Practice Note for Managing Air Quality in Air-conditioned Public Transport Facilities

Railways

Environmental Protection Department
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ENVIRONMENTAL PROTECTION DEPARTMENT

PRACTICE NOTE FOR PROFESSIONAL PERSONS

Introduction

1. This Practice Note provides guidelines to professional persons on the management of air quality in air-conditioned railway facilities operated within the territory of Hong Kong by the local railway companies.

2. The guidelines include the following:

   (i) **Air Quality Guidelines -** controlling parameters and limits to indicate better air quality in railway facilities;
   (ii) **Company Framework and Responsibilities -** incorporation of company policies or service pledge to achieve better air quality in railway facilities;
   (iii) **Design Considerations -** factors that should be considered in the design of railway facilities in order to achieve better air quality;
   (iv) **Operational Practices -** good practices to be followed for the achievement of better air quality in railway facilities; and
   (v) **Monitoring, Inspection and Maintenance Requirements -** sampling and maintenance to be taken to achieve and maintain better air quality in railway facilities.

3. Scope and Definitions

   (i) This Practice Note provides guidelines for all air-conditioned railway facilities, covering:
      (a) train compartments/saloons for passengers; and
      (b) stations, i.e. facilities for transfer and interchange of passengers, including concourse and platforms.
   (ii) "Railway facilities" in this Practice Note means "air-conditioned railway facilities".
   (iii) Concourse refers to the public areas within stations where commuters are expected to have a transient stay for transit purpose, or else they will be classified as public places in building because of their similar usage patterns, and the management of indoor air quality will be covered by the 'Guidance Notes for the Management of Indoor Air Quality in Offices and Public Places' published by the Indoor Air Quality Management Group of the HKSAR Government.
   (iv) Environmental control system refers to the air-conditioning and ventilation system which sustains the intended environmental quality inside the railway facilities. All equipment and materials used in operation, maintenance and cleaning of the system are included.

Air Quality Guidelines

4. The number and higher density of people inside the railway facilities, and the quality of outdoor/make up air taken into the railway facilities for the purpose of diluting pollutants influence the air quality in railway facilities. The area of concern in railway facilities is the adequacy of ventilation, i.e. supply and quality of outdoor/make up air.

5. Since it is difficult and resource intensive to effectively monitor the numerous air pollutants found inside railway facilities, an effective way to monitor the air quality is to measure appropriate surrogate air quality 'indicator(s)' which can indicate the adequacy of ventilation. The choice of surrogate indicator(s) depends on many factors:

(i) how representative they are of actual air quality;
(ii) ease of measurement;
(iii) ease of interpretation of results;
(iv) possibility of real-time monitoring; and
(v) feasibility of incorporating measurements into a schedule of routine maintenance procedures.

6. Carbon dioxide is selected as a surrogate indicator because its concentration in an indoor environment is a good indicator of the effectiveness of ventilation system and the adequacy of ventilation.

7. To allow flexibility for railway operators and to encourage them to strive for better air quality, a set of two-level air quality guidelines is established to act as the benchmark for evaluating and assessing air quality in railway facilities. The two-level air quality guidelines are as follows:

Level 1 - represents good air quality of a comfortable railway facility at which there is no health concern identified.

Level 2 - represents the air quality of a railway facility at which there is no health concern identified.

The numerical values of carbon dioxide for the two-level air quality guidelines are tabulated below:

Parameter	**Air Quality Guidelines (Hourly average)**	
	Level 1	**Level 2**
Carbon dioxide	2,500 ppm (4,500mg/m^3)	3,500 ppm (6,300 mg/m^3)

8. Since thermal comfort will influence the perception of indoor air quality in the railway facilities, the recommended ranges of temperature and relative humidity are set out in Annex A.

Company Framework and Responsibilities

9. Railway service providers should establish a framework and action plan to demonstrate their intention to achieve and maintain better air quality in their facilities, including but not limited to:

(i) put up a pledge to maintain better air quality in railway facilities;
(ii) make known the pledge in (i) above to all employees of the company and the public;
(iii) set up procedures to take into account the pledge in (i) above in procurement, design, operation and maintenance of the railway facilities;
(iv) take appropriate actions when the relevant air quality guidelines set out in paragraph 7 above have been exceeded;
(v) operate a proper complaint procedure on air quality in railway facilities and make it known to the public; and
(vi) nominate air quality manager(s), either part time or full time, with authority and responsibility to maintain better air quality within railway facilities, including the investigation, mitigation and logging of air quality complaints.

Design Considerations

10. The following design guidelines should be taken into consideration when new railway facilities are built. Existing facilities should be upgraded or retrofitted to meet the design guidelines where reasonably practicable.

(A) Train Compartment/Saloon for Passengers

11. (i) Compartment/Saloon Body

(a) facilitate regular maintenance and cleaning works. Reduce niches that may accumulate dirt and micro-organisms.
(b) ventilate all parts of the compartment/saloon adequately by airflow induced by the ventilation system.
(c) select materials having minimum emission of pollutants for use inside the compartment/saloon, such as paints with low VOC content, and seat coverings that resist soiling to avoid the growth of bacteria and fungi, etc.

(ii) Ventilation System

(a) consist of outdoor/make up air and re-circulated air.
(b) install particulate filters making reference to the relevant ASHRAE standards.
(c) install fans of appropriate size, taken into account the expected operational resistance of the filters (prior to filter cleaning or disposal), to deliver the designed flow rate at all times.
(d) allow access for regular maintenance and cleaning.
(e) design and locate the air outlets and return air grilles so that air can be evenly distributed throughout the compartment/saloon for flushing all parts and yet avoiding excessive draughts on passengers.
(f) design the air-conditioner on a train to reset automatically and safely when the compressor of the air-conditioner returns to normal conditions.

(g) design the outdoor/make up air ventilation rate based on the licensed maximum passenger-carrying capacity to meet the relevant air quality guidelines in Paragraph 7 above.

(B) Station

12. Design guidelines for stations are:

(i) Ventilation System

(a) design the outdoor/make up air supply flow rate and the ventilation rate based on the designed passenger transfer rate to meet the air quality guidelines set out in Paragraph 7 above.
(b) install particulate filters at the outdoor/make up air inlet and if needed at the re-circulated path. Efficiency of the filters should follow the "General Specification for Air Conditioning, Refrigeration, Ventilation and Central Monitoring and Control System Installation" published by the Architectural Services Department or the relevant ASHRAE standards.
(c) install fans of appropriate size, taken into account the expected final resistance of the filters (prior to filter cleaning or disposal), to deliver the designed flow rate at all times.
(d) ensure that there will be no short-circuiting of foul air into the system and no reduction in outdoor/make up and total supply air quantity due to by-pass away from intended air paths.
(e) install duty fans for minimum outdoor/make up air and for total supply air for air-conditioning purposes. Outdoor/make up air fans sized for 100% supply air (free cooling fans), individual supply air fans, return air fans and exhaust air fans should be considered, as usually they provide better system performance and flexibility with air circulation and re-circulation.
(f) take into account the expected latent heat load in calculating the cooling capacity of the primary air units and air handling units. Construct equipment with adequate numbers of rows of cooling coils for the required duty. Avoid condensation and cold spots by careful planning of the air distribution and the temperature set points. Reference shall be made to the relevant ASHRAE standards.
(g) allow access for regular maintenance and cleaning of the ductwork and cooling coils, and cleaning and replacement of the particulate filters.
(h) install a separate exhaust at kiosks if they are expected to emit excessive amount of air pollutant.
(i) provide a dedicated air cleaner or exhaust connections for temporary renovation sites within stations to avoid dispersal of pollutants if significant amounts of pollutants are expected.

(ii) Plumbing and Drainage System

(a) use durable materials for piping, valves and drains to avoid leakage and odour.
(b) provide drainage for underground water seepage and condensation to avoid accumulation of water.
(c) provide dedicated exhaust systems to areas that are considered to have higher risk of odour problems such as toilets, sump pits and culverts.

13. In general, railway service providers should use environmentally friendly materials in all railway facilities. If the use of any materials, which emit harmful pollutants or odour is unavoidable, the pollutants should either be baked out before the materials are put into service, or the concentration of the pollutant should be controlled at an acceptable level by operating the environmental control system in an appropriate mode (details are in Annex B).

Operational Practices

14. The following good operational practices should be adopted :

(i) operate and schedule trains so as to avoid or minimise congestion period inside tunnels as far as practical.

(ii) operate station fans and tunnel fans integrally to provide the desired outdoor/make up and supply air flow rate as well as the required air distribution and exhaust rate at the design capacity. It can be achieved by well planned operating modes for different conditions :

(a) normal train operation in summer time;
(b) normal train operation in winter time;
(c) station congestion;
(d) tunnel congestion;
(e) station emergency operation;
(f) tunnel emergency operation; and
(g) energy conservation operation.

(iii) operate the environmental control system in an appropriate mode such that the relevant air quality guidelines in Paragraph 7 will be met.

Monitoring, Inspection and Maintenance Requirements

15. Sampling for compliance checking of carbon dioxide:

(i) all train stations should be selected.
(ii) at least 10% of the railway fleet of the same model or such percentage as determined by the air quality manager(s) based on statistical method should be selected.

16. Inspection frequency:

(i) monitor 1-hour average concentration of carbon dioxide during normal operations at peak hours at least once a year.
(ii) check the ventilation rate or ventilation system in each train compartment/saloon for passengers in the workshop during the overhaul.

17. When the relevant air quality guidelines in Paragraph 7 above are exceeded, the air quality manager(s) should conduct investigation and suggest mitigation measures to ensure the compliance of the relevant guidelines.

18. The air quality manager(s) should develop a cleaning programme to remove dirt and rubbish, avoid water or damp materials, and remove stains, bacteria and mould growth, etc. from the tunnels, concourses, platforms, plant rooms and train

compartments/saloons. The programme should cover, but not limited to, the following:

(i) regular cleaning and replacement of air filters in ventilation systems of the railway facilities;

(ii) regular (or at such interval as recommended by manufacturers) cleaning of cooling coils, drain pans and those accessible air ducts in train compartments For passengers. Use a high suction power vacuum cleaner with HEPA filters or other equivalent equipment as determined by the air quality manager(s) in order to avoid dust being returned to the compartment;

(iii) adequate purging of areas including air ducts and cooling coils that have undergone cleaning procedures or fumigation with outdoor air before the stations/trains are returned to service;and

(iv) keeping cleaning records for individual train compartment/saloons and stations.

Enquiries

19. Please contact the Air Policy Group of the Environmental Protection Department (Telephone: 2594 6262，Facsimile: 2827 8040) for enquiries on managing air quality in railway facilities.

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Annex A

Thermal Comfort

1. Air temperature and relative humidity are indicators of thermal comfort conditions, which influence the perception of air quality in railway facilities. For example, cold drafts are frequently a cause of passenger complaints and high relative humidity encourages the proliferation of bacteria and fungi.

2. The recommended air temperature range is 20 to 28^{o}C and the recommended relative humidity range is 40 to 70%, or such comfortable ranges as recommended by the air quality manager(s), taking into consideration the preference of the passengers as indicated in any opinion surveys carried out from time to time.

3. Although the thermal comfort conditions in trains and stations could be influenced by the outside weather conditions, the railway operators should endeavour to design, operate and maintain the environmental control systems on board to achieve the recommended ranges of air temperature and relative humidity under normal operating modes of their new facilities. For existing facilities, they should be upgraded or retrofitted to meet the recommended ranges of air temperature and relative humidity, where reasonably practicable.

Annex B

Harmful Pollutants

1. The air quality manager(s) should –

   (i) ensure that environmental friendly material is used in railway facilities as much as possible;

   (ii) be aware of any potential risk of harmful substances including odour emitted from any material if the use of such material is unavoidable;

   (iii) obtain information such as emission rate of air pollutants from suppliers and manufacturers of the material in (ii) above; and

   (iv) dilute the harmful pollutants with adequate outdoor/make up air by properly managing the environmental control system.

2. The air quality at any zone of a railway facility is a function of the pollutants, ventilation rate and quality of the outdoor/make up air. The concentration of a pollutant at steady state condition is given by:

$$C_{ss} = C_o + G/Q$$

where C_{ss} = concentration of a pollutant at steady state of an operating mode of the environmental control system
C_o = in-facility background concentration of that pollutant of the effective ventilation
G = generation rate of the pollutant at the zone of concern
Q = effective ventilation rate at the zone of concern.

C_o and G constitute the inventory of a pollutant. It can be determined by adopting appropriate measurement protocols to suit the characteristics of the zone and configuration of the environmental control system. The dynamic characteristics of the pollutants can be taken into account by determining the profiles of the pollutants.

3. The "Guidance Notes for the Management of Indoor Air Quality in Offices and Public Places" published by the Indoor Air Quality Management Group of the HKSAR Government in September 2003 and the "Guidelines for Air Quality" published by the World Health Organization (WHO), Geneva, 2000 provide guidelines for the most common pollutants in indoor air.