The First International Seminar
on
Road Tunnel Operations Management and Safety

NFPA 502

Regulations, Standards and Guidelines

World Road Association (PIARC)
Technical Committee C3.3
Road Tunnel Operation

18 October 2006
Chongqing, China

Regulations, Standards & Guidelines
Presentation Outline

- Introduction
- Objective
- Documents
- Comparison
- Conclusions
- Future Issues

Regulations, Standards & Guidelines
Introduction

Regulation documents contain specific mandatory requirements and are produced by a legal government entity.

Standard documents contain mandatory language, and they are usually produced by a technical entity such as an association or society. These documents by themselves have no legal standing except where they have been adopted by or on behalf of a government agency by legislative action.

Guideline documents provide, to the reader, recommended practices which can be applied in the design, construction, installation, operation and safety of the fire life safety and fire protection systems in a road tunnel. These documents are usually prepared by technical associations; however some have been prepared by governmental agencies.

Regulations, Standards and Guidelines
Individual Countries

Austria	*Design Guidelines Tunnel Ventilation*, RVS 9261:9262, Austria, 1997
Croatia	*Regulations on technical Standards and Conditions for Design and Construction of Tunnels on Roads*, Croatia, 1991
Czech Republic	Design of road tunnels, Standard ČSN 73 7507 Road tunnel equipment - technical specifications - Guideline TP 98
France	*Inter-Ministry Circular No. 2000-63—Safety in the Tunnels of the National Highways Network*, Ministry of the Establishment, Transport and Housing, France, 2000
Germany	Forschungsgesellschaft für Strassen- and Verkehrswesen, Richtlinien fuer Ausstattung und Betrieb von Strassentunneln (RABT), Germany, 2006
Japan	*National Safety Standard of Emergency Facilities on Road Tunnel*, Japan Road Association, Japan, 2001
Netherlands	*Recommendations Ventilation of Road Tunnels*, RWS Bouwdienst, Steunpunt Tunnelveiligheid, 2005,
Norway	Norwegian Design Guide—Road Tunnels, Public Roads Administration, Norway, 1990
Nordic Countries	Ventilation of Road Tunnels, Sub-Committee 61, Nordisk Vejteknisk Forbund (NVF), Report No. 6, 1993
Sweden	Tunnel 2004—General Technical Specification for new tunnels and upgrading of old tunnels, Swedish National Road Administration, Publ. 2004,124, Sweden 2004
Switzerland	Ventilation for Road Tunnels, Swiss Federal Roads Authority (FEDRO), 2004
United Kingdom	*Design Manual for Roads and Bridges*, Part 9, BD 78/99, Design of Road Tunnels, 1999
United States	*Road Tunnel Design Guidelines*, Federal Highway Administration, FHWA-IF-05-023, 2004

Regulations, Standards and Guidelines
International Organizations

NFPA	NFPA 502, Standard for Road Tunnels, Bridges, and Other Limited Access Highways, National Fire Protection Association, Quincy, MA, 2004
PIARC	Fire and Smoke Control in Road Tunnels, World Road Association (PIARC), Paris, 1999
European Union	Directive 2004/54/EC of the European Parliament and of the Council on minimum safety requirements for tunnels in the trans-European road network, 2004
United Nations	Economic Council, Economic Commission for Europe, Inland Transport Committee, Recommendations of the Group of Experts on Safety in Road Tunnels, 10 December 2001

Regulations, Standards & Guidelines
Objective

Three specific documents will be compared

- **Regulation Document** – *"Directive 2004/54/EC of The European Parliament and of the Council on Minimum Safety Requirements for Tunnels in the Trans-European Road Network"* **(EU Directive)**
- **Standard Document** - *"Standard for Road Tunnels, Bridges and Other Limited Access Highways"* **(NFPA 502)**
- **Guideline Document** - *"Fire and Smoke Control in Road Tunnels"* **(PIARC 1999)**

Regulations, Standards & Guidelines
Objective

Three specific documents will be compared

- **Regulation Document** – **(EU Directive)**
  - È *"Directive 2004/54/EC of The European Parliament and of the Council on Minimum Safety Requirements for Tunnels in the Trans-European Road Network"*
- **Standard Document** - **(NFPA 502)**
  - È *"Standard for Road Tunnels, Bridges and Other Limited Access Highways"*
- **Guideline Document** - **(PIARC 1999)**
  - È *"Fire and Smoke Control in Road Tunnels"*

Regulations, Standards & Guidelines
Regulation Document – EU Directive

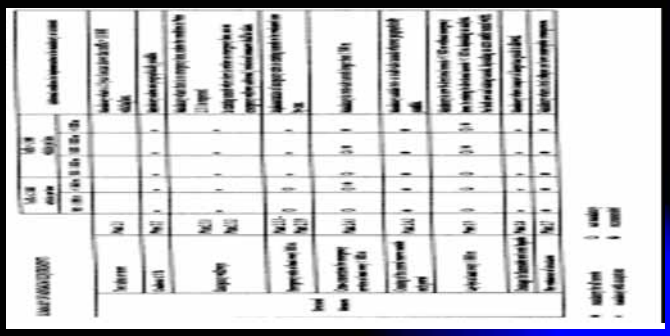
Directive 2004/54/EC was developed by the European Parliament and the Council as the required minimum safety requirements for all tunnels belonging to the trans-European road network.

The directive as adopted is dated 29 Aril 2004.

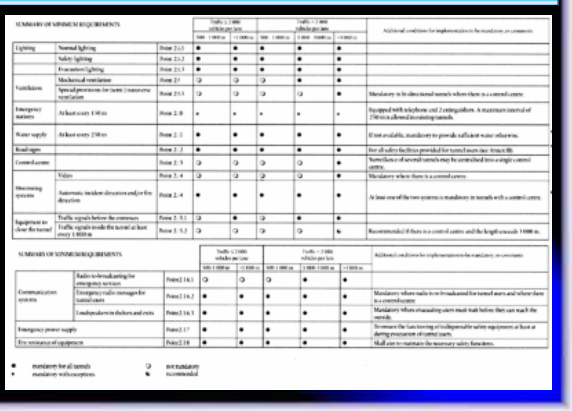
Regulations, Standards & Guidelines
Regulation Document – EU Directive

Fire Safety System Requirements - EU Directive, which is extracted from the EC Directive document, clearly shows the specific fire protection and fire safety systems requirements for all tunnels on the trans-European road network over 500 meters in length.

Regulations, Standards & Guidelines
Regulation Document – EU Directive



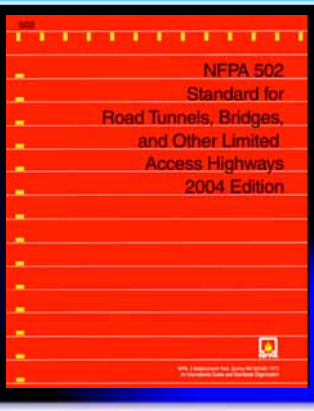
Regulations, Standards & Guidelines
Regulation Document – EU Directive



Regulations, Standards & Guidelines
Standard Document – NFPA 502

Standard for Road Tunnels, Bridges and Other Limited Access Highways

Provides fire protection and fire life safety requirements for road tunnels, bridges and other roadways including those that are located beneath air-right structures



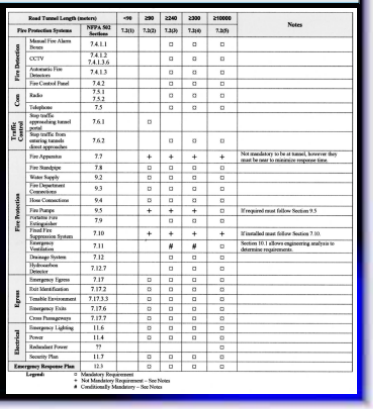
Regulations, Standards & Guidelines
Standard Document – NFPA 502

The 2004 edition of the standard has been published with numerous revisions including new technical provisions for analysis of the protection of concrete and steel tunnel structures, clarification of the use of closed-circuit television monitoring for automatic fire detection, new requirements for emergency lighting and illumination of the tunnel roadways, new language to focus on tunnel security issues, and updated Annex material regarding fire data for typical vehicles.

Regulations, Standards & Guidelines
Standard Document – NFPA 502

Fire Safety System Requirements

Mandated by NFPA 502 for road tunnels.



Road Tunnel Length (meters)			<90	290	≥240	≥300	≥10000	Notes
Fire Protection Systems		NFPA 502 Section	7.2(1)	7.2(2)	7.2(3)	7.2(4)	7.2(5)	
Fire Detection	Manual Fire Alarm Boxes	7.4.1.1			□	□	□	
	CCTV	7.4.1.2 7.4.1.3.6			□	□	□	
	Automatic Fire Detection	7.4.1.3			□	□	□	
Com	Fire Control Panel	7.4.2			□	□	□	
	Radio	7.5.1 7.5.2			□	□	□	
	Telephone	7.5			□	□	□	
Traffic Control	Stop traffic approaching tunnel upon activation	7.6.1		□				
	Stop traffic from entering tunnels direct approaches	7.6.2			□	□	□	
Fire Protection	Fire Apparatus	7.7		+	+	+	+	Not mandatory to be at tunnel, however they must be near to minimize response time.
	Fire Standpipe	7.8		□	□	□	□	
	Water Supply	9.2		□	□	□	□	
	Fire Department Connections	9.3		□	□	□	□	
	Hose Connections	9.4		□	□	□	□	
	Fire Pumps	9.5		+	+	+	□	If required must follow Section 9.5
	Portable Fire Extinguisher	7.9			□	□	□	
	Fixed Fire Suppression System	7.10		+	+	+	+	If installed must follow Section 7.10.
	Emergency Ventilation	7.11			#	#	□	Section 10.1 allows engineering analysis to determine requirements.
	Drainage System	7.12			□	□	□	
	Hydrocarbon Detector	7.12.7			□	□	□	
Egress	Emergency Egress	7.17		□	□	□	□	
	Exit Identification	7.17.2		□	□	□	□	
	Tenable Environment	7.17.3.3		□	□	□	□	
	Emergency Exits	7.17.6		□	□	□	□	
	Cross Passageways	7.17.7		□	□	□	□	
Electrical	Emergency Lighting	11.6		□	□	□	□	
	Power	11.4		□	□	□	□	
	Redundant Power	??			^		□	
	Security Plan	11.7		□	□	□	□	
Emergency Response Plan		12.3		□	□	□	□	

Legend:
- + Mandatory Requirement
- # Not Mandatory Requirement – See Notes
- ^ Conditionally Mandatory – See Notes

Regulations, Standards & Guidelines
Guideline Document – PIARC 1999

This technical report, entitled *"Fire and Smoke Control in Road Tunnels"* was published in 1999 in conjunction with the XXI[st] World Road Congress in Kuala Lumpur.

Regulations, Standards & Guidelines
Guideline Document – PIARC 1999

This 1999 report presented the "state-of-the-art" assessment prepared by the Technical Committee C5 (now C3.3) and its Working Group 6. It was intended for all those who are interested in road tunnel planning, design, construction, operation or safety: owners, consultants, operators, researchers, regulators and emergency responders. It provides an overview and recommendations, as well as the background on the way to provide reasonably efficient and cost-effective systems to protect against fire and smoke in road tunnels. It also provides references that are useful to obtain further details. This report became one of the "best selling" publications in PIARC history and went into its second printing in 2004.

Regulations, Standards & Guidelines
Guideline Document – PIARC 1999

Table of Contents for this guideline document, the technical report titled *"Fire and Smoke Control in Road Tunnels"* (PIARC 1999)

Regulations, Standards & Guidelines
Comparison – Critical Systems

- Fire Detection System
- Portable Fire Extinguishers
- Water Supply System
- Standpipe
- Hydrants/Hose Connections
- Fire Department Connections
- Fixed Fire Fighting System
- Drainage System
- Communications System
- Emergency Exits
- Emergency Ventilation System
- Structure resistance to fire

Regulations, Standards & Guidelines
Comparison Systems

- Water Supply System
- Fire Detection System
- Emergency Exits
- Emergency Ventilation System
- Hydrants/Hose Connections
- Portable Fire Extinguishers
- Fixed Fire Fighting System

Regulations, Standards & Guidelines
Comparison – Water Supply System

- EU Directive
  - Application Criterion
    - Required in all tunnels longer than 500 meters
  - Required Capacity
    - Not Addressed
- NFPA 502
  - Application Criterion
    - Required in all tunnels longer than 90 meters
  - Required Capacity
    - 1 hour at 1,920 L/min
- PIARC 1999
  - Application Criterion
    - Recommended
  - Recommended Capacity
    - 1,000 L/min at 0.5 mPa

Regulations, Standards & Guidelines
Comparison – Fire Detection System

- EU Directive
  - Application Criterion
    - Required in all tunnels longer than 500 meters
- NFPA 502
  - Application Criterion
    - Required in all tunnels longer than 300 meters*
- PIARC 1999
  - Application Criterion
    - Recommended

* 240 m when the maximum distance from any point within the tunnel to a point of safety exceeds 120 m

Regulations, Standards & Guidelines
Comparison – Emergency Exits

- EU Directive
  - Application Criteria
    - Required in all tunnels longer than 500 meters
      and
    - Tunnel Traffic is greater than 200 vpl (vehicles per lane)
  - Required Spacing
    - Spacing shall not exceed 500 meters
- NFPA 502
  - Application Criterion
    - Required in all tunnels longer than 300 meters
  - Required Spacing
    - Spacing shall not exceed 90 meters
- PIARC 1999
  - Application Criterion
    - Recommended
  - Recommended Spacing
    - Spacing should be 100 meters to 200 meters

Regulations, Standards & Guidelines
Comparison – Emergency Ventilation

- EU Directive
  - Emergency ventilation required when:
    - Tunnel length is 1,000 meters or greater
      and
    - Tunnel Traffic is greater than 200 vpl
- NFPA 502
  - Emergency ventilation required
    - Tunnel length is 300 meters* or greater
- PIARC 1999
  - Emergency ventilation recommended
    - No specific application criteria specified

* 240 m when the maximum distance from any point within the tunnel to a point of safety exceeds 120 m

Regulations, Standards & Guidelines
Comparison – Hydrants

- EU Directive
  - Application Criterion
    - Required in all tunnels longer than 500 meters
  - Required Spacing
    - Spacing shall not exceed 250 meters
- NFPA 502
  - Application Criterion
    - Required in all tunnels longer than 90 meters
  - Required Spacing
    - Spacing shall not exceed 85 meters*
- PIARC 1999
  - Application Criterion
    - Recommended
  - Recommended Spacing
    - Spacing should be 100 meters to 200 meters

*No location on the protected roadway shall be more than 45 m from the hydrant

Regulations, Standards & Guidelines
Comparison – Portable Fire Extinguishers

- EU Directive
  - Application Criterion
    - Required in all tunnels longer than 500 meters
  - Required Spacing
    - Existing tunnels - spacing shall not exceed 250 meters
    - New tunnels - spacing shall not exceed 150 meters
- NFPA 502
  - Application Criterion
    - Required in all tunnels longer that 300 meters*
  - Required Spacing
    - Spacing shall not exceed 90 meters
- PIARC 1999
  - Application Criterion
    - Recommended
  - Recommended Spacing
    - Spacing should be 100 meters to 200 meters

Regulations, Standards & Guidelines
Comparison – Fixed Fire Fighting System

The application of fixed fire fighting systems to road tunnels is still evolving. These systems are not yet universally accepted as a legitimate fire protection and fire safety system in road tunnels by the industry.

- EU Directive
  - Application Criterion
    - Not addressed
- NFPA 502
  - Application Criterion
    - Not required but permitted
- PIARC 1999
  - Application Criterion
    - Optional

Regulations, Standards & Guidelines
Comparison

Comparison Table

This table provides a concise direct comparison of the technical requirements of the three documents being examined

Regulations, Standards & Guidelines
Comparison

Location of Fire Safety Requirements and Recommendations

Locate specific fire protection and fire safety requirements and recommendations contained in each of the three documents being compared.

Regulations, Standards & Guidelines
Conclusions

It is clear that each of the documents examined provides a differing albeit sometimes a small difference in setting or suggesting the criteria for the design of fire safety systems in road tunnels. This does not mean that any of them are wrong, as they have each been developed from a different vantage point. The standard and the regulation are developed to set a minimum level of fire safety making it incumbent on the tunnel owner to provide a safe facility while the guidelines provide simply a guide to good and safe design.

Regulations, Standards & Guidelines
Future Issues

The two most significant future issues most likely to be considered by both the PIARC and NFPA Technical Committees related to road tunnels the issue of the installation of automatic fire fighting systems (FFFS) in road tunnels and the determination of the proper size of the vehicle fire to be employed in the road tunnel safety design process.

Regulations, Standards & Guidelines
Fixed Fire Fighting Systems

- PIARC Position **(1999)**
  - è "… sprinklers (FFFS) are generally not considered as cost-effective and are not recommended in usual road tunnels."
- NFPA Position **(2004)**
  - è "… the use of sprinklers (FFFS) in road tunnels generally is not recommended."

Regulations, Standards & Guidelines
Future Issues – NFPA 502

- The 2007 Edition of NFPA 502 is currently being prepared and should be available to the industry in the fall of 2007.

NFPA 502
Potential Issues

- Fixed Fire Fighting Systems (FFFS) [7.10 + Annex D]
  - A total rewrite
    - New Table on US Tunnels with FFFS
- Definitions [3.2]
  - Improved and additional definitions
- Design Fire Size [10.5.1 + Annex A]
  - New table
- Applicability of Standard to Tunnels [7.2]
  - Based on length, new table
- Fire Detection [7.4]
  - Improved requirements
- Tenable Environment [Annex B]
  - New material
- Wires and Cable [11]
  - Improved requirements
- Control of Hazardous Materials [13]
  - New requirements
- SI Units [1.6]
  - Corrected conversion factors and additional values

Regulations, Standards & Guidelines
Future Issues ~ PIARC

There are several technical reports, which will contain guidelines related to road tunnel fire safety currently being prepared by PIARC Technical Committee C3.3 (Working Group 6) all of which may be published sometime in the period 2006 to 2008. The titles of these documents are as listed below:

Road Tunnels: Systems and Equipment for Fire and Smoke Control

Road Tunnels: A Guide to Optimising the Air Quality Impact upon The Environment

Road Tunnels: Operation Strategies for Tunnel Ventilation

Road Tunnels: An Assessment of Fixed Fire Fighting Systems

Road Tunnels: Update of Design Fire Size

Thank you for your Kind Attention