UNITED
NATIONS

E

Economic and Social
Council

Distr.
GENERAL

TRANS/SC.1/AC.5/34
28 July 1999

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

INLAND TRANSPORT COMMITTEE

Working Party on Road Transport

Ad hoc Meeting on Implementation of the
European Agreement on Main International
Traffic Arteries (AGR)

REPORT OF THE SEVENTEENTH AD HOC MEETING ON THE IMPLEMENTATION OF THE AGR (28-29 June 1999)

1. The seventeenth session of the Ad hoc Meeting on the Implementation of the European Agreement on Main International Traffic Arteries (AGR) met on 28 and 29 June 1999 in Geneva. The following countries were represented: Finland, France, Georgia, Germany, Italy, Kazakhstan, Lithuania, Poland, Romania, Russian Federation, Slovakia, Turkey, Ukraine. The following non-governmental organization participated: the International Road Transport Union (IRU).

INTRODUCTORY REMARKS

2. The Director of the Transport Division, Mr. José Capel Ferrer, opened the Meeting by informing delegates about the status of the proposed amendments to the AGR adopted by the Working Party on Road Transport at its ninety-second session. He also invited the Meeting to consider the issue of safety in tunnels from the angle of infrastructure design and the possibility of developing international provisions or recommendations thereon, following recent serious accidents in tunnels.

ADOPTION OF THE AGENDA

Documentation: TRANS/SC.1/AC.5/33

3. The provisional agenda was adopted without change.

ELECTION OF OFFICERS

4. Mr. Marek Rolla (Poland) was elected Chairman.

INFORMATION ON THE STATUS OF APPLICATION OF THE EUROPEAN AGREEMENT ON MAIN INTERNATIONAL TRAFFIC ARTERIES (AGR)

Documentation: ECE/TRANS/16 and Amends 1-7.

5. The Ad hoc Meeting was informed that there were 31 States Contracting Parties to the AGR. Prior amendments made to Annexes I and II of the AGR proposed by the Governments of Lithuania, Ukraine, Turkey and Germany at the ninetieth session of the Working Party in 1996 had entered into force on 15 January 1998 and were contained in amendment 7 to the AGR (ECE/TRANS/16/Amend.7).

STATUS OF PRIOR AMENDMENTS TO THE AGR

Documentation: ECE/TRANS/128, TRANS/SC.1/363.

6. The Ad hoc Meeting was informed that three meetings held in 1998 had discussed the extension of the E road network. These were the Round Table on the Extension of the E-Road Network to the Caucasus and Central Asian ECE Member States (30 April 1998), the sixteenth Ad hoc Meeting on the Implementation of the AGR (30 April - 1 May 1998), and the Informal Meeting on the Numbering of E Roads in the AGR Network (31 August - 1 September 1998). The proposals of those three Meetings had been discussed, modified and adopted at the ninety-second session of the Working Party on Road Transport (19-21 October 1998) and were contained in TRANS/SC.1/363, annex 1.

7. Following the ninety-second session of the Working Party, the secretariat had received from the Government of the Russian Federation new proposals concerning the numbering of roads E 115 to E 125. These proposals had been circulated to the Ad hoc Meeting as TRANS/SC.1/AC.5/1999/1. The Inland Transport Committee at its sixty-first session (8-11 February 1999) had decided, in light of the "provisional acceptance" of the Russian Federation and its subsequent proposals, to ask the United Nations Legal Office in New York to exclude roads E 115 to E 125 from the amendments to be notified to the Contracting Parties directly concerned. As to the reservation entered by Bulgaria, the Committee had been of the view that Bulgaria could not be considered a Contracting Party directly concerned by the extension of the E 60.

8. In a letter dated 22 March 1999, the United Nations Legal Office in New York had advised the secretariat that the AGR only stipulated rules for the adoption of proposed amendments by the Working Party on Road Transport and did not provide any competencies for the Inland Transport Committee to retract or overrule the decisions of the Working Party. The depositary had confirmed, therefore, that it

would circulate the proposed amendments as adopted by the Working Party. In this regard, it further confirmed that each proposed amendment should be considered separately and that it would be indicated in the depositary notification that an objection to one E road should not affect the entry into force of the remaining amendments.

9. The Ad hoc Meeting was informed that the Treaty Section of the United Nations Legal Office had advised the secretariat that the above-mentioned amendments had been circulated to the competent administrations of Contracting Parties by Depositary Notification (reference C.N.380.1999.TREATIES-1) dated 2 June 1999 and that consequently the six-month notification period would end on 2 December 1999 and the amendments would be considered as having been accepted as of that date if no objections were received.

10. The depositary had, basing itself on the voting procedures outlined in paragraph 3 of Article 8 of the AGR, deleted from its notification to Contracting Parties the reference to the provisional acceptance of the Russian Federation (E 115 to E 125) and the reservation of Bulgaria (E 60) which had been contained in the report of SC.1.

11. Regarding the depositary notification, the delegation of Turkey requested clarification regarding the route of the E 70. The secretariat confirmed that in Amendment 7 to the AGR (ECE/TRANS/16/Amend.7) the E 70 ended with the following reference cities: - ... ... - Craiova - Alexandria - Bucuresti - Giurgiu - Ruse - Razgrad - Choumen - Varna ... Samsun - Ordu - Giresun - Trabzon, and that the proposal contained in the depositary notification was to extend the E 70 further to Batumi and Poti.

12. The representative of Turkey requested that this correction be transmitted to the United Nations Legal Office.

13. In addition, the Ad hoc Meeting requested the delegation of Georgia to clarify whether it was in agreement with the proposal for the E 60 as circulated by the depositary, i.e. - ... ... - Constanta ... Poti - Samtredia - Kashuri - Tbilisi, etc. The delegate of Georgia stated that he had checked with his authorities in Tbilisi and that they were in agreement with the route as proposed in the depositary notification. The Ad hoc Meeting therefore confirmed the itinerary of the E 60 as proposed.

PROPOSALS FOR AMENDMENTS TO ANNEX I TO THE AGR

Documentation: TRANS/SC.1/AC.5/1999/1, TRANS/SC.1/AC.5/1999/2, TRANS/SC.1/AC.5/1999/3.

14. The Ad hoc Meeting examined the proposed amendments to Annex I to the AGR made by the Government of the Russian Federation concerning some itinerary changes relating to the E 115 and E 117, also taking into consideration the possible future extension of those itineraries, and the consequent deletion of the
E 591 (TRANS/SC.1/AC.5/1999/1). It agreed to the proposals and, as proposed in TRANS/SC.1/AC.5/1999/1, decided, in accordance with the AGR grid system, to revise the numbering of the main north-south reference roads in Central Asia which had been adopted at the ninety-second session of SC.1. Consequently, the E 117 was renumbered as the E 119, the E 119 as the E 121, etc. The new proposals by the Russian Federation and the revised numbering of the north-south reference roads are

contained in annex 1 to this report which will be forwarded for adoption by SC.1 at its ninety-third session (19-21 October 1999). The delegate of the Russian Federation confirmed that both the E 115 and E 117 might be extended in the future.

15. The Ad hoc Meeting agreed to the amendment to Annex I of the AGR proposed by the Government of France in TRANS/SC.1/AC.5/1999/2 concerning a modification to the E 25 and decided that it should be forwarded to SC.1 for adoption (see annex 1 to the present report).

16. The Ad hoc Meeting also considered and approved the proposal by Romania to add a new E road (E 675) between the Black Sea port of Constanta (Romania) and Negru Voda on the Romanian/Bulgarian border.

PROPOSALS FOR AMENDMENTS TO ANNEX II TO THE AGR

Documentation: Informal document No. 1 and Addendum 1 (notes by the secretariat).

17. The Ad hoc Meeting expressed its concern at the recent road traffic accidents in the Mont Blanc and Tauern tunnels which had resulted in the loss of over 50 lives. It was informed that this was the first serious accident in the 40-year history of the Mont Blanc Tunnel.

18. The Ad hoc Meeting also took note of a declaration by the International Road Transport Union (IRU) adopted on 16 April 1999 concerning the catastrophe at the Mont Blanc Tunnel, calling on the competent authorities to investigate thoroughly all the causes of the tragedy with a view to taking urgent measures to ensure the future safety of all tunnel users.

19. Basing itself on Informal document No.1 which contained the updated 1999 draft Standards and Recommended Practice of the ECE TEM Project regarding tunnels and Addendum 1 to that Informal document, the Ad hoc Meeting decided, keeping in mind that the TEM provisions are basically developed for motorways, that the following general provisions regarding safety in road tunnels could be considered: 8.1.1.2, 8.1.1.3, 8.1.3, 8.1.3.1 to 8.1.3.4 and from 8.2 to 8.6 inclusive (the draft TEM Standards and Recommended Practice regarding Tunnels are reproduced in their entirety in annex 2 to the present report).

20. The Ad hoc Meeting considered the usefulness of the establishment of a multi-disciplinary group of experts to work on the development of appropriate proposals for amendments to the AGR as well as other legal instruments dealing with road safety and other aspects.

21. In this connection, the Ad hoc Meeting decided to ask the Working Party on Road Transport (SC.1) to promote the establishment of such a multi-disciplinary group consisting of experts, for example, from the fields dealt with by Working Parties such as WP.1 (road traffic safety), WP.15 (dangerous goods) and WP.29 (vehicle construction). The timetable for completion of its work could be one year after its composition. Such a group could draw upon, for example, the TEM Standards and Recommended Practice mentioned above and national legislation, and should take into account work being carried out in other organizations on the development of regulations and/or standards for improved safety in road tunnels. It could also take advantage of other external expertise (e.g. International Tunnelling Association) in specialist fields such as firefighting techniques, lighting, ventilation, drainage, signalling and

telecommunication systems, etc. If considered appropriate, this body could also examine provisions for rail tunnels.

22. The Ad hoc Meeting stressed the importance for international tunnels (i.e. between two countries) of well coordinated management in the case of emergencies and was of the view that this might be achieved by the better use of existing bodies or setting up a single command structure.

23. The Ad hoc Meeting was also informed that in the case of exceptional circumstances on E roads such as the Mont Blanc Tunnel closure, which is part of the E 25, alternative roads have to be opened with the active participation of all bordering countries in order to assure a minimum level of service related to traffic demand.

OTHER BUSINESS

24. Under this agenda item, the Ad hoc Meeting took note of resolution No. 247 on the 2000 E Road Census and Inventory, adopted by the Inland Transport Committee at its sixty-first session (ECE/TRANS/128, annex 3).

ADOPTION OF THE REPORT

25. The Ad hoc Meeting adopted the report of its seventeenth session based on a draft prepared by the secretariat in English only. The secretariat was asked to finalize the report and to ensure its translation into French and Russian.

* * *

Annex 1
Proposals to amend annex I to the AGR

Russian Federation

A. Main roads

(2) North-south orientation

(a) Reference roads

E 115 - Delete sector Rostov-na-Donu - Vladikavkaz - Makhachkala - Baku - Iran. Extend from Moskva to Jaroslavl and from Rostov-na-Donu to Novorossijsk.

New overall reference: E 115 Jaroslavl - Moskva - Voronezh - Rostov-na-Donu- Krasnodar - Novorossijsk

In the future it is proposed to extend this route to the north in the direction of Vologda - Archangelsk and to the south in the direction of Trabzon - Syrian border.

E 117 - New E road from Mineraljnie Vodi to Megri

Overall reference: E 117 Mineraljnie Vodi - Naljchik - Vladikavkaz - Tbilisi - Yerevan - Goris - Megri

In the future, it is proposed to extend this route to the north in the direction of Stavropol - Elista - Volgograd.

E 119 - New E road from Moskva to Astara

Overall reference: E 119 Moskva - Tambov - Povorino - Volgograd - Astrakhan - Makhachkala - Kuba - Baku - Alyat - Astara

E 121 New E road from Samara to Gorgan

Overall reference: E 121 Samara - Uralsk - Atyrau - Beineu - Shetpe - Zhetybay - Fetisovo - Bekdash - Turkmenbashi - Gyzylarbat - border of Iran (Gorgan)

E 123 New E road from Chelyabinsk to Nizhiniy Panj (Afghanistan)

Overall reference: E 123 Chelyabinsk - Kustanay - Esil - Derzhavinsk - Arkalyk - Dzehezkazgan - Kzyl-Orda - Shymkent - Tashkent - Ayni - Dushanbe - Nizhiniy Panj

E 125 New E road from Petropavlovsk to Torugart (China)

Overall reference: E 125 Petropavlovsk - Kokchetav - Albasar - Akmola - Karaganda - Balkhash - Burylbaytal - Almaty - Bishkek - Naryn - Torugart

E 127 New E road from Omsk to Maikapshagai (China)

Overall reference: E 127 Omsk - Pavlodar - Semipalatinshk - Georgiyevka - Maikapshagai

B. Branch, link and connecting roads

Road E 591 - Delete

France

A. Main roads

(2) North-south orientation

(a) Reference roads

E 25 - Modification to include the following reference towns on the island of Corsica - Bastia - Porto Vecchio - Bonifacio

New overall reference: E 25 Hoek van Holland - ... - Alessandria - Genova - (maritime link) Bastia - Porto Vecchio - Bonifacio - Porto Torres - Sassari - Cagliari - ... ... - Palermo

Romania

B. Branch, link and connecting roads

E 675 - new E road

Overall reference: E 675 Constanta - Agigea - Negru Voda/Kardam (RO/BG border)

* * * *

Annex 2

General Provisions relating to Tunnels from the TEM Standards and Recommended Practice which the Ad hoc Meeting regarded as relevant when considering the addition of provisions on safety in tunnels to ECE legal instruments

Note: The following draft TEM Standards and Recommended Practice regarding tunnels were adopted at a Meeting of the Group of Experts on TEM Standards held in Budapest on 19-21 April 1999. No major changes are foreseen in the process of their finalization with the exception of Subchapters 8.5. - Ventilation and 8.6. - Lighting, where, inter alia, Austrian guidelines on tunnels will be reflected.

TUNNELS

8.1 Scope

In preparing the preliminary design of the TEM, even after the cross section, design speed and service levels have been decided, a large range of choice still remains, insofar as the route may be laid out in many different ways to take account of topography, geology and landscape.

In difficult topography there are various options for arranging the motorway: tunnels or cuts, tunnels or hillside tracts with many curves, viaducts or embankments, etc.

In each of these cases there will be differences in the construction and operation costs, and also in the manner in which the motorway is inserted into the environment, in the stability characteristics of the motorway and in the quality of the traffic flow.

The insertion of a tunnel, in particular, especially – but not only – in rough topography, is one of the most difficult tasks right from the initial design stages; as recent experience shows, the costs of such works can vary extremely from case to case, sometimes by as much as ten times, depending on the nature of the terrain involved.

The costs involved – and therefore, the decisions taken at the design stage – may be greatly affected by the rapid strides made recently in tunnel design, construction, technical systems (lighting, ventilation, traffic control equipment, etc.) and in operating procedures.

In conclusion, the decisions as to whether to construct a tunnel and what techniques to adopt have a considerable effect on the economics of the project.

8.1.1. Advantages of Road Alignments with Tunnels

8.1.1.1. In determining the profitability of road alignments involving tunnels, the designer should take into account both the direct and indirect benefits (such as habitat and environmental problems) and the costs (those of construction and operation, of externalities of foreseeable variations in user costs).

8.1.1.2. Among the variants considered in the analysis and comparison of costs and benefits (S), it may sometimes be preferable to include tunnels, even in non-mountainous terrain.

8.1.1.3. In rough terrain, better flow conditions may by achieved using tunnels.

8.1.2. Geological and Geotechnical Studies

8.1.2.1. Tunnels must be designed and constructed in accordance with the nature and behaviour of the surrounding terrain, the possible presence of water and all other local factors of influence (S).

8.1.2.2. In studying tunnel alternatives, special attention should be given to prior geological and geotechnical studies; these entail surface observations, surveys, borings, assays, laboratory tests, arc sometimes even exploratory tunnels to determine the various types of soil present, their characteristics and their stratigraphic and tectonic relationships (S).

Particular attention should be given to unstable or landslide zones and other areas affected by seismic action (S).

8.1.3. Decisions Regarding Suitability of Techniques of tunnel Construction

8.1.3.1. Situations where tunnels might represent valid alternatives to open construction include the following:

- solution of specific urban or landscape problems;
- improvement of route alignment, with less need to cope with significant differences in elevation and considerable reduction in the length of the route;
- crossing of unstable or barely stable hillside zones, with care taken to avoid tunnels with weak coverage in soils showing “flow” phenomena;
- protection of a route against natural hazards (avalanches, falling rock, etc.) – recent experiences show that tunnels hold up well in zones hit by earthquakes;
- cases where specific environmental protection is required in particularly important areas.

8.1.3.2. On the other hand, there are also difficult situations where heavy water seepage or soil instability, for example, may cause that costs outweigh the benefits of the tunnel alternative.

8.1.3.3. With regard to construction procedures, since the nature and degree of important parameters vary with every tunnel, as do the number and variety of construction techniques which may be adopted, the choice should be made on a case-by-case basis.

8.1.3.4. Finally, every tunnel is a unique structure in itself and must therefore be dealt with in a unique manner, at both the design and construction stages (S).

8.2. Guidelines Related to Technical Characteristics

8.2.1. General

8.2.1.1. Flow conditions occurring in tunnel sections differ from those occurring in open stretches.

8.2.1.2. Where tunnels are located along the route, it will therefore be necessary to ensure that continuity is not disrupted, i.e., that the capacity, service levels and safety conditions remain as similar as possible to those in open stretches (S).

Where this is not possible, the latter need to be adapted to the specific characteristics of underground traffic (S).

8.2.2. Capacity and Service Levels

8.2.2.1. The methods used in calculating capacity and determining service levels in tunnels do not differ from those used in the open motorway.

8.2.2.2. Factors to be taken into account include those influencing traffic in the open, specific parameters such as the length of a single tunnel, the possible existence of a series of tunnels in close succession, and the specific visibility conditions (S).

8.2.3. Determination of Tunnel Characteristics According to Traffic Forecasts and Service Levels.

8.2.3.1. Number of Lanes

Once the traffic forecast is known and the service levels established, the number of lanes is determined in the same manner as for adjoining normal layouts, taking into account that it is inadvisable to reduce the number of lanes in tunnels with respect to the motorway approaching the tunnel (S).

8.2.3.2. Lane Width

It is recommended that traffic lanes in tunnels should be of the same width as those in the adjacent normal layouts (RP).

The contingent reduction of their width, depending on local conditions (speed limitation, length of the tunnel, composition of the traffic flow) are governed by the national standards.

8.2.3.3. Lateral Clearance

In between the traffic lane and the curb of the service walkway, the edge line of min. 0.25 m must be safeguarded. In special cases (very short tunnels, cut-and-cover tunnels, very high traffic volumes, etc.) the shoulder or emergency lane should be provided.

In order to protect pedestrians and equipment located along the wall, it is recommended that service walkways at least 0.75 m wide be provided, equipped with reflectors.

In the case of tunnels longer than 1000 m (RP), different solutions should be adopted case by case, depending on the specific factors involved.

In these cases, it will be necessary to provide, in addition to the service walkways, lay-bys for the parking of broken-down vehicles (see para 8.4.3).

8.2.3.4. Overhead Clearance

The overhead clearance of 4.50 m be left in tunnels (S), besides the 0,20 m for future repaving (RP).

8.3. Traffic Regulation

8.3.1. General

Traffic regulation in tunnels has the following aims:

- to avoid as much as possible reduction of the service level;
- to regulate vehicle movement in emergency situations such as accidents, fires, etc.;
- to reduce the risk of accidents;
- to regulate the transit of dangerous goods.

8.3.2. Traffic Regulation to Avoid Lowering the Service Level

In general, the following measures will be adopted:

- prohibition of overtaking;
- installation of illuminated signs and signals (S);
- advance signs and direction signs must be repeated in the case of interchanges or service areas located immediately after tunnels – a situation which is in any case highly inadvisable (S);
- installation of the management and information system.

8.3.3. Traffic Regulation in Emergency Situations

8.3.3.1. In the event of partial or complete obstruction of the tunnel as a result of accident or fire, traffic access must be limited or barred (S).

8.3.3.2. In cases of reduction of carriageway, change of carriageway, alternation of one-way traffic in the case of two-way tunnels, etc., the personnel of the nearest operation centre should install portable emergency signs as appropriate to the situation.

8.3.3.3. Where a tunnel is blocked for a long period of time, traffic must be diverted from the motorway at the preceding interchange (S).

8.3.4. Traffic Regulation When Dangerous Goods are Carried

8.3.4.1. The transit of dangerous goods must be governed by special regulations issued by the relevant authorities in the individual countries.

8.3.4.2. In general, traffic safety requires that the transit of vehicles carrying dangerous goods be forbidden or obliged to comply with the special regulations set by national legislation (S).

8.3.4.3. Both in the construction stage and in the operation stage, it will be necessary to install special devices designed to limit the damage caused by fire or explosion according to national regulations (S). Examples of these devices are indicated below:

- an in-situ channel to collect liquids spilled on the carriageway should be provided along the whole length of the tunnel, with dimensions permitting a flow of 200 l/sec. This channel will be connected by means of syphons to the tunnel drainage system;

- a sump for the collection of road surface water and discharge of liquids at the exit of the tunnel, with a capacity of at least 50 m^3, (its capacity depending on the length of the tunnel), connected to the tunnel cleaning system;

- inspection pits with bolted-down covers, situated at least every 65 m;

- a fire detection system connected with the operation centre, designed to react at a predetermined temperature or upon sharp rises in temperature;

- illuminated signals to close access to the tunnel.

8.4. Equipment

8.4.1. General

Technological equipment of tunnels is the following:

- traffic management system;
- lighting;
- ventilation;
- safety equipment;
- communication equipment;
- fire extinction equipment;
- close-circuit TV;
- central operation system;
- energy supply;
- maintenance equipment.

8.4.2. To avoid accidents and limit their effects, it is advisable to equip tunnels – depending upon their length, traffic volumes, etc., and also on the costs involved – in order to:

- control and regulate traffic;
- communicate with users;

- provide emergency equipment.

Depending upon the specific case, the following should be supplied:

- no-overtaking signs, danger signs, signal lights, etc. (S);
- variable message signs to set speed limits and possibly to reverse the flow direction;
- traffic counting points;
- loading gauges to control the heights of freight vehicles;
- television control;
- devices for radio transmissions and information;
- SOS call posts (S);
- equipment to monitor temperature irregularities;
- all-purpose portable fire extinguishers (RP);
- hydrants directly connected to a pressurized water system;
- equipment to measure the level of carbon monoxide, visual opacity, etc., regulating the operation of the ventilation system;
- suitable housings for cable passages, conduits, pipes, etc. (S).

All the relevant data must be transmitted to the tunnel operation centre (if such exists) and/or to the Co-ordination Centre.

8.4.3. Lay-bys

8.4.3.1. Lay-bys for the parking of broken-down vehicles must have a net area of min. 30 x 2.5 m, besides the service walkway.

8.4.3.2. The spacing of lay-bys should be determined by national regulations.

8.4.4. Turning Bays and Cross-Connection Tunnels

8.4.4.1. The cross section must be enlarged at certain points in long two-way tunnels to permit U-turns, at least for passenger cars (RP).

8.4.4.2. In twin unidirectional tunnels, turn-arounds should be permitted via cross-connection tunnels between the two tubes, which should also take into account possible constraints related to the ventilation systems employed (RP).

8.4.4.3. The distance intervals between the turning bays and/or cross-connection tunnels must be determined according to national regulations.

8.4.5. Human Safety Measures

Local conditions permitting, shelters of suitable size and pedestrian safety exits must be provided along the tunnel (RP).

In addition to the contingent cross-connection tunnels for vehicles (see para. 8.4.3.2), also the cross-connection passages for pedestrians must be provided according to national standards.

8.5. Ventilation

8.5.1. General

8.5.1.1. In general, the feasibility of artificial ventilation should be investigated for two-way tunnels if their length exceeds 300 m (RP) and for unidirectional tunnels with the length exceeding 500 m (RP).

8.5.2. Natural Ventilation

8.5.2.1. Natural ventilation in tunnels depends upon a number of variable factors difficult to evaluate, and is capable of diluting vehicle emissions only to a very limited extent.

8.5.3. Artificial Ventilation

8.5.3.1. Traffic to be Considered

Any calculation to determine the quantities of fresh air necessary to ventilate a tunnel presupposes forecasts of the traffic which will pass through it.

8.5.3.2. Quantities of Fresh Air Necessary for Tunnel Ventilation

8.5.3.2.1. The fresh air volumes introduced into a tunnel to dilute the harmful substances should be calculated according to the national methodology (RP).

8.5.3.3. Choice of Ventilation System

8.5.3.3.1. Various types of artificial ventilation systems are possible: longitudinal, transverse, semi-transverse and reversible semi-transverse.

8.5.3.3.2. The designer should select the most economical type of ventilation system in relation to technical parameters, traffic parameters, microclimatic conditions, safety, etc.

8.5.4. Pollution in the Area of the Tunnel Portals

The contaminated air expelled from the tunnel will diffuse in the atmosphere according to the conditions existing at the tunnel exit. This problem should be examined on a case by case basis and, where necessary, steps should be taken to avoid undesirable pollution.

8.5.5. Recirculation between Portals

In the case of unidirectional tunnels lying adjacent to one another, it is necessary to prevent the contaminated air expelled from one being sucked into the other as fresh air.

8.6. Lighting

8.6.1. General

8.6.1.1. In daytime conditions drivers experience visibility problems at tunnel entrances due to the sudden drop in luminance after entry.

8.6.1.2. In tunnels longer than 200 m, it is advisable to consider the use of artificial lighting to permit drivers to adapt gradually to the difference in visibility conditions outside and inside the tunnel.

8.6.1.3. Daytime Luminance Levels

The luminance levels to be provided in the various tunnel sections and the shape of the curve which joins them are a function of the outside luminance, which should be measured once the construction works have been completed.

In the preliminary design, a luminance is frequently adopted at the entrance and for the first 50-80 m of L'sp equal to 1/15 of the Lsp taken at braking distance from the tunnel portal (RP). This L'sp level is then progressively lowered as a function of the speed limit for a distance generally of from 40 to 60 m, down to the Lsc level in the running section.

This Lsc level varies in relation to the traffic characteristics, dimensions of the tunnel, etc. traffic.

It is necessary to provide a short zone of 50-80 m of additional lighting at the exit in special cases only (view at the sea, frequent snow, etc.) or in the case of unidirectional tunnels which might occasionally be used for two-way traffic.

8.6.1.4. Nighttime Luminance Levels

To ensure safety at night it is advisable to provide a low luminance level (e.g., 1 cd/m²) (RP).

8.6.1.5. Power Supply and Control Devices

It is advisable to provide for installations which, even in cases of a power cut, would provide emergency lighting and power for the safety devices (signals, teletransmission, alarms, etc.).

Economic factors require more than one single operating regime (RP). For example, three regimes should be provided in relation to the luminance present outside the tunnel: nighttime, cloudy daylight or bright sun.

It is recommended that the maintenance requirements be taken into consideration in designing the system (RP).

_____