

PIARC'S ROAD TUNNEL COMMITTEE: PAST AND FUTURE ACTIVITIES

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ABSTRACT

This paper presents the outputs of PIARC's road tunnel committee from the last work cycle 2016-2019 and summarizes the planned activities for the new work cycle 2020-2023. Topics include sustainable tunnel operation and maintenance, tunnel safety and resilience, tunnel ventilation, complex and heavily trafficked tunnels, vehicles with new propulsion technologies, ITS in tunnels and the PIARC Online Tunnel Manual.

Keywords: tunnel operation, tunnel safety & resilience, tunnel maintenance, Online Tunnel Manual, transport of dangerous goods, tunnel ventilation

1. INTRODUCTION

The World Road Association PIARC is an international, non-political, non-profit organization, established in 1909. The mission of PIARC is to promote international cooperation on issues related to roads and road transport. Since more than 100 years PIARC continues to foster and facilitate global discussion and knowledge sharing on roads and road transport. The Association now boasts 122 government members worldwide and retains consultative status to the Economic and Social Council of the United Nations. The main objective of PIARC is to facilitate exchange of knowledge on roads and road transport policy and practices within the context of integrated, sustainable transport. PIARC is worldwide acknowledged for the quality of its outputs. The work within PIARC is organized in Technical committees (TC) which are regularly nominated for a working period of 4 years (so-called work cycles). PIARC's tunnel committee is one of the oldest and one of the largest committees in PIARC. During the past decades the TC Tunnels has produced a total of approximately 45 technical reports, numerous articles in PIARC's quarterly magazine Routes/Roads, a comprehensive Online Tunnel Manual and many more contributions to international events. Work topics for the TC's are defined in the 4-years Strategic Plan [PIARC, 2020].

2. RESULTS OF THE 2016-2019 PIARC WORK CYCLE

During the last 4-year PIARC work cycle several technical reports [PIARC, 2019] and other outputs were produced by TC D.5 "Road tunnel operations".

In the following subchapters the content of these reports and other outputs is briefly summarized. All reports are published at least in English language on the PIARC website. The translations into French and Spanish, the other two working languages of PIARC, are in progress, for some reports already finished.

2.1. An introduction to the RAMS concept for road tunnel operations

Guaranteeing the **R**eliability, **A**vailability, **M**aintainability and **S**afety (RAMS) of road tunnel systems/equipment is an objective of all road tunnel operators. The European standard EN 50126, widely used to achieve RAMS in the rail sector, has been gaining increasing interest from the road transport sector in recent years, as its principles can quite easily be transposed. The report "An introduction to the RAMS concept for road tunnel operations (2019R05EN)" outlines why, when and how the RAMS concept can be applied to road tunnel operations and gives examples of countries which have adopted its principles at least in part. Recommendations for tunnel operators wishing to apply the RAMS standard are also presented in this report.

2.2. Prevention and mitigation of tunnel-related collisions

Many tunnel safety measures are rightfully aimed at controlling the risks of fires and dangerous goods. However, practice generally shows that most injuries and fatalities in tunnels are actually related to traffic incidents that could also happen on the open road. Usually, several causes contribute to a specific collision occurring in a tunnel, or in its direct vicinity. To improve tunnel safety, the tunnel operator (and other stakeholders) therefore needs to have an overview of the possible measures that can be taken to control the risk of collisions.

The report “Prevention and mitigation of tunnel-related collisions (2019R03EN)” summarizes the possible organizational and technical measures that can be implemented to prevent and /or mitigate collisions in which the specific characteristics of a tunnel play a role in either the cause or the effect.

2.3. General principles for improving accessibility for persons with reduced mobility in road tunnels

The number of persons with reduced mobility is set to rise, due to increases in aging populations and in chronic health conditions such as diabetes, obesity and cardiovascular disease. For these road tunnel users, reaching a place of safety during an incident that requires self-evacuation can be particularly challenging. Certain countries have begun to address this issue, but there is still a considerable way to go before full accessibility for all tunnel users becomes the norm. The technical report “General principles for improving accessibility for persons with reduced mobility in road tunnels (2019R20EN)” outlines the general principles that can be adopted to make allowance for persons with reduced mobility when designing or refurbishing a road tunnel. Examples of implementations from various countries are presented in the report.

2.4. Vehicle emissions and air demand for ventilation

Fresh-air requirements for adequate in-tunnel air quality are of particular importance in tunnels with high traffic volumes and frequent congestion. The emission standards for new vehicles are becoming increasingly stringent and the vehicle fleet is constantly being renewed. The data for calculating vehicle emissions and the resulting fresh-air demand consequently requires updating on a regular basis. The technical report “Road tunnels: Vehicle emissions and air demand for ventilation (2019R02EN)” gives an overview of the revised version of the 2012 PIARC report on vehicle emissions and fresh-air demand. This new report provides updated emission rates and an assessment methodology to support the tunnel ventilation system designer in establishing the minimum fresh-air demand for adequate in-tunnel air quality and visibility thresholds.

2.5. Large underground and interconnected infrastructures

The growing demand for mobility and the increase in large urban areas has naturally led to the development of underground road networks, which can sometimes be highly complex in their design. The technical report “Large underground and interconnected infrastructures: Report Part B – Specific analysis and recommendations (2019R42EN)” deals with specific challenges that such networks face and presents certain recommendations that can be issued with regard to ventilation, signage, operation and maintenance aspects.

2.6. Online Road Tunnel Manual

The Online Road Tunnels Manual is primarily aimed at developing countries with little or no tunnel culture and provides a wealth of information for tunnel operators, builders or designers and tunnels owners (administrations). All Working Groups of TC D.5 have undertaken considerable work during the 2016-2019 cycle to restructure the existing Road Tunnels Manual.

The new structure respects the common overall structure of all PIARC manuals. The new version of the Manual contains 4 tool pages and 4 main chapters or “books”:

- Strategy and General Design (26 web pages)
- Safety (30 web pages)
- Equipment and Systems (38 web pages)
- Operation and Maintenance (33 web pages).

The new version of the Manual contains 131 web pages, whereas the previous version contained 77 web pages. Its content has been considerably enriched with new topics, numerous new figures and tables and over 300 hyperlinks to PIARC Technical Reports on road tunnel operations or to various tunnel-related regulations. The new version of the Tunnel Manual in English is online since October 2019. The French and Spanish versions will follow in 2020.

2.7. Dangerous Goods Quantitative Risk Assessment Model

The Dangerous Goods Quantitative Risk Assessment Model, known as “DG-QRAM” is a software tool developed in the previous PIARC cycle, which enables its users to perform a specific risk analysis for dangerous goods transport.

Since the release of this software, the DG-QRAM software has been widely used by many European countries to perform risk analysis for dangerous goods transport as required by the European Directive 2004/54/EC on minimum safety requirements for tunnels in the trans-European road network, and to support the choice of a tunnel category according to ADR (dangerous goods regulations).

In the 2016-2019 work cycle the tool was updated to make it compatible with more recent versions of the software that it is based on. A task group has been responsible for overseeing the update process and exploring the possibility of upgrading the tool, taking into account feedback from users. Thanks to initial financial contributions provided by 8 funding countries, the updated version of the software tool is now available for sale through PIARC. User training sessions were organized for both expert users and new users. A further upgrade of the tool will be done in the 2020-2023 work cycle.

2.8. Other outputs

Other outputs include

- Various articles in the quarterly PIARC magazine Routes/Roads, among them a special issue of Routes/Roads dedicated to road tunnels (N°378),
- An International seminar on “Road Tunnels in Low and Medium Income Countries” which was held in Cape Town, South Africa,
- The 1st International Conference on Road Tunnel Operations and Safety in Lyon, France and
- Many TC D.5 workshops and contributions to external conferences and events.

3. PLANNED ACTIVITIES FOR THE 2020-2023 PIARC WORK CYCLE

The new Strategic Plan for the cycle 2020-2023 includes a new structure of PIARC Technical Committees and task Forces (**Figure 1**). TC 4.4 Tunnels is part of the Strategic Theme 4 “Resilient Infrastructure”.

In the following subchapters the main topics for the coming 4 years are briefly discussed. For detailed information please refer to the PIARC Strategic Plan published on the PIARC website (www.piarc.org).

Strategic Theme 1 Road Administration	Strategic Theme 2 Mobility	Strategic Theme 3 Safety and Sustainability	Strategic Theme 4 Resilient Infrastructure
TECHNICAL COMMITTEES			
TC 1.1 Performance of Transport Administrations	TC 2.1 Mobility in Urban Areas	TC 3.1 Road Safety	TC 4.1 Pavements
TC 1.2 Planning Road Infrastructure and Transport to Economic and Social Development	TC 2.2 Accessibility and Mobility in Rural Areas	TC 3.2 Winter Service	TC 4.2 Bridges
TC 1.3 Finance and Procurement	TC 2.3 Freight	TC 3.3 Asset Management	TC 4.3 Earthworks
TC 1.4 Climate change and resilience of Road Network	TC 2.4 Road Network Operation/ITS	TC 3.4 Environmental Sustainability in Road Infrastructure and Transport	TC 4.4 Tunnels
TC 1.5 Disaster management			
Terminology Committee			
Road Statistics Committee			
TASK FORCES			
TF 1.1 Well-Prepared Projects	TF 2.1 New mobility and its impact on road infrastructure and Transport	TF 3.1 Road Infrastructure and Transport Security	TF 4.1 Road Design Standards
TF 1.2 HDM-4			

Figure 1: New PIARC Structure according to 2020-2023 Strategic Plan

3.1. Measures for increasing resilience of tunnels

The activities and outputs in relation to the topic “Measures for increasing the resilience of tunnels (4.4.1)” focus on increasing the resilience of a tunnel system, i.e. measures to increase the availability of the tunnel for users and measures to increase the robustness of the tunnel system. A “tunnel system” is defined as the system that consists of e.g. the road (in and nearby the tunnel), the tunnel construction, the tunnel technical installations, including the control systems / control center from which the tunnel is operated, etc. All these elements work together as a system to assure the safety and availability for the tunnel users, at a certain designated service level (based on requirements set by the tunnel manager). Hence, the integrated performance of all these elements defines the resilience of the tunnel system.

Criteria for the design and construction of more resilient tunnels will be established based on a literature review and an analysis of current international best practices. Resilience measures will be identified with regard to risk reduction measures and associated risk management methods.

3.2. Best practices in management particularly in of urban and heavily trafficked tunnels

In the past years numerous technical equipment has been installed in road tunnels. The maintenance of this equipment is increasingly complex and has become an important issue. This is notably the case in urban tunnels or tunnels with heavy traffic (i.e. high traffic volume) where accessing equipment and conducting road works while the tunnel is open to traffic can be particularly challenging. Other important issues in this context are special safety aspects and maybe additional resilience measures which should be taken into account during maintenance work under traffic conditions.

Urban tunnels consist in many cases of a complex system of interconnected tunnels, many slip roads, branching tunnels, etc. Hence, they are a quite complex system in terms of management and operation of tunnel sub-systems like e.g. ventilation systems during normal and fire ventilation. By collecting already existing knowledge about these topics as well as about minimum operating conditions in times of non-availability of single sub-systems like ventilation and ventilation control items, especially ventilation related aspects of refurbishment/upgrading of tunnels under operation should be taken into account.

3.3. Impact of new propulsion technologies on road tunnel operations and safety

Regarding New propulsion technologies (NPT), considerable headway has been made in this field in recent years. The experience shows that in a road tunnel context these technologies can have a potentially significant impact on user safety. The objective would be to focus on the impacts of NPT on road tunnel operations (e.g. ventilation) and safety. It should notably discuss the many and varied types of alternative fuels now being explored in the industry. Example technologies include: hydrogen, liquefied natural gas (LNG), compressed natural gas (CNG), biodiesel, ethanol and electric vehicles.

Currently multiple research and test activities are on the way in order to investigate the effects of incidents involving vehicles with alternative propulsion technology (mainly battery electric vehicles) on tunnel safety and ventilation strategy. This information shall cover e.g. change in heat release rates due to vehicle fires, critical substances in form of gases, liquids or particles, need of additional sensors for gas detection or need of a different approaches for operation strategy in case of incidents w/o fire. The activities will aim at collection of the most relevant information of these tests and to draw conclusions on impacts on tunnel users, tunnel infrastructure, safety and ventilation strategies and rescue operations (from firefighting to clearing the tunnel).

3.4. Intelligent Transportation Systems in tunnels

Regarding Intelligent Transport Systems (ITS), the last few years have seen considerable technological advances in this field. In a road tunnel environment, these systems can have a significant impact on operation and user safety. The objective of this task would be to focus on the impacts of such systems on road tunnel operations and safety. Regarding ITS in tunnels there are a few main issues that needs to be assessed and discussed from a tunnel community perspective:

- Given the very quick development of ITS on open roads, how can service continuity of such systems be guaranteed in the specific context of road tunnels?
- Are there any obstructions for the development of ITS in current tunnels that should be dealt with?
- What changes do we expect in terms of required safety and traffic management systems in a tunnel: what systems could possibly be deleted (under which conditions) and what new systems do we need (under what conditions)?
- What are the tunnel community's expectations with regard to these ITS: safety distance control, lane departure warning systems (LDWS), heavy vehicle guidance systems, vehicle localization and counting systems, identification of hazardous goods vehicles, etc.
- More generally speaking, how can these ground-breaking systems improve user safety in road tunnels?

3.5. Update of the Tunnels Manual

During the last cycles the TC on Road Tunnel Operations has produced a total of approximately 45 technical reports plus many R/R articles and special issues. The main added value of the Online Tunnel Manual is to incorporate and disseminate this information through an electronic document currently published in 10 languages, so as to reach the widest possible audience.

In the future development and update of the Manual (starting from this strategic cycle 2020 to 2023) the main focus will be on the translation of the current newly published English version into French and Spanish and the update of the content regarding the results of the last cycle (see chapter 2) and the new results of the 202-2023 cycle. The update of the Tunnel Manual will be managed by a Task Force with the support of all Working Groups of TC 4.4.

3.6. Preparation of the 2nd International Conference on Tunnels

The previous 1st International conference in Lyon (October 2018) was a very successful event (see chapter 2.8). The 2nd International Conference on Tunnels will be organized in autumn 2022 in Spain. A Task Force with participation of members of TC4.4 will be responsible for the preparation of the technical program in closed collaboration with the Spanish National Committee of Road Tunnels and other relevant international organizations in the field of Road Tunnels.

3.7. Support for updating and improving of DG-QRAM

After the successful update of the DG-QRAM software regarding current operational system versions in the last cycle (phase 1, see chapter 2.7) the focus in the 2020-2023 cycle is the upgrading of the tool, based on feedback of users. The management of phase 2 (improving of the software) will be done by the Task Force already involved during the last cycle.

4. SUMMARY AND CONCLUSIONS

Since 1957, date of creation by PIARC of the "Committee on Road Tunnels", the Association has conducted an ongoing activity on all matters relating to the operation of road tunnels: geometry, equipment and maintenance, operating, safety and environment. All outputs of the last work cycle 2016-2019 (and the cycles before) are available online (free download) on the PIARC website (see References). The new topics for the coming for years (work cycle 2020-2023) include:

- 4.4.1: Measures for increasing resilience of tunnels
- 4.4.2: Best practices in management (maintenance and traffic operation) in urban and heavy traffic tunnels
- 4.4.3: Impact of new propulsion technologies on road tunnel operations and safety
- 4.4.4: Intelligent Transport Systems on tunnels
- 4.4.5: Update of the Tunnels Manual
- 4.4.6: Preparation of the 2nd International Conference of Tunnels
- 4.4.7: Support for updating and improving of DG-QRAM

There will be continuous publications on the PIARC website during the next 4 years. For the first time not only full technical reports will be published but also intermediate deliverables like a literature review, a collection of case studies or a briefing note. Please visit the PIARC website regularly to stay updated. Anyone interested in contributing to the topics mentioned above is cordially invited to participate in TC 4.4.

5. REFERENCES

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