

TUNNEL INVESTMENTS

Threats and Risks: A Multi-Hazard Approach to Making The Decision

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Content

- ▶ Introduction
- ▶ Review of the types of threats and risks with investments in underground facilities
- ▶ Multi-hazard systems approach to evaluating and managing risks
- ▶ The work ahead

Uses of Underground Space

Three Categories of Critical Facilities/Assets:

A. Operational: government functions; control centers; emergency management

B. Storage: nuclear waste & other chemicals; fuels; food & water; documents/banking; defense materiel

C. Lifelines: Energy and fuels distribution; communications; transportation of people and goods; water and wastewater

For Infrastructure Facilities – Select Owner's Decision Data Points

- ▶ Life-cycle Performance Parameters/Life-cycle Costs
- ▶ Threats from:
 - **Natural Phenomena**
 - System or Facility Failures
 - Accidents
 - **Malevolent Acts/Security Breaches**
 - Marketplace
 - Legislative or Regulatory Change
- ▶ Derive Risk Event Probabilities and Impacts
- ▶ Define Alternative Investments with Necessary Risk Mitigation Strategies....then Choose

Natural Hazards & The Underground

- ▶ Earthquakes – we have good results with well-designed lifelines; concerns and unknowns remain for storage and operations
- ▶ Floods/Adverse Weather Events – controllable risk for lifelines and operations; concerns remain for risk of damage to stored materials
- ▶ Hostile cold weather climate – use of underground space enables controlled artificial climate - highly advantageous for day-to-day activity in urban settings, eg. Canada, Scandinavia, Russia

Security Threats and The Underground

- ▶ For some applications (operational bunkers and select high value/high risk assets, eg. fuel storage) the only viable security solution is deep underground
- ▶ Transport tunnels and other lifelines present both advantages and vulnerabilities
- ▶ For most applications a case-by-case evaluation is necessary; generalized conclusions are not possible
- ▶ Note also that the network of underground lifelines in urban areas can create additional security vulnerabilities for both the lifelines and those facilities they connect, for which creative mitigation measures are needed

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Risk Management

- ▶ Handles the results of vulnerability assessments for new and existing facilities
- ▶ Brings the security risks of which we have new awareness into the traditional risk management decision-making framework
- ▶ Uses the best of asset management (systems) approach to optimize decisions

Security Risk Management

- ▶ Characterize malevolence
 -bombs.....tograffiti
 -terrorists....to...disgruntled employee
- ▶ For each risk event – what happens if?
 - identify and describe the impacts on performance and cost
- ▶ For each risk event – how likely?
 - assign probability
 - this is the most difficult challenge and may not even be feasible. Alternative: seek overlapping risks to justify mitigation investments

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Making the Decisions: The Systems Approach

- ▶ Define alternatives, including the risk management elements
- ▶ Focus on performance/reliability/availability
- ▶ Model whole life costs
- ▶ Consider:
 - flexibility of capacity – adapt to fluctuating demand
 - ease of recovery from failure or attack
 - minimizing disruption with planned renewal activity
- ▶ Multi-hazard; multi-disciplinary – systems approach

Life-cycle Cost Effectiveness in Use of The Underground: More Research

- ▶ For select storage and operational bunker applications it has been demonstrated that the underground provides clearly the highest and best cost-effectiveness
- ▶ For lifelines, especially long-distance ones (eg. oil and gas pipelines), and for the urban underground utilidor, there is more work to be done
- ▶ Clearly aesthetic parameters (part of the qualitative performance definition) can also be drivers (eg. visitor center at US Capitol)

Conclusions

- ▶ Use of underground space for infrastructure and other facilities will continue to grow
- ▶ For most of the applications, multi-hazard risk evaluation will be a key element of decision-making
- ▶ For most of the applications there is little current precedent or body of knowledge to lean on
- ▶ Need to accumulate this body of knowledge so that it is appropriately accessible