



DESIGN FOR MAINTAINABILITY GUIDE: NON-RESIDENTIAL

VERSION 1.0



Design for Maintainability Guide (Non-residential) Revision Log

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PART I: INTRODUCTION

Design for Maintainability

Design for Maintainability (DfM) is the practice of integrating operations and maintenance experience in the planning and design process to achieve ease, safety, and economy of maintenance tasks throughout the life of an infrastructure. A lack of maintainability considerations at the onset of a building project often creates avoidable maintenance demands which can lead to higher upkeep costs and manpower needs.

The four main principles of DfM are:

- (a) *Forecast maintenance* – Designers should understand the impact of their designs and the expected downstream maintenance works, thereby making necessary upstream design provisions.
- (b) *Access for maintenance* – Designers should give due considerations for all areas requiring access for inspection and maintenance, thereby making necessary design provisions.
- (c) *Minimise maintenance interventions* - Designers should give adequate attention to materials performance and detailing to minimise common and critical defects.
- (d) *Enable simple maintenance* – Designers should consciously consider standardisation and prefabricated components to facilitate easy inspection and productive maintenance.

Purpose

This guide provides a set of design recommendations and best practices to aid buildings' owners and designers in integrating maintainability concepts in the upstream design processes. This guide is also a useful reference for facilities managers (FM), service buyers and service providers, who are involved in the design decision process.

This guide is not meant to be definitive nor exhaustive. It also does not address construction quality, maintenance operations and the economic aspects of design decisions. The guide is not intended to override or replace any legal rights, responsibilities or regulatory requirements.

Scope

The Design for Maintainability Guide (Non-residential) places emphasis on good planning and design details, as well as the use of appropriate materials and technology to facilitate efficient maintenance activities. The guide is structured according to the various types of building components in a non-residential development. Each building component is then considered in relation to three critical design factors.

The three critical design factors are:

i) Access for Maintenance

The ability and ease to access, inspect and maintain the facilities is a critical factor for enabling efficient routine servicing and maintenance works. Access provisions must be designed to be safe and provide sufficient circulation and working space for maintenance machines, vehicles or personnel carrying tools, equipment and component parts.

Key considerations include:

- i. Adequate provision of access for execution of maintenance tasks including cleaning, inspections, repair and replacement of materials, components or equipment.
- ii. Design layout gives sufficient circulation and working space.
- iii. Minimise the need for maintenance at height or in confined spaces. Where it is not possible, measures should be put in place to reduce the associated risks.

ii) Materials and Finishes

Beyond the aesthetics qualities, designers should consider the suitability of materials in terms of their ability to minimise defects from normal wear and tear (durability), and perform the intended functions throughout the design life. The appropriate use of materials can minimise the frequency of cleaning, repair and replacement.

Key considerations include:

- i. Strike a balance between aesthetics, costs, safety and maintenance needs.
- ii. Select materials that are durable and suitable for the local climate. Consider innovative, high-performance materials that require minimal maintenance.
- iii. Choose materials that are easily available during the life of the facility.

iii) Design and Detailing

Proper architectural design and construction detailing can help to minimise the occurrence of defects and reduce the need for maintenance interventions. The main concerns include having careful detailing to prevent staining, water penetration and premature deterioration, as well as to enable simple maintenance methods and replacement of elements.

Key considerations include:

- i. Proper and effective detailing to reduce the impact of weather.
- ii. Design enables simple maintenance methods, such as easy diagnostic checks, installation and disassembly/assembly of components.
- iii. Consider standardisation and modular layout of components, and the use of prefabricated materials/ components.

The main components identified in a non-residential development are:

1. Architecture

- Facades
- Roofs
- Building Spaces and Elements
- Parking Areas

- M&E Rooms
- Washrooms

2. Mechanical & Electrical (M&E)

- Facades and Roof Areas
- Common Areas, Plants and Equipment Rooms
- Smart FM
- Security

3. Landscape

The following good practices are encouraged in this guide:

- Design Collaboration with FM stakeholders
- Maintain proper building records
- Adopt innovative solutions
- Prepare a Maintenance Strategy Report

How to use this guide

The designer should indicate “Y”, “N” or “NA” in the Y/N/NA column against the design recommendations.

Abbreviation	Denotes
Y	Yes – meet or exceed the design recommendation
N	No – does not meet the design recommendation
NA	Not Applicable – design recommendation is not applicable

The designer should provide a brief description of the provision. If the design recommendation is not met or not applicable, the designer should explain why the recommendation is not considered and whether alternative solution is proposed. Additional notes, references and drawings could be attached to this guide as supporting documents.

As the design objectives differ from one building to another, the recommendations of the guide may not comprehensively address the scope and specific maintenance requirements of a project. The designer should use this guide in conjunction with other applicable codes, regulations, and design guidelines.

An example of how the columns are filled is given below:

A1.	Access	Y / N / NA	Description of provision (Attach relevant drawings or references, etc. where necessary)	If No or Not Applicable, please explain
A1.1	Protruding façade features Avoid extensive niches, fins and ledges that protrude more than 600mm. If the protrusions exceed 600mm, designers should make specific considerations for safe and easy access.	NA		<i>No protruding features on façade.</i>
A1.2	Internal Access Façade design should promote minor cleaning and repair works to be carried out from within the building, while major repair works can take place from the outside. Use modularised window panels which are not too large (max 750mm) or reversible windows for ease of cleaning from within the building, i.e. within reach of a cleaner’s arm and his/her handheld tools.	Y	<ul style="list-style-type: none"> <i>Gondola system and elevated walkway access provided</i> 	
A1.3	Access to any part of the façade should not encroach on private spaces or require deconstruction of window units or other building components.	Y	<ul style="list-style-type: none"> <i>No encroachment into private spaces</i> 	
A1.4	Building Maintenance Unit (BMU) Where BMU is used for façade maintenance, ensure that the BMU is: a) electronically powered and programmable.	N		<i>No BMU system is used. See ‘façade access strategy’ described in the Maintenance Strategy Report</i>

1. ARCHITECTURE

A1. ACCESS TO FACADES

Objectives:

Provide safe and easy access to every part of a building's façade and all elements therein (e.g. sunshades, canopies, claddings, lights, signs and other façade features) – for efficient cleaning and maintenance, and inspection.

A1.	<u>Access</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or Not Applicable, please explain
A1.1	<p>Protruding façade features Avoid extensive niches, fins and ledges that protrude more than 600mm. If the protrusions exceed 600mm, designers should make specific considerations for safe and easy access.</p>			
A1.2	<p>Internal Access Façade design should promote minor cleaning and repair works to be carried out from within the building, while major repair works can take place from the outside.</p> <p>Use modularised window panels which are not too large (max 750mm) or reversible windows for ease of cleaning from within the building, i.e. within reach of a cleaner's arm and his/her handheld tools.</p>			
A1.3	Access to any part of the façade should not encroach on private spaces or require deconstruction of window units or other building components.			
A1.4	<p>Building Maintenance Unit (BMU) Where BMU is used for façade maintenance, ensure that the BMU is:</p> <p>a) electronically powered and programmable.</p> <p>b) designed to enable positioning/ suspension of working platforms to reach all exterior surfaces of the building.</p> <p>c) easily accessible via common areas.</p> <p>d) designed with suitable restraints and bumpers to address wind loads.</p>			

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A1.	<u>Access</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary))</i>	If No or Not Applicable, please explain
A1.5	<p>Suspended Working Platform Where suspended working platform (gondola) is used for façade maintenance, ensure that:</p> <ul style="list-style-type: none"> a) there are provisions for gondola to be safely affixed to the building (e.g. permanent installation points) as well as adequate anchor points for safety ropes and independent anchor for lifelines. b) the gondola is able to reach all parts of the building facade. c) façade features do not obstruct the operation of the gondolas. Surfaces below protrusions/ cantilevered structures should be reachable and maintainable from the gondola. d) there are adequate safe launching/ landing places for the cradle/ working platform. e) the launching and landing spaces and the access routes to these spaces are located within common spaces, and should avoid landing in landscaped areas. f) there is provision of power supply for gondola operations and water supply for carrying out maintenance works. 			
	<ul style="list-style-type: none"> g) ensure spacing between external walls/ structures of adjacent blocks is at least 1.2m to facilitate the safe use of gondolas. 			
A1.6	<p>Ground-based (Mobile Elevating Work Platform (MEWP)) Where MEWP is used for façade maintenance, ensure that:</p> <ul style="list-style-type: none"> a) unobstructed access route and working space are provided, b) access route and working space should be level and designed to take the equipment's load. 			
A1.7	<p>Provision for use of ladders Provide firm and level surface for use of ladders.</p>			
A1.8	<p>Safety of Maintenance Personnel Provide safe working environment for the setting up and operation of access systems such as:</p> <ul style="list-style-type: none"> a) railing, b) anchorage points and/ or lifelines for sliding safety harness, c) eyebolt fixing for rope to secure ladder. 			

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A1.	<u>Access</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or Not Applicable, please explain
A1.9	Air Conditioning (AC) Unit Service Ledge Provide sufficient working space and safe working environment (e.g. anchorage for safety harness) for maintenance personnel.			
A1.10	Where maintenance access to the service ledge is via windows or wall apertures, the size of the openings should allow safe and easy access for maintenance personnel carrying tools, equipment and component parts. Maintenance activities should not require the dismantling of services and building elements.			
A1.11	Provide safety barriers or guard rails (minimum height of 1m) around the service ledge.			

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A2. CHOICE OF MATERIALS & FINISHES FOR FAÇADES

Objectives:

Use appropriate materials and finishes that are resistant to deterioration and exposure to weather elements.

A2.	<u>Materials & Finishes</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
A2.1	Adopt materials and finishes that are readily available (i.e. does not require special procurement).			
A2.2	Paint Systems Use paint systems that enhance weather protection and lengthen the cyclical period needed for façade re-painting (e.g. paint with anti-stain and self-cleansing properties).			
A2.3	Fastenings and Fixings Use materials that are not prone to corrosion or rust e.g. stainless steel.			
A2.4	Outdoor Materials Avoid materials that are prone to deterioration when exposed to weathering (e.g. plaster or calcium silicate board).			
A2.5	Sealants Use sealants that are resistance to staining and bleeding.			

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A3. DESIGN & DETAILING FOR FAÇADES

Objectives:

Provide effective design and detailing to promote efficient run-off on façade surfaces to minimise water ponding, penetration and staining problems.

A3.	<u>Design & Detailing</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
A3.1	External Walls Provide drip edges to prevent streaks on exterior soffits, walls, and glazed surfaces.			
A3.2	Grade all top surfaces of walls to fall away from external face of walls to minimise streaks on the facade. The coping should overhang the rear side of the walls and comes with drip control to mitigate streaks on the back walls.			
A3.3	Stone Panels Stone panels should be mechanically fixed. Avoid the use of adhesive which are prone to efflorescence.			
A3.4	Install stone panels in a way that allows for inspection of its concealed mechanical connections to pre-empt corrosion or defects (e.g. accessible for fibre-optics inspection).			
A3.5	Metal Cladding and Fixtures Avoid metal cladding and wrapping around external building components where high pedestrian traffic is expected.			
A3.6	Install metal cladding in a way that allows for inspection of its concealed mechanical connections to pre-empt corrosion, dilapidation and loose or defective fixings.			
A3.7	Glazed Surfaces Avoid inclined glass surfaces, being prone to dirt and dust collection.			
A3.8	Size up external glazing optimally such that glass panels can be transported by lifts to facilitate future replacement from within building.			
A3.9	Avoid the use of non-planar or curvilinear glass surfaces which are difficult to maintain or not readily available in the market.			

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A3.	Design & Detailing	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
A3.10	Ensure that glass (e.g. glazed canopies) are able to withstand the loads imposed during maintenance.			
A3.11	Glass Parapets Avoid extensive use of glass parapet walls at outdoor areas as weather stains on glass surfaces are more visible and require more frequent cleaning.			
A3.12	Weather Control Devices Incorporate appropriate weather control devices (such as overhanging ledges, copings and rain screens) to external openings to minimise rainwater ingress. Where wall openings/doors are subject to external weathering, incorporate details such as overhang at the top, and water-bar or threshold kerb at the bottom to minimise water ingress.			
A3.13	Joints Provide movement joints to accommodate movement in large continuous areas, or between adjacent building components (e.g. brick wall and concrete column) and dissimilar substrates. The backer-rod material in the joint should be compatible with the sealant used.			
A3.14	Anti-Roosting Measures Adopt designs that mitigate roosting of birds (e.g. use chamfered or steeply sloped surfaces).			
A3.15	Planter boxes Planter boxes should be accessible for easy maintenance (e.g. located at window sill level, along service balcony/ corridor).			
A3.16	The location of drainage outlets of planters should not cause stains on building facade.			
A3.17	Loading/ Unloading Areas Provide protection to beams and columns in loading/ unloading areas (e.g. rubberised sleeves).			

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B1. ROOF ACCESS

Objectives:

Design the roof space for safe and efficient movement of maintenance personnel carrying tools, equipment and spare parts.

B1.	<u>Access</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
B1.1	Direct Access Provide at least one direct staircase access to main roof areas for maintenance purpose.			
B1.2	Safety Provide safety barriers/guard rails (min height of 1.0m) or anchor points for safety harness along the roof perimeter and roof openings (such as skylights and air wells) to prevent fall from height.			
B1.3	Provide minimum 1.5m clear working space (or larger as specified by M&E equipment supplier) between the building edge/parapet wall and M&E installations.			
B1.4	Provide non-slip steps/platforms/catwalks over/along maintenance path to prevent stepping on rooftop services such as piping/ trunking/ conduit.			
B1.5	Provide clear demarcation of maintenance boundaries and access at roof areas.			
B1.6	Provide hoisting facilities and anchorages at the roof for hoisting of equipment after completion of the building.			
B1.7	Where façade extends more than 5m above the roof, provide catwalk or other means of access at the internal side of the façade.			

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B2. CHOICE OF MATERIALS & FINISHES FOR ROOFS

Objectives:

Use appropriate materials and finishes that are resistant to deterioration and exposure to weather elements.

B2.	<u>Materials and Finishes</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
B2.1	Provide adequate waterproofing to roof surfaces			
B2.2	Avoid extensive use of transparent and translucent roofing materials that are prone to discolouration and deterioration when exposed to weather elements.			
B2.3	Use roofing materials/finishes that are able to withstand heavy maintenance works (e.g. removing of algae).			

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B3. DESIGN & DETAILING FOR ROOFS

Objectives:

Provide effective design and detailing to ensure optimal run-off to avoid water ponding and penetration problems.

B3.	<u>Design & Detailing</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
B3.1	Drainage Grade all roof areas and open terraces to fall, with adequate gradients, so storm water is directed away from door openings and flow towards rain water outlets/ floor waste outlets.			
B3.2	Slope the RC roof slab and roof gutters at 1:50 or steeper to facilitate efficient run-off.			
B3.3	Design two-directional fall to improve drainage and to reduce roof slab thickness.			
B3.4	Provide drainage outlet with "debris trap" to prevent choking of the drainage system. Use leaf guards and overflow spouts to prevent water stagnation.			
B3.5	Expansion Joints Incorporate adequate expansion joints to prevent cracking and support the vibration of plants and equipment on the roof. The expansion joints should be at regular intervals over large continuous roof areas due to continuous weather exposure.			
B3.6	Fixtures of façade access equipment on the roof should not affect/damage the components of the lightning protection system.			

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C1. ACCESS FOR BUILDING SPACES AND ELEMENTS

Objectives:

Ensure that access design and systems enable ease of maintenance to various building elements, vertical spaces and services.

C1.	<u>Access</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
C1.1	<p>Air Well and Atrium</p> <p>a) Avoid constricted areas, air wells and atrium which are difficult to access for maintenance.</p> <p>b) Provide suitable access system to maintain the façade/ glazed surfaces within air well/ atrium (e.g. maintenance tracks systems with suspended platforms around large voids and air wells).</p> <p>c) Avoid high volume voids or “soft storeys” with “flying” beams” which do not have easy means of access for maintenance.</p>			
C1.2	<p>Ceiling Spaces and Height</p> <p>Avoid lobby areas with high ceiling spaces (e.g. > 5m) which are difficult to access for maintenance.</p>			
C1.3	Where ceilings exceed 5m in height, provide catwalks, elevated platforms and/or unobstructed access route for maintenance equipment and vehicles e.g. scissors lift and mobile elevated platforms.			
C1.4	Provide a service lift of adequate capacity to transport the maintenance equipment and vehicles to for maintaining high ceiling spaces of sky terraces.			
C1.5	<p>Outdoor Lightings</p> <p>Lampposts should be safely and easily accessible for lamp replacement (e.g. areas should have firm surface to allow proper deployment of ladders).</p>			

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C2. CHOICE OF MATERIALS & FINISHES FOR BUILDING SPACES AND ELEMENTS

Objectives:

Use appropriate materials and finishes to minimise the frequency of cleaning, repair and replacement.

C2.	<u>Materials & Finishes</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
C2.1	Walls Avoid spray textured finish on walls and columns where there is heavy pedestrian traffic.			
C2.2	Floors Use stain resistant (e.g. mid tone colours) floor finishes in areas with heavy pedestrian traffic such as lift lobbies and common corridors.			
C2.3	Avoid combining metal elements with natural stones to reduce risk of staining associated with metal corrosion.			
C2.4	Use metal (e.g. aluminium-finished) fixtures or doors (with appropriate fire rating, where necessary) instead of timber in areas exposed to weather or damp conditions.			
C2.5	Exterior Ceiling Use weather and wind resistant ceiling materials (e.g. metal panels) in areas exposed to weather elements.			
C2.6	External Signage Use weather-resistant materials in semi-gloss finish for easy maintenance.			
C2.7	Vehicle Drop-off Areas For vehicle drop-off areas, use oil-resistant surface (e.g. pavement or stone) to reduce permanent staining caused by vehicles. Avoid <ul style="list-style-type: none"> i. porous soft stone materials; ii. glossy surfaces; or iii. light-coloured materials, in areas with heavy pedestrian traffic. 			
C2.8	Driveway Paving Avoid the use of rough stone paving for driveway as they are more prone to trapping dirt.			

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C2.	<u>Materials & Finishes</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
C2.9	<p>Timber All timber finishes should be kiln-dried and well-seasoned to prevent shrinkage, splits and deformation.</p> <p>All timber finishes should be treated for fungi and insect attack, including anti-termite treatment, with an approved wood preservative.</p>			
C2.10	<p>Masonry, Stone and Tiles Provide appropriate and compatible sealer/impregnator to the sides, top and bottom surfaces of stone works.</p>			
C2.11	<p>Where masonry/ stone finishes are used near wet areas, the stone should be appropriately treated (e.g. sealant, admixture, water repellent) and detailed to prevent efflorescence.</p>			

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C3. DESIGN & DETAILING FOR BUILDING SPACES AND ELEMENTS

Objectives:

Provide effective design & detailing for protection against weathering and enabling simple maintenance.

C3.	<u>Design & Detailing</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
C3.1	Linkways and Drop-off Areas Provide sufficient roof gradient (min 3° slope for flat roof) for efficient water run-off.			
C3.2	Design of linkways, drop off porches, and external corridors should minimise ingress of rain, ensuring at least 50% dry covered passage, e.g. i. Provide drop panels and weather proof louvers for high volume roof, ii. provide sheltered area or canopy with a depth of at least 2 times the entrance width.			
C3.3	Design of linkways and drop-off porches should be modularised with demountable parts (no welded parts) for ease of maintenance, where required, and to facilitate access for maintenance vehicle.			
C3.4	Provide concrete curb / collar at the base of metal columns to minimise contact with water and reduce corrosion.			
C3.5	Floor slabs should come with removable panels for inspection and maintenance of concealed services.			
C3.6	Grade all exposed floors and flat surfaces to fall so as to direct run-off to the external drains and scuppers.			
C3.7	Avoid corners and cavities which are inaccessible to cleaning machines.			
C3.8	Provide anchor points for safety harness on linkways and canopies for maintenance personnel.			
C3.9	Entrance to Building Provide floor mats with integrated drainage system at the main entrance to reduce entry of water, dirt and dust into buildings. Floor mat should flush with the floor finishes to prevent tripping hazards.			

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C3.	<u>Design & Detailing</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
C3.10	Ceiling Avoid monolithic ceiling design (joint-less with no access to internal services) which are more costly and tedious to repair and maintain.			
C3.11	Use suspended modular ceiling panels that are easily demountable for its easy replacement and maintenance of embedded services.			
C3.12	Where metal ceiling panels are used, they should be designed to prevent sagging and withstand wind loads. Panels should be sized such that they can be easily handled by one person.			
C3.13	Staircase Provide appropriate nosings to avoid chipping of edge of the steps.			
C3.14	Expansion Joints Ensure that sufficient expansion joints are provided to external and internal finishes to prevent cracking, warping, etc.			
C3.15	Drainage All concealed drainage, rainwater down pipes should have access openings.			
C3.16	Recessed Floor Lightings Avoid the use of recessed floor lights that is prone to water damage. If such lights are used, provide drainage to prevent water-logging.			
C3.17	Safety of Maintenance Personnel Provide appropriate warning signs for maintenance crew to prevent stepping on ceiling boards and non-load bearing surfaces (e.g. in voids of service risers),			

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D1. ACCESS DESIGN FOR PARKING AREAS

Objectives:

Provide adequate and unobstructed access for maintenance personnel and equipment.

D1.	<u>Access</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
D1.1	Where services/ plant rooms are within car park, provide service route(s) with adequate headroom and sufficient working space for maintenance vehicle/ equipment. (e.g. access and manoeuvring space for refuse collection truck).			
D1.2	Car park lots should not block the doors of M&E rooms.			

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D2. CHOICE OF MATERIALS & FINISHES FOR PARKING AREAS

Objectives:

Selection of materials and finishes should take into consideration stains and wear and tear due to vehicular traffic and exhaust fumes.

D2.	<u>Materials & Finishes</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
D2.1	Provide epoxy coating on car park driveway and parking lot for greater durability. Use resilient material (e.g. thermoplastics) for directional and parking lot markings.			
D2.2	The surface material of the driveway and walls should allow easy removal of oil and water stain as well as heavy-duty washing.			

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D3. DESIGN & DETAILING FOR PARKING AREAS

Objectives:

Provide effective design & detailing to protect against damages from vehicles and ensure optimal surface run-off to avoid water stagnation.

D3.	<u>Design & Detailing</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
D3.1	<p>Guards and Wheel Stoppers</p> <p>Use wheel stopper and crash guards to protect columns, walls, and exposed pipes and services near car park lots and driveways.</p>			
D3.2	<p>Ramps</p> <p>Provide groove lines on access ramps to facilitate water discharge to the scupper drains on the side of ramps.</p>			
D3.3	<p>Drainage</p> <p>Provide adequate drain outlets to prevent water stagnation (e.g. scupper drains in the vicinity of wheel stoppers).</p>			
D3.4	<p>Provide cut-off drains with adequate depth and gradient at all areas of the car park that are exposed to weather including:</p> <ul style="list-style-type: none"> i. the top and bottom of ramps. ii. open/partially exposed staircase (at intermediate landing and/or base of staircase). 			

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E1. CHOICE OF MATERIALS & FINISHES FOR M&E ROOMS

Objectives:

Selection of materials and finishes for the floors and walls should take into consideration wear and tear and exposure to weather elements.

E1.	<u>Materials & Finishes</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
E1.1	Floors Use darker tone epoxy top coat for the floor finishes in service rooms and service corridors.			
E1.2	Walls Provide metal chequered plate on walls (up to 1.2m high) for surface protection in service rooms and service corridors that are subject to frequent, heavy wheeled traffic.			
E1.3	Doors Provide door kick plate for service rooms that are subject to frequent, heavy wheeled traffic.			
E1.4	Use corrosion-resistant material (e.g. aluminium doors) for service doors exposed to weather or damp conditions.			

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E2. DESIGN & DETAILING FOR M&E ROOMS

Objectives:

Provide effective design and detailing to prevent water ingress/egress problems and to enable simple maintenance.

E2.	<u>Design & Detailing</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
E2.1	Avoid locating wet areas above critical service rooms (e.g. server rooms, LAN rooms, and electrical rooms). If this is not possible, provide double slab with access and adequate height between slabs for maintenance.			
E2.2	Provide raised kerb at AHU room, water tank room and electrical rooms to prevent water ingress/ egress.			
E2.3	External AC Screens Design the sound barriers/ visual screens for air-conditioning equipment in easily demountable, modularised units so as to facilitate easy access and maintenance.			
E2.4	Louvres Provide at least 300mm overhang above louvre vents facing external or set back the louvre vents by 300mm from the building edge.			

PART II: DESIGN FOR MAINTAINABILITY GUIDE (NON-RESIDENTIAL)

F1. ACCESS FOR WASHROOMS

Objectives:

The design and layout of toilet facilities should allow easy access for maintenance.

F1.	<u>Access</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
F1.1	<p>Cleaning Machines and Equipment Provide at least one service lift to facilitate the transport and access for cleaning machines and equipment.</p>			
F1.2	The washroom entrance should be wide enough for cleaning machines and equipment.			
F1.3	<p>Circulation Adopt "doorless" or vestibule entry to facilitate ease of access and improve ventilation.</p>			
F1.4	The layout of toilet should minimise circulation space and adequately designed to handle the anticipated peak traffic.			

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F2. CHOICE OF MATERIALS & FINISHES FOR WASHROOMS

Objectives:

Use materials that are resistant to damp and chemical environments.

F2.	<u>Materials & Finishes</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
F2.1	Use moisture impervious, durable (e.g. ceramic tiles and phenolic panels) and cleanable materials for toilet wall and floor surfaces so as to facilitate cleaning and resource conservation (such as minimising the use of water and cleaning agents).			
F2.2	Provide slip-resistant flooring (e.g. slip resistant index of R11) for safety of maintenance workers.			
F2.3	Use metal gratings of sufficient quality (e.g. Stainless Steel 304) to prevent rusting.			

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F3. DESIGN & DETAILING FOR WASHROOMS

Objectives:

Provide effective design and detailing to prevent water damages and to facilitate easy cleaning and maintenance.

F3.	<u>Detailing and Design</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
F3.1	Fixtures Provide wash basins of appropriate size and depth to reduce splashing and wetting of floors.			
F3.2	Use modular and smaller basin mirrors instead of full-span wall mirrors for ease of cleaning.			
F3.3	Use suspended cubicle partitions to facilitate floor cleaning and prevent partition panels from constant contact with damp floor.			
F3.4	Use suitable hinge and lock for cubicle doors – taking into account the material and weight of doors – to prevent misalignment after prolonged use.			
F3.5	Ensure that the size of recessed/ built-in trash bin can adequately meet the waste capacity demand.			
F3.6	Provide a minimum of 25mm level difference between the corridor and the toilet floor.			
F3.7	Use wall-mounted wash basins, urinal bowls, and water closets to facilitate floor cleaning.			
F3.8	Door frame/architrave should be raised above the wet areas and terminate above the floor level. Consider installing sub-frames above the screed level to reduce the chance of water ingress from the wet floor through the masonry works.			
F3.9	Dispensers Install dispensers' (soap/ hand towel) above the vanity top for ease of replacement/refill. Avoid installing the dispensers behind mirror/ feature.			
F3.10	The dispenser should have a visual indicator (e.g. transparent window) to show the amount of soap/ towel in the dispenser to assist in timely refilling.			

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F3.11	Install dispensers (soap/hand towel) / hand dryer close to wash basin.			
F3.	<u>Detailing and Design</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
F3.12	Waterproofing Apply waterproofing membrane to the wall or substrate immediately adjacent or behind a washbasin, sink or similar fixture at a height of not less than 300mm above the fixture.			
F3.13	Waterproofing membrane should be dressed up at pipe penetrations to the finished floor level and dressed down at least 50mm into the floor outlet. Waterproofing membrane should be applied at least 100mm horizontally around the pipe.			
F3.14	Avoid laying tiles directly onto the waterproofing membrane. As a protective measure against damaging the membrane during tiling, a layer of screed should be laid over the membrane when it is cured.			
F3.15	Shower Facilities Provide raised kerbs of at least 100mm at the base walls to act as barriers against lateral movement of water.			
F3.16	Apply waterproofing membrane with an upturn of at least 300mm to create a minimum tanking protection against migration of water to spaces adjacent or below the wet area.			
F3.17	Apply waterproofing membrane of at least 1800mm height and 1500mm width of the wall or the entire enclosure at bath and shower areas.			
F3.18	Supporting Facilities for Cleaners Provide a janitor closet/ store on each level for storage of daily-use cleaning tools/equipment, chemicals and supplies. Store rooms should come with a large sink for filling and emptying cleaning buckets.			
F3.19	Provide a designated room of sufficient size for cleaners to rest and store personal belongings.			
F3.20	Provide a central store room/area for storage of large cleaning machines (e.g. ride-on sweeper/scrubber). Access doors and aisles need to be large enough for the machines' movement.			

2. MECHANICAL & ELECTRICAL (M&E)

G1. ACCESS TO M&E INSTALLATIONS ON FAÇADE AND ROOF AREAS

Objectives:

Provide safe and easy access for the inspection and maintenance of M&E installations.

G1.	<u>Access</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
G1.1	<p>Air Conditioning Condenser Unit Provide adequate working space around the condenser unit to accommodate maintenance and replacement.</p>			
G1.2	<p>Externally-mounted M&E installations Provide proper means of access for maintenance for externally-mounted M&E installations:</p> <ul style="list-style-type: none"> i. access to LPS installations (strike pads, down conductor tapes etc.) on façade, ii. replacement of lights on the façade as well as light fittings located in high volume spaces (canopy, drop-off porch, sky terrace, etc.), iii. maintenance of other externally-mounted M&E installations (e.g. ACMV louver, CCTV, and PA/AV system, etc). 			
G1.3	<p>Lifts Service lift should preferably land at roof level. Lift should be designed with adequate capacity to transport equipment and parts for replacement and maintenance purposes.</p>			
G1.4	<p>Provide designated access for motor room-less lift (e.g. 'knock-out wall panel') and hoisting beam for servicing and replacement of lift motor.</p>			
G1.5	<p>M&E Installations on Roof Provide adequate working space (e.g. 600m) around and between M&E installations at the roof (cooling tower, generator, condenser unit, photovoltaic panels, etc.) to accommodate easy maintenance and replacement.</p>			

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G1.	<u>Access</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
G1.6	Lightning Protection System Provide adequate means of access for workers to inspect and maintain air terminals and lightning tapes at edge of the building.			

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G2. CHOICE OF MATERIALS & FINISHES FOR M&E INSTALLATIONS ON FAÇADE AND ROOF AREAS

Objectives:

External M&E services and equipment should be able to withstand exposure to weather elements.

G2.	<u>Materials & Finishes</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
G2.1	Use weather-resistant material for all external signage with lighting.			
G2.2	Use weather-proof material for outdoor M&E devices such as lightings, speakers, cameras, card reader: a) IP65 rated lightings and relevant accessories (transformers/controllers/drivers etc..), e.g. near green wall since exposed to dirt and irrigation. b) External access control equipment (cameras, card reader, etc.) should come with weather proof covers and/or made of weather resistant materials c) Avoid locating fire alarm call points in weather-exposed areas. Alternatively, call points should be made of weather proof material .			
G2.3	Use corrosion-resistant material for pipes, ducts, louvers, cables, and trays (including their fixing accessories) that are exposed to weather.			
G2.4	Use weather proof materials for M&E services and equipment. Provide suitable cover/shelter to equipment or component (e.g. electrostatic filters for kitchen exhaust, inverters of photovoltaic installations) that do not come with weather-proof option.			

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G3. DESIGN & DETAILING OF M&E INSTALLATIONS FOR FAÇADE

Objectives:

Provide effective design and detailing to enable proper functioning and ease of maintenance for M&E equipment.

G3.	<u>Design & Detailing</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
G3.1	Lightning Protection System Use natural down conductor (e.g. steel in reinforced concrete structures) instead of exposed lightning tape.			
G3.2	Avoid mounting aluminium tape directly onto calcareous building surfaces (e.g. concrete limestone and plaster) to minimise aluminium corrosion.			
G3.3	External Air-conditioning Units Avoid locating air-conditioning units in recesses or enclosed areas (e.g. basements) to mitigate the rejected heat from being recirculated into the equipment			
G3.4	Lighting on Roof Provide adequate lighting to access routes leading to M&E installations.			
G3.5	Cooling towers Provide adequate water points and power points close to cooling towers to facilitate cleaning and top-up in the event of pump failure (serving make-up water tank).			
G3.6	Provide effective cooling tower water treatment to prevent corrosion, fouling, and algae growth.			
G3.7	Photovoltaic (PV) Panels Provide adequate water points for cleaning of PV panels.			

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H1. ACCESS FOR M&E INSTALLATIONS IN COMMON AREAS, PLANTS AND EQUIPMENT ROOMS

Objectives:

Provide safe and easy access to various M&E installations to enable efficient inspection, repair and replacement

H1.	<u>Access</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
H1.1	Overhead Services Provide adequate maintenance access space to all M&E installations (light fittings, ventilation equipment, fire alarms, ELV equipment etc.) above the suspended ceiling			
H1.2	Provide ceiling access panels near floor traps, valves, water heater and air conditioning equipment to facilitate inspection/ maintenance of services.			
H1.3	Provide multi-tier trays with at least 150mm access space in between for installation/ maintenance of services cables.			
H1.4	Provide a minimum of 600mm clear depth between beam soffits and false ceilings for insulated chilled water pipes to pass below the beam. Provide a minimum of 400mm clear depth between beam soffits and false ceilings for insulated refrigerant pipes to pass below the beam.			
H1.5	Prefabricated MEP System Where prefabricated MEP is used, provide a minimum work space of 600mm along the centre of the modules. The width of services on each side of the access space should be kept within one arm's length to allow easy reach to all the services.			

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H1.	Access	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
H1.6	<p>Headroom Provide minimum 2m clear headroom in M&E rooms and access walkways/ service corridors to facilitate safe access and ease of maintenance.</p> <p>Obstructions that result in reduced headroom should be clearly identified and marked.</p>			
H1.7	<p>High Volume Spaces For easy access, provide signs and location indicators for services located above high ceiling areas.</p>			
H1.8	<p>Provide permanent guarded ladders, catwalks and hydraulic powered platforms for occasional access to high volume spaces. Such maintenance activities should not require dismantling of services and building elements.</p>			
H1.9	<p>Provide scaffolding, staging and temporary ladders for infrequent access to high volume spaces.</p> <p>Ensure any fixtures below such spaces can be easily removed to make space for installation of temporary access systems</p>			
H1.10	<p>Sanitary and Rainwater downpipes Avoid casting sanitary pipes within wall structures. Sanitary waste stacks and downpipes should be easily accessible from common areas for maintenance.</p>			
H1.11	<p>'Cleaning eye' for sanitary/waste piping system should be clear from obstruction and easily accessible for maintenance. Avoid placing 'cleaning eyes' at high and inaccessible areas.</p>			
H1.12	<p>Lightning Protection System Provide adequate means of access to inspect and test the test-link panels and earth pits.</p>			
H1.13	<p>Working Space Provide at least 600mm unobstructed space or larger (manufacturers' requirements) for maintenance around all M&E equipment for safe maintenance and replacement of components.</p>			
H1.14	<p>Ensure adequate working space for the installation and removal of mechanical equipment (e.g. 2.5m unobstructed space at the back of chiller for replacement of chiller tube or unobstructed space to operate lifting equipment).</p>			

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H1.	<u>Access</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
H1.15	Plumbing & Sanitary Provide access panel of minimum 600 x 600 mm for plumbing maintenance.			
H1.16	Provide adequate working space within service shaft to allow access for maintenance.			
H1.17	Waste Management Provide vehicle access to grease traps.			
H1.18	Safety for Maintenance Personnel Provide adequate lightings along access walkways and in M&E rooms.			

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H2. CHOICE OF MATERIALS & FINISHES FOR M&E INSTALLATIONS IN COMMON AREAS, PLANTS AND EQUIPMENT ROOMS

Objectives:

Use suitable materials that are resistant to deterioration and exposure to weather elements and dampness.

H2.	<u>Materials & Finishes</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
H2.1	Use durable (e.g. metalclad) lighting switches and power sockets in M&E rooms			
H2.2	Waterproofing Provide at least IP65 rated power sockets in wet areas (e.g. pantry, water dispenser, toilets, wash area and potential wet areas in M&E rooms).			
H2.3	Sanitary and Rainwater downpipes Provide anti-corrosion material for piping and installations (e.g. UPVC pipes).			
H2.4	Fabric Ducting System Use fabric ducting system for large spaces (e.g. atrium and auditorium) for ease of maintenance and replacement.			

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H3. DESIGN & DETAILING OF M&E INSTALLATIONS IN COMMON AREAS, PLANTS AND EQUIPMENT ROOMS

Objectives:

The design and placement of M&E installations should aim at minimising maintenance interventions and enabling ease of repair and replacement.

H3.	<u>Design & Detailing</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
H3.1	Provisions for Maintenance Provide switch socket outlets (each point to cover a radius of max. 15m) in common areas to allow use of powered equipment for maintenance.			
H3.2	Provide sufficient water points and socket points to facilitate the use of electrical cleaning equipment in washrooms. Socket points should be provided with splash proof covers.			
H3.3	Equip cleaners' store rooms with utilities supply for washing of cleaning tools and equipment, as well as drainage points and splash proof socket points to facilitate the charging of cleaning tools/equipment.			
H3.4	Condensation Treatment Provide condensation treatment to air distribution outlets located in high humid areas			
H3.5	Prefabricated MEP System Adopt prefabricated Mechanical, Electrical, and Plumbing (MEP) systems for more productive replacement and installation.			
H3.6	Labelling Provide labelling and colour coding of piping and conduits consistent with industry standards (e.g. provide directional signs and valve status on pipes for ease of identification).			
H3.7	Provide isolation valves and proper identification to all pipes and ductworks for easy maintenance.			

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H3.	<u>Design & Detailing</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
H3.8	High Volume Spaces Use wall mounted lights and/or suspended lighting systems for rooms with high ceilings (e.g. atria, lecture theatres, reception or lobby areas and stairwells).			
H3.9	Parking Areas Locate electrical services away from voids that are exposed to weather elements.			
H3.10	Avoid locating electrical outlets on columns or walls adjacent to car park lots.			
H3.11	Provide adequate water and power points at appropriate locations (each point to cover a radius of max. 15m) to facilitate washing and cleaning.			
H3.12	Sanitary and Rainwater downpipes Avoid locating sanitary and waste pipe in areas with high pedestrian traffic (e.g. above escalators and within high voids above common staircases, food preparation area and water tank).			
H3.13	Avoid concealing drain pipes in the screed of dry areas.			
H3.14	Manholes Depending on their location, manhole covers should be designed to withstand the required loads. Manholes should be located away from high traffic areas to minimise risk to workers during maintenance.			
H3.15	Where possible, manhole cover / cable trench cover/ grating should be moveable by one person. Where covers are too heavy to be lifted by one person, lifting tools must be provided.			
H3.16	Bin Centre Provide water point and discharge point inside the bin centre for regular cleaning purposes.			
H3.17	Lighting and Ventilation Provide sufficient lighting and ventilation in M&E rooms and risers that houses heat emitting equipment (e.g. electrical panels, IT switches). Provide backup emergency lighting in event of power failure.			
H3.18	Flood Mitigation Provide flood mitigation measures (such as sump pump) for M&E rooms located at basements.			

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H3.	<u>Design & Detailing</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
H3.19	Ductworks/ Pipes across Floor Avoid ductworks/ pipe installations onto M&E room floors to minimise tripping hazards, and damage due to stepping.			
H3.20	Redundancy Systems Shutdown maintenance of M&E installations should not affect building's daily operation. Provide redundancy systems and emergency power for shutdown maintenance.			
H3.21	Provide at least 2 lifts for redundancy to avoid downtime during maintenance.			
H3.22	Lift Motor Room Install lighting switches near entrances of lift motor rooms, preferably within an arm's length, so that the working space can be lit before entering.			
H3.23	Provide a conducive environment for maintenance personnel in the lift motor room (e.g. well ventilated, provision of fans).			
H3.24	Provide a minimum 1m overhang above lift motor room doors to prevent rainwater ingress.			
H3.25	Lift Well Provide 2-way switch for lift well lighting between the lift well and the lift machine room.			
H3.26	Bulky MEP Equipment Provide removable facade with hoisting platform for replacement of bulky MEP equipment if it cannot be transported via service lift.			
H3.27	AHU Provide kerb up washing area with water point and floor trap in AHU rooms for maintenance of the filters. Proper mechanical ventilation in the AHU rooms should be provided for maintenance personnel.			
H3.28	Locate water points at least 1m away from any electrical installations (e.g. control panel) in AHU rooms.			
H3.39	Direct drainage pipe from AHU into the floor trap instead of terminating the pipe above the floor trap to avoid spillage.			

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H3.	<u>Design & Detailing</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
H3.40	Avoid placing AHU/FCU directly above critical equipment (e.g. server rack, electrical panel, etc.).			
H3.41	Provide auxiliary insulated drain pan with insulated drain pipe for ceiling mounted FCU in M&E rooms. The auxiliary installation must not affect proper operation of the FCU (e.g. hindrance to airflow of FCU).			
H3.42	Provide dampers/ vibration isolators to equipment prone to vibration transmittance (e.g. ducted FCU)			
H3.43	Provide suitable waterproofing for AHU rooms.			
H3.44	Chiller Provide auto-tube cleaning system for condenser tube to avoid fouling.			
H3.45	Service Risers Design service risers with adequate width and depth to allow ease of maintenance. (e.g. Minimum width of 600mm should be provided for access to services and components)			
H3.46	Provide handles (recessed typed) for service riser doors			
H3.47	Provide riser doors that can be opened from inside without the need of keys.			
H3.48	Provide load bearing floor in risers that require access by maintenance personnel.			
H3.49	Uninterruptible Power Supply (UPS) Provide by-pass for maintenance of UPS to prevent downtime.			

PART II: DESIGN FOR MAINTAINABILITY GUIDE (NON-RESIDENTIAL)

I. SMART FM

I1.	<u>Digital Readiness and Automation</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
I1.1	Building Management System (BMS) Install appropriate computer-based BMS to control and monitor M&E equipment such as centralised air-conditioning system, ventilation, lighting, power system, fire protection services, plumbing, security system and landscape irrigation system.			
I1.2	BMS should cater to specific operational needs of building instead of comprising generic specifications from the industry.			
I1.3	Use BMS systems which have analytic features such as monitoring, charting and trending reports for optimal maintenance planning.			
I1.4	Include alarm notification options (such as SMS) for buildings not operating 24/7.			
I1.5	Provide remote web-based monitoring.			
I1.6	Provide common (BACnet, Modbus etc.) or non-proprietary protocol for the network backbone of the building management system (BMS). (This will enable standard compliant sensors or equipment to be easily added to the building and be monitored through the BMS)			
I1.7	Use common file formats for automated and scheduled exported data from any chosen data points. (This will enable exchange of data between systems and allow such data to be analysed by analytics or optimisation software readily).			
I1.8	Sensors Place sensors strategically with consideration to access, accuracy and operation.			
I1.9	Sub-metering Divide sub-metering by energy loads and areas. (This will facilitate energy audit, identify maintenance needs and targets to reduce energy use).			

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11.	Digital Readiness and Automation	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
11.10	Building Information Modelling (BIM) Use BIM to facilitate integration of relevant information on facility and asset management and better coordinated documentation for maintenance operations.			
11.11	Adopt comprehensive digital building management through 3D building model integrated with sensors, video analytics and command centre. (e.g. facial recognition, incident reporting, and crowd monitoring etc.)			
11.12	Documentation Prepare adequate documentation to ensure operational continuity from design to maintenance, comprising: <ul style="list-style-type: none"> a. Written description of all the systems operation and control actions to meet the functional requirements of the system, including control strategy and logic diagrams. b. Integration test results of air and hydronic systems and gases (CO & CO₂). c. Network schematic of the BMS network, showing device locations and network addresses. d. Description of BMS point list including user adjustable points (IT/BMS), hard and derived points, and their respective controller and register addresses. e. Instructions manuals and training guides and quick reference procedures/ checklist 			
11.13	Power and Data Provision Provide adequate power and data provisions (LAN cables, Wi-Fi, network switches, server with spare capacity etc.) for future smart FM features.			

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J. SECURITY

J1.	<u>Access and Control</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
J1.1	Locate central control console in areas with 24-hours manning.			
J1.2	Locate the fire command centre (FCC) and security centre to oversee at least one main ingress/ egress point or critical area. Design the FCC such that the operator is able to view all alarm signage from his sitting position instead of having to turn round to see the alarm soundings.			
J1.3	Use turnstile with proximity security access passes.			
J1.4	Remote monitoring/ CCTV Use CCTV surveillance technology with motion sensing alert to reduce security personnel. Provide CCTV surveillance at all common and critical areas including but not limited to: <ul style="list-style-type: none"> • Car park • Lift lobbies • Entries into staircases • Main lobbies • All exits of the building/ car park • Last landing of escape staircase staircases • Loading/unloading area • Essential plants and equipment rooms 			
J1.5	Visitors Management System Use computer-based Visitors Management System to record usage of facilities by specific visitors and provide documentation of visitor's whereabouts.			
J1.6	Natural Surveillance Natural surveillance of a concealed or isolated route should be encouraged. For example, provide external-facing windows or openings for enclosed stairs or ramps such that they are visible from the surrounding properties.			

3. LANDSCAPE

K1. ACCESS FOR LANDSCAPE MAINTENANCE

Objectives:

Provide appropriate access to planters, green walls and other landscaped features to safely and efficiently carry out pruning, maintenance and replacement.

K1.	<u>Access</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
K1.1	<p>Access Route Landscaped areas should have suitable access routes (e.g. pavement, gravel, mulch paths) of adequate width to facilitate maintenance access for workers, equipment and materials.</p>			
K1.2	<p>Vertical Greenery Frontal access to green walls <i>(including its sub-system – such as substrate, drainage, irrigation pipe lines, supporting sub-frames, gratings, etc.)</i></p> <p>For green walls that are less than 2m in height, allow maintenance access from the front via elevated work platforms (e.g. ladder stand platform, mobile tower scaffold, and pole pruner).</p>			
K1.3	<p>For green wall that are more than 2m in height, provide an unobstructed, flat, stable surface of adequate structural capacity in front to allow safe and effective deployment of MEWPs (mobile elevated work platforms).</p> <p>Where the foreground is turfed, the latter should comprise supporting underlayers to withstand the load of MEWPs.</p>			
K1.4	<p>Rear access to green wall <i>(including its sub-system – such as substrate, drainage, irrigation pipe lines, supporting sub-frames, gratings, etc.)</i></p> <p>Provide permanent rear access (e.g. walkways and platforms) with minimally 600mm clear width to all parts of the green wall.</p> <p>The rear access must be designed with edge protection to mitigate risks of fall-from-height.</p>			

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K1.	<u>Access</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
K1.5	Mark and identify all designated access/inspection points for maintaining vertical greeneries.			
K1.6	Growth lights Provide direct access to growth lights so as not to damage the greenery.			
K1.7	Sky Garden Provide adequate access and work space around trees and tall plants.			
K1.8	Large Turfed Surfaces/ Fields Locate large turfed surfaces near fire engine access way (with gates of adequate width, if fenced) to facilitate access of equipment e.g. turf mower.			
K1.9	Irrigation Provide adequate access to irrigation systems for maintenance and replacement. This includes subsurface irrigation systems.			
K1.10	Provide proper access (e.g. pavers, gravel or mulch paths) to sources of water supply.			
K1.11	Water Features Provide safe and direct means of access for maintenance of water features (e.g. lightings in water feature).			
K1.12	Provide adequate and safe access to pump room, balancing tanks and other pump equipment which serves the water features.			
K1.13	Storage Provide adequate storage areas for landscape maintenance equipment and materials.			

PART II: DESIGN FOR MAINTAINABILITY GUIDE (NON-RESIDENTIAL)

K2. CHOICE OF MATERIALS FOR LANDSCAPE

Objectives:

Select appropriate plants species and landscape materials to minimise the frequency of maintenance interventions such as pruning, cleaning and replacement.

K2.	<u>Materials</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
K2.1	<p>Plants selection</p> <p>Select plant species in response to the expected environmental conditions (e.g. choose plants which are appropriate for sunny/ shady areas, waterlogged grounds, high pedestrian footfall areas, elevated edges, sloped terrain, wind conditions etc).</p> <p>Avoid planting fruit trees next to walkways to reduce maintenance due to falling fruits.</p>			
K2.2	<p>For vegetation abutting water features and water bodies, avoid selecting plant species with excessive shedding of leaves and blooms. Accumulated plant debris may end up choking the water systems.</p>			
K2.3	<p>Avoid species with invasive roots system near non-suspended pavement, or for sky gardens and roof-top landscape.</p> <p>Provide root barriers in these areas to prevent them from penetrating into structures, weep holes, drains, and floor traps.</p>			
K2.4	<p>In areas where plant inspection is infrequent and/or cannot be effectively conducted, avoid plants species (e.g. species of bromeliad, alocasia) with thick axils that trap water and require regular monitoring for signs of mosquito breeding.</p>			
K2.5	<p>Plant ferns and hardy ground covers (instead of turf) on sloping grounds to prevent soil erosion and minimise the need of frequent maintenance.</p>			

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K2.	Materials	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
K2.6	Use synthetic turf in areas with high pedestrian traffic or intensive activities (e.g. school fields), as well as areas with difficulty of access (e.g. green islands within pool/ water feature).			
K2.7	<p>Test Plots</p> <p>Prior to skyrise greenery installation, set up plant test plots (mock-up surfaces, etc.) in consultation with skyrise greenery consultants to ascertain the horticulture performance of selected greenery systems and species.</p> <p>The test plots will help to identify suitable species as well as inform building owners/ users on the maintenance needs and strategies.</p>			
K2.8	<p>Water Features</p> <p>Use concealed bracket systems for stone claddings within water features to minimise the occurrence of efflorescence and stains on grouting.</p>			
K2.9	Avoid water features with rough edges and surfaces as they are prone to dirt accumulation and algae growth.			
K2.10	Provide backwash for filters; Coarse screens shall be provided to keep dry leaves and rubbish getting into pump. Precautions to be taken in design to avoid pump overheating due to pump suction being choked with debris.			
K2.11	Provide adequate lighting and ventilation to pump rooms.			

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K3. DESIGN & DETAILING OF LANDSCAPE FEATURES

Objectives:

Provide effective design and detailing to facilitate water drainage as well as to enable safe and ease of maintenance.

K3.	Design & Detailing	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
K3.1	Locate plants with similar water requirement within the same vicinity.			
K3.2	Planters Provide sufficient soil depth for roots to grow. In general, groundcovers and shrubs require soil depths of between 300mm and 500mm, while small and medium trees (mature heights of 8m to 10m) require between 1m and 1.5m soil depth.			
K3.3	Planting on Ground Planting should be carried out directly on ground wherever possible to reduce the use of planter boxes. If located on true ground, the planter boxes should be built on true ground and not on concrete surface to ensure proper drainage.			
K3.4	Un-edged Planting Areas Planting soil should preferably be 50mm lower than unedged planters flushed in level to adjacent hardscape finishes, so as to reduce soil erosion and spillage onto common and public areas. These are applicable to areas such as true-ground planting, sunken e-deck, roof gardens.			
K3.5	Drainage Landscaped footpaths should be at least 50mm higher than the drain for effective drainage. The footpaths should be sloped to fall effectively to the nearest drain.			
K3.6	Ensure runoff from roofs does not fall directly onto landscape areas. Otherwise, provide materials to reduce impact (e.g. gravel).			
K3.7	Provide appropriate drainage outlets for vertical greenery to avoid stains on façade or water ponding at the base of the installation (e.g. use drainage trays at the base of the installation).			

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K3.	Design & Detailing	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
K3.8	Turfs Avoid planting turf right up to the base of trees to minimise the risk of mechanical damage to tree barks during turf mowing.			
K3.9	Avoid having isolated thin strips of turf or small grass patches that require frequent mowing			
K3.10	Grass surface should be at the same level or slightly higher than adjacent hard surfaces (e.g. pavements) to ease turf mowing.			
K3.11	Provide buffer strips (e.g. gravel) between the turfed surfaces and pavements/footpaths to prevent soil erosion and spillage. Sub-soil drainage should be avoided.			
K3.12	Sky Gardens Allow adequate exposure of plants to direct sunlight to avoid etiolation, or leaning of trees beyond the edge of building in search of light.			
K3.13	Where landscape is located near building edges, provide edge protection (e.g. guardrails, life lines or anchor points) to mitigate risk of fall-from-heights.			
K3.14	Trees should be adequately secured to withstand strong wind and mitigate risks of uprooting.			
K3.15	Avoid planting shrubs beyond parapets so that maintenance personnel do not have to lean over the parapet to reach the foliage.			
K3.16	The floor slab should be sloped towards the drainage outlet with silt control system. Waterproofing membrane should be properly installed around the drain opening so that water drains off from the waterproofing membrane to the roof outlet. Plants should not be allowed to grow into guttering.			
K3.17	Provide adequate sources of water supply (e.g. taps) that are separated from the irrigation system in landscape areas.			
K3.18	The finished level of sky gardens should be lower than adjoining indoor threshold to avoid rainwater ingress.			
K3.19	In circumstances where sky gardens finished level is higher than the indoor finished level (e.g. retrofitted roof garden in an existing building), provide up-stand or cut-off drains with adequate capacity to minimise rainwater ingress.			

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K3.	<u>Design & Detailing</u>	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
K3.20	Provide adequate distance between tall plants and lamp posts to avoid damage to the lamp post by the roots.			
K3.21	Waterproofing Provide adequate waterproofing system at landscaped areas and planters. Waterproofing should make to be root resistant and/or alongside a suitable root barrier.			
K3.22	Tree Wells & Gratings Tree well gratings are to be durable and weather-resistant with effective drainage to avoid waterlogging issues. Gratings should be designed to prevent litter from entering the tree well, facilitate inspection access (i.e. designed with moveable modular segments, etc.) to the tree well and cater for installation of tree support system and future tree growth in girth.			
K3.23	Irrigation system Adopt automatic-irrigation systems with rain sensors. Ensure that landscape under sheltered areas remain irrigated even on rainy days.			
K3.24	Where water supply to the irrigation system comes from rain harvesting systems, effective strainers should be provided to prevent blockages and frequent maintenance to the irrigation network.			
K3.25	Water Features Use concealed bracket systems for stone claddings within water features to minimise the occurrence of efflorescence and stains on grouting.			
K3.26	Avoid water features with rough edges and surfaces as they are prone to dirt accumulation and algae growth.			
K3.27	Provide backwash for filters; Coarse screens shall be provided to keep dry leaves and rubbish getting into pump. Precautions to be taken in design to avoid pump overheating due to pump suction being choked with debris.			
K3.28	Provide adequate lighting and ventilation to pump rooms.			

4. Other Good Practices

L.	Design Collaboration	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
L1.	Design Brief Provide a clear design brief for maintenance performance and operations.			
L2.	Collaborate with FM and other stakeholders Engage FM practitioners throughout the planning and design phase for their inputs and review of design drawings and specifications.			
L3.	Collaborate with relevant WSH consultants to review the necessary safety provisions for all areas that require maintenance access.			
L4.	Virtual Reality Conduct virtual walkthrough of the digital building model to identify potential maintenance issue during design.			

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M.	Building Records	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
M1.	Prepare as-built drawings (showing equipment layout, routing of M&E services, concealed services and landscape) and O&M manuals for end-users' future reference and maintenance purposes. These documentations should be regularly updated and kept for record purposes. All maintenance personnel should be made aware of such records. The records are preferably in both hard and soft copies, with proper dates of updating.			

PART III: MAINTENANCE STRATEGY REPORT

N.	Innovation	Y / N / NA	Description of provision <i>(Attach relevant drawings, references, etc. where necessary)</i>	If No or not applicable, please explain
N1.	<p>Self-cleansing Facade Adopt façade materials with self-cleansing properties (e.g. titanium dioxide coating) to reduce the frequency of façade cleaning.</p>			
N2.	<p>Pneumatic Waste Conveyance System (PWCS) Adopt PWCS to improve productivity in refuse collection and disposal. PWCS can be fitted with sensors to monitor waste disposal patterns and volume. The frequency of waste collection can thus be adjusted accordingly.</p> <p>Provide adequate openings to access PWCS pipings, especially when concealed underground.</p>			
N3.	<p>Smart Lighting/Sensor Adopt lighting with sensors to help understand human traffic patterns and optimize/reduce the provision of lighting in low traffic areas. This can help to reduce energy and maintenance.</p>			
N4.	<p>Smart Bin Adopt litter/ compactor bins with sensors to facilitate on demand refuse collector</p>			
N5.	<p>Smart Toilet Adopt autonomous systems with the use of sensors. Sensors can detect, monitor, and feedback any defects or situations (e.g. ammonia, people traffic, lighting levels, abnormal water usage, hand soap, hand towels, toilet paper and litter bins).</p> <p>Data gathered from sensors can use for analytics such as the determination of peak and off-peak usage and forecast cleaning regimes to optimise cleaning crew deployment.</p>			
N6.	<p>Use tiles, basins, urinals and WCs that are infused/coated with anti-stain material or self-cleaning protective coatings (e.g. fluoropolymer coating) to facilitate cleaning efforts and eliminate the problem of tough stains and graffiti.</p>			

PART III: MAINTENANCE STRATEGY REPORT

N7.	Provide anti-odour tiles that are able to address foul smell such as urine spillage on the floor.			
N8.	Digital Pest Control Adopt smart surveillance/ monitoring systems to detect pests (e.g. rodent tracker)			
N9.	Autonomous Cleaning Adopt autonomous cleaning robots. Minimise level changes such as ramps and steps to enable its deployment.			
N10.	Mobile Incident Reporting Management Adopt mobile app based incident reporting to facilitate efficient maintenance.			
N11.	<p>Lift Sensors Monitoring</p> <p>Adopt autonomous systems with the use of sensors. Sensors can detect, monitor and feedback any predictive events and potential breakdowns (e.g. mislevelling of lift car, abnormal travelling speed of lift, abnormal performance of lift door, and condition of lift rope).</p> <p>Data gathered from sensors can be used for analytics such as determination of usages of lifts and forecast the necessary maintenance regimes.</p> <p>Lift mechanics can be dispatched effectively to rectify the abnormality, and prevent any faulty lift incidents). This can also be extended to escalators</p>			

PART III: MAINTENANCE STRATEGY REPORT

Maintenance Strategy Report

It is important to ensure that all parties understand future maintenance obligations before the building has been constructed. Notwithstanding the recommendations in the Design for Maintainability Guide, designers are advised to prepare a Maintenance Strategy Report at the early stage of the design process to document their maintenance philosophy and operational assumptions.

Report Content

In the Maintenance Strategy Report, designers should state their proposed maintenance strategies which typically include, but not limited to the following:

- unique requirements of the project
- areas requiring maintenance access (including spatial and structural requirements, etc.)
- anticipated maintenance tasks and frequency
- particular materials/ equipment that have specific maintenance requirements
- proposed/ assumed maintenance methodology (equipment, methods, etc.)
- maintenance activities that create specific risks and/or safety issues to maintenance personnel and building users

The report is not intended to be a voluminous paperwork. Information provided in the report should be clear, concise and in a format (e.g. design notes, drawings, tables, charts and written information - see example below) suitable for parties involved in constructing the building, operating the premises or carrying out maintenance works.

Consultation with Stakeholders

In developing the Maintenance Strategy Report, designers should consult relevant stakeholders such as building managers, maintenance contractors and end-users who can advise on the safe, appropriate and cost-effective solutions. The consultative process will ensure that the proposed maintenance methodology is coherent with the future maintenance regime and that all stakeholders are made aware and amenable to the strategy.

Updates and Handing Over

Updates should be made to the report to document the revisions made and eventual maintenance strategies adopted during the design development and construction phases.

Upon construction completion, the Maintenance Strategy Report should be handed to the building owner/ manager and used as a reference for contractors undertaking the maintenance work.

Example

A sample of a proposed maintenance strategy for façade cleaning:

A. EXTERNAL AREAS						
	Building Area/ Element	Routine Maintenance	Major Maintenance	Solution		Comments
1	Tower Block - Façade curtain wall <ul style="list-style-type: none"> • Full height from ground level to roof • All elevations including recesses and protrusions 	<ul style="list-style-type: none"> • Façade cleaning and inspection 	<ul style="list-style-type: none"> • Glass replacement • Curtain wall repairs • Façade lighting repairs 	<ul style="list-style-type: none"> • Routine maintenance • Major maintenance 	A	<ul style="list-style-type: none"> • Permanent suspended platform with monorail system to access all façade surfaces • Integrated restraints in façade system
2	Tower Block – External planters	<ul style="list-style-type: none"> • Routine inspection and cleaning • Planting, pruning and fertilising 	<ul style="list-style-type: none"> • Plant/ soil replacement • Drainage/ irrigation repairs 	<ul style="list-style-type: none"> • Routine maintenance • Major maintenance 	A	<ul style="list-style-type: none"> • Permanent suspended platform with monorail system to access all planters • Integrated restraints in façade system • Protection rail for hanging planters
4	Tower Block - Entrance glass canopy <ul style="list-style-type: none"> • Top and underside including structural element 	<ul style="list-style-type: none"> • Cleaning • Luminaire replacement 	<ul style="list-style-type: none"> • Glass replacement • Building services repair (drainage, electrical, etc) 	<ul style="list-style-type: none"> • Routine maintenance • Major maintenance 	B	<ul style="list-style-type: none"> • Access using self-propelled access platform • Accessible via paved fire engine access • Fall arrest system provided on surface of canopy
5	Covered walkways	<ul style="list-style-type: none"> • Cleaning 	<ul style="list-style-type: none"> • Cladding repairs • Building services repair (drainage, electrical, etc) 	<ul style="list-style-type: none"> • Routine maintenance • Major maintenance 	C	<ul style="list-style-type: none"> • Accessible via ground level walkway • Fall arrest system provided on surface of canopies
B. INTERNAL AREAS						
	Building Area/ Element	Routine Maintenance	Major Maintenance	Solution		Comments
6	Atrium	<ul style="list-style-type: none"> • Glass cleaning • Cleaning shading devices • Luminaire replacement 	<ul style="list-style-type: none"> • Glass repair/ replacement • Ceiling/ shading devices repair • Building services repair 	<ul style="list-style-type: none"> • Routine maintenance • Major maintenance 	D	<ul style="list-style-type: none"> • Personnel lifting hoists for suspended platforms

Legend

Solution A –Suspended platform with monorail system (see details in Annex 1)

Solution B – Self-propelled access platform (see details in Annex 2)

Solution C – Rope access (see details in Annex 3)

Solution D – Personnel lifting hoists (see details in Annex 4)

References

Source	References
BCA	Approved Document BIM Guide for Asset Information Delivery Code on Accessibility in the Built Environment Façade Access Design Guide
LTA	Architectural Design Criteria Architectural Materials and Workmanship Specifications Civil Design Criteria Code of Practice on Street Works Proposals Relating to Development Works Materials and Workmanship Specifications Standard Details of Road Elements
MOM	WSH (Design for Safety) Regulations
NEA	Code of Practice on Environmental Health (2017 edition)
NParks	Guidelines on Greenery Provision and Tree Conservation for Developments Landscape Design Guidelines for Productive Maintenance
NParks (CUGE)	Guidelines on Design for Safety of Skyrise Greenery Selecting Resistant Species and Varieties for the Control of Pests and Diseases Sustainable Landscape
PUB	Code of Practice on Sewerage and Sanitary Works Code of Practice on Surface Water Drainage

Source	References for Codes and Standards for access systems
British Standards	<p>BS EN 795 Personal fall protection equipment – Anchor devices</p> <p>BS EN 1808 Safety requirements for suspended access equipment</p> <p>BS 6037-1 Code of practice for the planning, design, installation and use of permanently installed access equipment – Suspended Access Equipment</p> <p>BS 6037-2 Code of practice for the planning, design, installation and use of permanently installed access equipment – Travelling ladders and gantries</p>
Enterprise Singapore	<p>SS 528 Specification for Personal fall-arrest systems</p> <p>SS 607 Specification for design of active fall-protection systems</p> <p>SS 588-1 Personal equipment for protection against falls – Rope access systems – Part 1</p> <p>SS 588-2 Personal equipment for protection against falls – Rope access systems – Part 2</p> <p>SS 598 Code of practice for suspended scaffolds</p> <p>SS 616 Code of practice for safe use of mobile elevating work platforms</p> <p>SS 617 Code of practice for the lifting of persons in work platforms suspended from cranes</p>

Acknowledgements

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Public Sector agencies

Building and Construction Authority (Co-chair)

Housing & Development Board (Co-chair)

Infocomm Media Development Authority

JTC Corporation

National Environment Agency

National Parks Board

Industry stakeholders

City Developments Limited

CBRE Singapore

ISS Facility Services Pte Ltd

International Facility Management Association, Singapore Chapter

MOH Holdings Pte Ltd

Singapore Institute of Architects