

The Role of URLs in the Repository Implementation Phase

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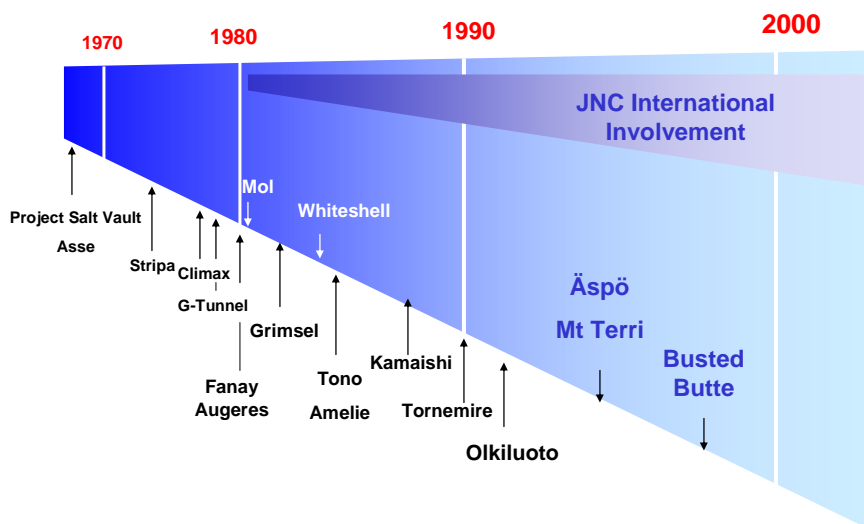
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URLs....a long history



Content

- **Types of URL and types of URL activity: definitions**
- **Stages of a Repository Development Programme (RDP)**
- **What type of work is done in URLs at each stage of an RDP?**
- **Do we still need generic experimentation?**
- **URLs to demonstrate knowledge, technology and feasibility**
- **How URLs help to build confidence and propagate expertise**
- **URLs in the Japanese HLW programme**

Types of URL and types of URL activity: definitions

Types of URL

(OECD-NEA definitions)

- **GENERIC: at locations that will not be used for a repository**
 - ◆ in extensions to existing mines or tunnels (Stripa, Grimsel)
 - ◆ purpose built generic (PBG-URL) at a previously undeveloped site (Whiteshell, Äspö)
 - ◆ this sub-division is purely a matter of convenience of availability and access: it is not usually technically driven
- **SITE-SPECIFIC: at sites intended for development as repositories**
 - ◆ SS-URL (proposed UK Sellafield RCF; various 'pilot' and 'test' facilities)
 - ◆ eventually, all programmes are likely to need a SS-URL

Types of URL Activity - 1

- **Experimentation**
 - ◆ investigate processes that affect repository evolution (e.g. water, heat and gas transport)
 - ◆ develop and test models for these processes
 - ◆ aimed at a particular geological environment and rock type
 - ◆ has been carried out in generic URLs and is generally experimental R&D

Types of URL Activity - 2

➤ Rock Characterisation

- ◆ develop, test and deploy rock and groundwater characterisation **techniques** and **strategies**
 - development at **generic URLs**
 - characterise a **specific rock formation & geological environment** at a potential repository site: **site-specific URLs** (rock characterisation facilities: RCFs)
- ◆ underground investigations used to extend surface investigations, to gather data for design & SA of
 - conceptual repository (generic URLs)
 - actual repository (site-specific URLs, RCFs)

Types of URL Activity - 3

➤ Test and Demonstration (T&D)

- ◆ develop, test and demonstrate engineering aspects of repository operation, including:
 - excavation
 - EBS and waste emplacement (and retrieval)
 - closure and sealing
 - monitoring.
- ◆ carried out in either generic or site-specific URLs:
 - some programmes refer to a site-specific URL intended for T&D as a **Pilot, or Demonstration and Validation Facility**.

Stages of a Repository Development Programme (RDP)

RDP Phases

- **Early Stage:** generic concept development & exploration of alternative designs & rock formations
- **Middle Stage:** reference concepts identified in reasonable detail (alternatives still considered for optimisation), site selection process underway
- **Late Stage:** 1(++) sites identified, work taking place on them, final design(s) being optimised in detail
- **Operational Stage:** repository operating, waste being emplaced

What type of work is done in URLs at each stage of an RDP?

1. The Implementor's View

Experimentation

Generic URL	Site-Specific URL
Early Stage <ul style="list-style-type: none"> • explore key issues in design and safety (e.g. heat transfer, controls on EDZ, solute and colloid transport) • Almost an historical usage • Still a number of important generic issues being explored (e.g. gas movement) 	Early Stage
Middle to late stages <ul style="list-style-type: none"> • Resolve outstanding (long-standing problem) issues, • Resolve issues arising during mature generic studies • Very long experiments to gather decade-long data sets that will be used as validation during repository licensing 	Middle stage
	Late Stage <ul style="list-style-type: none"> • verify generic models under actual site conditions • populate models with real data, thereby reducing range of uncertainty
Operational Stage	Operational Stage

Rock Characterisation

Generic URL	Site-Specific URL
Early to Middle Stages <ul style="list-style-type: none"> develop underground site investigation techniques (e.g. fluid sampling, pilot drilling, remote sensing of major features ahead of excavation, patterns of water movement) test and develop models for rock physical and chemical properties 	Early Stage Middle stage
Late Stage	Late Stage <ul style="list-style-type: none"> measure distribution & variability of actual rock properties in and around potential repository volume link underground observations (generally more extensive and simpler) with those from surface investigations (generally more limited) spearhead what will eventually be a system-wide monitoring system
Operational Stage	Operational Stage

Test & Demonstration

Generic URL	Site-Specific URL
Early Stage	Early Stage
Middle to Late Stages <ul style="list-style-type: none"> develop and test engineering aspects of repository implementation (excavation, emplacement, sealing, monitoring, retrieval, QA): both techniques and machinery 	Middle stage
Late Stage <ul style="list-style-type: none"> long-term (decades) demonstration projects when technology has been largely decided upon could be 'fully active', using real waste packages, retrieved at end of demonstration – few programmes care to surmount political and regulatory problems of doing this at a non-repository location 	Late Stage (actual site) <ul style="list-style-type: none"> Pilot Facility: demonstrate how activities will be carried out, possibly before repository is constructed (e.g. in support of a construction or operation license) If no generic T&D facility has been available, some engineering testing and development may be needed first. Pilot Facility: show complete emplacement (and backfilling or retrieval) before full scale disposal commences
Operational Stage	Operational Stage <ul style="list-style-type: none"> demonstrate sealing and post-closure monitoring technology

What type of work is done in URLs at each stage of an RDP?

2. The Regulator's View

Regulatory Requirements from URLs

- Regulators need to build up parallel knowledge so they can understand the implementor
- should have **no** influence on early/middle RDP stages
- some national regulations **require** implementor to use URLs in late, site specific stage (RCF)
- might require some T&D work as part of licensing:
 - ◆ late stage: emplacement & retrieval before operating license
 - ◆ operational stage: seal emplacement & repository monitoring technology, before closure license
 - ◆ both point to a pilot facility with long period of observations

What type of work is done in URLs at each stage of an RDP?

3. Common Benefits

Public Demonstration Capability of URLs

- **most people are not familiar with the underground**
- **demonstrate the method and technology of geological disposal**
- **in earliest stages: show people what deep rock is like and show how science is being used to aid design and assess safety**
- **from middle stage onwards: developed concepts can be shown at increasing scale**

Do we still need generic experimentation?

Yes....but must be highly focussed

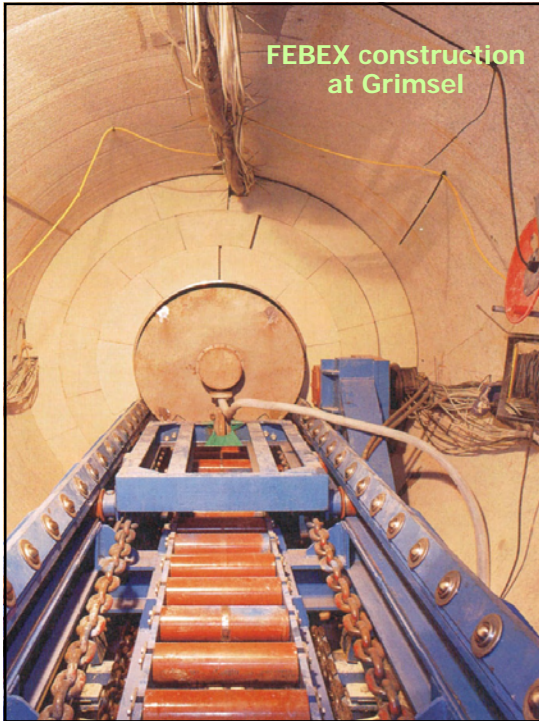
- **Most of what is needed for generic design and PA has already been gathered from URLs**
- **URLs have successfully tested and validated theories on groundwater flow, solute transport, excavation impacts on rock, etc.**
- **The 'learning period' is largely over (c.f. 1970s)**

What experimentation is still needed?

- **gas** movement through clays and very low conductivity rocks with sparse fracture networks
- time dependent, spatially variable **resaturation of clay buffer** and backfill materials
- medium to long-term function of **EDZ** in transporting water to tunnel and borehole backfills and buffer
- techniques for characterising '**flow-wetted surface**' in fractured rocks
- experimental evidence for efficient **colloid filtration** in fractured rocks
- impact of **high pH plumes** in cement-based repositories on rock properties and radionuclide migration

**URLs to demonstrate
knowledge, technology and
feasibility**

*.....no-one has yet put a HLW
container into a final repository*



Large/Full Scale Demonstrations

Ease of emplacement

Ease of remote handling

Ease of retrieval

Show long-term (decades)
stability of near-field
system

Grimsel VI 'DORT' project

Think in decades!

Äspö: Deposition of first canister in Prototype Repository Project



Äspö: Deposition of first canister in Prototype Repository Project



Technology for trial canister disposal: Asse



Building Confidence & Propagating Expertise

It is not all about resolving technical issues.....

- **Historically, URLs were focal points of team and expertise building in 1980s-90s (Stripa, Whiteshell, Grimsel, Mol.....)**
 - ◆ progressive growth in **confidence** about ability to characterise rock-water systems
- **URL lifetimes ⇨ repository operational lives**
 - ◆ permanent **training** centres for generations of scientists & technologists
 - ◆ diverse, multidisciplinary projects
 - ◆ focus of cutting edge thinking and testing of concepts: **staff exposed to central issues of an RDP**

ITC School, Switzerland

- independent
- close to Grimsel URL and other underground facilities not directly related to waste management
- set up in 2003 via an Association which will control the School
- distance learning via internet
- international network of associated teaching centres



Tono & Horonobe PBG-URLs

- **Develop capability to characterise rock volume and put in regional context (including baseline conditions)**
 - ◆ analogous, at smaller scale, to surface-to-depth repository site investigations (boreholes, shafts, excavation.....)
 - ◆ allow development of investigation strategies and testing of QA programmes before real site use
 - ◆ may go beyond other national programmes: different geology... transfer international experience to local conditions
- **Addressing remaining generic issues**
 - ◆ long lead times mean results take years: think long-term!
- **Team building and training -> confidence to characterise a real site when NUMO has site(s)**

Think long-term.....

- think now about engineering T&D projects at Horonobe, and long-term experiments in both URLs
 - ◆ further characterisation needed before such projects can be fitted to characteristics of Horonobe
- long-term experiments most readily accomplished at MIU, as environment is already reasonably well understood?
- Internationally, much talk but limited movement towards large-scale demonstration projects
- Japan's strong engineering base could take lead: attract other national programmes into shared, long-term, high-profile tests and demonstrations of repository engineering