

ITA – COSUF



Operational Safety of Underground Facilities

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Operational Safety

- Introduction
- Accidents – lessons learnt and open points
- L-surF – a European initiative for safety
- ITA-COSUF – an international platform



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Introduction

Operational Safety

- Underground infrastructures are **complex environments**, in which – usually because of the great number of users - the risk of tragedy is ever present.
- **Operation and maintenance** are **increasingly complex and expensive**.
- In confined spaces, **safety is an ongoing concern**.



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Introduction

Responsibility for Safe Operation:

- The owner / operator of an infrastructure is responsible for safe operation in **normal, maintenance and emergency** conditions.
 - be aware of his responsibility (organisation)
 - **analyse and to recognise hazards and risks**
 - plan according to the **rules of technology** (standards)
 - realise safety measures according to the **state of the art of safety measures** during the entire life time of the facility
 - account for the **cost-benefit** relation of measures
 - know about the **residual risks**

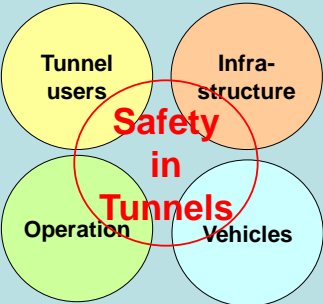



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Introduction

Safety Parameters

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Operational Safety

- Introduction
- **Accidents – lessons learnt and open points as an input for actions needed -> L-surF**
- L-surF – a European initiative for safety
- ITA-COSUF – an international platform



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Lessons learnt and open points

Overview on safety measures:

- **Active safety** - through prevention measures to **prevent** critical events
- **Passive safety** - through well adapted safety measures to **mitigate / limit the consequences / damage** (construction, technical equipment, organisation)
- **Operational measures** – supervision, alerting, fast intervention and immediate incident response



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Lessons learnt and open points

Prescription for safe operation

- A large number of **prescriptions concerning safety** requirements and safety measures exist.
- Usually they are **risk-based**, also **performance-based**.



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Lessons learnt and open points

Prescription for safe operation

- Safety Objectives:
 - Primary objective:
 - to **prevent critical events** that endanger human life, the environment or the installations.
 - Secondary objective:
 - people involved in the incident to **rescue themselves**
 - **immediate intervention of (road) users** to prevent greater danger
 - ensuring efficient action of **emergency services**
 - protecting the **environment**
 - limiting **infrastructure damage**



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Lessons learnt and open points

The key to success in case of an incident

- **Key requirements:**
 - Rapidity
 - Reliability
 - “Failure safe” mechanisms
- **The operators / owner’s responsibility:**
 - Appropriate equipments and systems (design, realization, renewal)
 - Maintenance
 - Innovation!
 - Organisation, instruction and exercises
- **Requirements and approach very similar for road, rail and metro tunnels**



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Lessons learnt and open points

The important issues:

- **Rapid detection** (fire, smoke, incident, direct user information etc.)
- **Automatic response** of key safety systems („tunnel reflexes“):
 - Signalisation of escape routes, tunnel closure etc.
 - Ventilation (smoke extraction, control of longit. air velocity)
 - Lighting of escape routes
 - Fire suppression systems etc.
- **Warning and instructions** to tunnel users
- **Alarming** of intervention services and operators
- **Evacuation** (human behaviour, capacities of escape routes, safe havens)
- **Communication** (fire services, technical services, ambulances, police)



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Lessons learnt and open points

Fire and smoke detection

Road tunnels - generally a well-solved issue:

- Technologies:
 - „Linear“ thermal detection systems (temperature measurement)
 - Optical smoke detectors
 - Video-based systems (image analysis)
- **Issues and need for action:**
 - **Sensitivity and velocity of detection**
 - **Reliability: detect always but prevent false alarms – „intelligent“ cross-check!**
 - **Cost reduction**



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Lessons learnt and open points

Fire and smoke detection

Railways & Metros - very heterogenous state-of-the-art:

- Technologies:
 - Detection in vehicles (passenger compartments → Metros)
 - Detection in tunnel less frequent
 - Fixed detection systems for hot train components (brakes, axle boxes, ...)



- Issues and need for action:
 - Standards required
 - New technologies for the infrastructure (espec. hubs)



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Lessons learnt and open points

Ventilation

Road tunnels - state-of-the-art well established and advanced :

- Technologies:
 - High to very high level in several countries
 - Requirements / safety levels too heterogeneous in different countries
- Issues and needs for action :
 - International harmonization required, e.g.
 - Applicability of longitudinal ventilation, smoke extraction rates
 - Optimum ventilation control for bi-directional tunnels
 - Interaction with other equipment (e.g. extinction systems)
 - Excessive requirements on operator's capabilities
 - New visions for preventing very expensive retrofits



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Lessons learnt and open points

Ventilation

Long Railway tunnels: State-of-the-art too heterogeneous

- Technologies:
 - Safety stations, safe havens (fresh air, smoke extraction), typically every 20 km
 - Cross passages (typically 300 to 500 m)
 - Sometimes longitudinal ventilation of tubes (e.g. Eurotunnel)
 - Requirements too heterogeneous in different countries
- Issues and needs for action:
 - More detailed data on combustion characteristics of modern vehicles
 - more international harmonization required



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Lessons learnt and open points

Ventilation

Metros

Very heterogeneous situation - Local standards often more history- than technology-dominated:

- Typical ventilation strategies:
 - Comfort ventilation in stations
 - „Push – pull“ between stations, longitudinal ventilation with jet fans
 - Ventilation and smoke extraction in stations
- Issues and need for action:
 - More detailed data on combustion characteristics of modern vehicles
 - Homogenization of strategies
 - Homogenization in application of design tools (CFD)



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Lessons learnt and open points

Evacuation

New road tunnels - typically excellent standard:

- Technologies:
 - Separated escapes to the exterior
 - Cross-connections between tubes
 - Safety tunnel with cross-connections
 - Walkways in the tunnel
 - Maximum distance typically in the range of 300 – 500 m
- Older tunnel have frequently a much lower standard – Retrofit is very expensive.

Issues and need for action:

- User information and education!
- Cost-effective retrofit technologies



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Lessons learnt and open points

Evacuation

Railway and metro tunnels / stations:

- Technologies:
 - Generally very heterogenous situation
 - More history-defined than technical-defined
 - Retrofit is very expensive
- Issues and need for action:
 - Harmonization on strategies
 - Cost-effective retrofit technologies



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Lessons learnt and open points

Evacuation

Metros – more and more deep stations:

- **Safety concept:**
 - Definition design fire & number of people in the station
 - Safe escape routes (2 independent ways)
 - Safe havens in the shaft: overpressure > critical velocity
 - Safety case: fire modelling and evacuation simulation
 - Ventilation in the running tunnel
 - Protected fire compartments
- **Issues and action needed:**
 - In vehicles: fire detection and FFSS (water mist)
 - Deep stair cases plus long ways to surface
 - Mezanine level with high safety requirements
 - Harmonization of strategies is required



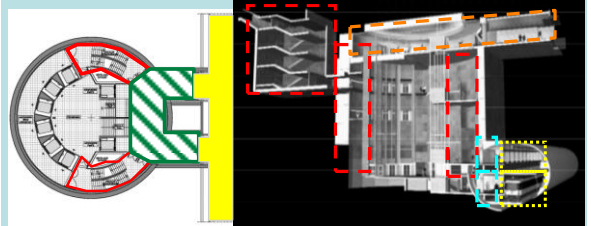
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Example: Metro Barcelona (1)

Metro Line 9 Barcelona - deep shaft stations:

Fire compartments

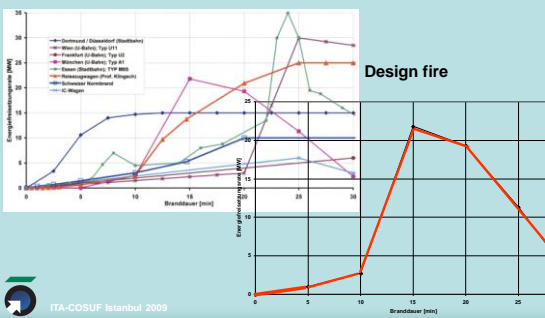


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Example: Metro Barcelona (2)

Metro Line 9 Barcelona - deep shaft stations

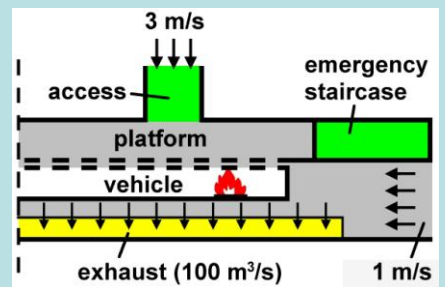


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Example: Metro Barcelona (3)

Ventilation (example)



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Lessons learnt and open points

Evacuation

Roads, Railway and metros stations:

- **Introduction of Fixed Fire Suppression Systems (FFSS)**



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Example: FFSS (1)

Road tunnels:

- **Technologies:**
 - Fixed fire suppression systems for road tunnels quite effective
 - Different techniques (water mist, sprinkler, foam, ...)
 - Choice of technology difficult
 - Expensive in long tunnels



- **Issues and need for action:**

- Reliability is still an issue (depending on technology)
- Activation strategy and mode
- Interaction with other safety equipments needs careful design
- Define rules for application: where needed, rather than in all tunnels!



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Example: FFSS (2)

Road, rail and metro tunnels and infrastructures, rolling stock:

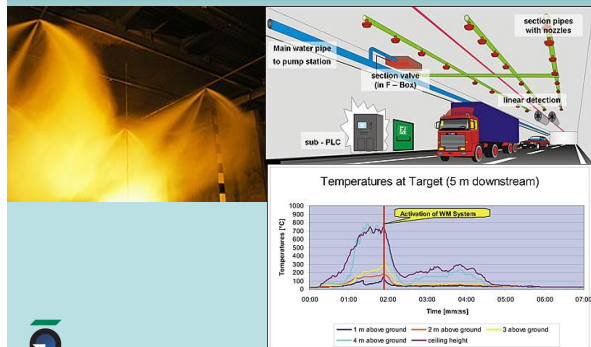
- Research projects showed effectiveness of FFSS (water mist) for tunnel applications (e.g. UPTUN (EU), SOLIT (D))
- Water mist technology highly accepted: in road tunnels, railway / metro vehicles, technical rooms and platforms
- Positive effects on
 - Evacuation of persons,
 - Safe conditions for intervention services
 - Protection against structural damage
- Further research activities are in preparation (SOLIT II)



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Example: FFSS (3)



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Example: FFSS (4)



Issues, need for action :

- Reliability is still an issue
- Activation strategy and mode
- Better cost-effectiveness for long tunnels
- Dependencies with ventilation situation
- Interaction with other safety equipments need careful design
- Define rules for application: where needed, rather than in all tunnels!
- High accuracy to combine fire detection and localisation systems



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Lessons learnt and open points

Immediate response (operator)

In general:

- Technologies:
 - Tunnel management system to bring together many subsystems of the infrastructure
 - Scenarios-based pre-defined response plans
 - Alarming and warning also to users
 - Formation and training of operators

Issues and need for action:

- Adequate response in different situations:
 - all emergencies and special situations
 - traffic diversion, maintenance,



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Lessons learnt and open points

First responders and intervention forces

In general:

- Adequate equipment (interruption of event chain, cooling, self-protection)
- Formation (specific hazards in long tunnels during intervention, reaction to special situation)
- Intervention plans
- Exercises!

Issues and need for action:

- Interaction with new equipment
- New fire sources (gas powered vehicles, etc.)



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Lessons learnt and open points

First responders and intervention forces

In general:

- Adequate equipment
- Exercises!

- JANUS (Mont Blanc road tunnel)
- Extinguishing & rescue trains
- LUF 60 (rail, road tunnels)



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Lessons learnt and open points

Conclusions

Operational safety / safe exploitation needs

- Adequate planning during design phase
- Adequate safety measures
- Complex infrastructures need more and more smart systems for underground intelligence
- Maintenance + continuous modernisation!
- Exercises!

Therefore innovation & research efforts should aim ...

- to reach high safety level with good cost-benefit ratio
- to develop & optimize smart and robust systems for safe underground infrastructures



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Operational Safety

- Introduction
- Accidents – lessons learnt and open points
- L-surF – a European initiative for safety
- ITA-COSUF – an international platform



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L-surF – An European Initiative for Safety

Content

1. L-surF Project
2. Partners
3. Business Scenarios
4. L-surF Foundation
5. Outlook



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L-surF – An European Initiative for Safety

What is (was) the L-surF project?

- Design study within the Sixth Framework Programme of the European Community
- Cooperation of 5 European leading Institutes on safety and security for underground facilities



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L-surF – An European Initiative for Safety

Objectives of the project

1. **Feasibility study**
for harmonisation and coordination inclusive feasibility of R&D facilities (layout, R&D needs, activities, clients, partners etc.)
2. **Scientific and technological research**
technical specifications for a convertible contour, shape and size scheme (CCSS) and innovative 2D and 3D measurement sensors
3. **Business plan**
including users, customers and financial options for the different business scenarios
4. **To establish legal entities called L-surF**



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L-surF – An European Initiative for Safety

The L-surF Core Consortium

- | | |
|---|---|
|  VSH
VersuchsStollen Hagerbach AG
Hagerbach Test Gallery Ltd.
Sargans, Switzerland |  TNO
Netherlands Organisation for Applied
Scientific Research
Delft, The Netherlands |
|  SP
SP Technical Research Institute of
Sweden
Boras, Sweden |  INERIS
Institut National de l'environnement
industriel et des risques
Vermeuil en Halatte, France |
|  STUVA
Studiengesellschaft für unterirdische
Verkehrsanlagen e.V.
Köln, Germany | |



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L-surF – An European Initiative for Safety

L-surF's strategy – Base of the Scenarios

Theoretical approach:

- Need for European harmonisation
- Collaboration and exchange in desk research

Experimental approach:

- Existing R&D facilities require standards for test and research activities
- Need for a 'Gap'- facility and for a groundbreaking new research facility was identified



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L-surF – An European Initiative for Safety

Business Scenarios

A – Harmonisation / Coordination

B – Collaboration among existing

- research organisations (RO) and
- research infrastructures (RI)

C – Collaboration among existing RO / RI plus implementation of 'gap facility'

D – Groundbreaking new research facility



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L-surF – An European Initiative for Safety

Business Scenario A

- Coordination and harmonisation
- Networking between existing research infrastructures and other key players in safety and security for underground structures
- Service for the design and execution of large scale experiments
- Translate research questions and requests into research programmes and coordinate the SRA



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L-surF – An European Initiative for Safety

Business Scenario B

- Use of the existing research facilities (L-surF partner facilities – present and future)
- Integrated approach to safety and security research
- Offering a 'one stop shop' for large scale experimental services
- Increase the efficient use and sustainability of the L-surF partner facilities within the European Research Area



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Business Scenario C

- Completion of the existing research facilities with a 'Gap facility'
- Possible gaps to be bridged could be:
 - HUB – vertical connection between different means of transportation
 - Versatile cross sections for experiments in underground environment
 - Boundary conditions relevant for human behaviour research
 - Flexible ventilation for the whole Research Infrastructure (RI)
- to answer new R&D questions



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Business Scenario D

- The groundbreaking new research infrastructure
- Flexible cross sections, shapes and sizes (CCSS)
- Meeting all requirements worked out during the L-surF project
- Satisfying environmental criteria (waste water treatment, waste air treatment, e.g.)



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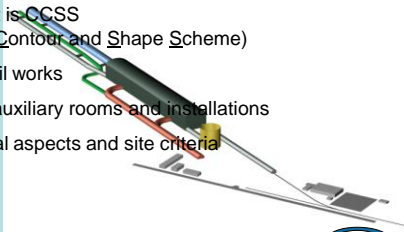


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L-surF – An European Initiative for Safety

Description of the Scenario D-facility

- Core element is CCSS (Convertible Contour and Shape Scheme)
- Lay out of civil works
- Definition of auxiliary rooms and installations
- Environmental aspects and site criteria



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L-surF – An European Initiative for Safety

Purpose of L-surF

- L-surF will be a strong player in the European Research Area
- Collaboration and harmonisation in the field of underground safety and security research
- To provide a pan European network of facilities and scientific personnel to the research community



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L-surF – An European Initiative for Safety

L-surF - Foundation and L-surF - Services

Continuation of activities on results of the L-surF project:

- L-surF - Foundation
- L-surF - Services



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L-surF – An European Initiative for Safety

L-surF - Foundation

L-surF Foundation has been established jointly by the L-surF project partners. It holds the IR of the L-surF project.

The operational branch of the L-surF Foundation is L-surF services.



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L-surF – An European Initiative for Safety

L-surF - Services

L-surF services is the jointly developed activity of the L - surF Foundation and its partners, offering:

- expertise on testing and safety R&D
- training and education
- support in the implementation of standards

as an activity of the L-surF entities.



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L-surF – An European Initiative for Safety

Outlook

- Legal entities are active according to business scenarios and business plans
- Partners, collaborators, co-operators, associates etc. are welcome
- Private and public (both national and international) funding are raised
- 'Lobbying' for business scenarios C and D (ESFR1, EU nations)

www.l-surf.org



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Operational Safety

- Introduction
- Accidents – lessons learnt and open points
- L-surF – a European initiative for safety
- **ITA-COSUF – an international platform**



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ITA-COSUF - an International Platform for Safety

The **Committee on Operational Safety of Underground Facilities (COSUF)**

of
The International Tunnelling and Underground Space Association (ITA)

by

F. Amberg, Chairman

Amberg Engineering Ltd and Hagerbach Test Gallery Ltd, Switzerland



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Content

1. Origin, Scope and Objectives of ITA-COSUF
2. Structure of ITA-COSUF
 - Activity Groups
 - European Forum of Road Tunnel Safety Officers
 - Membership
3. Activities



ITA-COSUF Istanbul 2009
Origin/Scope/Objectives

Development

Activities

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COSUF – an ITA Committee

In May 2005 in Istanbul, the General Assembly of ITA installed the

Committee on operational safety in underground facilities

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Origin/Scope/Objectives

Development

Activities

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Scope

The scope of ITA-COSUF is:

- **Safety** in tunnels and other underground facilities **in operation**, not during construction.
- Safety during construction is covered by ITA WG 5 „Health and Safety“
- **Security** is considered as part of safety.



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Origin/Scope/Objectives

Development

Activities

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Objectives (1)

Objectives of the activities of ITA-COSUF are:

- **Maintain and develop a network** to:
 - exchange knowledge
 - encourage collaboration
 - create dedicated teams for specific research activities
- **Facilitate co-operation world-wide**



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Origin/Scope/Objectives

Development

Activities

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Objectives (2)

- **Promotion of safety (and security)** by:
 - fostering innovation
 - raising public awareness of current and newly developed safety (and security) issues
- **Raising** of national, European and international **funds**
- Promoting of **financial support**
- Supporting the **development of improved regulations**



ITA-COSUF Internal 2009
Origin/Scope/Objectives

Development

Activities

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Addressees

ITA-COSUF addresses the following categories of people, organisations and bodies:

- decision makers,
- professional end-users,
- consultants and risk managers
- contractors, manufacturers and suppliers
- operators
- financers
- first responders
- international forums and other stakeholders.



ITA-COSUF Internal 2009
Origin/Scope/Objectives

Development

Activities

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Content

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 - **European Forum of Road Tunnel Safety Officers**
 - **Membership**
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ITA-COSUF Internal 2009
Origin/Scope/Objectives

Development

Activities

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Basic Structure

COSUF is structured in 3 Activity Groups (AG):

- AG 1: Interaction with European and International Initiatives
- AG 2: Regulation and Best Practice
- AG 3: Research and New Findings

Led by Coordinators the AGs get their strategically advice and support from the SB. The SB reports to the annual ITA-General Assembly.



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Origin/Scope/Objectives

Development

Activities

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The Activity Groups (1)

The objectives of the AGs are:

- to contribute to sufficient safety and security for tunnel users, operator-staff and rescue personell
- to support and develop cost efficient solutions
- to respect life-cycle aspects, economical and societal demands
- to combine innovation and visions of future needs and technical possibilities



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Origin/Scope/Objectives

Development

Activities

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The Activity Groups (2)

The AGs themselves do not conduct studies, research or similar commercial work which could be done by institutes or companies.

They should develop to **Centers of Excellence** for world-wide exchange of information and know-how regarding safety and security of tunnels



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Origin/Scope/Objectives

Development

Activities

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Activity Group 1 Interaction with European and International Initiatives

Scope:

- Take and keep contact with external institutions, groups, and projects like ECTP, ETPIIS, PIARC, ISO, fib, RILEM, TUNCONSTRUCT, and EuroTAP
- Avoid duplication of activities
- Give externally information about COSUF
- Influence activities of third parties



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Origin/Scope/Objectives

Development

Activities

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Activity Group 2 Regulations and Best Practice

Scope:

- Cover regulations, state-of-the-art and best practice in various countries world-wide
- Discussion and comparison of regulations and practice procedures of different owners, operators, networks, projects



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Origin/Scope/Objectives

Development

Activities

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Activity Group 3 Research and New Findings

Scope:

- motivate to relevant research
- encourage the use of research results and findings to improve safety and security in underground facilities
- specify needs of new research



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Origin/Scope/Objectives

Development

Activities

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European Forum on Road Tunnel Safety Officers

- EU Directive 2004/54/EC introduced Safety Officers. They are in charge of ...*coordinating all preventive and safeguard measures to ensure the safety of users and operational staff.*
- Since 2004 a lot of such Safety Officers have been appointed
- The ITA COSUF Forum will offer a platform to exchange experiences, know-how etc among the Safety Officers



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Origin/Scope/Objectives

Development

Activities

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Membership

- Invitation to all parties world-wide interested in operational safety and security of tunnels and other underground facilities
- Exclusively cooperative members, no individual members
- COSUF membership does not require ITA membership
- Membership in both association is possible and welcome



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Origin/Scope/Objectives

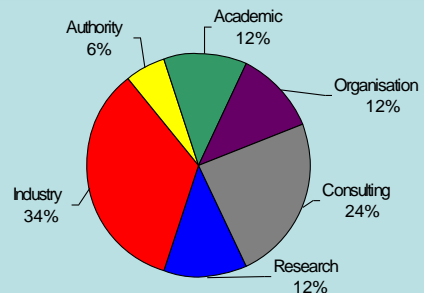
Development

Activities

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Members of COSUF (status September 2008)

57 Members from 15 Countries



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Origin/Scope/Objectives

Development

Activities

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Content

1. Origin, Scope and Objectives of ITA-COSUF
2. Development of ITA-COSUF
 - Activity Groups
 - Membership
3. **Activities**

Activities 2006 - 2009

- 11 Workshops on i.e.:
 - Fire protection engineering for new and existing Tunnels
 - New aspects in tunnel safety
 - Safety in metro and railway tunnels
 - Emerging technologies for tunnel safety
 - New energy carriers and tunnel safety

Activities 2006 - 2009

- 7 presentations i.e. on:
 - Fire in tunnels – design options and possibilities
- 4 General Assemblies
- 11 AG and SB meetings

Activities 2009 onward

- Workshop 5.10.2009, Lyon, France on Safety Challenges
- 1. European Forum for Road Tunnel Safety Officers, 4.10.2009, Lyon, France
- Workshop and GA 2010, 17.-19.3.2010, Frankfurt, Germany

Mission Statement ITA-COSUF

ITA COSUF, the
Centre of Excellence
for world-wide exchange of information and know-how regarding safety and security of underground facilities

Mission Statement ITA-COSUF

www.ita-aites.org



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Thank you for your attention !



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