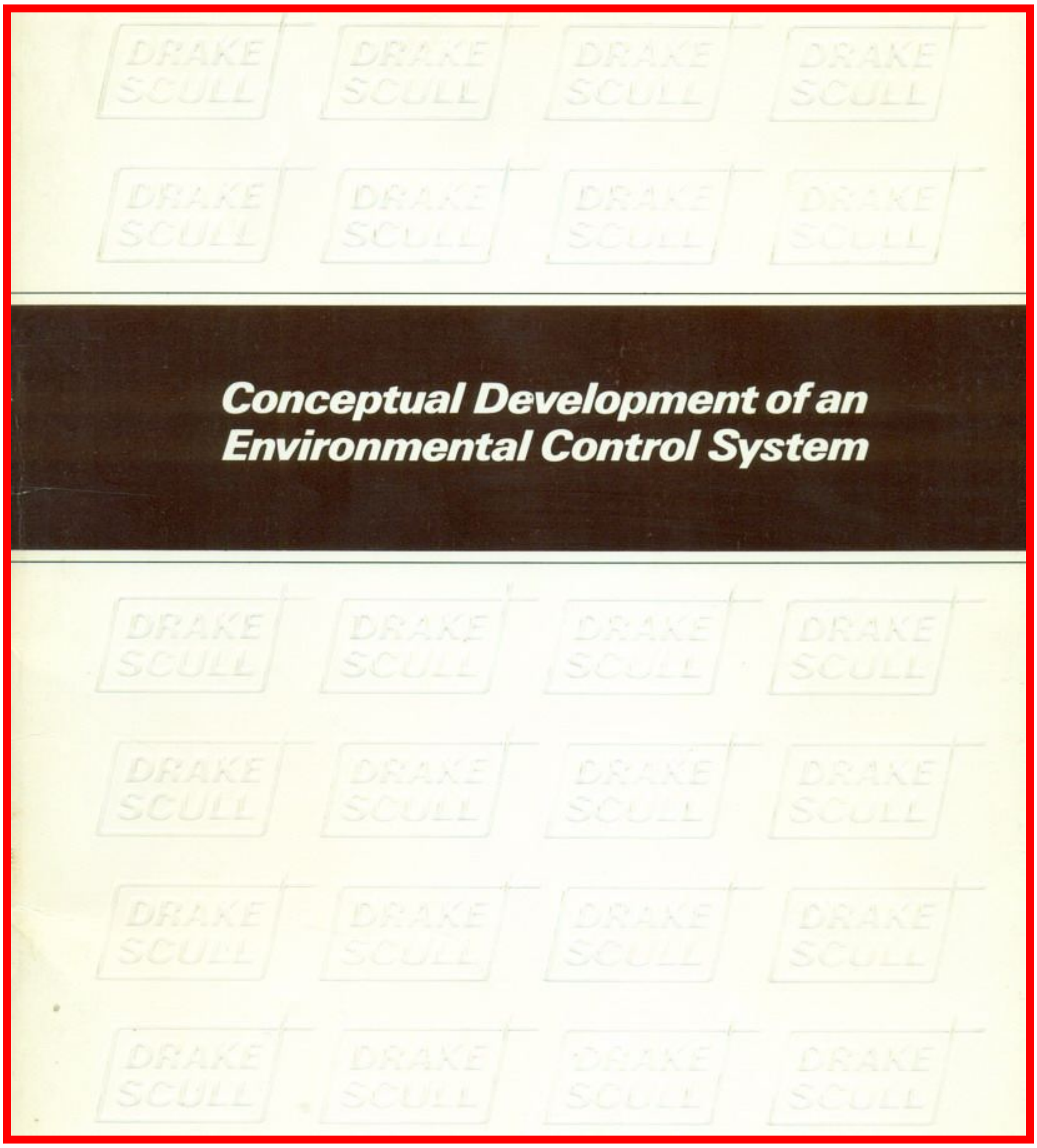
HONG KONG MASS TRANSIT RAILWAY



In 1976, former Heritage Group Chairman (then Company Chief Engineer for Drake & Scull) headed a design team which produced a study on air conditioning requirements for the Hong Kong MIS (Modified Initial System) the first phase of the Mass Transit Railway.

Working in New York and Hong Kong with PBQD (Parsons, Brinckerhoff, Quade & Douglas) the team used the American SES (Subway Environmental System) Computer Program to simulate train operation, passenger movements, heat loads and tunnel and station airflow patterns. The study also examined train air conditioning systems, tunnel ventilation and smoke control ventilation systems, as well as safety, emergency and control considerations

Background

The control of environment in the underground portions of fixed guideway mass transit systems has in recent years come to the fore as a significant systemwide element. Today's generation of high-performance, air-conditioned rolling stock produces large quantities of heat which, if not properly dealt with, lead to patron discomfort and possibly even distress. The transit system proposed for Hong Kong presents factors which make proper engineering of the Environmental Control System (ECS) even more critical. Not only does Hong Kong experience severe temperature and humidity ambient conditions for many months of the year, but the urban railway is being designed to carry almost twice the maximum passenger loading of other comparable systems (Ref. 1).

The Hong Kong Mass Transit Railway Corporation (MTRC) recognised the potential consequences of an uncertain ECS, both in terms of reduced ridership and patron safety. This recognition led to the commissioning of Drake & Scull Engineering Ltd. in association with Parsons Brinckerhoff Quade and Douglas Inc. to undertake a study of ECS performance goals and alternative engineering solutions leading to positive recommendations on the most viable and economical concept for that portion of the Mass Transit Railway known as the Modified Initial System (MIS) (Ref. 2).

Implementation of this two-month Initial Design Study (IDS) was on a team basis, utilizing experienced professionals in the fields of subway environmental analysis, equipment design and performance, automated controls, and plant design and construction. Detailed, quantitative analyses of alternative ECS concepts were made possible by the use of latest state-of-the-art techniques as reflected in the Subway Environmental Design Handbook (Ref. 3) and the Subway Environment Simulation (SES) computer model (Ref. 4), developed and verified during an ambitious four year research program sponsored jointly by the United States Department of Transportaion and the the American Public Transit Association, which represents the operating transit agencies in North America.

The IDS comprised three distinct phases of work:

* **ECS Performance Goals,** including recommendations for air temperature, humidity and velocity criteria in the underground stations and tunnels during normal and emergency operating conditions.

Analysis of Alternative Engineering Solutions, including detailed performance analysis of three alternative ECS concepts under normal conditions and emergencies, and recommendation of the best concept.

* **Mechanical Systems Development,** including the development of preliminary functional specifications for major equipment required by the best ECS concept.

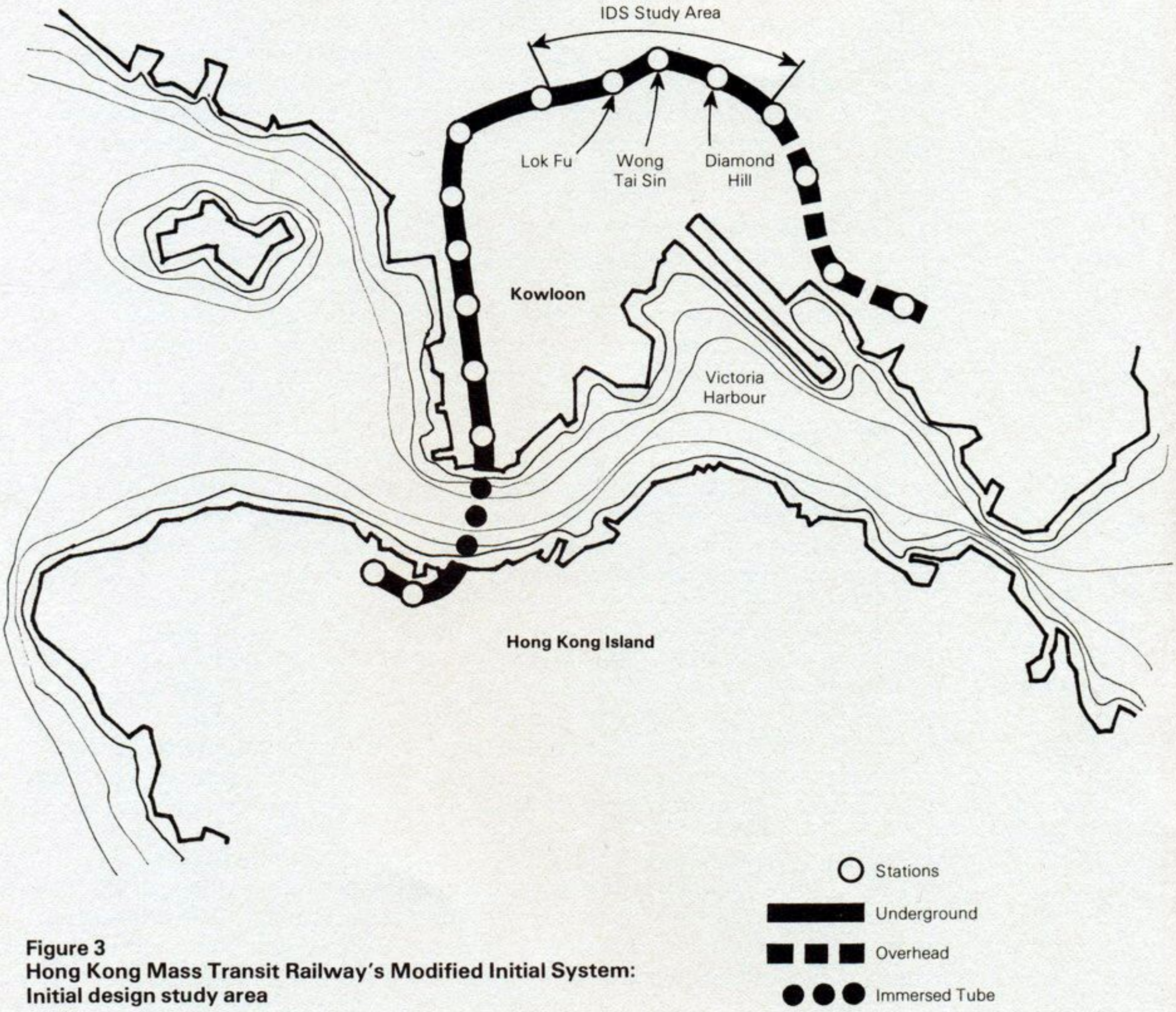


Figure 3
Hong Kong Mass Transit Railway's Modified Initial System: Initial design study area

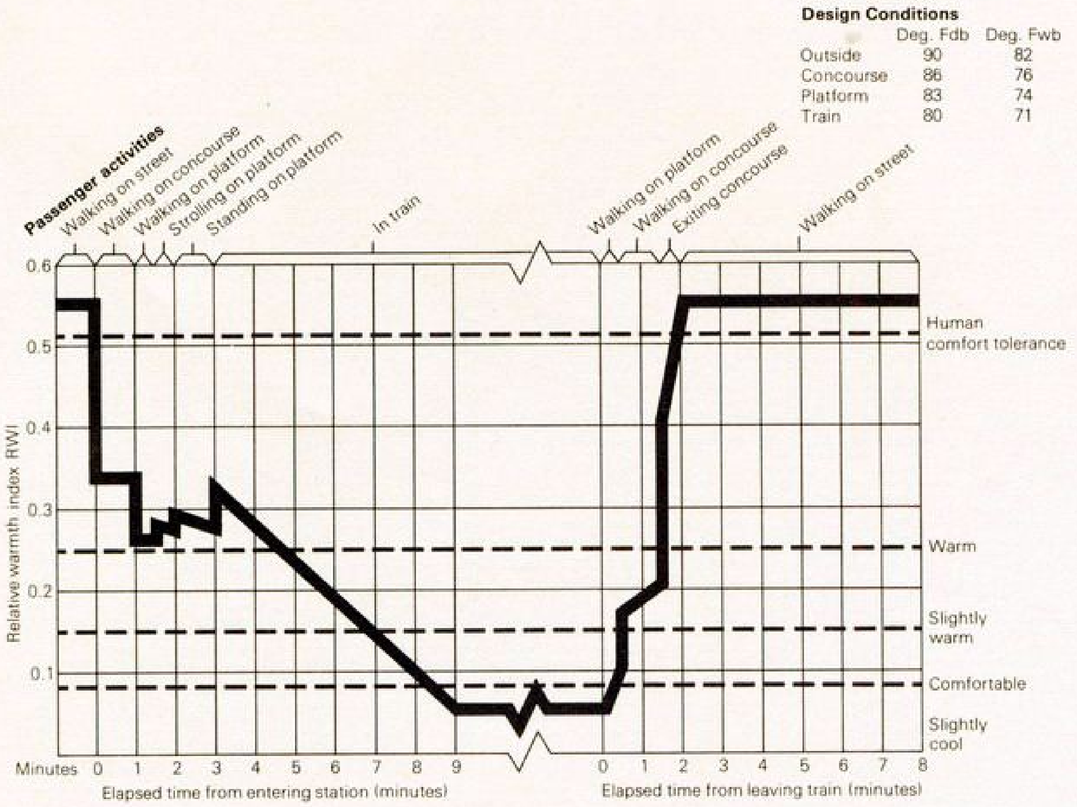


Figure 1
Relative warmth histogram in subway system: Evening rush period

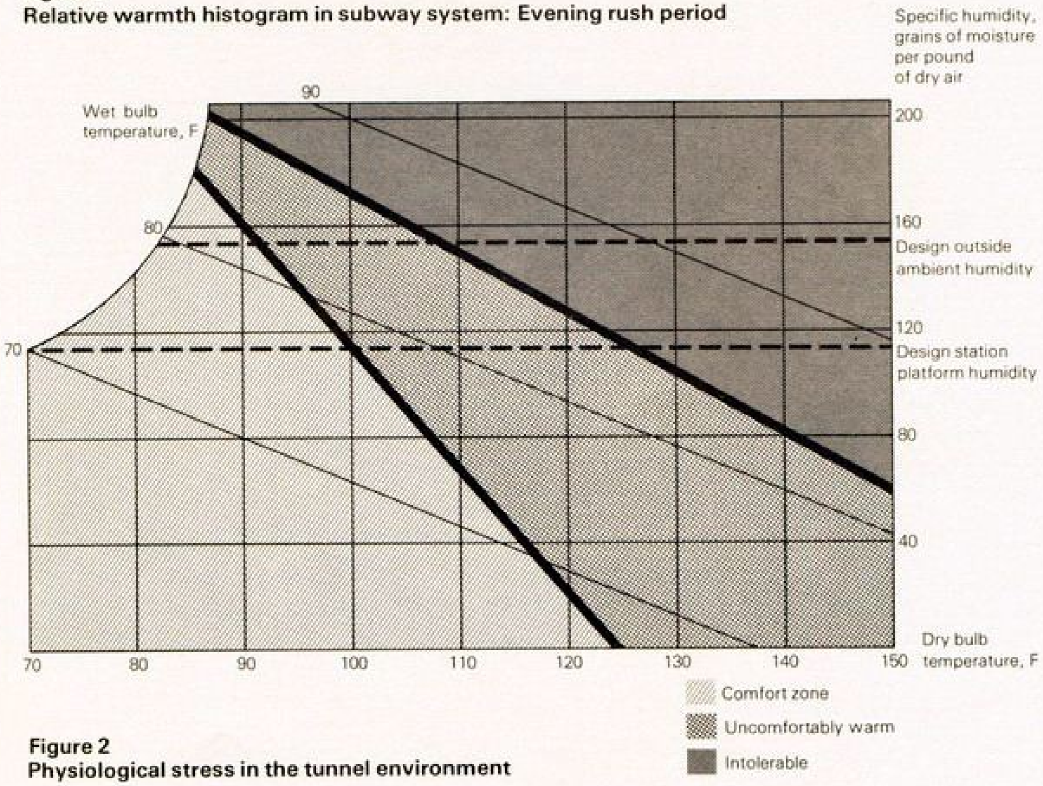


Figure 2
Physiological stress in the tunnel environment

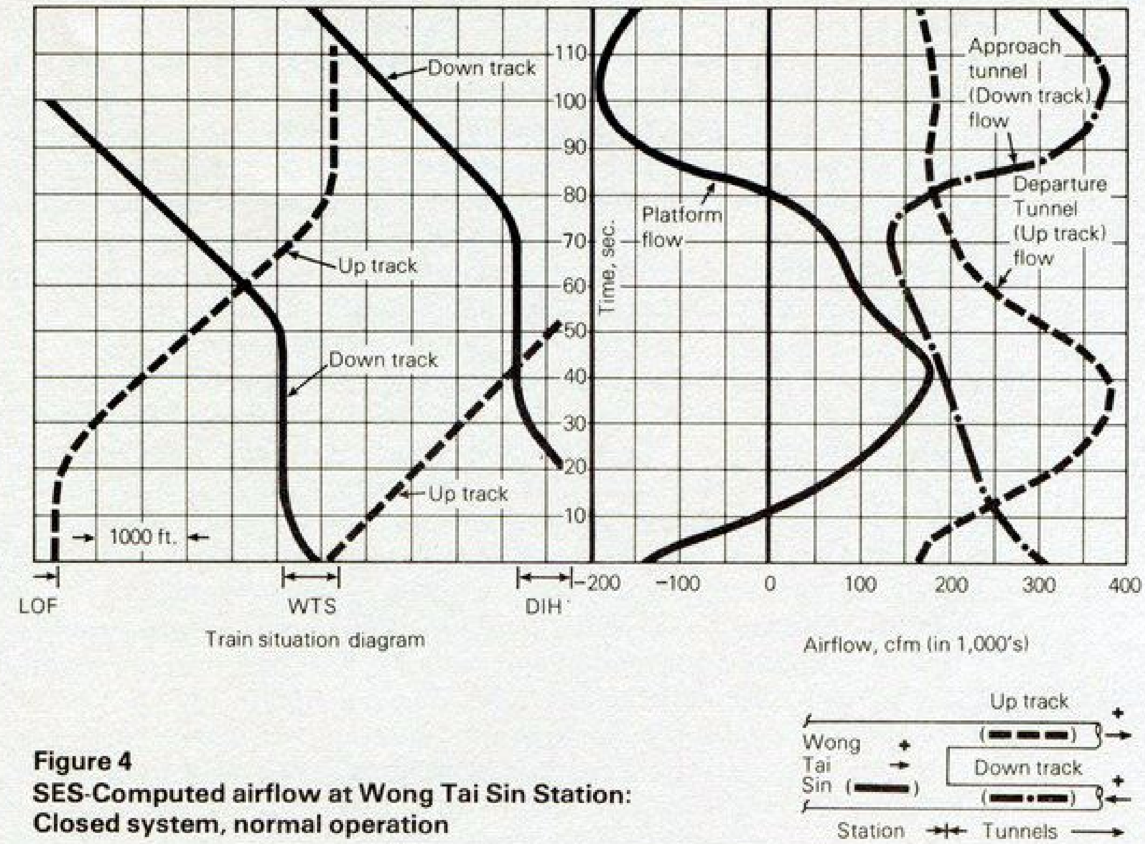


Figure 4
SES-Computed airflow at Wong Tai Sin Station: Closed system, normal operation

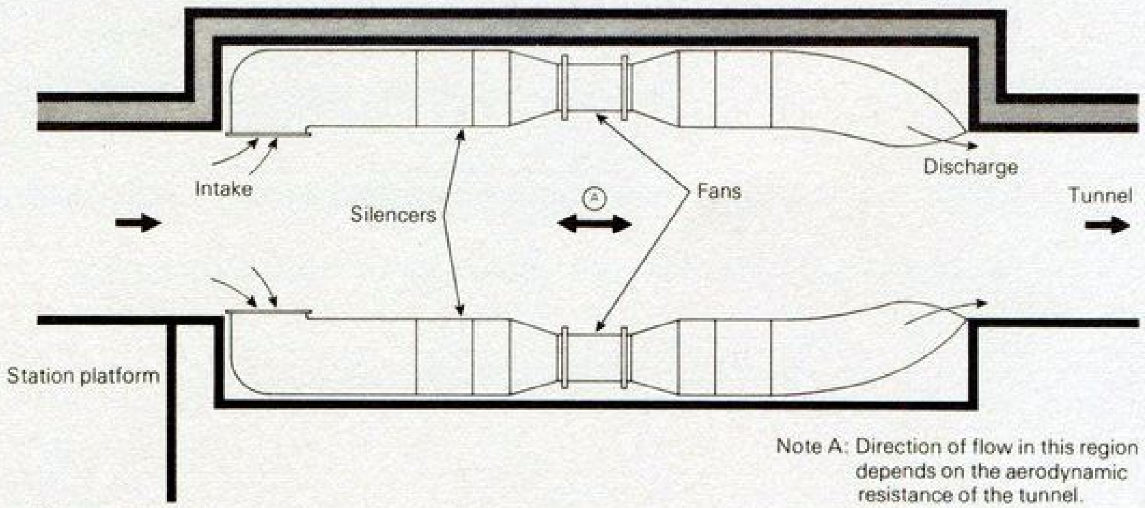


Figure 5
Impulse fan system schematic

Following information from "COOL Hong Kong,"
ASHRAE Hong Kong Chapter, 2010

Hong Kong Mass Transit Railway

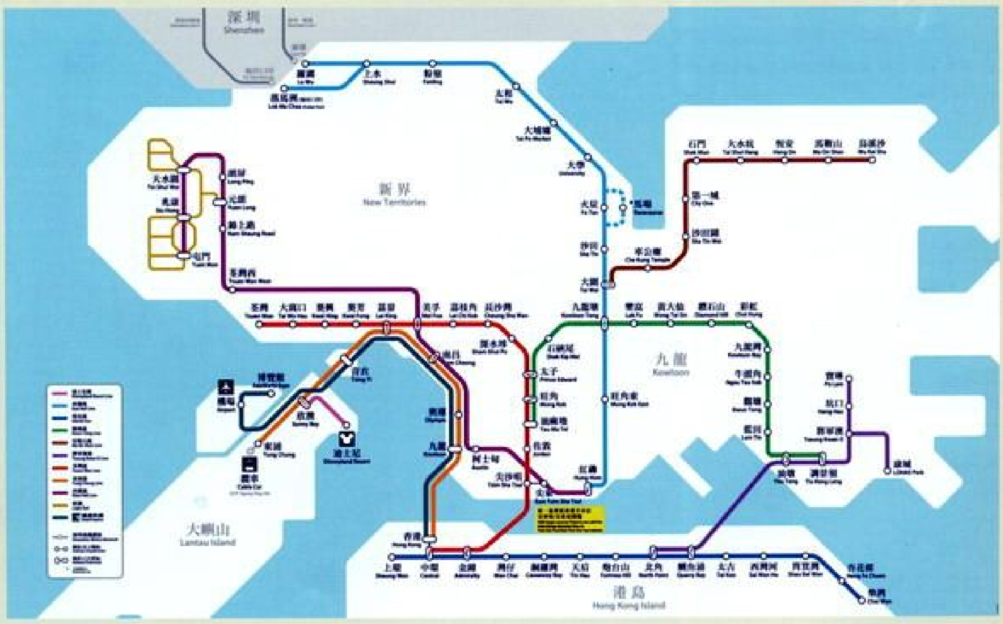
Owner
MTR Corporation Limited

Rail lines

- Disneyland Resort Line – Sunny Bay to Disneyland Resort
- East Rail Line – Lo Wu/Lok Ma Chau to Hung Hom
- Island Line – Chai Wan to Sheung Wan
- Kwun Tong Line – Tiu Keng Leng to Yau Ma Tei
- Ma On Shan Line – Wu Kai Sha to Tai Wai
- Tseung Kwan O Line – Po Lam/LOHAS Park to North Point
- Tsuen Wan Line – Tsuen Wan to Central
- Tung Chung Line – Tung Chung to Hong Kong
- West Rail Line – Tuen Mun to Hung Hom
- Light Rail – Tuen Mun/Yuen Long

Completion

- 1979 – Kwun Tong Line from Shek Kip Mei to Kwun Tong and Tsuen Wan Line from Central to Mong Kok
- 1982 – Tsuen Wan Extension covering part of the Tsuen Wan Line from Prince Edward to Tsuen Wan
- 1983 – Full electric train service of East Rail Line from Hung Hom to Lo Wu
- 1986 – Island Line from Sheung Wan to Chai Wan
- 1988 – Light Rail system commenced operation
- 1989 – Kwun Tong Line extended from Kwun Tong via Lam Tin to Quarry Bay
- 1998 – Tung Chung Line from Hong Kong to Tung Chung
- 1998 – Airport Express from Hong Kong to Airport with further extension to Asia World-Expo in 2005
- 2002 – Tseung Kwan O Line from Po Lam to Yau Tong, connection from Yau Tong across the Harbour to Quarry Bay and North Point
- 2003 – West Rail Line from Nam Cheong to Tuen Mun
- 2004 – East Rail Line extended from Hung Hom to East Tsim Sha Tsui
- 2004 – Ma On Shan Line from Tai Wai to Wu Kai Sha
- 2005 – Disneyland Railway from Disneyland Resort to Sunny Bay
- 2007 – Lok Ma Chau Spur Line commenced service
- 2009 – LOHAS Park added to Tseung Kwan O Line
- 2009 – West Rail Line extended to Hung Hom via Austin and East Tsim Sha Tsui



HVAC system

Environmental Control System (ECS)

The ECS controls the indoor conditions of the MTR underground system and provides:

1. a suitable environment within the public and non public areas of the underground stations;
2. a suitable and tolerable environment within the tunnel during normal and congested operations;
3. a tenable condition through ventilation for evacuating passengers during emergencies.

Station air conditioning and ventilation system

Air conditioning is provided for public areas during traffic hours for all underground stations and ventilation is provided for ground level or overhead stations. Air conditioning is provided on a 24 hour basis for offices, staff areas and for certain electronic equipment rooms, such as the rooms for signaling equipment, telecommunication equipment and environmental control system. Kiosks in all station public areas are also provided with air conditioning. Other equipment rooms are ventilated to ensure the room temperature is within their operation limits.

Generally, two ECS plants are provided at each station, each catering for approximately half of the station cooling and ventilation needs. For stations with an island platform with side tracks, or side platforms with centre tracks, and where the concourse and platform levels are of similar length and width, the plant rooms are located at each end of the concourse and platform.

For stations with bored tunnel platforms, the concourses and plant rooms are located in the basements of the high-rise developments above and offset from the bored tunnel platforms. Bored tunnel platforms are connected with concourses through adits and platform distribution areas.

Enthalpy control is used to optimize energy consumption for station air conditioning system serving the public areas. In hot seasons, the conventional air conditioning circulation mode of operation, called `re-circulation' is adopted. Return air is mixed with minimum quantities of fresh air, cooled by a air handling unit, and distributed to the public areas to be air conditioned. In cool seasons, when the enthalpy of the outside air is less than the enthalpy of the return air by a preset amount, the return air is exhausted and full outside air is supplied to the public areas. The mechanical cooling plant is shut down and the station public areas are cooled by 100% outside air. This mode of operation is called `free cooling'.

If a fire occurs in a public area, the station air conditioning system can be used to remove smoke from the station to facilitate passenger evacuation by stopping the fresh air supply and extracting the return air to outside.

Various types of heat rejection for station air conditioning systems are used depending on station locations and constraints. Air-cooled chillers are most commonly used with chiller plants located at the podium level of the development above the station, on station roof or ground level adjacent to the stations. Water-cooled chillers are also used. The heat from the water-cooled chillers is rejected by cooling towers or fresh water/sea water plate heat exchangers and dumped into the harbour. Split type air conditioners or small chillers are used to provide air conditioning for non public areas needed.

Equipment	
Air-cooler chiller	3 x 240RT
Trackway exhaust fan	8 x 33m^3/s
Trackway supply fan	8 x 27m^3/s
Tunnel ventilation fan	8 x 50-100m^3/s
AHU	3 x 2 per level

Air-conditioning plant at Tiu Keng Leng Station completed in 2002

Jordan Station completed in 1979 and retrofitted with platform screen door in 2001

Central Station Concourse refurbished in 2000

Central Station Concourse completed in 1980

Kwun Tong Station completed in 1979, an above ground station utilizing natural ventilation for the platform

Tunnel Ventilation: Normal Operation

The tunnel ventilation system originally adopted for the Modified Initial System, Tsuen Wan Extension, Island Line and Eastern Harbour Crossing is defined as a 'closed' system. Vent shaft dampers are closed and the tunnel heat is removed at the stations by over-track and under-platform ducts.

Where the tunnels are not separated from the platform, the tunnels are also cooled by the station air conditioning system. In 2000, platform screen doors began to be retrofitted, separating the tunnels from platforms. This has reduced overall station cooling demand.

The tunnel ventilation system adopted for the Tung Chung Line, Airport Express Line and Tseung Kwan O Extension is defined as an 'open' system. Vent shaft dampers are open and the tunnel heat is removed by air exchange created by the piston effect through the vent shafts. Relatively hot tunnel air is prevented from entering the platform by the platform screen doors.

Tunnel Ventilation: Congestion Operation

When a train is stopped in a tunnel section due to congestion upstream, the air flow through the tunnel induced by piston effect decays and heat from the train builds up locally. Train-borne air-conditioners cannot dissipate the heat inside the trains effectively, making prolonged stoppages potentially uncomfortable for passengers. To prevent this, tunnel ventilation fans or impulse fans at stations are turned on to create the required air flow through stationary trains in tunnels for heat removal. The signaling system automatically starts and stops the tunnel ventilation fans once a train is detected to be stationary for a pre-determined period.

Tunnel Ventilation: Emergency Operation

In the event of an emergency when a train is on fire and is unable to move to the following station, passengers must evacuate towards the exit station as directed by the train operator.

Air flow through the incident tunnel will be provided to remove the train heat and smoke away from the evacuation route. This is achieved by the operation of tunnel ventilation fans or emergency fans in intake mode drawing outside air into the tunnel towards the evacuation route at the exit station. Fans at the other end of the tunnel operate in exhaust mode to remove heat and smoke from the tunnel at the station.

The tunnel ventilation fans and emergency fans can be operated in either intake or exhaust to suit the evacuation route in either direction as determined by the operator.

Background

Established in 1975, the rail lines operated by the MTR Corporation carries an average of 3.7 million passengers everyday. It is regarded as one of the world's leading railways for safety, reliability, customer service and cost efficiency.

Most of the stations are typical 2-storey structure except interchange stations with additional platform levels to meet operational needs.

Station concourse accommodates major station operation facilities such as automatic fare collection system, ticket issuing machines, entry/exit gates, barriers to separate paid and unpaid areas, station control room, customer services centres and kiosks for customer services.

Concourse is connected to road level by staircases, escalators and lifts as appropriate. Offices, staff areas and plant rooms are normally located at the station ends on both concourse and platform level.

All public areas are equipped with signage, passenger information display system, public address system and CCTV system for effective station operations.

Information provided by:
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Olympic Station completed in 1998

Po Lam Station completed in 2002


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