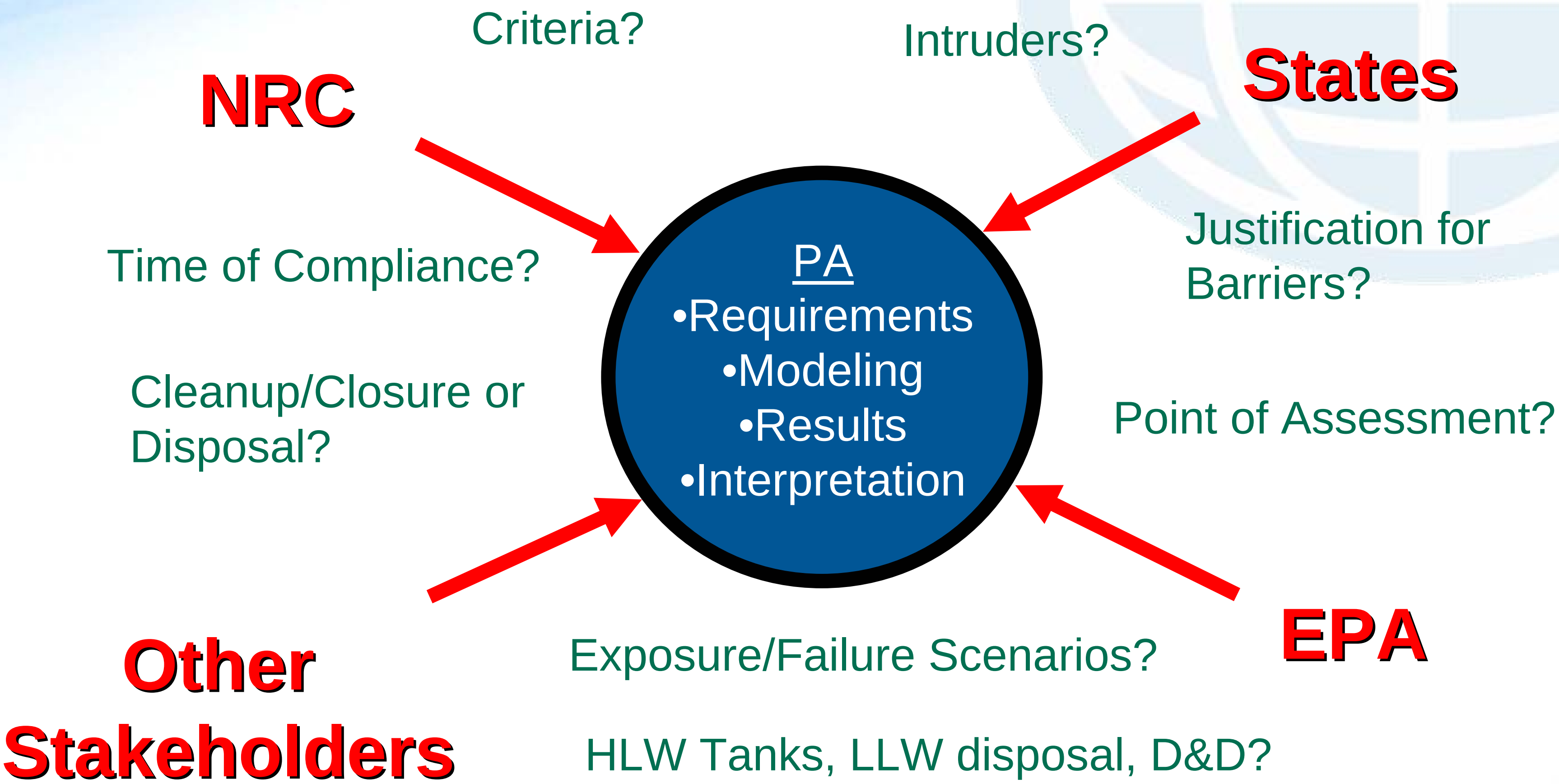

# Performance Assessment Community of Practice

**DOE Office of Environmental Compliance-led organization to facilitate centralized sharing of information related to performance assessment and improve consistency of implementation**

**<u>Example Activities</u>**

- **Annual Technical Exchanges with presentations on current PA activities and topical focus areas**
  - 2011 Decision-making and Software QA
- **Performance Assessment Assistance Teams**
- **Other supporting activities**

# Stakeholder Involvement




- **Scoping Process and Public Educational Forums**

# Conclusions

- **DOE authorization approach is very similar to safety case, PA is used to help make decisions**
- **Latest DOE PAs are based on a graded and iterative, hybrid modeling approach and systems view of waste disposal**
- **Current modeling approaches involve a combination of deterministic and probabilistic simulations - ASCEM developing capabilities to consider greater detail**
- **Variety of confidence building approaches used within the concept of performance assessment maintenance**
- **Active efforts to improve sharing of information among practitioners at different DOE sites and to involve stakeholders during the development of assessments**

# WASTE MANAGEMENT 2011

## SESSION 101

### LOW-LEVEL WASTE PERFORMANCE ASSESSMENT, THE SAFETY CASE (PRISM) AND LONG-TERM MONITORING

### OPEN DISCUSSION

### (101-10)

# WASTE MANAGEMENT 2011

## SESSION 101

LOW-LEVEL WASTE PERFORMANCE

ASSESSMENT, THE SAFETY CASE (PRISM) AND LONG-TERM MONITORING

BRIEF TECHNICAL SUMMARY

(101-11)

BOBY ABU-EID (US NRC)

# WASTE MANAGEMENT 2011

## SESSION 101

### LOW-LEVEL WASTE PERFORMANCE ASSESSMENT, THE SAFETY CASE (PRISM) AND LONG-TERM MONITORING

### CLOSING REMARKS
### (101-12)

L. CAMPER (US NRC) & C. GELLES (US DOE)