Implementing Geological Disposal of Radioactive Waste Technology Platform (IGD-TP)

Prioritisation of RD&D Topics - The SRA Approach -

Exchange Forum, 08/02/2011

BMWi
(presented by Wernt Brewitz)
SRA aims outlined in the Vision Report  
(see page 17 of Vision Report)

• Specific **scientific challenges** are encountered when reducing the uncertainties in order to improve confidence in long-term safety.

• The **technological challenge** is to transfer the studies and the results of RD&D activities into proven and reliable technologies for construction, operation and closure of a deep geological repository.

• **Social and political challenges** are related to the siting of repositories and bridging the chasm of knowledge between experts and general public.
Scientific and technical basis for the SRA?

- **Waste Management Programs & Conceptions**
  - HLW disposal concepts - state of advancement - time frames - etc

- **International & National Framework Conditions**
  - regulations - legal requirements - safety standards - etc

- **State-of-the-Art**
  - radioactive waste management - engineering - sciences - RD&D

- **WMOs needs for**
  - licensing - construction - operation - final closure
  - confidence building - public acceptance
  - training and education
Main tasks on the road to the SRA

Stakeholders’
- scientific concerns

Advice - Review

Proposals

Co-operation - Consultation

WMOs
Applied Research

WMOs
Safety Cases

Non Host Rock related
- broad spectrum of issues -

Prioritisation of Needs

Host Rock related
- specific RD&D needs

Vision 2025

Issues of joint interest
Prioritisation and consultation process

SRA
Topics of importance and urgency
Co-operation of the participating WMOs

Programs (Licensing before 2025)
- Topics of high urgency to Vision 2025
  - Key Topics of SRA

Programs (Licensing after 2025)
- Topics important for advancing in individual programs

All Programs
- Other Topics important to Vision 2025
  - Cross-cutting activities of SRA

Collaboration & Technology Transfer
- Results = crucial for implementation
- Results = needed for progressing to next stage
- Results = needed e.g. for reducing uncertainties, optimisation, acceptance, ....
Needs for implementing geological disposal at an advanced Stage

VISION - 2025

Requirements to reach the VISION

- Demonstration of long term safety
- Demonstration of techniques & components
- Confirmation of site related matters

Scientific background, e.g.
- waste characteristics
Safety case, e.g.
- methods & methodologies
- modelling and simulation

Technology development
- Waste acceptance & disposal
  - operational safety
  - industrial scheme
- Monitoring
- Closure & sealing
- Others

Cross-cutting activities
- Dialogue with regulators, competence maintenance, education and training,
  knowledge management (including information preservation & memory keeping),
  communication supporting information exchange

Site properties
- Site analysis
# Basic tasks in repository development and implementation

<table>
<thead>
<tr>
<th>Task Area</th>
<th>Specific Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Safety strategy and methodology</strong></td>
<td>Development of safety assessment methodology</td>
</tr>
<tr>
<td><strong>Long-term safety: scientific and technical basis</strong></td>
<td>Research narrowed to deal with host rock-specific aspects and specific aspects associated with the selected EBS</td>
</tr>
<tr>
<td><strong>Facility and component design</strong></td>
<td>- Concept variant studies</td>
</tr>
<tr>
<td></td>
<td>- Repository design concepts adapted to specific rock type</td>
</tr>
<tr>
<td><strong>Site-related characteristics</strong></td>
<td>- Surveys of potential host rocks and their characteristics based on available information</td>
</tr>
<tr>
<td></td>
<td>- Host rock characterization and site-specific studies</td>
</tr>
<tr>
<td><strong>Selection of host rock &amp; site selection</strong></td>
<td>Application of methodology in safety case and improvement of methods</td>
</tr>
<tr>
<td><strong>Technology development and repository design</strong></td>
<td>In situ experiments and improvement of data bases and understanding</td>
</tr>
<tr>
<td><strong>Technology demonstration and repository construction</strong></td>
<td>Scientific work focused on small number of residual issues; large-scale in situ experiments &amp; component tests</td>
</tr>
<tr>
<td><strong>Industrial-scale manufacturing and repository operation</strong></td>
<td>Confirmation studies on components under site conditions incl. monitoring</td>
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<tr>
<td></td>
<td>- Full-scale prototypes constructed; industrial scheme developed</td>
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<tr>
<td></td>
<td>- Construction of main underground facilities; confirmation of rock properties for final design</td>
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<tr>
<td></td>
<td>- Full-scale production and operation</td>
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<tr>
<td></td>
<td>- Construction, confirmation, monitoring</td>
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</table>
The path to implementation of geological disposal and its RD&D tasks

<table>
<thead>
<tr>
<th>STAGES</th>
<th>Generic Studies</th>
<th>Selection</th>
<th>Development</th>
<th>Demonstration</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Conceptual Engineering</td>
<td>Host Rock &amp; Site</td>
<td>Components Engineering</td>
<td>Components Testing</td>
<td>Industrial Scale Manufacturing</td>
</tr>
<tr>
<td>Repository</td>
<td>Conceptual Design</td>
<td></td>
<td>Repository Design</td>
<td>Repository Construction</td>
<td>Repository Operation</td>
</tr>
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</table>

Safety Strategy & Methodology

Long-term Safety: scientific/technical basis

Facility & component design

Site related characteristics

Application of methodology in safety case

- In situ experiments
- Confirmation studies under site conditions
- Full-scale production & operation
- Construction Confirmation Monitoring

Basically done for reaching the Vision in 2025

IGD-TP

European Commission

EURATOM
Grounds for uncertainties in geological waste disposal

- There are no “standards” for geological disposal systems!
- Long time-frames are a source of uncertainties!
  (Elements of aleatory and epistemic uncertainties)
- Safety criteria reflect today’s understanding of the repository system!
- PA models deal with probabilities (high, moderate, low)
- Material properties have to match short-, medium- and long-term requirements
- Technical components are designed to engineering standards
- Coupled effects with short-, medium-, long-term consequences
Ways and means to reduce uncertainties

• Criteria based site selection
• Thorough site investigation & characterization
• Adaptation of disposal concept to site conditions
• Experiments on safety related issues
• Investigation of processes relevant to repository performance
• Demonstration of disposal techniques
• Natural analogue studies
• Repository system’s performance analysis
• Scenario based safety assessment studies
Handling of uncertainties in view of implementing geological disposal
(Starting point for detailed discussions on remaining uncertainties)

<table>
<thead>
<tr>
<th>Nature of uncertainty</th>
<th>Scientific and technical basics</th>
<th>Facility component design</th>
<th>Site related properties</th>
<th>Suitability of repository and site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borders of knowledge</td>
<td>Readiness “gap”</td>
<td>Knowledge “gap”</td>
<td>Confidence “gap”</td>
<td></td>
</tr>
<tr>
<td>Underlying research</td>
<td>Adaptation of technologies to site conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practical experience &amp; analogues</td>
<td>Testing &amp; demonstration</td>
<td>Safety case development</td>
<td>Qualification of site &amp; repository design</td>
<td></td>
</tr>
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</table>

Type of work
- Underlying research
- Data synthesis & evaluation
- Site modelling
- Site selection & disposal system development

Work needed
- Practical experience & analogues
- Safety case development
- Qualification of site & repository design
## Addressing of “uncertainties” in the planning & performance of comprehensive RD&D programs

<table>
<thead>
<tr>
<th>Nature of uncertainties</th>
<th>Scientific basis</th>
<th>Technical components</th>
<th>Site properties</th>
<th>Safety case development</th>
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</thead>
<tbody>
<tr>
<td>“Borders” of knowledge</td>
<td>Readiness “gap”</td>
<td>Knowledge “gap”</td>
<td></td>
<td>Level of “total” uncertainty arising from scientific-technical fields &amp; site condition</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of work needed for reducing uncertainties</th>
<th>Scientific basis</th>
<th>Technical components</th>
<th>Site properties</th>
<th>Safety case development</th>
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</thead>
<tbody>
<tr>
<td>Verification of theories and models</td>
<td>- Development of components &amp; technologies in view of safety and licensing requirements</td>
<td>- Compilation of site data &amp; site models</td>
<td>- Compilation &amp; evaluation of all safety relevant data</td>
<td></td>
</tr>
<tr>
<td>Hypothesis testing</td>
<td>- Testing under site conditions</td>
<td>- Synthesis &amp; evaluation of all findings</td>
<td>- Scenario analysis</td>
<td></td>
</tr>
<tr>
<td>Analogue studies</td>
<td>- Adaptation of disposal concepts to site conditions</td>
<td>- Adaptation of disposal concepts to site conditions</td>
<td>- Sensitivity analysis &amp; performance assessment models</td>
<td></td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Vision related aims</th>
<th>Scientific basis</th>
<th>Technical components</th>
<th>Site properties</th>
<th>Safety case development</th>
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<tr>
<td>Update of the state-of-the-art in the main R&amp;D areas</td>
<td>Demonstration of functioning with respect to industrial scale operation</td>
<td>In-depth site performance &amp; site evolution understanding</td>
<td>Definition of safety potential &amp; margins</td>
<td></td>
</tr>
<tr>
<td>Input to RD&amp;D work for further reduction of uncertainties</td>
<td></td>
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## Vision related aims

- Update of the state-of-the-art in the main R&D areas
- Definition of safety potential & margins
- Input to RD&D work for further reduction of uncertainties

## Type of work needed for reducing uncertainties

- Verification of theories and models
- Hypothesis testing
- Analogue studies

## Vision related aims

- Update of the state-of-the-art in the main R&D areas
- Demonstration of functioning with respect to industrial scale operation
- In-depth site performance & site evolution understanding
- Definition of safety potential & margins

## Nature of uncertainties

- “Borders” of knowledge
The handling of “uncertainties” in the scope of an advanced RD&D program

<table>
<thead>
<tr>
<th>Main uncertainties</th>
<th>Scientific basics</th>
<th>Technical feasibility</th>
<th>Site properties</th>
<th>Safety case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borders of knowledge not defined</td>
<td>Engineering standards for limited time frame</td>
<td>- Heterogeneity of geologic formations - Future evolution</td>
<td>Framing of uncertainties &amp; scenarios</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activities in progress</th>
<th>- Hypothesis testing - Works on models &amp; analogues</th>
<th>Large scale in situ tests &amp; demonstration</th>
<th>- Site survey &amp; data compilation - Data synthesis &amp; evaluation - Site modelling</th>
<th>- Sensitivity analysis - Performance assessment models</th>
</tr>
</thead>
</table>

| Current status regarding licensing by 2025 | Sufficient basis exists for safety case & repository design | Testing in URLs in progress | Sufficient knowledge exists for safety case & repository design | - Sufficient safety potential & safety margins - Further reducing of uncertainties |

| Vision related aims | Underpinning the robustness of theories and models | Establishing safe disposal technologies on industrial level | Increase of confidence in long-term safety |
Key elements of the prioritization process

• Acknowledgement of the state-of-the-art
• Systematic approach in the identification of
  - RD&D issues
  - key topics of common interest
• Stepwise procedure in the prioritization of
topics (importance, urgency)
• Transparency and traceability of procedure
• Monitoring of decisions
• Monitoring of stakeholders concern / advice
Structure of the **Prioritization Process**

1) Checking of WMOs programs for their specific RD&D issues and **compilation of the issues** important to WMOs

2) Overall **classification of main areas of issues** in view of their importance to Vision 2025

3) Detailed analysis of major trends in RD&D with **identification of common interests and common needs**
   *(Brussels seminar: check up and input from stakeholders)*

4) Definition of key topics and **prioritisation of topics** for vision related strategic RD&D
   *(Paris exchange forum: consultation of participants, information of stakeholders)*

5) **Finalization** of the **Strategic Research Agenda**, followed by the development of the deployment plan
Key Topics – the basis of the SRA

- Safety case
- Waste forms and their behaviour
- Technical feasibility and long-term performance of repository components
- Development strategy of the repository
- Safety of construction and operations
- Monitoring
- Governance and stakeholder involvement
Importance for receiving a license:
- low
- medium
- high

Urgency:
- #1 until operation starts
- #2 as soon as possible
- #3 after start of operation
- #4 before licensing starts

Key Topic: ______
Topic #: 1, 2, 3, 4, ……
Cross-cutting issues are important - relevant to every program, at any stage -

- Dialogue with regulators,
- Competence maintenance,
- Education and training,
- Knowledge management (incl. information preservation, memory keeping),
- Communication and other activities supporting information exchange.