

Code of Practice for **Amusement Rides**

2015 Edition

Code of Practice
for
Amusement Rides

Electrical and Mechanical
Services Department
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Foreword

The Code of Practice for Amusement Rides (the 'Code') is issued by virtue of section 49 of the Amusement Rides (Safety) Ordinance (Cap. 449). Unless otherwise stated by the Director of Electrical and Mechanical Services (the 'Director'), the Code is applicable to the design, manufacture, installation and examination of amusement rides under the purview of the Ordinance.

The Code intends to provide general requirements for the design and operation of amusement rides for the safety of the public. The amusement ride owners (the 'Owners') and trade practitioners shall take necessary steps to ensure that relevant requirements stipulated in the Code are complied with and the amusement ride design is in compliance with the latest international standards, specifications and guidelines (such as EN 13814, ASTM F-24, GB 8408, AS 3533 and/or HSE 175) as recognized by the Director at the time of lodging an application to the Director. The international standards quoted in this Code of Practice are reference yardsticks. Other equivalent international standards as recognized by the Director shall be acceptable.

Apart from the general requirements laid down in the Code, more specific and detailed requirements for individual category of amusement rides may be issued in the form of technical guidelines, which shall also be observed by the Owners and relevant personnel.

It shall be noted that updates on the Code or technical guidelines may be required with emerging technology and experience. As such, these documents will be reviewed and updated from time to time and new guidelines for other special subjects may be issued where situation warrants. Enquiries may be lodged to the General Legislation Division of the Electrical and Mechanical Services Department (the 'EMSD').

1 General

1.1 Scope

The Code specifies the general requirements for the design, manufacture, installation and examination of amusement rides to be operated for use by members of the public in Hong Kong. It covers the general design requirements, specification of materials and equipment, provisions of redundancy and emergency arrangement, as well as testing and commissioning of amusement rides.

1.2 Definitions

In addition to the interpretations stated in section 2 of the Ordinance, the following definitions will be used in this Code:

'Competent Person', 'Qualified Person', 'Owner' and 'Surveyor' have the same meaning as defined in the Amusement Rides (Safety) (Operation and Maintenance) Regulation (Cap. 449B).

'Registered Professional Engineer' (RPE) has the same meaning as defined in the Engineers Registration Ordinance (Cap. 409) and is qualified to practice in a particular engineering discipline in Hong Kong.

'Safety Factor' means the ratio of the ultimate breaking load of a component against the maximum allowable load which may be imposed on that component.

'Safety-critical Component' and 'Safety-critical System' are component and system whose failure will result in uncontrolled operation or movement of the ride or failure of the restraint system, or where there is a risk of failure leading to fatality or injury.

1.3 Application Process

This section provides practical guidelines on the licensing requirements for the Owners of amusement rides and any person who wishes to operate amusement rides for use by members of the public in Hong Kong.

The design, manufacture, installation, operation and maintenance of amusement rides in Hong Kong are regulated under the Amusement Rides (Safety) Ordinance (Cap. 449) (the 'Ordinance') and its subsidiary legislation, for which the Electrical and Mechanical Services Department is the regulating authority. Amusement ride is a power driven device, together with the machinery, equipment and plant connected to, or used in connection with, such device, which is designed to be driven or ridden by members of the public primarily for amusement purposes:

- (a) and includes any such device that is capable of being moved from one place of operation to another;
- (b) but does not include any such device which is driven solely either by human physical effort or by gravity or partly by such effort and partly by gravity only (that is, it is neither wholly nor partly power driven), other than a device which is specified in Schedule 2 of the Ordinance.

The guidelines hereunder outline the requirements of the Ordinance and are not exhaustive. The operation of amusement rides in fairground activities / carnivals can be subject to other statutory requirements in Hong Kong, for instances the requirements for building works, fire services installations, admission of the general public to the premises for entertainment, and/or

airspace restrictions. The Owners and his/her agents shall consult the relevant Government departments / authorities for the applicable requirements.

1.3.1 Licensing Process for Amusement Rides

The licensing process for amusement rides has three stages as outlined below. Section 5 is a flow chart that shows the sequence of events and key milestones of the first 2 stages, namely "design approval" (Stage 1) and "permit to use and operate" (Stage 2).

(a) Stage 1 : Design Approval

Before commencement of any on-site installation work, the applicant has to demonstrate to the satisfaction of the Director, with proper supporting documents, the adequacy of engineering design and the approach in addressing the reasonably foreseeable safety-related issues during the installation, operation and maintenance of the amusement ride. The applicant shall submit a Form 1 (downloadable on EMSD website) to the Director together with details of the mechanical, electrical and structural design, safety systems and operation instructions of the ride. The list of typical information to be submitted is given as follows:

(1) General

- Particulars of manufacturer, model number, serial number and date of manufacture.
- Motive power and power rating.
- Duration of a normal ride cycle.
- Maximum number of passengers, number of passenger carrying units and maximum weight to be carried on the amusement ride.
- Location map of the amusement ride.

(2) Description of Design and Operation

- Total weight of the amusement ride and the arrangement for foundation, anchorage and/or tensioning.
- Description of the ride motion with amplitude and duration of maximum speed, maximum acceleration and maximum deceleration in different directions.
- Description of ride components and driving systems from power source to passenger seats.
- The principle of ride control system with a comprehensive list of safety devices and/or systems which are operational in normal use and/or emergency cases. The list shall include the purposes and functions of these devices as well as the test method.
- Signaling and communication equipment.
- Means of braking, stopping and holding.
- Passenger containment system including restraints, safety devices and redundancy provisions.
- Outline description of key operational matters including the functional and operating procedures, the settings of safety gears, operation of controls, calibration and adjustment of the overload sensing devices, etc.

- Outline description of passenger flow and crowd control matters including the description of passenger loading and unloading process as well as the duties of individual operators during normal and emergency situations.
- Risk assessment and other design tools such as Fault Tree Analysis, , etc.

(3) Drawings

- Layout plan showing the dimensions of the amusement ride, all round clearances from nearby objects and the safety envelope throughout the ride cycle.
- Layout plan showing the passenger queuing and crowd control arrangement, location of the control consoles, indicative signs, chief operator and operators.
- Assembly drawings including, but not limited to, ride tracks, lifting and swiveling mechanisms, bearings, supports, passenger units, grab devices, locking and safety systems, buffers, devices for prevention of roll-back, derailment and overturning, etc.
- Drawings and schematic diagrams for power supply, pneumatic system, hydraulic system, closed circuit television (CCTV), public address (PA) system, mechanized exhibits and show set elements.
- Drawings and schematic diagram for the ride control system including, but not limited to, the details of interface, intrusion detection, overload/overspeed sensing, alarm and other safety systems. The specifications of sensors and field control equipment shall be included.

(4) Calculations

- Design calculation and stress analysis that demonstrate the adequacy of strength of the design and materials, including safety factors.
- Design calculation that demonstrates the adequacy of safety-critical components including safety devices, overspeed governor, driving machines, brakes, wire rope suspension, etc.
- Details of the software packages (author and version number of software) used in preparing design calculation, if any, and the list of clearly identifiable inputs and outputs with explanatory notes. For finite element analysis, system plots with assumed conditions shall be provided.

(5) Others

- An outline of the rules and regulations (in both Chinese and English) to the passengers in respect of the prohibited behaviours and restrictions on the physique of passengers.
- A rescue plan for evacuation of passengers under different scenarios within a reasonable time. The plan shall include the rescue procedures, details of rescue equipment/facilities to be provided within or in the vicinity of the location and the arrangement for mobilizing adequate staff members for rescue operation.
- Quality assurance document.
- Past inspection certificate or approval issued by other government agencies and/or authorities in the amusement ride industry.
- Method and programme of installation

- Method and programme of dismantling (if appropriate).
- Fire safety.
- Design review completed by a Registered Professional Engineer (RPE) or other experienced professionals in the amusement ride industry. The design review body shall be independent from the manufacturer and the designer of the ride being reviewed.
- Identification documents of the applicant, for instances copy of business registration certificate, authorization document for company's representative, etc.

For amusement ride with permanent or temporary structure higher than 5 metres or where the circumstance warrants, the Owner shall appoint a Registered Professional Engineer (RPE) in the structural discipline to verify that the structural design is sound and the relevant calculations are correct. A sound structural design means a design whose structure can safely carry all the design loads under all operating conditions.

For amusement rides of substantial height and/or where passenger may be suspended in a position that he cannot return to the ground safely by himself, the rescue operation may require the assistance of the Fire Services Department (FSD). Under such circumstances, the Owner shall consult the FSD on the requirements of rescue facilities, rescue procedure, and emergency vehicular access.

The approval of design, specification, method and programme of installation of an amusement ride shall in general be granted with a Form 2. The Owner shall ensure the compliance of the conditions that are imposed on the Form 2 by the Director.

(b) Stage 2 : Permit to Use and Operate

After the completion of installation of an amusement ride and before operating the ride for use by members of the public, the Owner shall arrange the following works and provide the following information to the satisfaction of the Director.

(1) Operation, Maintenance and Emergency Manuals

The Owner shall submit manuals with details of pre-operational checks, operation and maintenance of the amusement ride as well as the procedures for handling emergency situations.

(2) Examination by Surveyor

All the manufacture and installation of an amusement ride shall be in conformity with the approved design and manufacturer's recommendations. Upon completion of manufacture, installation, testing and commissioning of amusement ride, the Owner shall engage a Surveyor to carry out a comprehensive examination for the amusement ride and prepare a survey report recording the detailed results of the examination and certifying the integrity of the ride and its fitness for public use.

The examination shall include, but not limited to, the following:

- An assessment of conformity of the ride to the approved design including the overall operational performance and that of individual mechanical, electrical, structural, control, safety, hydraulic and pneumatic systems.
- Test and measurement of all safety-critical components, stability of the ride, safety clearance and all relevant functional and performance tests laid down in section 4 of

this Code or any other tests deemed necessary to ensure the safety and performance of the ride.

The Owner shall also make necessary arrangement for a Surveyor to witness and certify all the critical procedures during the construction, installation, testing and commissioning stages as deemed required for determining the integrity of the ride. Such pre-inspections are particularly important for the procedures that cannot be carried out again later on.

Where any part of the examination (for instance the non-destructive tests on structural components) is carried out by a recognized body other than the Surveyor, all findings provided by the recognized body shall be submitted as part of the survey report and be scrutinized and endorsed by the Surveyor .

(3) Ride Inspection by EMSD

During the manufacture and installation, EMSD may carry out surveillance inspection from time to time. Upon completion of testing and commissioning, EMSD shall carry out the final inspection.

(4) Rescue Drill

After satisfactory examination completed by the Surveyor, the Owner shall arrange a rescue drill performed by his/her operational crew to demonstrate the effectiveness of rescue arrangements. For high-rise or special rides where the rescue procedures involve the participation of the Fire Services Department (FSD), a rescue drill in collaboration with the FSD shall be arranged.

(5) Competent Person

Before operating the amusement ride for public use, the Owner shall nominate at least one of his employees, who has appropriate academic qualifications and work experience, to apply for approval as the Competent Person, who shall be the key person responsible for the management of the operation and maintenance of the ride. The application for being a Competent Person shall be lodged with a Form 21 (downloadable on EMSD website) and the prescribed fee. Upon receipt of application, EMSD would invite the suitable candidate for an assessment consisting of a written test and a site test to ascertain whether the candidate has possessed sound engineering knowledge and good understanding on the statutory requirements and the design, installation, operation and maintenance of the ride.

Upon completion of the above, the applicant shall submit a Form 3 (downloadable on EMSD website) to the Director together with the survey report, the prescribed fee and any necessary documents.

The permit to use and operate an amusement ride shall in general be granted with a Form 5. During the operation and maintenance of the ride, the Owner shall comply with the conditions that are imposed on the Form 5 by the Director.

(c) Stage 3 : Annual In-service Examination

The Owner is obliged to ascertain the integrity and safe operation of the amusement ride. As a part of the requirement, the Owner shall appoint a Surveyor to carry out detailed examination at least once a year.

The Owner shall submit the survey report with a Form 23 to the Director within 30 days after the examination is completed.

1.3.2 Additional Requirements for Mobile Rides in Carnival Events

The licensing requirements detailed above shall be applicable to the mobile amusement rides for carnival events. In addition, more specific requirements are given in the "Supplementary Conditions for Design and Operation of Mobile Amusement Rides in Carnival Events", which is downloadable on EMSD website.

1.3.3 Major Alteration

Major alteration of amusement ride refers to any modification that involves changes in loading (e.g. changes in seating arrangement), speed, operating range (e.g. height), safety clearance, major load-bearing structure, driving mechanism, control mechanism (e.g. brakes, shock absorbers, speed limiters), software packages, passenger restraints, safety protection systems, safety-critical components, etc.

The Owner shall not carry out any major alteration to an amusement ride without the prior approval of the Director. The Owner who wishes to carry out major alteration shall provide a detailed proposal of major alteration to the Director with a Form 10. The Director's consent to major alteration shall in general be granted with a Form 11. When the modification is completed, the Owner shall arrange an examination of the ride by a Surveyor and apply for the permission of the Director for re-opening the ride for public use by submitting a Form 12, the survey report and the prescribed fee. In general, similar procedures as required for licensing a new amusement ride shall be followed. The permit to resume the use and operation of amusement ride after major alteration shall in general be granted with a Form 13. During the operation and maintenance of the ride, the Owner shall comply with the conditions that are imposed on the Form 13 by the Director.

1.3.4 Kiddie Rides

Kiddie ride means an amusement ride that is designed primarily for use by children aged not more than 12 years, and has a designed carrying capacity of not more than 100 kg and a motive power not more than 1.1 kW.

Design approval and Competent Person are **not** mandatory requirements for kiddie rides. The licensing process of kiddie rides is summarized as follows:

(a) Permit to Use and Operate

Upon completion of installation of kiddie ride, the applicant shall appoint a Qualified Person or a Surveyor approved under the Ordinance to examine the kiddie ride and certify its fitness for public use. The application for Permit to Use and Operate shall be made with a Form 4 (downloadable at EMSD website) together with the following documents:

- Survey report prepared and endorsed by Qualified Person or Surveyor;
- Photo of the kiddie ride;
- Location plan showing dimensions of the kiddie ride and clearance from nearby objects;
- Notice of prohibited conducts;
- The prescribed fee; and

- Any other documents deemed necessary to demonstrate the kiddie ride in safe working conditions.

The Permit to Use and Operate for kiddie ride shall in general be granted with a Form 6. During the operation and maintenance of the kiddie ride, the Owner shall comply with the conditions that are imposed on the Form 6 by the Director.

(b) Half-yearly In-Service Examination

The Owner of kiddie ride shall appoint a Qualified Person or a Surveyor to carry out detailed in-service examination of the kiddie ride at least once every 6 months.

2 Design Requirements

2.1 Risk Assessment

The applicant shall conduct risk assessment to analyze and evaluate the risks associated with the amusement ride in a systematic way followed by risk reduction. The risk assessment shall comprise the following steps:

- (a) Determination of the operational limits of the amusement ride, with due consideration given to the aspects of height, velocity, acceleration and deceleration;

where	height	is the maximum elevation of the passengers on the ride;
	velocity	is the maximum speed attained by the passengers;
	acceleration	is the maximum acceleration attained by the passengers; and
	deceleration	is the maximum deceleration attained by the passengers.
- (b) Systematic identification of reasonably foreseeable hazards, hazardous situations and/or hazardous events during all phases of the amusement ride life cycle;
- (c) Estimating the elements of risk associated with these hazards; and
- (d) Application of appropriate protective measures to reduce the risk to the acceptable level. If additional hazards do occur, they shall be added to the list of hazards and appropriate protective measures will be required.

Risk analysis shall be conducted in accordance with ISO 12100 and ISO 13849-1; otherwise the methodology and process of risk assessment should be properly documented.

For safety-critical components or systems where single or double point failure, involving sensitive equipment or undetectable failure, could lead to fatality or injury, further assessment with Fault Tree Analysis (FTA) and/or Failure Mode and Effect Analysis (FMEA) shall be carried out.

2.2 Design Loads

Paragraphs 2.2.1 to 2.2.5 hereunder set out the various modes of loading that shall be taken into account in performing design calculation and stress analysis for the amusement ride. If departure from the below-stated design consideration is necessary for special applications such as uncommon ride operation, a set of appropriate and proven design procedures shall be followed with details of design loads and calculation documented.

2.2.1 Dead Loads

Dead loads are loads that are permanently applied on the ride, including:

- (a) The weight of structural components of the ride; and
- (b) The weight of fixed parts and moving parts associated with the ride.

2.2.2 Live Loads

Live loads are loads that are applied to the ride and are varying during normal operation. For verification of structural integrity, the average mass of each passenger shall be assumed to be not less than 75 kg and 40 kg for adult and child respectively. The designed carrying capacity may be higher than the said loads.

The aisles, walkways, platforms or the likes on which passengers and operators can access shall be of adequate strength to bear the uniformly distributed load of not less than 5 kPa.

2.2.3 Dynamic Loads

Dynamic loads are loads that are applied to the structure or components due to the ride motion. Usually, they are generated by:

- (a) acceleration, deceleration, braking, forces of centrifugal, gyroscopic and Coriolis type.
- (b) release of potential or kinetic energy during operation of the ride.
- (c) difference in passenger seating pattern.

A comprehensive analysis of the ride motion, including its anchorage and foundation, shall be made. Forces, moments and their magnitudes and directions during all operating conditions shall be estimated for all critical components and structural members.

The analysis shall take into consideration the effect of partial and unbalanced loading. In particular, the effect of emergency braking shall be checked.

For the effect of vibration, the effect of unusual vibration arising from excitation frequencies of the structures and critical components shall also be checked.

2.2.4 Wind Loads

For outdoor rides comprising structures higher than 5 metres or where the circumstance warrants, design checking by a Registered Professional Engineer in the structural discipline in respect of the structural stability against overturning. For out-of-service condition, the wind pressure specified in the Code of Practice on Wind Effects in Hong Kong (or other applicable Practice Note issued by the Building Department) or the wind speed of 28 m/s, whichever larger, shall be used. For in-service condition, wind speed of not less than 15 m/s shall be used.

The requirements specified in the above paragraph are the minimum requirements. Rides that are designed and verified with wind speeds higher than the minimum requirements shall be operated in accordance with the design or the conditions imposed by the Director in the permits.

2.2.5 Other Special Loads

Where appropriate, the following special loads shall be taken into account in the design calculation:

- (a) Thermal stress due to temperature changes.
- (b) Pre-tensioning effect on membrane structure and supports.
- (c) Change in ambient conditions (weather elements).
- (d) Ground unevenness and settlement.
- (e) Forces due to assembling or erection.
- (f) Forces due to unusual conditions, e.g. perpetual vibrations induced from neighbouring environment.
- (g) Hydrostatic forces (e.g. pressure or weight) or wave shocks.
- (h) Test loads.

2.3 Stress Analysis and Related Issues

2.3.1 Structural Calculation and Stress Analysis

The design calculation of an amusement ride shall include a comprehensive stress analysis of the combination of loads (as outlined in paragraph 2.2) exerted on individual structural components so as to demonstrate that the entire ride design is structurally sound. The structural design involving structural steel works shall conform to the "Code of Practice for the Structural Use of Steel" published by the Buildings Department of HKSAR, or other international standards accepted by the Director.

2.3.2 Mechanical Design and Safety Factors

For mechanical design involving the use of materials other than structural steels, the safety factors used in the design calculation should be consistent with established mechanical/materials handbooks and/or international standards for the particular material under the specific design conditions.

When the relevant standards are at variance over the safety factors required for a particular mechanical design, if the material or mechanical part is a critical component and upon consideration of the following, the requirements of the more conservative standard shall be followed:

- (a) The nature of amusement ride taking into account the maximum height, speed, acceleration and deceleration of motion;
- (b) Ambient factors such as wind loads, rains, etc.
- (c) Result of risk assessment and the nature of possible incidents;
- (d) The failure mode, for example whether the failure is due to ductile deformation, initiation of fatigue cracking, brittle fracture or their combination; and
- (e) The likelihood of discovery of incipient failure during day-to-day inspection of the ride before such failure has progressed to a stage where a real danger exists.

2.3.3 Fatigue Life

Every amusement ride and any parts thereof shall be designed for prolonged operation under full and unbalanced load conditions before the occurrence of fatigue failure. Proper measures including the following shall be put in place to ensure the signs of fatigue are continuously monitored in accordance with the design intent:

- (a) The methods, procedures and frequencies of inspections shall be documented in the operation and maintenance manual.
- (b) When cracks or other signs of fatigue are found, the structure/components shall be re-assessed by the manufacturer or other qualified engineers. With respect to the result, the method and frequency of inspection shall be adjusted accordingly.
- (c) Non-destructive tests of the following types shall be adopted: visual, dye-penetrant, magnetic particle, ultrasonic and/or radiographic examination techniques in compliance with appropriate international standards.
- (d) The manufacturer shall clearly identify the components for non-destructive tests on drawings for inclusion into the operation and maintenance manual.
- (e) Where the manufacturer specifies fatigue-prone components for testing, the calculated fatigue life of such components shall determine the intervals of tests.
- (f) Repairs to fatigue failures shall be carried out by qualified welders, under the supervision of the Competent Person or Surveyor, and be in accordance with the welding procedure

specification approved by the ride manufacturer or other experience professionals in the amusement ride industry.

2.3.4 Deflection

The deflection of simply supported beam shall not exceed 1/360 of the span. The deflection of cantilever beam and column shall not exceed 1/180 of the cantilever length, or otherwise in compliance with the requirements of the "Code of Practice for the Structural Use of Steel".

2.4 Stability

The following requirements against overturning and lateral sliding are applicable to all amusement rides. Design check by a Registered Professional Engineer in the structural discipline for compliance with the said requirements shall be required for rides of height (dynamic) exceeding 5 metres or where circumstance warrants.

2.4.1 Overturning

The stabilizing moment under the most unfavourable in-service conditions shall not be less than 1.5 times of the overturning moment along the most critical direction. The stabilizing moment under the out-of-service conditions shall not be less than 1.25 times of the overturning moment.

Where the stabilizing moment is totally or partially provided by a permanent foundation/anchoring system, the connection between the ride and the foundation shall have a safety factor of not less than 6.

2.4.2 Lateral Sliding

Where a holding force is required to counteract the lateral sliding of the ride as a result of ride motion or loads (e.g. due to unbalanced loads, wind loads, etc.), the following requirements shall be satisfied:

- (a) For free-standing structure with or without additional dead weight (i.e. friction being the only holding force against lateral sliding), a safety factor of not less than 1.5 shall be attained. Additional dead weight can be added to the free-standing structure to achieve the required safety factor. The plan of placing the dead weight shall be verified by a Registered Professional Engineer to be of no adverse effects to the structure.
- (b) For anchoring system involving hold-down bolts or other direct connections to the foundation, the strength of connection in shear direction shall be of a safety factor of not less than 6.

2.5 Restraint Device

2.5.1 Application

Restraint device shall be provided when passengers may:

- (a) be ejected due to the motion of the ride;
- (b) be moved suddenly and unexpectedly within the passenger unit or collide with protrusions adjacent to the ride; or
- (c) pose a danger to themselves or others if they do not remain seated during the ride cycle.

- Remarks :
- (i) Partial restraint may be achieved by the design of the passenger unit, seat configuration and other inherent restraint features. On the other hand, such features may also have negative effects on the protection of the passengers. Manufacturer should carry out an overall review to arrive the best protection for passengers.
 - (ii) Restraint device of mechanical type is considered not suitable for waterborne rides.

2.5.2 General

The configuration of restraint device shall in general be determined by the magnitudes and directions of acceleration (deceleration) attended by the passengers during the ride cycle.

Restraint device shall be secure and comfortable to the passengers. Harness and seat belt shall be easily adjustable. Bars, belts, supports, locks and latches shall be of sufficient strength to withstand the forces applied to them under the most unfavourable operating conditions.

Restraint device shall be easy to use and designed to prevent accidental release due to movement of the passengers or the ride.

2.5.3 Warning Sign

If the restraint device is not adjustable, signs shall be displayed restricting the minimum and maximum physique of passengers permitted to ride on it.

In all cases, if a warning sign is deemed necessary, it is important to make sure that the consequences of disregarding the warning are not severe. If they are, the ride should be redesigned to eliminate these consequences or else effective measures in the actual operation shall always be in place.

2.5.4 Fixing of Restraint Device

Restraint device shall be securely fastened to the structural members of the ride. Where bolts are used, nuts shall be provided with locking devices, e.g. castellated nuts with locking pins or other means to make the nuts captive. The use of screws for fastening restraint device shall be avoided.

If the restraint device forms part of or is attached to the door or gate of the passenger unit, double lock or double latch shall be provided.

2.5.5 Requirements for Interlocking

If the ride motion is so vigorous that there is a risk of passengers being ejected from the seat, the restraint device shall be interlocked with the ride control as follows:

- (a) The restraint device shall be locked in the operating position by positive means and the release mechanism shall be inaccessible to passengers. The restraint device shall allow manual release by operators or rescue personnel in the event of emergency situations.
- (b) During normal operation, the restraint device shall be released automatically by the control system or manually by the operators at the unloading position.
- (c) Where practicable, the control system shall prevent the dispatch of ride from the loading point unless all the restraint devices are engaged.

Provided that the risk of passengers being ejected or falling off or out of the ride is negligible, if there is a risk of passengers colliding with protrusions along the path of ride motion, the restraint shall be locked by positive means but the release mechanism may be accessible to the passengers.

2.5.6 Restraint of Simpler Design

If the passengers are expected to remain seated in the entire course of ride cycle, but there are no extraordinary movements or protrusions which passengers could come into contact with, a lap-bar restraint may suffice and the release mechanism may be accessible to passengers.

2.5.7 Deletion of Restraint Device

Where a risk assessment has concluded that, because of the nature of a ride, a safer outcome could be accomplished by enabling the passenger to part company with the ride in the event of abrupt stoppage, then restraint device need not be provided.

2.5.8 Cushion

Cushion shall be provided for restraint device and the surface of the rides with which passengers will impact during the ride cycle.

2.5.9 Lock and Latch

The lock and latch on rides shall provide a clear indication on its locking status such that the operators can easily check during the loading/unloading process. Lock and latch shall be located in a proper position so as to prevent inadvertent release by passengers. The loss of holding power (e.g. spring tension, power supply, pneumatic pressure, etc.) shall not cause the lock or latch to release.

2.5.10 Movement of Passengers on the Seats

The seat shall be shaped to prevent the passengers from sliding under the restraint device (lap-type bar, seat belt or chain); otherwise, crotch strap, chain or the likes shall be provided.

2.5.11 Prevention of Vigorous Head Movement

The seat and restraint device shall be designed to mitigate any excessive head movement for protection of passengers' head and neck muscles.

2.5.12 Strength of Restraint Device

When the ride is designed to operate in a position with the passengers in an upside-down position and the passengers' body weight is supported by the restraint device, the restraint device shall be specially designed to carry the passengers' weight for such mode of operation.

2.6 Brake System

The brake system of an amusement ride shall be one or a combination of the following kinds of systems:

- (a) Pressure or mechanically actuated friction brake acting on the drive mechanism or directly on the passenger unit. For friction brake applied to a free running passenger unit, the brake shall perform effectively under all weather and operating conditions.

- (b) Hydraulic regenerative brake or hydraulic relief brake in which the hydraulic motor is decelerated by reversing the hydraulic flow in a controlled manner to achieve a smooth braking action.
- (c) Electrical brake of the regenerative, dynamic or eddy current (permanent magnet or electromagnet) type.

For vertical rides, the brake shall be fail-safe, that is the brake is automatically engaged in the event of loss of power or control signal (e.g. hose breakage, wire breakage).

If the ride may move during the loading and unloading of passengers, parking brake or holding brake shall be provided.

The braking action, including emergency stop, shall be designed to avoid excessive force / deceleration that would cause injury of passengers or damage to the integrity or stability of ride structure.

For ride which stops by inertia or any mechanisms other than those mentioned above, an explicit risk assessment shall be carried out to validate the adequacy of the design.

2.7 Lifting System

2.7.1 General

Where passengers on an amusement ride are lifted or lowered, appropriate means shall be provided to safely return the passenger carrying unit to its loading / unloading position, or to another designated location for safe disembarkation in accordance with paragraph 3.16 regarding evacuation.

2.7.2 Hydraulic System

Hydraulic cylinders or rams used in the lifting system shall:

- (a) conform to ISO 4413;
- (b) have a safety factor of not less than 6 against rupture under the most extreme acceleration and deceleration;
- (c) be designed to prevent buckling at full extension; and
- (d) be fitted with a hydraulic restrictor at its lifting pressure port.

2.7.3 Pneumatic System

Pneumatic cylinder or rams used in the lifting system, no matter acting bi-directionally or carrying load in both directions (over-centre system), shall:

- (a) conform to ISO 4414 and the Boilers and Pressure Vessels Ordinance (Cap. 56);
- (b) be designed to accommodate the maximum pressure developed in the most extreme acceleration and deceleration;
- (c) be designed to prevent buckling at full extension; and
- (d) be fitted with a quick-action holding valve at its pressure port(s).

If the pneumatic cylinder or ram cannot be fitted with a positive load-holding device, the ride shall be equipped with an independent and automatic system that activates under emergency conditions (e.g. overspeeding) to restraint the motion.

2.7.4 Wire Rope Systems

If the passengers are lifted by hoisting a passenger unit or a cradle with wire ropes, the wire rope system shall comply with the following requirements. Any special design departing from the following shall be supported by sufficient grounds and in compliance with applicable international standards on wire rope system.

- (a) Minimum number of wire ropes
 - (1) At least 4 suspension ropes are required. Design with 2 suspension ropes may be considered for the following exceptional cases:
 - i. The height of falling does not exceed 2 metres; or
 - ii. Rail-guided passenger unit is equipped with fall arrestor, eddy-current brake or the likes.
- (b) Rope loading
 - (1) The imposed load shall be equally shared by the wire ropes.
 - (2) In case spring equalization is used, each individual spring shall be capable of supporting the total static load without damage (without permanent deformation).
 - (3) In case equalizer beam is used, the movement within the equalizer members shall be restricted such that, on the loss of one suspension rope, the load is transferred to the other ropes but the unbalanced load among the remaining ropes shall not be more than 10% of the load carried by any individual rope.
- (c) Emergency brake (Safety brake)
 - (1) The emergency brake shall operate directly on, or be rigidly coupled to, the winding drum or the traction drum or directly on the wire ropes.
 - (2) The emergency brake shall be capable of stopping the motion within a safe distance under the conditions of 25% overloading or 40% overspeeding.
- (d) Winding drum machinery
 - (1) Multiple layer drum shall not be used.
 - (2) Roller pressing the wire rope on the drum or equivalent device shall be provided to prevent the rope from leaving the drum inadvertently.
 - (3) Under all operating conditions, there shall be not less than 2 full dead turns of wire rope remaining on the drum.
 - (4) A wire rope spooling device synchronized mechanically with the rotation of the winch drum shall be provided to guide the wire rope positively so that the wire rope is accurately wound and channeled in the grooves.
 - (5) If wire ropes are wound on more than one drum, all the drums shall be synchronized mechanically to ensure proper leveling of the passenger unit or cradle at all operating positions.
 - (6) The winding motion shall stop when wire rope slack or cross over on drum is detected, and alarm signal shall be given.

- (7) Operational limit switch and whole-current non-self-resetting over-travel limit switch shall be provided for normal and emergency stop control at both ends of travel.
- (e) Traction drive machinery:
 - (1) Wire rope slippage shall not be allowed in the operating range; and
 - (2) Operational limit switch and whole-current non-self-resetting over-travel limit switch shall be provided for normal and emergency stop control at both ends of travel.
- (f) Lifting with wire ropes
 - (1) Device shall be provided to detect the breakage of wire ropes and to stop the ride motion, unless fall arrester or equivalent safety gear is provided, or it is proved that the velocity will be within a safe limit in all circumstances;
 - (2) The fall arrester shall be of fail-safe design. Fall arrester would be engaged whenever the speed of descend exceed 140% of the normal full speed;
 - (3) The ratio of sheave or drum diameter to wire rope diameter shall not be smaller than 40:1 for all components in contact with wire ropes; and
 - (4) Buffering devices shall be provided at landing so as to prevent excessive impact to passengers in any case of failure.

3 General Specification for Materials, Installation and Facilities

3.1 Suspended Passenger Unit

Suspended passenger unit shall be suspended with rigid distributor device or similar design to prevent entanglement of lifting chains / wire ropes. Backup system shall be provided for all single-point suspended passenger units, sways, arms and other passengers-carrying components. The backup system may consist of chains, ropes, pins or other structural members of adequate size and strength. Pin holes and bolt holes of the suspension and backup system shall be properly staggered to avoid wrong assembly.

For amusement ride where there is a risk of falling from a height of 2 metres or more, the passenger unit shall be suspended by 4 wire ropes or chains unless other fall protection system such as a fall arresting device and safety gear is in place. The anchoring position shall be suitably designed such that when one of the wire ropes or chains broke, the passenger unit shall remain reasonably stable and the tilting of the passenger unit shall not cause passengers to fall out.

3.2 Wire Ropes, Shackles and Pulleys

Suspension wire ropes shall be stranded steel wire ropes complying with EN 12385. The rope shall be free of joints or repairs. The safety factor of wire rope shall not be less than 10, but a higher safety factor of 14 shall be considered where the circumstance warrants. Both ends of the wire rope shall be securely fastened and the strength of rope termination shall be not less than 80% of the breaking load of the wire rope. The wire rope shall be properly guided throughout the path of travel. Pulleys with self-lubricating bearings shall be provided at all bends. The diameter of pulley shall be compatible with that of the corresponding wire rope. Guidance device shall be provided to prevent the wire rope from slipping off the pulley.

3.3 Hydraulic System

All the hydraulic fluid transmission system associated with amusement ride shall conform to ISO 4413 and the requirements specified hereunder.

3.3.1 Design Information

The design submission shall include a schematic diagram of the hydraulic system, in accordance with ISO 1219-2, and the following information:

- (a) Identification of equipment by name and model number;
- (b) Torque and speed of hydraulic motor;
- (c) Flow rate of pump;
- (d) Power and speed of pump prime mover;
- (e) Pressure settings; and
- (f) Fluid type and viscosity grade.

3.3.2 Installation and Safety Features

Hydraulic system components which require regular maintenance or adjustment shall be easily accessible from a safe working position. The following safety features shall be incorporated into the design of the hydraulic system:

- (a) Safety device to protect against hose failure which could affect the operational stability of the ride;
- (b) Overpressure protection for the discharge side of pump capable of handling the maximum flow of the pump;
- (c) Overpressure protection for loadbearing hydraulic cylinders; and
- (d) Protection device against over-travelling.

3.4 Pneumatic System

The pneumatic system shall conform to ISO 4414. Pressure vessel inside the pneumatic system shall fulfill the requirements of the Boilers and Pressure Vessels Ordinance (Cap. 56). The design submission shall include a schematic diagram of the pneumatic system, in accordance with ISO 1219-2, and the following information:

- (a) Identification of equipment by name and model number;
- (b) Torque and speed of compressor motor;
- (c) Flow rate of compressor;
- (d) Power and speed of compressor prime mover; and
- (e) Pressure settings.

3.4.1 Installation and Safety Features

Pneumatic system components which require regular maintenance or adjustment shall be easily accessible from a safe working position. The following safety features shall be incorporated into the design of the pneumatic system:

- (a) Safety device to protect against hose failure which could affect the operational stability of the ride; and
- (b) Pressure vessel shall be fitted with appropriate pressure relief valve. The discharge point shall be contained or directed so as to eliminate the risks of equipment contamination or injury of persons.

3.5 Electrical Requirements

All electrical works associated with amusement ride shall comply with the Electricity Ordinance (Cap. 406), the Code of Practice for Electricity (Wiring) Regulations, IEC 60364, BS 7671 and the requirements specified hereunder.

3.5.1 High Voltage Installation

High voltage electrical installation (exceeding 1,000 V a.c. or 1,500 V d.c.) shall be prohibited for amusement rides, except cold-cathode illumination systems (e.g. neon lights).

3.5.2 Low Voltage Installation

Low voltage installation (50 to 1,000 V a.c. or 120 to 1,500 V d.c.) for amusement rides shall be equipped with over-current protective device of appropriate rating. The protective device may either be:

- (a) Air Circuit Breaker (ACB) and Moulded Case Circuit Breaker (MCCB) shall be in compliance with and type tested to IEC 60947-2; or
- (b) Miniature Circuit Breaker (MCB) shall be in compliance with and type tested to IEC 60898-1; or
- (c) Residual Current Device (RCD) shall be in compliance with and type tested to IEC 61008-1 or IEC 61009-1; or
- (d) Fuse switch shall be in compliance with and type tested to IEC 60269-1.

3.5.3 Extra Low Voltage Installation

For extra low voltage installation (less than 50 V a.c. or 120 V d.c.), transformers shall either be inherent short-circuit proof or provided with overload and short-circuit protection. Bare conductors shall not be used.

3.5.4 Equipotential Bonding Requirements

All electrical installations, except for extra low voltage installations, shall be earthed in accordance with the following requirements:

- (a) When the power is from the mains supply, all conductive parts not forming part of the live conductors shall be solidly and effectively earthed in accordance with IEC 60364 and the Code of Practice for the Electricity (Wiring) Regulations.
- (b) When the power is from a generating set, the generating set shall comply with ISO 8528. The star point of the generator and the generator frame shall be solidly bonded to an earth electrode solely driven for the purpose. The amusement ride and the generator frame shall be connected together with earthing conductor of adequate ample size to the same requirements as mains supply in accordance with IEC 60364.

3.5.5 Local Wall-mounted Switch Panels

The panels shall comply with IEC 61439-1 and constructed generally to Form 2b to IEC 61439-2. The enclosure shall be of ingress protection at least IP 41 for indoor applications and at least IP 54 for outdoor applications to IEC 60529.

3.5.6 Free-standing Motor Control Switchboard

The low-voltage motor control switchboard shall be free-standing floor-mounted cubicle switchboard containing the motor starters, controls and switchgears for various electrical equipment of the amusement ride. The switchboard shall be verified to comply with IEC 61439-1 and constructed generally to Form 3b of IEC 61439-2. The enclosure shall be of ingress protection at least IP 31 for indoor applications and at least IP 54 for outdoor applications to IEC 60529. The switchboard shall be clearly marked and labeled with the safety signs, control circuits and electricity characteristics of the switchboard.

3.5.7 Isolating Switch

Every amusement ride that is connected to a power supply shall be provided with an isolating switch in a position readily accessible to the maintenance personnel working in the vicinity of the ride.

3.5.8 Emergency Lighting

Adequate emergency lighting and illuminated "EXIT" signs shall be provided for safe operation of the amusement ride in accordance with the Codes of Practice for Minimum Fire Service Installations and Equipment.

3.5.9 Power Points

Where the public is admitted, the power supply to motors, equipment, lighting and socket outlets installed on the moving parts of an amusement ride and to all socket outlets which are less than 2.5 m above the floor level or within the arm reach shall be protected by one of the following method:

- (a) Provided with residual current device (RCD) of rated residual current not exceeding 30 mA; or
- (b) An extra-low voltage system connected to the non-earthed secondary side of the isolating transformer.

3.5.10 Other Requirements

- (a) Any cable passing under an amusement ride or within 1 metre of any moving part thereof shall be provided with mechanical protection.
- (b) Exposed lamps, except those supplied by extra-low voltage or protected by a residual current device, shall not be installed in any locations accessible to the public.
- (c) All electrical terminations and connections shall be capable of withstanding any reasonably foreseeable vibration and movement.
- (d) Power supply to the control devices handled by passengers shall be an extra-low voltage supply only.
- (e) Pendant, roving controls or any control handled by operators shall be either double insulated or connected to an extra-low voltage supply.

3.5.11 Flexible Cable and Plug

- (a) The supply cord and other connecting cables shall be of heavy-duty type and shall be mechanically protected where necessary.
- (b) The removal of a single access cover from the coin container, coin mechanism or other similar components shall not cause the live part or basic insulation to be exposed.
- (c) Every drive motor and all exposed metal parts of the equipment shall be effectively earthed to the mains earth.

3.5.12 Electrified Metallic Grid

Where an amusement ride involves an electrified metallic grid installed in an area accessible to the public, the electrified metallic grid shall be installed at least 2.5 metres above the floor level and the supply voltage shall not exceed 120 V ripple free direct current.

3.5.13 Electrical Installation of Aquatic Rides

Electrical installation in the vicinity of water pools or channel (e.g. those of aquatic ride) shall comply with Code 26M of the Code of Practice for the Electricity (Wiring) Regulations.

3.6 Ride Control Equipment

The control panel (also called control station, control console or control equipment) of the amusement ride shall fulfill the following requirements:

- (a) The location of control panels shall be carefully selected so as to minimize any interference of passengers or passers-by, and to allow the operators at the main control panel to have an unobstructed view of the loading and unloading process. Should the operator at the main control panel be unable to view the whole loading and unloading process or passenger's misbehavior during ride motion, then proper monitoring and communication measures such as CCTV, intercom, public address system, etc. shall be provided. Such provisions shall be considered in the risk assessment.
- (b) The Chief Operator shall be able to have direct and supervisory control of all functions for loading, unloading and handling emergency situations from the main control panel.
- (c) Visual indicators should be installed, where necessary, to display the operational status of the ride. For alerts, warning and abnormal status, audible alarms shall be available.
- (d) The controls and indicators on the mimic panel shall be arranged in such a way that the flow of signals and control actions corresponds to the actual ride cycle.
- (e) Any emergency stop shall bring the ride to stop in a safe manner. The ride shall only be reset manually after activation of emergency stop. The emergency stops shall be of push-button type located prominently for immediate access by operators.

3.7 Lightning Protection

For outdoor amusement rides involving tall and massive structures, an assessment on the risk of being struck by lightning shall be made in accordance with BS EN 62305-2. If provisions of lightning protection are determined to be necessary, the design shall conform to BS EN 62305.

3.8 Steam and Gas Propelled Equipment

- (a) All boilers and steam receivers associated with amusement ride shall comply with the requirements of the Boilers and Pressure Vessels Ordinance (Cap. 56).
- (b) High-pressure steam is not allowed in amusement rides.
- (c) Hot water boilers and burners shall be constructed to BS 855 and BS 799, respectively. All the exposed surfaces, pipeworks and accessories shall be well insulated such that the surface temperature shall not exceed 40°C.
- (d) The steam or hot water systems shall be equipped with safety devices including, but not limited to, dual safety valves, low water level cutout, over temperature protection and automatic firing control.
- (e) Miniature locomotives and steam engines shall comply with BS 7328.
- (f) When hot air is used (except hot air balloon), all the exposed ducting, diffusers or other components shall be well insulated such that the surface temperature shall not exceed 40°C. The temperature of hot air shall not exceed 60°C.
- (g) For flying captive balloons or the likes, prior approval from the Director of Civil Aviation shall be sought and where the use of fuel gas is required, requirements of the Gas Safety Ordinance (Cap. 51) shall be complied with.

3.9 Fire Protection

If the passenger of an amusement ride is totally enclosed in a cabin, all the upholstered furniture inside the cabin shall be verified to comply with appropriate international standards on fire resistance, non-combustibility and toxicity control on smoke emission. Subject to risk level, automatic firefighting equipment (e.g. sprinkler heads) shall be provided if deemed necessary.

3.10 Propulsion System and Associated Protective Mechanism

The propulsion system of an amusement ride shall comply with the following requirements.

3.10.1 Protection for Overspeed

For amusement ride where overspeed may cause fatality or injury (e.g. a vertical ride involving a traction drive in the course of descending), the drive shall be fitted with sensing devices that would trigger the mechanism to shut down the movement of passengers in a safe manner whenever the designed maximum speed is exceeded. The amusement ride shall only be reset manually after overspeed.

The overspeed sensing devices shall be fail-safe and be able to be tested regularly. The test method and recommended test frequency shall be mentioned in the maintenance manual.

3.10.2 Protection for Underspeed

For amusement ride where underspeed may cause fatality or injury (e.g. failure to maintain the centrifugal force to keep the passenger unit in proper orientation), the drive shall be fitted with underspeed sensing devices that would trigger the mechanism to prevent the passenger unit from reaching a dangerous orientation whenever the designed minimum speed is not maintained. The passenger unit shall be able to restore to a safe orientation immediately upon loss of speed. The amusement ride shall only be reset manually after underspeed.

The underspeed sensing devices shall be fail-safe and be able to be tested regularly. The test method and recommended test frequency shall be mentioned in the maintenance manual.

3.10.3 Retrieval by Manual Winding

If passenger unit may be stranded in the event of drive system failure (e.g. loss of power), the ride shall be equipped with proper facilities and procedures to facilitate manual winding of the passenger unit back to a safe position or emergency disembarkation in accordance with paragraph 3.16 regarding evacuation.

If the ride is of a size/configuration that manual winding is not practical mean, an emergency power system and other appropriate measure shall be installed/provided for evacuation.

3.11 Vehicle Body

Any part of amusement ride which the passengers may contact, including the passenger unit, loading and unloading area, queue area, etc., shall be free of sharp edges and corners, and have no protruding objects such as studs, bolts and screws. Adequate padding shall be provided at the locations on which passengers may impact during the ride cycle.

Each individual passenger unit shall be provided with clear, unique and identifiable marking.

3.12 Safety Clearance and Envelope

Any fixed or moving objects that may injure the passengers during the ride cycle shall be beyond the reach of the passengers. The following requirements on the safety envelope shall apply to all amusement rides unless otherwise the safety risk is properly avoided to the satisfaction of the Director.

3.12.1 Fully Enclosed Passenger Unit

If passengers are fully enclosed inside the passenger unit but there are openings of the following dimensions on the passenger unit, the minimum clearance from adjacent objects shall be:

- (a) If opening < 9 mm, minimum safety clearance = 90 mm
- (b) If opening ≥ 9 mm and opening < 50 mm, minimum safety clearance = 150 mm
- (c) If opening ≥ 50 mm, the requirements specified in clauses 3.12.2 and 3.12.3 shall apply.

3.12.2 Restrained Passenger in Open Type Passenger Unit

If passenger unit is not fully enclosed but passengers are effectively restrained in the seat, the following requirements shall apply:

- (a) The upper space of 1.5 m extending upward from the seating surface shall not be obstructed.
- (b) The height of seat back (H_{back}) under different angle of seat rest (θ) shall be of the following minimum dimension:
 - (1) If $0^\circ \leq \theta < 15^\circ$, $H_{back} \geq 400$ mm
 - (2) If $15^\circ \leq \theta < 30^\circ$, $H_{back} \geq 550$ mm
 - (3) If $30^\circ \leq \theta < 45^\circ$, $H_{back} \geq 700$ mm
 - (4) If $45^\circ \leq \theta < 90^\circ$, $H_{back} \geq 800$ mm
 - (5) If $\theta \geq 90^\circ$, $H_{back} \geq 900$ mm

Remarks : θ is inclination of seat back measured from a vertical plane; and

H_{back} is the height of the seat back measured from the seat surface to the top edge of the seat back

- (c) If θ exceeds 45° during the course of ride motion, rigid over-shoulder restraint system shall be provided.
- (d) The lateral safety space ($R_{lateral}$), i.e. the distance extended laterally outward from the edge of the seat, under different height of seat side (H_{ss}) shall be of the following dimension:
 - (1) If $200 \text{ mm} \leq H_{ss} < 400 \text{ mm}$, $R_{lateral} \geq 1,000$ mm
 - (2) If $400 \text{ mm} \leq H_{ss} < 600 \text{ mm}$, $R_{lateral} \geq 750$ mm
 - (3) If $H_{ss} \geq 600 \text{ mm}$, $R_{lateral} \geq 450$ mm
- (e) If the speed of passenger unit exceeds 3 m/s, low seat sides shall be not be acceptable.
- (f) Where passengers are properly restrained but their legs are hanging free, the bottom safety space of 900 mm extending downwards from the bottom of the seat surface shall be maintained.

3.12.3 Unrestrained Passenger in Open Type Passenger Unit

If passenger unit is not fully enclosed and passengers are not effectively restrained in the seat, the following requirements shall apply:

- (a) The vertical safety space of 2.1 m extending upwards from the floor shall not be obstructed.
- (b) The lateral safety space of 750 mm extending outwards from the outermost envelope of the passenger unit shall not be obstructed.

3.12.4 Maintenance and Inspection Requirements

If a ride may need to be serviced and inspected by maintenance personnel during its operation, the clearance beyond the surface profile of any moving vehicles shall not be less than 350 mm.

3.13 Passenger Gates

Gates for access control shall be positively locked to prevent unauthorized entry. Entry to an amusement ride shall be controlled with gates that are only openable from the inside, unless other appropriate control measures (e.g. the entry is manned and defined by a barrier, drop-bar, or chain, etc.) are provided.

Exits with proper indications and directional signs, including those used for emergency evacuation to enable the patrons to leave the ride in a smooth manner, shall be provided.

Exit points, which is independent of entry points, shall either be manned and delineated as for an entry point, or shall be fitted with a gate secured against entry from outside but equipped with an obvious mean for opening from inside.

3.14 Maintenance Access

The platforms, walkways, stairways and ladders which are used by the operators and maintenance personnel for operation and maintenance purposes shall be designed and constructed in accordance with BS 4592. Guarding and restraints shall be provided to prevent falling from height.

3.15 Guard-rails

Guard-rail shall be provided as appropriate to:

- (a) ensure the safety of maintenance personnel when carrying out the maintenance works;
- (b) confine operators and passengers inside a safe zone ; and
- (c) protect the safety of the spectators, passers-by and those queuing in the vicinity of the ride .

The height of guard-rail shall be between 900 mm and 1,150 mm with intermediate rails at the height between 450 mm and 600 mm. Where there is hazard of falling object, toeboard of height not less than 200 mm shall be provided.

3.16 Evacuation Facilities

Appropriate procedures and facilities shall be provided for the safe emergency disembarkation of passengers taking into account all reasonably foreseeable stoppage such as power failure, malfunction and fire. Such facilities may include, but not limited to:

- (a) equipment to bring the ride to the loading/unloading position or any other positions that allows safe disembarkation of passengers; and
- (b) walkways, stairs, platforms and hatchways that are strategically installed with signs as appropriate.

If an amusement ride is located within a building, provisions of fire services installation and means of escape shall in principle comply with the statutory requirements under the Building Ordinance (Cap. 123) irrespective of whether the building is specifically designed to accommodate the ride or not. The facilities may be standalone structures, or form part of the ride or the building works. The provision of evacuation facilities shall be sufficient for use by all passengers with the assistance of the operation staff or firemen in case of emergency disembarkation.

3.17 Welding

All welding works shall be carried out in accordance with the manufacturer's welding procedure specification by qualified welder possessing recognized certificate of proficiency to the satisfaction of the Surveyor. On-site welding under unfavourable site or weather conditions shall be avoided. Any doubts on the adverse implication of welding work on the structural integrity of the ride shall be referred to the manufacturer or the Surveyor for advice.

All welding works shall comply with the following requirements and equivalent international standards:

- (a) All load-bearing welds on metallic components shall be produced in accordance with EN 1011 to at least Level C to ISO 5817. Welding of steels not covered by the above-said standard, e.g. wear-resistant or hardened steels used in specific applications such as pins, shafts or tracks, shall only be carried out if due consideration has been given to the metallurgical effects of the welding on the purpose of use of the component. Welds subject to dynamic stress, i.e. fatigue loads, shall be to at least Level B to ISO 5817.
- (b) Welding procedures shall be approved in accordance with ISO 15614-1. Welders shall be approved in accordance with ISO 9606.
- (c) Butt welds shall be made using procedures which will give both yield and tensile strengths in the filler metal not less than those of the parent metal.

3.18 Guarding of Machinery

All moving or dangerous parts of machines shall be effectively guarded in accordance with the requirements of the Factories and Industrial Undertakings (Guarding and Operation of Machinery) Regulations (Cap. 59Q).

4 Testing and Inspection

The amusement ride shall be examined by the Surveyor upon completion of the installation works and thereafter regularly at a frequency not less than once every 12 months. The examination shall cover the structure, electrical and mechanical systems, control and safety systems, and all other systems which may affect the integrity and safe operation of the ride. The following tests and verifications, as appropriate, shall be included in the examination:

- (a) Overall inspection with regard to proper manufacture and installation as specified in the design documents and this Code.
- (b) Conformity of the main dimensions, safety envelopes and clearances necessary for safe and free running of moving parts.
- (c) Functional tests of the control system and protective devices.
- (d) Checking and measurement of the performance of brakes and safety-critical systems in normal and emergency conditions.
- (e) Testing of the pneumatic and hydraulic systems.
- (f) Electrical tests.
- (g) Non-destructive tests for welds and structural works.
- (h) Checking and measurement of the performance of the ride under full load and unbalanced load in all operating conditions.
- (i) Measurement of speeds, accelerations and/or forces to check against the design.

4.1 Full Load Test

Full load test shall be carried out by operating the ride at the nominal speed and under the designed service conditions, with equivalent dummy loads placed on the passenger units. Continuous running of the ride at full load for a prolonged period may be required to verify the reliability of the ride.

4.2 Unbalanced Load Test

The unbalanced load test shall be carried out with the configurations specified by the manufacturer or decided by the Surveyor. Such configurations shall be probably documented. The Surveyor shall not proceed with the unbalanced load test if there is any adverse vibration, harmonic oscillation or abnormal movement of the ride or its foundation / footing.

4.3 Electrical Test

Electrical works shall be inspected and tested in accordance with the requirements of IEC 60364 and the Code of Practice for the Electricity (Wiring) Regulations. In particular, the following electrical tests shall be conducted in sequence during the initial and periodic examination, except for those parts of installations that have been satisfactorily certified in the recent inspection and testing required under the Electricity (Wiring) Regulations, Cap. 406E, with a valid Form WR1 or Form WR2.

4.3.1 Visual Inspection

The visual inspection on the electrical works shall be carried out in accordance with Code 21A of the Code of Practice for Electricity (Wiring) Regulations.

4.3.2 Continuity of Protective Conductors

Every protective conductor, including all conductors and any extraneous conductive parts used for equipotential bonding, shall be tested for continuity.

4.3.3 Insulation Resistance

The insulation resistance of the electrical works shall be measured and shall be not less than the following values.

Circuit nominal voltage	Test voltage	Minimum insulation resistance
Extra-low voltage circuits when the circuit is supplied from a safety isolation transformer	250 V dc	0.5 M Ω
Up to and including 500 V with the exception of the above cases	500 V dc	1.0 M Ω
Above 500 V	1,000 V dc	1.0 M Ω

Care shall be taken to ensure that the insulation of the equipment under test can withstand the test voltage without damage.

4.3.4 Polarity

The test of polarity shall be carried out to verify that:

- (a) fuses, single-pole controls and protective devices are connected in the phase conductor only;
- (b) centre-contact bayonet and Edison-type screw lampholders have earthed neutral conductor, or have their outer or screwed contacts connected to the neutral conductor; and
- (c) wiring to socket outlets and similar accessories are correctly connected.

4.3.5 Earth Fault Loop Impedance and Earth Electrode Resistance

A test shall be carried out to verify the effectiveness of the earthing by means of a phase-earth loop tester. The impedance for each loop shall not exceed the requirements as stipulated in Code 11 of the Code of Practice for Electricity (Wiring) Regulations.

The earth electrode resistance shall be measured with the method specified in Code 21B(7) of the Code of Practice for the Electricity (Wiring) Regulations.

4.3.6 Functions of Protective Devices

Every residual current device shall be tested with residual current device tester simulating an earth fault or other methods complying with relevant international standards.

Air circuit breakers, moulded case circuit breakers, miniature circuit breakers, isolators, switches and indicative devices should be checked by hand operation.

Overload and fault current protection characteristics of protective relays shall be verified with secondary injection test.

4.3.7 Lightning Protection System

The lightning protection system shall be tested as per paragraph 3.7 of this Code.

4.4 Tests for Hydraulic and Pneumatic System

The following components of hydraulic and pneumatic system shall be checked:

- (a) Ram and cylinder;
- (b) Leveling switches;
- (c) Pipeworks, joints, bolts, fixings, stop valves, oil reservoir, pump and motor;
- (d) Control valves, pilot and leveling valves, overrun and cut-off devices, pressure relief valves, safety valves;
- (e) Air release cock and anti-siphon valve; and
- (f) Pressure vessels.

Besides, the following tests shall be carried out to verify the integrity of the hydraulic / pneumatic system and its components as per the manufacturer's specifications:

- (a) Functional test to ascertain the correct operation of the system and all safety devices; and
- (b) Pressure tests to every part of the hydraulic / pneumatic system at the maximum working pressure under all operating conditions.

4.5 Non-Destructive Test

Non-Destructive Test (NDT) referred hereunder comprises a variety of methods for locating cracks or discontinuities on the surface or inside of structural components of the ride. The presence of these cracks or discontinuities may be detrimental to the structural or functional integrity of the components and hence affect the overall integrity of the ride. The cracks may be present in the process of welding, machining, casting or variations in structural properties which can lead to reduction in mechanical strength. The NDT shall have no deleterious effects on the material or structure under testing.

NDT ranges from simple techniques such as visual examination of surfaces, through the well-established methods of radiography, ultrasonic testing, magnetic particle crack detection (MPI), to the specialized methods such as the measurement of Barkhausen noise and positron annihilation. Every test method has attributes and limitations that shall be considered when choosing a NDT program for a ride. The factors that shall be taken into account include the manufacturing process, the intended service, and the service environment of the component.

Aspects of NDT methods such as terminology, equipment and working principles shall comply with CEN-TC138 or CEN-TC121. The technician carrying out the NDT shall be familiar and experienced with the standard and procedures relevant to the particular method used. The technician shall be accredited according to ISO 9712, PCN (Personnel Certification in NDT), ASNT (American Society of NDT) or other internationally recognized certification scheme.

The Surveyor or the appointed technician carrying out NDT shall be able to distinguish between original manufacturing flaws and flaws developed during ride operation, and to distinguish between significant and insignificant flaws. Therefore, the Surveyor or the appointed technician shall acquaint himself with the fabricating method, the stresses acting on that component, and the type, size and orientation of flaw which is significant under those conditions of stress, material or geometry.

Manufacturer shall recommend a schedule of components for non-destructive tests in terms of running hours of the ride, otherwise the Owner shall arrange to carry out NDT on a portion of critical welds at least once a year, and ensure that all critical welds are checked with magnetic particle inspection, ultrasonic test or equivalent methods in a 10-year cycle or at a frequency determined by the actual status of the ride (ie. any frequent pre-mature failure of components). NDT shall cover elements like structural frames, supports, tracks, wheel assemblies, shafts, spindles, sweep arms, vehicle frame and attachments, steel cables, structural columns, chains, pins and bolts, etc. The acceptance criteria shall be in accordance with ISO 5817 or equivalent international application standard.

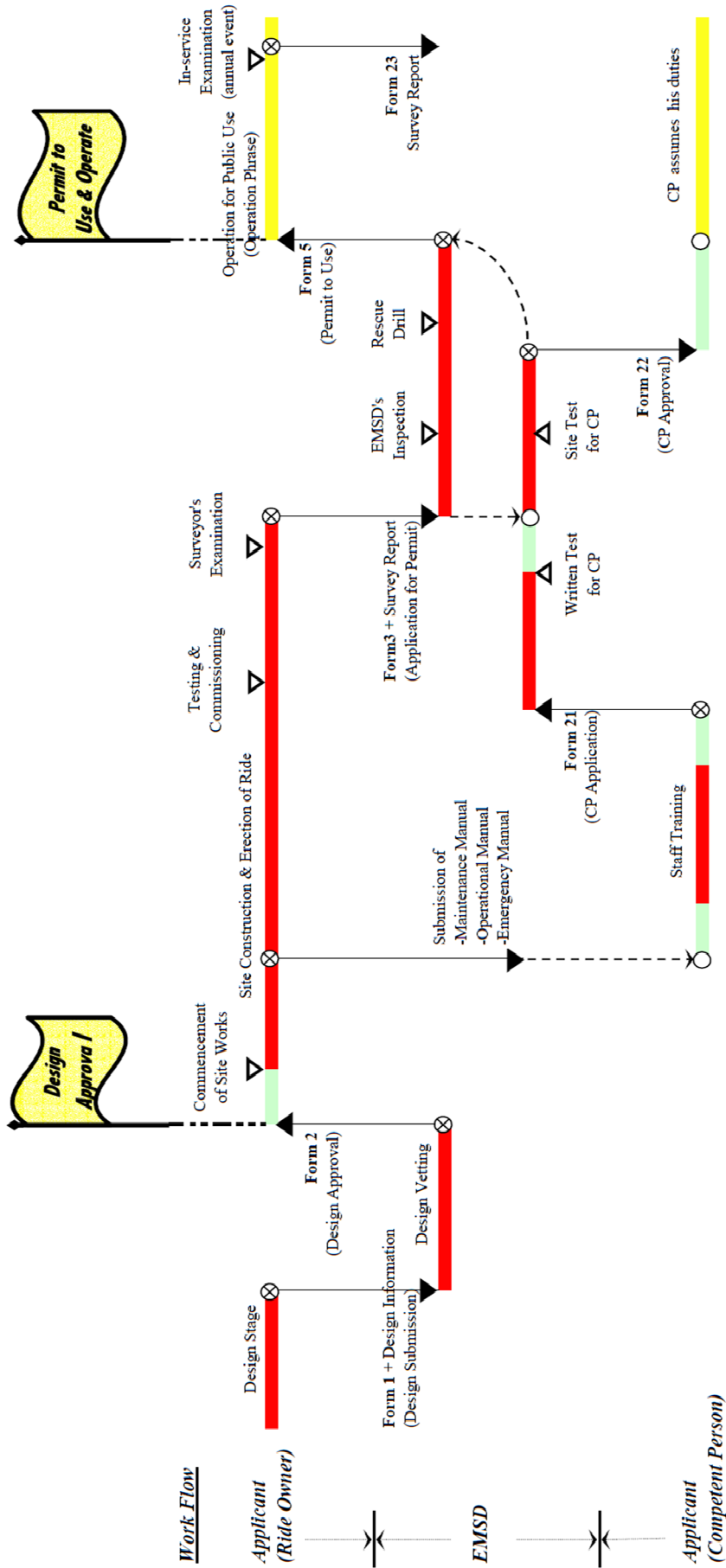
4.6 Certification and Test Record

Under the Ordinance, the Surveyor is the person who is appointed by the Owner to be responsible for examination of the ride, and certification on the integrity and safe operation of the ride. Test records on individual parts or sub-system of ride performed by manufacturers or others inspection bodies is acceptable if reasonable steps have been taken to verify that the tests are relevant, the procedures used are appropriate and the results reliable. Such test records include:

- (a) Type test certificate of standard product;
- (b) Test certificate issued by an independent testing institute for wire ropes, pressure vessels, safety gears, buffers, etc; and
- (c) Non-destructive test on welding and structural works.

Although the Surveyor may make reference to above-mentioned information as he/she thinks fitted, the Surveyor shall always exercise his due diligence to check the accuracy of these test records and carry out a thorough examination of the ride to check and verify its fitness for use by members of the public. Any tests performed by the Surveyor or critical information that underlies his/her conclusion shall be documented in the survey report. Apart from a conclusion on the integrity and safe operation of the ride, the Surveyor shall report on wider safety-related matters and recommend on improvement measures for the ride.

Chart of Licensing Process



6 Reference

- (a) Amusement Rides (Safety) Ordinance, Cap. 449
- (b) Amusement Rides (Safety) (Operation and Maintenance) Regulation, Cap. 449B
- (c) Boilers and Pressure Vessels Ordinance, Cap. 56
- (d) Building Ordinance, Cap. 123
- (e) Electricity Ordinance, Cap. 406
- (f) Engineers Registration Ordinance, Cap. 409
- (g) Gas (Safety) Ordinance, Cap. 51
- (h) Code of Practice for Electricity (Wiring) Regulation
- (i) Code of Practice for Fire Resisting Construction
- (j) Code of Practice for Minimum Fire Service Installations and Equipment
- (k) Code of Practice for the Provision of Means of Escape in Case of Fire
- (l) Code of Practice for the Structural Use of Steel
- (m) Code of Practice on Wind Effects in Hong Kong

7 Enquiry

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