



**ONDRAF/NIRAS**

# Contextual framework and Strategy for the monitoring of geological disposal of radioactive waste

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# Outline

## **1st part: Contextual framework (= regulatory framework & guidelines): 3 questions**

### **1) Which boundary conditions are provided by the contextual (regulatory) framework ?**

- International law (nuclear & environmental) and recommendations
- Belgian legal framework:
  - A.R. « Wenra » - chapter 4 (May 2011) + technical guides

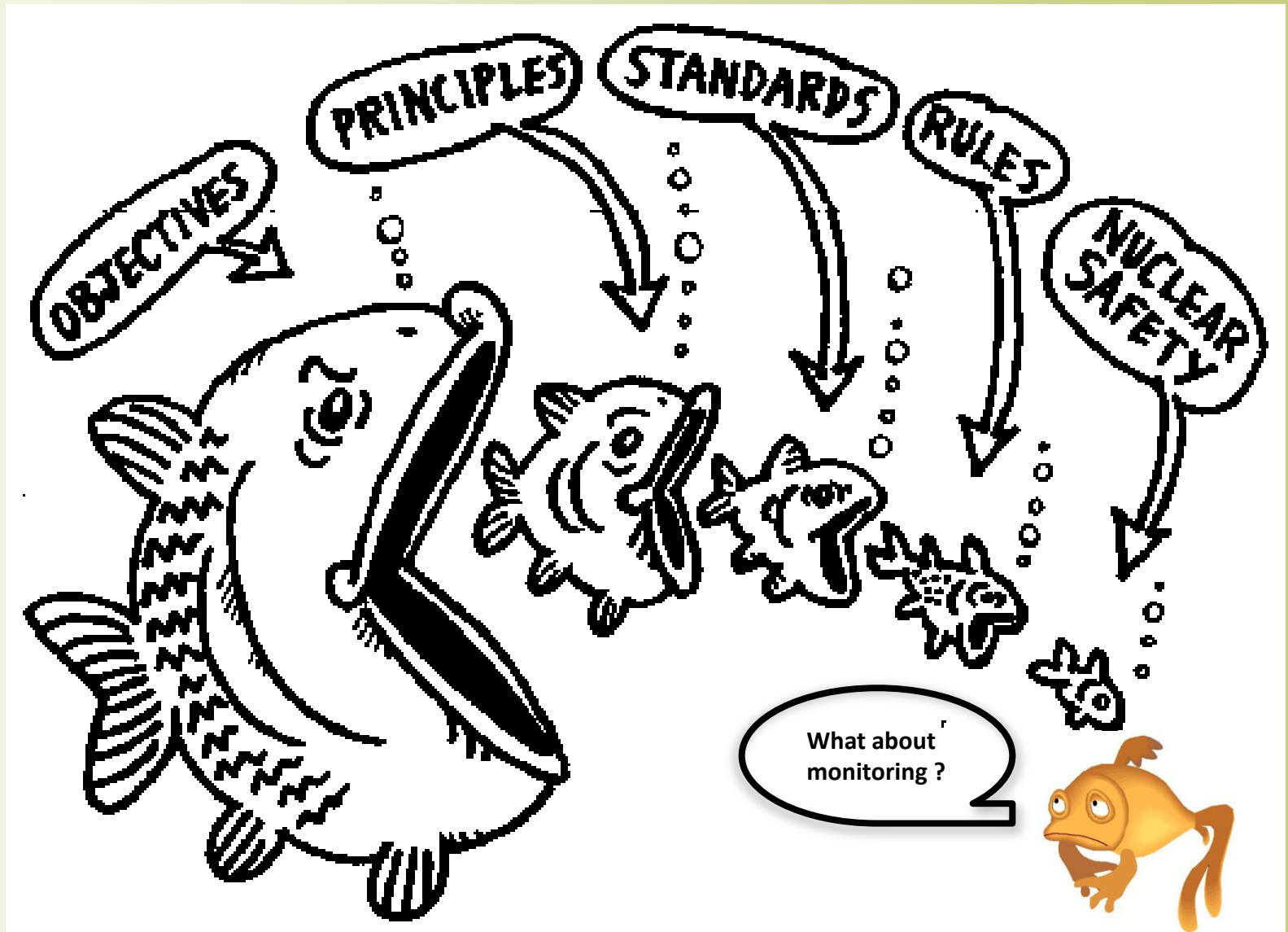
### **2) Does the contextual (regulatory) framework suggest a « technical content » for the monitoring programme ?**

### **3) Issues, gaps & limitations**

## **2nd part: ONDRAF/NIRAS Monitoring Strategy**



# Part I: Regulatory framework Synopsis



# International & European law as boundary conditions... which obligations ?

- **The Joint Convention (on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management )**
  - *Adopted in 1997, e.i.f in 2001. Belgium is a State Party since September 2002. « Incitative » convention (soft law) but still binding for the State through the peer review process every 3 years. Warning: JC is split in two parts: SNF & RW. JC specifies:*
    - « operation, maintenance, **monitoring, inspection** and testing of a spent fuel management facility are conducted in accordance with established procedures” (art 9, (iii) for SNF + art 16 (iii) for RW on “operation of facilities”)

# International & European law as boundary conditions... which obligations ?

- « active or passive institutional controls such as **monitoring** or access restrictions are carried out, if required [...]» (art. 17 (ii) RW on “institutional measures after closure” )
  
- « The legislative and regulatory framework shall provide for:
  - [...]
  - a system of appropriate institutional control, regulatory **inspection** and documentation and reporting»  
(art. 19.2 (iv) )

→ Monitoring & surveillance (inspection) are obviously recommended both on the operator and regulator sides (JC binds the State as a whole) but no specific modalities.

# International & European law as boundary conditions... which obligations ?

- **Council Directive 2011/70/EURATOM (establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste)**
  - *Is doubly binding for the European States(2013 & 2015).*

*The directive specifies:*

- « a system of **appropriate control**, a management system, regulatory **inspections**, documentation and reporting obligations [...], including appropriate measures for the post-closure periods of disposal facilities» (art. 5 on “national framework”)
- « [...]to regularly **assess**, verify and **continuously improve**, as far as is reasonably achievable, the safety of the radioactive waste and spent fuel management facility [...]» (art. 7.2 on “ licence holders”) → **Performance Confirmation/challenging**



# International & European law as boundary conditions... which obligations ?

- « *the concepts or plans for the post-closure period of a disposal facility's lifetime, including the period during which appropriate **controls** are retained [...]* » (art. 12 (e) on “ contents of national programme”)

Let us notice that the preamble (17§) of the directive mentions the conclusions of the ENSREG report (2009) where:

«[...] Features such as reversibility, retrievability and **monitoring** in geological disposal appear to be key issues that need to be thoroughly assessed in terms of repository safety»

→ Requirement for inspection, (continuous) control and monitoring of the facilities. The idea of « performance confirmation » is expressed.

# International & European law as boundary conditions...which obligations ?

## Council Directive 96/29/EURATOM (laying down BSS for the protection of the health of workers and the general public against the dangers arising from ionizing radiation):

« Whereas the **operational protection of exposed workers**, [...]requires [...] **monitoring of areas** and working conditions [...] » ; «The **scope** of the precautions and **monitoring** [...] must be **appropriate to the risks** [...] » (art. 18) (graded approach);

individual exposure monitoring (dosimetry); corrective measures (art.41) ; ...

+ **environmental law** (quoted in the 2011/70 preamble)

e.g. Aarhus Convention (1998)	--	85/337/CEE & 97/11/CE + <u>2003/35/CE</u> (projects)
Espoo Convention (1991)		
Kiev protocol (2003)	--	<u>2011/42/CE</u> (programs)



# International & European law as boundary conditions...which obligations ?

- **Directive 2001/42/EC (on the assessment of the effects of certain plans and programmes on the environment\*):**

« Member States shall **monitor the significant environmental effects** [...]» (art.10)

\* and applicable for nuclear facilities (<> 2003/35/CE & 97/11/CE)

- **Directive 96/61/EC (on integrated pollution prevention and control) – « IPPC directive »** establishing a.o. the **BAT principle** and associated monitoring :

« The permit shall contain **suitable release monitoring requirements**, [...]»; «the operator regularly informs the competent authority of the **results of the monitoring of releases** and [...] affecting the environment»

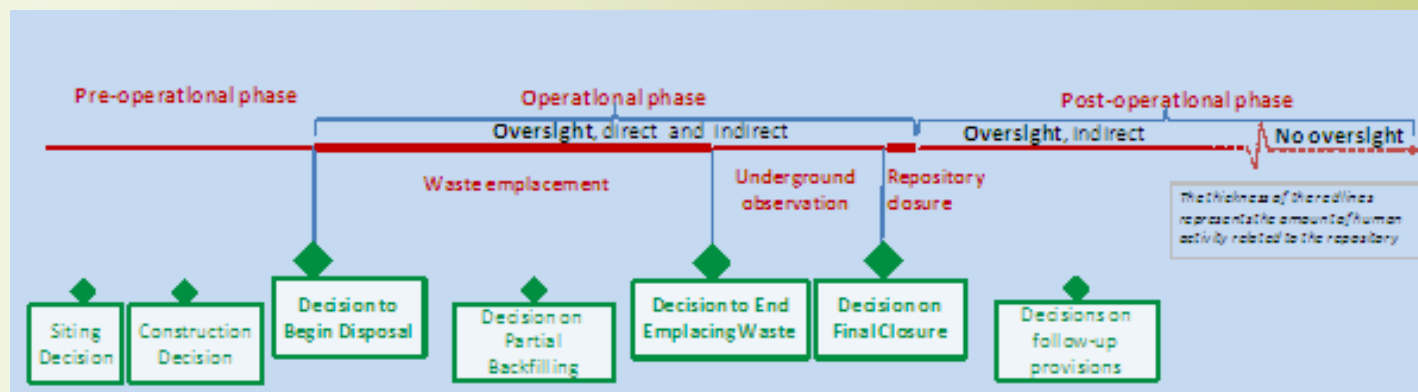
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« classic » industrial activities legislation e.g. **Directive 2006/21/EC** (on the management of waste from extractive industries):



# International recommendations

- Only « recommendations » ?



- **ICRP -122** recommends different levels of oversight...
- **WENRA** group provides dispositions for the monitoring programme:
  - Before starting construction, the licensee shall establish a baseline state of the environment both for supporting the **monitoring programme** and for evaluating the impact of the facility on the environment **(1)**

# International recommendations

- **Monitoring programme** for construction, operation, decommissioning and closure, and as appropriate after closure (**monitoring has to be carried out at each step**)
- **Monitoring objectives** are to:
  - demonstrate adequate protection of man & env. and demonstrating compliance with the regulatory requirements (**compliance purpose**) \_ **(2)**
  - confirm that the disposal facility and system behaves and evolves as expected in the safety case; (**performance confirmation**)\_ **(3)**
  - identify any deviations (**performance confirmation(PC)/challenging**)
  - confirm and refine the key assumptions in the safety case & enhance understanding of the env. & the system (**PC & process understanding**)
  - acquire data for supporting decision-making(**data record, stepwise process**) \_**(4)**
  - provide background information for any post-closure surveillance programme (**stepwise process**)



# Belgian regulatory framework

## ... and the A.R. « WENRA » in line with WENRA recommendations

especially regarding **(1)** – baseline; **(2)** – compliance; **(3)** – evolution & **(4)** – decisions + its iterative nature

- In particular: RN releases; radiological impact; evolution of key parameters
- In case of dysfunctions: consequences must be assessed, therefore

Limits and use conditions; means to detect dysf. ; possibilities to repair; calibration pgm ( !! Safety & system performances !!)

- In case of deviation → actions for remediation...  
→ How to expect data values outside the unexpected ranges ?
- The access to the repository has to be backfilled and sealed ASAP (closure phase)

## • Technical guides (generic & geologic)

# Regulatory framework: in summary ?

## Monitoring (strategy) specifications (1/2)

Attributes	Description	Sources of law
Status	(Appropriate) monitoring & (regular) inspection are conducted in accordance with procedures... Monitoring programme is <b>mandatory</b>	Joint Convention (JC), 2011/70/Euratom  (future) Belgian law (A.R. « WENRA »)
Purpose/roles	Improving continuously the safety Compliance purpose with regulatory requirements Performance confirmation (of the system) Process understanding Assessment of radiological impact To support safety-oriented decisions	2011/70/Euratom WENRA recommendations, IAEA (DS 357; SSG-14), Belgian A.R. « WENRA »(draft)
Definitions	Monitoring/surveillance/inspection	WENRA group; IAEA DS 357 Belgian law plans to follow WENRA
Implementation/ timeline	Plans for monitoring have to be drawn before construction A monitoring programme must be implemented during construction, operation, decommissioning and closure and as appropriate after closure	IAEA DS 357, WENRA recommendations
Modalities	Monitoring programme is a stepwise process Monitoring programme has to remain flexible Monitoring must be periodically reviewed, especially to move on from one stage to the next Monitoring should be designed following the graded approach of the repository programme	WENRA recommendations IAEA SSR-5 A.R. « WENRA »  IAEA DS 357

# Regulatory framework: in summary

## Monitoring (strategy) specifications (2/2)

Attributes	Description	Sources of law
Constraints (general)	<ul style="list-style-type: none"> <li>-Monitoring is designed/implemented so as not to reduce the overall safety after closure</li> <li>-The disposal is passively safe design and should not require/rely on post-closure monitoring</li> <li>-Post-closure monitoring may be performed for public assurance. In general, the monitoring programme must take into account the societal expectations...<b>but how to predict social motivations in 100 yrs ?</b></li> <li>-Periodically reviewed</li> <li>-Operator has to assess the consequences of dysfunctions of monitoring</li> <li>-In case of deviations, remediations have to be proposed...</li> <li>-Accesses to the repository for the monitoring programme has to be backfilled and sealed ASAP (at the closure phase max.)</li> <li>→ <b>No regulatory requirement, at the Belgian level, to maintain post-closure monitoring (passive safety). In case, this monitoring must be performed without invasive means.</b></li> </ul>	<p>IAEA DS 357, SSG-14</p> <p>Belgian law (A.R. « WENRA »)</p>
<u>Link with the safety case &amp; management system</u>	<ul style="list-style-type: none"> <li>-The monitoring programme should be driven by (and inform) the safety case. The results are used <u>to strenghten the SFC</u> and build confidence in safety.</li> <li>-The monitoring programme should <u>adhere to the management system</u> principles</li> <li>- <u>LT safety - operational safety interface</u>: the monitoring programme should confirm that the performances of the barriers are not compromised by the operational activities</li> </ul>	IAEA DS 357

# Does the regulatory framework suggest a « technical content » for monitoring ?

- **Monitoring for baseline information:**  
Groundwater flow in HR & environment ; geochemistry of groundwater ; background levels of radioactivity; geomechanical properties of the HR; ...
- **Monitoring conditions of emplaced waste packages**
- **Monitoring of disposal facility structures:**  
Mechanical properties (rock stresses, deformations in walls and lining, deformation and loads on rock support...)
- **Monitoring of the perturbations**  
Monitoring of the THMC disturbances: (T) temperature distribution, thermal conductivity(M): stress field, deformation, fractures (H): permeability, water pressure (C): composition and mineralogy of interstitial water, pH, redox,...
- **Monitoring of the changes in the geosphere**  
temperature, stress, groundwater pressure, solute chemistry and mineralogy... using boreholes drilled to acquire the baseline information
- **Environmental database**  
Meteorology, hydrology ,concentration of pollutants ,localised erosion, slope evolution, geothermal heat flow, seismic activity,...measurements from the surface

# Issues, gaps, limitations...

## General issues/gaps:

- **Compatibility** of a potential **independant** monitoring program regulator vs operator ?  
(e.g. LT safety and security aspect (HI) )
- « **Demonstration** » of compliance monitoring vs SFC... Expectations overestimated?

*« Submission of a robust safety case would always be the principal method for demonstrating confidence in the safety [...] however, data collected through a monitoring programme [...] would help to support the basis for having confidence in safety »*

*(MoDeRn, Expert Stakeholders Workshop, June 2011)*

- « Verifying that the disposal system is functioning as expected » - Timescales !
- **Nuclear safeguards** for spent fuel with a dedicated monitoring (DIV; satellite imagery, 3D laser scanning, passive seismic,...) → Interface safety/security
- **Retrievability/Reversibility** → monitoring strategy  
(e.g. monitoring of the integrity of waste package)





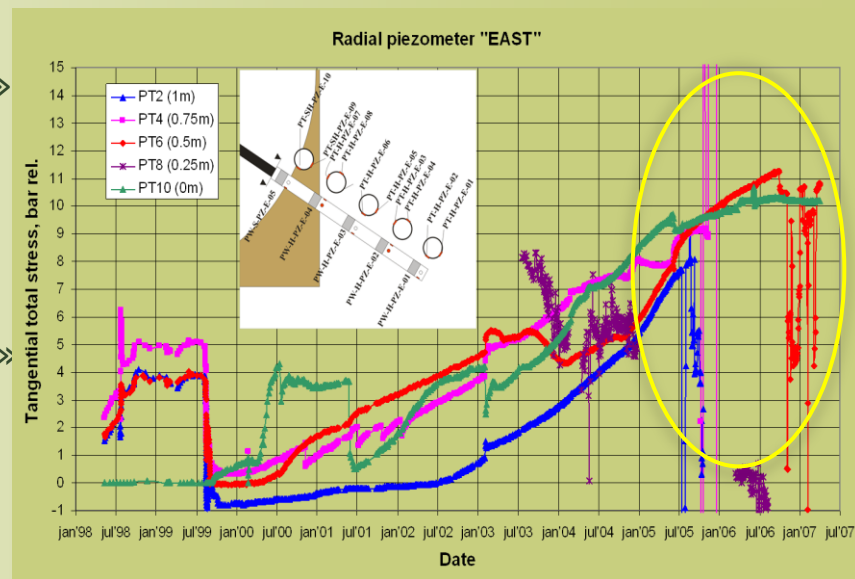
# Issues, gaps, limitations & communication

## Limitations (examples):

- By physical challenges (longevity of equipment; inability to directly measure parameters of interest; spatial variability...) (IAEA DS 357)
- The limitation in time is however not obviously mentioned...

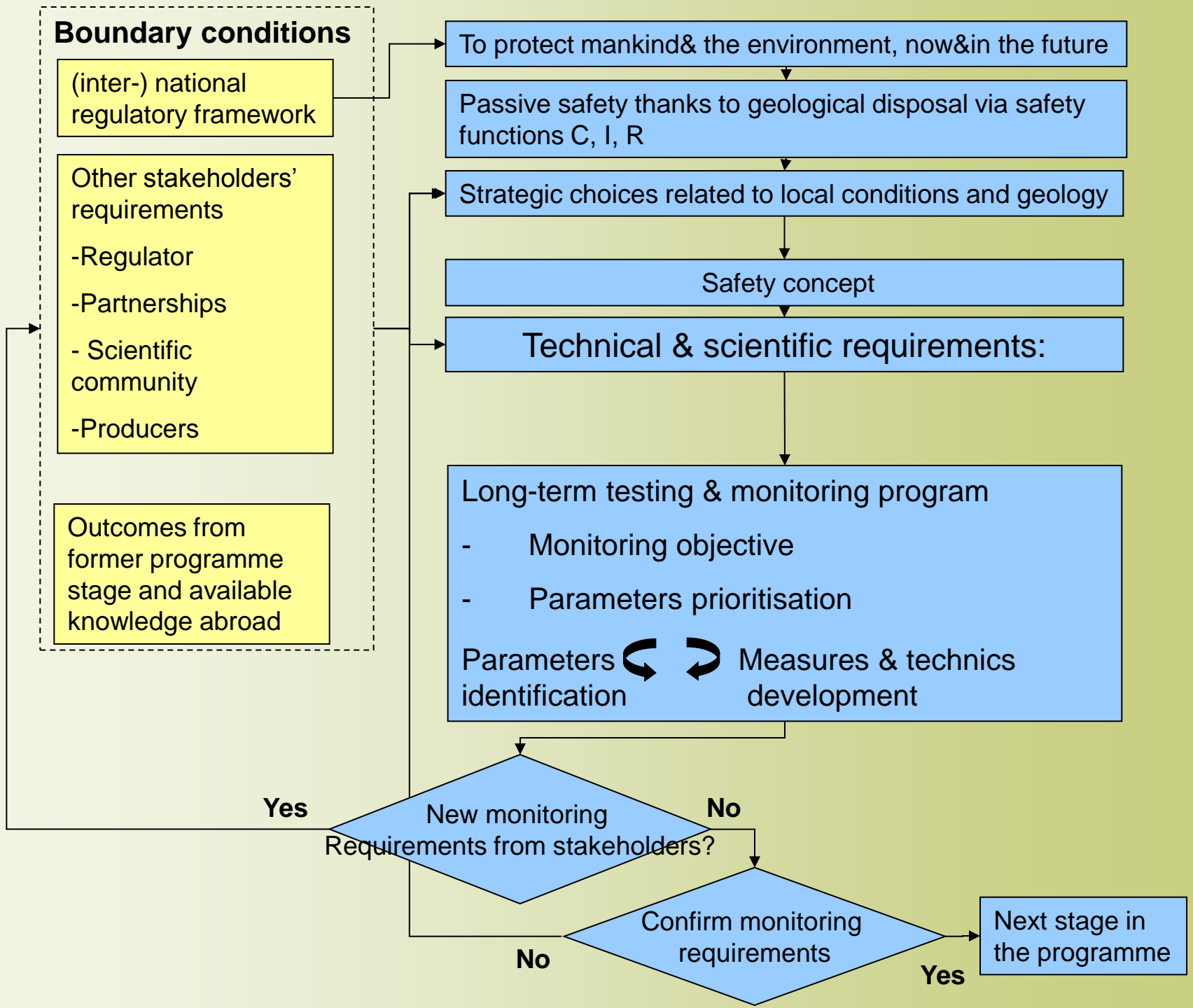
## Communication issues (examples)

- « Users of monitoring information should be all concerned parties **including [...] the public** » **but...** « only well-trained and **experienced staff** should be entrusted with the monitoring and associated activities »... **because...**  
« **information should be analysed with care** to determine its significance within the safety case»
- Transparency vs safeguards

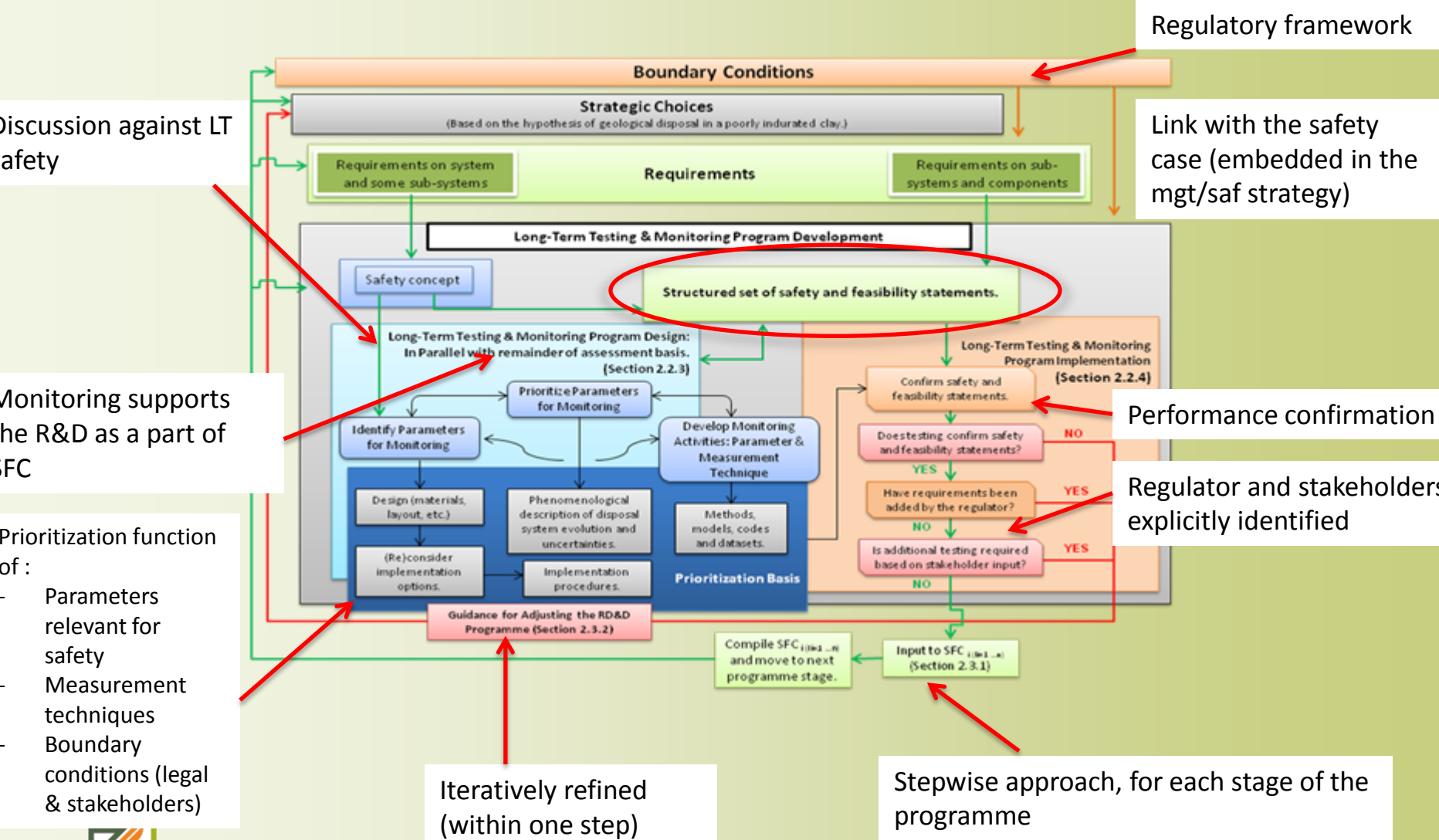


## Part II: Monitoring Strategy

**Monitoring strategy: simplified view**



# Ondraf/Niras Monitoring Strategy (the real one !)



Regulatory framework

Link with the safety case (embedded in the mgt/saf strategy)

Discussion against LT safety

Monitoring supports the R&D as a part of SFC

Performance confirmation

Regulator and stakeholders explicitly identified

- Prioritization function of :
- Parameters relevant for safety
  - Measurement techniques
  - Boundary conditions (legal & stakeholders)

Iteratively refined (within one step)

Stepwise approach, for each stage of the programme

# Conclusions (monitoring strategy) – 1/2

- **Monitoring is closely related to R&D and starts at the first stage of the project (before the construction)**
- **Monitoring programme has to be regularly updated (BAT) and adapted to move on from one stage to the other (site selection, construction, operation,...)**
- **Monitoring focuses a.o. on the confirmation of the safety performances of the disposal as well as process understanding (ongoing R&D) but has to deal with other interests (security & safeguards)**
- **Monitoring is performed by multiple agencies (operator & regulator). An integrated view should probably be developed but independency must be maintained**
- **Monitoring state-of-the-art is under continuous development**




# Conclusions (monitoring strategy) – 2/2

- **Monitoring is multiply constrained by law, at different levels (hierarchy; nuclear/environmental;...)**
- **If law matters for monitoring activities, monitoring matters for environmental law (standards are based on baseline monitoring)**
- **Monitoring programme cannot compromise the passive safety and the safety cannot rely on monitoring activities**
- **Some expectations (stakeholders) are still under debate and could influence the monitoring activities but these expectations should decrease as the project moves forward in time**
- **Monitoring programme may be related to other open questions like e.g. reversibility and retrievability**

→ Regulatory framework is still growing... let's be careful

→ The design of the monitoring program is certainly not a stand-alone activity for engineers only...

→ The monitoring program can certainly not meet all the expectations

The image shows the interior of a tunnel or shaft. On the left, a large, light-colored pipe is visible, surrounded by a dense network of electrical and data cables. Two rectangular lights are mounted on the pipe, casting a warm glow. The tunnel walls are made of grey, segmented concrete blocks. In the lower right, there is a blue panel with some white text that is partially obscured. The overall scene is dimly lit, with the primary light source being the two rectangular fixtures.

**Thank you for your attention !**

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