ITA - AITES WORLD TUNNEL CONGRESS 2007 PRAGUE

The 3rd Training course
TUNNELLING IN URBAN AREA
Prague, 4-5th May 2007

Risk Management

TRAINING MATERIAL PREPARED BY

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Director of Jacobs, UK
& ITA Vice President

ASSOCIATION INTERNATIONALE DES TRAVAUX EN SOUTERRAIN
AITES

ITA
INTERNATIONAL TUNNELLING ASSOCIATION

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Introduction

- Why we need proactive Management of Risks
- Recent tunnelling failures
- What is ITA doing about this?
- ITA Working Groups
- Summary of relevant Risk Codes

Introduction

All parties have a role to play in Safety and Risk Management

- Client
  - Designers
  - Coordinator for H&S
  - Contractors
  - TBM Manufacturers
  - Workforce
  - Professional Organisations
  - Regulators and Standards makers
  - Insurers

Introduction

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- What you do affects peoples lives
- Affects costs + programme
- Affects the public
- Affects the perception of our industry
- Your decisions matter!!!

Introduction

- Qualitative Risk Analysis
- Quantitive Risk Analysis
- Management of Risk

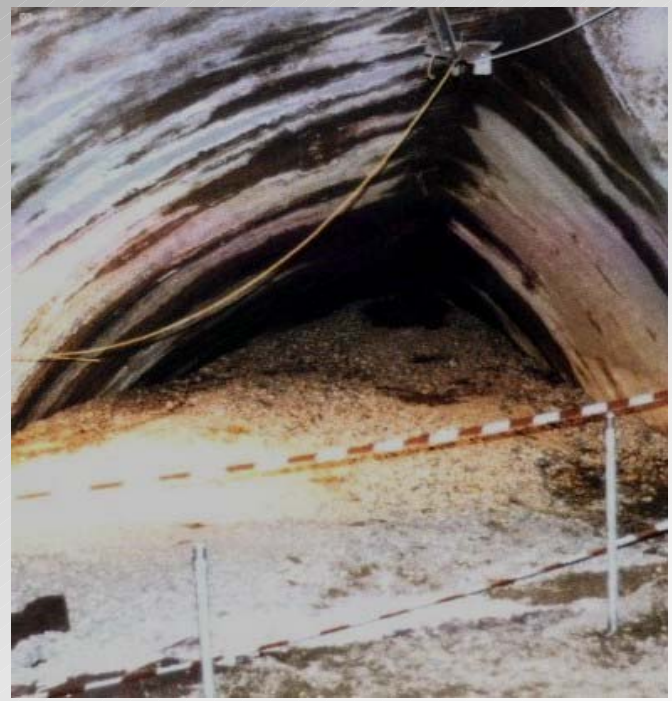
Introduction

- Significant number of tunnel claims
- Increasing trend
- Insurance difficult to get for Tunnel Projects
- Damage to Tunnel Industry

Chapter 2

Nicoll Highway – Singapore 2004

Chapter 1



Munich Metro – (Germany) 1994

Chapter 1

Taegu Metro (South Korea) 2000

Chapter 1

SOCATOP Road Tunnel A86 (France) 2002

Chapter 1

Shanghai Metro (China) 2003

Chapter 1

Chapter 2

- Action by British Tunnelling Society
- Discussions with British Insurers
- Some Insurers abandoning Tunnel Market
- Need to promote proactive Risk Management techniques
- British Code of Practice published 2003

Chapter 2

- International Tunnel Insurance
- International Tunnel Insurers Group (ITIG)
- Drafts submitted to ITA 2004
- ITIG wanted ITA support
- WG2 had commenced work early in 2000

Chapter 2

- ITA Task Force
- Set up Post WTC 2004 – led by Martin Knights
- Comments from member nations and Working Groups
- Meetings between ITIG and ITA
- Agreement by December 2005

Action by ITA

Chapter 2

- How serious was the threat to the tunnel industry?
- Definition of words “Code” or “Robust”
- Compatibility with National Standards/Regulations
- Compulsory use of code?
- Support of ITA
- Ensure principles of Risk Management are followed
- “Model” code
- Is the BTS code too prescriptive?

Chapter 2

- ITIG Code published 2006
- ITA support acknowledged by ITIG
- Ongoing dialogue with ITIG
- ITIG Code feedback and revision
- Framework for agreement between parties
- ``Living Document``

Chapter3

- ITA Guideline WG2 “Managing Risks” – Soren Degn Ekesen & Eric Leca
- ITA Guideline WG3 “Contractual Practices” – Arnold Dix & Martin Smith
- ITA Guideline WG5 “Safety” – Donald Lamont

Korean Risk Management – Woong- Suk Yoo

- Insurers Perspective (ITIG) – Heiko Wannick
- Good debate!
- (*Most of these speakers are attending WTC 2007)*

Chapter 3


Introduced by
Eric Leca, EGIS SA
Animateur of WG2
Reported by:
Søren Degn Eskesen, COWI A/S

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Scope and Purpose

- To present a guideline
- for designers to prepare comprehensive tunnelling risk assessment
- To indicate to owners what is accepted industry practice for construction risk analysis
- Does not include guidelines for contractor's risk management
- Published in ``TUST``

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incorporating Trenchless Technology Research

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ITA/AITES Accredited Material

Guidelines for tunnelling risk management: International Tunnelling Association, Working Group No. 2 ☆

Søren Degn Eskesen, Per Tengborg, Jørgen Kampmann, Trine Holst Veicherts

ITA Working Group 2, Research, ITA-AITES, c/o EPFL, Bat GC, CH 1015 Lausanne, Switzerland

Abstract

These guidelines, prepared by Working Group 2 (Research) of the International Tunnelling Association, are prepared in order to give guidance to all those who have the job of preparing the overall scheme for the identification and management of risks in tunnelling and underground projects. The guidelines provide owners and consultants with what is modern-day industry practice for risk assessment, and describes the stages of risk management throughout the entire project implementation from concept to start of operation.

Preface

Front page articles in the news on spectacular tunnel collapses during the 1990s focused the public and in particular potential tunnel owners' attention on the inherent risk associated with underground construction works. As a result, risk management became an integral part of most underground construction projects during the late 1990s. However, from discussions in international forums, it became clear that handling and management of risks were performed in many different ways, some more concise than others. Out of the discussions came the idea of establishing international guidelines on tunnelling risk management.

Work on these guidelines began at the meeting of ITA Working group 2 "Research" in Oslo in June 1999. After much study, discussions and investigations, the guidelines were completed in April 2003.

These guidelines consider that present risk management processes can be significantly improved by using systematic risk management techniques throughout the tunnel project development. By the use of these techniques, potential problems can be clearly identified such that appropriate risk mitigation measures can be implemented in a timely manner.

The guidelines show how risk management may be utilised throughout the phases of a project implementation:

1. Early Design Phase
2. Tendering and Contract Negotiation Phase
3. Construction Phase

The guidelines also contain some typical components of risk management and a short introduction to general risk management tools as well as a glossary of risk terms. Finally, an example of how risk management was carried out for the Copenhagen Metro following principles similar to those presented in the guidelines is included as an appendix.

The practice of performing risk management requires much experience, practical and theoretical knowledge. It is, therefore, not expected that these guidelines will cover every aspects of tunnelling risk management, but it is

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Guideline for Tunnelling Risk Assessment

Chapter 3

Contents

Risk definitions

- Hazard:
  A situation or condition that has the potential for unwanted consequences:
  - Human injury
  - Damage to property
  - Damage to environment
  - Economic loss
  - Delay to project completion

- Risk:
  A combination of the frequency of occurrence of a defined hazard and the consequences of the occurrence

List of hazards

General hazards:

1. Contractual disputes
2. insolvency and institutional problems,
3. authorities interference,
4. third party interference,
5. labour disputes

Specific hazards:

6. Accidental occurrences,
7. unforeseen adverse conditions,
8. inadequate designs, specifications and programmes,
9. failure of major equipment, and
10. substandard, slow or out of tolerance works.

Chapter 3

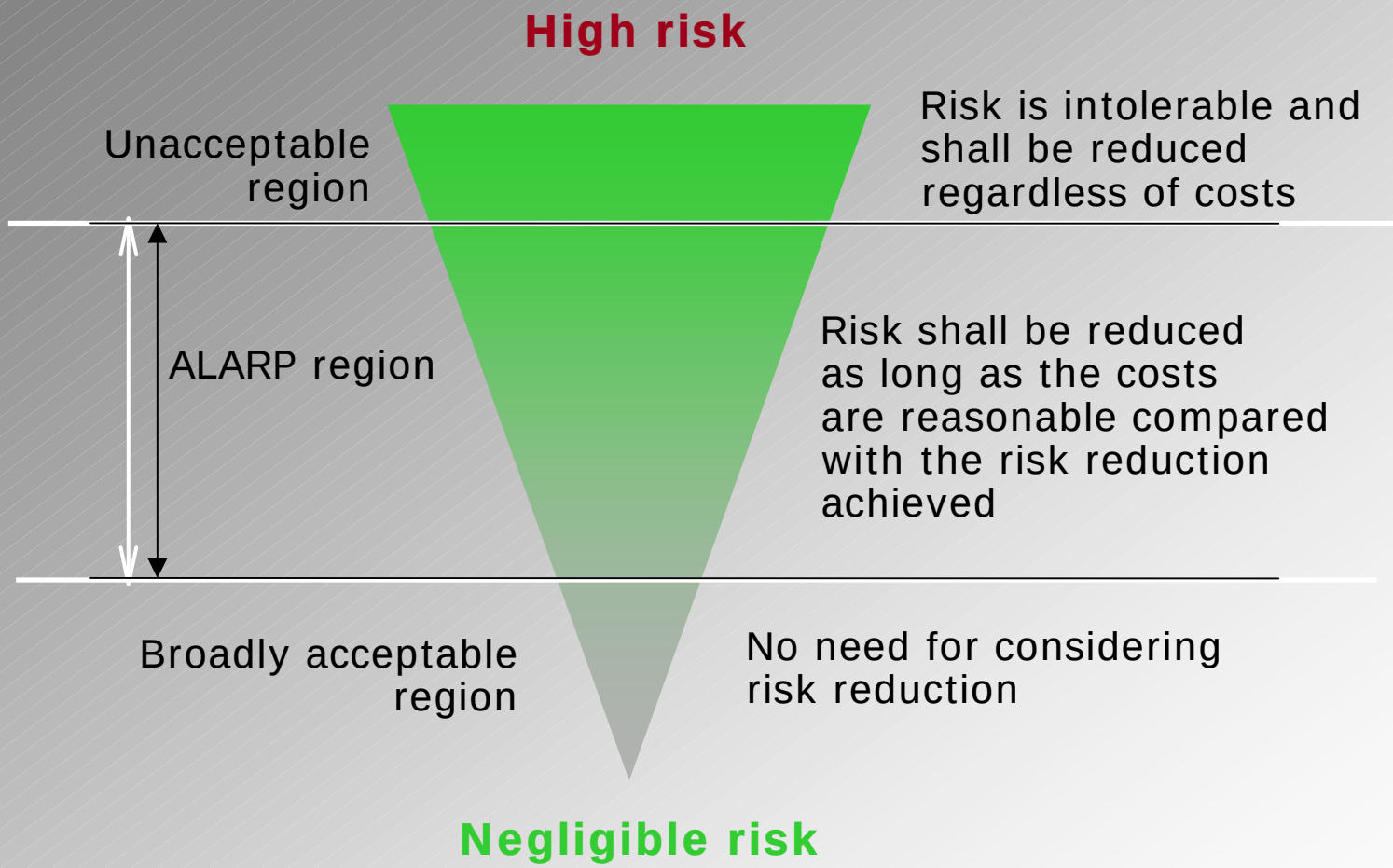
Risk analysis

- Risk analysis: a structured process which identifies both the probability and extent of adverse consequences arising from a given activity.
- Risk analysis includes identification of hazards and description of risks, i.e. probabilities and consequences (qualitative or quantitative)

Risk acceptance criteria

- Common sense: aim at reducing risk once identified
- More formal criteria:
  - The risk shall be below a certain value
  - Cost benefit type criteria / ALARP (As Low As Reasonable Practicable - Developed in UK and widely used)

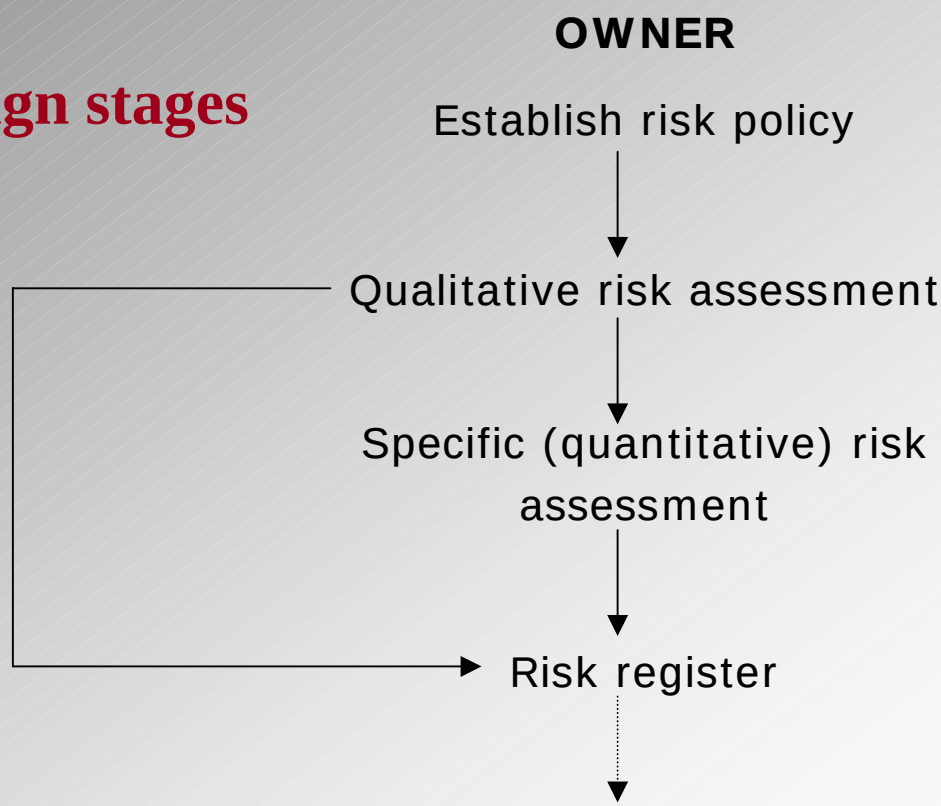
Risk Management


High risk
Unacceptable region
Risk is intolerable and shall be reduced regardless of costs
ALARP region
Risk shall be reduced as long as the costs are reasonable compared with the risk reduction achieved
Broadly acceptable region
No need for considering risk reduction
Negligible risk

Chapter 3

Risk management activity flow

Phase I: Early design stages



Risk management activity flow
Phase II: Tendering and contract negotiation

Preparation of tender documents, including:

- Description of significant technical risks
- Technical requirements to mitigate risk
- Description of required risk competence

CONTRACTOR

Preparation of tender, including:

- Proposed risk management system
- Description of experience and competence in risk management
- Identification and description of risks associated with the proposed technical solution
- Identification and description of proposed risk mitigation measures

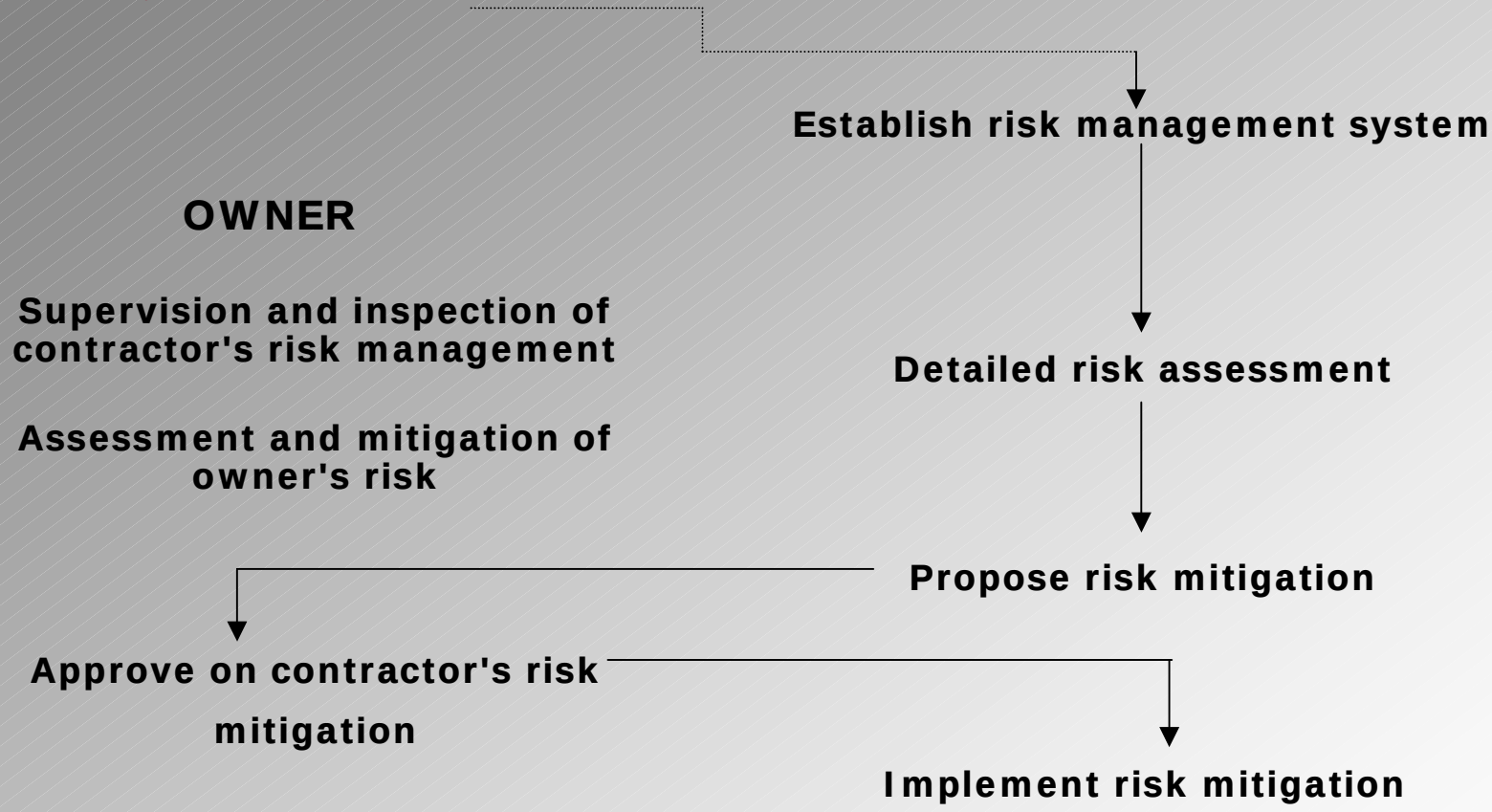
Selection of contractor, evaluation of

- Contractor's ability to perform risk management
- Risks involved in contractor's proposed technical solutions

Prepare contract with risk clauses

1 2 3 4 5

Risk management activity flow
Phase III: Construction



Chapter 3

Risk Management Strategy

The risk strategy should provide:

- a definition of the risk management responsibilities of the various parties involved (different departments within the owner's organisation, consultants, contractors)
- a short description of the activities to be carried out at different stages of the project in order to achieve the objectives
- a definition of methods to be used for follow-up on results obtained through the risk management activities. This could be accomplished by establishing a risk register of some form.

Qualitative risk assessment

- Hazard identification through brainstorming sessions with risk screening teams.
- Classification of the frequency, consequence and risk levels of the identified hazards.
- Identification of risk reduction measures.
- Documentation of risk management work in risk register.
- Simple tools for Classification

Chapter 3

Assessment of Scenario Frequencies

Frequency of occurrence in the construction period

Descriptive frequency class	Frequency class	Central value	Frequency Interval
Very likely	5	1	> 0.3
Likely	4	0.1	0.03 – 0.3
Occasional	3	0.01	0.003 – 0.03
Unlikely	2	0.001	0.0003 – 0.003
Very unlikely	1	0.0001	< 0.0003

Chapter 3

Consequence classes

	Disastrous	Severe	Serious	Considerable	Insignificant
Injury to workers and emergency crew (No. of fatalities / Injuries*)	> 30 F	3<F<30	1-3 F 3-30 I	1-3 SI 3-30 MI	< 3 MI
Injury to third party persons (No. of fatalities / Injuries*)	> 3 F	1-3 F 3-30 I	1-3 SI 3-30 MI	< 3 MI	-
Economic loss to third party (mio. Euro)	> 3	0.3 to 3	0.03 to 0.3	0.003 to 0.03	<0.003
Economic loss to owner (mio. Euro)	> 30	3 to 30	0.3 to 3	0.03 to 0.3	<0.03
Delay in construction (per hazard)	> 2years	½-2 years	2-6 months	½-2 months	< 2 weeks
Harm to the environment	Permanent severe damage	Permanent minor damage	Longterm effects	Impermanent severe damage	Impermanent minor damage

*F=fatality, SI=serious injury, MI=minor injury.

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Hazard Ranking / Risk Classification

Risk Matrix		Consequence				
		Disastrous	**Severe**	**Serious**	**Considerable**	**Insignificant**
Frequency		**5**	**4**	**3**	**2**	**1**
Very likely	**5**	Unacceptable	Unacceptable	Unacceptable	Unwanted	Unwanted
Likely	**4**	Unacceptable	Unacceptable	Unwanted	Unwanted	Acceptable
Occasional	**3**	Unacceptable	Unwanted	Unwanted	Acceptable	Acceptable
Unlikely	**2**	Unwanted	Unwanted	Acceptable	Acceptable	Negligible
Very unlikely	**1**	Unwanted	Acceptable	Acceptable	Negligible	Negligible

1 2 3 4 5

Risk Classification

Risk Classification	Example of actions to be applied against each class
Unacceptable	**The risk shall be reduced at least to Unwanted regardless of the costs of risk mitigation**
Unwanted	**Risk mitigation measures shall be identified. The measures shall be implemented as long as the costs of the measures are not disproportional with the risk reduction obtained (ALARP principle, *as low as reasonably practicable*)**
Acceptable	**The hazard shall be managed throughout the project. Consideration of risk mitigation is not required**
Negligible	**No further consideration of the hazard is needed**

Quantitative risk assessment (example)

- Identify and select risks to be quantified.
- Assign most likely, minimum and maximum figure for each frequency and consequence.
- Calculate the resulting risk estimate as a probability distribution (instead of a single figure) allowing presentation of e.g. 50%, 75% and 95% fractals for the risk.
- Quantification is most suitable for estimation of the risk of economic loss to the owner and delay, but may in principle be used for all types of risk.

RISK MANAGEMENT IN TUNNELLING
A systematic framework for the contractual apportionment of construction risk.

WG3 Contractual Practices

Arnold Dix
Adj. Prof of Engineering QUT, Barrister at Law
BSc (Hons). Aust Asia Fire Eng.

Martin Smith
BSc MICE CEng. SIA Dipl.Baumeister

Chapter 3

- Contracts are the fundamental mechanism for Financial Risk Management *in every country* in the world.
- Effective delivery of underground construction projects demands sophisticated contracts to manage the special risks of underground projects.
- ITA has always recognised the critical importance of contractual provisions – and has developed 25 key contractual propositions in WG3 Guidelines

Chapter 3

ITA Risk Framework: *few very important key issues from WG3*

1 Incorporating past experience:
– professional development and fit for purpose QA cycle

2 Awareness of risk certainty factors:
- appropriate staging of development to reduce risk exposure

3 Standardisation of classification of issues:
- to assist evaluation of issues

4 Awareness of different forms of contract:
- appropriate form depending on client circumstances

5 Creating a model framework:
- providing flexibility to analyse information from different sources

6 Awareness of different legal systems and procedures:
- conformity with local law and custom

7 Awareness of different methods of construction:
- appropriate technology depending on local circumstances

8 Awareness of different methods of payment:
- appropriate technology depending on financial circumstances

Chapter 3

Donald R Lamont C.Eng.,FICE.
Animateur

ITA WG5 - Health & Safety in Works

Chapter 3

All parties have a role to play in safety and risk management

- Client
- Designers
- Coordinator for H&S
- Contractors
- TBM Manufacturers
- Workforce
- Professional Organisations
- Regulators and Standards makers
- Insurers

Korean Risk Management Practices : a Contractor's Perspective

Woong-Suk Yoo
President, SK E&C
Korea

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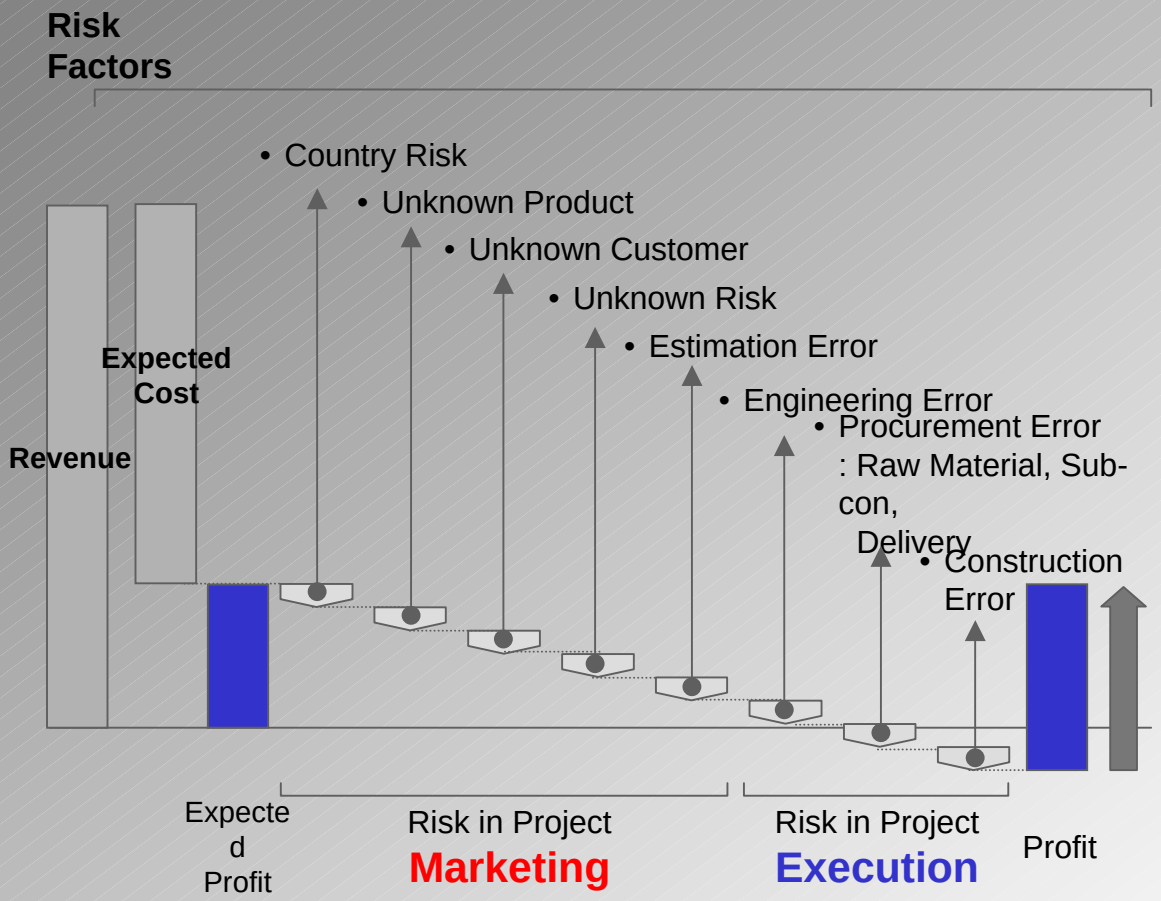
RM = PM



- **Project Selection based on Risk & Impact Analysis**
- **Risk Hedge Planning**
- **Preventing Risk**
- **Contingency Plan**

Risk Management is Project Management

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•Marketing Phase			•Operation Phase		
•Gate 1 •Proposal Project selection	**•Gate 2** •Proposal development	**•Gate 3** •Contract Negotiation	**•Gate 4** •Project Preparation	**•Gate 5** •Project Execution	**•Gate 6** •Project review
Main Activity					
• Advance Risk Finding • Decide Bid or Not	• Feasibility Evaluation • Bid Price Decision	• Nego. Strategy for Risk Hedging Strategy	• Project Execution Planning	• Gap Analysis in Progress • Risk Control	• Project Performance Evaluation • Lessons Learned Reporting

- Selection of Better Project(Go/Drop)
- Assurance of Sufficient Profit considering Risk
- Marketing Cost Reduction by Avoidance of Imprudent Participation

- Successful PJT for Profit Management
- Minimization of Opportunity Expenses through Prepared Risk Response
- Update Know-How by Experience

Chapter 3

Münchener Rück
Munich Re Group

The Code of Practice for Risk Management of Tunnel Works

Future Tunnelling Insurance from the Insurers' Point of View

ITA Conference Seoul, April 25, 2006

Guideline for Tunnelling Risk Assessment

Chapter 3

- Trend towards design + build contracts
- One-sided contract conditions
- High risk type construction methods
- Tight construction schedules
- Low financial budgets
- Fierce competition in construction industries

Chapter 3

- High frequency of major tunnel losses
- Insufficient premium income to pay for all the losses
- Wide scope of cover indemnifies far beyond repair costs
- Repair costs exceeding original construction costs
- Insurance was “cheapest risk management tool”
- Tunnelling insurance notoriously unprofitable business

Chapter 3

The International Tunnelling Insurance Group

The International Association of Engineering Insurers

Current Codes on Risk

Summary of requirements of BTS/ITIG "Codes"

Prepared by Dr. T Mellors

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The Framework

The Code is based on a 'project stage' basis rather than a task basis with four identified stages –

1) The Project Development Stage which includes:

- project feasibility studies;
- site and ground investigations;
- assessment and evaluation of project options and the identification of a preferred project option and Form of Contract for construction (for example design and construct or design-construct);
- project design studies appropriate to the Form of Contract for construction

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The Framework

2) the Construction Contract Procurement Stage which includes:

- the preparation and issue of adequate contract documentation for issue for tendering purposes;
- the selection or pre-qualification of contractors for tendering;
- tender assessment.
- preparation of Ground Reference Conditions by the clien or the contractor

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The Framework

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3) **the Design Stage** or Stages which include –

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- Design Stage Risk Assessments
- Design Checks to appropriate level of risk
- Risk of failure to be extremely remote
- Design to be constructable

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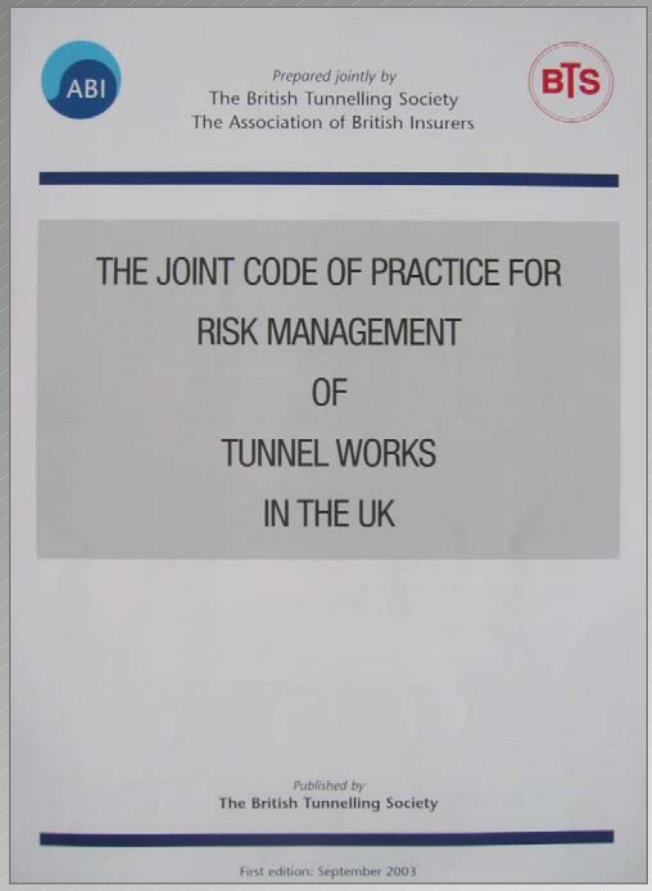
The Framework

4) the Construction Stage

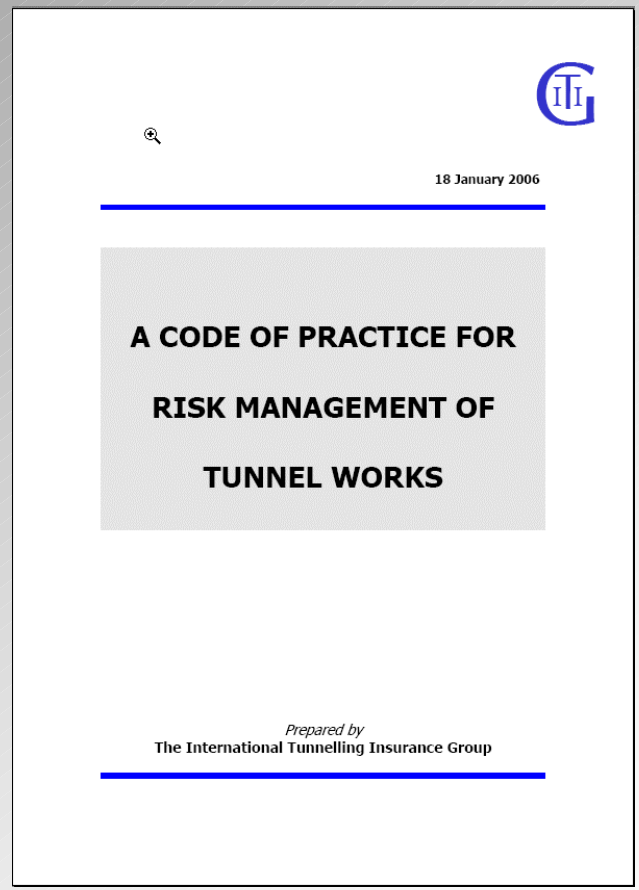
- Management systems, including Risk Management Plan
- Project Risk Register
- Procedures for Value Engineering and Changes in design or risk
- Design Checks to appropriate level of risk

(The Code excludes the operational performance of tunnels and underground structures other than that included within any stipulated maintenance period.)

Code of Practice



www.britishtunnelling.org



www.imia.com

BTS + ITIG Codes

Contributions

- Eric Leca
- Soren Degn Eskesen
- Arnold Dix
- Martin Smith
- Donald Lamout
- Woong-Suk Yoo
- Keiko Wannick
- Michael Spencer

- Dr. Terry Mellors
- Dr. Harvey Parker
- ITIG
- BTS
- ITA Task Force
- Sir Alan Muir-Wood
- Harald Wagner

Thank You

The Guys who provided all the data and did all the work!!