
Practice Note on Control of Air Pollution in Vehicle Tunnels

Air Services Group
Environmental Protection Department
November 1995

INTRODUCTION

1. This Practice Note provides guidelines on control of air pollution in vehicle tunnels by setting out :-

- (i) the air pollution concentration limits required for protection of public health; and
- (ii) other factors that should be considered in design and operation of vehicle tunnels.

CONCENTRATION LIMITS

2. Carbon monoxide, nitrogen dioxide and sulphur dioxide are the 3 indicative air pollutants inside vehicle tunnels in Hong Kong. To protect the health of the public, the air quality inside these tunnels should be kept within the following concentration limits :-

		Maximum Concentration		
Air Pollutants	Averaging Time	Microgrammes Per Cubic metre ($\mu\text{g}/\text{m}^3$)*	Part Per Million (ppm)	
(a)	Carbon monoxide	5 minutes	115,000	100
(b)	Nitrogen dioxide	5 minutes	1,800	1
(c)	Sulphur dioxide	5 minutes	1,000	0.4

* Expressed at the reference condition of 298K and 101.325 kPa.

3. In addition to the above, the visibility in tunnels is a gross indicator of the smoke concentration. It should be monitored and controlled to a level equivalent to an extinction coefficient of 0.005 per metre or less during any 5-minute interval.

VENTILATION REQUIREMENTS

4. The quantity of fresh air provided for a vehicle tunnel should be sufficient to ensure that the quality of the air is always maintained within the aforementioned concentration limits. To achieve this, the capacity of the ventilation system should be sufficient to cope with the maximum air pollution emission rate under the worst foreseeable traffic condition. Extra ventilation capacity would normally be required if tidal flow operation is expected.

AIR POLLUTION EMISSION RATES

5. Before the ventilation requirement can be determined, it is necessary to assess the maximum emission rates of the air pollutants inside a vehicle tunnel. The air pollution emission rates are determined by a number of factors including the traffic mix, speed limits as well as the configuration of the tunnel. The assessment would need to be done by specialists with suitable experience and background. Appendix I gives the categories of the basic emission values making reference to the emission factors recommended by the Permanent International Association of Road Congresses in the publication “Road Tunnels – XIXth World Road Congress, 1991”.

MONITORING

6. Monitoring of the traffic flow and air pollution concentrations inside vehicle tunnels is essential in ensuring acceptable air quality. There should be a real time system to feedback the information to the tunnel management so that the ventilation system can always be operated at the appropriate capacity level. If the air quality cannot be maintained to within the concentration limits, the traffic flow may need to be regulated to help reduce the air pollution. Appendix 2 sets out the normal requirements in monitoring air pollution inside vehicle tunnels.

TRAINING, SUPERVISION AND MAINTENANCE

7. Training, supervision and preventive maintenance are also vital factors to ensure an effective air pollution control system for vehicle tunnels. For these purposes, appropriate management plans should be derived.

ENQUIRIES

8. Officers in the Air Services Group of the Environmental Protection Department are glad to answer any enquiries concerning the control of air pollution in vehicle tunnels. Enquiries can be addressed to the Senior Environmental Protection Officer, Air Services Group, Environmental Protection Department (Telephone: 25946264, Facsimile: 28278040).

(R.J.S. LAW)

Director of Environmental Protection

Appendix I

EMISSION FACTORS

The emission factor is determined by :-

$$Q = q_0 \times f_v \times f_i \times f_H$$

where: q_0 = basic emission value per vehicle and hour at a velocity of 60 km/h
 f_v = speed factor, relative to hourly emission value
 f_i = gradient factor
 f_H = altitude factor

Vehicle Type	Registration Date	Basic Emission Value To Be Derived from PIARC 1991 Under the Following Category
Passenger Cars	Registered before 1 January 1992	EEC R15/04 (No control)
	Registered on or after 1 January 1992	FTP 75
Taxis and Vans Having Gross Weights Less Than 2.5 Tonnes	Registered before 1 January 1992	EEC R24 (No control)
	Registered on or after 1 January 1992	FTP 75
Diesel Engine Goods Vehicles	Registered before 1 April 1995	EEC R24 (No control)
	Registered on or after 1 April 1995	EURO1 (or approximately equivalent to US Transient 1990/91)
	Registered on or after 1 January 1998	EURO2 (or approximately equivalent to US Transient 1994)

Appendix 2

MONITORING REQUIREMENTS

1. Continuous measurement of parameters including carbon monoxide, nitrogen dioxide and visibility should be conducted inside a tunnel. At least one analyzer for each parameter at each kilometre section of the tunnel should be installed and operated. For sulphur dioxide, although it is a parameter for tunnel design, considering the traffic mix in Hong Kong, continuous monitoring is normally not required.

2. The monitoring of nitrogen dioxide may be replaced by that for nitric oxide through the application of the following equation or any correlation relationship between these two parameters with a regression coefficient or not less than 0.85 :-

$$\begin{array}{l} \text{Nitrogen dioxide} \\ \text{concentration } (\mu\text{g}/\text{m}^3) \end{array} = 320 + 0.1056 \times \begin{array}{l} \text{Nitric oxide} \\ \text{concentration } (\mu\text{g}/\text{m}^3) \end{array}$$

3. To ensure accurate measurement of the air quality, all monitoring instruments should be checked for zero and span once a week and calibrated and certified at least once per year by an independent environmental laboratory in accordance with the manufacturers' recommendations.

4. For existing tunnels, prior to the retrofitting of the nitrogen oxides/nitrogen dioxide analyzer, the tunnel professional persons should estimate the nitrogen dioxide concentration and ensure compliance with the air quality guidelines by applying the following equation :-

$$\begin{array}{l} \text{Nitrogen dioxide} \\ \text{concentration } (\mu\text{g}/\text{m}^3) \end{array} = 560 + 0.0141 \times \begin{array}{l} \text{Carbon monoxide} \\ \text{concentration } (\mu\text{g}/\text{m}^3) \end{array}$$

5. The analyzer mentioned in paragraph 3 above should activate an audible alarm in the main control room of the tunnel whenever the measured carbon monoxide and nitrogen dioxide concentrations exceed 60,000 $\mu\text{g}/\text{m}^3$ and 1,000 $\mu\text{g}/\text{m}^3$, respectively. Prompt action, including the fan operation, restriction of the traffic flow and other acceptable means should be taken whenever appropriate.

6. For individual cases, additional measures might be required. Advice from the Environmental Protection Department should be sought before finalising the monitoring requirements for a vehicle tunnel.

Addendum to the Practice Note on Control of Air Pollution in Vehicle Tunnels
(valid from 22 November 2005)

Original	Amendments
<p data-bbox="236 394 395 427">Paragraph 8</p> <p data-bbox="236 443 758 902">“Officers in the Air Services Group of the Environmental Protection Department are glad to answer any enquiries concerning the control of air pollution in vehicle tunnels. Enquiries can be addressed to the Senior Environmental Protection Officer, Air Services Group, Environmental Protection Department (Telephone: 25946264, Facsimile: 28278040).”</p> <p data-bbox="236 969 667 1003">No contact address was provided</p>	<p data-bbox="799 443 1321 667">“Enquires on the Practice Note can be made to the Air Science Group of the Environmental Protection Department (Telephone: 2594 6421, Facsimile: 2827 8040, email: enquiry@epd.gov.hk).”</p> <p data-bbox="799 969 1294 1238">Contact address is: Air Science Group Environmental Protection Department 33/F, Revenue Tower 5 Gloucester Road Wan Chai, Hong Kong</p>