

Code of practice for design, construction, installation, testing and inspection of the man-machine interface of Mechanised Car Parking Systems (MCPS)

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Preface

1. The first edition of this code of practice was published in 2019 with the formation of the Code Review Committee (“Committee”) led by the Building and Construction Authority (BCA) and representatives from the private sector. To obtain a well-rounded perspective, the Committee had also consulted other stakeholders such as government agencies, industry players and interest groups that were not represented in the Committee.

2. The code of practice sets out the essential requirements and guidelines for the design, construction, installation, testing and inspection of Mechanised Car Parking Systems (MCPS), with emphasis on the man-machine interfacing between user and equipment. It aims to provide a reference for the industry to ensure safe usage by authorised users, while preventing unauthorised usage, of the MCPS.

3. The Building and Construction Authority would like to extend its sincere appreciation to the members of the Committee, the industry and the public for contributing invaluable effort, time and inputs towards the development of this code of practice.

1. Introduction

1.1 Scope

1.1.1 This code shall apply to the design, construction, installation, testing and inspection of permanently installed mechanised car parking systems (MCPS), with emphasis on the safety of the man-machine interfacing between user and equipment.

This code does not apply to:

- (a) mechanised car parking systems used for the purpose of storage of vehicles and not for parking
- (b) Vehicle warehouse
- (c) Vehicle showroom
- (d) Vehicle workshop lifting device, used for maintenance

1.2 Purpose

1.2.1 The purpose of this code is to establish standard safety guideline in the man machine interface of MCPS in the Republic of Singapore with the intent to minimize the risk of injury associated with the usage and operation of MCPS.

2. Definitions and terminology

For the purpose of this code, the following definitions apply:

2.1 Anti-fall device

A mechanical or structural mean that prevents the lowering of the load carrier in event of failure of mechanical elements such as gearbox, shaft, motor brake, wire rope, chain, wire rope drum, hydraulic etc.

2.2 Authorised Person

A person that is authorised to access transfer area of the MCPS, including driver who has parked or is intending to park his vehicle in the MCPS

2.3 Automatic/Semi-automatic system

The driver is not in control during the storage and retrieval process of the vehicle and the sequence of events is fully or semi-automated.

For semi-automatic system, the driver need to communicate the location of the stored vehicle to the MCPS control system.

Below is a typical sequence of events for:

Parking of vehicle

1. Driver parks the vehicle onto the load carrier;
2. Driver initialises the MCPS at the control panel outside the transfer area;
3. Door of MCPS closes;
4. Vehicle is automatically store by mechanised system and sequence is completed.

Retrieval of vehicle

1. Driver initialises the MCPS at the control panel outside the transfer area and identifies the vehicle to be retrieved;
2. Vehicle is moved to the load carrier;
3. Driver enters transfer area;
4. Driver enters the vehicle and drives out;
5. Door of MCPS closes and sequence is completed.

2.4 Load carrier

The platform on which the vehicle is supported (1) before the parking sequence is initialised, and/or (2) after the retrieval sequence is completed.

2.5 Main Entrance

The entrance where the vehicle enter or exit the transfer area.

2.6 Manual system

The user controls the mechanism that store and retrieve the vehicle. Without user's control, the system will not activate and stop to operate.

Below is a typical sequence of events for:

Parking of vehicle

1. Driver parks the vehicle onto the load carrier;
2. Driver initialises the MCPS by engaging a hold to run control;
3. Vehicle is stored by mechanised system;
4. Driver disengages the hold to run control and sequence is completed.

Retrieval of vehicle

1. Driver identifies the vehicle to be retrieved;
2. Driver initialises the MCPS by engaging a hold to run control;
3. Vehicle is retrieved by mechanised system;
4. Driver disengages the hold to run control and sequence is completed.

2.7 Man machine interface (MMI)

All aspects of the MCPS that involve interaction between the user and the system. This includes, but is not limited to, the physical area where the driver of the vehicle will be exposed to the MCPS at the transfer area and control panel, as well as the control logic that regulates all interactions between user and MCPS.

2.8 Mechanised car parking systems (MCPS)

A system for the parking of vehicles where each vehicle is parked automatically by a sequence of events or by manual action. The MCPS is used for the sole purpose of parking, and is used by public or resident, where there is man machine interface between user and equipment during the processes of parking of the vehicle. This also include Automated Guided Vehicle Parking Systems (AGV).

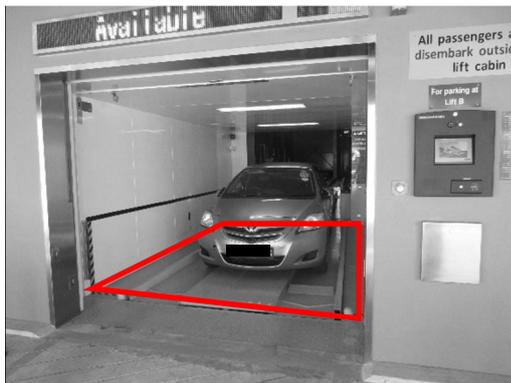
2.9 Side Door/Maintenance Door/Emergency Exit

A door within the Transfer Area other than the main entrance when the vehicle enter and exit the transfer area.

2.10 Transfer area

The area of the MCPS where the driver will enter to park or retrieve his vehicle. This includes any area that the driver can stand at within the MMI of the MCPS.

Note: The passengers shall disembark outside of the transfer area. Only the driver shall enter the transfer area.



The Box encapsulates the transfer area and load carrier of an automatic MCPS

3. Access to the MMI of the MCPS

3.1 Access to the transfer area of MCPS shall be restricted to authorised person. Means shall be provided to prevent unauthorised person from entering the transfer area of the MCPS e.g. by lock, or restrictions in access code, magnetic card, or key operated switch.

3.2 Main entrance shall be so designed, constructed and installed such that, when the fully closed door is subjected to a force of 300N, applied on an area of 5cm² at right angles to and approximately at the centre of each panel, it shall resist a permanent deformation and an elastic deformation not greater than 15mm. All other doors shall comply with local building code requirement.

3.3 For an Automatic/semi-automatic system, the opening of the main entrance, side and maintenance door shall stop the MCPS immediately and cause the MCPS to remain stopped. Re-starting can only be done after an authorised maintenance person has checked and ensure it is safe to re-start.

3.4 Means shall be provided to prevent the main entrance and side door from opening when the MCPS is in operation. The mean shall resist a force of 1000N in the direction of the movement of the door. Retaining means shall not be electromagnetic, pneumatic and hydraulic devices, and shall be positively locking to prevent unauthorised opening of the door in the event of loss of power.

3.5 If the MCPS is equipped with a side door, it shall open outwards without any lock from inside the transfer area and should be self-closing. The door shall only be able to be opened by means of a key from outside of the MCPS. It shall also be equipped with an electrical safety switch to prevent operation of the MCPS when the door is opened. The door shall have a minimum opening of 1.0m width and height of not less than 2.1m.

Note: If the MCPS has provision for handicap personnel, the side door opening shall be 1.2m in width.

3.6 The main entrance shall be equipped with door protective devices e.g. light beam or light curtain that is activated when an obstruction is detected. The main entrance shall re-open upon activation of door protective devices.

3.7 There shall be at least one emergency exit in the transfer area.

4. Transfer area

4.1 The transfer area shall have an illumination of at least 200 lux.

4.2 The surface of the transfer area, excluding the load carrier and platform, shall be as flat and smooth as possible to prevent any tripping hazard. Where openings are unavoidable, they should not allow spherical objects larger than 40mm in diameter to fall through. Demarcation should be used to warn the driver of the opening.

4.3 There shall be a provision of a signage to indicate that only the driver is allowed in the transfer area and passengers shall disembark from the vehicle outside of the transfer area. The signage shall be located outside of the transfer area and be clearly visible.

4.4 Where there is a risk of falling more than 1.0m in height from the transfer area, barricade according to local building code requirement shall be provided to prevent falling from height.

4.5 A path shall be clearly marked to show the driver the way out of the MMI of the MCPS from his vehicle to the door access.

4.6 For manual systems, all the sides except the entrance and exit shall be barricaded. The barricade shall be installed in a manner to sufficiently prevent any personnel from being endangered by the moving parts of the MCPS or interfering with the safe operation of the MCPS or reaching the MCPS equipment. Effective means, such as intrusion sensor, to prevent person from being injured by the moving parts can also be used for this purpose.

4.7 CCTV shall be installed with coverage of the whole transfer area and the control panel outside of the transfer area. The minimum specifications -.

- a. Capacity to record 24 hours a day, 7 days a week;
- b. Frame rate of at least 6 frames per second;
- c. Video resolution of at least 352 x 240 pixels or CIF CCTV resolution; and
- d. Storage of video footage of at least 30 days.

5. Load carrier design

5.1 The carrier shall be designed so that the driver can alight in a safe manner without any sudden or jerky movement of the system.

5.2 An anti-fall device shall be installed to prevent the lowering of the load carrier during the parking process when the driver is inside or alighting from the vehicle. The device shall act directly on the load carrier or not through any mechanical transmission device such as gear box, chain, wire rope, drive shaft, hydraulic etc.

5.3 To prevent tripping, the height different between the top of the platform side upturn and the transfer area shall preferably be less than 150mm. Demarcation shall be used to warn the driver of the height different.

6. Control

6.1 Automatic/Semi-automatic system

6.1.1 Initializing the storage and retrieval of the vehicle shall only be possible from a control panel located outside the transfer area.

6.1.2 Control panel shall be constructed, mounted and secured to minimise the risk of unintended or unauthorised operation. It shall also be installed in a fixed location.

6.1.3 If the MCPS is installed with more than one control panels, they shall be mutually interlocked, so that the initializing the storage and retrieval of the vehicle shall only be possible using one control panel at a time.

6.1.4 There shall not be any control devices to initiate the storage and retrieval of the vehicle inside the transfer area or within the reach of the driver from inside the vehicle.

6.1.5 Sensor shall be installed to detect the presence of any person in the transfer area. Additional sensor, e.g. Motion sensor shall be installed to enhance to detection of the presence of any person. Upon activation of any of the sensors, the systems shall not operate.

Note: This requirement may not apply to semi-automatic systems.

6.1.6 Emergency stop shall be provided inside the transfer area, at all the control panels outside of the transfer area and shall be clearly identifiable and visible.

6.1.7 The reset of the emergency stop shall only be done by authorised maintenance person.

6.2 Manual system

6.2.1 The motion of the load carrier shall only be initiated using a hold-to-run control.

6.2.2 The hold-to-run control shall be located in a manner that the driver has an unobstructed view of the load carrier and the driver is not exposed to any moving part of the MCPS during its operation.

6.2.3 The hold-to-run control shall be constructed, mounted and secured to minimise any risk of unintended or unauthorised operation. It shall also be installed in a fixed location.

6.2.4 When the load carrier is in motion, there shall be light or audio signal to warn person in the vicinity.

6.2.5 When more than one manual system MCPS are installed together, each manual MCPS shall be equipped with its own control panel, or if consolidated to a single panel, only one MCPS can be operated at a time.

6.3 When the emergency stop is pressed, the MCPS shall stop immediately and remain stationary until an authorised maintenance person resets the emergency stop.

6.4 If there is any risk that a user will be trapped inside the transfer area and there is no means to escape, alarm device shall be installed where the risk exist. Such device must be powered by an emergency backup power supply.

7. Composition of code review committee

7.1 Government Agencies

1. Building and Construction Authority (Chair)
2. Land Transport Authority
3. Singapore Civil Defence Force

7.2 Industry Players

1. Chris Ray Engineering Pte Ltd
2. Astec Technology Pte Ltd
3. MHE-Demag (s) Pte Ltd
4. Singapore Institute of Architects
5. Specialist Professional Engineers

Annex A

Periodic maintenance and examination of MMI of MCPS

A.1 MCPS MMI Maintenance

A.1.1 Registered MCPS Contractor

A.1.1.1 The owner of the MCPS shall cause the MCPS, all machinery and equipment connected therewith and the safety equipment to be cleaned, oiled, adjusted and replaced (if required) by a competent person working under the responsibility of a registered MCPS contractor.

A.1.2 Maintenance interval and scope of work

A.1.2.1 The MCPS shall be maintained at an interval stipulated by the manufacturer or the local legislation.

A.1.2.2 The maintenance of the equipment shall be done by a competent person. The general scope of work includes:

- Lubrication and cleaning
- Inspection and check for normal proper operation of components and parts including the necessary adjustment
- Repair and replacement of components and parts that is required due to wear and tear

A.1.2.3 A typical list of items to be maintained are listed below.

- Sensors
- Doors
- hold to run control or automatic control
- Lifting and rotation mechanism
- Anti-fall device
- Interlocking mechanism
- Wire rope or transmission equipment
- Hydraulic systems
- Electrical control and interface
- Anti-fall device

A.2 Periodic Examination, test and inspection

A.2.1 The owner of every lift shall, at an interval of 12 months, have the MMI of the MCPS thoroughly examined and inspected by a Specialist Professional Engineer (SPE), in order to determine whether the MCPS is in safe working order.

A.2.2 A typical list of items to be examined, tested and inspected are listed below.

- Sensors
- Doors
- hold to run control or automatic control

- Lifting and rotation mechanism
- Anti-fall device
- Interlocking mechanism
- Wire rope or transmission equipment
- Hydraulic systems
- Electrical control and interface
- Anti-fall device

Annex B

Inspection and Test of MMI of MCPS

B.1 Acceptance inspection and tests of new installation and alterations

To ensure the safe operation of new MCPS, such devices shall, on their completion and before being placed in service, be subjected to an acceptance inspection on and tests in the field to determine that all parts of the installation shall conform to the requirement of this code. A similar inspection and test shall also be carried out on an existing installation after major alteration.

B.2 Inspection and test procedure

B.2.1 General

B2.1.1 Cycle test each pallet/lot with maximum loading capacity and check for abnormal operation of mechanical devices, deformation to the pallet and structural element.

B2.1.2 Check that all bolts and nuts are securely fastened.

B.2.2 Door access

B2.2.1 Check that the width and height of the main entrance and access door are in accordance with code or local building code requirement.

B.2.3 Transfer area

B2.3.1 Check that there are provision for the following signage

- Only driver are allowed in the transfer area
- Passenger shall disembark from the vehicle outside of the transfer area
- The maximum capacity of the MCPS and the maximum vehicle size.

B2.3.2 Check that the signage shall be clearly visual from outside the transfer area

B2.3.3 Check for any height different is not more that 150mm and it is demarcated.

B2.3.4 Check that the CCTV is operational

B.2.4 Load carrier design

B2.4.1 Check the holding capacity of the brake by loading the load carrier to maximum capacity and hold it for 1 minute. After 1 minute, there shall not be any displacement from the point when the vehicle was loaded.

B.2.4.2 Check that during landing, the load carrier levels at the correct position

B.2.5 Control

B.2.5.1 For manual system, check that the hold-to-run function works properly

B.2.5.2 Check that any access point into the MCPS function according to the code

B.2.5.3 Test for any false retrieval when the driver is inside the transfer area

B.2.5.4 Check that the motion sensor has the correct sensitivity and there no dead zone inside the MMI of the MCPS

B.2.5.5 Safety Sensor – Ensure that the operation of any of the switch shall render the MCPS inoperative and remain in stop position. The sensor includes (but not limited to):

- Terminal limit switch
- Main entrance switch

- Door interlock
- Estop
- Intrusion sensor
- Door protective devices

B.2.5.6 Activate the e-stop and check that the MCPS stops immediately and remain stopped

B.2.5.7 Check the response of the MCPS during power failure. There shall be at least one exit route for the driver inside the MMI of the MCPS to exit the MCPS.