ROAD TUNNEL OPERATION

Thursday 23 October 2003 (8.30 – 12.00 a.m.)

SESSION AGENDA & INTRODUCTORY REPORT

22.05.E

SESSION AGENDA

1. CURRENT ACTIVITIES OF THE C5 COMMITTEE

a) Introduction

Mr. Didier LACROIX (C5 Chairperson/FRANCE)

b) Overview of activities in the 1999-2003 cycle

Mr. Willy de LATHAUWER (C5 French-speaking Secretary/BELGIUM)

2. PRESENTATIONS AND DISCUSSION OF SIGNIFICANT TOPICS STUDIED BY C5

a) Good practices for operation and maintenance of road tunnels

Mr. Oivind SOVIK (Leader of WG1, C5/NORWAY)

b) Air quality in the environment of road tunnels

Mr. Yves DARPAS (Leader of WG2, C5/FRANCE)

c) Cross-sectional geometry of uni- and bi-directional road tunnels

Mr. Ben RIGTER (Member of WG4, C5/THE NETHERLANDS)
Mr. Joan ALMIRALLE BELLIDO (Member of WG4, C5/SPAIN)

d) Lessons learned from recent tunnel fire disasters

Mr. Arthur BENDELIUS (Leader of WG6, C5/USA)

3. WAYS FOR THE FUTURE

a) Views of the future and what we will need to know

Mr. Evert WORM (C5 member/THE NETHERLANDS)

b) Discussion on future directions and progress expected in 5 years and 6-10 years

4. Conclusion

Mr. Didier LACROIX (C5 Chairperson/FRANCE)

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INTRODUCTION

More and more road tunnels are put into operation every year, adding to the already large number of operated tunnels. These tunnels are sensitive parts of the road system and raise specific problems concerning their geometry, equipment, operation, safety, environmental impact, etc. For these reasons, tunnel operation has been on the agenda of the Road Tunnel Committee of PIARC for many years and has given rise to a number of reports and recommendations. A complementary scope is investigated by the International Tunnelling Association, which deals with all construction aspects.

After the tragic fires which occurred in Europe in 1999, and further to the Kuala Lumpur World Road Congress, it was felt that even more emphasis should be laid on the operational aspects of road tunnels, with a special focus on the safety of the users. These directions were taken into account in the work programme of C5 for the 2000-2003 period, including the creation of a new Working Group No. 3 and a change in the scope of Working Group No. 4. The following six working groups were active during this period:

Working Group No. 1:	Operation (leader: Oivind Søvik, Norway)
Working Group No. 2:	Pollution, Ventilation, Environment (leader: Yves Darpas, France)
Working Group No. 3:	Human Factors of Safety (leader: Bernd Thamm, European Commission)
Working Group No. 4:	Communication Systems and Geometry (leader: Urs Welte, Switzerland)
Working Group No. 5:	Dangerous Goods (leader: John Potter, United Kingdom)
Working Group No. 6:	Fire and Smoke Control (leader: Arthur Bendelius, USA)

The leaders of the working groups and Mr. Willy de Lathauwer (Belgium), French-speaking Secretary of C5, were the main contributors to this introductory report.

1 OPERATION

1.1 Introduction

As a consequence of the high expenses tunnels implicate, tunnel owners and managers have been more and more aware of the importance of using means to reduce operating costs and getting more “Value for Money”.

At the previous Congress in Kuala Lumpur, Working Group No. 1 presented a report and recommendations that set focus on three important issues:

- Cost of energy
- Cost of personnel
- Cost of maintenance

After the Kuala Lumpur Congress, the Committee has extended this scope to also cover tunnel safety and other issues related to a sound operation. Working Group No. 1 has prepared a report in the form of a Best Practice Manual on Operation and Maintenance of Tunnels (BPM) that covers the following issues:

- Safety and Risk Management
- Operation and Maintenance
- Quality Plans
- Value for Money
- Whole Life Costing
- Training and Emergency Exercises
- Renovation of Tunnels

1.2 Safety and Risk Management

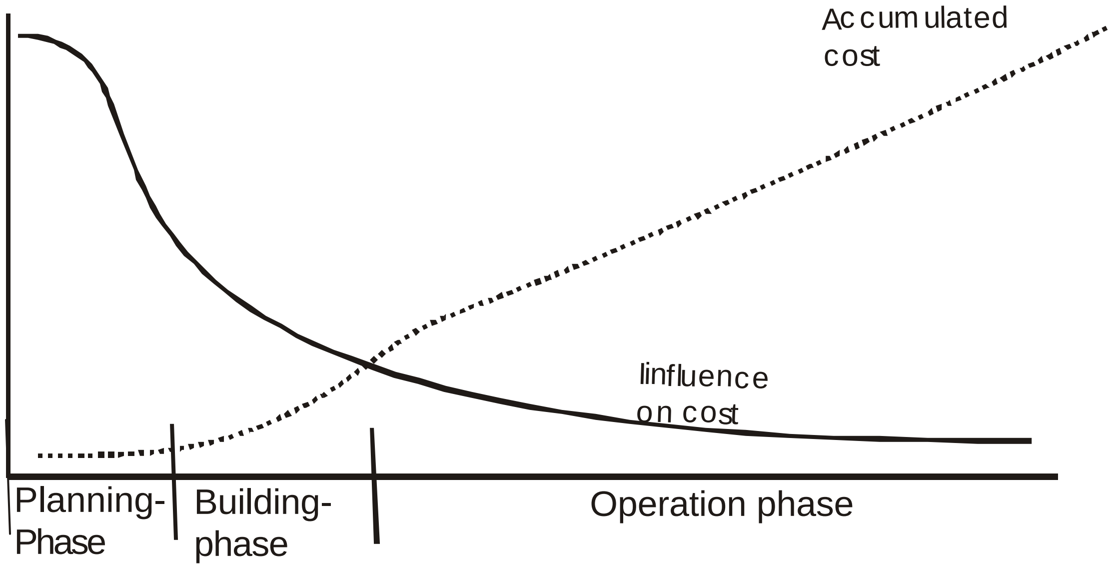
Statistics show that tunnels are the safest parts of the road network. However, since a tunnel is a road in a confined space, driving in tunnels has a potential for a large accident and this gives rise to strong concern. In recent years there has been a number of accidents in Europe that put the safety and the risk management of tunnels on the agenda. In the operation of tunnels, it is important to avoid accidents by ensuring that the operation levels are well fitted to the needs and that the safety facilities are working properly to prevent accidents or to reduce their consequences, should one occur.

The Best Practice Manual shows how risk management can enable the operator to determine the risk of accidents and handle an accident when it occurs.

1.3 Maintenance and Operation

The way tunnels are maintained and operated has been subject to a large development in the recent years. New developments in maintenance and operation became necessary to cope with the amount of tunnels that have been built, because tunnels have become a more natural choice to solve difficult road connections, but also because they have become the most complicated parts of the road network. In the Best Practice Manual, emphasis has been put on the following topics:

- Good practice to save cost
- Tunnel management systems
- Tunnel management tools
- Optimisation in operation and maintenance.



1.4 Quality Plans

A Quality Plan is a very effective means to ensure that all the actions required to undertake a project are handled in a consistent and professional way.

For successfully operating and managing a road tunnel, the use of a Quality Plan does not yet have the same traditions. However, particularly for modern tunnels, the complexity of operation and management has become so challenging that an effective Quality Plan has become a necessity.

Projects have a beginning, a middle and an end. Road tunnels have a very long operating life and very few of those involved in the original planning and construction works will be available to share their knowledge with those coming after them to operate and maintain the tunnel. It is particularly important to record the reasons for changes, as they occur, so that continuity and operational quality is maintained.

Road tunnel operation is subject to continuing change and ever increasing challenges. Examples are: increases of traffic volume, heavier goods vehicles with larger fire loads, increased demands for uninterrupted availability of the tunnel, health and safety improvements, legislative changes, environmental issues, new technologies for equipment, the integration of tunnels into wider highways operational and maintenance strategies, etc. A Quality Plan needs to set the framework for dealing with all such issues.

1.5 Value for Money / Value Engineering / Benchmarking

The Best Practice Manual presents some closely related methods for constantly improving the output with a reduced level of input and financial/general resources.

Increasingly, accountability and process tracking for decisions taken have to be audited. At the same time, ever-higher demands are made on improving the quality of the output. For road tunnels, the quality of operation often means availability of the tunnel to the road user, reliability of operation, perceived safety, freedom from congestion and pleasantness of use. For the tunnel manager/supervisor, these aims will tend to be cost-rising and therefore require careful and constant watching over cost/quality relationship.

The Best Practice Manual gives some tools to meet these goals. Where Value for Money is the goal, Value Engineering is the engineering method to obtain it. Whole life costing is a philosophy wherein Net Present Value calculation is a tool. Benchmarking is a way to measure if one has obtained Value for Money.

1.6 Training and Emergency Exercises

Engaging and training operating staff and performing emergency exercises are an important part of a sound operation. This task should therefore be an important part of the tunnel manager's Quality Plan.

1.6.1 Training

It is important to define the necessary levels of competency for the operation. Since the needs for competency are changing over time, the right level of competency some years ago may not still be the right level today. It is therefore necessary to continuously evaluate and seek the right level of competency, then continuously try to fill the gap between what is available and what is needed, through training and new employment. In the Best Practice Manual, good practice is presented from France on engaging and training operating staff, and from Norway on performing gap analysis.

1.6.2 Emergency exercises

Emergency exercises are also an important part of training. It is a continuous process and requires a national or international policy on how it should be organized, in order to be prepared when a real accident occurs. The Best Practice Manual includes good practice from the United Kingdom, which is not necessarily representative of Europe or the world. The Best Practice Manual sets focus on the following types of exercises:

- seminar (also called workshop: discussions based on exercises)
- table top (also called floor plan exercises)
- control post (also called training without troops)
- on-site (also called live, practical, operational or field exercises).

1.7 Renovation of Tunnels

It is necessary to renovate or upgrade tunnels and/or installations at regular intervals. During renovation activities, the main goals and points of attention are to maintain:

- safety for the traffic,
- safety for the personnel working in the tunnel,
- minimum hindrance to traffic.

Safety and hindrance can be influenced by performing the renovation activities in an as short a period as possible. The renovation period can be minimized by working in as effectual a way as possible.

2 POLLUTION, ENVIRONMENT, VENTILATION

2.1 Pollution emitted by road vehicles

Regulations and consecutive progress made on road vehicle engines have led to a decrease in pollutant flows emitted by road vehicle engines. For this reason, it was felt necessary to issue a new PIARC report, which updates the data included in the report "Road Tunnels: Emissions, Ventilation, Environment" (05.02.B) published in 1995.

Tables giving updated emission factors have been developed to calculate the ventilation flows necessary to dilute pollution in tunnels in the future, taking into account the evolution of the vehicle fleet.

Concerning particles, measurements recently made showed that, taking into account the current improvements, other particles than those exhausted by engines could no more be neglected. Although current data are too poor to give precise rules, provisional elements make it possible to take these sources in account.

2.2 Pollution at tunnels portals

Increasingly, road tunnels are being built in urban locations to mitigate the environmental impacts of road traffic. An emerging issue is the resistance of communities to accept any increase in the level of pollutants around tunnel air discharge points.

The treatment of air within the tunnel or at ventilation shafts, prior to discharge, has been increasingly seen by community groups as a possible way of addressing these concerns. It seemed useful to gather experiences from different countries and to collect the current experience on the different aspects of this question: air quality and health, existing environment, designing for air quality, dispersion of tunnel air, ventilation system operation, control and monitoring.

However, no universal conclusions or recommendations have been reached at this stage.

2.3 Ventilation control

Ventilation control in normal operation is generally based on pollution measurements. This method has some drawbacks: especially it does not allow a smooth regulation of ventilation and is not optimum for energy consumption. An alternative method is to base control on traffic measurements. The current objective is to collect data allowing a precise evaluation of the two methods in order to promote control based on traffic measurements when it is better suited.

2.4 Control of smoke in case of fire

A cooperation has been set up between Working Groups No. 2 and 6 to gather the competencies of their members.

The contribution of Working Group No. 2 focused on the three points described below, which are integrated in a common report on Systems and Equipment for Fire and Smoke Control in Road Tunnels.

2.4.1 Smoke dampers

Among the means used to limit the consequences of fires in road tunnels, smoke control systems are especially important for economic and strategic considerations.

In transverse and semi-transverse ventilation systems, an efficient means is to exhaust smoke near the fire by concentrating the extraction flows in the vicinity of the fire. These ventilation systems generally have an extraction duct with openings for the exhaust of smoke, which are connected to extraction fans. In order to concentrate the extraction in the zone with smoke, these openings are more and more often equipped with remote-controlled dampers. Such smoke dampers have been installed in many tunnels in different countries.

The purpose of the corresponding section of the report is to describe the different types of smoke dampers and their characteristics, specifications, rules of installation and the tests they must pass, as well as to give some examples of their application.

2.4.2 Longitudinal ventilation

Longitudinal ventilation is most often used in tunnels. In case of fire, the air temperature downstream the fire can destroy some jet fans and decrease the thrust of the remaining ones. Guidelines and calculation methods have been issued to size the ventilation system, taking into account the effects of the temperatures resulting from a given fire power, and to give recommendations for setting up jet fans.

2.4.3 Follow-up in operation and regular tests for ventilation systems

In operation, it is important to be sure that the ventilation system has kept the characteristics foreseen in the initial design and tested during commissioning, and will be available without delay in case of emergency. Recommendations have been prepared so as to be able to follow the state of the ventilation system and perform regular and periodical tests.

3 HUMAN FACTORS OF SAFETY

3.1 Scope of work

The scope of work of Working Group No. 3 was to answer the need for minimum standards for the behaviour of tunnel users, and to make recommendations concerning the behaviour of tunnel operators and intervention forces. It also seemed important that information on the current reactions of the users in the tunnel environment (e.g. ignoring signals) were collected and that simple measures for improving any wrong responses were identified. International harmonisation is required with regard to users' behaviour in tunnels in all countries.

3.2 Questionnaire

A questionnaire was set up and sent to many countries. This questionnaire aimed at collecting information in order to find out the state-of-the-art concerning human behaviour in road tunnels. The questionnaire contained 15 questions, which were divided into four parts: General Information, Heavy Goods Vehicles, Operation and Intervention Forces.

The answers to the questionnaire were evaluated and a summary is given in this paragraph. In no country there were driving examinations which included questions concerning the behaviour of users in case of incident / accident in road tunnels. In no country there were either written recommendations on how drivers should behave when they detect smoke or fire development in their own car, whilst driving through a tunnel. Only in some countries information and recommendations existed about behaviour in road tunnels, as well as specific data about incorrect behaviour of drivers. In most countries, regulations existed for the control and enforcement of traffic rules, also with respect to road tunnels. Official instructions and corresponding tests were, however, still lacking in some countries on how professional drivers should behave in road tunnels.

The conclusions to be drawn from these findings were that it was urgently necessary to develop a guide for the best behaviour of road tunnel users.

3.3 Best behaviour of road tunnel users

3.3.1 Behaviour leaflet

From the results of the different national answers, a first common proposal for a recommendation "Best Behaviour of Road Tunnel Users" for non-professional tunnel users was developed. These recommendations were used as a PIARC C5 input to the recommendations produced by a Multidisciplinary Group of Experts on Road Tunnel Safety of the United Nations Economic Commission for Europe (Geneva). These recommendations appeared in a slightly changed version in the report issued by this group of experts in December 2001.

In spite of many discussions on the use of mobile phones in tunnels, this topic has not been fully solved in the working group for the time being. At the moment, some countries have forbidden their use in tunnels in order to incite users to use existing emergency phones or push buttons in tunnels, because this allows immediate localisation and shortens the alarm times. It will, however, be difficult to ask the public to act against the technological main stream of using mobile phones and restrain from using them also in tunnels. *"It is harder to change human behaviour than to invent new technologies"*.

It was recommended that in the future all emergency calls from inside a tunnel should automatically go directly to the tunnel control centre.

The above-mentioned C5 and UN ECE recommendations were the basis for the preparation of a leaflet "Safe driving in Road Tunnels" issued by the European Commission, and translated into all 11 EU member states languages.

In spite of the discussions to already amend certain details of the first edition of the European leaflet (e.g. use of mobile phones, development of harmonized traffic signs, some descriptions of the infrastructure, escape direction against the airflow, etc.), Working Group No. 3 stated that harmonized information was urgently needed and that this first edition should be backed also by PIARC and UN ECE. Possible new developments, together with the discussed items, could be taken up again by Working Group No. 3 at a later stage, which might end up in a second version of this leaflet.

3.3.2 Information campaigns

In the aftermath of the Mont Blanc and Tauern tunnel incidents, a considerable number of different national information leaflets were distributed for information of tunnel users. Among them were also those asking the users in case of smoke in the tunnel *"to close their windows, shut down the air intake and restrain from smoking".* This contra-productive information may lead users to believe they can survive in their vehicles. Some leaflets on human behaviour gave rules which, according to psychologists, nobody would respond to, if they could not be controlled and enforced. Therefore a harmonized approach using these experiences and the expertise of information and communication specialists is urgently necessary.

The observations and investigations of the Gotthard tunnel fire in October 2001 once again showed that human behaviour is crucial for the limitation of consequences of a fire. The users who did not survive the incident either stayed in their vehicle, or tried to save their vehicle rather than their life, or left their vehicle too late to reach existing exits to the emergency gallery. This wrong human behaviour leads to the conclusion that it is necessary to launch an awareness campaign using international information harmonized by experts, including traffic psychologists and public relation experts.

The information campaign of the European Commission throughout its member states in 2003 includes the above mentioned leaflet "Safe Driving in Road Tunnels" and two videos: one on human behaviour, based on the leaflet, and another one on the minimum requirements of tunnel safety for the Trans-European Road Network (TERN). The leaflet includes a short introduction on the minimum safety equipment of road tunnels and recommendations for best behaviour of road tunnel users.

3.3.3 Professional drivers

As the initial stages of a fire are the most critical, there is a need to investigate what the users, and here especially the professional drivers (trucks, buses and coaches), can do to fight the fire. Indeed, in most cases it will take more than 15 minutes for intervention forces to reach an incident in a tunnel. What could be done at the very initial stages by the drivers on the spot could significantly reduce possible consequences, and professional drivers could be considered by other tunnel users as examples to follow in case of an incident.

Therefore, it was felt necessary that professional drivers should know more about behaviour in a tunnel environment than ordinary drivers. It was decided to add some special sentences concerning professional drivers to the text already published. Possible new developments from the discussions of Working Group No. 3, e.g. mobile phones, could also be added. The descriptions of safety equipment in road tunnels have not to be enlarged but amended in some cases (e.g. to delete the recommendation to systematically escape against airflow direction).

3.3.4 Driving schools

It was decided to also prepare proposals for driving schools with respect to possible questions on road tunnel users behaviour in driving examinations.

3.4 Tunnel operators

Since the human reaction of the operators and fire services had been crucial in the Mont Blanc tunnel fire, there has been a strong wish to include all other categories of people whose behaviour is important in the scope of Working Group No. 3. The qualifications of staff need to be discussed, with a close laison with Working Group No. 1 to avoid duplication of work. Therefore it was decided to develop a guide for operators of road tunnel control centres, which will include the following points:

- detection,
- information,
- action,
- intervention.

3.5 Intervention forces

The aim is not to tell the intervention forces what to do in case of an incident, but to try to give some basic information, which will be useful for these services with respect to road tunnels. The aim is not to provide a guide for intervention forces, but an information on tunnel equipment and operations. Therefore it was decided to develop an information leaflet for intervention forces. The text will deal with services, priorities, alarm, information necessary for the intervention services, actions to facilitate the users' evacuation and the intervention of help in tunnel, training.

4 COMMUNICATION SYSTEMS AND GEOMETRY

4.1 Introduction

Working Group No. 4 started its task by concentrating on the subjects Cross Section, Traffic Management and Size of Signalling Panels. The working group aimed at getting a further and more precise knowledge of those aspects, which have an impact on the safety in tunnels.

4.2 Cross section

The cross section of a tunnel differs in every country with respect to the design philosophy. The principle design of "lanes and shoulders" is varied in many aspects: there are constructions with elevated sidewalks (e.g. 20 cm in most cases or up to 1 m above ground in the USA), with ordinary emergency lanes at grade, with rollover kerbs, etc. All these facilities have different influences on the driver's behaviour in normal situation and in emergency situations, and therefore have an impact on the safety.

It goes without saying that most design philosophies do not follow safety concepts only, but cost and other construction considerations also. The uni or bi-directional traffic, the number of lanes, the maximum gradient, the building method, the design velocity, the traffic density, the percentage of trucks, etc., are important input parameters. The safety aspects should also be among the priority criteria since it is known that different designs have a significant influence on the driver's safety.

It is widely accepted that reduced cross sections lead to accidents. The average lane width is in most cases 3.50 m; the smallest widths are ca. 2.80 m in low density areas or in 3-lane-arrangements; the widest are 3.75 m. The left and right shoulders exist in all variations: from non-existing up to 1 m, elevated or not, separated with roll-over kerbs or not.

The safety value of elevated hard shoulders is still under discussion – in some countries they are not existing – but they are nevertheless advantageous for maintenance activities.

Emergency lanes, just separated by a marking lane, are well known from the open roads, and their value with respect to broken-down vehicles is unquestionable. Nonetheless, the high cost of a cross section with emergency lanes is the reason for their absence in most tunnels.

Further, the width of emergency lanes as well as hard shoulders should not lie between 1.00 and 2.00 m, because such widths may make drivers feel safe to stop, while they are not.

The report „Cross Section Geometry in Unidirectional Road Tunnels" (05.11.B, published in 2001) deals with all these aspects and gives conclusions and recommendations. This report will be followed by another one dealing with the same subject for bi-directional tunnels.

4.3 Traffic Incident Management Systems used in road tunnels

A report has been prepared on this topic in order to identify devices and equipment currently being used in Incident Management Systems in road tunnels to provide a safe environment for users.

A Traffic Incident Management System generally consists of detection, verification, traffic/incident control devices and traffic control plans or strategies to respond to incidents. Systems can also be used to stop users before they enter the tunnel, until safe conditions are restored. A rapid detection and verification of incidents allows the Central Control Room Operators to activate traffic/incident control signs, to implement traffic control plans and to notify outside response agencies in order to minimise loss of human life and damage to the tunnel structure.

Recent tunnel fires have demonstrated that lives can be saved and damage minimized with early detection and verification of incidents. Users can be safely evacuated from the tunnel and directed to another tube, to safety galleries or to another exit to reach the open air or wait for rescue teams.

Voice communication between the Central Control Rooms and the users is also important to provide instructions, verify locations of stranded users and reduce panic by users who feel abandoned.

Technologies for traffic incident management devices are continually being improved and new devices and systems are being developed. New technology is allowing cost-effective installations for existing tunnels, which greatly improve the overall safety for users.

4.4 Lay-bys and SOS-stations in road tunnels

These last years, the safety discussions around road tunnels have also be widened in another aspect: what is the need and best design of lay-bys and SOS-stations? It was decided to investigate thoroughly the different national specifications, to compare the experiences and to draw the attention to this important field of tunnel safety.

The study, not yet completed, will show that there are at present considerable variations in the regulations of the different countries. On the one hand they are based on different safety philosophies, and on the other hand they do not have appropriate justifications. Especially the question is to be asked whether there should be different levels of safety. When there is an incident, it is questioned whether the same safety has to be demanded depending on whether the tunnel is more or less used.

4.5 Directional signalling in road tunnels

Signalling, whatever it may be, follows rules set up according to specific criteria, which in most cases do not include the geometric constraints connected with underground structures. Generally speaking, the design rules for signalling are suitable for open routes. In lack of special recommendations for tunnels, the same rules normally apply to this type of structures.

However, in underground structures, space is often too restricted for a proper incorporation of the required signalling panels, and increasing this space is often very costly. The investigation is therefore aimed at studying in which manner incorporation and adaptation of directional signalling can be made. This investigation must take into account the fundamental principles that govern the signalling design and consider all tunnel peculiarities.

Nevertheless all signalling types encountered in a tunnel do not show the same constraints. Signalling of "police" type, like the signalling of safety facilities for tunnel users (recesses, exits for the users, cross-connections between tubes, etc.) have fixed sizes. Also, this type of signalling is generally placed above the sidewalks and the panel sizes are moderate, therefore this type of signalling is relatively easy to incorporate. As a matter of fact, space available above the sidewalks, which are often 0.7-1 m wide, make it possible to install panels, the sizes of which are consistent with the various size ranges recommended according to speed in different countries.

Therefore, the report, still in preparation, will only deal with signalling above traffic lanes, which has to meet the most severe constraints, i.e. traffic direction and traffic management signalling.

5 DANGEROUS GOODS

5.1 Introduction

The joint OECD/PIARC Research Project ERS2 on the “Transport of Dangerous Goods through Road Tunnels” was launched in 1995 and its intermediate results were discussed during a special session at the XXI[st] World Road Congress in Kuala Lumpur in October 1999. The project has been completed and the final report was jointly published by OECD and PIARC in 2001.

This joint research project has produced risk assessment tools (Quantitative Risk Assessment Model – QRAM – and Decision Support Model – DSM) and proposed legislation (groupings of dangerous goods loadings) to assist governments and operators to the decision to allow or ban the transportation of dangerous goods through road tunnels. Support and funding for this project was world-wide and the results are to be promoted through PIARC to the international tunnel community.

As a consequence, Working Group No. 5 is focusing on the dissemination and further development of the outputs of the joint OECD/PIARC project. The designated objectives include:

- Validation and dissemination of the ERS2 project results
- Follow up of the policy aspects relating to UN/ECE
- Support to the users of the tools produced by the ERS2 project - Quantitative Risk Assessment Model (QRAM) and Decision Support Model (DSM)
- Continuing support and development of the tools
- Review of the existing work on the “Cost Effectiveness of Risk Reduction Measures” for new and in-service tunnels.

5.2. Quantitative risk assessment and decision support models

5.2.1 Validation

The validation of these tools was concluded in 2002 and the final version of the QRAM and DSM produced. The QRAM is currently applied to both tunnels in design and those in operation. The DSM is not in general use at this time. The QRAM has extensively been applied in France. The QRAM has also been successfully applied to tunnels in the UK and Spain. The application of the models has been demonstrated in PIARC seminars in Chile and China.

The application of the tools assists in further validating the models and identifies areas for changes, upgrades and development. A number of demonstrations in application of the QRAM have been included on a dedicated web site to further assist those organizations considering the use of the model (http://www.wg5dangerousgoods.com).

5.2.2 Distribution

The models are now completed and have been validated. The issues surrounding the distribution and support of the tools are presently being formulated by OECD/PIARC.

5.2.3 User Group

The formation of a User Group was a priority for Working Group No. 5. The tools are not widely used and opportunity exists to promote their use through the formation of such a Group. There is an effective user base of France, UK and Spain. Interest has been expressed from a number of other countries (Norway, Sweden, Austria, Denmark, Czech Republic, Switzerland) to join the user Group. This work will assist the organizations/countries to evaluate and introduce the models into their risk assessment processes.

A number of countries are producing their own risk assessment models for assessing the implications of allowing dangerous goods through road tunnels. It will be helpful to also include the users of these alternative methods in the user Group.

To promote the formation of a user Group, developers and users of the tools were invited to a Working Group No. 5 meeting. These included holding workshops to promote the “community” aspects of a user Group. Further funding for the support and development of the QRA and DSM is required to secure the ongoing use of the tools.

5.3. Policy aspects

5.3.1 Introduction

The main policy recommendation of the joint OECD/PIARC project was to internationally create five groupings of dangerous goods loadings to be used for harmonized tunnel regulations.

5.3.2 United Nations Organization

The final report of the joint project recommended that the United Nations Committee of Experts for the Transport of Dangerous Goods should include the system of groupings in the UN’s Model Regulations and promote it in all regions of the world. As this committee has a multimodal scope, an alternative could be the United Nations Economic Commission for Europe (UN ECE) Working Party No. 15 on the transport of dangerous goods. This working party could include the proposed system in the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR).

The aforementioned Multidisciplinary Group of Experts on Road Tunnel Safety created by the UN ECE took these recommendations into account in its final report of December 2001, which includes measures relating to the passage of Dangerous Goods through Road Tunnels. These measures are currently being examined by the relevant bodies of the UN and UN ECE for possible incorporation in the international recommendations and European agreements.

5.3.3 European Union (EU)

In the very beginning of 2003, the European Commission proposed a European Directive on minimum safety requirements for tunnels on the Trans-European Road Network. For dangerous goods transport, the proposal refers to the joint OECD/PIARC project and includes provisions in accordance with its conclusions.

5.3.4 Action by Working Group No. 5

The working group will follow up the current developments in UN, UN ECE and EU, including possible recommendations in application, support and development of the OECD/PIARC proposed grouping system as well as QRAM and DSM tools.

5.4 Cost effectiveness of risk reduction measures

5.4.1 Background

The aforementioned joint OECD/PIARC research project included a task devoted to the measures to reduce the risk in a tunnel if dangerous goods transport is allowed. The risk reduction measures were identified, and in-depth studies were performed towards quantifying the effectiveness of the measures for safety, using the QRAM as far as possible.

5.4.2 Review and update of previous work

The Working Group had previously examined this area and produced a number of contributions to the OECD/PIARC project. It has prepared a report to disseminate the main findings of the OECD/PIARC project in this field.

The Working Group found that an attempt to update this work would present difficulties in establishing resources for further research. An achievable outcome would be to present a number of risk reduction measures "Case Studies" based on tunnel construction projects and the upgrades to existing tunnels.

Further research is required to establish the relationship between the investment in risk reduction measures and the derived cost benefits in the protection of lives, tunnel assets and the economic impact on the community. A number of EU research projects are addressing the use of risk assessment tools.

6 FIRE AND SMOKE CONTROL

6.1 Introduction

Working Group No. 6 planned to continue the work performed earlier regarding fire and smoke control in road tunnels. As relative new subject in the road tunnel field there was still much to accomplish in the fire and fire life safety area. The scope of work was intensified by the occurrence of several large tunnel fires in Europe.

6.2 Work Plan

Working Group No. 6 was put in charge of the following tasks:

Task 1 – Lessons learned from past disasters
Task 2 – Safety concepts for tunnel fires
Task 3 – Structure resistance to fires
Task 4 – Transverse ventilation
Task 5 – Emergency exits
Task 6 – Fire specific safety equipment
Task 7 – Fire response management
Task 8 – Measures/regulations further to Mont Blanc & Tauern fires
Task 9 – (added later) - Emergency ventilation system operation/control

6.2.1 Task 1 – Lessons learned from past disasters

This task was originally established to address the Mont Blanc and Tauern Tunnel fires and to deliver the lessons to be learned from these two disasters. Later, during the cycle, another serious tunnel fire occurred in the St. Gotthard Tunnel in Switzerland; this more recent disaster was added to the scope of this task.

6.2.2 Task 2 – Safety concepts for tunnel fires

This task was conceived to provide a general set of objectives and design scenarios for road tunnel fires which could be used as a backdrop for all other Working Group No. 6 work efforts.

6.2.3 Task 3 – Structures resistance to fire

This task was a continuation of the work performed during the previous cycle, as a consequence of an agreement reached between PIARC and ITA for a co-operative effort regarding structures resistance to fire. This cooperation was conducted between PIARC's Working Group No. 6 "Fire and Smoke Control" and ITA's Working Group No. 6 " Repair and Maintenance". The agreement was that PIARC would provide the appropriate criteria (temperature-time curves and resistance times) for such resistance and ITA would develop the required implementation measures to provide the structures resistance to fire in road tunnels.

Part of the original agreement was that there would be a joint publication by PIARC and ITA in their respective magazines of an article or articles presenting the results of this co-operative effort. PIARC's results will also be included in the aforementioned report, and ITA will produce a handbook/manual presenting the whole recommendations.

6.2.4 Task 4 - (Semi-) transverse ventilation.

This task was to address the design and operation of transverse ventilation systems and provide information on smoke (de-)stratification conditions (if possible).

6.2.5 Task 5 – Emergency exits

It was clear that the subject of emergency egress and specifically emergency exits had not been thoroughly addressed previously. The aim has been to identify the kinds and characteristics of emergency exits (including how to deal with disabled people) and to present the necessary spacing between exits according to people behaviour and tunnel ventilation.

6.2.6 Task 6 – Fire specific safety equipment

In the previous work published in 1999 in "Fire and Smoke Control in Road Tunnels" there was an assessment of previous work and some general recommendations. It was clear that much work needed to be accomplished in this area regarding assessment of the specific systems for fire detection and suppression in road tunnels.

The contents of this task were defined by Working Group No. 6 to include sprinklers, water mists and other automatic fire suppression equipment and automatic fire detection.

6.2.7 Task 7 – Fire response management

This task was originally developed to address the organization of fire tests (for tunnel commissioning and for staff training) and the definition of the behaviour expected from users in case of a fire.

6.2.8 Task 8 – Measures/regulations further to Mont Blanc & Tauern fires

This task was originally established to provide an analysis of measures and regulations taken by countries further to the fires. However it was clearly stated in the original work plan that "this topic will be examined only if it appears that it is not dealt with by the new multidisciplinary group of experts "Safety in tunnels" of the Economic Commission for Europe of the UN". When such efforts were determined to be underway this task was removed from the Working Group No. 6 Work Plan.

6.2.9 Task 9 – Emergency ventilation system operation / control

This task was later added to address emergency ventilation system operation and control.

6.2.10 Task 7/9 – Operational responsibilities for emergencies

Task 7 and Task 9 were combined into Task 7/9 to address operational responsibilities for emergencies which included operation of system for smoke control, designer/operator interface, fire service intervention, training and maintenance relating to fire and smoke control.

6.3 Joint Collaboration

It was determined that collaboration between Working Groups No. 2 and 6 should prove fruitful; the two working groups met and held joint meetings.

Agreement was reached on several subjects of joint interest as shown below:

1. smoke dampers
2. jet fans dimensioning in case of fire
3. jet fans setting up, efficiency and noise
4. following in operation for ventilation system
5. ventilation control.

Further agreement was reached to include the results of these collaborative efforts as defined above in a single joint report.