ENEP

筑波大学
University of Tsukuba

Gerhard Proehl

Safety Standards for the Management of Radioactive Waste

IAEA: International Atomic Energy Agency

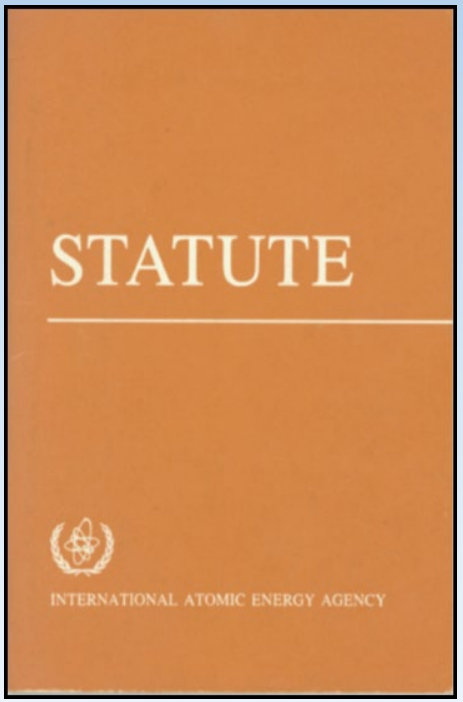
Founded in 1957 by the United Nations

Article III, *Functions*
Paragraph A.6.

" To **establish** or adopt, in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned,

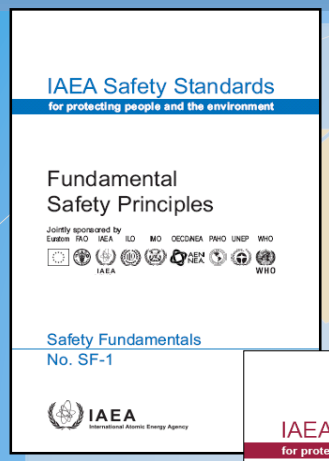
standards of safety for protection of health and minimization of danger to life and property (including such standards for labour conditions), and

to provide for **the application of these standards** to its own operation as well as to the operations making use of materials, services, equipment, facilities, and information made available by the Agency …; "

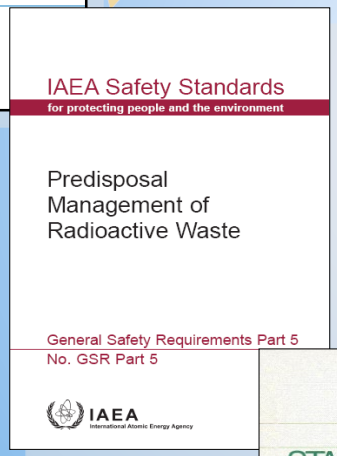


Statute 1957

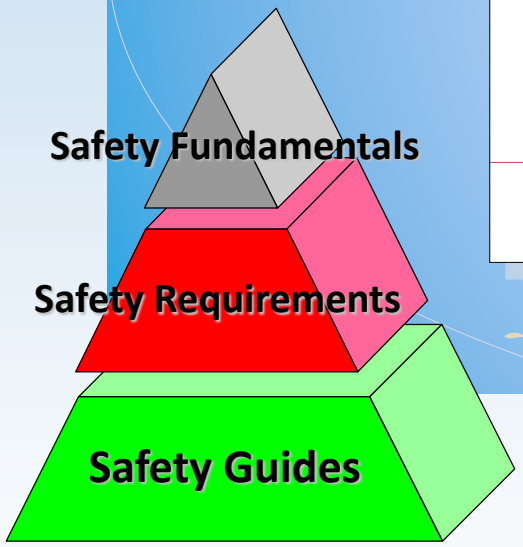
IAEA Safety Standards Categories

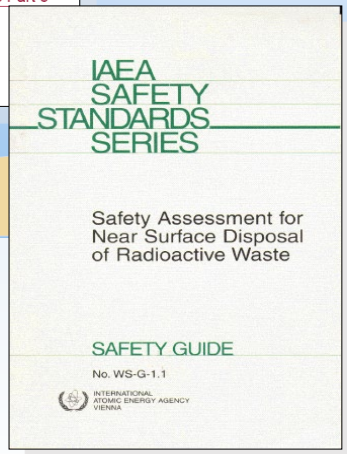


Fundamental Safety Principles



Requirements: What to do?

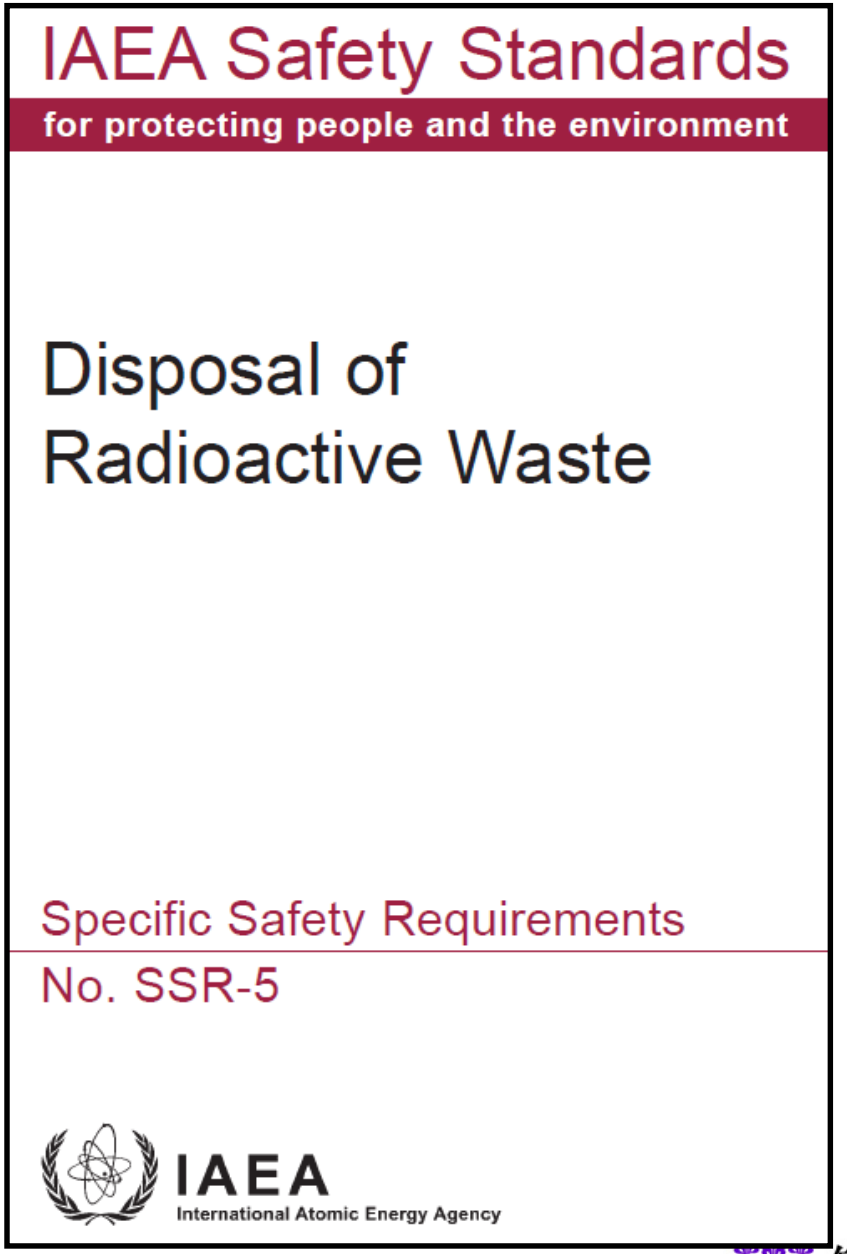




Best Practice to meet Requirements: How to do?

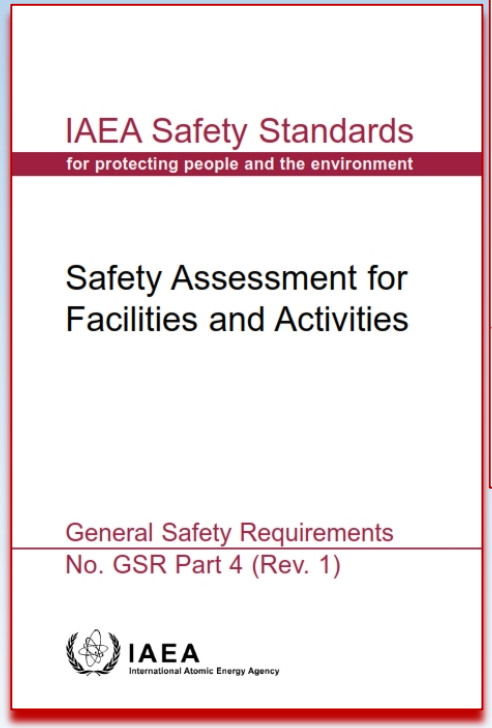
筑波大学
University of Tsukuba

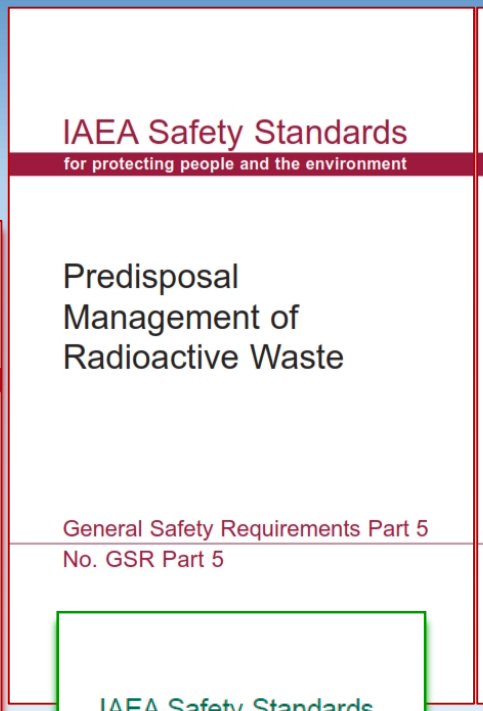
IAEA Safety requirements and standards

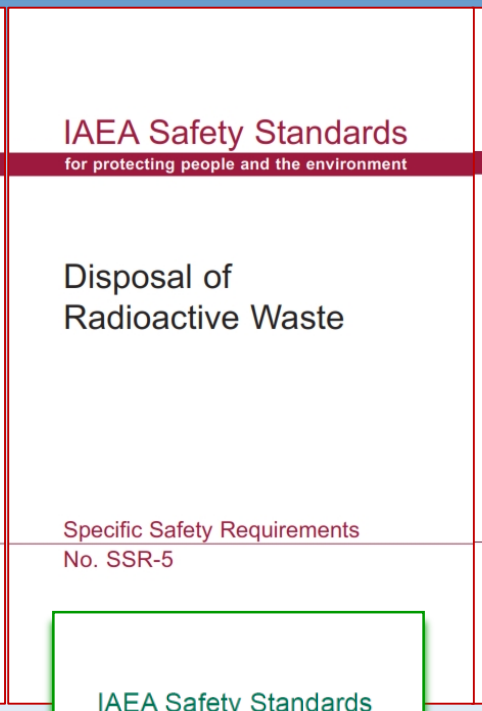


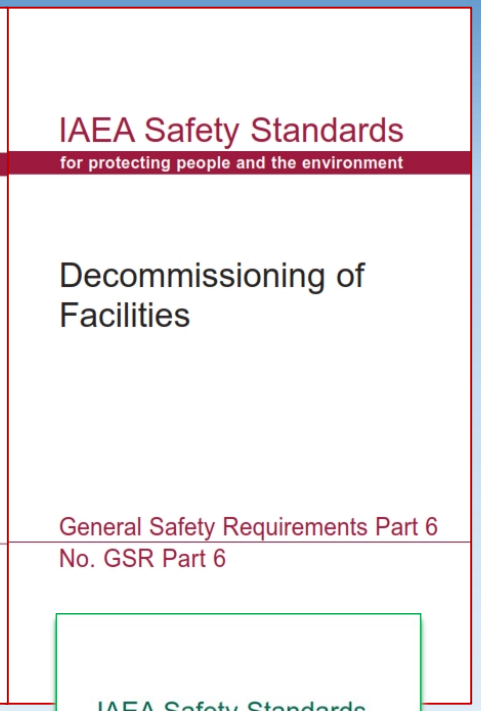
筑波大学
University of Tsukuba

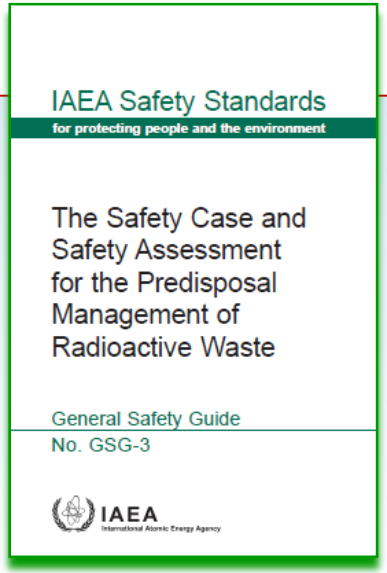
Safety Standards on Safety Assessment

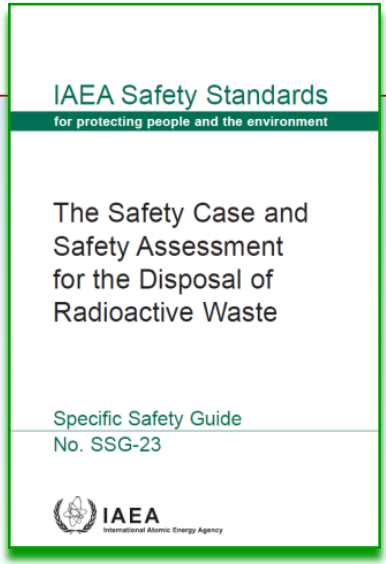


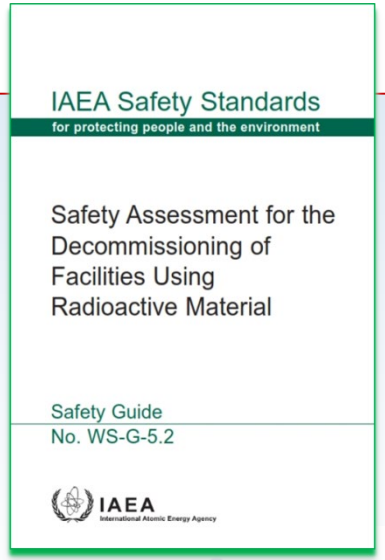








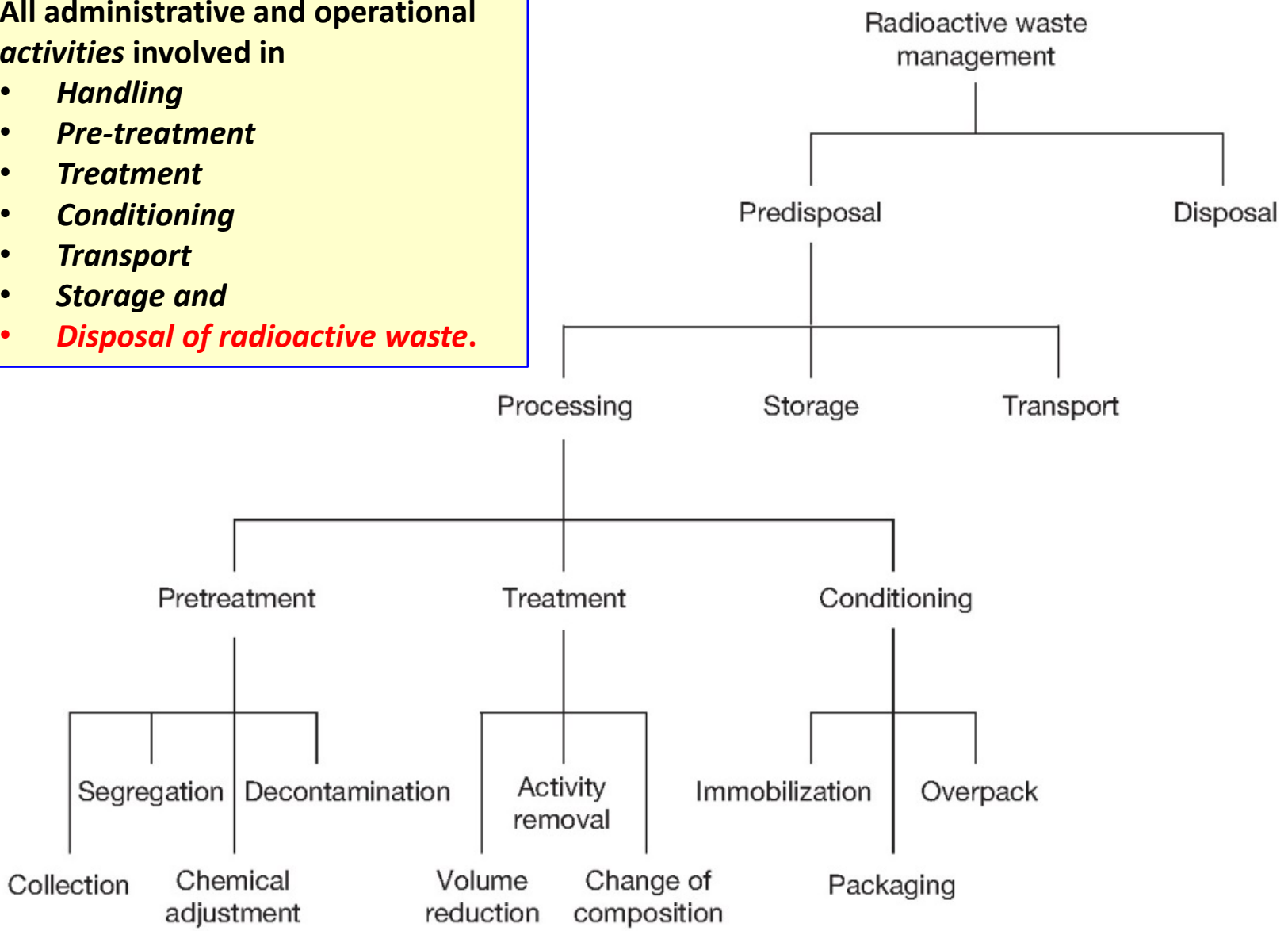




Radioactive Waste Management

All administrative and operational *activities* involved in

- ***Handling***
- ***Pre-treatment***
- ***Treatment***
- ***Conditioning***
- ***Transport***
- ***Storage and***
- ***Disposal of radioactive waste.***

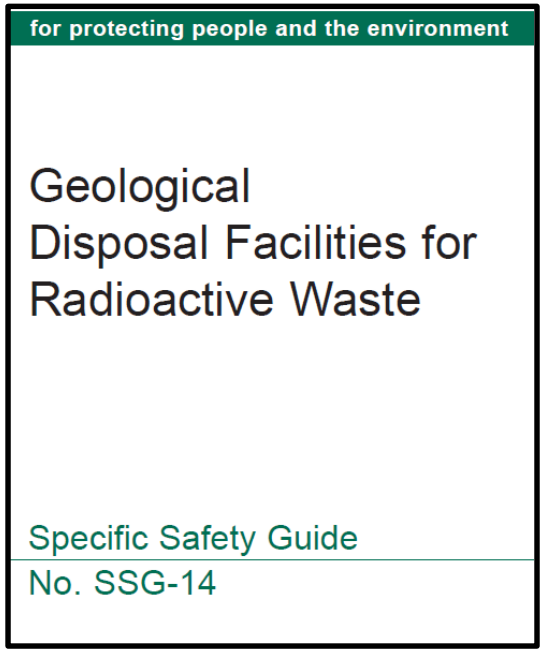


! Storage is only a temporary solution

- **Storage is not sustainable in the long term**
  - Requires active controls for safety and security
  - On-going responsibilities and costs (e.g. for maintenance, refurbishment, monitoring, security)

- **Events and developments with impact on the safety of storage**
  - Human-induced
    - Wars and terrorism
    - Urban growth
    - …
  - Natural:
    - Storms and floods
    - Earthquakes
    - Volcanic eruptions
    - …

ENEP



- Overview of geological disposal and its implementation
- Legal and organizational infrastructure
- Safety approach
- The safety case* and safety assessment
- Elements in a stepwise approach to the development of a geological disposal facility

*__Safety Case__: A comprehensive evaluation of the safety assessment
- Findings of a safety assessment and a statement of confidence in these findings.
- Addressing weak points of the safety assessment and how to overcome them

筑波大学 University of Tsukuba

Timeline of the development of a geological disposal facility (IAEA Safety Standard SSG-14)

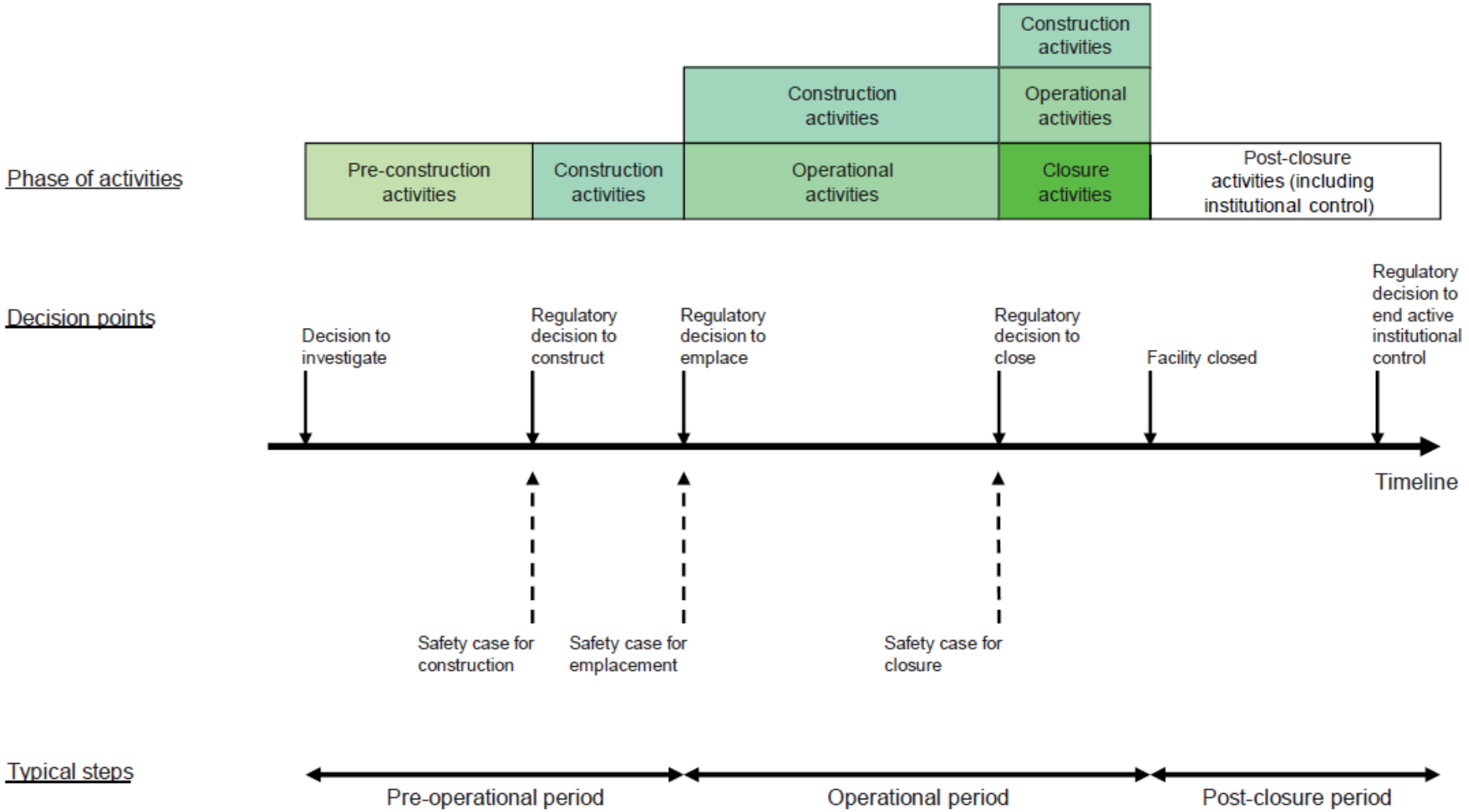


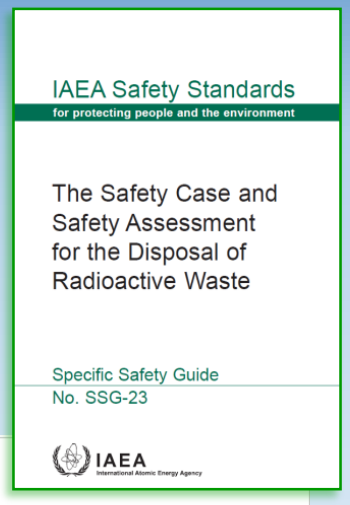
FIG. 1. Timeline to illustrate the development, operation and closure of a near surface disposal facility.

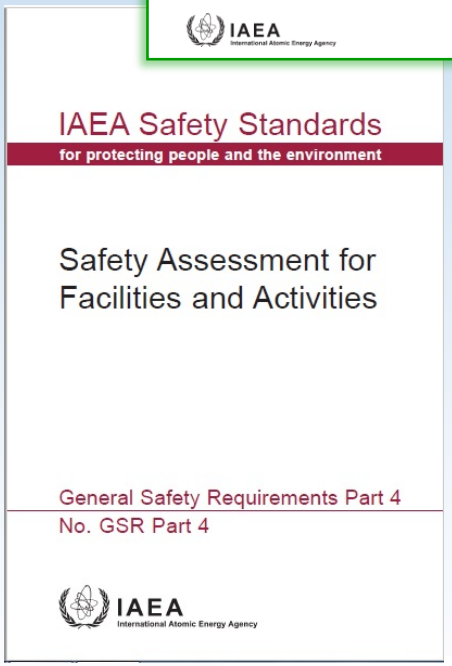
Requirements for safe disposal

- R15-19 Steps in disposal:
  - **Site characterization**… to support a general understanding of the characteristics of the site and **how the site will evolve over time**
  - **Design**… the facility shall be designed to provide **operational and post-closure safety**
  - **Construction**… the facility shall be constructed **in accordance with the design in the safety case**
  - **Operation**… the facility shall be operated in accordance with the licence, relevant regulatory requirements and Waste Acceptance Criteria
  - **Closure**… the facility shall be closed **to provide the safety functions** shown in the safety case to be **important for safety**

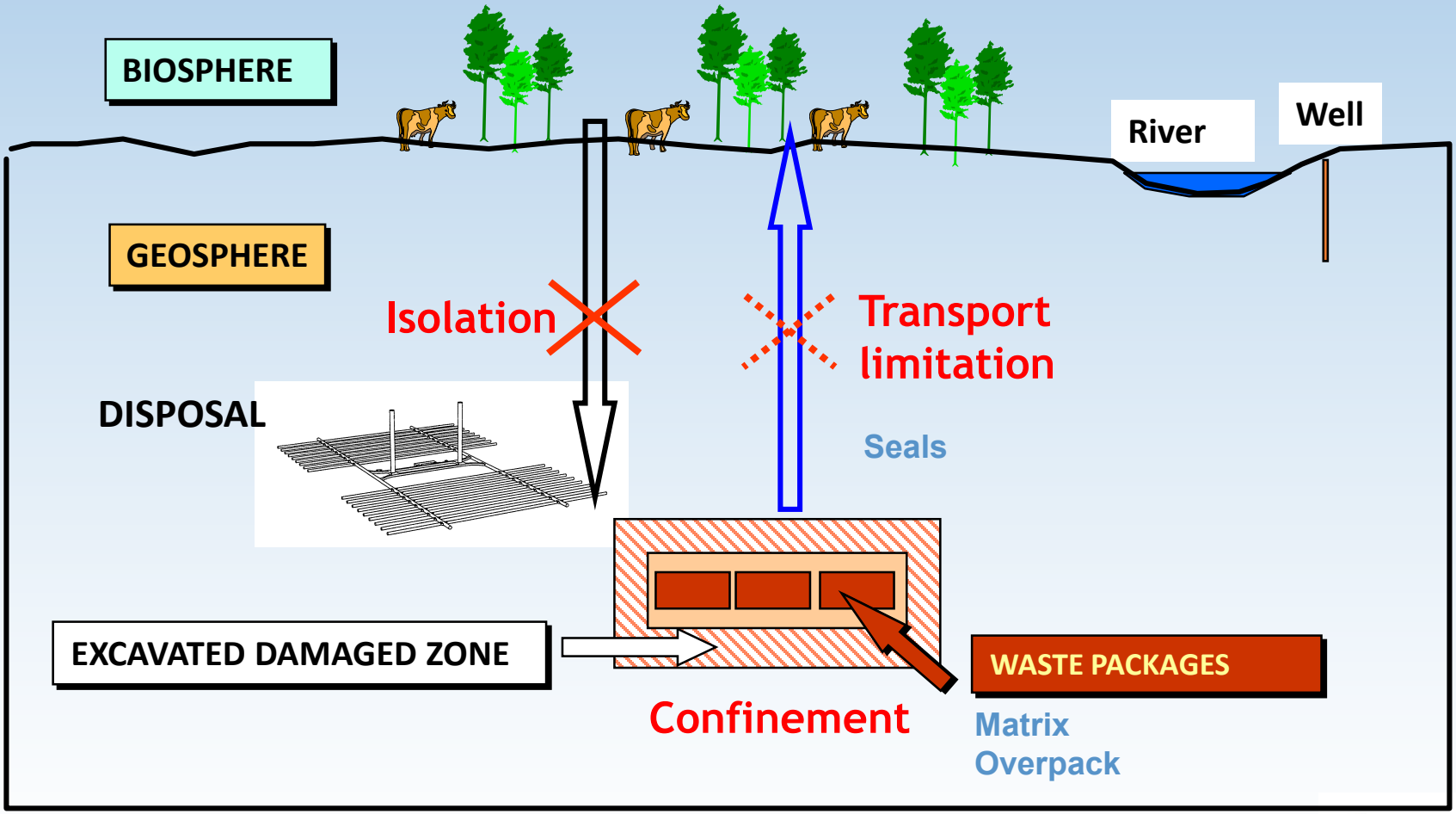
Safety assessment

- **Evaluating the overall performance** of a disposal system, including
  - –Host rock
  - –Confinement area
  - –Overlaying rock
  - –Biosphere
- **Systematic assessment** of radiation hazards
  - –Quantifying its potential radiological impact
  - –both in operation and after closure.

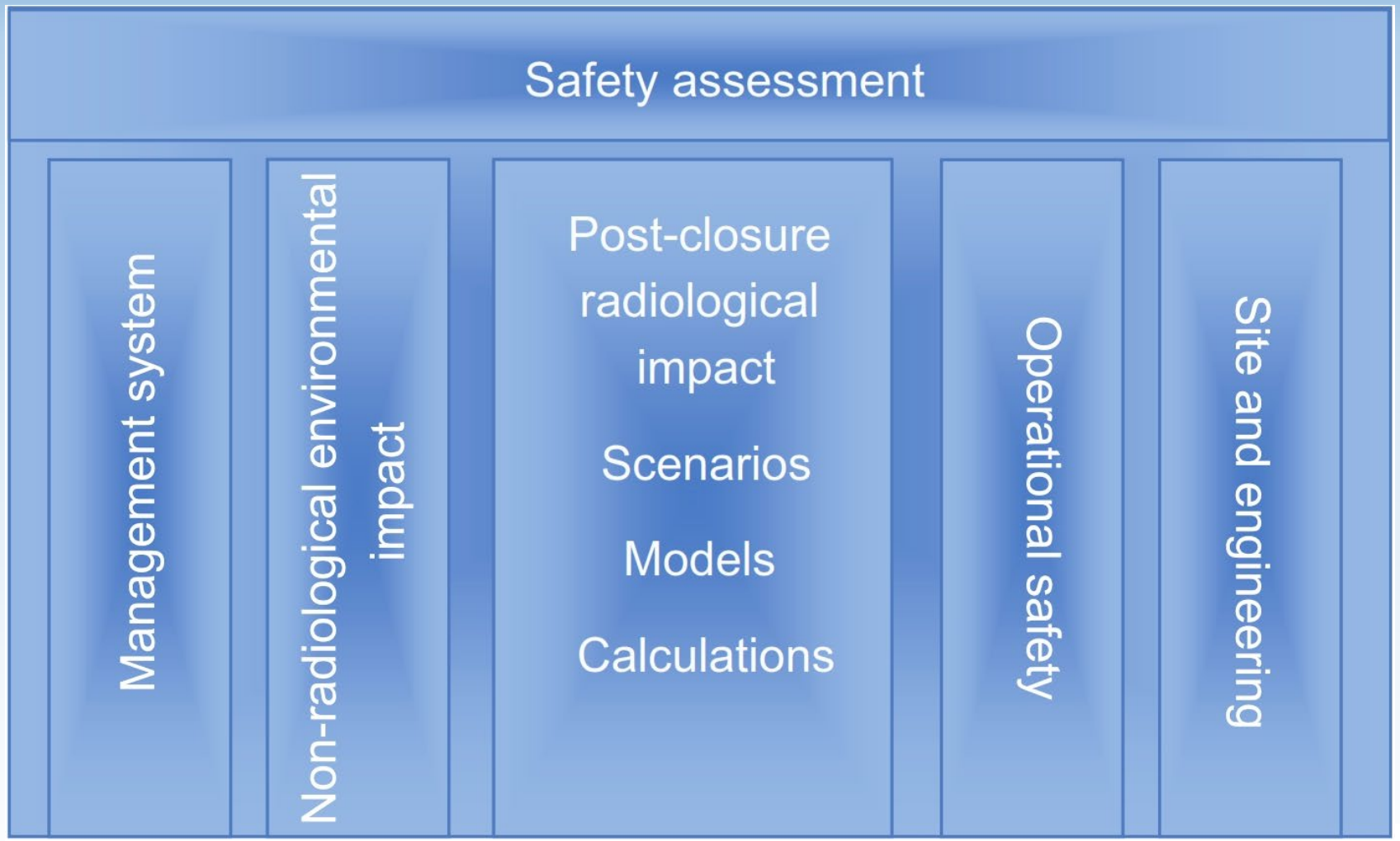




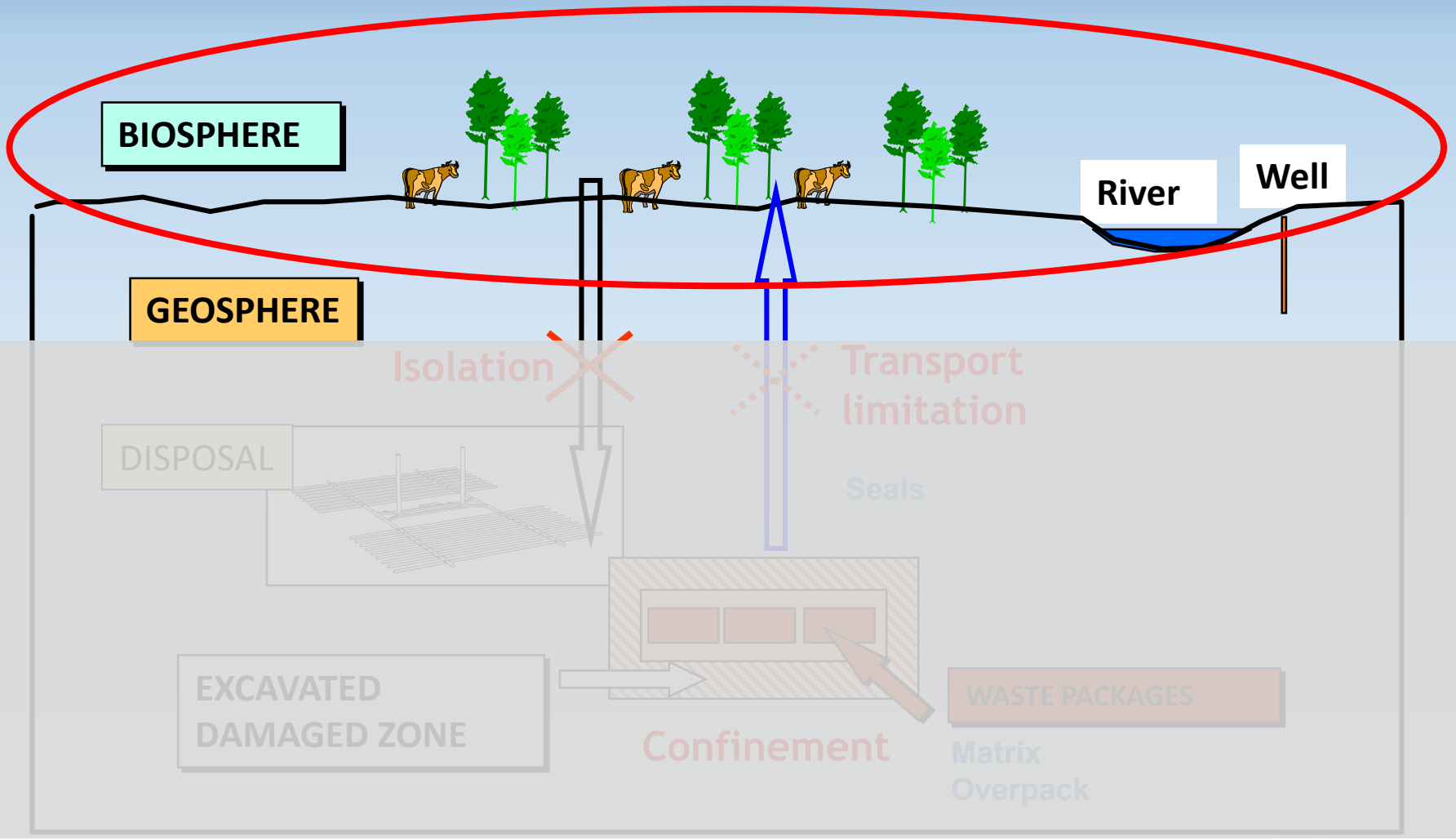
IAEA Specific Safety Guide 14 (SSG-14)
Geological Disposal Facilities for Radioactive Waste



Safety Assessment – A complex document



Biosphere in the post-closure period of a disposal facility



ENEP

IAEA Safety Standards

for protecting people and the environment

The Safety Case and Safety Assessment for the Disposal of Radioactive Waste

Specific Safety Guide

No. SSG-23

IAEA
International Atomic Energy Agency

筑波大学
University of Tsukuba

Radiation protection in the post-closure period

Safety objectives

- The safety objective is
  - to site, design, construct, operate and close a disposal facility
  - so that **protection after its closure is optimized, social and economic factors being taken into account.**
- A reasonable assurance also has to be provided
  - **that doses** and risks …. in the long term will **not exceed the dose** constraints or risk constraints that were **used as design criteria**.

Criteria

- The **dose limit for members of the public** for doses from all planned exposure situations is an effective dose of **1 mSv/a**.
  - This criteria should **not to be exceeded in the future**.
- To comply with this dose limit, **the calculated dose** or risk …. does not exceed a **dose constraint of 0.3 mSv/a** or a risk constraint of the order of 10^{-5} per year

筑波大学 University of Tsukuba

Criteria in national disposal facility projects

*Exposure from natural background: 2.4 mSv/y

Sweden

- Risk constraint: 10^{-6} per year (ca. 20 µSv /y)*
- Time frame after closure
  - First 1000: Quantitative assessments
  - > 1000 y: Sequence of possible developments
  - Assessment as long time as barrier functions are required, but at least 10 000 y

- **Finland**
  - Dose criteria
    - Dose to the most exposed people …. below of 0.1 mSv/y
    - Average doses to other people shall remain insignificantly low.
  - Time frame after closure
    - Several 1000 y
    - Then: constraints on radioactive releases to the environment
    - Releases can be averaged over one 1000 years.

Criteria in national disposal facility projects (cont.)

France

- Risk constraint: 0.25 mSv/a
- Time frame after closure
  - 10000 years for safety demonstration

Germany

- Dose criteria for HLW disposal facility
  - 10 µSv per year (still under discussion)

- Time frame after closure (still under discussion)
  - 10 000 years: Detailed assessment
  - 1 million (!) years: A more stylized assessment

Safety Guide SSG-14

Appendix II: Post-Closure Safety Assessment

- Radiation exposure is the major safety issue
  - Develop **confidence** in modelling
  - **Reasonable conservatism**
- Any approach to make that **acceptance easier** will be a long term benefit
  - Acceptance can be the most difficult aspect of an assessment
- An approach which balances
  - **simplicity, conservatism and realism** is likely to be the best starting point for assessments.

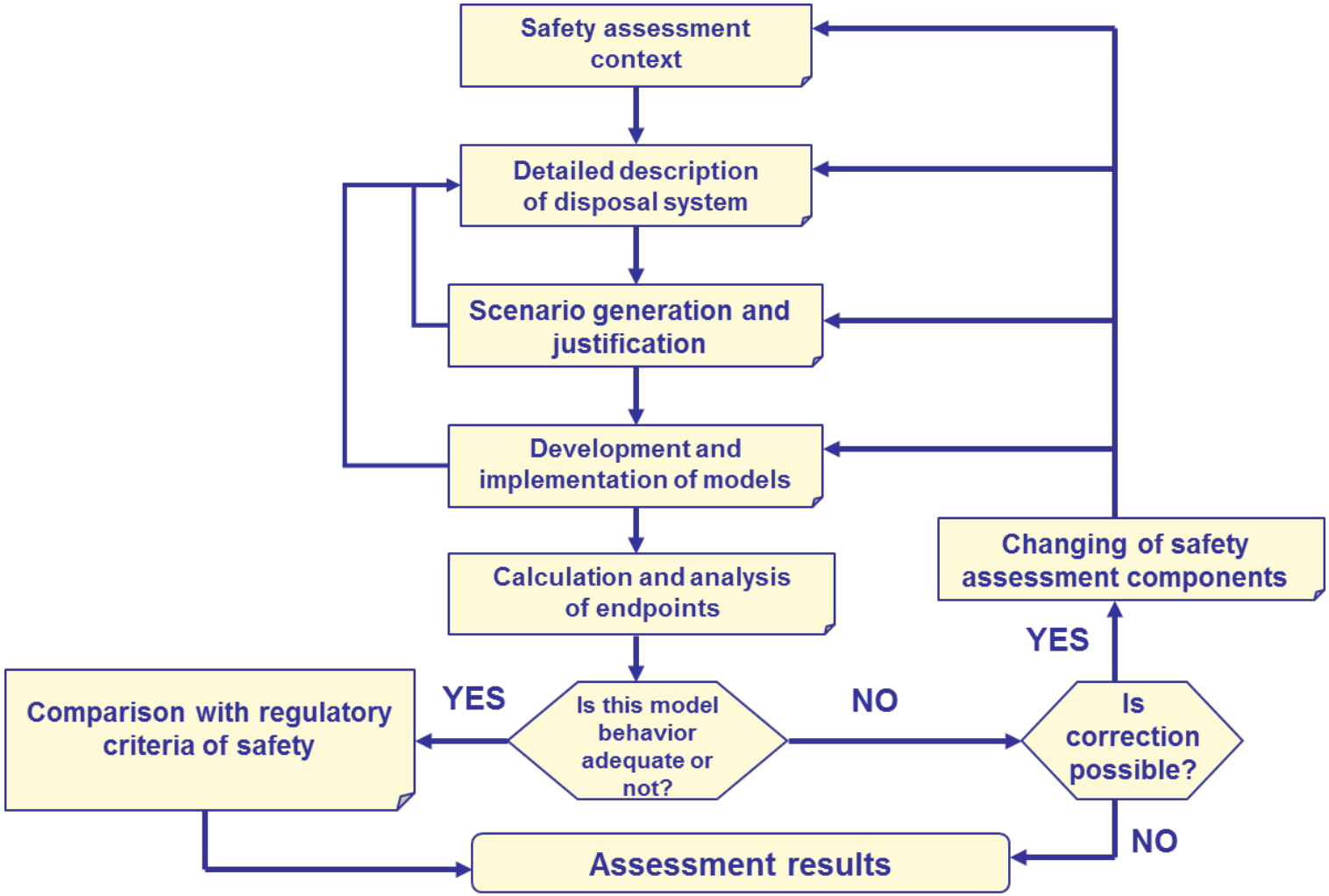
筑波大学 University of Tsukuba

Compliance with safety objectives and criteria

- In **estimating doses to individuals in the fut**ure due to a disposal facility,
  - …. **people** will be present locally,
  - ….People make some **use of local resources** that may contain radionuclides originating from the waste in the disposal facility.
- It is **not possible to predict the behaviour** of people in the future with any certainty,
  - Its representation in **assessment** models **is necessarily stylized**.
- The rationale and possible approaches to the **modelling of the biosphere** and the estimation of doses arising from waste disposal facilities have been considered in the **IAEA BIOMASS** Project.

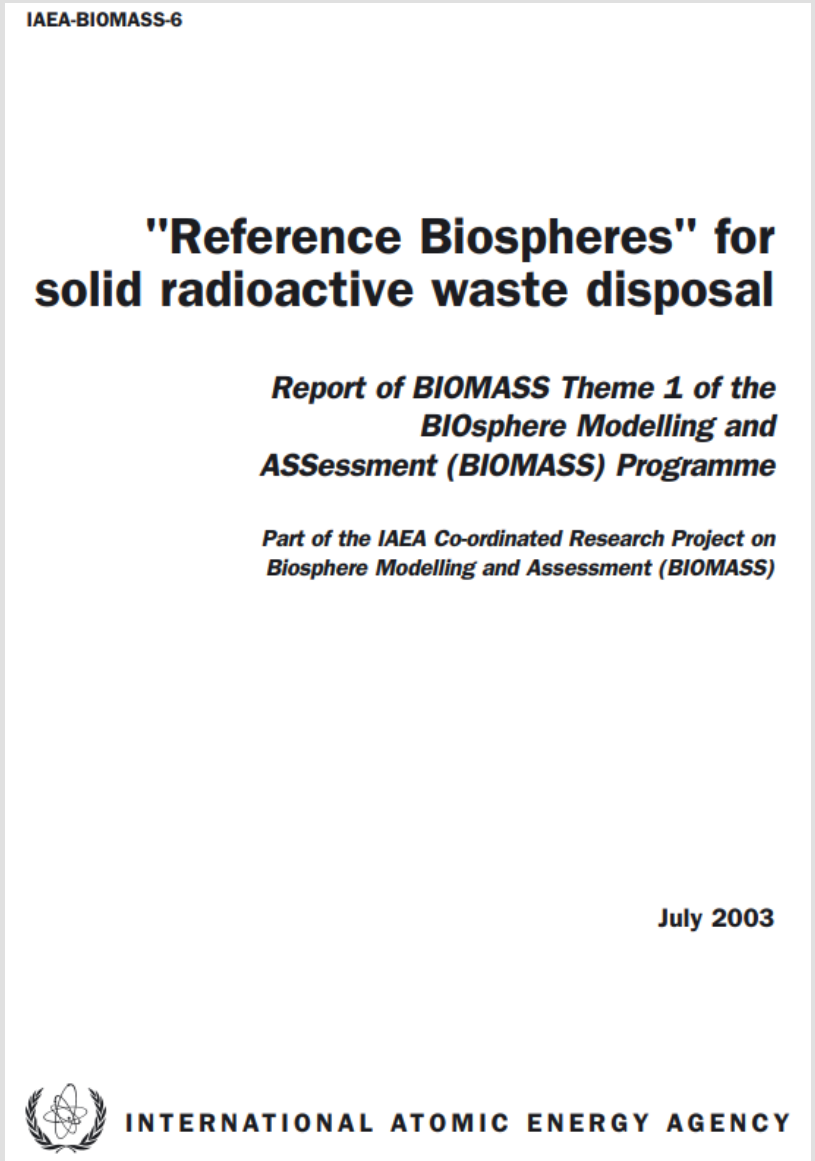
筑波大学
University of Tsukuba

Assessment of potential exposures after closure of the facility



筑波大学
University of Tsukuba

The IAEA BIOMASS Project (1998-2003)



筑波大学
University of Tsukuba

Conclusions

- IAEA has developed Safety Standards on the disposal of radioactive waste
- The **safety assessment** for a waste disposal facility has to cover all components and aspects of a facility
  - Host rock, waste packages in the confinement, geology and hydrology, exposures to people in the biosphere
- **Radiological criteria** in the post-closure period
  - Well below 1 mSv/a
  - Time frame to be considered up to a million years
- IAEA developed a methodology to set up **assessment models for exposures in the far future**