Legislative Council Panel on Transport
Subcommittee on Matters Relating to Railways

Environmental Measures for New Railway Projects

Introduction

Railway is one of the most environmentally-friendly transport modes. To better protect the environment, the MTR Corporation (MTRCL) is dedicated to constantly exploring opportunities for the application of new designs and technologies to increase the energy and operational efficiencies of the railway system. This paper aims to introduce the environmentally-friendly designs and energy-saving measures adopted for the design, construction and operation of the five new railway projects, namely the West Island Line, Express Rail Link (Hong Kong Section), South Island Line (East), Kwun Tong Line Extension and Shatin to Central Link, currently undertaken by the MTRCL.

Environmental Measures of Railway System

2. A number of environmentally-friendly design and measures have already been put in place in the railway system in Hong Kong to enhance energy efficiency. They include energy efficiency considerations in the design of railway alignment and ventilation system, the establishment of the Comprehensive Energy Consumption Monitoring System and regenerative braking system, and the reduction in power loss resulting from power transmission, distribution and conversion.

Railway Alignment Optimization

3. Since most of the traction energy of the railway is used for motoring, acceleration, deceleration and braking, the MTRCL has implemented the energy saving strategy in the design for railway alignment. The vertical track profile between stations is designed in the form of a valley while platforms are located in a higher position. By doing so, a train will face a down-slope when it departs from a platform; it will face an up-slope when approaching the next platform. The valley alignment design allows the acceleration and deceleration of the train to be aided by its own weight, thus reducing the overall traction energy consumption . The alignment design also avoids sharp curvature to maintain the stability of train speed and to reduce the frequency of energy-wasting train braking and re-motoring efforts.

Ventilation System

4. Ventilation shafts of the railway system in Hong Kong enable outdoor fresh air to be brought into railway tunnels to ensure continual air circulation and to avoid temperature build-up and thereby the need for mechanical cooling. Computer modelling is also used in the architectural design of elevated stations to consider sunlight, wind direction and ambient conditions, so that natural ventilation can be introduced to maintain the temperature of elevated stations. Platform screen doors, while ensuring passenger safety, are usually provided in underground stations to prevent the loss of air-conditioning to trackways and thereby energy wastage.

Comprehensive Energy Consumption Monitoring

5. The existing railway system is equipped with a Comprehensive Energy

Consumption Monitoring System with advanced energy management functions that can continuously monitor energy consumption at different levels of railway operations. For example, digital energy metres are installed at infeed sub-stations, traction sub-stations, station sub-stations and low-voltage switch boards to carry out real-time monitoring of energy consumption and effectiveness of energy efficiency improvement initiatives. The continuous comprehensive energy consumption records allow the MTRCL to identify areas for further improvement in energy-saving.

Regenerative Braking

6. The regenerative braking system is adopted in MTR trains to transform the kinetic energy of a moving train into electric energy, which is then fed back to the overhead line for use by other trains.

Power Transmission, Distribution & Conversion

7. Power transmission and distribution and voltage conversion constitute part of the total energy consumption in railway operations. To reduce such power losses, one voltage level will be eliminated in the conversion of high voltage power to lower voltage power. That means the voltage level will be stepped down from the incoming 33kV directly to 380 or 415V, skipping the intermediate 11kV level.

8. These environmentally-friendly designs and energy-saving measures will continue to be adopted in new railway projects.

Environmentally-friendly Designs & Measures for New Railway Projects

9. Over the years, while engaging in railway construction and operation, the MTRCL has been continuously exploring and identifying areas of the railway system where environmentally-friendly designs and measures can be introduced. Aside from the measures mentioned above, more green designs and measures will be implemented in new railway projects. These include enhancement of energy efficiency, reduction in energy loss, utilization of regenerated energy, adoption of environmental mitigation measures, introduction of greening and tree conservation.

Enhancement of Energy Efficiency

10. High energy efficiency equipment and systems to be adopted in new MTR stations and trains include:

(a) High-efficiency Lighting System

A high-efficiency lighting system (e.g. T5 fluorescent tubes and LED lamps) will be adopted in all new stations and trains. Compared with the old lighting system, the high-efficiency lighting system can save around 30% energy consumption. The station intelligent lighting system and more natural light applied will also enable a higher level of energy saving.

(b) High-efficiency Air-conditioning System

The water-cooled type air-conditioning system, in place of the air-cooled type, will be adopted as far as practicable in new MTR stations to save air-conditioning energy consumption, and is expected to achieve a 20% saving in chiller plant energy

consumption, or a 3% saving in the overall energy consumption of the station environmental control system. Moreover, energy optimization control algorithms will be implemented in new stations to adjust station temperature according to occupancies and ambient conditions to avoid unnecessary energy wastage.

(c) Minimising Unnecessary Braking & Re-motoring

The signalling system of new railway projects will incorporate an algorithm to optimize the speed profile of trains and to minimize any unnecessary braking and re-motoring, thus achieving less energy consumption. Moreover, the enhancement of the response times of the various systems, including the signalling system, train door system and platform screen door system, will effectively control station dwell time and avoid unnecessary train delay; otherwise, the following trains would have to do more re-motoring to catch up with the timetable, resulting in unnecessary energy consumption.

Reduction in Energy Loss

11. New technologies will be introduced in the railway power system to reduce energy losses arising from railway operations.

(a) Reduction in Power Distribution & Conversion Loss

The overhead rigid conductor system, which has low resistance characteristics, will be adopted for the overhead lines of new tunnel sections to replace the conventional catenary system, leading to a reduction in power distribution loss.

(b) Control of Maximum Power Demand

Power companies are required to provide sufficient power supply from additional electricity generating units for the transient but huge power demand of the railway system during the peak hours. The Comprehensive Energy Consumption Monitoring System of new railway projects will monitor and predict the real-time maximum power demand of the entire railway system. Load shedding or load balancing plans will be executed when necessary to effectively suppress maximum power demand. The motoring of trains constitutes a major portion of the energy consumption of railway operations. To make the power demand of the railway system more even and stable and to avoid a sudden surge in power demand at certain periods, some trains will start to be mobilized gradually before peak hours, and the station air-conditioning systems will be switched on at different times. All this can decrease the overall demand for electricity generating units in Hong Kong and save resources.

Utilisation of Regenerated Energy

12. The MTRCL is constantly exploring ways to utilise energy regenerated in railway operations. New technologies will be introduced to new railway projects, from trains to station lifts and escalators, to achieve this objective.

(a) Lifts & Escalators

Devices will be provided in the lifts and escalators of new stations, so that energy generated by their downward movements can be re-used, achieving an energy saving of approximately 10-20%.

(b) Energy Storage System

The South Island Line (East) is only 7 kilometres long and will have a smaller number of trains running at the same time. The energy regenerated from the motoring of trains may not be able to be immediately used up by other trains. Super-capacitor energy storage technologies will be introduced to absorb and store the surplus regenerative braking energy. The energy storage system is estimated to save about 10% of the total traction power for the South Island Line (East).

Mitigation of Environmental Impacts

13. Besides the implementation of the above energy-saving designs and measures, independent environmental consultants are appointed before the commencement of railway construction to carefully assess possible environmental impacts arising from railway construction and operation, and to propose corresponding mitigation measures to minimize impacts on the public and the environment. Environmental monitoring will also be carried out during the works period, and monitoring data and reports will be submitted to the Environmental Protection Department and made available for public inspection.

(a) Air Quality

Railway construction, such as excavation, transportation of spoil and operation of barging points may induce concern on dust generation. Effective measures are in place to suppress dust wherever applicable, including regular watering of the works areas, enclosure of the loading and unloading area of barging facilities, covering of stockpile areas, use of dump trucks with cover and

provision of watering facilities for vehicles at exits of works sites. **(see Appendix 1)**

For example, a fully enclosed conveyor belt system has been erected in the West Island Line project to transport the excavated spoil from the vertical shaft at the Kennedy Town Praya to the temporary barging point at the Western District Public Cargo Working Area for removal by sea. **(see Appendix 1)**

(b) Noise

The use of powered mechanical equipment for tunnel excavation, demolition and construction of above-ground structures might generate noise during the construction period. To effectively mitigate noise impact, low-noise machines, temporary noise barriers and noise-insulating fabric will be used on construction sites, and works sequence will be optimized as far as practicable. Taking West Island Line project as an example, water was used as blast ballast in the excavation of a construction adit at King George V Memorial Park to reduce vibration and noise caused by blasting. **(see Appendix 2)**

The MTRCL adopts appropriate measures to reduce noise generated by running trains, including grinding the rails and wheels regularly, proper maintenance of trains and rails, lubricating the tracks and wheels, and constructing noise barriers. For the noise generated at other sources during operation,for example, at ventilation buildings or ventilation shafts with E&M plants, proper measures like acoustic silencers will be adopted.

(c) Waste Management

Construction and demolition materials and spoil would be generated from the demolition, excavation and site formation works during the works period. To minimize the amount of waste generated during the construction stage, on-site sorting will be carried out and materials will be re-used wherever possible. For instance, a portion of the spoil excavated from the works site of Ho Man Tin Station of the Kwun Tong Line Extension will be transported to Anderson Road Quarry for manufacturing of construction materials. The materials generated from the construction of the Shatin to Central Link is also expected to be re-used in other infrastructure projects (e.g. Hong Kong-Zhuhai-Macao Bridge) that take place during the same period.

(d) Water Quality

Construction run-off and drainage diversion may lead to potential water pollution during construction. To minimize the impact on water quality, excavated materials will be covered, and on-site sedimentation tanks will be provided.

(e) Tree Conservation

During the planning and design of a railway project, tree conservation has already been taken into consideration, and tree surveys are carried out to record information of trees that may possibly be affected by railway works. Trees, particularly Old and Valuable Trees, will be retained in situ as far as possible. Tree experts will be engaged in the tree preservation work during construction. If removal of trees is unavoidable, transplanting will

be considered and the process will be supervised by tree experts. Compensatory planting will be implemented if trees cannot be transplanted and have to be felled unavoidably.

(f) Visual Impact & Greening

Railway facilities are part of the urban landscape. The MTRCL places great emphasis on the integration with the surrounding environment and urban context. Greening features, such as vertical greening and green roof, have been and will continue to be introduced to the external structures of new MTR stations (e.g. West Kowloon Terminus of Express Rail Link, Admiralty Station, Ho Man Tin Station and Hin Keng Station), where appropriate, to blend in with the environment. Railway viaducts and ventilation shafts will adopt green design wherever possible. **(see Appendix 3)**

Conclusion

14. To better protect our environment and efficiently use our resources while engaging in railway infrastructure development, the MTRCL, leveraging on its past experience, will continue to explore areas in its railway system where higher environmental efficiency can be achieved, to introduce latest green technologies and to implement appropriate green measures.

MTR Corporation Limited

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Mitigation of Dust Impact

Mitigation measures will be implemented to reduce dust impact during railway construction:

Wheels of vehicles are washed before leaving construction site to prevent dust from spreading around.

Spoil is transported to the temporary barging point through a fully-enclosed conveyor belt (marked in red) to suppress dust.

Spoil is transported to the barge for removal by sea, alleviating the impact on the community.

Mitigation of Noise Impact

Mitigation measures will be implemented to reduce noise impact during railway construction:

Water was used as blast ballast in the excavation of the construction adit of the West Island Line at King George V Memorial Park.

Visual Impact & Greening

Greening features, such as vertical greening and green roof, will be adopted for railway facilities to integrate with the surrounding environment and urban context.

Vertical greening will be adopted for Hin Keng Station of the Shatin to Central Link.

A green roof will be introduced to the ventilation building of the Shatin to Central Link at Ma Chai Hang.