Code of Practice on the Design and Construction of Peak Tramway

EMSD

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Electrical and Mechanical Services Department
The Government of the Hong Kong Special Administrative Region

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CONTENTS

Part 1 Foreword

1.1 This Code of Practice was issued by the Director of Electrical and Mechanical Services (the Director) of the Government of the Hong Kong Special Administrative Region under section 14A of the Peak Tramway Ordinance (Cap. 265). It is the intention of this Code of Practice to give advice on the fundamental areas on the design and construction of peak tramway.

1.2 During the compilation of this Code of Practice, reference has been made to several other national standards concerning cableway and funicular installations, including the Regulation (EU) 2016/424 of the European Parliament and of the Council of 9 March 2016 on cableway installations.

1.3 The design and construction of peak tramway shall comply with the relevant legislation in Hong Kong. All works associated with the peak tramway shall comply with the relevant ordinances and regulations of Hong Kong and the code of practices, design manuals, specifications, etc. promulgated by relevant authorities.

1.4 In particular, all buildings, stations and associated structures for the peak tramway shall comply with:

(a) The Buildings Ordinance (Cap. 123), the Building (Construction) Regulations (Cap. 123B) and the latest edition of the Code of Practice on Wind Effects in Hong Kong issued by the Buildings Department; and

(b) The Fire Services Ordinance (Cap. 95), the latest edition of the Code of Practice for Minimum Fire Service Installations and Equipment, the Code of Practice for Inspection, Testing and Maintenance of Installations and Equipment, the Requirements for Emergency Lighting Systems and the Requirements for Self-contained Luminaires Emergency Lighting Systems issued by the Fire Services Department (FSD).

1.5 The electrical works shall comply with the following:

(a) The Electricity Ordinance (Cap. 406);

(b) The latest edition of the Code of Practice for the Electricity (Wiring) Regulations issued by the Electrical and Mechanical Services Department (EMSD); and

(c) The latest edition of the "Supply Rules" issued by either The Hongkong Electric Company Limited or CLP Power Hong Kong Limited, as appropriate.

1.6 It is not the intention of this Code of Practice to prohibit the inclusion of innovation and improvement in design and performance of peak tramway but it must be stressed that any such developments shall be fully supported by sound engineering principles. Please refer to Section 2.5 of this Code of Practice for exceptions.

Part 2 Scope

2.1 Definition

"Peak Tramway" in Hong Kong shall be a typical funicular railway. Funicular railway means any engineering system for the transport of passengers or goods on slope in carriers or vehicles running along rails at ground level and drawn by a rope at one end, together with any machinery, equipment or plant connected therewith. (N.B. this Code of Practice will not deal with aerial ropeways or inclined lifts which are governed by other relevant ordinances).

2.2 Limitations

This Code of Practice is intended to give guidelines on the design and construction of a peak tramway but nothing herein contained shall replace the provisions of any standard in force in Hong Kong. The Director will make revision to this Code of Practice from time to time to suit the technological development.

2.3 Planning

When planning the location and route of a peak tramway, the following factors must be carefully considered.

(a) Amenity Value

Any passenger-carrying peak tramway intended for use by the general public shall be located in such a way that adequate facilities for inter-connecting public transport are available at the terminals.

(b) Route

A peak tramway shall be routed so that its effect on the environment is minimal. This involves consideration of noise pollution, unsightly construction and any detrimental visual impact on the local environment. In the design of the routing of a tramway, due regard shall be given to any hazards to existing vegetation, roads, bridges, electric power lines, streams, buildings and slope stability. Environmental impact must be duly addressed in accordance with the relevant legislation in Hong Kong enforced by the Environmental Protection Department.

Adequate consultation on various details of the project shall be conducted with relevant organisations and the local community. If land resumption is a related issue on the project, all necessary procedures as required by any other legislative requirement in force in Hong Kong shall be followed.

(c) Emergency Vehicular Access

Adequate access to terminals by emergency vehicles as may be required by the FSD shall be provided. A rescue plan shall also be drawn up in consultation with the FSD and the EMSD to deal with emergencies during operation.

(d) Submission of Plans

Any company or organisation wishing to install a peak tramway shall submit to the Director the design, specifications, plans, safety analysis report and calculations relating to the railway, together with such other information as may be required by the Director.

2.4 International Standards

For the design and construction of peak tramway, international standards applicable to cableway installations, including but not limited to the standards listed in Appendix 1, shall be complied with unless otherwise specified in this Code of Practice.

2.5 Exceptions

Exceptions to the requirements of standards mentioned in Appendix I are permissible, particularly in the case of innovation. These exceptions shall be justified by a safety analysis and offer at least an equivalent level of safety. The aforementioned safety analysis shall be endorsed by an independent expert and submitted to the Director.

Part 3 General Design

3.1 Every part of a peak tramway installation and its associated equipment shall be designed with consideration given to the safety of passengers, general public and operating staff, and shall be designed in compliance with this Code of Practice.

3.2 Because of the high probability of any structure in Hong Kong being subject to the effect of severe winds and very heavy rainfall, the design of any exposed equipment and the selection of any materials used in the construction of a peak tramway shall give due regard to these factors. Wind may act in any direction, including upward direction. As a general rule the pressure of the wind P_w N/m^2 on tramway and all exposed equipment may be calculated by the following empirical formula:

$$P_w = V_w^2 / 1.6 \quad N/m^2$$

where V_w is the maximum expected wind velocity in m/s in the vicinity of the line.

The above empirical formula may be adjusted proportionately by any variation in temperature or density of the air from the nominal condition of 15^{o}C and 1.25 kg/m^3. However, even without any adjustment, this value is considered appropriate as a first approximation. The tramcar shall be designed to sustain a minimum wind load of 250 N/m^2 or a value derived from the above formula, whichever is higher, when the tramcar is in operation.

The wind velocity in the vicinity of the line shall be continuously monitored and recorded at an optimum interval. The tramway shall not be operated for the carriage of passengers if the measured wind velocity exceeds the wind velocity calculated from the designed wind load.

3.3 The structure or rail of the peak tramway shall be designed for earthquake resistance in accordance with the relevant requirements of the Structures Design Manual for Highways and Railways of the Highways Department.

3.4 Prior to the construction of a peak tramway, the manufacturer shall furnish a full set of engineering drawings, together with sufficient information and design calculations to the Director, to justify the design and construction of a peak tramway is safe for operation and in compliance with this Code of Practice. During construction and testing, test certificates and reports from the manufacturers and the commissioning team shall also be submitted to the Director.

3.5 In addition to Section 3.4, a general layout showing the line and plan (to scale) and any topographical features is required. Accompanying this, a written description indicating the size and capacity of the installation, the operational philosophy together with an assessment of the likely usage is required to assist in determining if inter-connecting public transport will need to be arranged.

3.6 When there is major peak tramway safety critical modification, the company shall conduct safety analysis to identify all potential safety hazards of the system of peak tramway and its surroundings in the context of the design, construction and putting into services. The analysis shall also propose mitigation measures to contain the risks of the identified hazards. The result of the safety analysis shall be summarised in a safety report and submitted to the Director.

Part 4 Strength of Materials

4.1 Standards of material strength such as yield stress, tensile strength, safety factor etc. for peak tramway installations, shall be determined in accordance with the relevant national/international standards or codes for funicular railway systems or similar applications.

Part 5 Operating Speed

5.1 The average speed of a tramway to be operated for the carriage of passengers shall be determined taking into account but not limited to:

(a) safe and steady operation of the tramway under inclement weather;

(b) operational capability of the braking systems;

(c) geometry and condition of the track;

(d) static and dynamic forces on the tramcar;

(e) comfort of the ride; and

(f) any speed limit specified in the Peak Tramway (Safety) Regulations (Cap. 265A).

5.2 The average speed mentioned in Section 5.1 shall be suitably reduced to prevent overloading of the emergency power system.

5.3 The maximum speed of a tramway to be operated for the carriage of passengers at any point shall also be determined taking into account of the following:

(a) all effects arising from operating at a higher speed;

(b) the radius of curvature of the track (in m) is at least $6 \times V^2$ where V is the instantaneous operating speed in m/s; and

(c) any speed limit specified in the Peak Tramway (Safety) Regulations (Cap. 265A).

5.4 The maximum speed mentioned in Section 5.3 may be exceeded under test conditions without passengers for the purpose of inspecting the overspeed safety devices.

Part 6 Rollers, Sheaves and Drums

6.1 The haulage rope is required to keep at its normal position by the rope guidance devices and supports under any condition of operating speed or load and, in addition, under the influence of any external factor such as wind effect.

6.2 The sheave guides etc. shall be designed to accommodate any side thrusts (if applicable).

6.3 The diameter of lined sheaves and drums for haulage rope shall be at least as follows (measured in terms of nominal rope diameters):

Diameter of	As multiples of rope diameter	As multiples of outer wire diameter
Sheaves, haulage drum	80	800
Fixing drum	22	---

For unlined sheaves and drums, the values given above shall be increased by at least 25%.

6.4 The maximum allowable deflection of the haulage rope shall be 10% for lined rollers.

6.5 The distance between successive rollers shall be designed such that even when it oscillates, the haulage rope shall not come into contact with mountings or structural members of the track.

6.6 Means shall be provided to keep the haulage rope in touch with the rollers at all times even where the track has a concave profile.

Part 7 Haulage Rope Requirements

7.1 The haulage rope shall be examined, in accordance with the Peak Tramway (Safety) Regulations (Cap. 265A), by means of defectograph.

7.2 Lubricant shall be supplied to the wires at the manufacturing stage and any fibre core shall be similarly impregnated. In operation, the rope shall be lubricated at recommended intervals. In both cases, the lubricants (preferably the same) shall be compatible with each other as well as having no corrosive action on any part of haulage system with which it may have contact, especially rubber liners on sheave and haulage drum.

7.3 The haulage rope shall be generally of the steel wire stranded type. A safety factor of 8, which is equal to the calculated breaking force divided by the computed maximum tension caused by design loads, including the effects of friction, but excluding dynamic loads, in the section of rope that is most highly stressed, shall be used. Allowance for the line friction shall be determined in accordance with the relevant standards.

7.4 Testing and Certification of Rope

7.4.1 The testing of rope shall be fully documented in a certificate in accordance with European Standard EN 12385 Part 1 or other equivalent international standards.

7.4.2 After the testing and acceptance of a rope, a certificate from the manufacturer as to the detailed specifications of the rope and the constituent wires with regard to their strength, size and diameter tolerance shall be submitted to the Director. In addition, the Director may require independent inspection.

7.4.3 The rope shall have a diameter tolerance of +5% oversize, 0% undersize. Measurements shall be made on the new rope when it is tensioned between 10% and 20% of its minimum breaking force.

Part 8 Splicing and Haulage Rope Terminations

8.1 Splicing of the haulage rope is not permitted.

8.2 The haulage rope fastening to the tramcar shall be easily accessible for inspection and adjustment.

8.3 Fastening of the fixing drum to tramcar shall have a safety factor of 4.2 as measured against the calculated tension force in the rope.

8.4 The fixing of the rope onto the haulage drum shall be carried out using at least two clamps or any other system of equivalent design with the same level of safety. The fixing system shall be easily accessible for inspection and tightening. If the size of the drum permits, the rope shall first pass through a hole in the drum barrel or flange and be secured on the inside of the barrel or on the outside of the flange. The termination shall be able to resist at least 80% of the breaking load of the rope.

Part 9 Haulage Rope Replacement

9.1 The haulage rope shall be immediately replaced in the event of wear, corrosion, broken or damaged wires. The followings are situations requiring rope replacement:

(a) there is a reduction of 25% in effective bearing cross sectional area within a rope length equal to 40 times rope diameter;

(b) more than 50% of the outer wires of one strand of a stranded hauling rope are broken within one rope lay length; or

(c) the condition of the rope or its performance leaves any doubt as to its integrity and safety in operation.

9.2 For the purpose of calculation of reduction in effective bearing cross sectional area in Section 9.1, the followings are relevant:

(a) if the reduction of cross sectional area is the result of broken wires, the sum of the cross sectional areas of all the broken wires within the relevant length shall constitute the total amount of reduction;

(b) if there are several breaks in one and the same wire within the relevant length, only one wire's cross sectional area has to be taken into account; and

(c) loose wires and wires having strand deformation shall be considered as broken.

Part 10 Drive

10.1 The drive shall be able to continuously operate under the most unfavourable loading condition from rest to any selected speed and at maximum operating speed. As far as practicable the speed selected shall be suitably controlled and be constant with variation limited to ±5% of the speed setpoint.

10.2 The speed shall be governed to produce an indication at +5% in the control room, and stop the electric motors at +10% above the nominal speed. Lower values may be used if desired.

10.3 The starting of the drive shall be smooth and without jerking regardless of the load. Starting acceleration shall not be less than 0.15 m/s^2 with the most unfavourable load, and be adjusted according to the track characteristics and passenger comfort considerations.

10.4 The speed control of the drive shall be continuously adjustable. All electronic speed-regulated drives and electric motors shall shut down in the event of overcurrent.

10.5 The power of the drive system shall be fed from a dual supply. Standby power supply from a separate source or emergency generator is required. The tramcar shall be able to carry the passengers to reach the terminal within 30 minutes under the worst power supply scenario.

10.6 Flat belts and chains shall not be used for the drive.

10.7 It shall be possible for the motor to drive the rope at 0.3 m/s or at such a speed so as to allow the entire length of the rope to be inspected.

10.8 For the purpose of calculating the required drive output of the motor and the rope tension, the followings shall be taken into account:

(a) weight of a person taken as 75 kg; and
(b) friction resistance of rollers, sheaves and tramcar wheels in accordance with European Standard EN12930.

Part 11 Brakes

11.1 When the tramway is to stop in a normal manner, the deceleration shall be achieved by means of an electrical stop at, as far as practicable, a constant deceleration sufficient to slow down the tramway for reaching minimum speed before full braking force of the service brake is applied. In this respect, a deceleration value of at least 0.3 m/s^2, with the permissible stopping distances for the protection functions to be maintained, shall be achieved. The deceleration shall be monitored by the control circuit.

11.2 All drives shall be provided with a service brake and an emergency brake, each capable of independently stopping the tramway. The brakes shall be designed to operate by friction. Both brakes shall be operable and the braking effect shall be the same in both directions of travel. Normally the two brakes shall not come into operation simultaneously.

11.3 Service brake and emergency brake shall bring the tramway to a standstill even under the most unfavourable foreseeable load conditions. Each brake shall be designed so that a calculated mean deceleration can be achieved in relation to a total stopping distance of at least 0.3 m/s^2 and not exceeding 2 m/s^2. In the event of a decrease of 15% in the friction value of a brake, the tramway shall still be able to be brought to rest with this brake.

11.4 The braking force of all brakes shall be easily adjustable. The braking force of the service brakes and emergency brakes shall be produced by weights or by releasing pre-loaded compression springs and shall be applied mechanically. The brake surface pressure exerted by the braking force shall be distributed as evenly as possible over the brake lining and shall be equal over all the linings of a brake.

11.5 The hydraulic circuits of the service brake and emergency brake shall be separate, at least from the pressure generator to the oil reservoir. There shall be a second independent pressure generator to cover the event of failure of the main pressure generator. Any reduction of pressure in the hydraulic circuit of one brake shall not cause a reduction in pressure in the hydraulic circuits of other brakes that might impair their functioning. The pressure in the hydraulic system of each brake shall be clearly and visibly indicated.

11.6 The service brake shall operate automatically as soon as:

(a) the electrical braking is almost completed;

(b) the supply power is lost, under-voltage, over-voltage or in the case of three-phase circuits, the supply fails in any one phase;

(c) the maximum permissible running speed is exceeded by 10%; or

(d) speed feedback loss (see Section 12.14).

11.7 The service brake and emergency brake shall be designed that they can be operated from the tramcar. The braking force of the service brake shall be controlled by the deceleration it produces. When the service brake or emergency brake is applied, the electrical supply to the drive motor shall be tripped-off. To avoid excessive deceleration, the operation of the emergency brake may be delayed. The emergency brake, when applied at any point under the normal deceleration phase during entry to station, must be capable of stopping the tramway before the buffer at the terminal, irrespective of the load.

11.8 The service brake and emergency brake must operate directly upon the haulage drum or a brake rim attached thereto. The braking force shall be applied in at least two positions on the drum or the rim.

11.9 The emergency brake shall be able to be brought into action by hand at the control console either mechanically or electrically. Emergency stop switch or push button to stop the tramway shall be provided at the following locations:

(a) at the control console in control room;

(b) at the control console in tramcar;

(c) at the terminal platforms;

(d) in passenger compartments, if the tramway is unattended by operating personnel; and

(e) in the machine room and tramway inspection pit.

For items (d) and (e), either the emergency brake or the service brake, can be applied to stop the tramway. Emergency stop buttons shall be distinguished by shape, colour and label.

11.10 The emergency brake shall come into operation automatically under the following conditions:

(a) when the maximum permissible running speed is exceeded by 15-20%;

(b) when activated by the arrival monitor or other safety devices mentioned in Part 12;

(c) when the service brake fails; or

(d) when the pressure in the hydraulic circuit for holding open the brake drops below the specified level.

11.11 When the emergency brake is activated, it shall operate automatically in both directions of travel and shall be fail-safe, i.e. not dependent upon the power derived from mains supply or batteries. The braking force of the emergency brakes shall be produced by compression spring.

11.12 The automatic application of the overspeed governor shall be effected by means of a mechanical or electrical device which is connected directly to the movement of the rope or haulage drum. The overspeed governor shall operate and be adjustable with a tolerance of 5% of the maximum permissible speed. Automatic resetting of governor after operation shall not be allowed.

Part 12 Safety Devices and Control Circuit

12.1 The control room shall be located in the driving terminal and shall be so orientated as to afford the best possible view of the line. The approaching of tramway and the boarding and alighting of passengers shall be clearly visible in front of the control console inside the control room. However, the use of CCTV will be accepted as an alternative.

12.2 All control and safety circuits/devices shall be monitored and annunciated by means of visual indications or audible alarms. All instruments and devices required for monitoring of the operation shall be housed and made easily accessible in the control room.

12.3 All instruments or indications shall be clearly labelled, as to their functions, in English and preferably Chinese if practicable. When necessary, the visual indication can be accompanied by audible signal.

12.4 In case of the deactivation of one or more safety devices, a manual control system, which shall limit the operating speed to 1.5 m/s, shall be provided at the control room.

12.5 Starting up of the tramway shall only be possible when:

(a) the corresponding "Ready" command has been initiated from both tramcars;

(b) "Door Closed" signal(s) from both tramcars has been issued; and

(c) the corresponding "Ready" command from the control console at control room has been issued.

12.6 Any intended reversal of the direction of travel shall be possible only after the tramcars are brought to a complete stop.

12.7 Tramcar position indicator to show the tramcar position (in metre) and with the indication derived from the signal of a counting device at a deflection sheave of the haulage rope or haulage drum shall be provided. The position of all stations and crossing points shall also be shown. When two tramcar position indicators are provided at different locations, their indications shall be synchronised. The tramcar position indicator shall automatically correct the position indication in such a way that the starting positions are indicated when the tramcars are in the terminals.

12.8 In particular, the followings shall be monitored with indication displayed at the control room:

(a) status of all drives, i.e. by main drive or auxiliary drive;

(b) tramcar position;

(c) status of the brakes; and

(d) condition of wear of the brake shoes unless regular maintenance check has been properly implemented to avoid wearing of the brake shoes exceeding its replacement value.

12.9 The peak tramway shall be provided with end switches and buffers. The end switches shall bring about automatic stopping and impose change of direction of travel.

12.10 The speed of the tramway shall be reduced gradually before entry to the terminal. The reduction in speed shall be effected by an entry deceleration circuit.

12.11 For peak tramway which may be remotely controlled, two independent arrival monitoring systems shall be provided.

12.12 The arrival monitor shall activate the safety circuit to slow down or stop the tramway if the speed of the tramway has not been reduced to the permissible 0.6 m/s or less on its approach to the end switches.

12.13 Upon actuation of the arrival monitoring circuit, the tramway must be brought to a complete halt in front of the buffers by the emergency brake.

12.14 The speed sensing device for at least one of the arrival monitors shall be driven directly by the haulage drum or deflection sheave. The output signal from the speed sensing device shall be continuously monitored.

12.15 Additional safety device shall be provided after the end switches which will actuate the emergency brake.

12.16 The approach of the tramway to the terminals shall be indicated by an audible signal in the control room.

12.17 Automatic stopping must occur as soon as any breakdown occurs in the safety or control circuits. No re-start shall be possible until the fault is cleared. The operation of any safety circuit shall be clearly annunciated in the control room giving information about the type and location of the fault.

12.18 Bridging Circuits

(a) If a fault is occasioned by a breakdown or malfunction of the control circuitry, it may be permissible, under certain circumstances, to bypass that part of the circuit component with a bridging circuit. Any such devices shall be correctly engineered and their functions clearly described in the design documentation. Their use, however, will be restricted to responsible staff and under no circumstances must their use prejudice safety.

(b) The bridging circuit shall only be made possible by a key switch.

(c) The operating speed of the tramway shall not exceed 1.5 m/s when the bridging circuit is in use.

Part 13 Remote Monitoring System

13.1 Remote Monitoring System shall be provided to monitor whether the haulage rope is guided along the proper positions and check the integrity of signal cables.

13.2 Trackside signal cables which carry information relating to the railway safety shall be monitored by a monitoring circuit.

13.3 Stoppage of the peak tramway shall be initiated whenever the monitoring circuits are interrupted, short circuited with other monitoring circuit, or earthed.

13.4 Voltages of not more than 25 volts (AC) or 60 volts (DC) are allowed in the monitoring circuits between circuit and earth, and between circuit and circuit.

13.5 The tramcar shall be brought to stop by a monitoring circuit when the earthing resistance of the haulage rope drops below 500 ohms.

13.6 The activation of tramway stop as mentioned in Section 13.5 may be delayed for at most 0.5 second to avoid false stoppage as long as safety is not impaired in any impermissible way.

13.7 The insulation resistance to earth of the ropes to be monitored shall be at least 10 000 Ohm even in the most unfavourable weather conditions when measured with a 500 V test voltage.

Part 14 Communication System

14.1 A communication system between the operator in the operator cabin of the tramcar and the duty technician in the control room shall be provided. The communication system shall continue to work in the event of mains supply failure, application of any brakes or actuation of safety circuits.

14.2 Each tramcar shall be provided with a public address system that is audible at any point inside the tramcar. Annunciation informing passengers on action to be taken in the event of the tramway coming to a halt between normal stopping places shall be given through the system.

14.3 For vehicle without attendant, an intercommunication system between passenger and operator or duty technician in the control room shall be provided.

Part 15 Tramcar

15.1 The finite element method shall be used to calculate and verify the design calculations of the structure and load bearing components of the tramcar which shall take into account all anticipated static and dynamic forces that will be encountered in operation including:

(a) tramcar own weight plus payload;

(b) wind effect during operation;

(c) impact force due to passenger loading and unloading;

(d) force due to the action of the brakes;

(e) force due to the impact on the buffers; and

(f) force transverse to the track.

15.2 All components of the structure of the tramcar shall be easily accessible for inspection and maintenance. All internal and external surfaces shall be protected against corrosion.

15.3 The enclosure of the tramcar shall have the following provisions to ensure passenger safety:

(a) Tramcar shall be provided with body panel up to 0.4 m above the seating surface or 1.1 m above the floor surface for cabin with standing passengers. Sharp edges and abrupt protrusion inside the tramcar and near the door openings shall be avoided. Body panel material shall be metal or fibre reinforced plastic;

(b) Enclosed tramcars shall be adequately ventilated by means of operable windows or mechanical ventilators. Windows shall be safety glass or safety plastic;

(c) Door shall be secured with a lock. For power operated doors, the closing force shall not exceed 150 N over the final 150mm of the closing movement. The edges of the doors shall be buffered with a soft material. A specific device shall allow the passengers to unlock the doors in case of emergency;

(d) The peak tramway shall not be operated for carrying passengers unless the tramcar doors are securely closed;

(e) An emergency exit door, not on the same side as the normal exit door, shall be provided to give an adequate means of exit from the tramcar direct to the track in case of tramway/system breakdown; and

(f) A separate compartment at both ends of the tramcar shall be provided for the operator.

15.4 Tramcars shall be numbered or labelled for identification. The maximum permitted number of persons and the rated capacity in kilogram (kg) to be carried by each tramcar shall be conspicuously displayed inside the tramcar compartment.

15.5 The passenger carrying capacity shall be calculated as follows:

(a) For seated passengers:

Seat width : 0.4 m

Seating pitch : 0.7 m

(b) For standing passengers:

Floor area of 0.25 m^2 for each standing passenger.

15.6 Tramcars that allow standing passengers shall be provided with adequate handrails etc. Unattended tramcars shall be equipped with a device which indicates that there is an overload which shall be interlocked with the starting mechanism.

15.7 If any seat of the tramcar is so placed that the safety of a passenger seated upon it may be endangered, a safety assessment shall be submitted to the Director showing that effective safety measures have been considered so as to afford adequate protection to a passenger occupying that seat.

15.8 The tramcar shall be provided with an independent track braking system capable of stopping and holding the tramcar at any location on the track and shall be actuated automatically when:

(a) breakage of haulage rope;

(b) excessive slack in haulage rope, that is when the traction force of the rope is less than 5 kN; or

(c) tramway exceeding its maximum permissible speed by 25%.

15.9 All metallic parts of the tramcar shall be equi-potentially bonded and effectively earthed. Only low voltage electrical appliances shall be used in the tramcar.

15.10 If the tramway has two compartments, they shall be connected by a double fastening, each having a minimum factor of safety of 6. Each compartment shall also be provided with an emergency track brake of its own.

15.11 The track brake shall be able to be actuated by the operator from the control console in the tramcar.

15.12 The direction of travel and speed may be controlled from the tramcar. The brake instruction shall override the instruction to proceed.

15.13 Tramcars shall be fitted with interior lighting and headlamps.

15.14 Flooring of the tramcar shall be of non-slippery material.

15.15 All switches, controllers, meters and lamps on the control console in the tramcars shall be clearly labelled, in English and Chinese, as to their functions.

15.16 The level of each access door with respect to the corresponding landing elevation on the platform shall be designed to facilitate the passage of elderly / wheelchair passengers with minimal hindrance.

15.17 Tramcars specified to be accessible to wheelchair passengers shall have a minimum access width of 800 mm and shall be provided with at least one securing point with a minimum strength of 1 000 N.

Part 16 Track

16.1 The track, including rails, switches, sleepers, foundation and any bridges, shall be so designed, constructed and maintained to absorb any forces from the tramcars under the most adverse conditions of loading and during emergency braking, without undue deflection or permanent deformation.

16.2 After every application of the tramcar track brake, the track shall be inspected by experienced personnel in details, in particular the 50 metres length on either side of the point of application of the track brake.

16.3 The track shall at all times be clear of debris, soil and rocks, so allowing free passage of the tramcars and causing no impediment to the natural drainage along the track.

16.4 Lateral curve radii of the track shall be as large as possible. The track shall be laid in the straightest possible manner and with the most even angle of inclination possible.

16.5 For reasons of safety and comfort during the journey, the gradient of the track shall be selected so that the actual longitudinal inclination of the carrier floor varies at most by ± 0.20 rad to the horizontal.

16.6 The track shall be protected from unauthorised access as far as practicable.

16.7 A walkway shall be provided along the whole length of the track. Where this is not practicable, proper means of emergency evacuation from the tramcars shall always be provided.

16.8 At the ends of the track, inspection pits shall preferably be provided in which work can be carried out by maintenance staff in an upright position. In order to protect the staff working in the pit, the following safety installation shall be provided:

(a) an emergency stop switch inside the pit to stop the tramway through the activation of the emergency brake or the service brake; or

(b) a master switch within the control console of the tramcar which will be locked off during the maintenance work and the key is to be kept by staff working at the pit.

Part 17 End Buffers

17.1 The distance between the end buffer and the point of emergency brake application shall be at least equal to the braking distance of the emergency brake.

17.2 The capacity of the end buffers shall be designed to be capable of absorbing the kinetic energy of the tramcar under loaded condition. The permissible speed of 0.6 m/s or higher, mentioned in Section 12.12, shall be used for calculating the kinetic energy as well as the braking distance mentioned in Section 17.1.

Part 18 Stations

18.1 The drive and control equipment shall be housed in purposely designed plant rooms. One terminal shall include a workshop and storerooms. The building structures and facilities shall be constructed with reference to the Buildings Ordinance (Cap. 123). The design of the terminal buildings shall take account of all the imposed forces, including rope tensions and an earthquake loading as indicated in Section 3.3. Lightning protection shall be provided in accordance with EN 62305 (all parts) or equivalent international standards.

18.2 The layout and disposition of the stations shall be such that the entry and exit points are clear, even at times of maximum passenger flow. The circulation of passengers is, as far as possible, unhindered. Sufficient covered space shall be provided, under average passenger flow conditions, for waiting passengers.

18.3 The width of the station embarking platforms shall be at least one metre wider than that of the tramcar body. However, if the station is manned with staff for controlling the flow of passengers, and with additional waiting area, the width of the embarking platform can be suitably reduced. When passenger flow is low at intermediate stations, the width of those platforms shall be at least 1.2 m.

18.4 The clearance between the edge of the platform and the door opening of the tramcar shall preferably not exceed 50 mm.

18.5 Passengers shall not have access to any area housing machinery or operational equipment and shall be given access only to the boarding and alighting areas.

18.6 Notices to the passengers shall be displayed in conspicuous positions, and in both Chinese and English. Pictograms are allowed. Entry and exit points in a station shall be clearly illustrated.

18.7 Adequate lighting including emergency lighting shall be provided for public areas, machine room, control room and maintenance areas.

18.8 Proper management of terminals with specific reference to good housekeeping, effective control of passengers, unobstructed entrances/exits, fire services and smoke control, evacuation control, etc. are essential. Any fire services requirements in relation to the peak tramway as requested by the Director of Fire Services shall be complied with.

Appendix I

1. ANSI B77.2-2014: American National Standard for Funiculars – Safety Requirements, Clause 2.1.4.1.1 - Factor of safety and Annex A Clause A1.2.1 - Wire rope

2. EN 12385-8:2002 Steel wire ropes - Safety - Part 8: Stranded hauling and carrying-hauling ropes for cableway installations designed to carry persons.

3. EN 12927:2004 (all parts) - Safety requirements for cableway installations designed to carry persons – Ropes.

4. EN 12929-1:2015 - Safety requirements for cableway installations designed to carry persons - General requirements - Part 1: Requirements for all installations.

5. EN 12930:2015 - Safety requirements for cableway installations designed to carry persons – Calculations.

6. EN 13107:2015 - Safety requirements for cableway installations designed to carry persons - Civil engineering works.

7. EN 13223:2015 - Safety requirements for cableway installations designed to carry persons - Drive systems and other mechanical equipment.

8. EN 13243:2015 - Safety requirements for cableway installations designed to carry persons - Electrical equipment other than for drive systems.

9. EN 13796-1:2017 – Safety requirements for cableway installations designed to carry persons - Carriers. Part 1: Grips, carrier trucks, on-board brakes, cabins, chairs, carriages, maintenance carriers, tow-hangers.

10. EN 1838:2013 – Lighting applications – Emergency lighting.

11. EN 62305:2011 – Protection against lightning.

12. Society of Light and Lighting of the Chartered Institution of Building Services Engineers (CIBSE) – Code for Lighting.