Underground Hazardous Waste Disposal: Current Trends And Future Prospects

D. Kaliampakos
Professor, National Technical University of Athens, Greece

A. Benardos
Lecturer, National Technical University of Athens, Greece
The thousand phases of the modern underground space
Underground Development:

Underground development is the systematic use of the underground space for activities or infrastructures that are difficult, impossible, environmentally undesirable or even less profitable to be installed above ground.
Hazardous Waste Management: A pressing need

- EU member states generate around 70 million tones of hazardous waste (HW) per year (2007)
- The revenues of the hazardous waste management services is estimated around 6 billion euros (2007)
- There is an increasing demand for hazardous waste management solutions and more importantly for efficient disposal sites
Underground repositories: an interesting alternative

- The geologic medium constitutes an additional barrier which can effectively block the waste’s diffusion to the biosphere.
- The underground structure cannot be affected by severe weather conditions.
- The underground repository is less affected by earthquake loadings than surface structures.
- The underground siting of the repositories can efficiently tackle, to a degree, the NIMBY syndrome.

Underground hazardous waste repositories offer enhanced protection, isolation and security.
Hazardous Waste Disposal: Dealing with the people

- Not In My Back Yard - NIMBY
- Locally Unwanted Land Uses - LULU
- Build Absolutely Nothing Anywhere Near Anything - BANANA
- Citizens Against Virtually Everything - CAVE
- Not On Planet Earth - NOPE
- Not Over There Either - NOTE
European underground hazardous waste repositories

Germany
- Herfa Neurode
- Zielitz
- Heilbronn
- Borth

United Kingdom
- Minosus

France
- Wittelsheim mine
On site disposal:
Disposing the hazardous waste generated by a waste producer or an area, within the boundaries or in the vicinity of the producer’s site/plant
On site disposal: Pros

- Avoidance of waste transportation, minimisation of traffic disturbances, as well as, the transportation cost and the associated risks
- Direct disposal of the waste in the facility, avoiding the interim storage, attaining a safer and more environmental friendly waste management procedure
- The handling and the storage requirements are tailor-made to facilitate the needs of specific wastes
- There is no “export” of the environmental impacts of an activity, which leads in a better handling of NIMBY reactions.
On site disposal: limitations and solutions

Availability of the required area to host such an underground facility within the site’s boundaries

Problematic geological and hydrogeological conditions, in terms of waste containment

Nearby areas can be utilised and even clusters of neighboring waste producers may co-operate together, sharing mutually land and cost

Introduction of robust and efficient technical barriers that will ensure the waste’s long term containment
Lavrion Technological and Cultural Park (LTCP)

- The place is considered to be the “Parthenon” of ancient technology.
- It is also closely connected with the industrial revolution of Greece.
The environmental problem of LTCP

Contaminant                  | As  | Cd  | Pb  | Cr  | Cu  | Mn  | Ni  | Zn  |
---                           |-----|-----|-----|-----|-----|-----|-----|-----|
95% UCL of the mean          | 8,539 | 621 | 47,261 | 249 | 3,253 | 11,980 | 199 | 51,644 |
German trigger values (industrial-commercial sites) | 140 | 60 | 2000 | 1,000 | - | - | 900 | - |
The LTCP case: Rehabilitation project

✓ Almost the entire area has been treated, to an average depth of 4m

✓ 115,000 tons of contaminated soil disposed in a special “dry tomb” landfill structure
The LTCP case: Special wastes

The “Konofagos” building
The LTCP case: Construction of an on-site underground hazardous waste repository to store special hazardous waste
The LTCP underground hazardous waste repository

- UHWR (~2,500 m²)
- Access tunnel (~170 m)
- Shaft (~35 m)

General layout of the LTCP underground repository
The LTCP underground hazardous waste repository

✓ The repository is constructed at the elevation of +12m, within the marble formation, following the room-and-pillar mining method

✓ Patterned square 7m wide pillars support the repository, while the maximum room (span) is 7 m (6m in the side corridors)

✓ The total area of the repository is approximately 2,000 m² with a maximum height of 5.5 m, giving a capacity of 5,000 tn of hazardous waste
Technical barrier systems

1. Steel drums for the storage of the wastes

2. Complete waterproofing of the UWDR

   Sidewalls, roof: *special shotcrete waterproofing additives*
   Floor: *chemical resistant, impermeable industrial flooring*

3. Additional collection and treatment options in case of water infiltration in the repository
Final UHWR layout

Final Storage Layout
(max capacity ~5000 tn)
Gaining public acceptance
Gaining public acceptance
Gaining public acceptance
Gaining public acceptance
Gaining public acceptance
Cost issues: Comparison of the alternatives

Option A:
- Export the wastes to underground hazardous waste repositories found abroad
- Cost: 1,500 € to 3,000 € per tn
- Waste quantity: 5,000 tn
- Total cost: >7,500,000 €

Option B:
- Waste Storage in the developed LTCP UHWR
- Waste quantity: 5,000 tn
- Total cost: ~2,800,000 €
- Cost: ~560 € per tn
Conclusions

✓ The underground storage concept offers a reliable and cost effective long-term solution

✓ Technical barriers can efficiently create impermeable conditions where bedrock permeability is not satisfactory

✓ Even small scale UHW facilities are feasible, if compared to other alternatives

✓ The “on-site” development of underground hazardous waste repositories brings about new opportunities and advantages that should be given the proper attention and consideration, especially in the better handling of NIMBY arguments

✓ The mining technique employed in the LTCP case, the engineered barrier systems and the tailor-cut design of the repository is capable of meeting all requirements set by the special waste type and storage volume
Thank you for your attention!