PROGRESS IN RISK ASSESSMENT FOR EXISTING AND NEW ROAD TUNNELS

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  « Manage and improve road tunnel safety »

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OUTLINE

- Activities of WG2
« Manage and improve road tunnel safety »
- Risk assessment for road tunnels – principles
- Risk-based approach – current practice for risk evaluation
- Guidelines for improving safety of existing road tunnels
- Conclusions

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Activities of WG2

WG2 « Manage and improve road tunnel safety »

- Bernhard Kohl, Austria – Chairman
- Jürgen Krieger, Germany – Co-Chairman
- Bernt Freiholtz, Sweden – Secretary

19 MEMBERS from 14 countries:

Austria	Belgium	Czech Republic	Denmark	France
Germany	Greece	Italy	Nether-lands	Slovenia
Spain	Switzerland	Sweden	United Kingdom	…

... and 23 corresponding members

Activities of WG2

- Reports of cycle 2004 – 2007 as a starting point
  - Integrated approach for road tunnel safety
  - Risk analysis for road tunnels
  - Tools for tunnel safety management
- Further development of methods for risk assessment, focussing on state of the art of risk acceptability

  Report: Current practice for risk evaluation for road tunnel
- Focus on existing tunnels – strategies for safety improvements, including infrastructure and operation

  Report: Assessing and improving safety of existing road tunnels

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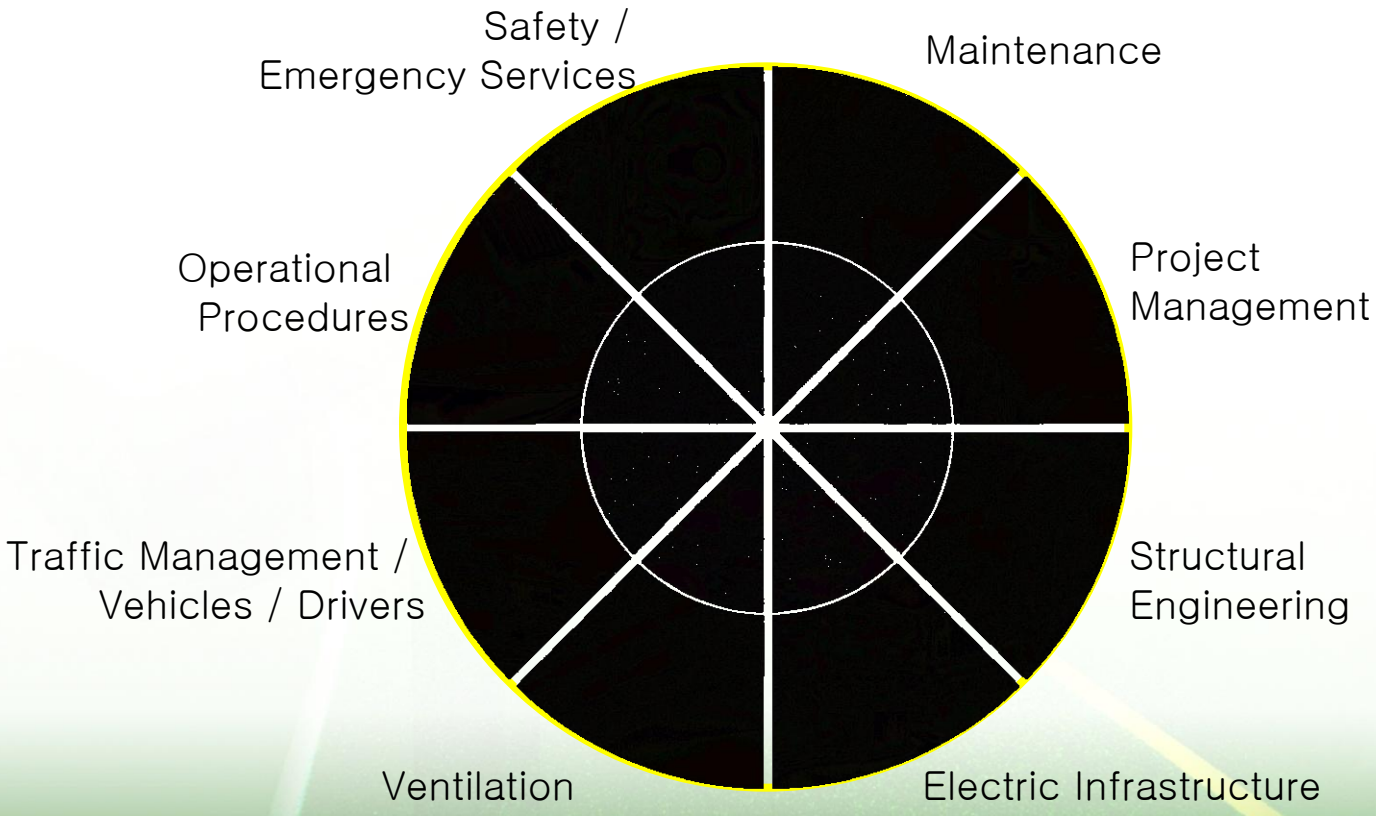
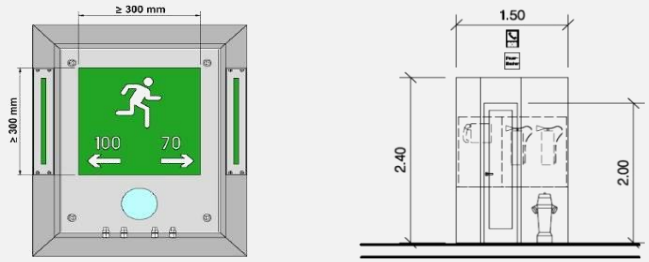
Risk assessment of road tunnels: principles

Basic principle of road tunnel safety: Holistic approach



Risk assessment of road tunnels: principles

Different approaches to road tunnel safety

Prescriptive approach	Risk based approach
	
A tunnel is safe if it is designed in line with valid regulations	*A tunnel is safe if it meets predefined risk criteria*
• Technical specification of safety features of a tunnel • Easy to implement, but scarcely taking specific characteristics into account • Residual risk (even if all requirements are met) – is not addressed	• Structured, harmonised and holistic safety analysis – basis for decision making • Consideration of specific characteristics of a tunnel • Quantitative evaluation of residual risk / of effects of safety measures

Risk assessment of road tunnels: principles

Different approaches to road tunnel safety

Prescriptive based approach and risk based approach have to be used as complementary elements of the safety assessment process.

Risk assessment of road tunnels: principles

Risk based approach: risk assessment process (1)

- **Risk analysis:**

systematic approach to analyse sequences and interrelations in potential incidents or accidents, identifying weak points in the system and recognising possible improvement measures

- **Risk evaluation:**

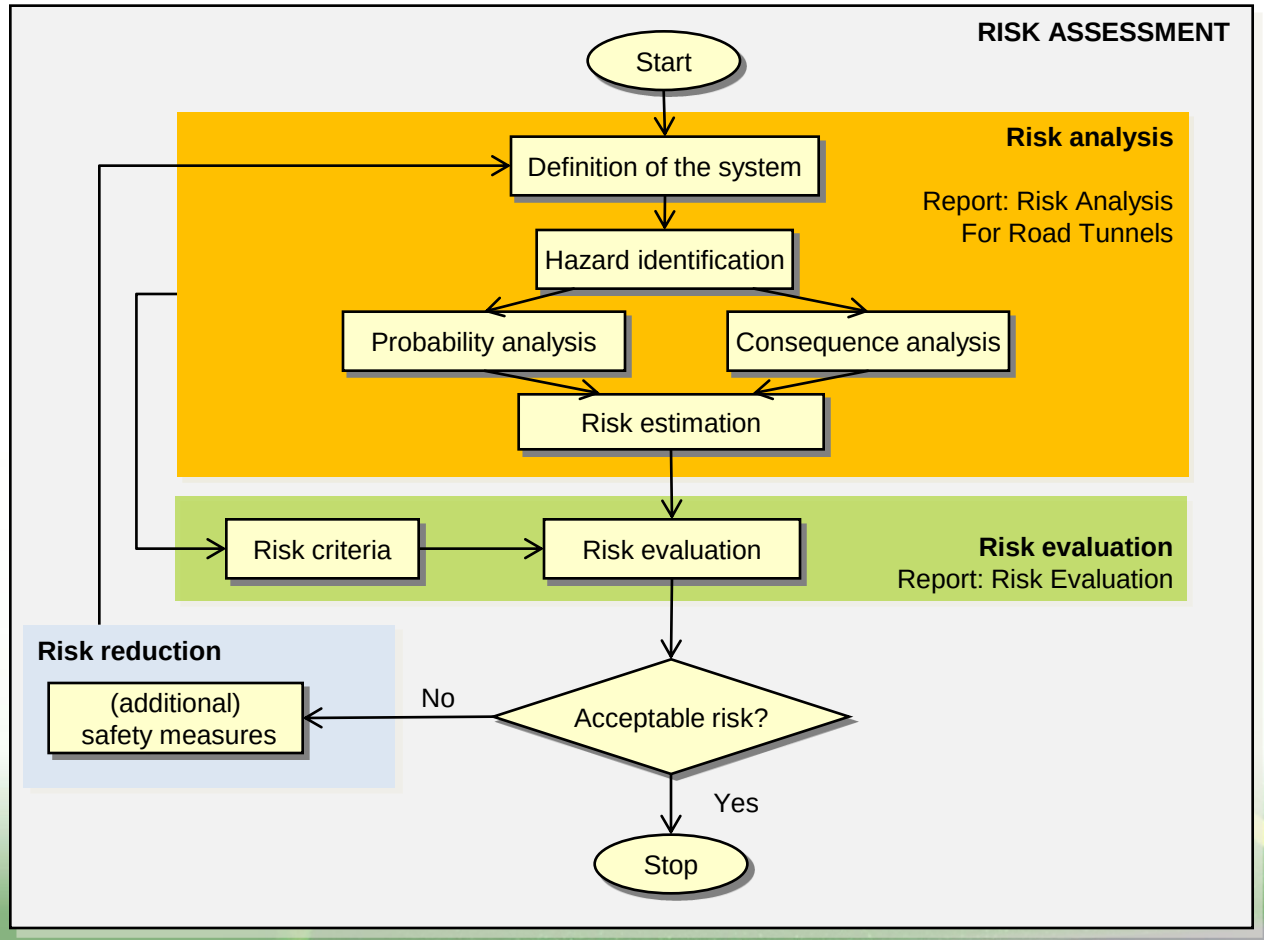
directed towards the question of acceptability of the identified risks – judged against particular risk criteria that have been defined

- **Risk reduction:**

required if the estimated risk is considered as acceptable, additional safety measures have to be proposed to reduce risk.

Risk assessment of road tunnels: principles

Risk based approach: risk assessment process (2)



Risk based approach: Different types of risk

Different types of risk can be addressed in a risk analysis:

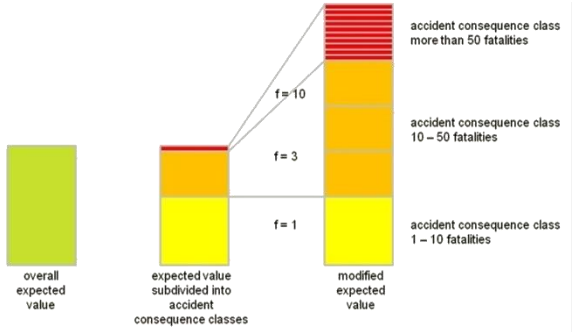
- Societal risk:
  harm to a specific group of people
- Individual risk:
  harm to an individual person
- Economical loss
- Damage to environment
- Damage to immaterial values

↳ Focus on societal risk of tunnel users

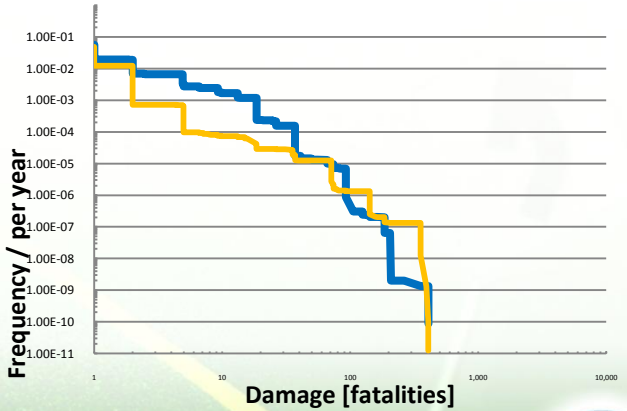
Risk assessment of road tunnels: principles

Risk based approach: Societal risk – risk indicators

- **Expected risk value (EV)**
  long-term average number of statistically expected fatalities per year



- **FN diagram**
  shows magnitude of consequences in relationship to the (cumulated) frequency of a hazard



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Risk based approach – current practice for risk evaluation

Background of risk evaluation:

- Risk analysis: **“What might happen?”**
  - Scientific process: Identification, structuring, assessment of probabilities and consequences
- Risk evaluation: **”Is the risk acceptable?”**
  - Socio-political process including ethical, political and societal aspects
  - Strongly influenced by risk perception
- Risk perception: is influenced by many parameters such as **perceived benefits**, **voluntariness**, **controllability** on **catastrophic potential**

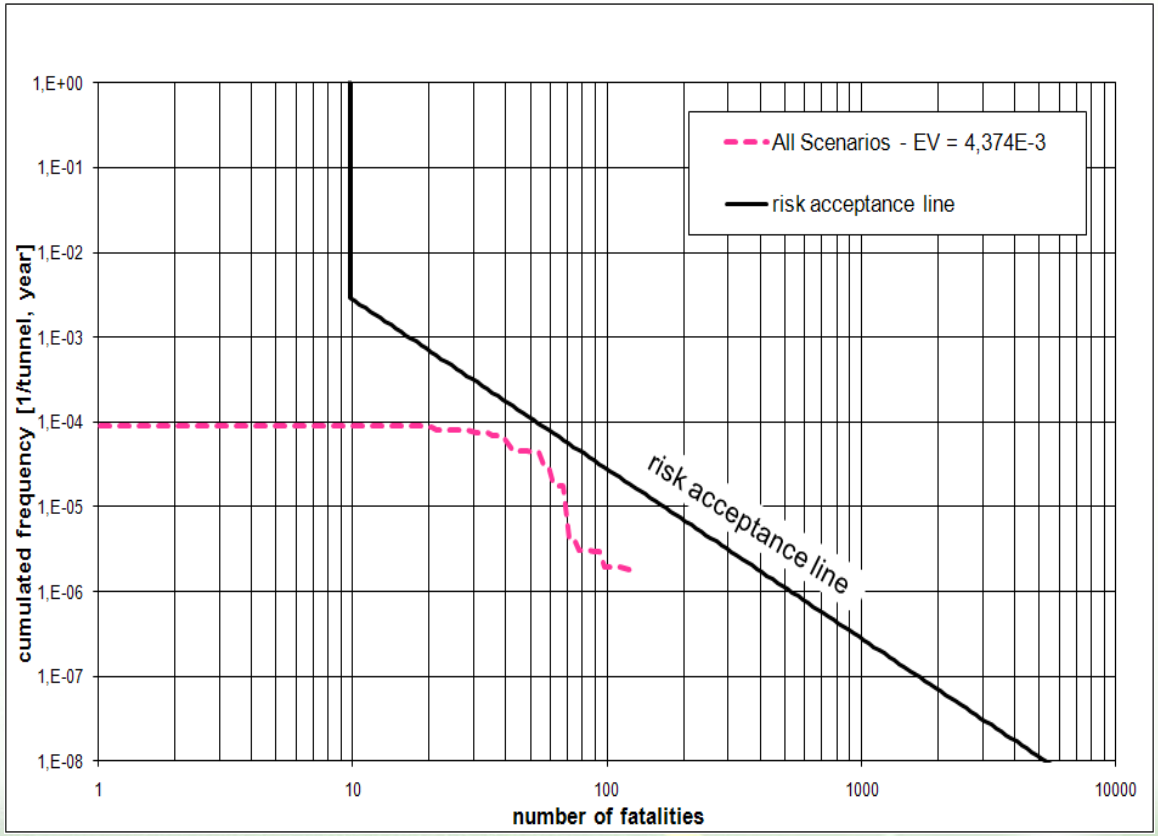
↳ No “right” or “wrong” risk evaluation criteria

Risk based approach – current practice for risk evaluation

Basic principles for risk evaluation

- **Absolute criteria**

  risk is acceptable as long as assessed risk is lower than a defined absolute threshold

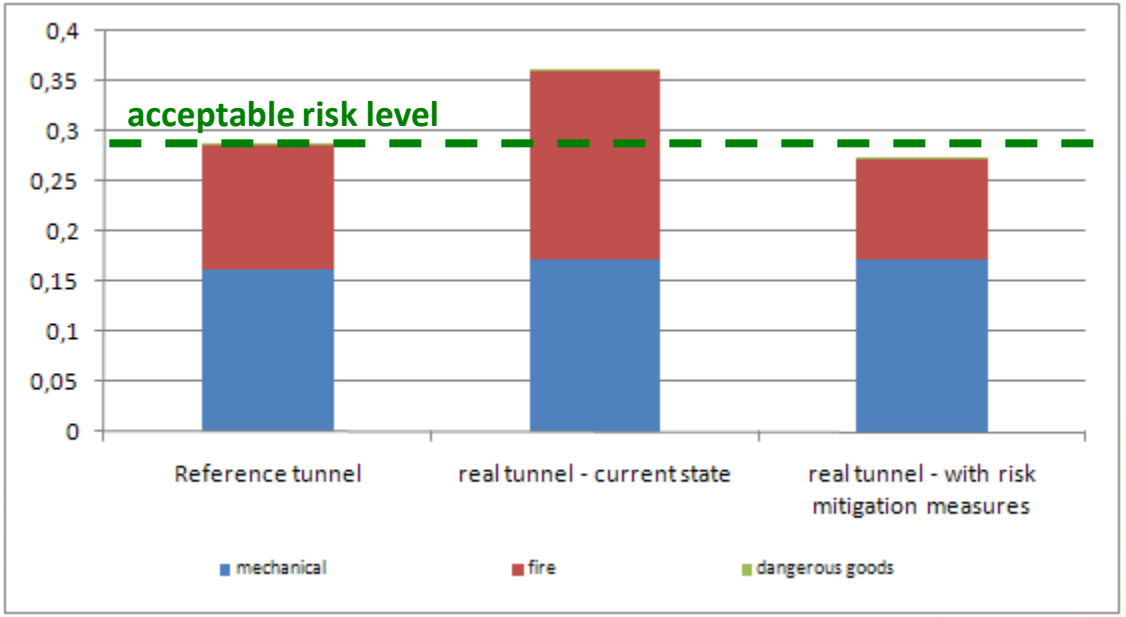


Risk based approach – current practice for risk evaluation

Basic principles for risk evaluation

- **Relative criteria**

  risk is acceptable, as long as assessed risk is lower than an established risk profile



Concept of "Reference Tunnel":

theoretical tunnel similar to tunnel under assessment, but fully complying with all requirements, conditions etc. defined in relevant regulations.

Risk based approach – current practice for risk evaluation

Basic principles for risk evaluation

- **Cost-effectiveness approach**

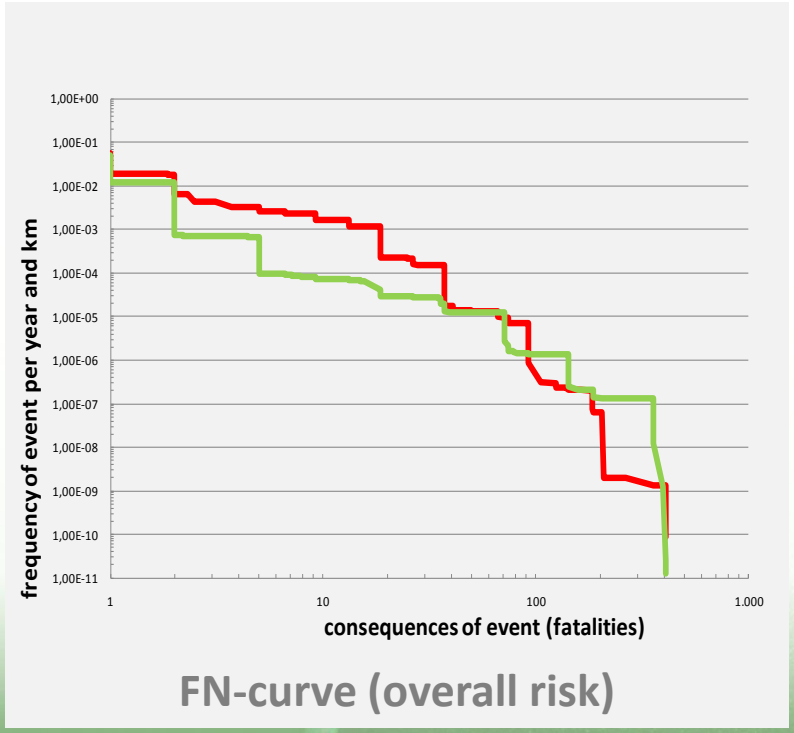
  Comparison of efficiency of safety measures and their risk reduction potential

  A tunnel is safe, if all cost-effective measures are implemented

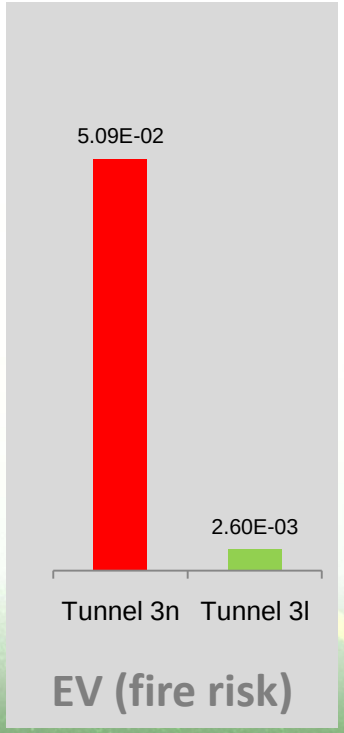
Risk based approach – current practice for risk evaluation

Practical example for a relative approach: Evaluation of safety measures for existing tunnel

Influence of mechanical ventilation in a unidirectional tunnel without ventilation



FN-curve (overall risk)



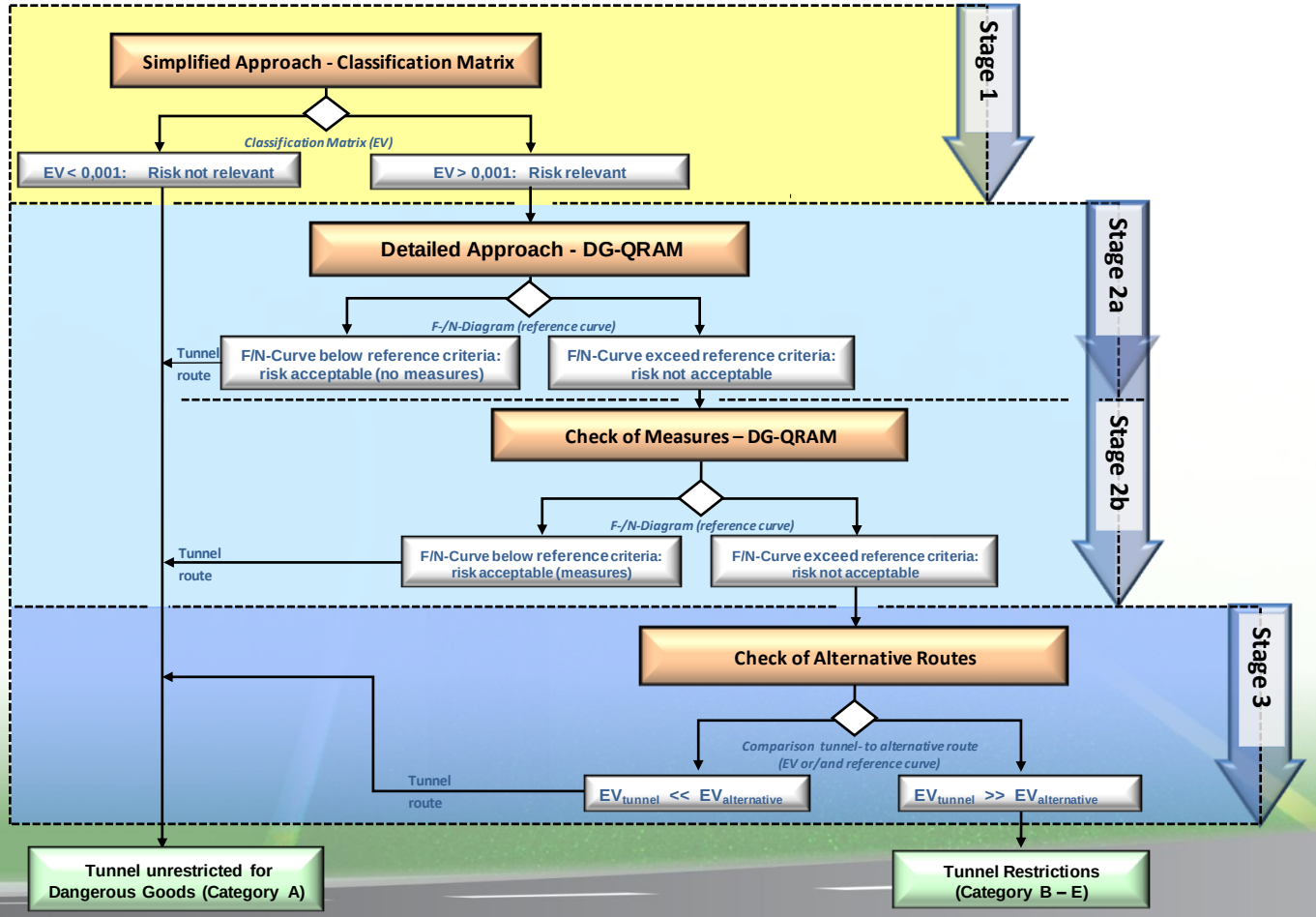
EV (fire risk)

Model tunnel:
0,6 km unidirectional; 70.000 veh/d; vaulted cross section

- **Tunnel 3n:** natural ventilation
- **Tunnel 3l:** longitudinal ventilation

Risk based approach – current practice for risk evaluation

Practical example for a complex evaluation procedure: acceptability of dangerous goods transports



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Reasons potentially triggering the upgrading of an existing road tunnel

- Gradually deteriorating constructions, tunnel structures and facilities
- Tunnel systems becoming obsolete
- Changes in the environment or in the exploitation of the tunnel
- Changing regulatory framework

In any case safety is a key consideration

Guidelines for improving safety of existing road tunnels

Approach for improving safety in a upgrading process:

- Identifies the key issues for an existing tunnel
- Addresses individual safety parameters as well as the global tunnel system
- Defines priorities for the implementation of the safety measures required
- Helps to select the most appropriate improvement programme

Big Challenge: development of practicable solutions considering existing physical constraints and individual tunnel safety characteristics

Guidelines for improving safety of existing road tunnels

Definition of clearly defined step-by-step process

ASSESSMENT OF CURRENT SITUATION

- Step 1: „Establish a safety framework“
- Step 2: „Investigate current condition“
- Step 3: „Evaluate current tunnel safety level“

FUTURE SITUATION

- Step 4: „Define a safety improvement programme“
- Step 5: „Evaluate future tunnel safety level“

Step 1: „Establish a safety framework“

Based on an existing regulatory framework:

- Prescriptive definitions of national standards or regulations
- Risk-based approach
- Definition of individual safety objectives

If no national regulations exist:

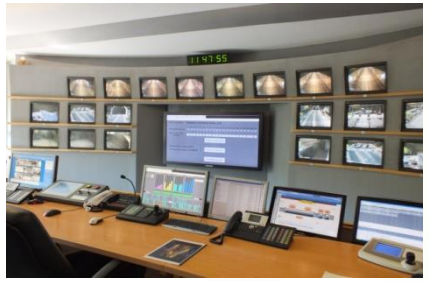
- International minimum requirements (like EC-Directive 2004/54/EC
- Best practice guidelines (e.g. PIARC reports)
- Regulations followed by other countries (to be applied with specific care)

Guidelines for improving safety of existing road tunnels

Step 2: „Investigate current condition“

Generate a description of the current tunnel condition in terms of

- Structural aspects
(condition and performance)
- Systems and equipment
(existence, condition, performance and interaction)
- Tunnel management and operation
(organisation, operational procedures, training and quality assurance)
- Safety documentation



Step 3: „Evaluate current tunnel safety level“

Evaluation based on prescriptive regulations

Consider all factors influencing safety including

- Tunnel structure and equipment
- Maintenance and operation

Evaluation using a risk based approach

Perform a risk analysis and evaluate results on the basis of quantitative or qualitative risk indicators

List deficiencies / requirements for risk reduction and define a set of corresponding measures

Guidelines for improving safety of existing road tunnels

Step 4: „Define a safety improvement programme“

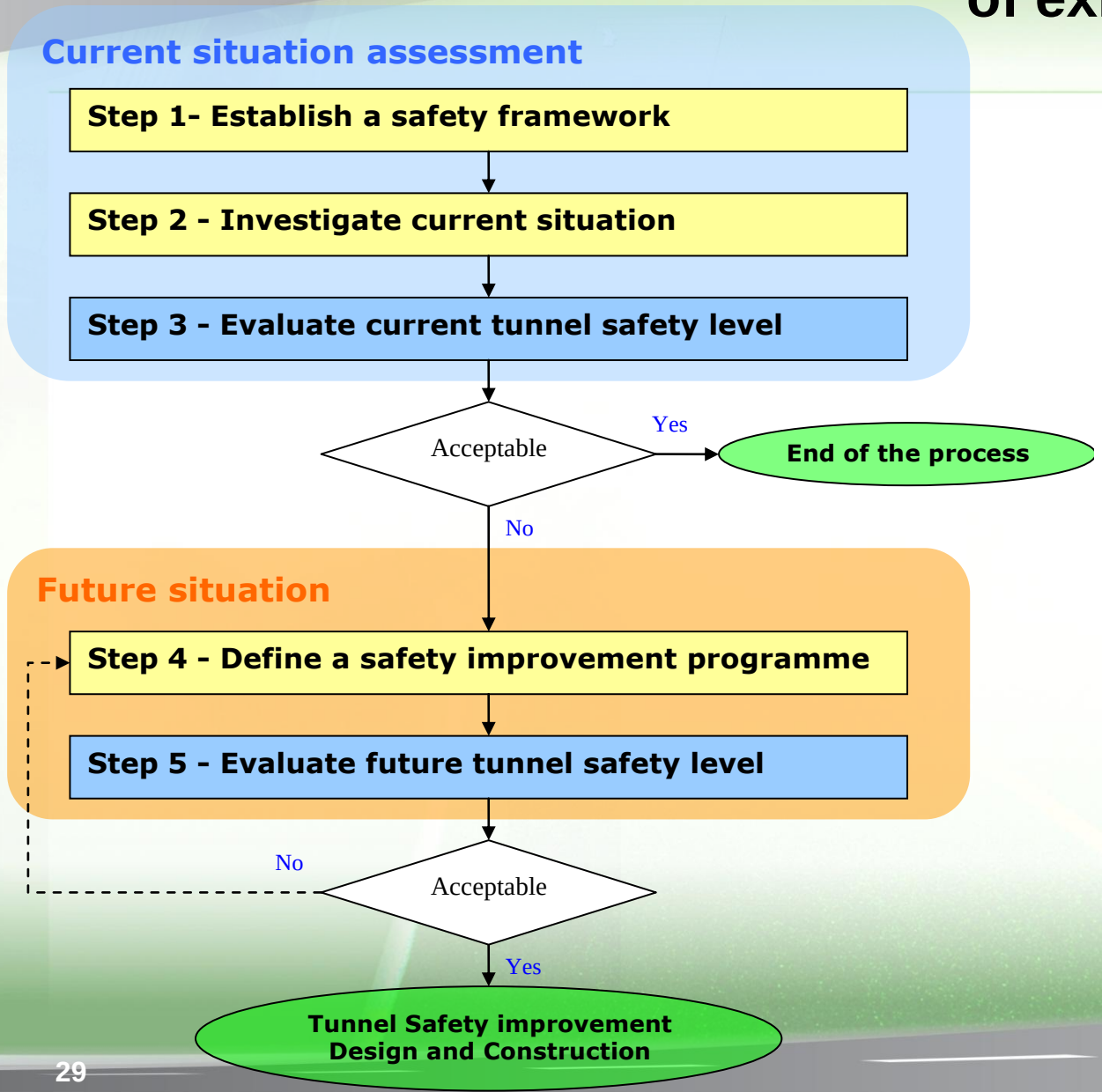
Interactive process for definition of a safety improvement programme:

- Review the deficiencies and propose solutions
- Develop an improvement programme (different options)
- Review the different options holistically (in terms of practical implementation, financial and operational constraints, etc)
- Choose the best solution and develop it

Step 5: „ Evaluate future tunnel safety level“

- Demonstrate that the safety tools defined in step 1 are met (applying same approach as for step 3)

Guidelines for improving safety of existing road tunnels



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Conclusions

- The two PIARC reports
  - **« Risk analysis for road tunnels »** and
  - **« Current practice of risk evaluation for road tunnels »**

provide a comprehensive survey of the methodical background as well as the practical application of risk analysis for road tunnels

- The report

« Assessing and improving safety of existing road tunnels»

presents a generally applicable approach for upgrading of a road tunnel – focussing on safety aspects

- Together with the reports of the cycle 2004 – 2007 and of other WG2 working groups PIARC provides comprehensive literature representing the state of the art of road tunnel safety

http://publications.piarc.org/en/technicalreports

Thank you for your attention!

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