IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Faire avancer la sûreté nucléaire

How to gain reasonable confidence at early stages?

From URL to the feasibility of a geological disposal

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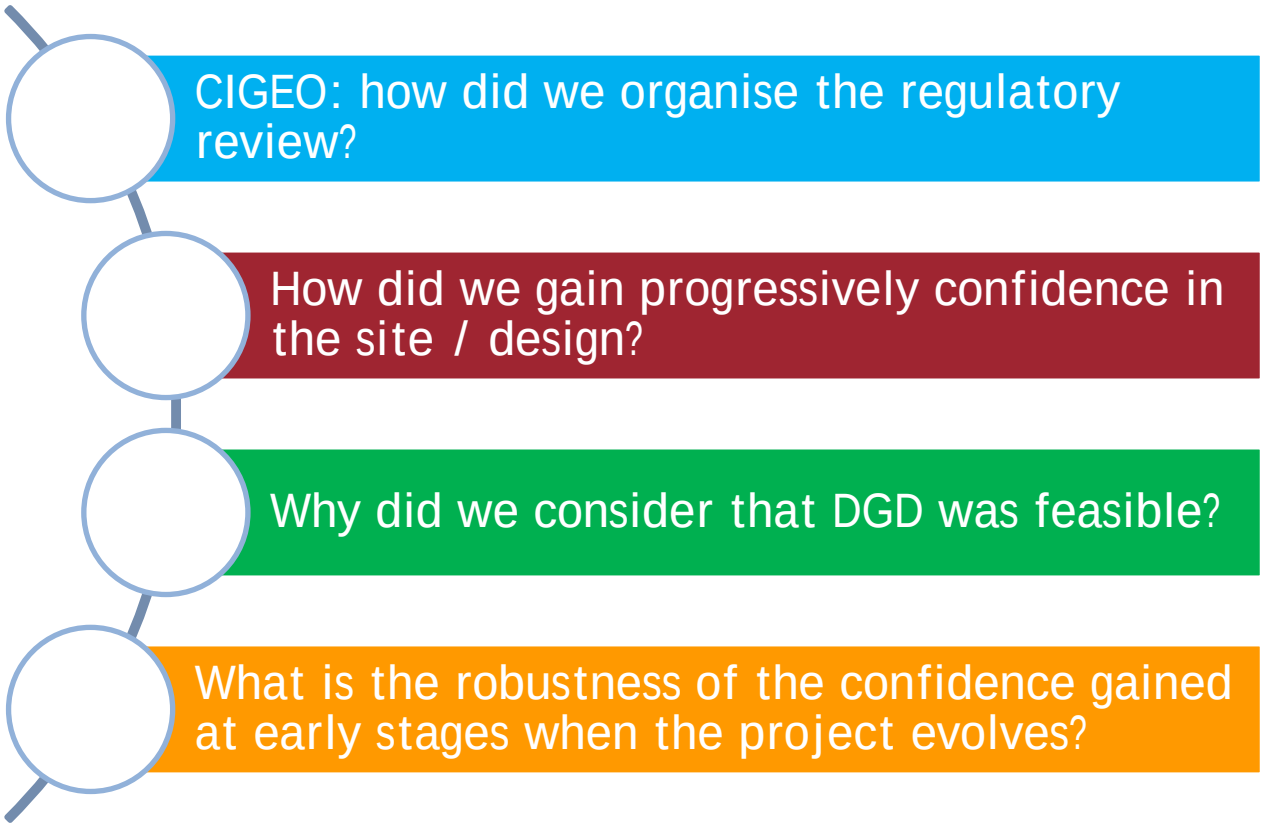
Outline


CIGEO: how did we organise the regulatory review?
How did we gain progressively confidence in the site / design?
Why did we consider that DGD was feasible?
What is the robustness of the confidence gained at early stages when the project evolves?

CIGEO : how did we organise the regulatory review?

- Along with major decision steps
- Focus on early stages between 1999 and 2005
- What is the feasibility of a DGD ?
- How did we move from URL to feasibility of a GD ?

What is the feasibility of a DGD ?

- Law of 30 December 1991 – management of high-level, long-lived waste (HLLW)
  - 2006: "*Project of law authorizing, should the occasion arise, the creation of a repository…*" → premature issue

New target

- Feasibility of a disposal design in the formation Callovo-Oxfordian clay, investigated via the Bure URL

What is the feasibility of a DGD ?

- Law of 30 December 1991 – management of high-level, long-lived waste (HLLW)

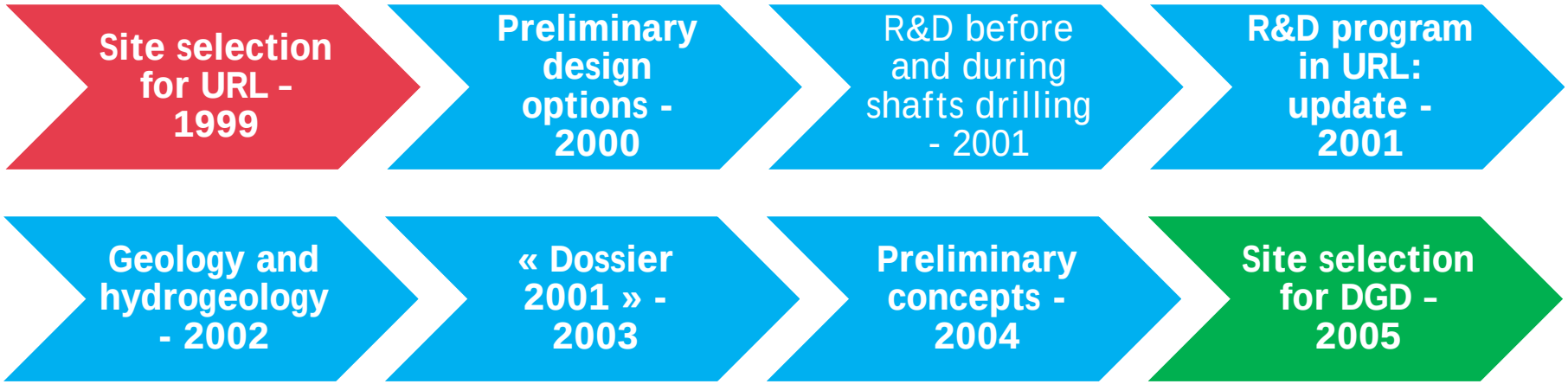
Are there issues at this stage that would rule out the safety of a repository in the Callovo-Oxfordian formation in the investigated sector?

New target

Does the safety demonstration of such disposal facilities appear “accessible“ in the future, given the identified uncertainties ?

What are the major issues which should be reinforced or acquired to establish this demonstration ?

CIGEO : how did we organise the regulatory review?



- 6 major intermediate holdpoints decided jointly by Nuclear Safety Authority (ASN), IRSN and Andra
- Topics covered scientific knowledge and safety approach mainly focused on safety after closure
- Competence building of IRSN's staff: strategic research agenda driven by the scientific/safety issues to be reviewed

- To assess consistency between geology, initial design options and safety approach to develop a Safety Case

- Reference and variant options but no evidence on construction feasibility : perturbations caused by the concept ?

How did we gain progressively confidence in the site / design?

- Ability to demonstrate feasibility of shaft drilling for a disposal, Influence of shafts on the site, Relevance of experiments

- Geomechanical program is relevant to understand influence of excavation on the rock but should be completed with the view to testing drilling methods able to minimize EDZ (objective: demonstrate feasibility of seals)

Site selection for URL - 1999 → Preliminary design options - 2000 → R&D before and during shafts drilling - 2001 → **R&D program in URL: update - 2001**

to assess the revised R&D program wrt to key safety questions arising from the previous regulatory reviews :

- Geomechanical studies satisfactory to assess feasibility of small tunnels but should be completed to evaluating feasibility of larger cavities ; ***if not possible before the hold point in 2005, alternatives should be proposed***
- Sealing feasibility based only on calculations and feedback from international not relevant: ***this uncertainty should be ruled out before the hold point in 2005 with the mean of a demonstration test in situ in the URL***
- Influence of operational phase and reversibility on the design options : Not sufficiently developed at this stage: *to be assessed later with the preliminary design (2004)*

Geology and hydrogeology - 2002 | « Dossier 2001 » - 2003 | Preliminary concepts - 2004 | Site selection for DGD - 2005

- to assess the state of the knowledge related to water flow patterns of the Bure site and the investigations to be carried out

- Confidence in safety assessment is poor because of lack of knowledge and no pessimist assumption considered to evaluate the margins

- Uncertainties due to the lack of knowledge about the presence or not of heterogeneities in the HR not considered in the model

- Alternative models should be considered by the implementer to evaluate the necessity to revise the design

Geology and hydrogeology - 2002 | **« Dossier 2001 » - 2003** | Preliminary concepts - 2004 | Site selection for DGD - 2005

- to assess the overall first integration of safety arguments in the CS : does the safety strategy make *possible* the safety demonstration ?

- Knowledge required should be better linked to the safety functions and characteristics of the components that are foreseen to achieve the overall safety of the disposal;

- Uncertainties should be better described and justified with the view to assessing the level of conservatism considered by the implemeter to develop the components and perform safety assessment

- The range of possible evolutions should be considered

- Uncertainties due to construction, interaction and failure should be considered in the description of the processes possibly occurring in the disposal with the view to better justifying the favorable properties of the different components and their ability to meet the safety functions

- The normal evolution scenario is too much « idealistic » and doesn't reflect the probable evolution

- The relationship between different elements in the Safety Case and their contribution to the overall safety demonstration should be better described and justified

Geology and hydrogeology - 2002 → « Dossier 2001 » - 2003 → **Preliminary concepts - 2004** → Site selection for DGD - 2005

- to assess the relevance of the preliminary concepts *wrt* THM and geochemical perturbations and how the implementer investigates those perturbations and takes them into account in the safety assessment

- Properties of the HR (containment) + geochemical evolution of the components: *knowledge should be sufficient in 2005 (considering on-going studies) to assess the feasibility of a disposal in COX provided that:*

  - Influence of heterogeneities is considered in the justification of the Design options (dimension of plugs, seals)

  - Sensitivity analysis is carried out, and remaining uncertainties are considered in SA

  - Justification of the method used to select the values in the models

Why did we consider that DGD was feasible?

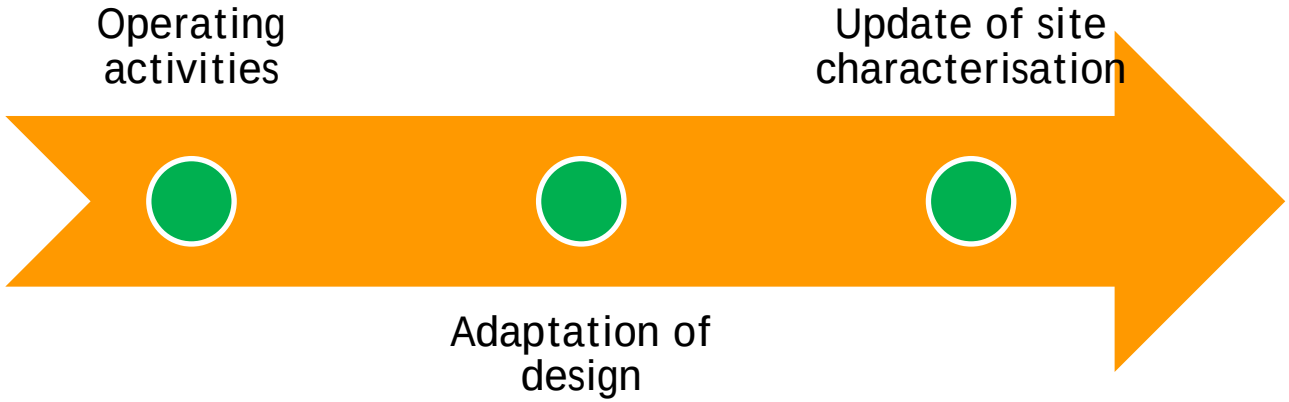
- Favorable elements

- High containment capacity of the host layer : no evidence of transfer
- Perturbations should not rule out the entire repository containment capacity
- Possible in principle to manage the separation of construction and operation
- **Important robustness of the repository system**

Why did we consider that DGD was feasible?

- Feasible in principle, but strong improvement required, in particular :
  - Understanding of the mechanical behavior of the rock and concrete ageing
  - Tests of sealing
  - Overpack and sleeves dimensioning with respect to corrosion phenomena; easy retrieval of package over long timeframes
  - Risk of explosion from H2 (ventilation efficiency), risk and remediation of package falling, fire risk
- Need for demonstration tests in situ

What is the robustness of the confidence gained at early stages when the project evolves?



- Progress in operational safety : e.g. ventilation…
- Overall architecture, dimensions, plugs…
- Influence of seals

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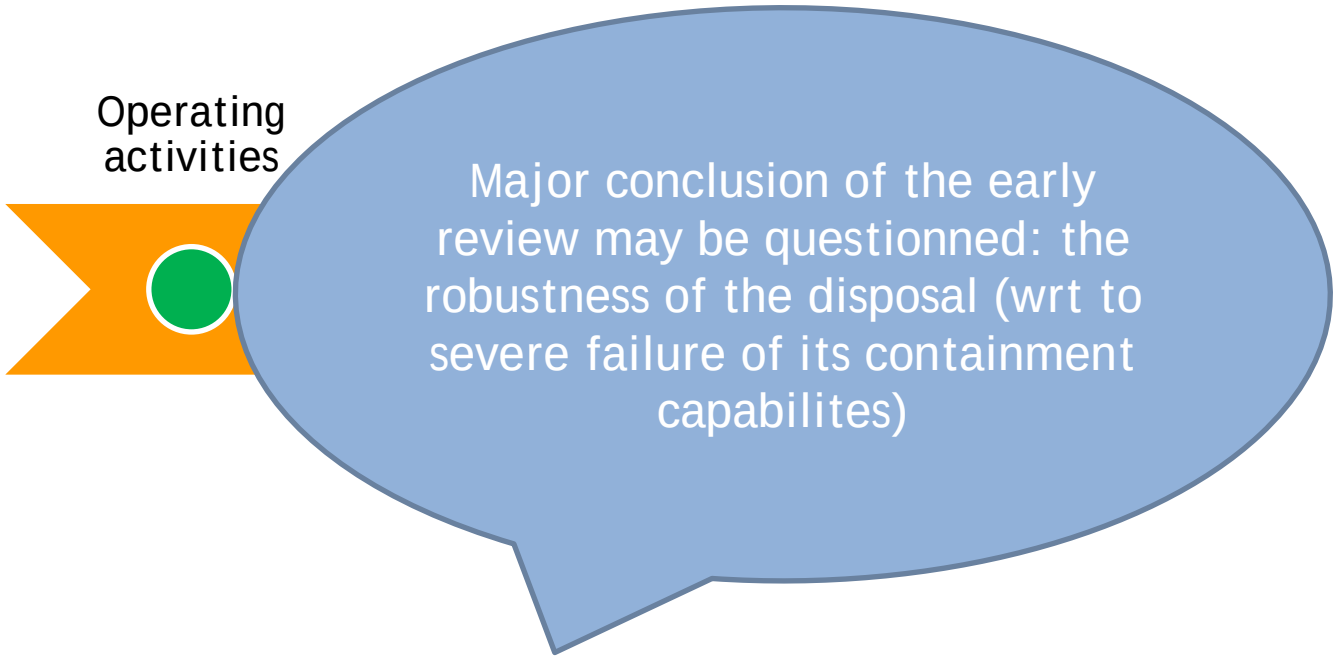

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- Overall architecture, dimensions, plugs…
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Conclusion

- Early dialogue is beneficial for all parties
- Challenging review on scientific issues : preparedness of IRSN a key factor
- It is possible to gain confidence « in principle » at early stages but mainly regarding long term safety and for preliminary design
- Operational safety drives design evolution
- Optimisation process drives design evolution
- As long as the project evolves , periodic evaluation of an « integrated safety demonstration » is necessary to assess influence of modifications on the overall safety

Thank you for your attention