Today’s Moderator and Presenters

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Today’s Presenters (cont.)

Jesus Rohena, Federal Highway Administration, Jesus.Rohena@dot.gov

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Introductory Remarks

Mary Lou Ralls
Ralls Newman, LLC
Chair of TRB’s Design and Construction Group

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TRB Announcements:

- We have emailed you the presenters’ slides in today’s webinar reminder email.

- Upcoming webinars:
  
  **Nighttime Seat Belt Enforcement: Background and Recent Findings**: March 9, 2 PM EST
  
  **A Master United States Catalog of Subgrade Soil-Water Characteristic Curve Default Input Values for the MEPDG**: March 17, 2 PM EDT
  

- Follow TRB on Twitter @TRBofNA [http://twitter.com/TRBofNA](http://twitter.com/TRBofNA)
Underground Transportation Systems

Safety, Operations & Emergency Response

by

Steve Ernst, P.E., FHWA Co-Chair
M.G. Patel, P.E., AASHTO Co-Chair
and the Scan Team

International Technology Scanning Program

Federal Highway Administration
American Association of State Highway and Transportation Officials
National Cooperative Highway Research Program
An Eleven Member Team of Tunnel Experts Representing:

State and Federal Government
Transportation Authorities
The Private Sector

The Team Visited Six European Countries and Met With Representatives From Three Others
UTS Scan Locations Visited

Yellow - countries visited
Blue - representatives from these countries joined the meetings

September 23 - October 9, 2005
Modes

- Highway tunnels
- Passenger rail tunnels
- Freight rail tunnels
Focus

Tunnel Systems and Designs

- Fire and blast protection and response, refuge areas, evacuation planning and passages

Arrangements of Components

- Maximize effectiveness, assure inspectability and maintainability, promote cost savings
Tunnel Operations

- Incident detection and deterrent technology
- Incident response and recovery planning

Specialized Technologies and Standards

- Monitoring or inspecting structural elements
- Operating equipment to ensure optimal performance
- Minimize downtime during maintenance or rehabilitation
Safety and Security Aspects

- Planning approaches
- Standards
- Manpower roles and responsibilities
- Communication techniques
- State-of-the-art products and equipment
- Education for users
Findings

34 technologies of interest

- 9 for further consideration

Key:

- Innovative design and emergency management
- Used for both natural and man-made disasters
Gotthard Tunnel Fire on October 24, 2001
Fire Issues

- Fire can quickly grow out of control in a tunnel
- Heat, smoke, and fumes are extremely dangerous
- Rescue and fire fighting may be very difficult
- Fire and smoke control is highly dependant on the ventilation system
Findings - 1

Escape Route Signs

- Uniformity Promotes Understanding
- Confusion is Minimized
- Engage Visual, Audible, and Tactile Senses

For U.S. Practice We Should Consider

- National Fire Protection Association Standards
- Manual on Uniform Traffic Control Devices
Guidelines for Existing and New Tunnels

• Need AASHTO tunnel guidelines
  - Planning, design, construction, maintenance, inspection, and operations
Tunnel Emergency Management Guidelines

- Human Factors

• Behavior hard to predict during emergency.
• People are their own first rescuers.
• People must react correctly and quickly.
• Guidelines must account for this human behavior.
• Guidelines should be included in tunnel planning, design, and emergency response.
Education for Motorist Response to Tunnel Incidents

• Self-rescue is best first response in tunnel incident.
• It is important to react quickly and correctly.
• Motorists are not clear on needed action.
Issues to consider: Emergency pull-out areas and variable message signs
Self Rescue
Issues to consider: Refuge room requirements
Automatic Incident Detection Systems
& Intelligent Video

- Automatically detects, tracks, and records incidents.*
- Tells operator to observe event in question.
- Allows operator to take appropriate action.

* This concept can also be applied to detect other activities and incidents in areas besides tunnels, from terrorist activities to accidents, vandalism and other crimes, fires, vehicle breakdowns, etc.
Design Criteria to Promote Optimal Driver/User Performance and Response to Incidents

- Designers - be aware of ways to minimize fire and traffic safety hazards
- Evaluate materials and design details
Emergency alcoves & shelters every 656 feet

One-way Traffic on Each Level

Independent Ventilation at each level

Uniform & Consistent Signs

A86 East Tunnel
One-Button Emergency Response & Automated Sensor Systems

- To “Take action immediately!” the operator must initiate several actions simultaneously.
- “Press one button”
  - Initiates several critical actions
  - Eliminates operator chance to omit important step or perform action out of order
- Automated sensor systems are helpful in determining response, e.g., opacity sensors.
Several actions are initiated by moving a yellow line over the area of a fire incident.
Mont Blanc Tunnel Fire Fighting Truck
Risk-Management for Tunnel Safety Inspection & Maintenance

- European use of risk-based methodologies for:
  - Safety inspection time and frequency
  - Maintenance/rehabilitation scope and timing

- Inspect less-critical or more-durable portions of system less frequently and concentrate inspections on more critical or fragile components.
Findings - 9

Light-Emitting Diode (LED) Lighting for Edge Delineation & Safe Vehicle Distance

- Lights identify edge of roadway

- Blue lights identify safe vehicle spacing
  - Blue lights are spaced among the edge delineation lights
  - More reliable than speed-based guidelines
LED Lights on Outside Roadway Edges in Grilstad Tunnel in Norway
LED Lights for Edge Delineation and Vehicle Spacing in Mont Blanc Tunnel
Thank You

International Technology Scanning Program

NCHRP 20-68A, Scan 09-05
U.S. Domestic Scan Program
Disclosure

This scan is being conducted as a part of NCHRP Project 20-68A, the U.S. Domestic Scan program. The program was requested by the American Association of State Highway and Transportation Officials (AASHTO), with funding provided through the National Cooperative Highway Research Program (NCHRP). The NCHRP is supported by annual voluntary contributions from the state Departments of Transportation. Partial support for selected scans is provided by the U.S. Federal Highway Administration or other agencies. Each scan is selected by AASHTO and the NCHRP 20-68A Project Panel to address a single technical topic of broad interest to many state departments of transportation and other agencies. The purpose of each scan and of Project 20-68A as a whole is to accelerate beneficial innovation by (a) facilitating information sharing and technology exchange among the states and other transportation agencies and (b) identifying actionable items of common interest.

Further information on the NCHRP 20-68A U.S. Domestic Scan program is available at http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1570"
Background

Recent events have highlighted the need for **national tunnel standards** for new and existing tunnels:

- Suspended tunnel ceiling collapse in Boston
- Truck tunnel fire in southern California
- Tunnel roof cracking in Colorado
- Tunnel flooding in Virginia

2005 Tunnel Scan
2009 Domestic Tunnel Scan

- Purpose:
  - Assist in addressing the need for national tunnel standards & a national tunnel inventory
  - Investigate tunnels on state, regional, & local highway systems
Domestic Tunnel Scan Development

- Scan proposal approved December 2008
- Planning meeting held May 2009
- Scan conducted August - September 2009
Scan Focus

- Design & construction standards practiced by state DOTs & other tunnel owners
- Maintenance & inspection practices
- Operations, including safety as related to emergency response capability
- Specialized tunnel technologies
- Inventory criteria used by tunnel owners
Scan Focus

- Including:
  - Fire suppression
  - Traffic management
  - Incident detection & management
  - Analysis, design, & construction repairs of existing tunnels
Amplifying Questions – Key Topics

- **Topic 1** – Specialized technologies currently used for existing and new U.S. roadway tunnel design, construction, maintenance, inspection, and operations

- **Topic 2** – Standards, guidance, and best practices for existing and new roadway tunnels in the U.S.

- **Topic 3** – Current criteria used by owners and states to identify tunnels in their inventory

Specific questions for Topics 1 & 2 were grouped by design, construction, maintenance, inspection, operations, and a general topics group
Scan Team Members

Central Artery Tunnel, Massachusetts Turnpike Authority
Scan Team Members

State DOTs:
- Kevin Thompson, Co-Chair, CA
- Alexander Bardow, MA
- Bijan Khaleghi, WA
- Louis Ruzzi, PA
- Michael Salamon, CO

FHWA:
- Jesus Rohena, Co-Chair
- Barry Brecto

TRB Tunnels Committee:
- Fulvio Tonon, UT-Austin

Report Facilitator:
- Mary Lou Ralls, TX

NCHRP Contract:
- Harry Capers, Principal Investigator, Arora and Associates
Scan Hosts

**East Coast:**
- Chesapeake Bay Bridge and Tunnel District
- Massachusetts Turnpike Authority
- Port Authority of New York and New Jersey
- Virginia DOT

**Western U.S.:**
- Caltrans
- Colorado DOT
- Washington State DOT
  - Seattle DOT
  - Sound Transit

**Web Conferences:**
- Alaska DOT
- District of Columbia DOT
- Pennsylvania DOT
Itinerary

August 30 – September 5, 2009
- Boston, MA
  - PennDOT Webinar
- New York/New Jersey
- Hampton Roads VA
  - Washington DC DOT Webinar

September 13 – 19, 2009
- Denver, CO
- Seattle, WA
  - Alaska DOT Webinar
- San Francisco, CA
Findings/Recommendations – 1

Develop standards, guidance, and best practices for roadway tunnels.

- Develop design criteria for new tunnels
- Consider future rehabilitation
- Use subject matter experts in advisory role
- Develop design & construction standards & guidelines for tunnel construction methods
Findings/Recommendations – 2

Develop emergency response system unique to each facility, considering human behavior, facility ventilation, & fire mitigation.

- Perform facility fire ventilation study & develop plan; consider realistic spread of fire & smoke including toxic gases & heat, & effect of ventilation types on fire
- Considering human instinctive response, improve facility procedures to direct public to safety
  - Consider better signage & intelligible public address systems
- Consider additional research on spread of fire & smoke & how people react
Findings/Recommendations – 3

Develop & share inspection practices among tunnel owners.

- Make tunnel inspection programs as similar as possible to bridge inspection programs
- Load rate per AASHTO *Manual for Bridge Evaluation*; do structural analyses after physical or load changes
- Develop inspection frequencies, minimum coding requirements, & federal coding manual
- Develop baseline data inventory for tunnels
- Communicate best practices
Consider inspection & maintenance operations during design stage.

- Involve all disciplines in design phase
  - Provide adequate, safe, & unimpeded access to all components
  - Tradeoffs between access & a practical design have cost & safety impacts for inspection & maintenance over life of tunnel
Findings/Recommendations – 5

Develop site-specific plans for safe & efficient operation of roadway tunnels.

- Develop concise site-specific operations manual
- Implement state-of-the-art video surveillance & communication systems
- Develop separate incident response manual
- Restrict hazardous cargo or if no alternate route, develop well-defined emergency response & ventilation plan
A tunnel includes a long-term commitment to provide funding for preventive maintenance, system upgrades, & training/retention of operators.

- Develop proactive plan that considers life-cycle costs and establishes target level of condition, system reliability, & performance
- Consider future availability of replacement parts
- Develop preservation guidelines for funding purposes
- Develop financial mgmt. plan with separate funding
- Develop training, retention, & succession plan
Findings/Recommendations – 7

Share existing technical knowledge within industry to design a tunnel.

- Provide range of practical tunnel design options
- File design documents electronically with backup for easy retrieval by controlling owner
- Share details & best practices while maintaining security
Findings/Recommendations – 8

Provide education & training in tunnel design & construction.

- Offer graduate tunneling courses in university civil engineering programs
- Provide highway tunnel owner & FHWA engineers with access to academic & industry education & training on tunnels
  - Include on-line courses & certificates
Implementation of Findings & Recommendations

- A step in process of developing national standards & guidance
- Provides data for consideration in development of national tunnel inventory
- Implementation lead: AASHTO HSCOBS Technical Committee for Tunnels (T-20) in conjunction with FHWA & TRB Tunnels & Underground Structures Committee (AFF60)
Implementation of Findings & Recommendations

- Planned activities:
  - Distribution of tunnel safety brochure
  - Research coordination & development of need statements
  - Technical presentations
  - Webinars
  - Articles & papers
Roadway Tunnel Related Topics

- NCHRP Task 261 - Best Practices QC/QA for Tunnels
- NCHRP Task 276 - Development of Guidelines for Rehabilitation of Existing Highway and Rail Transit Tunnels
- AASHTO HSCOBS (T-11) research proposal “LRFD Specifications” for Roadway Tunnels
- TRB SHRP 2 - High-Speed Nondestructive Testing Methods for Defects Behind or Within Tunnel Linings
- Advanced Notice of Proposed Rulemaking

Thank You
NBIS (23 CFR 650)

- FHWA bridge inspection regulations were developed as a result of the Federal Aid Highway Act of 1968 (23 U.S.C. 151).
  - But, tunnels were not included.
The tunnels are getting older

- The majority range in age from 51 to 100 years.

<table>
<thead>
<tr>
<th>TUNNEL AGE</th>
<th>YEAR CONSTRUCTED</th>
<th>NUMBER OF TUNNELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10 YEARS</td>
<td>1991 or Later</td>
<td>31</td>
</tr>
<tr>
<td>11 to 20</td>
<td>1981 to 1991</td>
<td>24</td>
</tr>
<tr>
<td>21 to 30</td>
<td>1971 to 1980</td>
<td>23</td>
</tr>
<tr>
<td>31 to 40</td>
<td>1961 to 1970</td>
<td>59</td>
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<tr>
<td>41 to 50</td>
<td>1951 to 1960</td>
<td>48</td>
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<tr>
<td>51 to 100</td>
<td>1901 to 1950</td>
<td>139</td>
</tr>
<tr>
<td>&gt;100</td>
<td>1900 or prior</td>
<td>13</td>
</tr>
</tbody>
</table>
Why an NTIS?

- Currently, there is no uniformity on how frequent tunnels are inspected.
- The frequency of tunnel inspections varies from one month to 10 years.
- Some owners in cold climates walk through air ducts on a daily basis to identify potential icing problems due to water leakage.
- Some owners inspect mechanical and electrical equipment on daily basis and many other perform such inspections on a monthly basis.
Why an NTIS?

• The proposed NTIS is closely aligned with the Grand Challenges identified by the AASHTO Subcommittee on Bridges and Structures in their report published in June 2005. This includes: Challenge 1, *Extending the Service Life of Tunnels*; and Challenge 5, *Monitoring Bridge (Tunnel) Condition*. 
Falling debris killed passenger in tunnel

Concrete panels fell from the ceiling of Boston's Big Dig highway project, killing a woman in a car near the entrance to the Ted Williams Tunnel.
Purpose of the NTIS

• ... to locate, evaluate, and act on existing tunnels deficiencies to ensure the safety of the traveling public.
Why an NTIS?

• After the CA/T Ceiling collapse, the National Transportation Safety Board (NTSB) recommended that the FHWA seek legislative authority to establish a mandatory tunnel inspection program that would identify critical inspection elements and specify an appropriate inspection frequency.
Crack repairs
The eastbound lanes of Interstate 70 in the Hanging Lake Tunnel will be closed through the summer as crews fix a large crack in a concrete slab. Rockfall and debris have placed stress on the concrete, causing a crack 70 feet long, 4 1/2 feet deep and 1 1/2 inches wide.
Repairing the tunnel

The Cinnamon Creek Complex was built in a cleft between two mountains that house the Hanging Lake Tunnel. The complex consists of a traffic-management center, ventilation chambers and man-made "transition" tunnels that link the mountain bors.

East tunnel entrance

Hanging Lake Trailhead

West tunnel entrance

Dirt and rock fill atop the eastbound tunnel must be removed before repairs.

The concrete-slab roof of the transition tunnel over the eastbound lanes has a crack 80 feet long — two-thirds the length of the slab.

The process

1. Monitoring devices will be installed to detect movement in the crack. The roof will then be supported with braces. The crack will be filled with an epoxy sealant.

2. Holes will be drilled through the slab every 2 feet in a grid pattern, and steel rods will be inserted through the holes, extending above and below the cracked slab.

3. Inside the tunnel, shotcrete, a high-strength concrete shot out of a gun, will form a bottom slab layer that bonds with the cracked roof slab and the steel rods.

4. A new layer of reinforced concrete will be poured atop the cracked roof slab, bonding with the steel rods.

Source: Colorado Department of Transportation

Joe Watts and Thomas McKay | The Denver Post
NTIS Tunnels

- More than 300 Highway Tunnels in the US
- Average age Tunnels is 44 years.
- Average age for Interstate system tunnels is 39 years.
- Some tunnels have other components than structural elements that need to be inspected also, like electrical, mechanical, ventilation, fire safety and security systems.
NTIS will establish

- Inspection procedures
- Inspectors qualifications
- Frequency of inspections
- Element based system
- Tunnel Inventory Database
- Training
CA Truck Tunnel Disaster
(October 2007)
Accomplished, ongoing, and future activities

• Reference manuals
  – FHWA/FTA Inspection Guidelines for rail and road tunnels – available
  – FHWA/FTA Maintenance and Rehabilitation for rail and road tunnels – available

• TMS software - available

• FHWA LRFD Tunnel Design Manual-available

• NHI Tunnel Inspector Training course – needed

• NHI National Tunnel Inventory Database - needed
Accomplished, ongoing, and future activities

- SHRP 2 Project Rapid NDT detection of voids and anomalies within and beyond tunnel linings – Ongoing
- AASHTO, FHWA, NCHRP International Tunnel Scan - 2005
- AASHTO, FHWA, NCHRP Domestic Tunnel Scan – 2009.
Notice of Proposed Rulemaking (NPRM)

• On November 2008, FHWA published an ANPRM for soliciting comments from AASHTO and all interested and knowledgeable parties to develop a NTIS.
• The ANPRM closed on February 2009.
• The FHWA has prepared a Notice of Proposed Rule Making (NPRM) to address the comments received.
• The next step is to publish the NPRM by early 2010.
Conclusions

• Tunnels should be inspected
• A National Tunnel Inventory Database is needed
• Tunnels are more complex than bridges, therefore all systems must be inspected and tested
• NTIS should be separate from NBIS
Our challenge is to make our tunnels safer than yesterday and tomorrow safer than today.

Any Questions

Thank You!
Overview of Four Manuals Related to Tunnels

Chester L. Allen, P.E.
Senior Vice President
AGENDA

- *FHWA Highway and Rail Transit Tunnel Inspection Manual* – 2005 (Gannett Fleming)

- *FHWA Highway and Rail Transit Tunnel Maintenance and Rehabilitation Manual* – 2005 (Gannett Fleming)

- *FHWA Road Tunnel Design and Construction Manual* – 2010 (Parsons Brinkerhoff)

Objectives

• FHWA and FTA foresaw the need in 2002 to give greater emphasis on inspecting and maintaining tunnels as many are aging (>50 years old).

• No national requirement existed for inspection/reporting of inspection results to FHWA or FTA.
Objectives

• FHWA/FTA as OneDOT desired to provide guidance to existing tunnel owners who may not have an in-house manual to use for conducting their inspections.

• Both manuals were to be a living document that would be updated over time as new methods, materials and equipment became available in the marketplace.
FHWA HIGHWAY AND RAIL TRANSIT TUNNEL INSPECTION MANUAL – 2005
CHAPTER 1: INTRODUCTION

CHAPTER 2: TUNNEL CONSTRUCTION AND SYSTEMS

A. Tunnel Types
B. Ventilation Systems
C. Lighting Systems
D. Other Systems/Appurtenances
CHAPTER 3: FUNDAMENTALS OF TUNNEL INSPECTION

A. Inspector Qualifications
B. Responsibilities
C. Equipment/Tools
D. Preparation
E. Methods of Access
F. Safety Practices
CHAPTER 4: INSPECTION PROCEDURES

A. Inspection of Civil/Structural Elements
B. Inspection of Mechanical Systems
C. Inspection of Electrical Systems
D. Inspection of Other Systems and Appurtenances
CHAPTER 4: INSPECTION PROCEDURES

CHAPTER 5: INSPECTION DOCUMENTATION
A. Field Data
B. Repair Priority Definitions
C. Reports
FHWA HIGHWAY AND RAIL TRANSIT TUNNEL MAINTENANCE AND REHABILITATION MANUAL – 2005
CHAPTER 1: INTRODUCTION

CHAPTER 2: TUNNEL CONSTRUCTION AND SYSTEMS – a repeat of the same chapter that was included in the Inspection Manual
CHAPTER 3: PREVENTIVE MAINTENANCE

A. Preventive Maintenance of the Tunnel Structure
B. Preventive Maintenance of Mechanical Systems
C. Preventive Maintenance of Electrical Elements
D. Preventive Maintenance of Track Systems
E. Preventive Maintenance of Miscellaneous Appurtenances
CHAPTER 4: REHABILITATION OF STRUCTURAL ELEMENTS

A. Water Infiltration
B. Concrete Repairs – where water may not be present
C. Liner Repairs
FHWA ROAD TUNNEL DESIGN AND CONSTRUCTION MANUAL - 2010
CHAPTER 1: PLANNING

- Describes the planning process of a road tunnel, alternative analyses for tunnel selection, and a tunnel type study
- Identifies other references, key issues of risk management during design and construction, and a perspective to the operational and financial planning of a road tunnel
CHAPTER 2: GEOMETRICAL CONFIGURATION

- Identifies key guidelines for the geometrical configuration of road tunnels

- Discusses requirements for horizontal and vertical alignment requirements, and tunnel clearance/cross sectional requirements
CHAPTER 3: GEOTECHNICAL INVESTIGATIONS

- Describes the process of a geotechnical investigation program for road tunnels, the importance of a “phased” investigation approach, the need for investigation during excavation and construction of mined/bored tunnels

- Identifies common testing methods for determining the permeability of soils and for determining the in-situ stress condition in rock
CHAPTER 4: GEOTECHNICAL REPORTS

- Describes the common types of geotechnical reports required for design and construction of road tunnels

- Identifies information required to be documented in the reports, and identifies interpretations and analysis needed for geotechnical interpretive reports
FHWA ROAD TUNNEL DESIGN AND CONSTRUCTION MANUAL - 2010

CHAPTER 5: CUT AND COVER TUNNELS

- Describes the design process for cut and cover tunnels
- Provides a description of loadings for design and an understanding of construction methods and support of excavation methods
- Discusses ground water control issues, methods for controlling groundwater, and maintenance/protection of traffic and utility support/relocation
CHAPTERS 6 – 9 : Discusses mined/bored tunneling design, loadings, and construction issues. Also, describes selection of temporary supports of excavation and input for permanent lining design for the four methods of construction below:

CHAPTER 6: ROCK TUNNELING
CHAPTER 7: SOFT GROUND TUNNELING
CHAPTER 8: TUNNELING IN DIFFICULT GROUND
CHAPTER 9: SEQUENTIAL EXCAVATION METHOD (SEM)
CHAPTER 10: TUNNEL LINING

- Lists various materials and methods used to construct tunnel linings, loads to be applied including soil-structure interaction, and the process for design and construction of permanent tunnel linings
CHAPTER 11: IMMERSED TUNNELS

- Describes the design process
- Identifies common types and subtypes
- Discusses loadings, the structural design process, water tightness, and waterproofing methods
- Identifies element placement, joining, and backfilling issues
CHAPTER 12: JACKED BOX TUNNELS

- Provides basic principles of jacked box tunneling (JBT) and review of JBT on the Central Artery Tunnel project
- Provides loads and structural considerations
- Discusses ground control and other considerations
CHAPTER 13: SEISMIC CONSIDERATIONS

- Provides information on determination of environment
- Identifies factors that influence tunnel seismic performance, and seismic evaluation procedures for ground shaking effects and ground failure effects
CHAPTER 14: TUNNEL CONSTRUCTION ENGINEERING

- Discusses constructability staging and sequencing, guidance on mucking and disposal, health and safety concerns, cost drivers and elements and identifies political costs

- Emphasizes the importance of a realistic schedule

- Discusses claims avoidance and disputes resolution
CHAPTER 15: GEOTECHNICAL AND STRUCTURAL INSTRUMENTATION

- Discusses ground movements – vertical and lateral deformations, tunnel deformation, and groundwater behavior.

- Identifies the need for monitoring of existing structures and dynamic ground movement

- Provides for instrumentation management
CHAPTER 16: TUNNEL REHABILITATION

- Provides for tunnel inspection and identification parameters
- Discusses groundwater intrusion and repair materials
- Provides guidance for structural repair of concrete, injection of cracks, segmental lining repair, steel repairs, masonry repairs, and rock lined tunnel repairs
AASHTO SCOBS Voted to adopt the FHWA version of the Tunnel Manual as an AASHTO Publication in July 2009

Balloted version of the Tunnel Manual currently being published with T-20 review

AASHTO to role out this Manual by mid year 2010
NATIONAL FIRE PROTECTION ASSOCIATION 502 – STANDARD FOR ROAD TUNNELS, BRIDGES AND OTHER LIMITED ACCESS HIGHWAYS – 2008 EDITION
CHAPTER 1: ADMINISTRATION

1.1 Scope

1.1.1 This standard provides fire protection and fire life safety requirements for limited access highways, road tunnels, bridges, elevated highways, and roadways that are located beneath air-rights structures.

1.1.2 This standard establishes minimum requirements for each of the identified facilities.

1.1.4 This standard is applicable where a facility is deemed appropriate by the authority having jurisdiction.
CHAPTER 3: DEFINITIONS

3.3.38 Road Tunnel. An enclosed roadway for motor vehicle traffic with vehicle access that is limited to portals

CHAPTER 7: ROAD TUNNELS

7.2 Application. For the purpose of this standard, tunnel length shall dictate the minimum fire protection requirements, as follows:

(1) Category X – Where tunnel length is less than 90 m (300 ft.), the provisions of this standard shall not apply
CHAPTER 7: ROAD TUNNELS (Continued)

(2) Category A – Where tunnel length is 90 m (300 ft) or greater, standpipe systems and traffic control systems shall be installed in accordance with the requirements of Chapter 9 and Section 7.6, respectively

(3) Category B – Where tunnel length equals or exceeds 240 m (800 ft) and where the maximum distance from any point within the tunnel to a point of safety exceeds 120 m (400 ft), all provisions of this standard shall apply
CHAPTER 7: ROAD TUNNELS (Continued)

(4) Category C – Where the tunnel length equals or exceeds 300 m (1000 ft), all provisions of this standard shall apply unless noted otherwise in this document.

(5) Category D – Where the tunnel length equals or exceeds 1000 m (3280 ft), all provisions of this standard shall apply.
7.4.1 At least two systems to detect, identify, or locate a fire in a tunnel shall be provided, including one manual means meeting the requirements of 7.4.1.2 and either a closed-circuit television (CCTV) system in accordance with 7.4.1.3 or an automatic fire detection system in accordance with 7.4.1.4.
CHAPTER 7: ROAD TUNNELS (Continued)

7.4.1.2 Manual Fire Alarm Boxes

7.4.1.2.1 Manual fire alarm boxes mounted in NEMA Enclosure Type-4 (IP 65) or equivalent boxes shall be installed at intervals of not more than 90 m (300 ft) and all cross-passages and means of egress from the tunnel.

7.4.1.3 Closed-Circuit Television (CCTV) Systems

7.4.1.4 Automatic Fire Detection Systems
CHAPTER 7: ROAD TUNNELS (Continued)

7.5 Communications Systems
7.6 Traffic Control
7.7 Standpipe, Fire Hydrants, and Water Supply
7.8 Portable Fire Extinguishers
7.9 Fixed Water-Based Fire-Fighting Systems
7.10 Emergency Ventilation
7.11 Tunnel Drainage System
7.12 Alternative Fuels
7.13 Control of Hazardous Materials
CHAPTER 7: ROAD TUNNELS (Continued)

7.14 Means of Egress

7.14.6.1 Emergency exits shall be provided throughout the tunnel spaced not more than 300 m (1000 ft) apart

7.14.7 Cross-Passageways

7.14.7.2 (1) Cross-passageways shall not be farther than 200 m (656 ft) apart
UPDATE

• This manual has undergone another update and is planned for release as the 2010 edition later this year.