Long-term safety of disposal of radioactive waste : radiation protection at the cross-roads of science and society

- BVS/ABR – 50th anniversary Symposium
- P. De Preter, M. Van Geet & Ph. Lalieux (NIRAS/ONDRAF)

NIRAS

Outline

- Disposal
- Policy decisions & disposal
- Disposal & timescales
- The radiation protection principles & disposal
- Where does this all lead us ?

NIRAS

Disposal

- **Endpoint(s)** of national waste management system
  - For « ultimate waste » - for which no further use is forseen or considered by the Member State (EC Directive 2011/70)
  - Recycling because of re-use of fissile material – otherwise disposal of it
- **Passive** isolation & containment
  - Beyond the timescales that active management can be relied upon
  - Active management requires continuity of installations, organisations, financial means, technical expertise, & institutional-societal-political stability, …
- The required disposal systems depend upon
  - The radioactive wastes to be managed (radiological contents, volumes, …)
  - Past, present and future nuclear activities (and some non-nuclear)

NIRAS

Policy decisions & disposal

- Radioactive waste management is a national responsibility
  - « Radioactive waste shall be disposed of in state in which it is generated »
    - Basic principle in the Joint Convention and EU Directive 2011/70/Euratom
    - Not excluding, under very specific conditions, the option of exporting waste to a disposal facility abroad
- Policy decisions define the national framework in which disposal projects can be implemented
  - Policy decision for near-surface disposal or not for LLW ?
  - Policy decision(s) for number of facilities, timing, decisional process, conditions, …

NIRAS

Policy decisions & disposal

- Near-surface disposal (in Dessel) for all Belgian LLW (1998 & 2006 decisions)
- No policy decision yet for ILW & HLW
  - NIRAS/ONDRAF waste plan Sept. 2011
  - The need for a geological disposal is a direct consequence of the policy decision for nuclear energy
    - Reprocessed HLW and/or spent fuel
    - Also long-lived ILW – reprocessing, operational waste, …

NIRAS

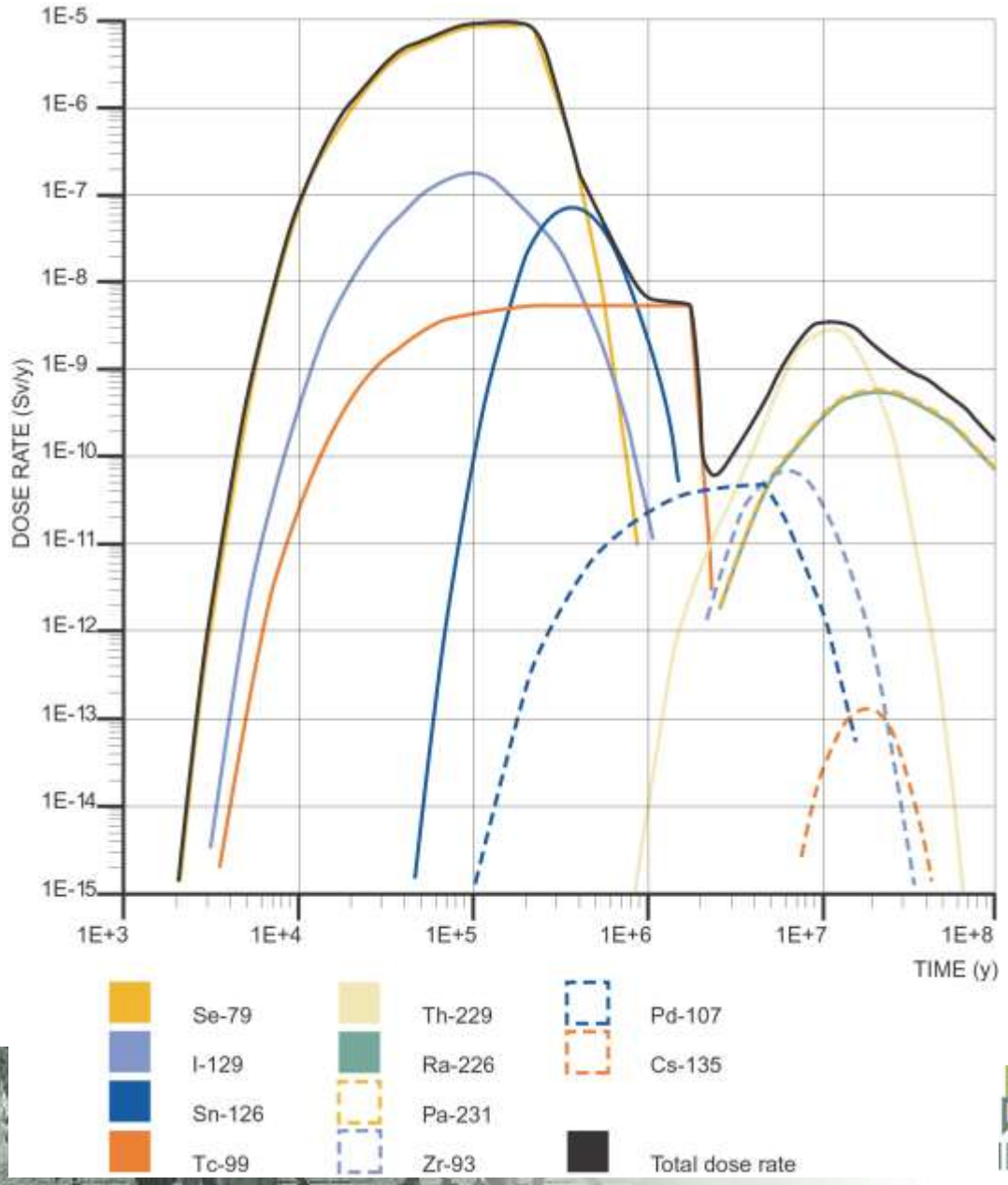
Disposal timescales

- From RD&D → facility operation & closure = more than a century
- Post-closure control & surveillance (societal oversight) as long as … future generations see benefit to do so
  - There is no intention to abandon oversight
  - But cannot be relied upon indefinitely
- Post-closure passive phase also after loss of oversight
  - HLW intrinsically hazardous for more than 100 000 years
  - About 4000 generations - 100 000 years ago era of Neanderthalers

NIRAS

Disposal timescales

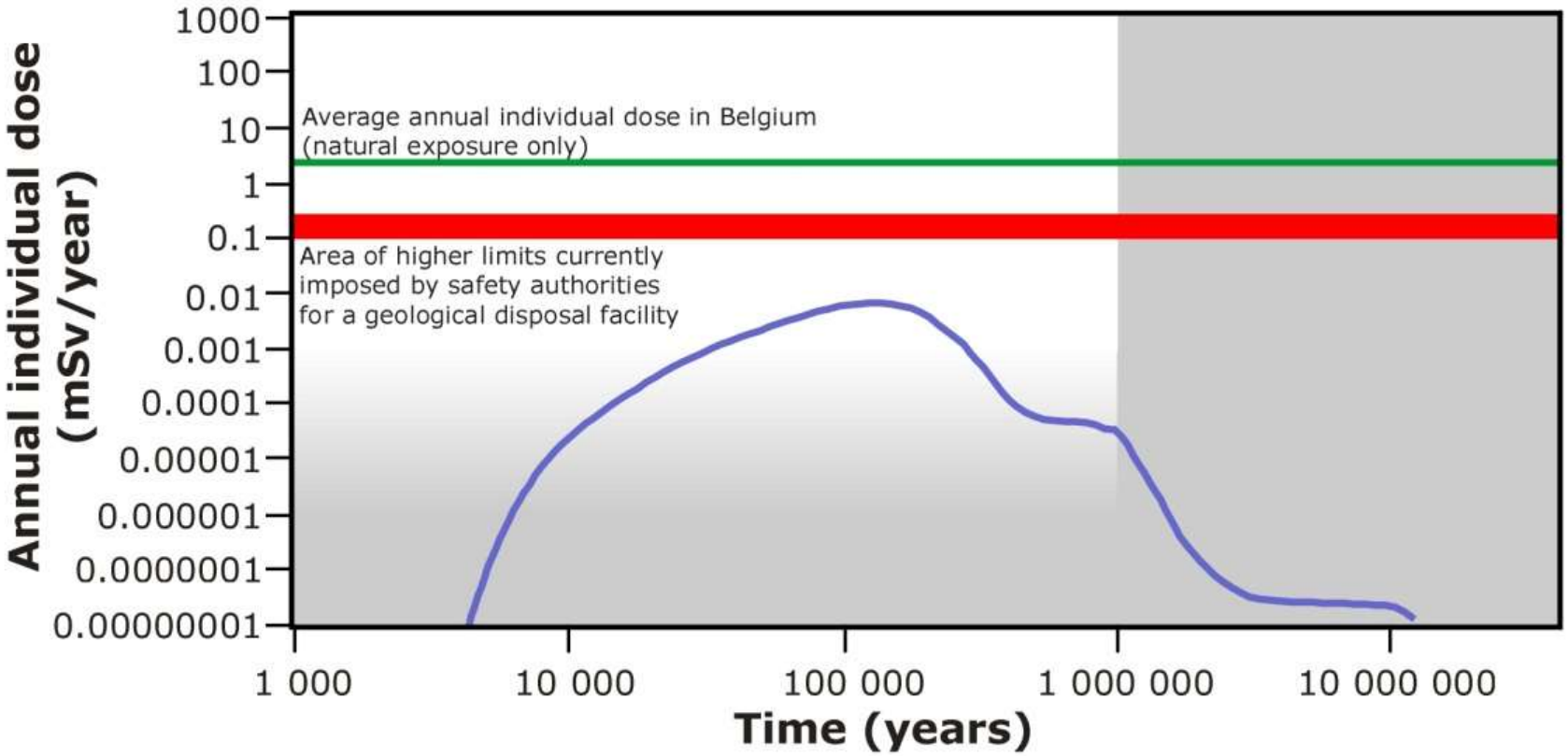
The calculational **illusion**:



Disposal timescales

The regulatory compliance **illusion**:

1. « Calculated doses below the regulatory protection criteria » suffices to demonstrate safety
2. Calculated dose in the far future as the main instrument for optimisation of the disposal system



The radiation protection principles & disposal

- Upcoming ICRP Publication 122 – geological disposal
- **Justification**:
  - Disposal cannot be seen as a freestanding practice that needs its own justification, but as an integral part of the practice(s) generating the waste
  - The need for disposal is a direct consequence of past deployed nuclear activities (nuclear energy)

NIRAS

The radiation protection principles & disposal

- **Justification**
  - Justification of the practice should include the long-term management options for the waste
    - There is no reasonable alternative for disposal
    - Geological disposal required for HLW (& ILW) resulting from nuclear energy production
    - There is no foreseeable recycling route that would eliminate the need for geological disposal
  - Justification of the practice to be reviewed **amongst other things** in the light of sustainability and safety assessments of geological disposal system
    - Existing waste & waste foreseen = disposal of a limited amount
    - Additional waste from new NPPs ? = new disposal capacity required ?

NIRAS

Disposal & the principles of radiation protection

Dose limitation

- Has intrinsic difficulties when applied to long-term safety of disposal because there is no retrospective dose assessment for demonstrating compliance with dose limits
- A process of constrained optimisation will obviate the (…) use of dose limits.

NIRAS

Disposal & the principles of radiation protection

- The principle of **optimisation**
  - Of key importance for developing and implementing disposal systems
  - Constrained optimisation : radiological optimisation below a dose or risk constraint
    - Typical range of 0.1 – 0.3 mSv/y and 10^{-5} – 10^{-6} per year
  - BUT: Effective dose loses its direct connection to health detriment in the future after a time span of a few generations

NIRAS

Disposal & the principles of radiation protection

- For the distant future – beyond a few generations:
  - We should not attempting to estimate radiation detriment for future individuals - an impossible task
  - A strict application of numerical criteria for regulatory compliance demonstration may be inappropriate – limits of our scientific basis
  - Dose and risk assessments to
    - give an appreciation of the excess of risk resulting from potential future exposures due to the disposal system
    - test the weakness and robustness of the disposal system and comparing disposal options, mainly at the design level.

NIRAS

Disposal & the principles of radiation protection

- The principle of **optimisation**
  - We have to acknowledge the limits of radiological assessments: limits of our scientific basis for assessing health detriment and for assessing disposal system radiological impacts in the remote future
  - Makes life more difficult for everybody ☹ - developer, regulator, general public, communicators, politicians, …

→ Evolution from radiological optimisation to system optimisation : focus has to be on quality of

- system development (site & design, RD&D programme)
- system assessment
- system implementation

NIRAS

Disposal & the principles of radiation protection

→ **Optimisation** as a forward looking process systematically evaluating options for choosing the best protective option

- Options for siting and designing a disposal system
- Duly taking account of constraints because of limited available options, e.g. host rocks, sites, financial and other means, societal acceptance decisions, …
- Systematically applying the concepts of BAT, Best international practice, periodic system assessment (international concept of safety case) and periodic regulatory & peer review, …

NIRAS

Where does this lead us ?

- Far away from a comfortable situation of just comparing calculational results with protection criteria
- A technical/technological and societal challenge to find a solution
  - Not finding a solution is easy
  - Not finding a solution is transferring the problem to future generations
  - Interim waste storage to provide for timing flexibility, but not as a fall-back solution
  - A transparent process focussing on key concepts such as BAT, Best International Practice for all aspects (RD&D, siting, designing, construction, …)
  - Emphasis on optimising the disposal system for the possible site(s)
    - The scarcity of sites is a determining factor
    - Not appreciating this can be a recipee for failure
- A solution to the best of our capabilities

NIRAS