

TECHNICAL COMMITTEE 4.4 – TUNNELS

4.4.1. Measures for increasing resilience of tunnels

Strategies / Objectives

- Use current experience on management of tunnel in order to develop best practices on design and construction for road tunnel operations.
- Establish criteria for the design and construction of more resilient tunnels for road tunnel operations.
- Identify resilience measures with regard to risk reduction measures and associated risk management methods.
- Encourage coordination with other TCs and TFs, such as *T.C. 1.4 Climate Change and Resilience of Road Networks*, *T.C.2.4 – Road Network Operation/ITS*, *T.C.3.1 – Road Safety*, *T.F.3.1 – Road Infrastructure and Transport Security*, and *T.F.4.1 – Road Design Standards*.

In the past cycles the topic of best practices in design and construction has been dealt with in different reports like e.g. “Lay bys and protection against lateral obstacles - Current practices in Europe (2016R16EN)”. In these reports the focus was mainly on user safety and associated measures to increase safety.

In this topic the new focus should be on increasing the resiliency of the tunnel system, i.e. measures to increase the availability of the tunnel for users and measures to increase the robustness (construction and operation) of the tunnel.

Past PIARC work on risk assessment and risk management includes reports like e.g. “Risk analysis for road tunnels (2008R02EN)” and “Integrated approach to road tunnel safety (2007R07EN)”. For existing tunnels, various countries have investigated the possibility of using risk reduction measures as an alternative to structural measures that are very expensive or technically impossible to implement. These types of measures might be temporarily implemented, provided decisions-makers are able to demonstrate an equivalent level of safety through risk analysis. The risk management methods described in the existing reports will be updated regarding best practices for the identification of alternative risk reduction measures and resilience measures.

The approach would be a literature review and a briefing note including collection of case studies to gathered best practices. A full report would be drafted including the findings.

Outputs	Expected Deadlines
• Literature review	• January 2021
• Briefing note including collection of case studies	• January 2022
• Full report	• March 2023

4.4.2. Best practices in management (maintenance and traffic operation) in urban and heavily trafficked tunnels

Strategies / Objectives

- Identify best practices in management (maintenance and traffic operation), particularly of urban tunnels and tunnels with high traffic volume.
- Take into account Data-driven approaches / Data Analytics with regard to preventive or predictive maintenance.
- Encourage coordination with other TCs and TFs, such as *T.C.2.1 – Mobility in Urban Areas*, *T.C.3.3 – Asset Management*, and *T.F.3.1 – Road Infrastructure and Transport Security*, and *T.F.4.1 – Road Design Standards*.

Since the major fires that occurred in Alpine tunnels, numerous 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 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. Additionally, best practices shall be shared on how reductions of redundant safety equipment could take place in order to reduce the “ever increasing workload” of tunnel operators. In Routes/Roads No.378 first approaches were discussed under the label “LeanTech”. Sharing best practices in this field could be beneficial to the whole road tunnel community.

This is the reason why the tunnel committee published various reports dealing with these challenging issues during the past cycles, notably:

- Introduction to the RAMS concept for road tunnel operations (2019R05EN),
- Road tunnel operation: first steps towards a sustainable approach (2017R02EN),
- Best practice for life cycle analysis for tunnel equipment (2016R01EN),
- Recommendations on management of maintenance and technical inspection of road tunnels (2012R12EN) and
- Good Practice for the Operation and Maintenance of road Tunnels (2004/05.13.EN).

In order to summarize, highlight and update the best practices in this context, it is suggested preparing a report dealing with "Best practices in management (maintenance and traffic operation) in urban and heavy traffic tunnels", based on the best practices studied from case studies.

Outputs	Expected Deadlines
<ul style="list-style-type: none"> • Collection of case studies 	<ul style="list-style-type: none"> • October 2021
<ul style="list-style-type: none"> • Full report 	<ul style="list-style-type: none"> • April 2022

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

Strategies / Objectives

- Identify the impact of new propulsion technologies on road tunnel operations and safety.
- Analyze how to prevent and mitigate the potential consequences of incidents involving alternative fuel vehicles.
- Encourage coordination with other TCs and TFs, such as *T.F.2.1 – New mobility and its impact on Road Infrastructure and Transport*, *T.F. 3.1. Road Infrastructure and Transport Security*, and *T.F.4.1 – Road Design Standards*.

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.

Whilst such vehicles remain a small overall proportion of the vehicle fleet, the combination of impacts of Government policy and technological advances in alternative fuels is expected to accelerate their increase in numbers on the road and in tunnels in coming years. There may also be particular initiatives in certain geographical areas, such as on airport land for example, where much higher proportions of alternatively fuelled vehicles are seen much sooner than on the open road. As a result, the nature of tunnel safety risk (including fire) is expected to change with time and detailed consideration of the risk of significant incidents involving such vehicles is required. This should include the evaluation of incident consequences with particular attention paid to fire characteristics and toxic emissions and their impact on tunnel users, ventilation and on intervention strategies. One main focus shall be on batteries, as future vehicles will increasingly be equipped with large batteries. Batteries, mostly Lithium-ion-type, will be for years the leading technology in new-energy-carrier vehicles. This will be the case regardless of the type of propulsion: for example, hydrogen fuel cell vehicles also require large buffer batteries.

In the strategic cycle 2016 to 2019 a Technology Watch document has been produced on the topic of NPT (Technology Watch: Road tunnel safety implications of alternatively fuelled vehicles, Technical Committee *D.5 Road Tunnels* (SP 2016-2019), 25.04.2019). Additionally, an article in R/R was written summarizing the current state of the art regarding NPT and tunnels (RR378-054).

The objective is to prepare a full report on the topic based on a collection of case studies and the before mentioned Technology Watch document.

Collaboration with ITA-COSUF is planned for this topic.

Outputs	Expected Deadlines
<ul style="list-style-type: none">• Joint Workshop with ITA-COSUF	<ul style="list-style-type: none">• November 2021
<ul style="list-style-type: none">• Collection of case studies	<ul style="list-style-type: none">• April 2022
<ul style="list-style-type: none">• Full report	<ul style="list-style-type: none">• March 2023

4.4.4. Intelligent Transportation Systems in tunnels

Strategies / Objectives

- Investigate and define the technological advances in ITS related to a road tunnel environment that can have a significant impact on operation and user safety.
- Highlight the main expectations from the tunnel community regarding these systems.
- Take into account role of Big Data and Data Analytics in road tunnel management and operation.
- Encourage coordination with other TCs and TFs, such as *T.C.2.4 – Road Network Operation/ITS*, *T.F.2.1 – New mobility and its impact on Road Infrastructure and Transport*, *TF.B.2 – Automated vehicles*, *T.C.3.1 – Road Safety*, *T.F.3.1 – Road Infrastructure and Transport Security*, and *T.F.4.1 – Road Design Standards*.

Regarding Intelligent Transportation 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.

At first sight, it would appear that the main issues to be discussed within this context are as follows:

- 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,...
- More generally speaking, how can these ground-breaking systems improve user safety in road tunnels?

Past T.C. Road Tunnel Operations reports dealt with ITS topics in connection with user communication and user behavior (e.g. 2016R06EN). The new evolving topics of Vehicle to Infrastructure communication and new vehicle assistance systems were not covered by these reports. In the strategic cycle 2016 to 2019 a Technology Watch document was produced on the topic of ITS.

The objective is to prepare a full report on the topic based on a collection of ITS technological advances and the before mentioned technology watch document. This report will not focus too much on details regarding ITS-technological issues but will definitively highlight the main expectations from the tunnel community.

Outputs	Expected Deadlines
<ul style="list-style-type: none"> • Full report. 	<ul style="list-style-type: none"> • October 2021

4.4.5. Update of the Tunnels Manual

Strategies / Objectives

- Complete the EN and ES versions of the Tunnel Manual.
- Translate and complete the FR version of the Tunnel Manual
- Update EN, FR and ES versions of Tunnels Manual incorporating the works carried out by *T.C.D.5 – Road Tunnel Operations* within Cycle 2016-2019 and the new products of the 2020-2023 Cycle.

The expected target audience for the Online Road Tunnel Manual includes:

- Operators: Manual allows them to quickly find any relevant document they are searching for in a few clicks,
- Countries with little tunnel culture: Manual gives them an overview of the main aspects of road tunnel design, safety, equipment, operation and maintenance, that can allow them to discuss issues with foreign consultants and various stakeholders,
- Tunnels owners and administrations: Manual gives them an overview of road tunnel complexity and links to detailed information,
- The tunnel community in general: Manual is a tool that integrates all the PIARC recommendations with links to detailed information (technical reports, R/R articles, and other relevant websites).

At the end of the cycle 2016 to 2019, the T.C. on Road Tunnel Operations will have produced approximately 45 technical reports plus many R/R articles and special issues. The main added value of the 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 EN, FR and ES versions. Other language versions could be updated under the responsibility of the respective countries.

Outputs	Expected Deadlines
<ul style="list-style-type: none">• Update of the Tunnels Manual	<ul style="list-style-type: none">• Up to June 2023

4.4.6. Preparation of the 2nd International Conference on Tunnels

Strategies / Objectives

- Define topics of interest to the road tunnel sector and develop an appropriate technical program, including:
 - PIARC works carried out on those topics
 - Identification of the following steps for future works
 - Definition of additional topics to be proposed in order to be presented as individual speeches
 - Evaluation of abstracts and full individual speeches
 - Taking into consideration possible contributions from other Technical Committees
- Contribution to the Proceedings.

The previous international conference in Lyon (October 2018) was a very successful event.

Outputs	Expected Deadlines
<ul style="list-style-type: none">• Technical Program	<ul style="list-style-type: none">• October 2022
<ul style="list-style-type: none">• Contribution to the Proceedings	<ul style="list-style-type: none">• January 2023

4.4.7. Support for updating and improving of DG-QRAM

Strategies / Objectives

- Support the work on DG-QRAM (phase 2).

DG-QRAM (Dangerous Goods – Quantitative Risk Assessment Method) is a software developed overtime by PIARC and its TC on Tunnel for European countries.

In November 2016, PIARC decided to update it in two phases, both funded by volunteering European countries:

- Phase 1: updating of the tool (compatibility with recent OS versions)
- Phase 2: upgrading of the tool, based on feedback of users

Once that Phase 1 was finished in 2018, Phase 2 started in 2019. It consists of:

- improvement of the guidelines
- verification of the ventilation model
- results according to ADR regulations
- extended influencing parameters

It is expected that *TC 4.4* works on DG-QRAM: management of phase 2 (improving the software) in coordination with the relevant Task Group.

Outputs	Expected Deadlines
<ul style="list-style-type: none">• DG-QRAM: management of phase 2 (improving the software) in coordination with the relevant Task Group	<ul style="list-style-type: none">• Up to March 2023