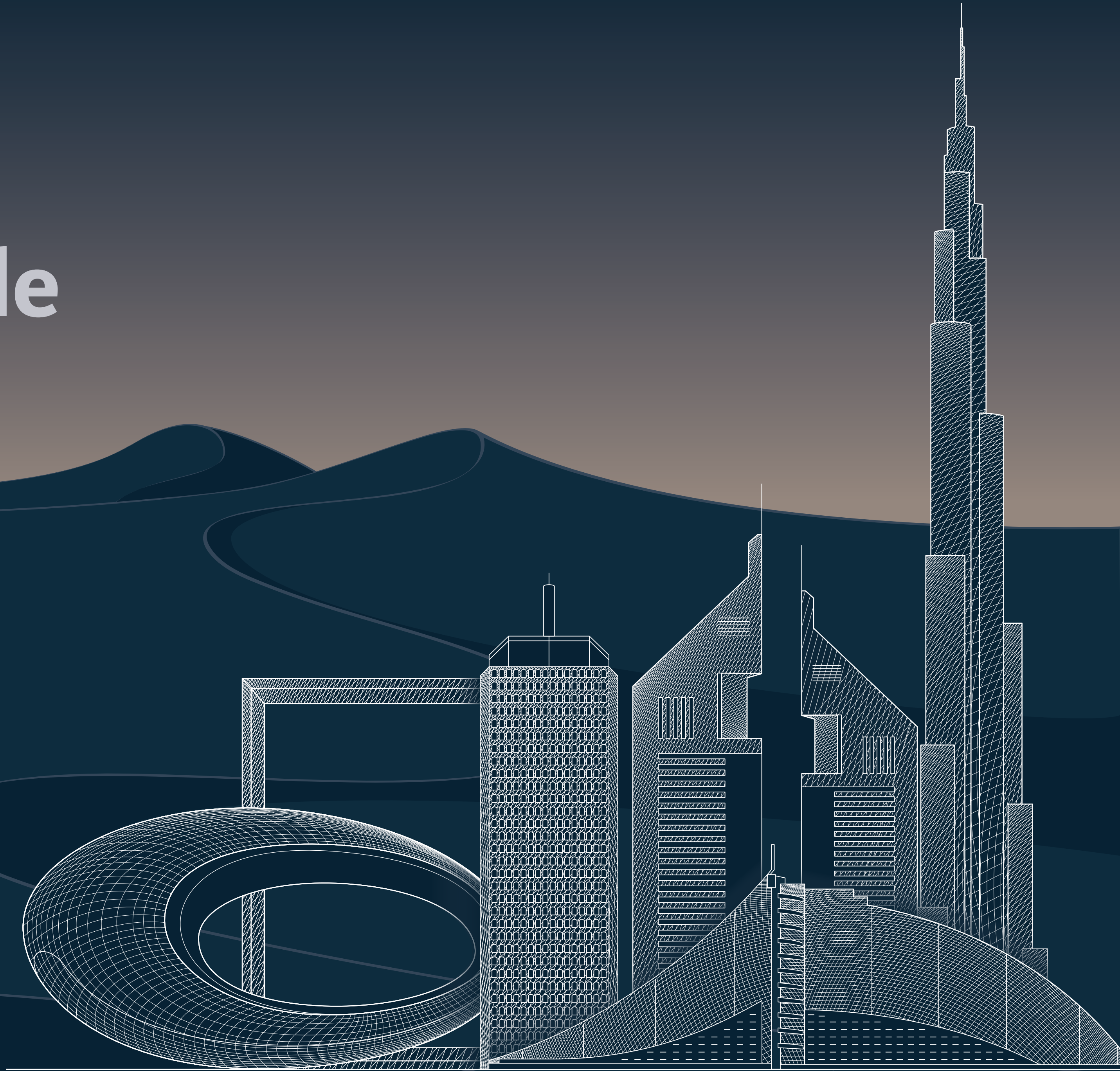
GOVERNMENT OF DUBAI

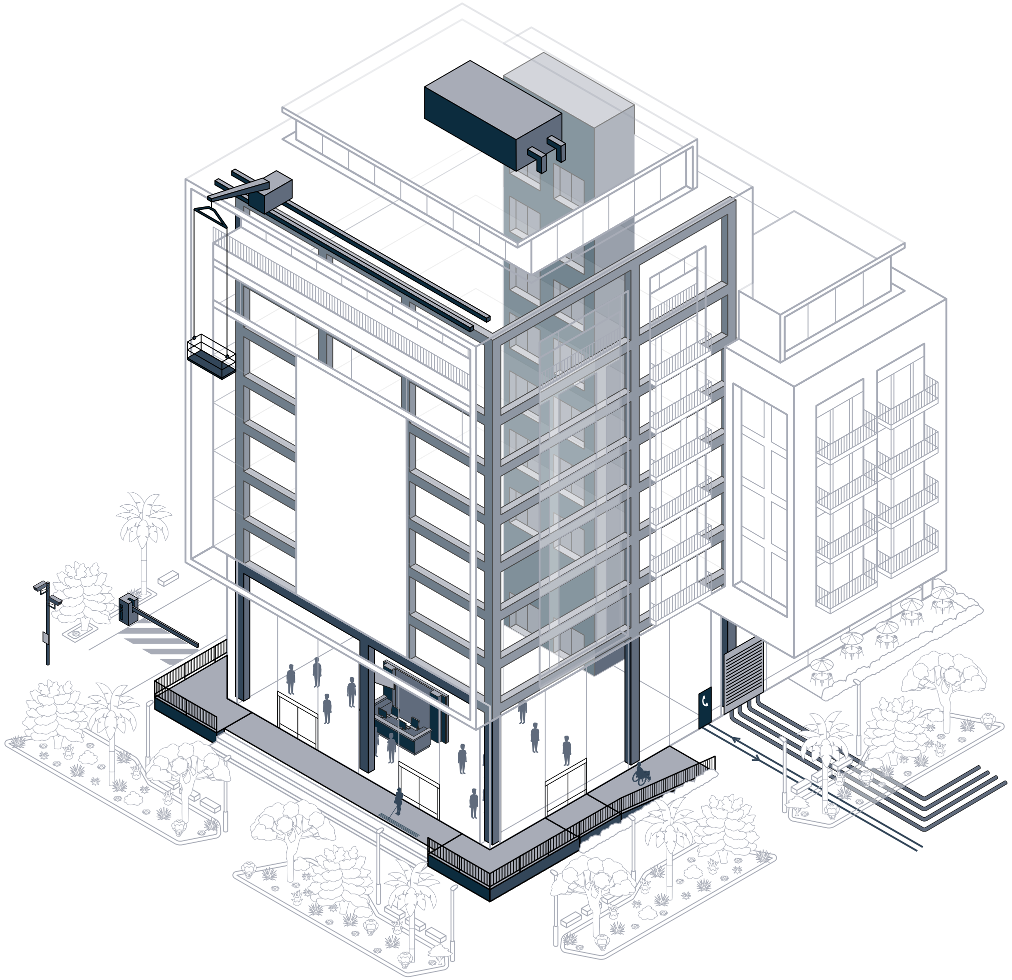
Dubai Building Code

2021 Edition



Contents

Part A
General



A.1 Introduction

The objective of the Dubai Building Code (DBC) is to unify building design across Dubai, and to create a building code that is easy to use and clearly mandates the minimum requirements for:

a) the health, safety, welfare and convenience of people in and around buildings;
b) the health, safety, welfare and convenience of people who might be affected by buildings;
c) building design to reduce the impact on the surrounding environment; and
d) the sustainable development of buildings.

The content of the DBC is based on the following inputs:

1) existing regulations and technical requirements produced by the various Authorities and Service Providers;
2) interviews with Government Authorities, Service Providers, Master Developers, Consultants and other stakeholders to understand gaps or inconsistencies between existing regulations;
3) benchmarking to international and regional codes.

The DBC is arranged under themes to integrate all relevant elements of building design.

The regulations stipulated in the DBC are the minimum requirements for building design. Nothing in the DBC prevents a building design that achieves higher standards than the minimum set out in the DBC.

A.2 Definitions

NOTE: This section gives common definitions that apply throughout the DBC. Each Part also has a section for terms specific to that Part.

A.2.1 Terms

Addition: Increase to a building's gross area or built-up area, and/or height or depth.

Architect: Physical or legal person in charge of designing or supervising building works, or both, and licensed to practise the architecture profession in Dubai in accordance with the applicable legislation.

Authority: Any ministry, department, entity, or federal or local government institution in Dubai or any department in licensing Authorities related to the implementation and the provisions of the DBC.

Building lifecycle: Series of stages through which a building passes during its lifetime, from initial design, through construction, commissioning, handover, and operation, to final demolition and recycling of demolished materials/systems.

Built-up area: Total constructed area in a building or structure measured from the external walls of the building, inclusive of balconies, terraces and other projections, as well as any other covered spaces such as covered parking structures, circulation corridors, loading/unloading bays, basements, service floors, indoor swimming pools and any other permanent structures on the plot.

Building: Structure for the use or occupancy of people or for shelter.

Change of use: Alteration to the use of a building to accommodate an alternative occupancy to that which it was originally designed.

Civil Engineer: Physical or legal person in charge of designing or supervising civil engineering works, or both, and licensed to practise the engineering profession in Dubai in accordance with the applicable legislation.

Consultant: Physical or legal person in charge of providing consulting advice during design or construction, or both and licensed to practise consulting in Dubai in accordance with the applicable legislation.

Contractor: Physical or legal person in charge of carrying out construction works and licensed to practise contracting activities in Dubai in accordance with the applicable legislation.

Developer: Person or entity who prepares land for building sites, constructs buildings, creates residential subdivisions or private enterprises, and rehabilitates existing buildings.

Development: General term for the construction, erection or placing of a building or structure; the making of an addition or alteration to a building or structure; a significant change in use or in intensity of use of any building or structure.

Development control regulations (DCR): Document that shows planning regulations (such as height, land use, area, setbacks, building lines) for the full development, and each plot in a subdivision plan, as issued by the relevant planning Authority or master developer.

Engineer: Physical or legal person in charge of designing or supervising construction works, or both, and licensed to practise the engineering profession in Dubai in accordance with the applicable legislation.

Existing building: Building that is completed, including commissioning and handover. The DBC applies to renovation, modification, reconstruction, addition to, or change of use of an existing building.

Floor area ratio (FAR): Ratio of gross floor area (GFA) to plot area.

Gross area (GA): Floor area within the inside perimeter of the exterior walls of a building. The measurement excludes shafts and courtyards, but includes corridors, stairways, ramps, closets, base of atria (or similar voids) and the thickness of interior walls, columns or other features.

Gross floor area (GFA): Measurement used by Planning Authorities in Dubai to define the floor area ratio (FAR), where FAR is the ratio of GFA to plot area. The building GFA is the sum of the GFA of all floors, measured to the exterior surface of the external wall thickness and from the centrelines of the common walls joining two spaces. The measurement excludes external wall features such as corniches, brackets, and façade cladding materials.

Habitable space: Space in a building for living, sleeping or eating involving occupancy for continuous period of time. Bathrooms, toilet rooms, closets, halls, storage or utility spaces and similar areas are not habitable spaces.

Heritage building: New or existing building in a heritage area. The heritage department of the Authority controls the elevation design and façade treatment of buildings in these areas.

Historical building: Existing building of historical importance where the original character of the building is to be retained.

Masterplan: Comprehensive plan to guide the long-term physical development of a specific area based on identified objectives, strategies, and timelines for implementation. Includes plans for land use, community facilities and utilities, transportation of goods and people, and energy use and conservation. Zoning ordinances and policies are developed for different areas or zoning districts based on the masterplan.

Modification: Fit-out of a space or unit, or change to a service system or building element.

Net area (NA): Actual occupied area, not including unoccupied accessory areas such as corridors, stairways, ramps, toilet rooms, mechanical rooms and closets.

Occupiable space: Room or enclosed space designed for human occupancy in which individuals congregate for amusement, labour, educational or similar purposes.

Owner: Any person, entity, firm or corporation having any legal or equitable interest in the property in whose name the plot or building is registered as Owner, including persons who have a long-term lease for a specified period; the Main or Sub-Developer in relation to unsold lands and buildings.

Performance-based design: Design that follows prescriptive design requirements, but an aspect(s) of which is based on an alternative solution that is equivalent to or better than the prescriptive design requirements.

Plot: Area of land that is:

a) clearly defined (by landmarks, coordinates, distinct number, and the lengths of its sides and location);

a) intended for construction under any approved plan or division project, or by any other method; and

a) legally authorized to be used for construction or building as one unit.

Plot area: Total area of a plot between its boundary lines as measured on a horizontal plane.

Prescriptive design: Design that meets the requirements entirely.

Project: Construction of a permanent building, or any other civil work on a leased property including any modifications or installations in pre-built facilities.

Reconstruction: Modification that is not standalone. It affects adjacent egress routes or systems that are not part of the reconstructed area, such that a larger part of the building might need to be closed down or not occupied for a period of time.

Renovation: Change to linings/finishes or strengthening of structure. It does not involve any reconfiguration of internal spaces.

Townhouse: Multiple villas connected by one or more walls to a series of similar villas.

Villa: Separate building located on a separate plot allocated with all its floors for the dwelling of one single family and an independent car parking space in addition to independent external open space.

A.3 References

NOTE: This section gives references that apply throughout the DBC. Each Part also has a section for references specific to that Part.

Ref. A.1 UAE MINISTRY OF THE INTERIOR GENERAL COMMAND OF CIVIL DEFENCE, 2018. UAE Fire and Life Safety Code of Practice (UAE FLSC). United Arab Emirates: Ministry of the Interior General Command of Civil Defence.

Ref. A.2 GOVERNMENT OF DUBAI, 2017. Dubai universal design code. Dubai: Government of Dubai.

Ref. A.3 DUBAI HEALTH AUTHORITY, 2012. Regulations (various). Dubai: Dubai Health Authority. Available at: www.dha.gov.ae/en/HealthRegulation/Pages/FacilityRelated.aspx.

Ref. A.4 DUBAI HEALTH AUTHORITY, 2019. DHA Health facility guidelines – Part A to Part F. Dubai: Dubai Health Authority. Available at: www.dubaitourism.gov.ae/en/services.

Ref. A.5 DEPARTMENT OF TOURISM AND COMMERCE MARKETING, 2019. DTCM Hotel classification criteria for hotels, guest houses and hotel apartments. Dubai: DTCM. Available at: classification.dubaitourism.ae.

Ref. A.6 DUBAI CIVIL AVIATION AUTHORITY Application for a no-objection certificate to construct a building (above and below 300 m) in Aviation Easement areas. Dubai: DCAA. Available at: www.dcaa.gov.ae/services/building-constructions/construct-building.

Ref. A.7 GREAT BRITAIN, 2015. The Construction (Design and Management) Regulations. London: The Stationery Office.

A.3.1 Acronyms and abbreviations

ASCE	American Society of Civil Engineers
BIM	building information modelling
BS EN	British Standard European Norm
Ch.	chapter
DTCM	Department of Tourism and Commerce Marketing
DBC	Dubai Building Code
DCAA	Dubai Civil Aviation Authority
DCR	Development Control Regulations
DDA	Dubai Development Authority
DEWA	Dubai Electricity and Water Authority
DHA	Dubai Health Authority
DM	Dubai Municipality
DLTM	Dubai Local Transverse Mercator
DSOA	Dubai Silicon Oasis Authority
Emicool	Emirates District Cooling LLC
Empower	Emirates Central Cooling Systems Corporation
FAR	floor area ratio
G	ground floor
GA	gross area
GFA	gross floor area
IACAD	Islamic Affairs and Charitable Activities Department
KHDA	Knowledge and Human Development Authority
MEP	mechanical, electrical and plumbing
NA	net area
RTA	Roads and Transport Authority
SI	International system of units
SIRA	Security Industry Regulatory Agency
TRA	Telecommunications Regulatory Authority
Trakhees	Department of Planning and Development – Ports Customs and Freezone Corporation
UAE FLSC	UAE Fire and Life Safety Code of Practice

A.3.2 Verbal forms used within the DBC

May	The associated text is permitted
Shall	The associated text is mandatory
Should	The associated text is recommended

A.4 Relationship of DBC to other local and international regulations

A.4.1 Local regulations

The DBC incorporates, unifies and replaces the regulations related to building design published by Dubai Municipality (DM), Dubai Development Authority (DDA), Department of Planning and Development – Ports Customs and Freezone Corporation (Trakhees) and Dubai Silicon Oasis Authority (DSOA).

Regulations related to building design by Dubai Electricity and Water Authority (DEWA) and Islamic Affairs and Charitable Activities Department (IACAD) are incorporated or cross-referenced by the DBC.

Regulations related to building design by the Security Industry Regulatory Agency (SIRA) are summarized and cross-referenced in Part J.

Federal regulations also remain in place. The DBC follows the Federal regulations of Telecommunications Regulatory Authority (TRA) and the Ministry of Interior Civil Defence. The TRA regulations are given in G.11. The UAE Fire and Life Safety Code (UAE FLSC) **[Ref. A.1]** is cross-referenced throughout the DBC.

Accessibility requirements of the Dubai Universal Design Code **[Ref. A.2]** applicable to building design are incorporated in Part C and replace these aspects of the Dubai Universal Design Code.

The Dubai Health Authority (DHA) regulations **[Ref. A.3 and Ref. A.4]**, along with the relevant Federal regulations, shall be followed for the design of all healthcare facilities.

The Department of Tourism and Commerce Marketing (DTCM) sets out the requirements to achieve star ratings for hotels, resorts, hotel apartments and guest houses **[Ref. A.5]**. Achieving the minimum requirements of the DBC does not guarantee a rating from DTCM. DTCM should be consulted at the earliest stage of design.

The Knowledge and Human Development Authority (KHDA) and the Ministry of Education both license education facilities, but they do not provide separate design requirements. Education facilities are approved by the main Authorities in accordance with the DBC.

Roads and Transport Authority (RTA) regulations in relation to the right of way are referenced by the DBC as appropriate.

Dubai Civil Aviation Authority (DCAA) regulates maximum building heights within the flight path.

Regulations related to permitting, procedures, construction and design of non-building elements such as infrastructure, transportation systems, and the public realm remain, and can be obtained from, the relevant Authority.

Planning development regulations published by Developers or Planning Authorities are not replaced by the DBC. The DBC contains planning regulations in Part B, but these shall be followed only where plot-specific planning development regulations are unavailable.

A.4.2 International codes and standards

The DBC relies on international codes and standards, mainly BS EN and American codes. These codes and standards shall be used in their latest edition except where the DBC lists an edition.

NOTE: As an example, Part F (Structures) mandates the 2016 edition of ASCE/SEI 7.

An edition is mandated in the DBC for one of two reasons.

a) The DBC refers to sections, tables and figures within that version of the international code or standard and therefore the cross-references might not apply to later editions.
b) The edition has been reviewed for its applicability to Dubai.

A.4.3 Hierarchy of codes and standards

The hierarchy of the adopted codes and standards is defined as follows.

a) The DBC and UAE Fire and Life Safety Code of Practice (UAE FLSC) **[Ref. A.1]** together form the main regulations for building design in Dubai. The UAE FLSC is referenced throughout the DBC.
b) The DBC follows the SIRA regulations for the design of security. These regulations are summarized and referenced in **Part J**.
c) The DBC follows the Federal regulations of TRA for the design of telecommunications. These regulations are documented in **G.11**.
d) The international codes and standards for design, material and product specification listed under the heading of "Essential references" in each Part, and referenced in the relevant sections of each Part, are also requirements of the DBC.
e) Documents listed under the heading of "Further reading" in each Part are provided for information as useful guides to building design.

Where there is conflict between the DBC and reference model codes or standards, the most restrictive/highest performance requirements shall be met.

Where there is a conflict between a general requirement and a specific requirement of the DBC or its referenced codes/standards then the specific requirement applies.

A.4.4 Safe by design

The principle of "safe by design" requires the Consultant to address the health and safety of all occupants, Contractors and users of the building. This includes Contractors, maintenance staff, occupants, visitors and demolition teams throughout the building lifecycle.

This process is documented in a risk register where the Consultant acknowledges the risk, investigates mitigation measures and provides a design solution which reduces the risk to a practicable level, while also taking account of cost, constructability, other project goals, etc.

Safe by design principles are not mandated by the first edition of the DBC, but are likely to be enforced in future revisions. Consultants should familiarize themselves with these principles by reference to the Construction Design and Management Regulations **[Ref. A.7]**.

A.5 Scope and application of the DBC

A.5.1 General

The DBC applies to new buildings and changes to existing buildings as described in Table A.1, except where an alternative solution is permitted (see A.8).

Change to an existing building	Description	Applicable codes
Renovation	Change to linings/finishes or strengthening of structure. It does not involve any reconfiguration of internal spaces.	DBC and UAE FLSC **[Ref. A.1]** apply to interior finish changes or building envelope changes.
Modification	Fit-out of a space/unit, or change to a service system or building element.	DBC and UAE FLSC **[Ref. A.1]** apply to the fit-out or change.
Reconstruction	Modification that is not stand-alone. It affects adjacent egress routes or systems that are not part of the reconstruction area such that a larger part of the building might need to be closed down or not occupied for a period of time.	DBC and UAE FLSC **[Ref. A.1]** apply to the reconstruction and any areas of the building which are impacted by the reconstruction.
Change of use	Change of use or occupancy of part or all of the building.	DBC and UAE FLSC **[Ref. A.1]** apply to the change of use and any areas of the building which are impacted by the change of use, e.g. existing exit stairs and routes, vertical transport, quantity and type of sanitary provisions.
Addition	An increase in the building's gross area or built-up area, and/or height or depth.	DBC and UAE FLSC **[Ref. A.1]** apply to the addition. If the addition relies on the remainder of the existing building for escape, vertical transport, etc., the existing building shall also be assessed against the DBC and UAE FLSC **[Ref. A.1]**.

Table A.1 Existing building and application of the DBC

The DBC applies to the occupancies and use types described in Table A.2.

Occupancy	Use
Assembly	Amusement park, theatre, cinema, restaurant, museum, art gallery, place of worship, library, exhibition and conference centre, etc.
Business	Office, professional services, government centre, post office, bank, etc.
Educational	University, college, school, kindergarten, nursery, educational institute
Hotel establishment	Hotel, resort, guesthouse, hotel apartment
Residential	Apartment, studio, student accommodation, labour accommodation, staff accommodation Villas and townhouses
Parking	Open, enclosed, mechanical
Retail	Shopping centre, department store, shop, kiosk, showroom, stores
Mall	Open mall, enclosed mall
Industrial	Factory, workshop
Storage	Warehouse

Table A.2 Occupancies and use types

The DBC does not apply to:

a) infrastructure such as road and rail bridges, tunnels, culverts, metro stations, hydraulic structures, buried and overhead utilities, power stations, antennas and masts, wind turbines and nuclear facilities;
b) marine structures such as canals, dams, dikes, levies, piers, jetties and wharves;
c) oil and gas structures such as petrochemical facilities, oil refineries, liquefied natural gas terminals, oil platforms and tanks;
d) structures such as tents, cranes, storage racks, scaffolding, formwork and falsework;
e) structures subject to specific loading conditions such as stadia, grandstands, silos and chimneys.

The DBC does not apply to historical buildings where the original character of the building is to be retained. Buildings considered to be historical shall conform to the guidelines of the relevant Authority as appropriate.

Buildings in heritage areas or considered to be heritage buildings shall follow the DBC. The heritage department of the Authority controls the elevation design and façade treatment.

Villas and townhouses are addressed in Part K.

A.5.2 Floor area and building height definitions in DBC

A.5.2.1 Gross floor area (GFA)

Gross floor area (GFA) is used by Planning Authorities in Dubai to define the floor area ratio (FAR), where FAR is the ratio of GFA to plot area. The building GFA is the sum of the GFA of all floors, measured to the exterior surface of the external wall thickness and from the centrelines of the common walls joining two spaces. The measurement excludes external wall features such as corniches, brackets, and façade cladding materials.

GFA is calculated based on Table A.3.

GFA might be in development control regulations (DCR). Consultants shall calculate GFA using the DBC definition and Table A.1 unless GFA is stated in the DCR.

Space or area	Included or excluded in GFA
Habitable and occupiable spaces including sanitary facilities	Included
Mezzanine floors	Included
Lobbies	Included
Corridors	Included
Stairs	Included
Basements in buildings other than villas	Habitable and occupiable spaces including sanitary facilities to be included
Basements in villas	Excluded
Attic spaces	Attic spaces less than 2.15 m height and used for services only to be excluded
Parking	Excluded
Parking lobbies	Excluded
Internal roads	Excluded
Loading areas	Excluded
Mechanical and service rooms	Excluded
Mechanical ducts	Excluded
Elevator shaft at elevator recall floor	Included
Elevator shafts at other floors	Excluded
Elevator machine rooms	Excluded
Mechanical, electrical and plumbing plant floors	Excluded
Shafts	Excluded
Refuse chutes	Excluded
Waste rooms	Excluded
Storage below ground	Excluded
Storage on ground and above	Included
Prayer room and ablution area	Excluded
Gym with gross area ≤50% of roof area	Excluded
Gym with gross area >50% of roof area	The gross area of the gym exceeding 50% is included*
Swimming pools (indoor and outdoor) including services (showers, toilets, lockers, changing rooms, etc.)	Excluded
Arcades (open, non-air conditioned)	Excluded
Base of double height volumes and atria	Included
Void of double height floors and atria	Excluded
Floor voids	Excluded
Terraces	Excluded
Balconies	Excluded
NOTE: * This rule is associated with the roof area but it applies to gyms located anywhere in the building.	

Table A.3 Areas included in GFA

A.5.2.2 Built-up area

Built-up area is used also by Planning Authorities. It is defined as the total constructed area in a building or structure measured from the external walls of the building, inclusive of balconies, terraces and other projections as well as any other covered spaces such as covered parking structures, circulation corridors, loading/unloading bays, basements, service floors, indoor swimming pools and any other permanent structures on the plot. Calculation of total built-up area shall exclude the following:

a) shafts, courtyards and yards including mechanical, electrical and plumbing (MEP) shafts, refuse chutes and similar;

b) non-covered outdoor landscape and hardscape surfaces and courtyards;

c) lightweight outdoor shading structures such as pergolas and standalone canopies.

An example calculation using a sample plan is shown in Figure A.1.

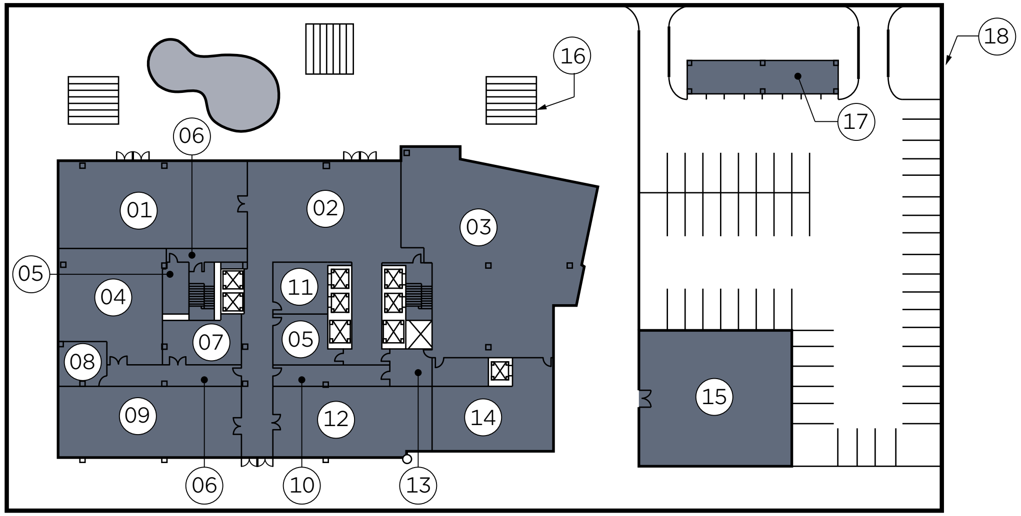


Figure A.1 Total built-up area (highlighted areas are included in area definition)

Key

01: Gym
02: Lobby
03: Ballroom
04: Prayer room
05: MEP
06: Corridor
07: Staff toilets
08: Staff
09: Meeting room
10: Service corridor
11: Electrical
12: Restaurant
13: Back-of-house
14: Kitchen
15: Service block
16: Pergolas
17: Parking canopy
18: Plot limit

A.5.2.3 Gross area and net area

The terms “gross area” (GA) and “net area” (NA) are used by the DBC to calculate occupant load in a floor or space. They are defined in A.2 and further described and illustrated in **Part B**.

A.5.2.4 Building height

Building height is a key variable that is checked by the Authorities for compliance with the DBC, DCR/affection plans, UAE FLSC **[Ref. A.1]** and, where applicable, DCAA restrictions on building heights located in Aviation easement areas due to overhead flight paths.

Each definition of building height is slightly different as they are used to regulate different issues. For this reason, Consultants shall check building height against the DBC, DCR/affection plans, UAE FLSC **[Ref. A.1]** and, where applicable, DCAA regulations **[Ref. A.6]**.

A.6 Navigating the DBC

A.6.1 Division into Parts

The DBC is divided into Parts as described in Figure A.2. Each Part is subdivided into sections by topic.

Minimum requirements for sustainability are embedded within the relevant Parts of the DBC. Developers and Consultants are encouraged to apply the rating system adopted by the relevant Authority to assess their projects and exceed these minimum requirements.

Fire safety requirements are given in the relevant Parts of the DBC and cross referenced to UAE FLSC [Ref. A.1]. The aim of this cross-referencing is to help Consultants navigate and coordinate the requirements of the two documents. Where an element of UAE FLSC is not applicable in Dubai, or the DBC contains additional information not in UAE FLSC, this is indicated in the text.

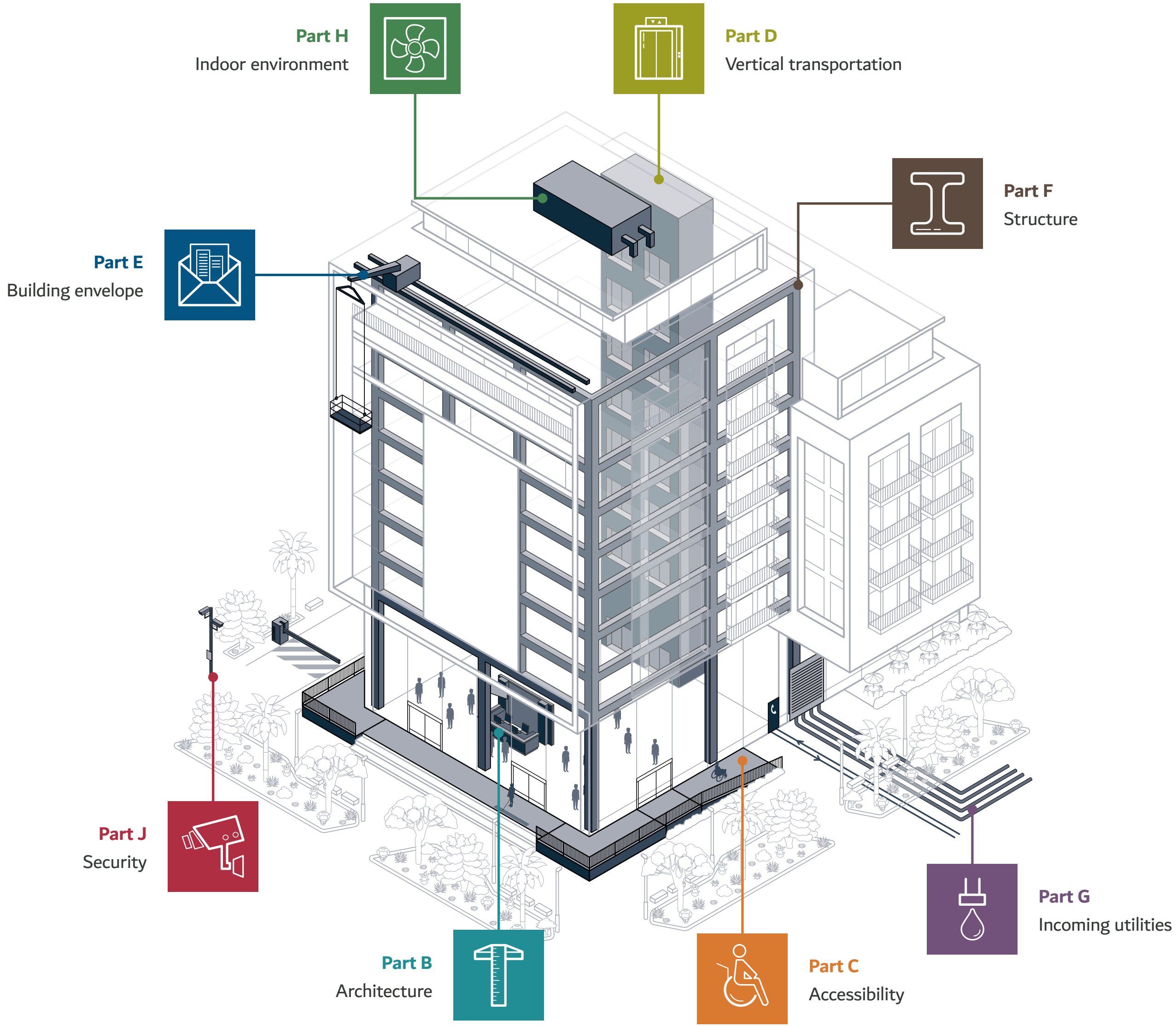


Figure A.2 How to use and navigate the DBC

A.6.2 Performance statements

The overarching objectives of the DBC, its intention and regulatory scope, are set out in A.1.

Each Part of the DBC starts with a set of performance statements. These set out the broad outcomes that the completed building is expected to achieve, and are provided to explain the intent of the prescriptive design requirements within the Part. If the prescriptive design requirements of the Part are followed, then the performance statements of the Part are deemed to be met and will be accepted by the Authority.

A.6.3 References

Each Part has a section for essential references and further reading. The requirements of the DBC and the essential references form the prescriptive design requirements of the DBC and will be enforced by the Authority. Websites and webpages shall be checked regularly for updates.

NOTE: Where websites and webpages have been cited throughout the DBC, they are provided for ease of reference and are correct at the time of publication. Changes to the location of a webpage or website, or its contents, cannot be guaranteed.

A.6.4 Definitions

In addition to the common definitions in A.2, each Part has a section for definitions.

A.6.5 Annexes

Any annex material is included at the end of the Part to which it relates. Annex material contains further explanatory material.

A.7 Adoption of DBC

Projects in design or construction that have a final approved design from the Authority do not need to conform to the DBC.

Projects in design without a final approved design shall conform to the DBC. The requirements of the DBC are based on regulations enforced prior to its publication and in many instances the DBC is less stringent. For example, requirements unrelated to health, safety, welfare and environment have generally been removed from the regulations. Therefore, it is expected that there will be benefits to Developers and Owners in adopting the DBC.

A.8 Alternative solutions

The DBC is intended to be a prescriptive design code. Performance statements are provided at the start of each Part to describe the outcomes that the completed building is expected to achieve.

The performance statements form a set of overarching regulations that convey the requirements of the DBC (see A.6.2).

The preferred method of meeting the performance statements of the DBC is to follow the prescriptive design requirements in each Part.

The inclusion of performance statements sets out the intent of the DBC and future-proofs it, supporting a possible transition to a more performance-based regulatory system in the future.

Alternative solutions which meet the performance statements of the DBC are permitted:

a) for projects that cannot reasonably meet the prescribed requirements; and
b) for changes to existing buildings where the requirements of the DBC would result in a disproportionate cost to the Owner/Developer.

The Authority will decide if an alternative solution is permitted.

An alternative solution shall meet the intent of the performance statements and provide at least an equivalent level of performance to all of the prescriptive design requirements.

Alternative solutions shall be applied to a performance-based design holistically such that a change from one Part of the DBC does not reduce the building's performance in other aspects.

Alternative solutions for changes to existing buildings shall demonstrate that the existing conditions are maintained to the current level of compliance or improved to meet the safety levels of the DBC and UAE FLSC **[Ref. A.1]**.

The Authority will decide whether or not a performance-based design is equivalent to the prescriptive design requirements. The responsibility is on the Consultant to demonstrate that the performance-based design is required and that it is at least equivalent to the prescriptive design requirements.

The DBC lists preferred international codes and standards in each Part (see A.4.2). Where permitted by the Authority, alternative standards can be used provided that the comparable standard meets the intent of the DBC.

A.9 Maintenance of DBC

A.9.1 General

The DBC is an interactive document available electronically.

The DBC will typically be maintained and updated on a two- to three-year cycle. If necessary, addendums will be issued between cycles. It is therefore important that Consultants, Contractors and Engineers check back regularly to ensure that they are following the latest version of the DBC.

A.9.2 Latest changes to DBC

This edition is the first edition of the DBC.

Amended content in future editions will be clearly indicated. For example, new content will be side lined in the first edition in which it is published.

A.10 Copyright

No content of the DBC, in part or whole, shall be copied, printed, sold or reproduced in any format.

A.11 Coordinate system

The coordinate system used by the Authority is Dubai Local Transverse Mercator (DLTM). The reference point for levelling is Port Rashid.

A.12 Dimensions, units and calculations

A.12.1 Dimensions

All dimensions in the figures and diagrams of the DBC are given in millimetres without units, unless the distance exceeds 1,000 mm, and then it is given in metres with units (m). Dimensions that are not stated as "maximum" or "minimum" are absolute.

All dimensions are subject to conventional industry tolerances, except where the requirement is stated as a range with specific minimum and maximum end points.

A.12.2 Units

All quantities shall be in metric units with the units defined.

All engineering shall be performed in dynamically consistent units. One of the two systems shown in Table A.4 should be used. Use of dimensions between analysis models, drawings and/or building information modelling (BIM) models shall be fully coordinated and consistent.

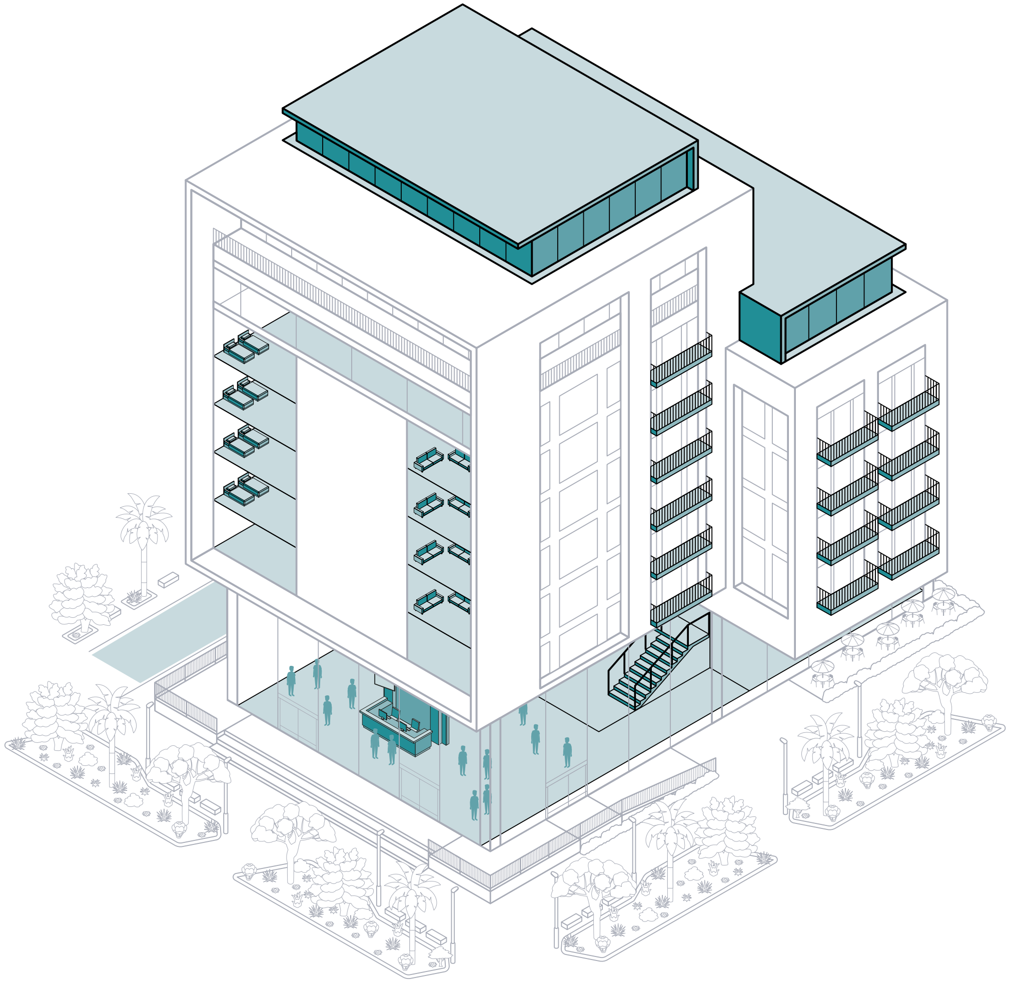
A.12.3 Calculations

Where the required number of elements (e.g. parking or sanitary provisions) to be provided is determined by calculations of ratios or percentages, and this results in remainders or fractions, the next greater whole number of such elements shall be provided.

Unit	SI-system symbol (preferred units)	System mm-t-s		System mm-kg-ms	
		Symbol	Conversion from SI units	Symbol	Conversion from SI units
Length	m	mm	10^3	mm	10^3
Mass	kg	t	10^{-3}	kg	1
Time	s	s	1	ms	10^3
Temperature	°C	°C	1	°C	1
Energy	J	mJ	10^3	J	1
Acceleration	m/s^2	mm/s^2	10^3	mm/ms^2	10^{-3}
Area	m^2	mm^2	10^6	mm^2	10^6
Frequency	Hz	Hz	1	$ms{-1}$	10^{-3}
Velocity	m/s	mm/s	10^3	mm/ms	1
Volume	m^3	mm^3	10^9	mm^3	10^9
Density	kg/m^3	t/mm^3	10^{-12}	kg/mm^3	10^{-9}
Stress	N/m^2	N/mm^2	10^{-6}	kN/mm^2	10^{-9}
Force	N	N	1	kN	10^{-3}
Moment	Nm	Nmm	10^3	kNmm	1
Stiffness	N/m	N/mm	10^{-3}	kN/mm	10^{-6}

Table A.4 Preferred units

Part B
Architecture



B.1 Performance statements

Performance statement	The performance statement will be met by following the requirements of:
The building shall be appropriately integrated with the surrounding natural and built environment.	B.4, B.9 and B.10
The building shall facilitate the safety, convenience and welfare of building occupants as they move in and around the building, including access and egress.	B.4, B.5, B.6, B.9 and B.11
The building shall provide appropriate access and safe circulation for vehicles within the site and building.	B.7 and B.9
The building shall provide minimum communal provisions and facilities for the welfare of occupants.	B.8 and B.9
The building shall be provided with adequate and accessible solid waste and recycling storage to safeguard people from injury or illness caused by infection or contamination.	B.8.5 and B.9

B.2 Definitions

B.2.1 Terms

Accessibility: Ease of independent approach, entry, evacuation and/or use of a building and its services and facilities by all of the building's potential users, regardless of disability, age or gender, and with an assurance of individual health, safety and welfare.

Accessible: Site, building, facility or portion thereof that conforms to Part C.

Advertising: Any identification or description or drawing or any other means to be fitted or erected or printed or written or drawn, either directly or indirectly, or any building or structure or plot, whose purpose is to draw attention to any business, product, service, etc.

Affection plan: Plan of the plot or site issued by the Authority, showing information that includes (but is not limited to) the plot boundaries, plot dimensions, plot areas, setbacks and surroundings as well as the land uses. Also called site plan.

Amenity space: Public or private area within the boundaries of a plot or a development site for the building occupant's recreation or convenience (such as landscaped areas, patios, swimming pools, play areas, prayer rooms, exercise areas and similar uses).

Annex: Building or installation, attached to or independent from the main building, the use of which is secondary or complementary to the function of the main building.

Arcade: Roofed corridor that leads to any building, faces a street or open courtyard, or links more than one building. Usually formed through a series of arches supported on columns or piers (see Figure B.1).

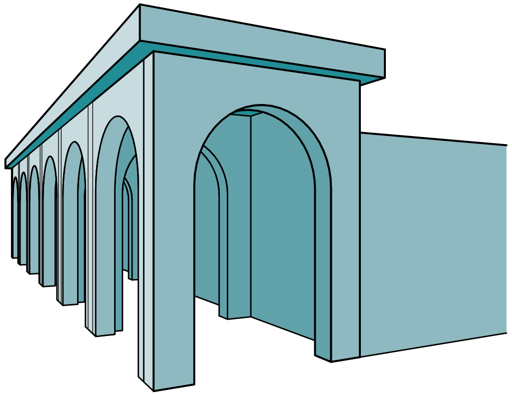


Figure B.1 Arcade

Assembly: Occupancy classification associated with the gathering of people for deliberation, worship, entertainment, eating, drinking, amusement, awaiting transportation, or similar uses.

Atrium: Large-volume space created by a floor opening or series of floor openings, connecting two or more storeys or exceeding 15 m in height from finished floor. The space is covered at the top of the opening(s) and used for purposes other than an enclosed stairway, an elevator hoistway, an escalator opening or a utility shaft.

Authorized use: Plot use or building occupancy authorized according to the classification of lands in Dubai noted in the official affection plan or development regulation.

Balcony: Covered or uncovered occupied projection or partial projection outside the external walls, attached to the building and accessed from the building's interior spaces (see Figure B.2).

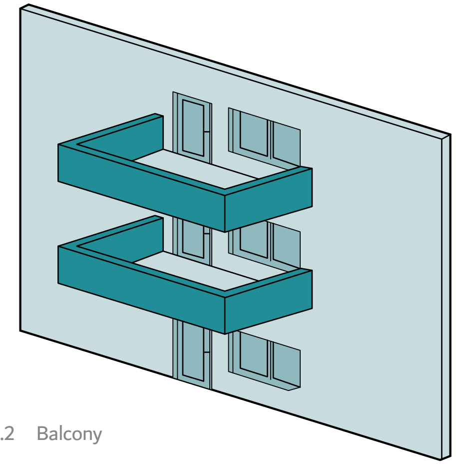


Figure B.2 Balcony

Basement floor: Storey of a building wholly or partly below the gate level that is not the first storey above gate level. A basement slab soffit level is not higher than 1,200 mm above the building gate level.

Bathroom: Room containing a water closet, a washbasin, and either a bathtub, a shower, or both.

Bi-separator: Piece of equipment fitted to the end of a refuse chute which allows the user to deposit multiple waste streams, such as recycling and residual waste, into a single refuse chute.

Boundary wall/fence: Free-standing structure constructed from approved materials surrounding a plot, resting on the ground and rising above ground level and used for confinement and/or screening for safety or security or division purposes.

Building: Structure for the use or occupancy of people or for shelter.

Building element: Component of a building, which might or might not be of fire resistance rated construction and is constructed of approved materials.

Building envelope: Physical barrier between the exterior and the conditioned environment of a building to resist air, water, moisture, heat, cold, light, and noise transfer. For an air-conditioned building, the building envelope comprises the elements of a building that separate conditioned spaces from the exterior. Crown extensions to the façade to cover plant screen cladding are part of the building envelope. The building envelope does not include the physical barrier below ground.

Building height, total: Vertical distance measured from the approved road edge level at the plot main access to the highest roof surface or element.

Building height: Vertical distance measured from the approved road edge level at the plot main access to the mean finished level of the building roof.

Building occupants: Persons using the building.

Building projection: Projection or protrusion that extends outside the vertical external wall of the floor below, such as balconies.

Building setback: Horizontal distance between the nearest part of any building or structure on the plot above ground and the plot boundary, measured perpendicular to the plot boundary.

Built environment: External and internal environments and any element, component or fitting that is commissioned, designed, constructed and managed for use by people.

Bulky waste: Waste, such as furniture, which is usually too large for regular waste collections.

Business: Occupancy used for the transaction of business other than retail, usually used for office, professional or service-type transactions, including storage of records and accounts.

Canopy: Building projection that provides weather protection, identity or decoration and is partially or wholly supported by the building to which it is attached.

Carpool vehicle: Shared vehicle used by people who each have a car but travel together to save cost, to reduce driving stress and to promote other socio environmental benefits.

Chimney: Primarily vertical structure containing one or more flues, for the purpose of carrying gaseous products of combustion and air from a fuel-burning appliance to the outdoor atmosphere.

Chute: Vertical shaft or sloping channel provided for building utilities and services.

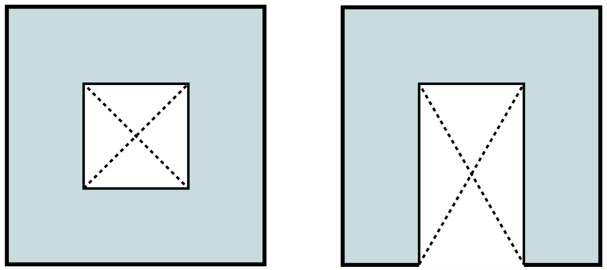
Circulation: Means of passage for pedestrians in and around the built environment, including (but not limited to) corridors, hallways, courtyards, stairways and stair landings.

Clear width: Free unobstructed space for access.

Clinic: Buildings (or portions thereof) used to provide medical care on less than a 24 h basis.

Corridor: Enclosed component that defines and provides a path of travel.

Courtyard: Open, uncovered space, unobstructed to the sky, bounded on three or more sides by exterior building walls or other enclosing devices as shown in Figure B.3.



(a) all sides bounded courtyard (b) 3 sides bounded courtyard

Figure B.3 Courtyard

Curb: Raised edge on a roadway, concrete floor slab or around roof plant.

Daylighting: Illumination of interior spaces using natural light.

Department store: Store, exhibition, building, or part of a building used for the retail sale of a broad variety of items.

Designated preferred parking spaces: Parking spaces that are closest to the main entrance of a building, excluding accessible spaces, or parking spaces closest to the pedestrian exit from the parking area.

Development: General term for the construction, erection or placing of a building or structure; the making of an addition or alteration to a building or structure; a significant change in use or in intensity of use of any building or structure.

Development control regulations (DCR): Document that shows planning regulations (such as height, land use, area, setbacks, building lines) for the full development, and each plot in a subdivision plan, as issued by the relevant planning Authority or master Developer.

Door: Combination of a door leaf or leaves, frame, hardware, and other accessories, positioned in an opening in a wall and intended primarily for access and egress.

Driveway: Access to a required off-street parking and loading facility area.

Education: Occupancy used for educational purposes, including training centres and universities.

Element: Component or space of a building, facility or site.

Elevator lobby: Landing from which occupants directly enter an elevator car(s) and into which occupants directly enter upon leaving an elevator car(s).

Enclosed parking: Parking occupancy that is partially or wholly enclosed on all sides, and that does not qualify as open parking.

Entrance: Access point to a building, portion of a building or facility. An entrance includes the approach walk, the vertical access leading to the entrance platform, the entrance platform itself and the entry door(s) or gate(s).

Environmental impact assessment (EIA): Process of predicting, identifying and evaluating the likely impacts (initial and cumulative), both beneficial and adverse, of a project on the environment including the potential effects of the environment on the project.

Exhibition: Space or structure used for the display of products or services.

Exit access: Portion of a means of egress that leads to an exit.

Exit discharge: Portion of a means of egress between the termination of an exit and a public way.

Exit passageway: Exit component that is separated from other spaces of a building or structure by fire resistance rated construction and opening protectives, providing a protected path of egress travel in a horizontal direction to exit discharge or public way or outside building. Additional uses for the exit passageway include stair transfer in upper floors as well as to reduce travel distance to an exit by having an exit passageway lead to a stair of exit discharge.

Exterior stairway: Stairway that is open on at least one side, except for required structural columns, beams, handrails and guardrails. The adjoining open area can be either yards, courtyards or public ways.
The other sides of the exterior stairway can be closed.

External wall: Wall, load bearing or non-load bearing, that is used as an enclosing wall for a building and might form part of the building envelope.

Facility: All or any portion of the buildings, structures, site improvements, equipment, roads, walks, passageways, parking lots or other property located at the site.

Feeding room or lactation room: Private space where a nursing mother can nurse a child or lactate.

Fixed seating: Furniture or fixture designed and installed for the use of sitting, and secured in place. Includes bench-type seats and seats with or without backs or arm rests.

Flight: Continuous run of stair treads from one landing to another.

Flood or flooding: General and temporary condition of partial or complete inundation of normally dry land from:

a) the overflow of inland or tidal waters;

b) the unusual and rapid accumulation or runoff of surface waters from any source.

Floor finish: Exposed floor surfaces of buildings including coverings applied over a floor or stair, including risers.

Floor height: Vertical distance from top to top of two successive finished floor surfaces. For the topmost storey, from the top of the floor finish to the top of the ceiling joists or, where there is no ceiling, to the top of the roof surface.

Floor or storey: Portion of a building located between the upper surface of a floor and the upper surface of the floor or roof next above.

Fuel dispensing facilities: Facility where motor fuels are stored and dispensed from fixed equipment into the fuel tanks of motor vehicles or marine craft or into approved containers, including all equipment used in connection therewith.

Gate level: Defined height on the plot boundary at the vehicular or pedestrian access point to the plot. It is an elevation difference between the road level (existing or future) and the level of the plot's access point.

The gate level of a plot shall be a minimum height of +300 mm from the edge of the road or a slope of between 2-5% from the edge of the road to the plot's access point.

Glazed element: Individual element within a building envelope that lets in light, including windows, plastic panels, clerestories, skylights, doors that are more than one half glass, and glass block walls.

Glazing: Glass that is installed as one of the components of a wall, floor, ceiling or roofing system.

Gross area (GA): Floor area within the inside perimeter of the exterior walls of a building. The measurement excludes shafts and courtyards, but includes corridors, stairways, ramps, closets, base of atria (or similar voids) and the thickness of interior walls, columns or other features.

Ground floor: First floor in the building above the gate level.

Guard room: Room, unit, or residential space on the same plot of land as the main building, or located within the main building, designated for the occupancy of the guard.

Guardrail: Vertical protective barrier erected along elevated walking surfaces, exposed edges of stairways, balconies and similar areas that minimizes the possibility of fall from elevated surfaces to lower level.

Habitable space: Space in a building for living, sleeping or eating involving occupancy for continuous period of time. Bathrooms, toilet rooms, closets, halls, storage or utility spaces and similar areas are not habitable spaces.

Handrail: Horizontal or sloping rail intended for handhold and grasping by hand for guidance or support (see Figure B.4).

Hardscape: Area of a project site, excluding buildings, made with hard materials, including roads, car parks, patios, courtyards and walkways.

Hazardous waste: Waste material that can cause substantial harm to humans, properties and/or the environment due to its inherent hazardous characteristics. Hazardous waste takes the form of solid, liquid, sludge, gas or any combination thereof.

Healthcare: Occupancy used to provide medical, psychiatric, surgical, therapeutic treatment for people.

Helipad: Dedicated structural surface used for the landing, taking off, taxiing and parking of helicopters.

High-rise building: Building height greater than or equal to 23 m and up to 90 m, measured in accordance with the UAE FLSC [Ref. B.1]. A more detailed definition is given in UAE FLSC.

Hospital: Building or portion thereof used on a 24 h basis for the medical, psychiatric, obstetrical or surgical care of four or more inpatients.

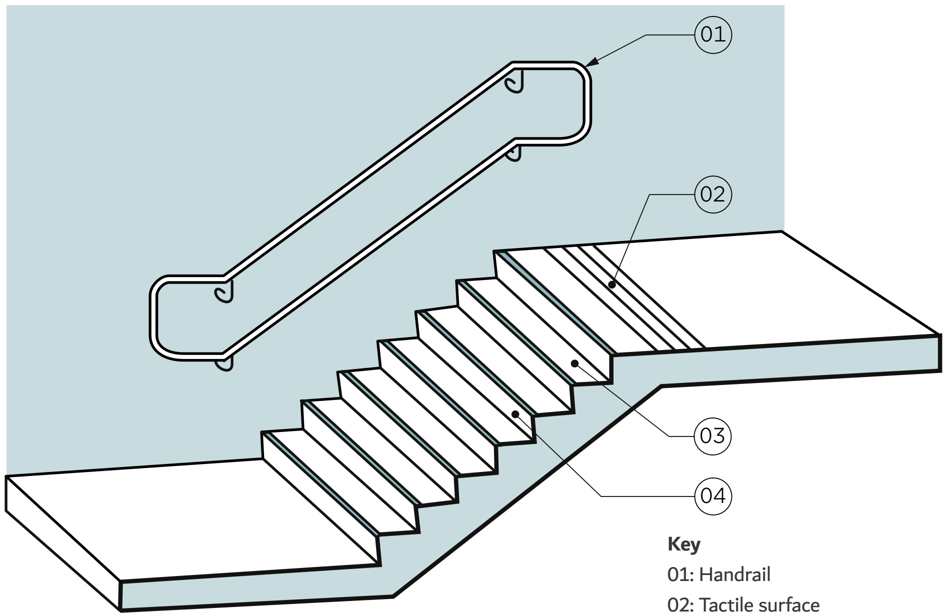
Hotel: Building or groups of buildings under the same management in which there are sleeping accommodations for lodging with or without meals for people on a transient basis.

Hotel apartments: Collection of apartments or studios that are rented to guests by the day, the week, the month or the year.

Hotel establishment: Hotels, guest houses, hotel apartments or resorts.

Hotel suite: Separate guest unit in a hotel that contains one or more bedrooms with a living room and other services.

Housekeeper's room: Attached or separate room or unit on the same plot of land as the main building, designated for the residence of housekeepers or other maintenance staff such as gardeners, guards and drivers.



Key
01: Handrail
02: Tactile surface
03: Tread
04: Riser

Figure B.4 Stair components

Hybrid vehicle: Vehicle using two different forms of power, such as an electric motor and an internal combustion engine, or an electric motor with a battery and fuel cells for energy storage.

Illuminance: Amount of light falling onto a surface area.

Industrial/factory/workshop: Occupancy in which products are manufactured or in which processing, assembling, mixing, packaging, finishing, decorating, or repair operations are conducted.

Intersection: Crossing of two or more roads.

Kiosk: Temporary or permanent structure of lightweight construction occupied as a retail outlet, food outlet or service outlet. Kiosks are generally located at malls, shopping centres, assembly areas and exhibition centres.

Kitchen: Place for the preparation of meals and beverages.

Labour accommodation: Building used for group accommodation for workers of a company or a firm, for which the sanitary facilities and other services are common.

Landing: Floor area at the top of a flight of stairs or between two flights of stairs, or a platform or part of a floor structure at the end of a ramp or at the entrance to an elevator car.

Land use: Activities, operations, or purposes that are employed in a particular geographic area; the specific manner in which a plot of land is utilized. Land use is usually regulated through zoning and planning regulations.

Level: Ground or floor surface, or part of a surface, having a slope of not more than 2% at any point and in any direction.

Line of sight: Imaginary line from the eye to a perceived object or view.

Loading area: Area used for loading or unloading of vehicles, located entirely on private property and provided with permanent independent access.

Lobby: Entrance or foyer to a space or building which acts as a transition area.

Local road: A roadway with the primary function of providing access to adjacent properties and to roadways of a higher functional classification.

Local species: Local plants and plants adapted to the local environment.

Low-rise building: Building height less than or up to 15 m, measured in accordance with the UAE FLSC [Ref. B.1]. A more detailed definition is given in UAE FLSC.

Low-depth underground building: Building up to 7 m below or having up to two basements below the level of exit discharge, measured in accordance with the UAE FLSC [Ref. B.1]. A more detailed definition is given in UAE FLSC.

Main building: Building used for the main or prime functional use within the plot.

Mall: Pedestrian area within a building that serves as access for multiple tenants with levels that are open to each other. A covered mall has an enclosed or roofed common pedestrian way. An open mall has an unroofed common pedestrian way.

Massing: Overall mass or size of a building or project, its physical volume or magnitude.

Masterplan: Comprehensive plan to guide the long-term physical development of a specific area based on identified objectives, strategies, and timelines for implementation. Includes plans for land use, community facilities and utilities, transportation of goods and people, and energy use and conservation. Zoning ordinances and policies are developed for different areas or zoning districts based on the masterplan.

Means of egress: Continuous and unobstructed route from any point in a building or structure to a public way.

Mechanical parking: Parking areas employing parking machines, lifts, elevators or other mechanical devices for vehicles moving from and to street level. Public occupancy is prohibited above street level.

Mezzanine floor: Intermediate level or levels between the floor and ceiling of any storey equal to or less than one-third of the floor it is contained in. A partial floor greater than one-third of the floor it is contained in is a floor, not a mezzanine.

Mid-rise building: Building height greater than 15 m but less than 23 m, measured in accordance with the UAE FLSC [Ref. B.1]. A more detailed definition is given in UAE FLSC.

Mixed use building: Building or structure containing two or more occupancies.

Mosque, Awqat mosque: Mosque building dedicated for the daily five prayers, usually located in the surrounding area of residential neighbourhoods.

Mosque, Eid Musalla: Non-roofed open Musalla used for Eid prayer congregation.

Mosque, Jumaa mosque: Mosque building dedicated for the daily five prayers and the Friday prayer attended by a large number of worshippers.

Neighbour: Any adjacent plot excluding roads and sikkas.

Net area (NA): Actual occupied area, not including unoccupied accessory areas such as corridors, stairways, ramps, toilet rooms, mechanical rooms and closets.

Net floor height: Net distance between the finished floor level (FFL) of a floor and the exposed surface of the floor celling.

Nosing: Projecting front edge of a stair tread or landing that can be rounded, chamfered or otherwise shaped.

Occupancy: Purpose for which a building or portion thereof is used or intended to be used.

Occupant load: Total number of persons that might occupy a building or portion thereof.

Occupiable space: Room or enclosed space designed for human occupancy in which individuals congregate for amusement, labour, educational or similar purposes.

Office: Building or space within a building in which business, clerical, or professional activities are conducted.

Open parking: Parking occupancy where each parking level has permanent wall openings for natural ventilation purposes. The exterior sides of the structure have uniformly distributed openings on two or more sides. The area of such openings in external walls on a level is not less than 20% of the total perimeter wall area of each level. The total width of all of the openings considered to be providing natural ventilation is not less than 40% of the perimeter of the level.

Open space: Portion of a plot or a building level that is set aside for public or private use and that is not occupied by rooms or equipment. The space may be used for passive or active recreation or may be reserved to protect or buffer natural areas.

Ornamental elements: Elements that are added to the building for purpose of beautification or for expressing a certain message or a symbol.

Pantry: Place for food preparation process or storage.

Parking: Building, structure, or portion thereof used for the parking, storage, or both, of motor vehicles.

Parking bay: Area occupied by a single vehicle depending on the position in which the vehicle is parked.

Parapet wall: Part of a wall entirely above the roof line.

Paved: Use of blacktop, asphalt, concrete or other similar substance to create a smooth surface, including bituminous penetration, but not the use of dirt, clay, slag or stone.

People of determination: People with specific needs or disabilities, who are suffering from a temporary or permanent, full or partial deficiency or infirmity in their physical, sensory, mental, communication, educational or psychological abilities.

Pergola: Shading device using solid material normally used for ornamentation or for shading (see Figure B.5).

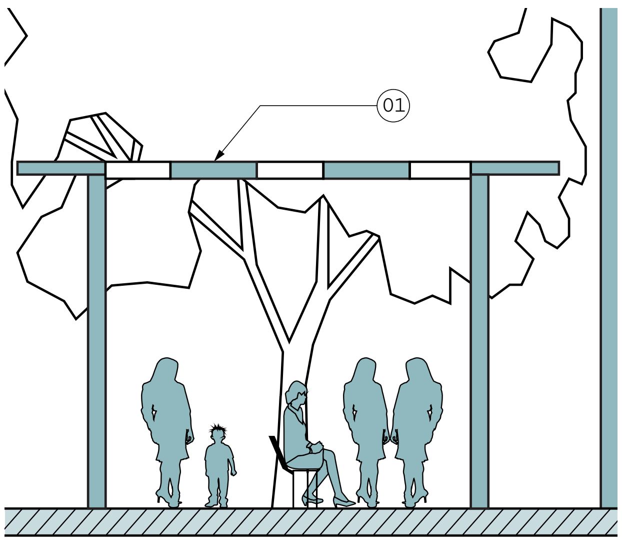


Figure B.5 Pergola

Key
01: Pergola

Planning regulations: Control by planning Authorities for the use of land and buildings, the height and massing of buildings, the density of population, and the relation of a plot's building coverage to open space, the size and location of yards and setbacks, and the provision of any ancillary facilities such as parking.

Plot: Area of land that is:

a) clearly defined (by landmarks, coordinates, distinct number, and the lengths of its sides and location);

a) intended for construction under any approved plan or division project, or by any other method; and

a) legally authorized to be used for construction or building as one unit.

Plot area: Total area of a plot between its boundary lines as measured on a horizontal plane.

Plot boundary: Boundary dividing one plot from another, or from a street or any public place.

Plot coverage: Horizontal area occupied by all main and annex buildings on the same plot, calculated from the external surfaces of external walls or useful roofed balconies in the ground or upper floors, whichever have more floor projections.

Podium (tower base): Lower group of floors of a tower which might or might not include the ground floor, and have different planning requirements from the typical floors of the tower.

Post-consumer recycled content: Waste material generated by households or any other public or private facilities in their role as end-users of the product, which can no longer be used for its original intended purpose.

Prayer room: Dedicated room or space in buildings used to perform Islamic prayers which might or might not be used for group prayers.

Pre-consumer recycled content: Material diverted from the waste stream during the manufacturing process. Reutilization of materials (i.e. rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it) is excluded.

Project: Construction of a permanent building, or any other civil work on a leased property including any modifications or installations in pre-built facilities.

Public use: Availability of interior or exterior rooms, spaces or elements for use by the public. Public use can be provided at a building or facility that is privately or publicly owned.

Public way: Street, alley, or other plot of land open to the outside air, leading to a street, that has been deeded, dedicated or otherwise permanently appropriated for public use, and has a clear width and height of not less than 3 m.

Ramp: Inclined solid flat plane that is steeper than 5% from the horizontal.

Recovery: Processing waste to serve a useful purpose by replacing other materials which would otherwise have been used to fulfil that function. Examples include using waste to generate energy, or converting organic waste into compost.

Recycling: Processing used materials into new products in order to prolong the life of useful material, reduce the consumption of fresh raw materials, reduce energy usage, and reduce air and water pollution by reducing the need for "conventional" waste disposal.

Reflectance: Measure of light reflected in a given direction by a surface and which is expressed in a unit term from 0 to 100 scale, respectively, that represents a grey scale progression from the notional extremes of total light absorption (black) to total light reflection (white).

Refuse chute: Passage, commonly used in high-rise buildings, through which waste is carried by means of gravity to a waste container at the lower end.

Regulations: Rules and statutes set by permitting or other governmental Authorities.

Residential: Occupancy that provides sleeping accommodation with independent cooking and bathroom facilities where people live on a permanent basis.

Residential unit: Single unit providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking and sanitation. An apartment can be a type of residential unit.

Retail: Occupancy used for the stocking, display and sale of goods, wares or merchandise.

Reuse: Activity that lengthens the life of an item, typically consisting of returning the item to active use in the same or related capacity.

Right of way (ROW): Strip of land occupied or intended to be occupied by a road, sidewalk, crosswalk, railroad, electric transmission line, oil or gas pipeline, water line, sanitary storm sewer, and other similar uses; the right of one to pass over the property of another.

Riser: Near-vertical element in a set of stairs, forming the space between one step and the next (see Figure B.4).

Road or street: Public or private road allocated for vehicles or pedestrian use or both, except for sikka as defined in land use classification and regulations in Dubai.

Roof: Floor or part of, located at the top level of the building and usually used for machinery and services equipment and/or providing building amenities and open spaces.

Roof deck: Flat or sloped surface not including its supporting members or vertical supports.

Self-closing (of a door or other opening protective device): Equipped with a device that enables closure from any position, and against any latch fitted, after having been opened.

Service corridor: Fully enclosed passage used for transporting of goods and services.

Service entrance: Entrance intended primarily for delivery of goods or services.

Shading device: Projecting fixture that extends outside the external wall of any building, or a cover (such as a louver), to protect any door or window from rain or solar effect.

Shaft: Enclosed unoccupied space extending through one or more stories of a building, connecting vertical openings in successive floors, or floors and roof.

Showroom: Space allocated for conducting a trading business, such as displaying commodities for purpose of wholesale or retail sale.

Sidewalk: Hard-surfaced walk or raised path along and parallel to the side of the street for pedestrians.

Signage: Displayed verbal, symbolic and pictorial information.

Sikka: Public or private path separating two adjacent plots or a group of adjacent plots, that can be used by pedestrians as a primary or secondary access to any plot.

Site: Plot of land bounded by a plot line or a designated portion of a public right-of-way. A site can be a single plot or multiple plots together.

Skylight or overhead glazing: Glass or other transparent or translucent glazing material installed at a slope of 15° or more from vertical.

Solar reflectance index (SRI): Index that combines reflectivity and emissivity, measuring a material's ability to reject solar heat. SRI is defined such that a standard black (reflectance 0.05 and emittance 0.90) is 0 and a standard white (reflectance 0.80 and emittance 0.90) is 100. Materials with higher SRI absorb less heat and can reduce heat island effect.

Space: Identifiable area including room, toilet, hall, assembly area, entrance, storage room, alcove, courtyard or lobby.

Staff accommodation: Building or part thereof in which sleeping units are provided and/or rented, and with private toilets and shared cooking facilities, for joint occupancy by staff members affiliated with a university, hospital, school or similar institutions.

Stage: Raised area within a building used for the presentation of music, plays or other entertainment; the head table for special guests; the raised area for lecturers and speakers; boxing and wrestling rings; theatre stages; and similar purposes.

Stair: Change in elevation, consisting of one or more risers.

Staircase: Space inside the building within which the stairs are erected.

Stairway: One or more flights of stairs, either exterior or interior, with necessary landings and platforms connecting them to form a continuous and uninterrupted passage from one level to another.

Structure: Constructed, erected material or combination of materials which requires being located on the ground or attached to something located on the ground.

Student accommodation: Building or part thereof in which sleeping units are provided for occupancy by university, school or other educational institute's students and which is regulated by such institution.

Studio: Independent residential unit with combined living room and bedroom and space provision for food preparation and sanitation.

Super high-rise building: Building height greater than 90 m, measured in accordance with the UAE FLSC [Ref. B.1]. A more detailed definition is given in UAE FLSC.

Swimming pool: Constructed pool for swimming, bathing or wading whether above or below the ground surface regardless of depth or water surface area.

Tandem parking: Two or more parking bays with one of the spaces placed behind the other.

Terrace: Covered or uncovered platform or roof, protected by a guardrail or parapet wall and supported by the structure of the floor below.

Toilet stall: Cubicle within a public toilet constructed with demountable partitions or walls surrounding a water closet.

Tread: Stepping space in a stair flight to set the foot (see Figure B.4).

Vehicle access: Roadway, usually paved, intended to provide ingress and egress of vehicular traffic from a public right-of-way to a building entrance or parking area.

Vehicle barrier: Component or system of components, near open sides of a parking floor or ramp or building walls that act as restraints for vehicles.

Warehouse: Occupancy used primarily for the storage or sheltering of goods, merchandise, products, or vehicles.

Waste: Unwanted or unusable materials which are discarded after their primary use.

Waste room: Room dedicated for the purpose of holding, prior to disposal, waste generated in the building. This room can be located within the plot limits or within building enclosure, subject to the approval of Authorities.

Waste segregation: Separation or sorting of waste materials into their respective fractions, such as the separation of recyclables.

Water closet: Toilet bowl and its attached accessories.

Wayfinding: System of providing appropriate information to assist a person to pass through the built environment towards a specific destination. Wayfinding includes orienting oneself, knowing one's destination, following the best route, recognizing one's destination and finding one's way back out.

Wind towers: Shelter with 50% of its area open to the sky usually constructed to enhance the architectural beauty of a building or to suit a certain climate need.

B.2.2 Acronyms and abbreviations

Ch.	Chapter
DCR	Development Control Regulations
DBC	Dubai Building Code
DCAA	Dubai Civil Aviation Authority
DHA	Dubai Health Authority
DHCA	Dubai Healthcare City Authority
DCD	Dubai Civil Defence
DEWA	Dubai Electricity and Water Authority
DM	Dubai Municipality
DM PH&SD	Dubai Municipality, health and safety department
DTCM	Department of Tourism and Commerce Marketing
EIA	environment impact assessment
EIAR	environment impact assessment report
EIAS	environment impact assessment summary
EMC	electromagnetic compatibility
FFL	finished floor level
FGI	Facility Guidelines Institute
G	ground floor
GA	gross area
IBC	International Building Code
LPG	liquefied petroleum gas
MEP	mechanical, electrical and plumbing
NA	net area
RCC	reinforced concrete
RMU	ring main unit
RTA	Roads and Transport Authority
SRI	solar reflectance index
TIA	traffic impact assessment
TIS	traffic impact study
UAE FLSC	United Arab Emirates Fire and Life Safety Code of Practice

B.3 References

B.3.1 Essential references

ASCE/SEI 7-16, Minimum design loads and associated criteria for buildings and other structures

ASTM F1346-91, Standard performance specification for safety covers and labelling requirements for all covers for swimming pools, spas and hot tubs

BS 1703, Refuse chutes and hoppers – Specification

BS EN 840-1, Mobile waste and recycling containers – Containers with 2 wheels with a capacity up to 400 l for comb listing devices – Dimensions and design

BS EN 840-2, Mobile waste and recycling containers – Containers with 4 wheels with a capacity up to 1,300 l with flat lid(s), for trunnion and/or comb lifting devices – Dimensions and design

BS EN 840-3, Mobile waste and recycling containers – Containers with 4 wheels with a capacity up to 1,300 l with dome lid(s), for trunnion and/or comb lifting devices – Dimensions and design

BS EN 840-4, Mobile waste and recycling containers – Containers with 4 wheels with a capacity up to 1,700 l with flat lid(s), for wide trunnion or BG- and/or wide comb lifting devices – Dimensions and design

BS EN 12574-1, Stationary waste containers – Containers with a capacity up to 10,000 l with flat or dome lid(s), for trunnion, double trunnion or pocket lifting devices – Dimensions and design

BS EN 14010:2003+A1:2009, Safety of machinery – Equipment for power driven parking of motor vehicles – Safety and EMC requirements for design, manufacturing, erection and commissioning stages

DIN 30722-1, Roller contact tipper vehicles, roller containers – Part 1:Roller contact tipper vehicles up to 26 t, roller containers type 1570 made from steel

DIN 30722-2, Roller contact tipper vehicles, roller containers – Part 2: Roller contact tipper vehicles up to 32 t, roller containers type 1570 made from steel.

DIN 30722-3, Roller contact tipper vehicles, roller containers – Part 3: Roller contact tipper vehicles up to 12 t, roller containers type 900 made from steel

ISO 14021, Environmental labels and declarations – Self-declared environmental claims (Type II environmental labelling)

PD ISO/TS 22002-2, Prerequisite programmes on food safety – Catering

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B.3.2 Further reading

There is no further reading in this Part.

B.4 General architectural provisions

B.4.1 General requirements

Buildings shall be designed according to the planning limitations and provisions required by the Authorities, as stipulated in development control regulations (DCR) and/or affection plans. Limitations on development include, but are not limited to:

a) authorized use of the building;

b) building setbacks;

c) floor to area ratio;

d) access locations;

e) the gate level;

f) building service lines.

Buildings located in heritage areas shall respect the identity of these areas and shall adhere to any conservation requirements imposed by the Authorities.

The building or development should take the following into account:

1) Arabic and Islamic cultural identity;
2) local architectural character, especially for buildings of cultural significance;
3) the building's relationship with the surrounding environment;
4) the building's compatibility with the planning limitations and urban planning themes of surrounding developments.

The massing of the proposed building should take into account the visual privacy of adjacent structures and buildings in the surrounding properties and neighbourhoods, as well as the privacy of different uses and occupancies within the same development.

B.4.2 Development limitation

B.4.2.1 Gate level

The gate level is a defined height on the plot boundary at the vehicular or pedestrian access point to the plot. It is an elevation difference between the road level (existing or future) and the level of the plot's access point.

The gate level of a plot shall be a minimum height of +300 mm from the edge of the road or a slope of between 2-5% from the edge of the road to the plot's access point.

The gate level, and the levels of the plot's corners, are calculated based on Dubai Roads and Transport Authority's (RTA) standard cross-section of road right of way (ROW), next to the plot.

B.4.2.2 Building height

Building heights shall follow the DCRs and affection plans.

Buildings plots located in areas requiring Dubai Civil Aviation Authority (DCAA) approval (as noted in the affection plan, DCR or DCAA map) shall meet the Authority's requirements and the height limitation imposed.

Building height shall be calculated from the approved road edge level at the main plot access to the average finished floor level (FFL) of the roof as shown in Figure B.6.

The total building height is the vertical distance measured from the approved road edge level at the main plot access to the highest roof surface or element.

Building ground should be elevated from adjacent roads to protect from flooding. Elevated access points shall also meet the requirements in C.5.

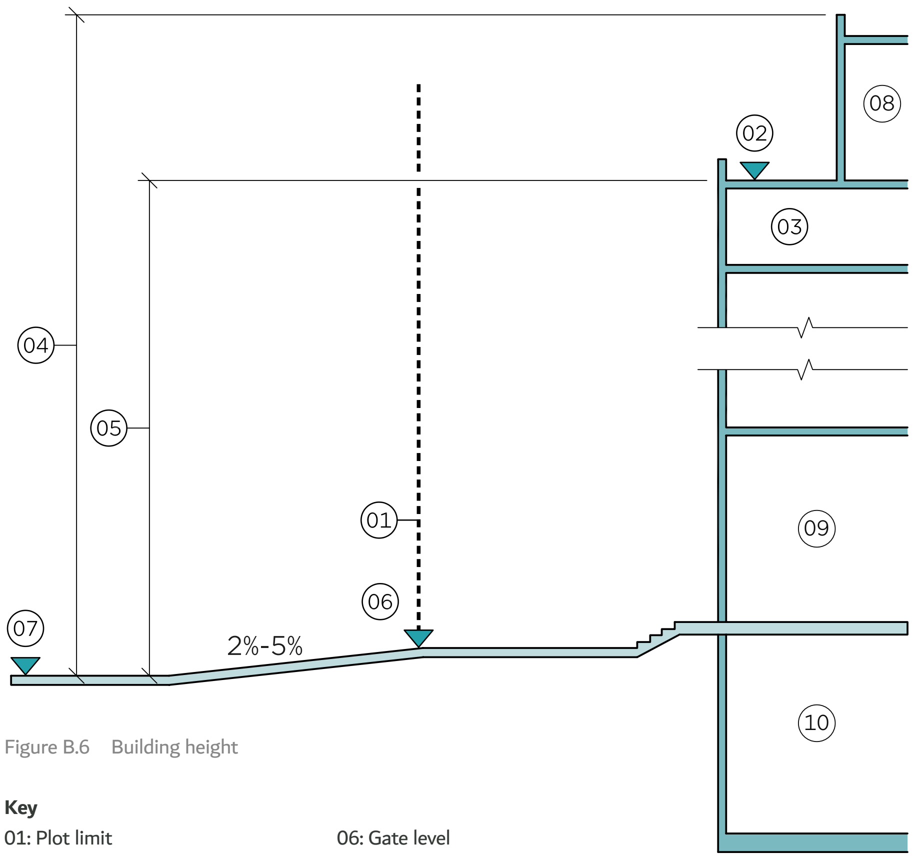


Figure B.6 Building height

Key

01: Plot limit
02: Roof level
03: Last floor
04: Total building height
05: Building height
06: Gate level
07: Road edge level
08: Roof structure
09: Ground floor
10: Basement

To calculate the total allowable building height, the allowable number of floors, as defined by the affection plan or DCR, shall be multiplied by 6 m per floor. This does not impose restrictions on single floor heights.

Example: For a building with G+10 floors limit, the maximum allowable height shall be calculated as 11 (the number of floors) × 6 m (the factor) = 66 m maximum building height. See Figure B.7.

Parts of buildings and installations may exceed the maximum allowable height provided that this increase does not conflict with DCAA or DCR requirements. These parts include:

a) ornamental elements such as minarets, dome and towers that are embellished in traditional and aesthetic patterns;
b) chimneys and smokestacks, water reservoirs, elevator shafts, stairways, radio and television aerials, wind towers, pergolas, helipads and roof shading devices;
c) advertisement boards conforming to Authority regulations for advertising (see E.10.9 for restrictions on advertising within façades).

When helipads are provided on buildings, they shall conform to standard specifications approved by DCAA.

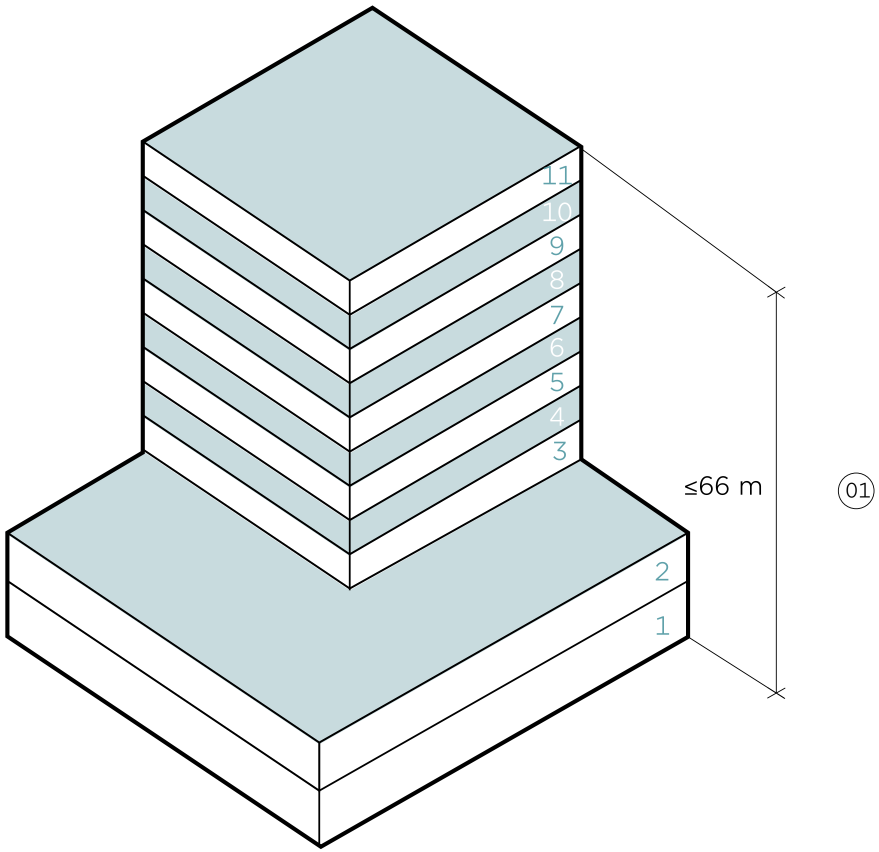


Figure B.7 Example of allowable building height calculation

Key

01: Maximum allowable total building height

B.4.2.3 Building setbacks

The building setback requirements in the affection plan or DCR shall take precedence over the setback requirements in this section.

When setback limitations for the plot or development are not defined, setbacks shall be calculated from the plot limit to the face of buildings in accordance with Table B.1.

Building height by number of floors	Setback from neighbour (X) (see Figure B.8) (m)	Setback from road (see Figure B.9) (m)
Basement	0	0
Ground (G)	3	0
G+1 to G+3	3	0
G+4	3.75	0
G+5	4.50	0
G+6	5.25	0
G+7	6	0
G+8	6.75	0
G+9	7.50	0
G+10 and above	7.50	0

Table B.1 Setback calculation table

Setbacks shall be calculated from ground floor and above.

Allowance for zero setback from neighbours shall be according to each affection plan or development DCR. Zero setback between two neighbouring retail plots is allowed unless otherwise defined in the affection plan or DCR. This only applies when both plots have retail use classification and for dedicated retail occupancy floors.

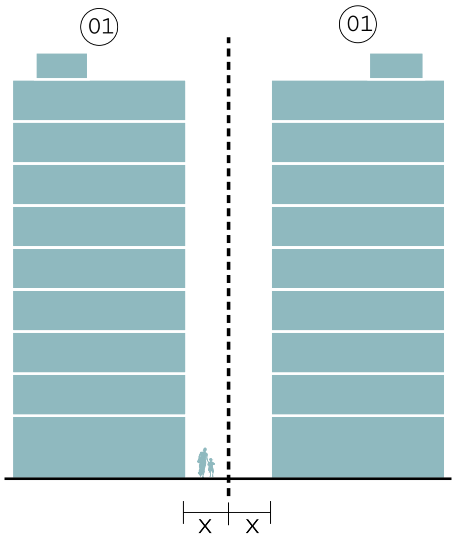


Figure B.8 Setback from neighbours

Key
01: Plot
X: Setback from neighbour (see Table B.1)
------ Plot limit

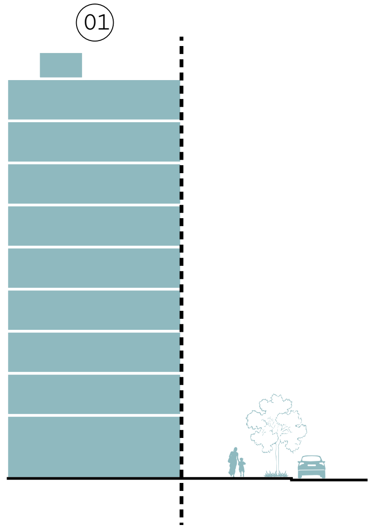


Figure B.9 Zero setback facing road

Key
01: Plot
------ Plot limit

Setbacks are shown in plan view in Figure B.10. Setbacks shall also allow for fire separation between buildings and fire truck access routes. To prevent external fire spread, the building, shall be physically separated from adjacent plots/buildings or external walls and openings of the building shall be fire resistance rated (see Sections 2.7 and 2.8, Ch. 1 of UAE FLSC [Ref. B.1]).

Fire truck access shall be provided between buildings and around buildings as required by Ch. 2 of UAE FLSC [Ref. B.1]. This vehicle access might need to be accommodated within the plot limits.

Where high-rise and super high-rise buildings (as defined by UAE FLSC [Ref. B.1]) are built on a podium and the distance from fire truck accessway to the façade of the high-rise/super high-rise exceeds 30 m, fire truck access to the podium shall be provided as required by Section 2.8, Ch. 2 of UAE FLSC [Ref. B.1].

Setbacks from sikkas shall be calculated from the centre of the sikka (see Figure B.11). When the sikka width is more than 6 m, the maximum applicable width from the centre of the sikka is 3 m. If the building setback from the plot limit is found to be 1.5 m or less, no setback is required.

Plots neighbouring cemeteries shall provide a minimum setback of 3 m.

Plots adjacent to metro stations or metro infrastructure shall conform to the RTA railway protection code for the emirate of Dubai [Ref. B.2].

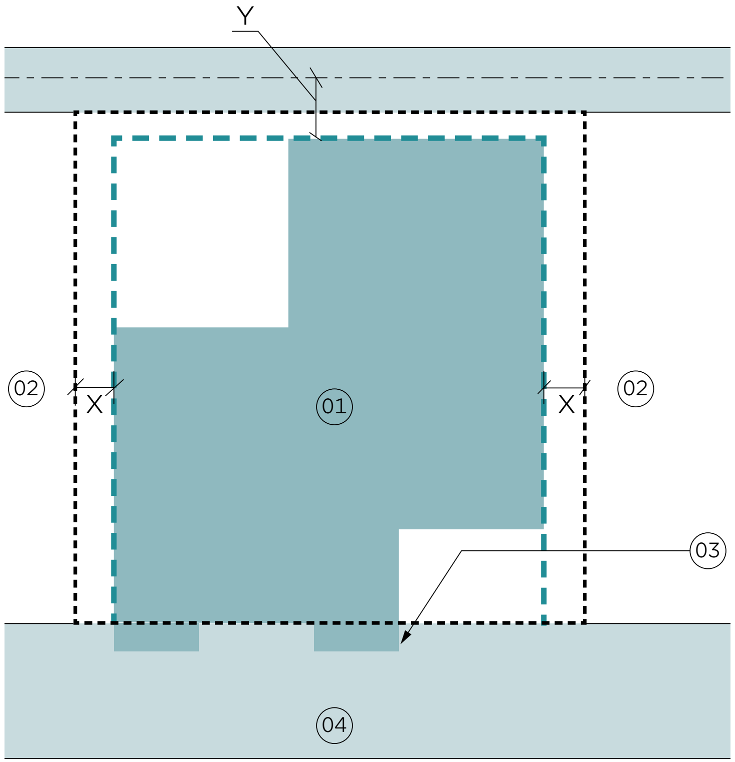


Figure B.10 Setback plan

Key
01: Building footprint
02: Neighbour
03: Allowable projection
04: Road
X: Setback from neighbour (see Table B.1)
Y: Setback from centre of sikka
Plot limit
Setback line

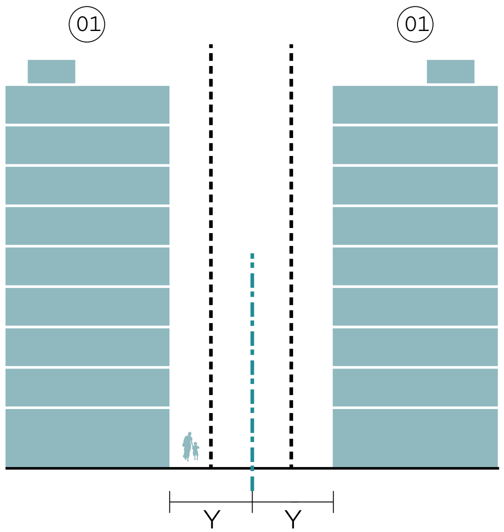


Figure B.11 Setback from sikka

Key
01: Plot
Y: Setback from centre of sikka
Plot limit

The distance between multiple buildings on the same plot shall be equal to the setback required for both buildings from a neighbouring building plot, identified as (X) in Figure B.12, measured from the least horizontal distance between buildings. This distance shall be not less than 3 m between buildings height of ground floor only.

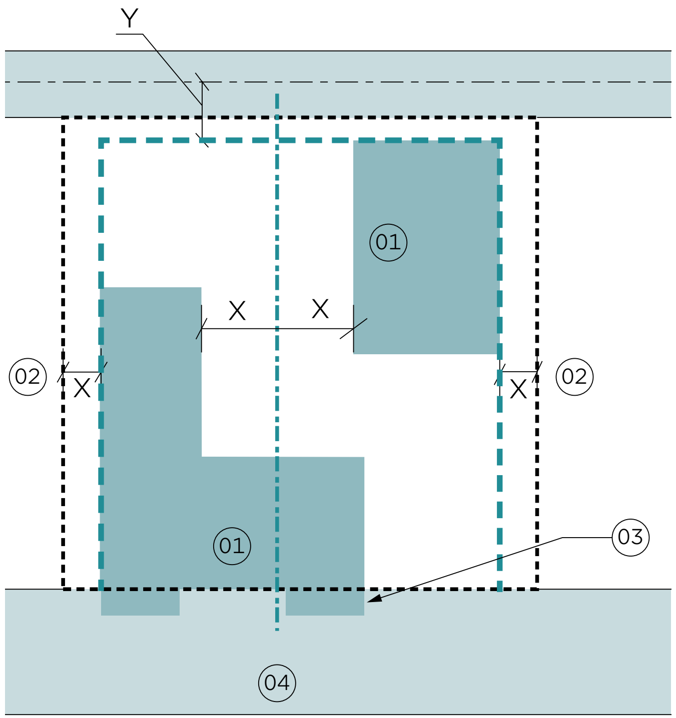


Figure B.12 Setbacks between buildings in same plot

Key
01: Building footprint
02: Neighbour
03: Allowable projection
04: Road
X: Setback from neighbour, internal setback between buildings
Y: Setback from centre of sikka
Plot limit
Setback line

The following structures shall be allowed within setbacks up to the plot limit as shown in Figure B.13:

a) plot boundary wall/fence;
b) site enhancement landscape and hardscape;
c) ring main unit (RMU) rooms and substations as required by service Authorities;
d) basement and building substructure;
e) pergolas and light weight parking shading structures;
f) uncovered car parking and roadways;
g) security and/or guard rooms;
h) retail structures on plots where the neighbour is also a retail occupancy.

Such arrangements shall not obstruct exit discharge to fire vehicle access way/public road (if any).

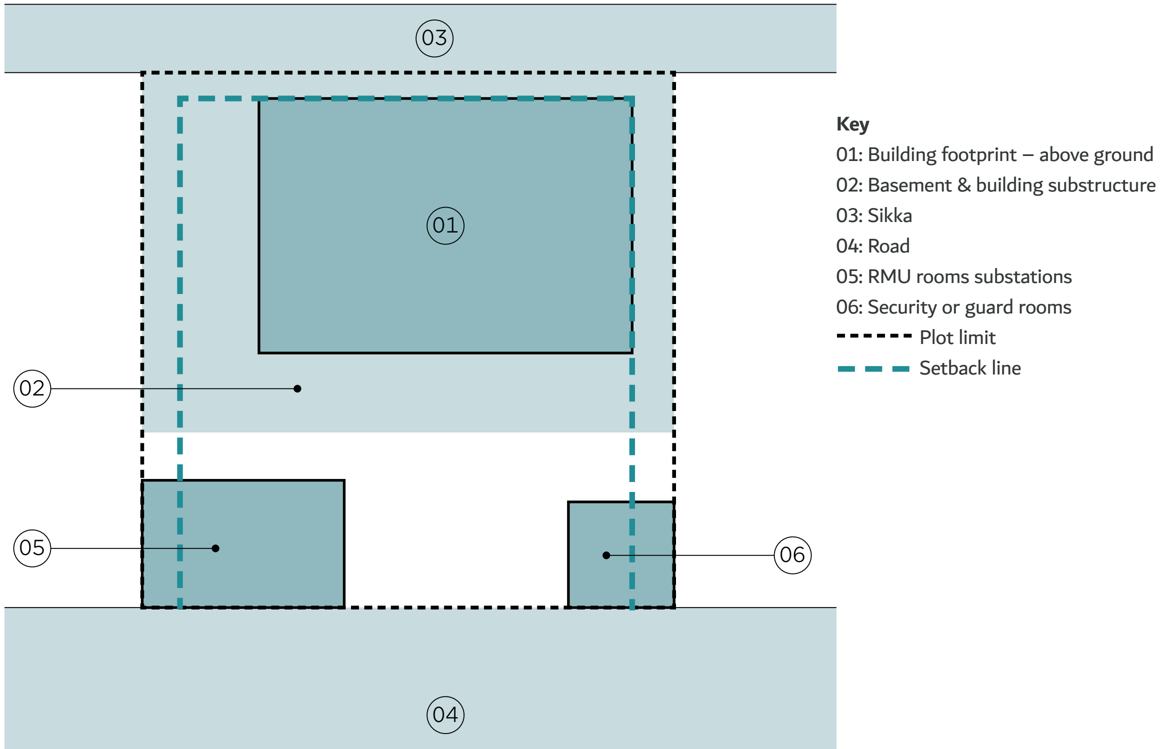


Figure B.13 Allowed construction within setback

B.4.2.4 Building areas

B.4.2.4.1 Gross area (GA)

Gross area (GA) is the floor area within the inside perimeter of the external walls of a building. The measurement excludes shafts and courtyards, but includes corridors, stairways, ramps, closets, base of atria (or similar voids) and the thickness of interior walls, columns or other features.

GA is illustrated in Figure B.14. The highlighted areas are those included in the definition.

GA is used for occupant load calculations as defined in Table B.2, elevator exemptions in Part C, in addition to other requirements in the DBC.

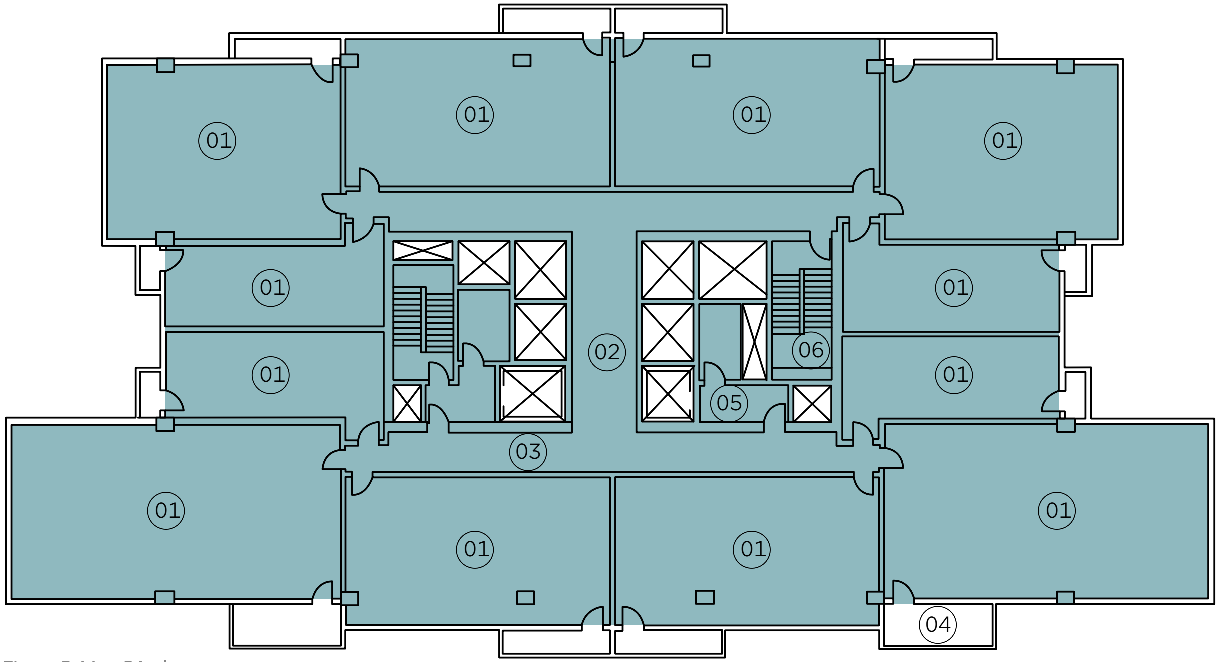


Figure B.14 GA plan

Key

01: Residential unit
02: Elevator lobby
03: Corridor
04: Balcony
05: Service room
06: Staircase

B.4.2.4.2 Net area (NA)

Net area (NA) is the actual occupied area, not including unoccupied accessory areas such as corridors, stairways, ramps, toilet rooms, mechanical rooms and closets.
The calculation of NA is illustrated in the sample plan shown in Figure B.15.

NA is used for occupant load calculations as defined in Table B.2 and parking rates defined in B.7.2.6.1, in addition to other requirements in the DBC.

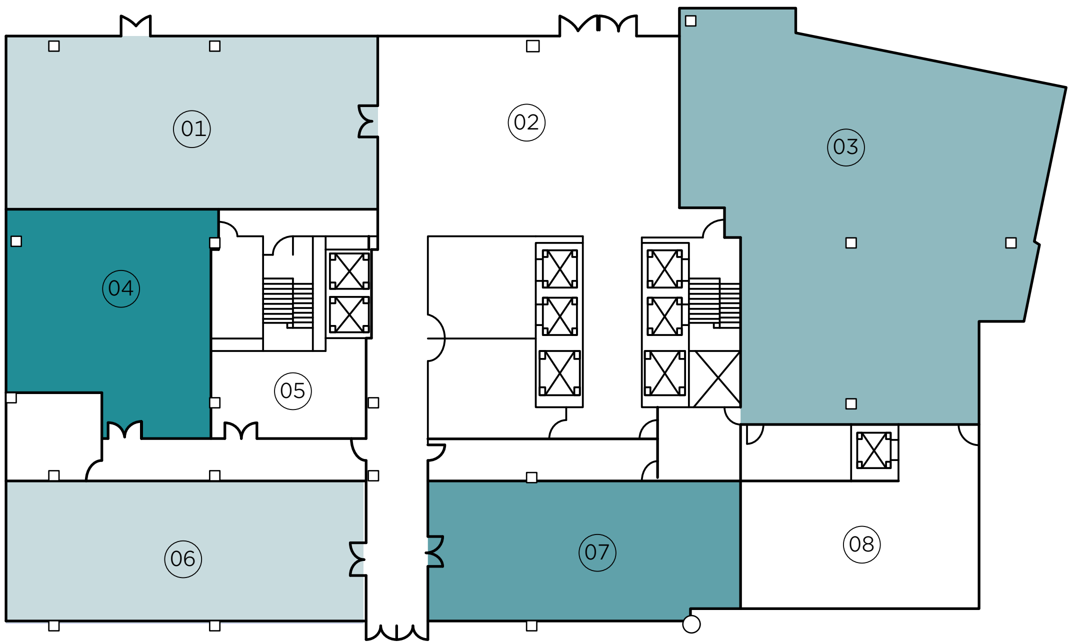


Figure B.15 Example of net area for different occupancies

Key
01: Meeting room 1
02: Lobby
03: Ballroom
04: Prayer room
05: Toilets
06: Meeting room 2
07: Restaurant
08: Kitchen

B.4.2.5 Balconies, building projections and terraces

B.4.2.5.1 Limitations

A balcony, building projection or terrace (see Figure B.16 and Figure B.17) can be provided along the whole or part of the building façade constructed on the side of the plot that overlooks a road or neighbours. Balconies, building projections and terraces shall meet the following requirements and limitations.

a) The affection plan or DCR shall take precedence over the provisions in this subclause.

b) A balcony or projecting building element shall be situated at an elevated level from ground floor, not less than 3 m from FFL of sidewalks and footpaths as shown in Figure B.16.

c) Projections from vehicle roads shall be set back a minimum of 0.6 m from the edge of vehicle road, or a height clearance of not less than 5.5 m shall be maintained from road level as shown in Figure B.16.

d) Projections above fire truck accessways shall be not less than 4.5 m in height from road level in accordance with Section 2, Ch. 2 of UAE FLSC [Ref. B.1].

e) Projections outside the plot boundary are permitted on the road-facing side when the width of road in which the balcony or projection protrudes exceeds 9 m.

f) Balconies and building projections shall be limited to 10% of the facing street width beyond the plot limit and 1.8 m maximum projection into the ROW as shown in Figure B.16.

g) The minimum horizontal distance of balconies and building projections from other adjacent buildings, structures or neighbouring plots shall maintain the minimum required setback (see Figure B.17).

Plots adjacent to metro stations or metro infrastructure shall conform to the RTA railway protection code for the emirate of Dubai [Ref. B.2].

Privacy of neighbouring plots should be taken into account when setting the location and orientation of balconies.

A privacy partition shall be provided between connected balconies of different residential units.

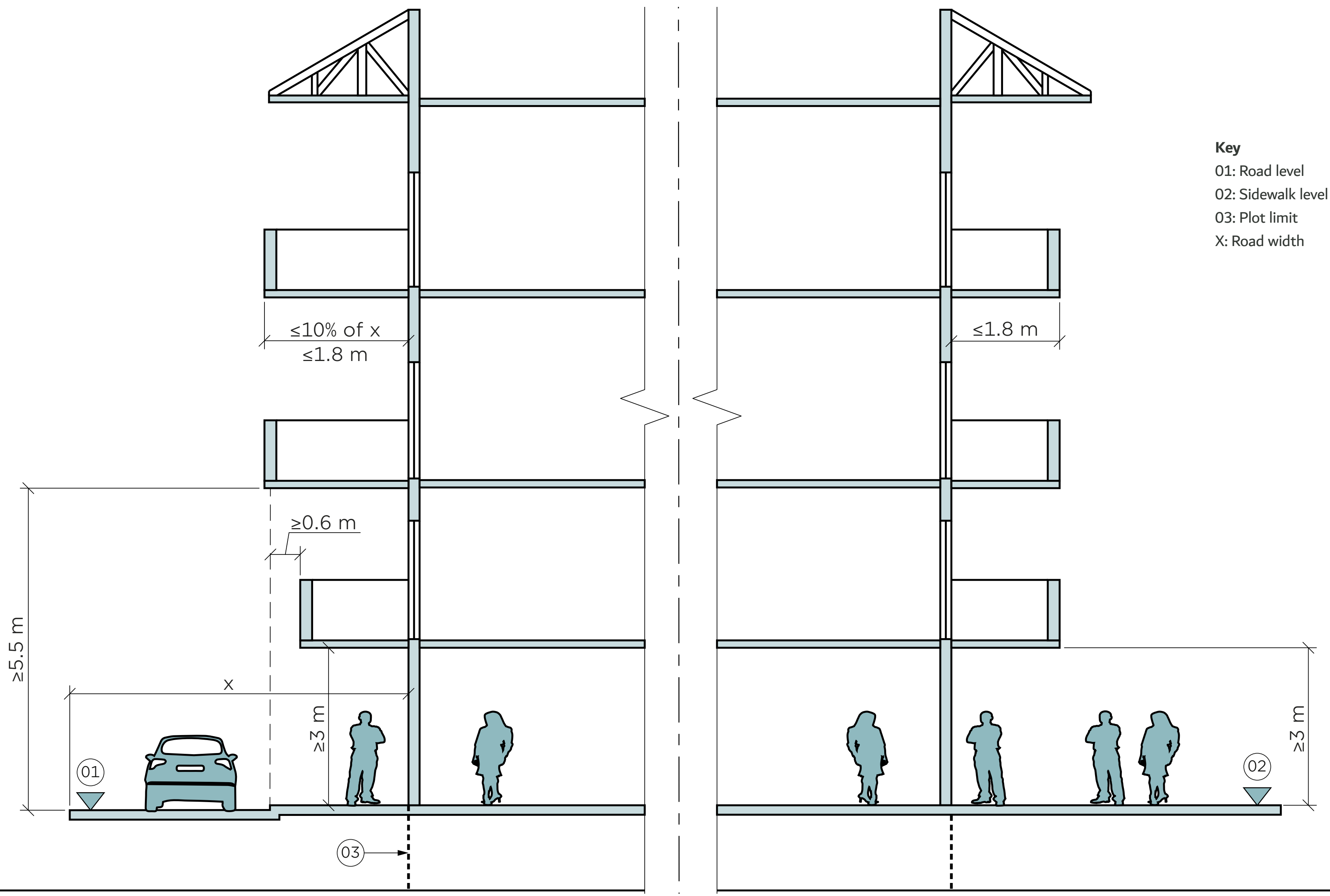


Figure B.16 Projection from ROW

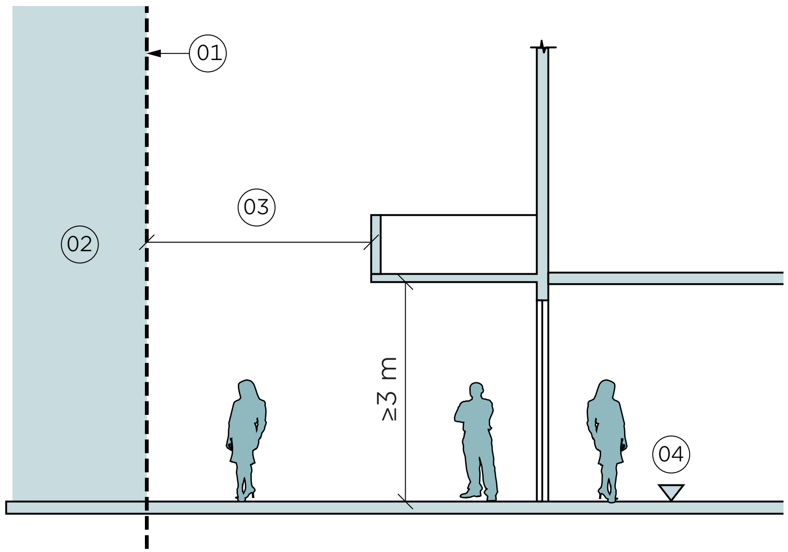


Figure B.17 Projections within setbacks

Key
01: Plot limit, if applicable
02: Neighbour
03: Minimum required setback
04: Ground level

B.4.2.5.2 Guardrails for fall protection

Guardrails are required for any space, walking or standing which is elevated 760 mm above the FFL, with the exception of:

a) the loading side of loading docks;
b) the audience side of stages and raised platforms, including stairs leading up to the stage and raised platforms;
c) raised stage and platform floor areas, such as runways, ramps and side stages;
d) vertical openings in the performance area of stages and platforms;
e) elevated walking surfaces associated with stages and platforms for access/use of special lighting or equipment; and
f) along vehicle service pits not accessible to the public.

The guardrail height from FFL (or lowest stepping feature, A in Figure B.18) shall be not less than 1,200 mm.

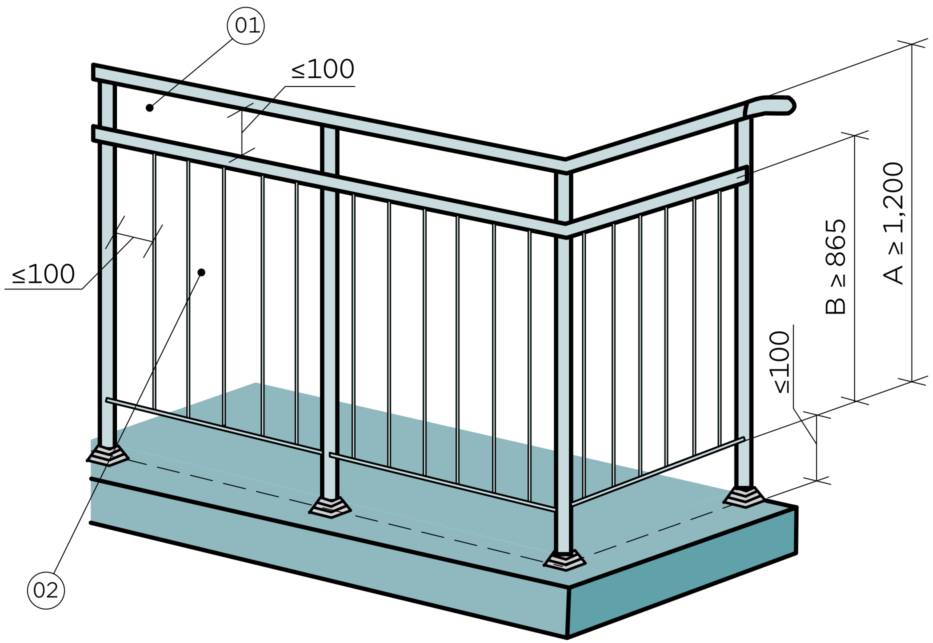
The separation distance between vertical posts or members (see Figure B.18), curved frames or design features, of balcony, guardrail or handrail shall not allow the passage of a 100 mm diameter sphere.

Horizontal climbable elements are not permitted within 865 mm height of the bottom of the guardrail, i.e. (B) in Figure B.18.

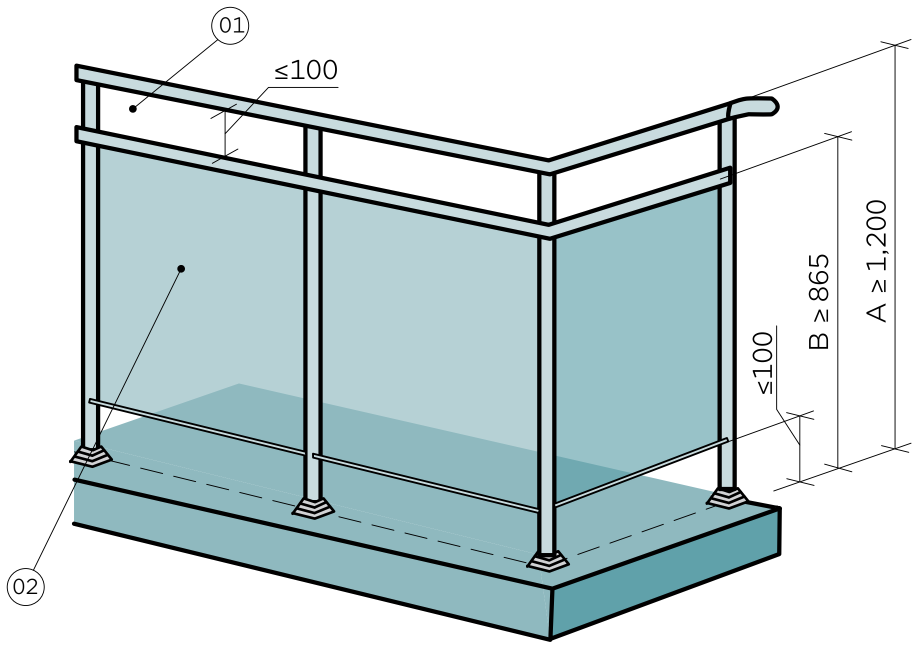
If the design requires any gap between finished floor surface and the bottommost horizontal component of the railing (see Figure B.18), the gap shall be not more than 100 mm.

The balcony, handrail, guardrail assembly shall be able to withstand the loads specified in ASCE/SEI 7-16.

If the design demands usage of glass panels in the balcony construction, such glass shall provide containment and withstand the loads specified in ASCE/SEI 7-16 (see E.9.2).



(a) Guardrail with stepping feature within 865 mm from FFL



(b) Guardrail without stepping feature within 865 mm from FFL

Figure B.18 Guardrail specifications

Key

01: Gaps more than 100 mm not acceptable

02: Stepping feature within 865 mm of base of guardrail not acceptable

B.4.2.5.3 Access doors

Balconies and terraces shall not have self-closing, self-latching or self-locking doors, which can accidentally lock people outside in the balcony or terrace.

B.4.2.6 Plot coverage

Plot coverage shall be calculated as the horizontal area occupied by all main and annex buildings on the same plot, calculated from the external surfaces of external walls or useful roofed balconies in the ground or upper floors, whichever have more floor projections.

The following shall be excluded (see Figure B.19):

a) lightweight structures such as a canopy, parking shade(s), pergola(s); and

b) ornamental and non-accessible building projections such as roof eaves, window shades.

Key
01: Building
02: Pergola
03: Non-functional projection
04: Parking canopy
05: Parking
06: Annex building
07: Roof eaves
------ Plot limit

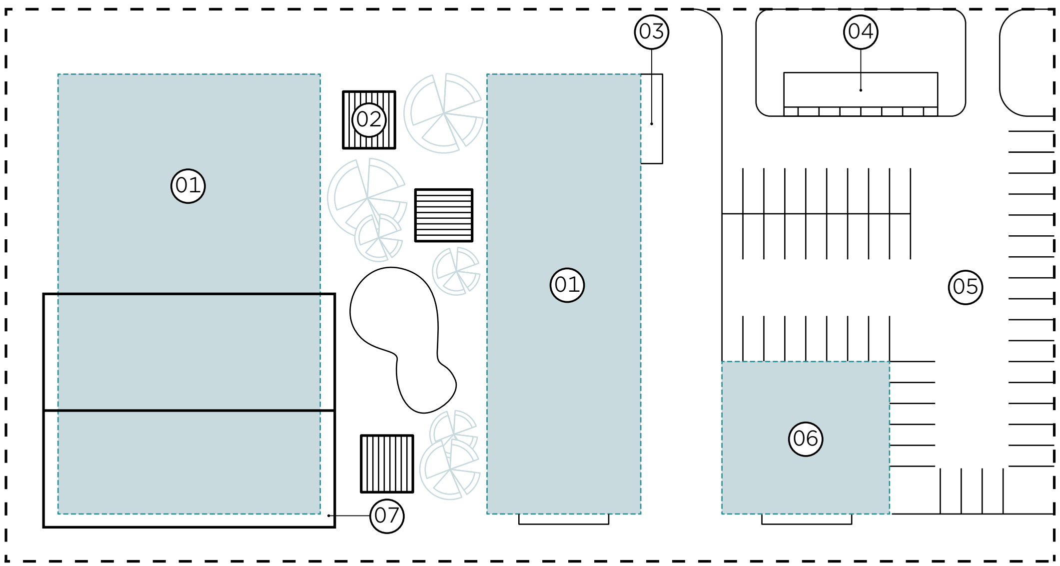


Figure B.19 Plot coverage

B.4.3 Building floors general requirements

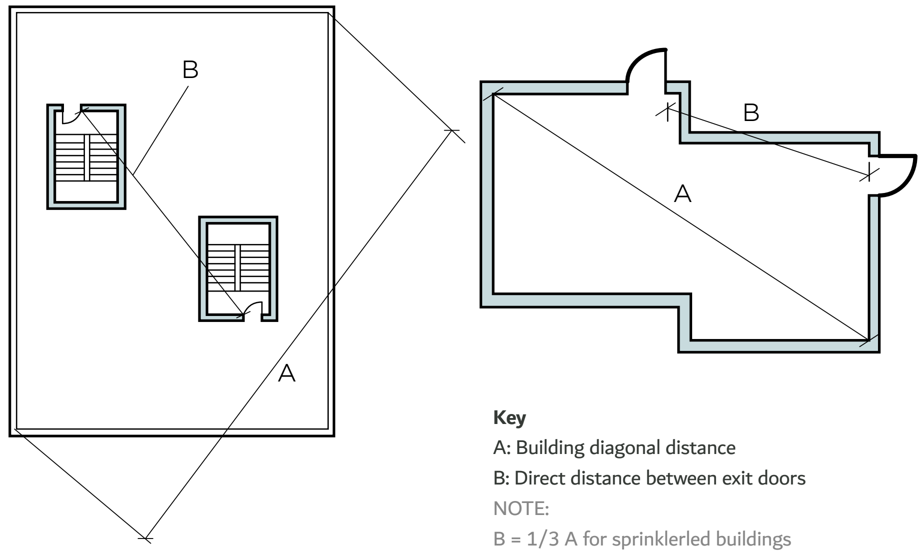
B.4.3.1 Ground floor

Ground floor use allowance shall conform to planning regulations. A building or facility may have more than one ground floor where a split-level entrance has been provided and where a building plot has significant level difference.

The ground floor shall be connected to the adjacent public ways by lobbies. The number and location of exits discharging directly from the building to outside shall conform to Section 3.10, Ch. 3 of UAE FLSC [Ref. B.1]. The points of exit discharge shall be separated from each other on plan by one third (sprinklered buildings) or one half (unsprinklered buildings) of the largest measurements of the building diagonal distance (see Figure B.20).

An emergency command centre conforming to Table 1.9, Ch. 1 and Section 2.9, Ch. 2 of UAE FLSC [Ref. B.1] shall be provided in malls, amusement park, high-rise and super high-rise buildings. The emergency command centre may be shared with a security room, rest area or control room, provided that it meets emergency command centre specifications.

The emergency command centre shall be at ground floor and separated from the remainder of the building by a 1 h fire barrier constructed in accordance with Ch. 1 of UAE FLSC [Ref. B.1]. The entrance to the emergency command centre shall be on the exterior of the building along the fire accessway or if this is not feasible, at the main entrance lobby of the building. Emergency command centres shall meet the minimum room sizes specified in B.5.2.



Key
A: Building diagonal distance
B: Direct distance between exit doors
NOTE:
B = 1/3 A for sprinklerled buildings
B = 1/2 A for unsprinklered buildings

Figure B.20 Building exit separation

B.4.3.2 Basements

The space use shall conform to planning regulations.

Basement floors shall not extend beyond the plot limits.

The basement shall be connected to the building by means of vertical circulation (staircases/elevators) in accordance with Ch. 1 to Ch. 10 of UAE FLSC [Ref. B.1].

The basement slab soffit level shall not extend 1.2 m above the building gate level as shown in Figure B.21.

B.4.3.3 Podium

Building podiums shall conform to planning regulations.

When podium floors are used for habitable and occupiable spaces, these spaces shall be designed as indoor spaces with building envelope, acoustic treatment and ventilation/thermal comfort as required by Part E and Part H.

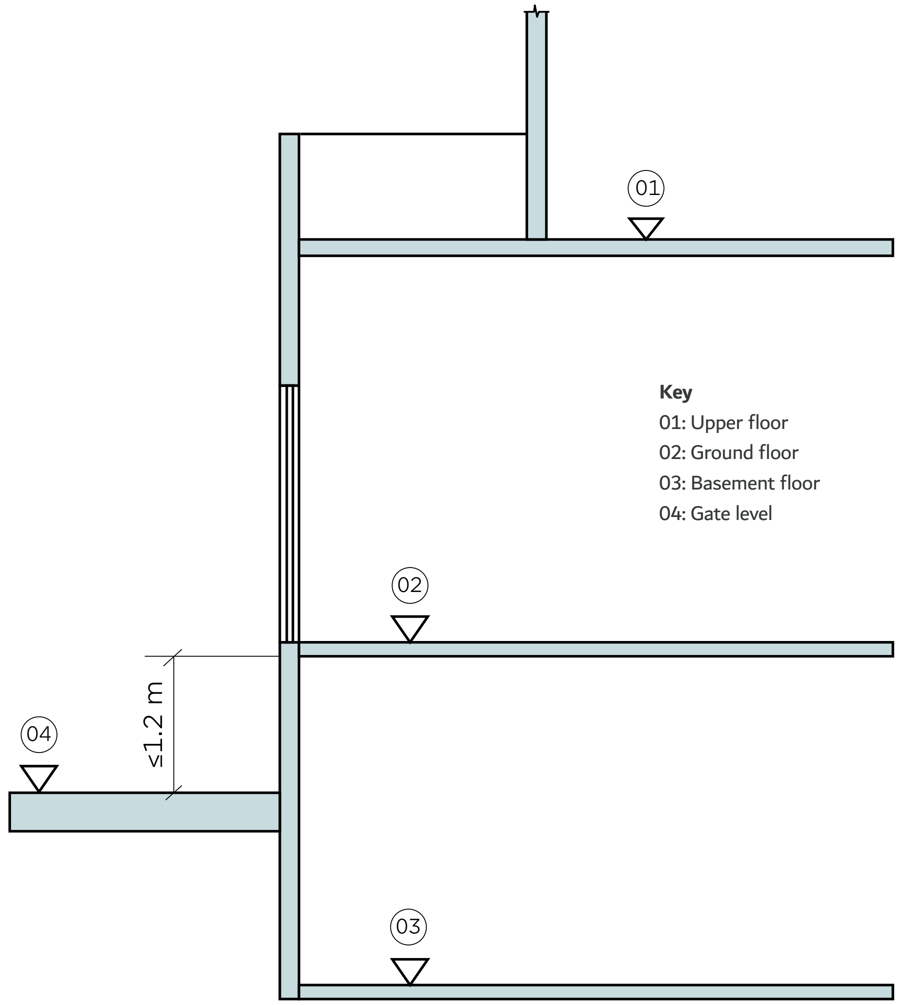


Figure B.21 Basement height from gate level

B.4.3.4 Roof

The space use shall conform to planning regulations.

Accessible roofs shall be provided with life safety features such as fall protection and guardrails in accordance with B.4.2.5.2.

Water proofing and thermal insulation material shall be fitted on the roof deck in order to protect it from water leaks (see E.7.3.2) and solar gain effects (see E.5.2.3).

Structures at roof level shall not exceed 50% of the roof floor area as shown in Figure B.22.

Roof structures shall be set back a minimum of 1.5 m from the building envelope. Staircases and elevator rooms are excluded from the 1.5 m setback requirement, but they shall be calculated as part of the 50% construction area.

Roof structures occupying more than 50% of the roof floor area or not provided with setback shall be treated as a regular floor.

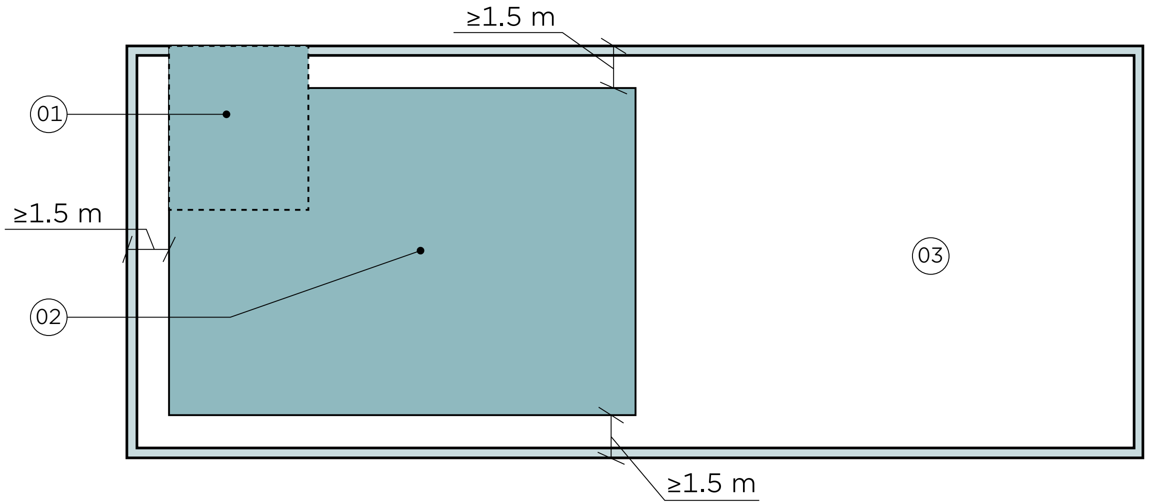


Figure B.22 Roof coverage and setback

Key
01: Staircase or elevator room
02: Roof structure not more than 50% of the roof area
03: Roof

B.5 Minimum space requirements

B.5.1 Occupant loads

Occupant load factors shall be determined in accordance with Table B.2.

Occupancy	Use	Occupant load factor (m^2 per person unless otherwise stated)	Area used for calculation
Assembly	Concentrated – ballrooms, multipurpose-assembly halls	0.65	Net area
	Mosques, prayer halls and prayer rooms	0.9 for prayer area	Net area
	Less concentrated – outdoor buildings, restaurants, dining areas, seated waiting areas	1.4	Net area
	Conference rooms, meeting rooms	1.4	Net area
	Exhibition halls, production studios	1.4	Net area
	Bench seating	455 mm linear	Net area
	Fixed seating spaces (cinemas, theatres and similar)	According to number of fixed seats provided	Net area
	Waiting areas – standing	0.65	Net area
	Kitchens (e.g. in restaurants, not private residential)	9.3	GA
	Library – reading areas	4.6	Net area
	Library – stack areas	9.3	GA
Assembly	Swimming pools – water surface	4.6	GA
	Swimming pools – deck	2.8	GA
	Exercise room – without equipment	1.4	GA
	Exercise room – with equipment	4.6	GA
	Stages	1.4	Net area
	Gaming, amusement arcades	1.0	GA
	Skating rinks	4.6	GA
	Food courts – seating areas	1.4	Net area
	Airport waiting areas	1.4	GA
	Airport baggage claim	1.9	GA
	Art galleries, museums	5.0	GA
Business	Office – enclosed offices, low concentration	9.3	GA
	Office – open offices, high concentration	4.6	GA

Table B.2 Occupant load factor per person

Occupancy	Use	Occupant load factor (m^2 per person unless otherwise stated)	Area used for calculation
Retail	Retail shops	5.6	GA
	Department stores, multi-level retail	3.7	GA
	Floors used for goods not accessed by public	27.9	GA
Mall	Mall – less than 14,000 m^2 in area	2.8	Gross leasable area in accordance with UAE FLSC [Ref. B.1]
	Mall – more than 14,000 m^2 in area	3.3	Gross leasable area in accordance with UAE FLSC [Ref. B.1]
Industrial	Factories	9.3	GA
Storage	Warehouse	27.9	GA
Educational	Classrooms	1.9	Net area
	Laboratories, vocational	4.6	Net area
Residential	Accommodation, shared sleeping spaces	5.0	Net area
	Labour accommodation – sleeping spaces	3.7	Net area
Healthcare		Refer to DHA regulations and guidelines [Ref. B.3 to Ref. B.18]	

Table B.2 Occupant load factor per person (continued)

The occupant load factors in Table B.2 generally align with UAE FLSC [Ref. B.1] with the exception of residential. However, exit widths and number of exits from a room, space, floor and building shall be calculated using the occupant load factors in Table 3.13, Ch. 3 of UAE FLSC [Ref. B.1].

Any space or building not listed in Table B.2 above shall conform to the occupant load factors noted in Table 3.13, Ch. 3 of UAE FLSC [Ref. B.1].

B.5.2 Minimum room sizes

The net area and clear dimension of a room/space shall be not less than the minimum sizes given in Table B.3. Minimum sizes for some other occupancies are given in B.9.

Occupancy/use	Minimum area (m^2)	Minimum dimension – length and width of a room (m)
Residential living space (bedroom, living room)	10.5	3 (See Figure B.23)
Residential studio (including bathroom and kitchen space)	21	3
Housekeeper's/guard rooms (single occupancy only exclusive of toilet area)	4.5	2.1
Retail shop	—	2.4
Retail showroom	—	9
Enclosed office	—	2.4
Enclosed kitchen	5.4	1.8
Bathroom and toilets	Shall meet fixture clearances noted in B.8.1.5	
Toilet stalls	Shall conform to B.8.1.4	
Hotel establishment	Refer to applicable DTCM classification criteria [Ref. B.19 to Ref. B.36]	
Healthcare facilities	Refer to DHA regulations and guidelines [Ref. B.3 to Ref. B.18]	
Fire pump rooms	Refer to Table 1.9, Ch. 1 of UAE FLSC [Ref. B.1] for minimum room sizes dependent upon equipment selected and other requirements such as proximity to exit stairways.	
Emergency command centre	19	3

Table B.3 Minimum room sizes

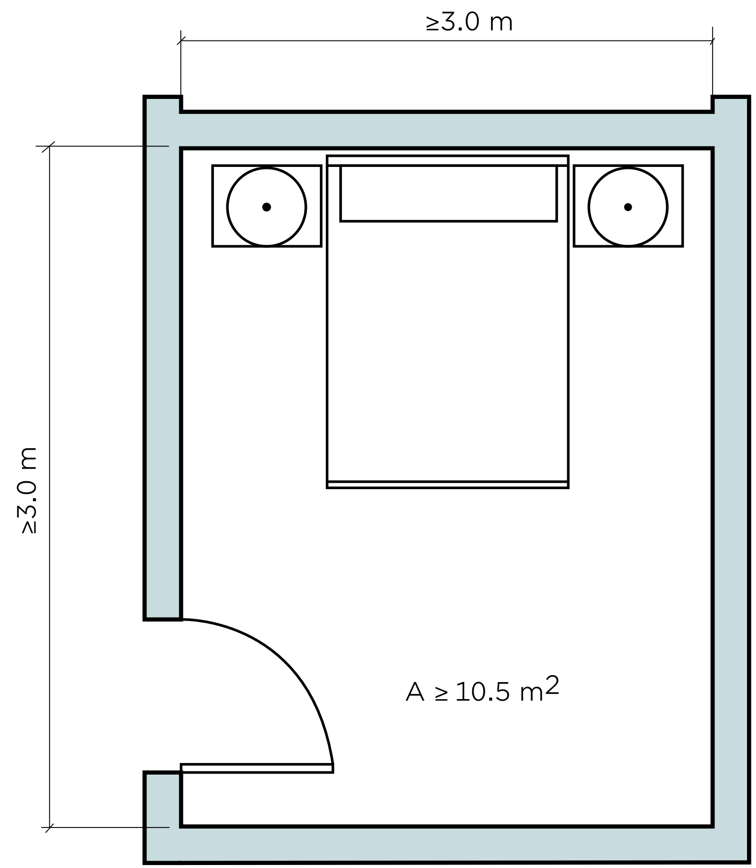


Figure B.23 Minimum residential living space dimensions

Key

A: Room area

The manoeuvring space between kitchen counters or adjacent to a single-sided kitchen counter shall be not less than 1.2 m, as shown in Figure B.24.

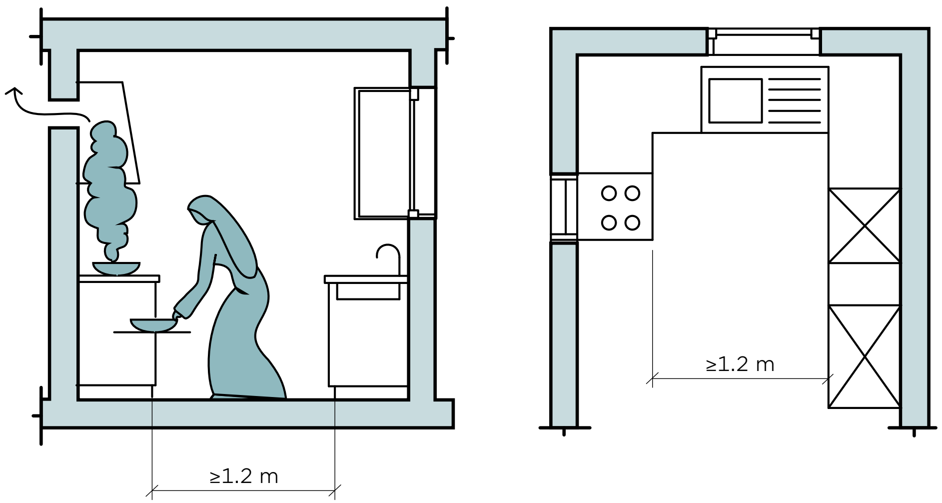


Figure B.24 Manoeuvring space within kitchen

B.5.3 Minimum clear heights

The clear height of a space shall be not less than the minimum values given in Table B.4.

The clear heights shall be calculated from FFL to any structural suspended element or ceiling soffits, as shown in Figure B.25.

Occupancy	Use	Minimum clear heights (m)
Assembly	Awqat mosque prayer hall	3.8
	Jumaa mosque prayer hall	5.0
	Prayer rooms	2.7
	Ballrooms, multipurpose assembly halls	2.7
Business	Offices	2.5
Retail, mall	Retail shops/stores, showrooms	2.5
Educational	Schools, nurseries and kindergartens – classrooms	2.7
Healthcare	—	Refer to DHA regulations and guidelines [Ref. B.3 to Ref. B.18]
Residential, hotel	Living and bedroom spaces	2.7

Table B.4 Minimum clear heights

Occupancy	Use	Minimum clear heights (m)
Industrial	Industrial equipment areas	Minimum headroom for industrial equipment access shall conform to Table 3.4, Ch. 3 of UAE FLSC [Ref. B.1].
Common areas	Parking – for light vehicles	2.3
	Corridors, passageways and elevator lobbies	2.3
	Occupiable spaces (other than listed above)	2.3
	Washrooms and toilets	2.3
	Storage and utility space	2.3
	Stairways	2.03 m above the stair treads and 2.3 m above the stair landings (see B.6.4.1.15)
	Means of egress	2.3 In not more than 50% of the ceiling area, protruding objects may extend below the minimum clear ceiling height, where a minimum headroom of 2.03 m from FFL shall be provided.
	Fire pump room	2.5 (see Table 1.9, Ch. 1 of UAE FLSC [Ref. B.1])

Table B.4 Minimum clear heights (continued)

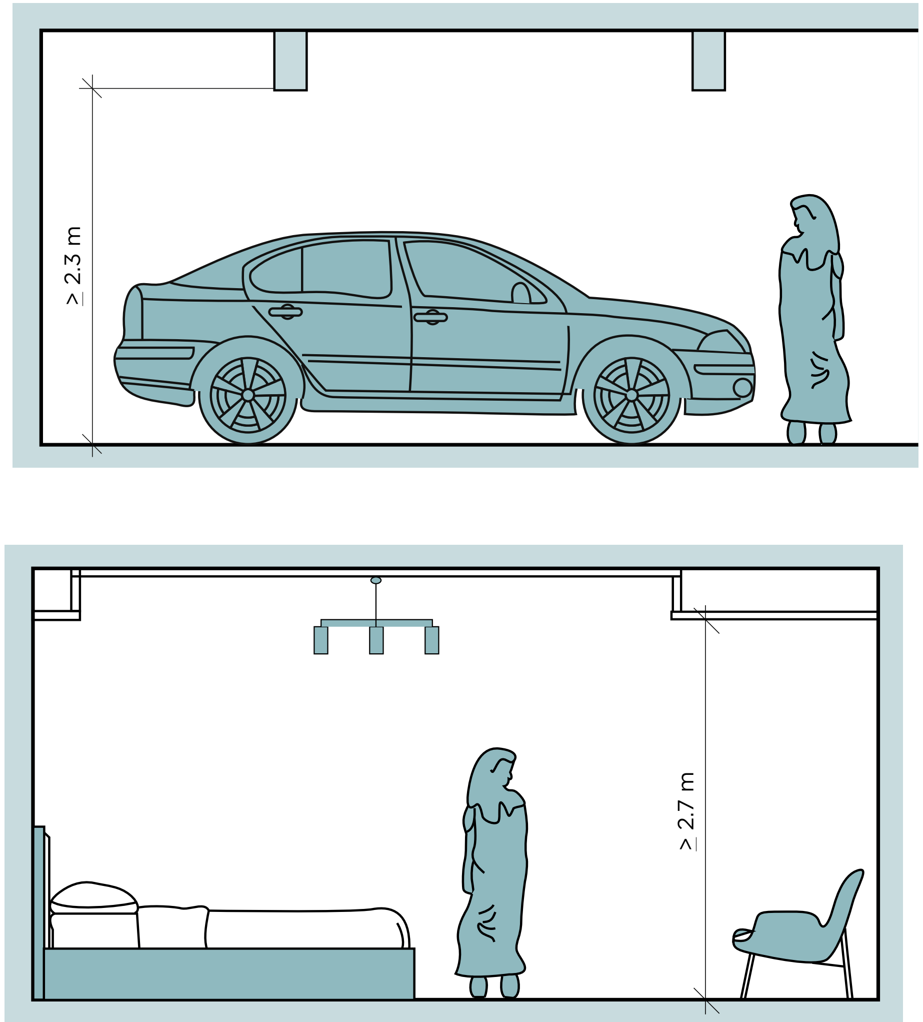


Figure B.25 Clear heights

B.6 Circulation requirements and openings

B.6.1 Walking surfaces

All walking surfaces, including accessible routes, shall conform to the requirements of C.5 & C.7.2.

Changes in level in means of egress of more than 13 mm, but not more than 535 mm, shall be achieved either by a ramp conforming to C.5.9.1 or by a stair conforming to B.6.4.1.

B.6.2 Corridors

B.6.2.1 Minimum clear widths

The clear width of corridors shall be not less than the values given in Table B.5. Where a corridor forms part of an accessible route, it shall also meet the requirements specified in C.5.

Occupancy/use	Minimum clear corridor width (m)
Assembly, other public use buildings	1.5 for single loaded corridors 1.8 for double loaded corridors
Residential (common corridor)	1.5 for single sided residential units 1.8 for double sided residential units (See Figure B.26 as example for corridor arrangement in residential building)
Retail	1.8
Mall and retail areas > 3,600 m² GA per floor (pedestrian way)	6 for double sided units 3 for single sided units
Healthcare	Refer to Dubai Health Authority's (DHA) regulation and guidelines [Ref. B.3 to Ref. B.18] for specific requirements and UAE FLSC [Ref. B.1]
Educational	2.1 for single sided classroom 3 for double sided classroom
Business – Offices	1.5 for single loaded corridors 1.8 for double loaded corridors
Hotel establishment (common corridor)	1.5 for single loaded corridors 1.8 for double loaded corridors Refer to DTCM classification criteria [Ref. B.19 to Ref. B.36] for specific requirements.
Internal corridors inside residential and hotel apartment units	1.0 (See Figure B.26 as example for corridor arrangement in residential building)
Service corridors	1.2
Corridors in all buildings	Section 5, Ch. 3 of UAE FLSC [Ref. B.1] mandates minimum clear corridor widths per occupancy type.
Exit passageways	If applicable, Table 3.8, Ch. 3 of UAE FLSC [Ref. B.1] mandates minimum clear exit passageway widths.

Table B.5 Minimum clear corridor widths

NOTE: Retail units under a single roof or not fire separated and having a ground floor GA of more than 3,600 m², irrespective of the number of storeys, are treated as a mall in accordance with Ch.1 of the UAE FLSC [Ref. B.1].

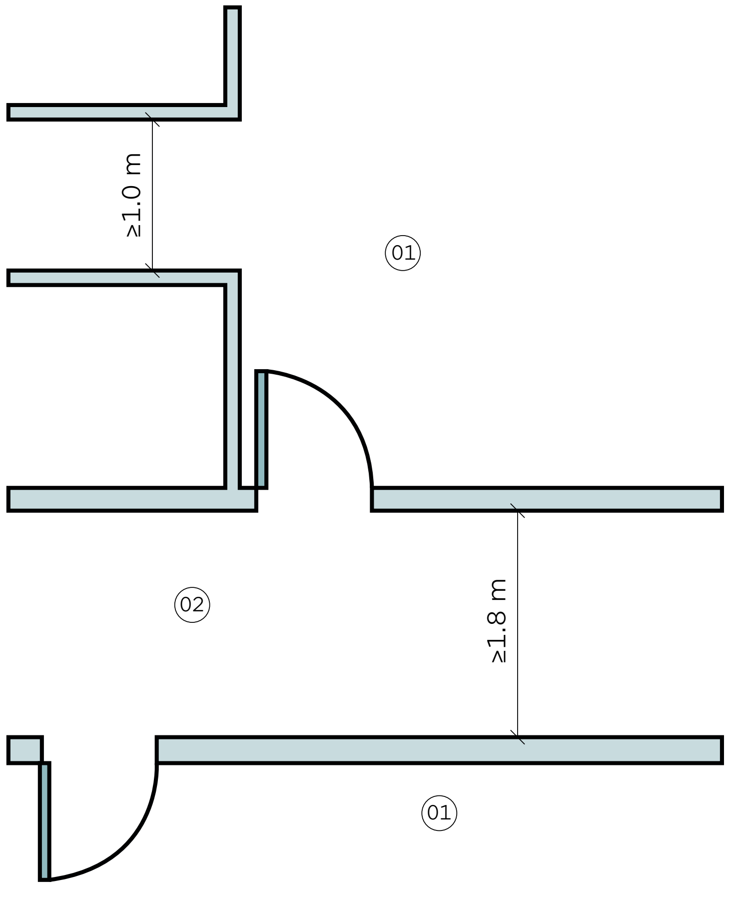


Figure B.26 Corridor arrangement in residential building example

Key
01: Apartment
02: Public corridor

B.6.2.2 Fire resistance rating

Exit access corridors shall be 1 h fire resistance rated when required by Table 1.11a, Ch. 1 of UAE FLSC [Ref. B.1].

Exit passageways shall achieve the fire resistance rating and construction requirements of Table 3.8, Ch. 3 of UAE FLSC [Ref. B.1].

B.6.2.3 Kiosks in mall pedestrian ways

Kiosks are allowed along a mall pedestrian way under the following conditions prescribed by Table 1.9, Ch. 1 of UAE FLSC [Ref. B.1].

a) The minimum corridor width between the kiosks and the adjacent shop or construction shall be 3 m as shown in Figure B.27.

b) The minimum horizontal separation distance between 2 adjacent kiosks shall be not less than 6 m.

c) The maximum area of a single kiosks or group of kiosks shall be 18 m^2 collectively, or 28 m^2 in an open mall.

d) Kiosks shall conform to the fire safety system provisions and construction materials required of Table 1.9 and Section 7.1.40, Ch. 1 of UAE FLSC [Ref. B.1].

B.6.3 Elevator lobbies

Elevator lobby design shall conform to Part D.

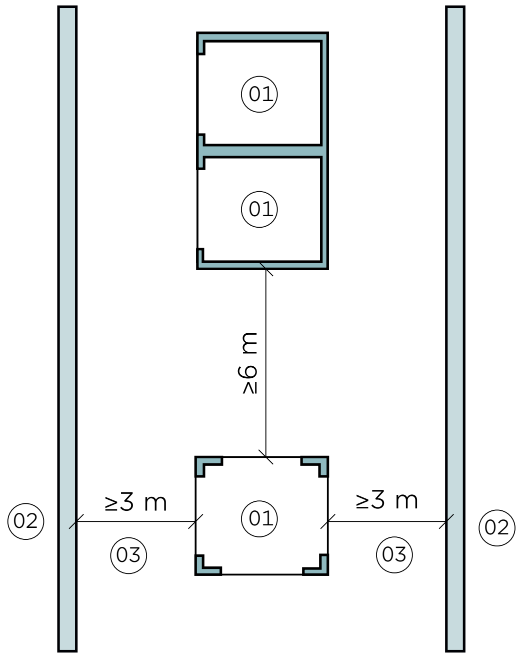


Figure B.27 Kiosk provision within malls

Key
01: Kiosk
02: Adjacent construction
03: Corridor width

B.6.4 Vertical circulation in buildings

B.6.4.1 Stairways

B.6.4.1.1 General

The minimum number of exit stairways, stairway width, stairway separation, exit discharge arrangements and fire resistance rating of the staircase shall be determined in accordance with Ch. 3 of UAE FLSC [Ref. B.1].

The architectural requirements of a stairway design in this subsection align with or exceed UAE FLSC [Ref. B.1].

At least one protected exit stairway shall extend to all roofs.

B.6.4.1.2 Exit staircase construction

Exit stairways shall be enclosed in fire resistance rated reinforced concrete (RCC) staircase construction when required by Table 3.4, Ch. 3 of UAE FLSC [Ref. B.1], except staircases serving low-rise buildings or low-depth underground buildings where 2 h fire resistance rated blockwork construction is permitted.

RCC staircases with separate cores but a common RCC divider are acceptable only in low-rise and mid-rise buildings, provided that the whole staircase conforms to building construction type and separation distance between exits.

B.6.4.1.3 Stairway width

All stairways shall have a clear width of not less than 1,200 mm. The minimum width of an exit stair shall be determined in accordance with Section 4, Ch. 3 of UAE FLSC [Ref. B.1] depending upon the number of occupants it serves.

The required width of a stairway shall be measured from wall to the clear available width of the step (see Figure B.28). The maximum projections of handrails allowed in this required width is 100 mm on each side, at a height of 865 mm to 965 mm (see Figure B.28).

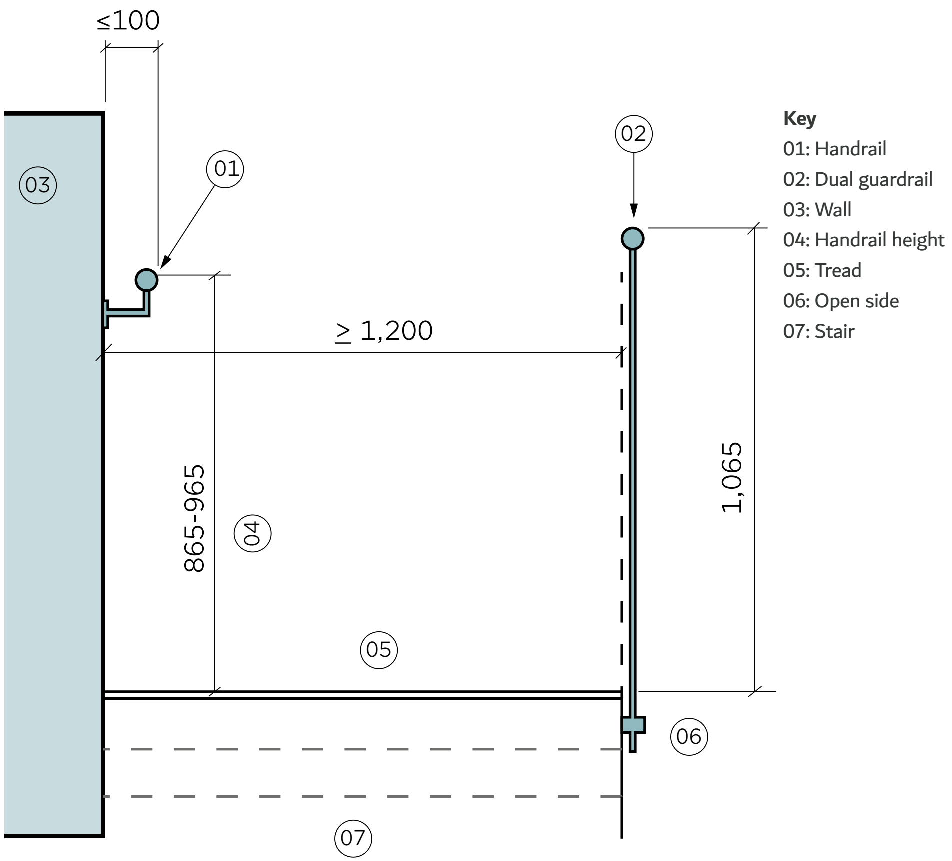


Figure B.28 Handrail encroachment

B.6.4.1.4 Stair risers and treads

Stair riser height as measured in Figure B.29 shall be in the range 100 mm to 180 mm.

Riser heights shall be as uniform as possible throughout each stair flight between landings. Where riser heights are adjusted to meet acceptable stair treads, flights and arrangements, there shall be no more than 10 mm difference in riser height within a single flight.

Stair treads shall have a depth of not less than 280 mm.

The tread slope shall not exceed 21 mm/m (2% slope).

Tread depth shall be as uniform as possible throughout the stair. There shall be no more than 10 mm difference in tread depth within a single flight.

Further recommendations on riser height and tread depth provided for regular use stairs and external steps are given in B.6.4.1.6.

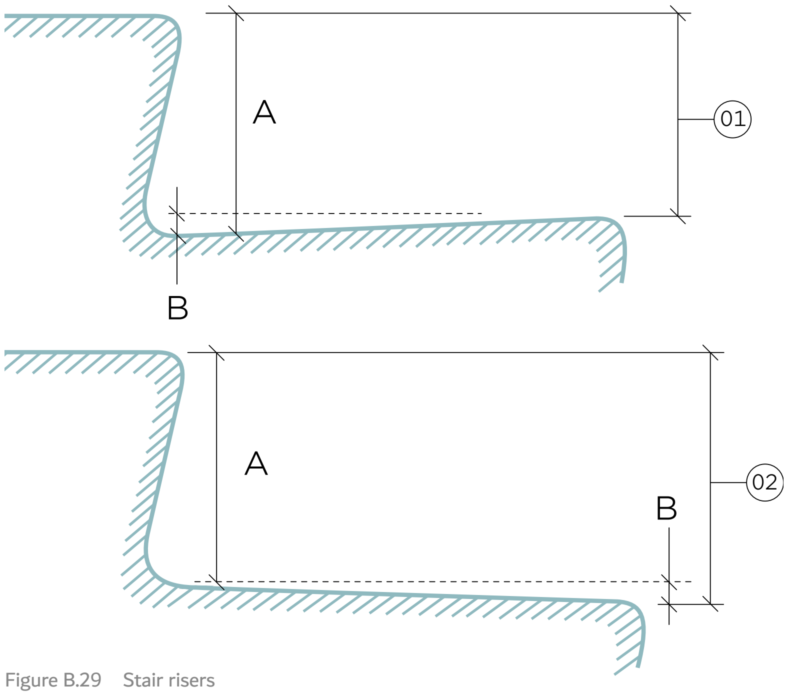


Figure B.29 Stair risers

Key
01: Stair risers = A – B
02: Stair risers = A + B

B.6.4.1.5 Landings

The height between landings shall be not more than 3,660 mm.

Every stair shall have a landing at the door opening. The landing width shall be not less than the required stairway width.

A staircase door shall not encroach in its swing into more than one half of the landing width (see Figure B.30).

The landing width shall not decrease in width along the direction of egress travel.

The landing width is not required to exceed 1,200 mm in the direction of travel, provided that the stairway has a straight run.

The landing slope shall not exceed 21 mm/m 2% slope.

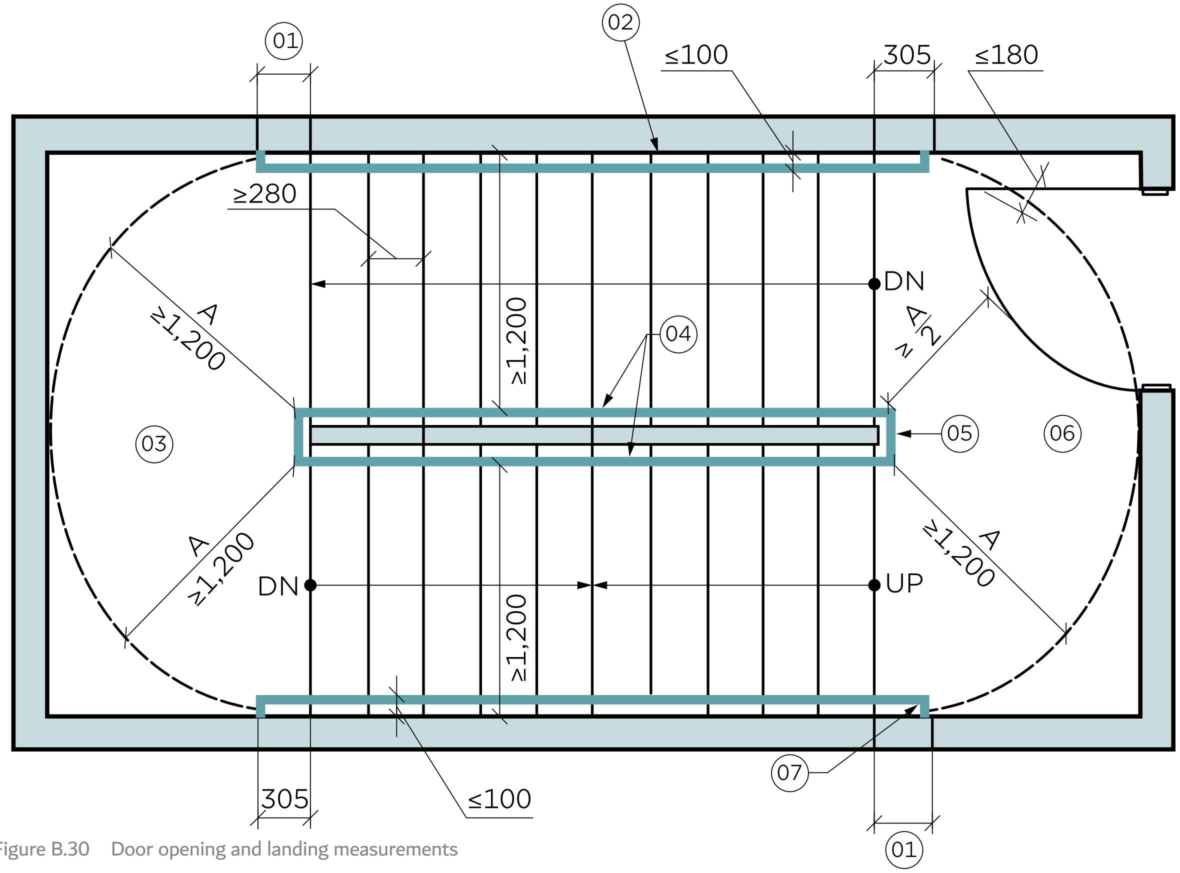


Figure B.30 Door opening and landing measurements

Key

01: Greater than or equal to tread depth
02: Finish wall
03: Intermediate landing
04: Dual guardrail
05: Continuous handrail
06: Top landing
07: Return of handrail to wall required
A: Minimum stairway width

B.6.4.1.6 Regular use and external stairs

The following requirements and recommendations apply to stairs used for daily circulation and external stepping.

a) Building entrance steps, landscaping steps and external circulation shall meet the requirements given in Table B.6.

b) For regular use stairs in buildings, where the stairs serve as a primary means of vertical circulation, conformity to Table B.6 is recommended.

Stair element	Requirement for stairs
Tread depth	≥300 mm
Riser height	150 mm to 165 mm (see Figure B.31)
Number of steps	2 steps min. 14 steps max.

Table B.6 Stair flight and steps

The step edge shall present a slip-resistant surface with a minimum reflectance contrast of 30 LRV points against the step surface (see Figure B.32).

It is recommended that a warning surface is provided at the descending edge of each stair flight, in accordance with B.6.4.1.14 and as shown in Figure B.32. The warning surface shall conform to the requirements in Part C.

Illumination along the whole flight of stairs should be not less than 200 lux.

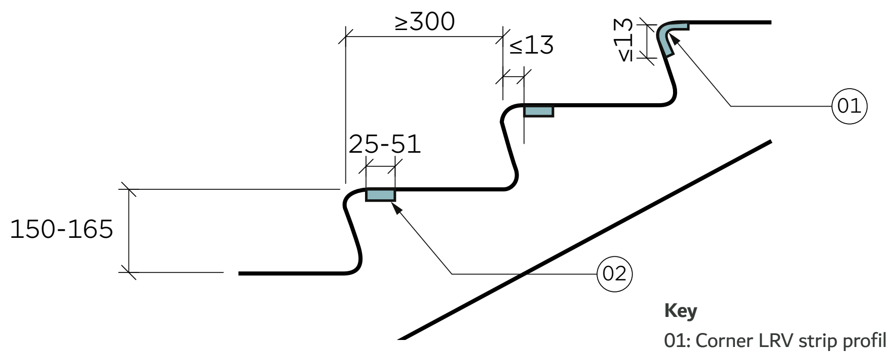


Figure B.31 Step dimensions for regular use stairs

Key
01: Corner LRV strip profile
02: Tread LRV strip profile

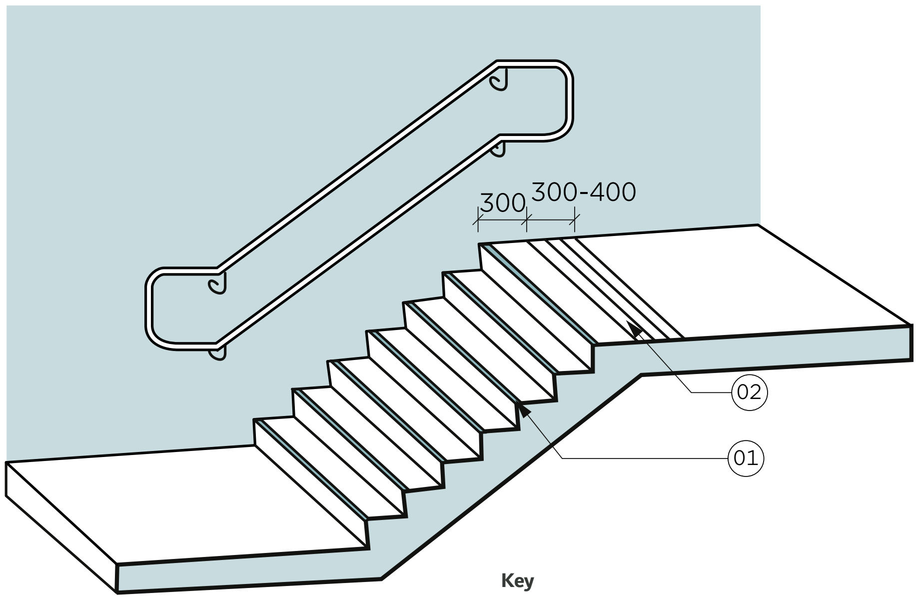


Figure B.32 Warning surfaces at stairs

Key
01: LRV 30 points contrast at step edge
02: Warning surface

B.6.4.1.7 Handrails

Stairs shall have handrails on both sides in accordance with the arrangement and dimensions shown in Figure B.33.

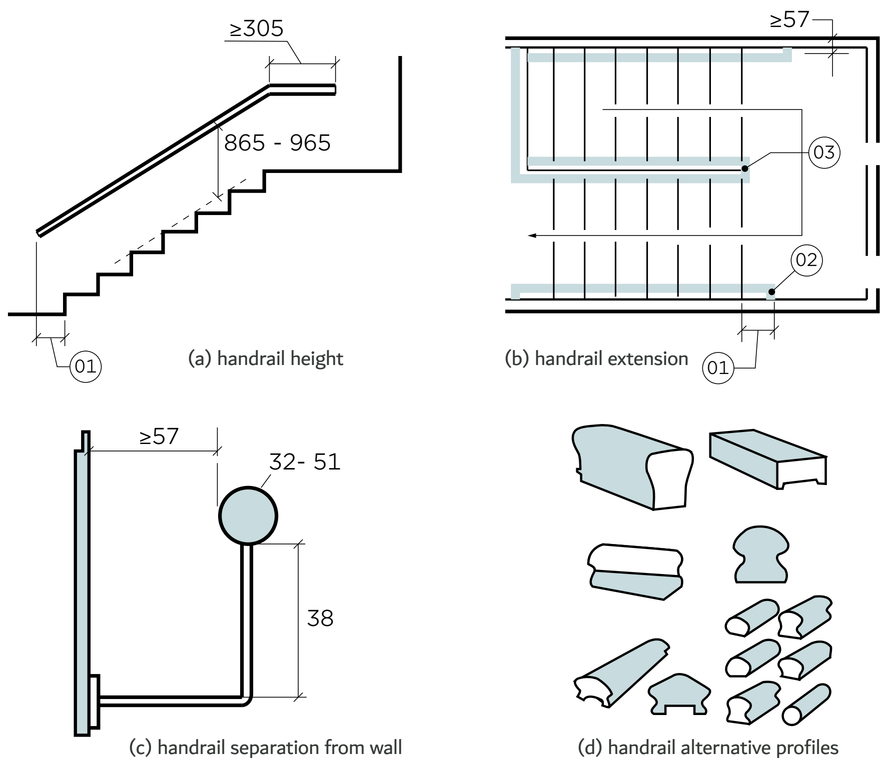


Figure B.33 Handrail specifications

Key

01: One tread depth handrail extension

02: Return of handrail to wall required

03: Handrail turn required

Handrails on stairs shall be located between 865 mm and 965 mm above the surface of the tread, measured vertically to the top of the rail from the leading edge of the tread.

Regular use stairs and external steps shall have an additional handrail, mounted at a height between 650 mm and 750 mm, to facilitate use by children and people of short stature.

Handrails forming part of a guardrail can exceed 965 mm, but shall not exceed 1,065 mm (see B.6.4.1.8), measured vertically to the top of the rail from the leading edge of the tread.

Handrails shall be installed to provide a clearance of not less than 57 mm between the handrail and the wall to which it is fastened.

Handrails shall be provided within 760 mm of all portions of the required means of egress width in stairs. Where intermediate handrails are provided, the clear width between handrails shall be a minimum of 760 mm along the natural path of travel.

Handrails shall continue for the full length of each flight of stair.

Inside handrails shall be continuous and graspable between flights at landings.

Handrails shall have circular cross-section with an outside diameter of not less than 32 mm and not more than 51 mm.

Handrail shape that is other than circular (see Figure B.34) shall be with a perimeter dimension of not less than 100 mm, but not more than 160 mm, and with the largest cross-sectional dimension not more than 57 mm, provided that graspable edges are rounded so as to provide a radius of not less than 3.2 mm.

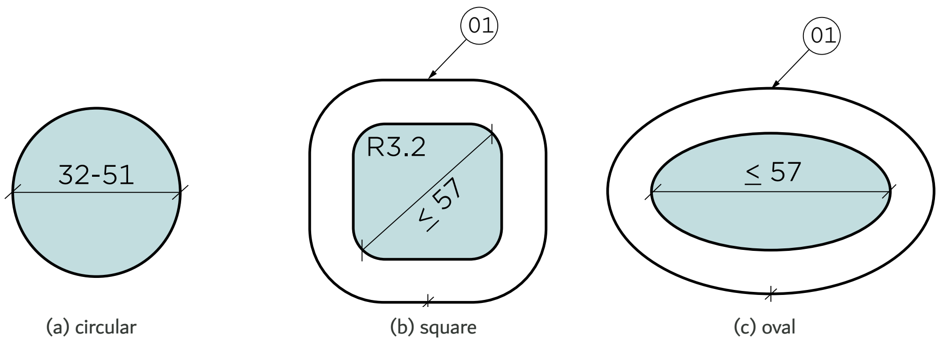


Figure B.34 Cross-sections of handrails

Key

01: 100 mm to 160 mm perimeter

Handrail brackets shall not project horizontally beyond the sides of the handrail within 38 mm of the bottom of the handrail and provided that, for each additional 13 mm of handrail perimeter dimension greater than 100 mm, the vertical clearance dimension of 38 mm is reduced by 3.2 mm.

Handrail brackets shall have edges with radius not less than 0.25 mm.

Handrails shall have a reflectance contrast of not less than 30 points LRV against its background.

Handrail materials exposed to the sun shall not reach temperatures that can harm the users.

B.6.4.1.8 Guardrails

Guardrails as shown in Figure B.35 shall be provided for every stairway where the elevated surface is more than 760 mm from finished ground level.

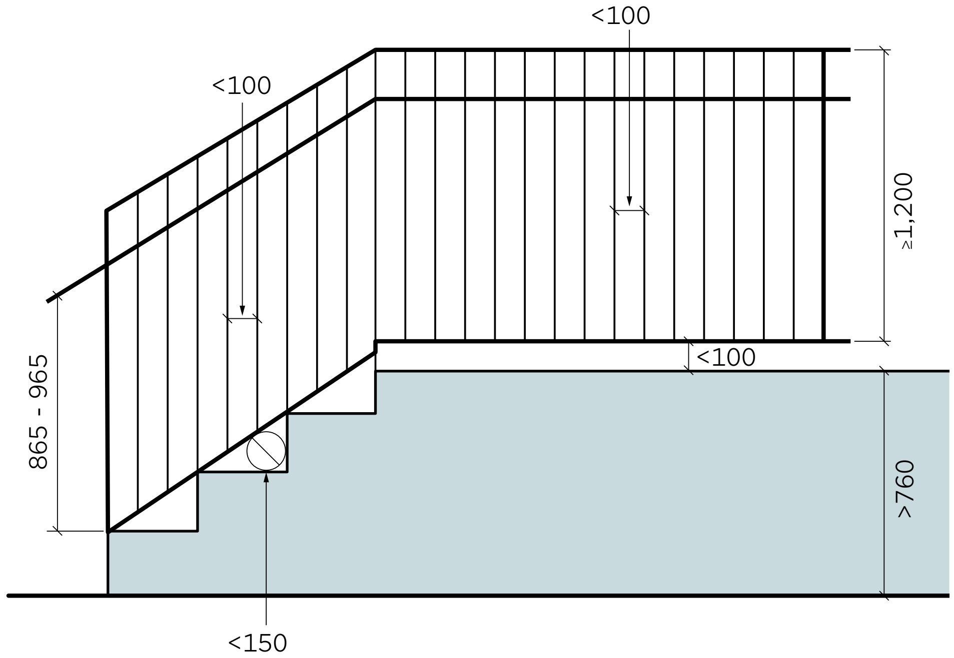


Figure B.35 Guardrail to a stairway

Such guardrails shall not encroach on the required clear width of the stairway.

Guardrails shall be not less than 1,200 mm high, measured vertically to the top of the guardrail from the leading edge of the tread.

In case of stairway or ramp handrails that form part of a guardrail, the height of the guardrail can be reduced to 1,065 mm.

Open guardrails shall have intermediate rails or an ornamental pattern up to a height of 865 mm, such that a sphere 100 mm in diameter is not able to pass through any opening.

The triangular openings formed by the riser, tread, and bottom element of a guardrail at the open side of a stair shall be of such size that a sphere 150 mm in diameter is not able to pass through the triangular opening.

Guardrails at landings or balconies over stairways shall also conform to B.4.2.5.2.

All staircases shall include signage indicating the floor level, wing of the building (if applicable), and direction of egress (see Figure B.36).

Signage shall be in English and Arabic and shall conform to B.11.4.5.

Signage shall be provided inside the staircase at floor landings. It is not required on mid-landings and shall not be located on door leaves. It shall be clearly visible for stair users, located at a height of not less than 1,220 mm from the floor landing to the bottom of the sign. The top of the signage shall be located not more than 2,135 mm above the floor landing.

Lettering shall be not less than 25 mm high.

Figure B.36 Example stair signage

B.6.4.1.10 Exterior stairways

An open outside exit stair shall not be provided in any building at more than 15 m from finished ground level.

Outside stairs more than 11 m above the finished ground level, shall be provided with an opaque visual obstruction not less than 1,200 mm in height.

Outside stairs shall be separated from the interior of the building by construction with the required fire resistance rating in accordance with Table 3.4, Ch. 3 of UAE FLSC [Ref. B.1].

B.6.4.1.11 Scissor or interlocking stairs

In accordance with Ch. 3 of the UAE FLSC [Ref. B.1], interlocking or scissor stairways (see Figure B.37) shall be counted as a single exit. As such, the two interlocking sections of a scissor staircase (see Figure B.38) are not required to be separated by fire resisting construction.

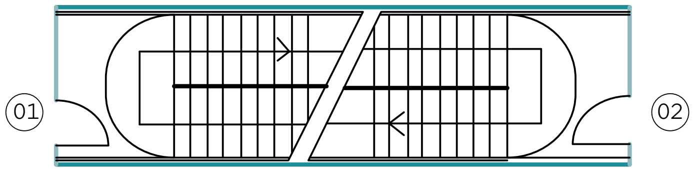


Figure B.37 Scissor stairways in plan

Key

01: Section 1

02: Section 2

B.6.4.1.12 Winders, spiral or curved stairs

Winders, spiral or curved stairs (see Figure B.38) are not permitted in means of egress, with the following exceptions:

a) industrial occupancies where the winders provide access/egress from equipment areas;

b) storage occupancies where the winders provide access/egress from mezzanines which are only used for storage and not office space; and

c) retail areas where the winders provide access/egress from mezzanines where goods are stored.

Winders may be used in stairs which are not exit stairs.

Winders shall have a minimum tread depth of 150 mm at their narrowest, and a minimum tread depth of 280 mm when measured 305 mm from the narrowest edge.

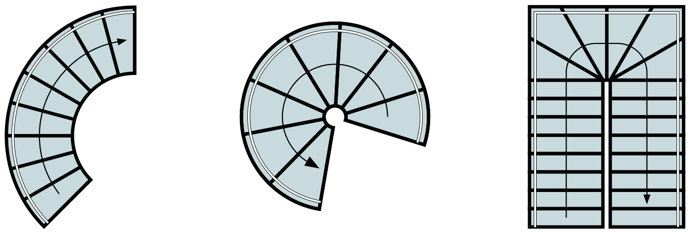


Figure B.38 Examples of curved stairs, spiral stairs and winders

Spiral stairs shall meet the following requirements.

1) Spiral stairs shall have:

   i) a minimum clear width of 660 mm;

   ii) a minimum headroom of 2,030 mm;

   iii) a maximum riser height of 240 mm.

2) Treads shall have a depth not less than 190 mm at a point 305 mm from the narrower edge (see Figure B.39).

3) All treads shall be identical.

4) Handrails shall be provided in accordance with B.6.4.1.7.

5) The turn of the stairway shall be such that the outer handrail is at the right side of descending users.

Curved stairs shall have tread depth of not less than 255 mm at a point 305 mm from narrowest edge (see Figure B.40).

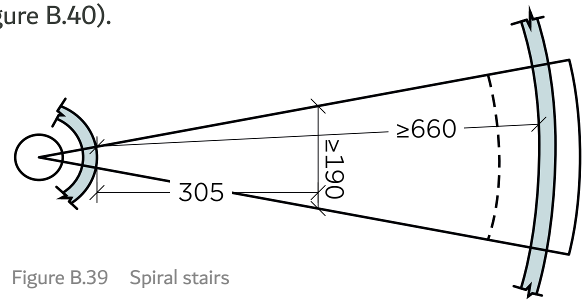


Figure B.39 Spiral stairs

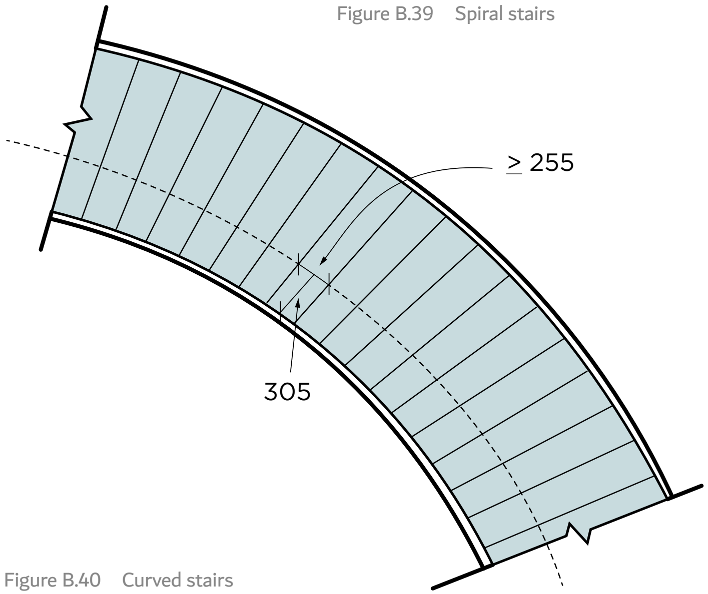


Figure B.40 Curved stairs

B.6.4.1.13 Equipment access

Industrial equipment access shall meet the following requirements.

a) Horizontal dimension of walkway, landing or platform shall be not less than 560 mm.
b) Stair or ramp width shall be not less than 560 mm.
c) Tread width shall be not less than 560 mm.
d) Tread depth shall be not less than 255 mm.
e) Riser height shall be not more than 230 mm
f) Height between landings shall be not more than 3,660 mm.
g) Head room shall be not less than 2,030 mm.
h) Width of door opening shall be not less than 560 mm.
i) Railings shall be 865 mm to 965 mm in height and may terminate directly above top and bottom risers.

B.6.4.1.14 Surfaces and floor markings

Stair treads and landings shall be free of projections or lips that could trip stair users.

Stair treads and landings within the same stairway shall have consistent surface traction.

Where contrasting marking is applied to stairs, such marking shall meet the following requirements.

a) Exit stair treads shall incorporate a marking strip that is applied as a paint/ coating or be made from a material that is integral with the nosing of each step.
b) Surface-applied marking strips using adhesive-backed tapes shall not be used.
c) The marking strip shall be installed along the horizontal leading edge of the step and shall extend the full width of the step.
d) The marking strip shall have a horizontal width between 25 mm and 51 mm.
e) The marking strip shall be not more than 13 mm from the leading edge of each step and shall not overlap the leading edge of the step by more than 13 mm down the vertical face of the step. See Figure B.32.

B.6.4.1.15 Minimum headroom

Head room in stairways shall be not less than 2.03 m, measured vertically above a plane, parallel to the most forward projection of the stair tread (see Figure B.41), and not less than 2.3 m above landings.

Key
01: 1 tread depth extension for handrail
02: Handrail

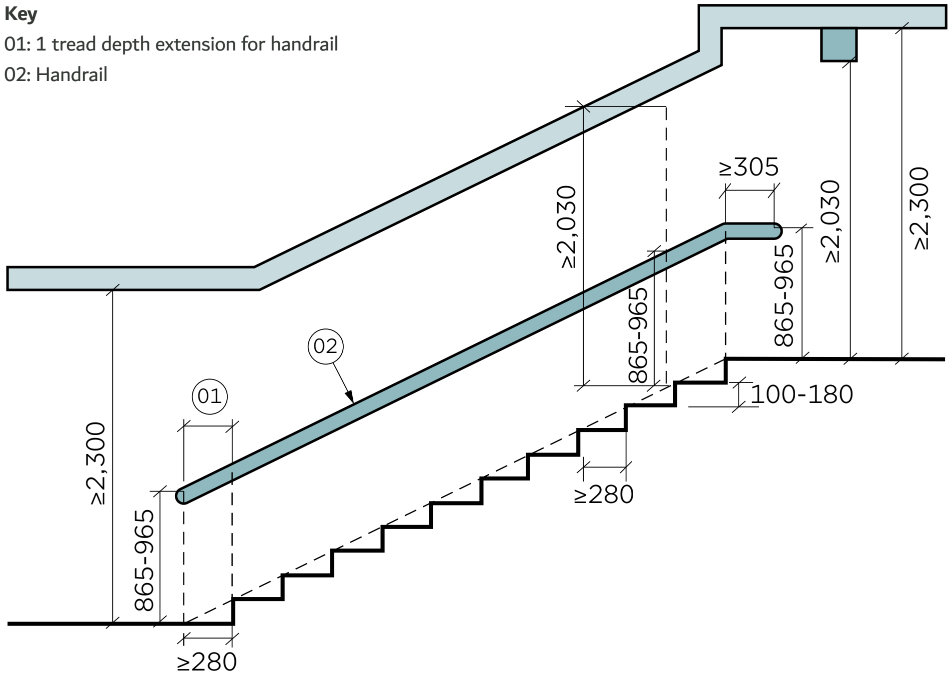


Figure B.41 Staircase arrangement

B.6.4.1.16 Examples of compliant stair arrangements

The stairway designs in Figure B.42 are deemed to be compliant with B.6.4.1 for the following reasons.

a) They have regular flights and consistent dimensions of steps.

b) There is a direct exit at discharge level from under the stair flight.

c) Where two doors on opposite sides are provided, each door swing does not obstruct more than half of the required landing width.

Straight run stairs are acceptable, provided that the height between landings is not more than 3,660 mm.

B.6.4.2 Ramps

Pedestrian ramps in buildings shall conform to C.5.9.

Guardrails shall conform to B.6.4.1.8. Handrails shall conform to C.5 or B.6.4.1.7. as applicable.

Materials of construction and fire resistance of ramps shall conform to Section 3.7, Ch. 3 of UAE FLSC [Ref. B.1].

B.6.4.3 Elevators

Elevators and vertical transportation systems shall conform to Part D.

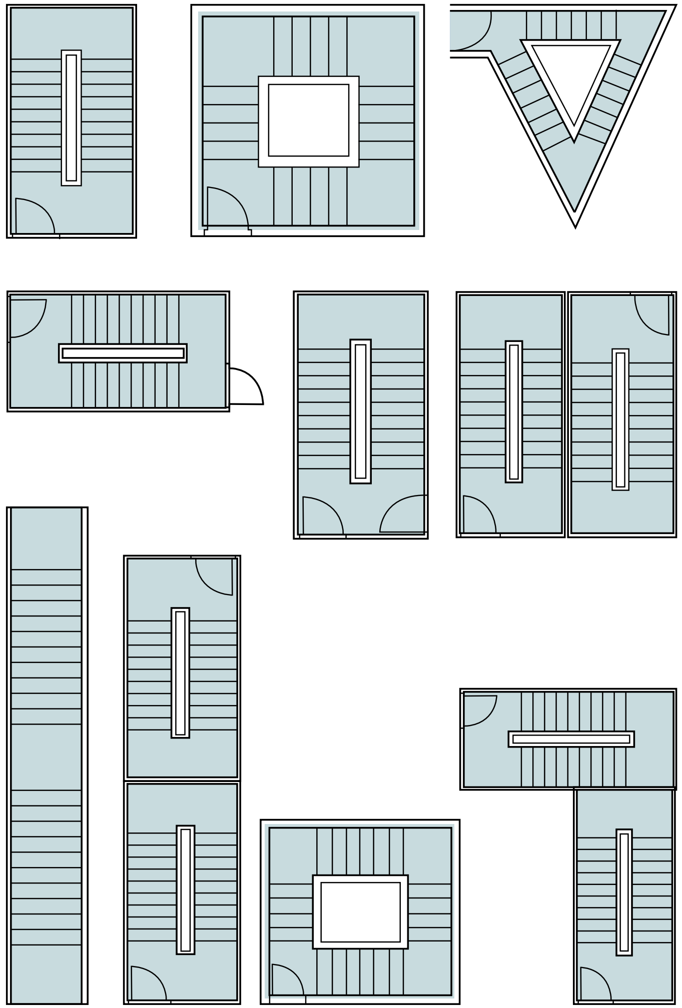


Figure B.42 Examples of compliant stair treads, flights and arrangements

B.6.5 Building openings

B.6.5.1 Doors

The door clear width shall be not less than the minimum values given in Table B.7 and Figure B.43.

Door location	Minimum door clear width (mm)
Entry doors, general	915
Bathrooms and toilets (excluding toilet stalls)	815
Exit doors, exit access doors	915 or greater depending upon the occupant load served, as specified in Section 3, Ch. 3 of UAE FLSC [Ref. B.1]

Table B.7 Minimum door clear width

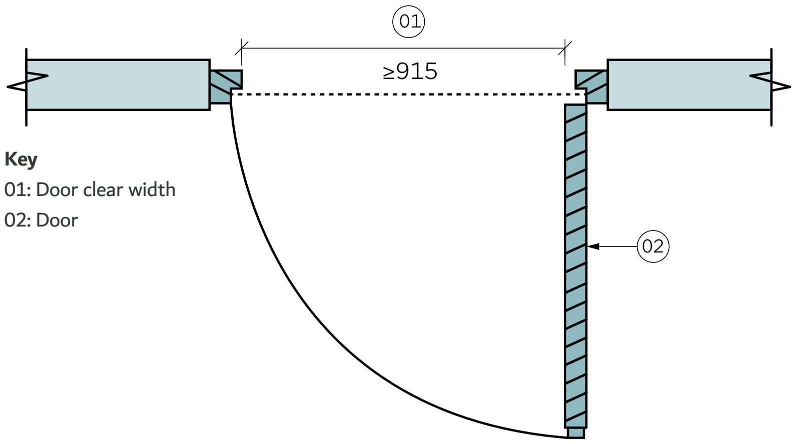


Figure B.43 Minimum door clear width

The clear distance between two doors openings shall be not less than 1.2 m, as shown in Figure B.44.

Accessible door requirements are given in C.5.8.

The design of doors as exits shall conform to the applicable requirements of Section 3.2, Ch. 3 of UAE FLSC [Ref. B.1] depending upon the location and purpose of the door, including:

a) direction of door swing;
b) limitations on when a particular door type (side hinged, powered, sliding, revolving, turnstile) can be used;
c) door hardware;
d) encroachment of the door swing into corridors/stairs;
e) fire resistance rating; and
f) security arrangement.

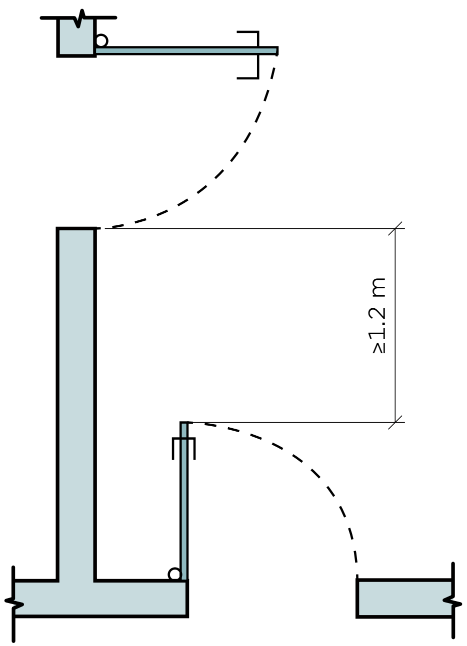


Figure B.44 Clearances between two adjacent doors.

B.6.5.2 Windows and daylighting

B.6.5.2.1 Minimum area of windows

Daylighting provisions for habitable and occupiable spaces shall conform to Table B.8 and Figure B.45. Housekeeper's rooms shall be provided with adequate daylighting similar to living spaces as shown in Table B.8 and Figure B.45.

The following requirements and recommendations apply to windows.

a) When windows are equipped with mechanical opening means, this shall be positioned at a height between 900 mm to 1,200 mm from the room FFL. Window latches for non-accessible spaces can be positioned higher than 1,200 mm.

b) Operable portion of the window shall be positioned at a safe height and equipped by means of fall protection, according to E.9.4.

c) The required amount of daylighting can be provided through skylights or windows or combination of both for all building spaces. The skylight glazing should be positioned at a slope of 15° or more from vertical and directly connected to the space it serves.

d) Windows may only face neighbouring plots when the required setback is achieved and when the requirements for external fire spread are achieved as per Sections 2.7 and 2.8, Ch. 1 of UAE FLSC [Ref. B.1].

Daylighting modelling to justify lightling levels can be used to reduce minimum opening percentage requirements, provided that minimum lux levels are achieved. Lux levels from daylight shall achieve a minimum of 150 lux in bedrooms and living rooms.

Occupancy	Use	Minimum window glazing area (percentage of window net glazing area to room area)
Business	Offices – workstation areas	10%
Residential and hotel	Living, bedroom spaces (excluding kitchen area)	10%
Educational	Schools, nurseries and kindergartens – classrooms	10%
Assembly	Mosques	10%

Table B.8 Minimum percentage of window to floor area

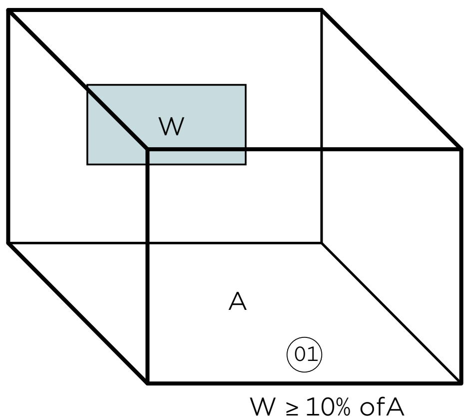


Figure B.45 Window glazing area to room area ratio

Key
01: Room
A: Room area
W: Window net glazing area

B.6.5.2.2 Daylighting

For habitable spaces to receive adequate natural light through windows, the room depth should not exceed three times the width of the wall in which the window is located (see Figure B.46).

When the room depth exceeds three times the width, additional daylighting should be provided through an additional window meeting the criteria set in B.6.5.2.1, and along any of the other sides of the room that have direct access to daylighting.

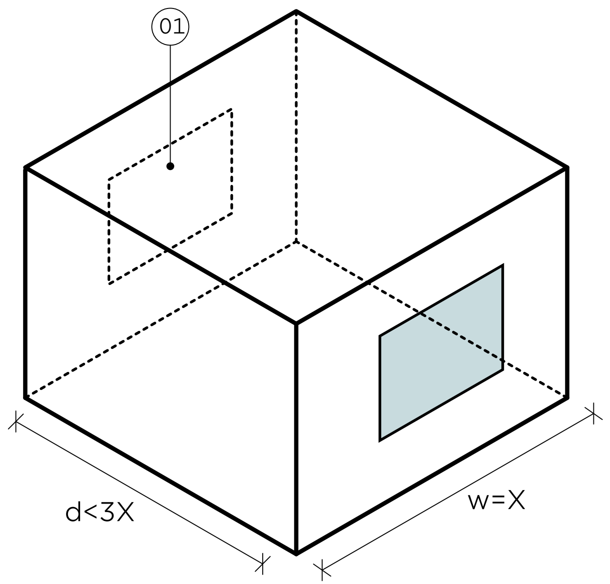


Figure B.46 Windows in rooms

Key
01: Additional opening

B.6.5.2.3 Access to views

Business, residential, educational and hotel occupancies shall provide direct line of sight (views) to the outdoor environment in occupiable spaces as shown in Figure B.47.

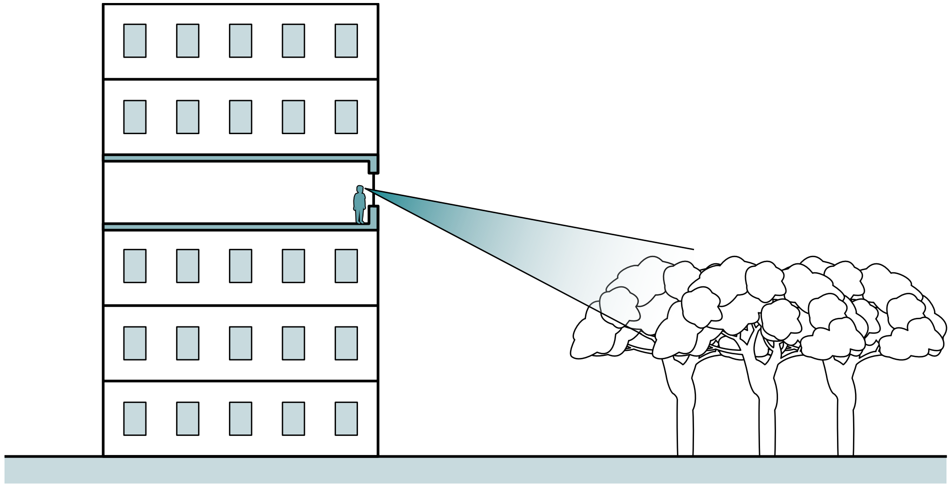


Figure B.47 Line of sight to the outdoor

B.6.5.2.4 Safety of windows

Safety requirements for windows are provided in **E.9**.

B.6.6 Openings between floors

B.6.6.1 Convenience openings and communicating spaces

Convenience openings and communicating spaces are described in Table 1.9, Ch. 1 of UAE FLSC [Ref. B.1].

Convenience openings for escalators and stairs shall conform to the fire safety requirements given in Table 1.9, Ch. 1 of UAE FLSC [Ref. B.1] depending upon whether or not the building is required to be sprinkler protected.

Floor voids forming a communicating space of maximum 3 floors shall conform to the fire safety requirements of Table 1.9, Ch. 1 of UAE FLSC [Ref. B.1] depending upon whether or not the building is required to be sprinkler protected.

B.6.6.2 Atria

In most cases, an atrium shall be separated from the rest of the building by 1 h fire resisting construction, as required by Table 1.9, Ch. 1 of UAE FLSC [Ref. B.1]. This does not apply if an engineered smoke control system is provided, in accordance with Section 2.7, Ch. 10 of UAE FLSC [Ref. B.1].

B.6.6.3 Courtyards

Courtyards provided through buildings to give light to habitable or occupable spaces may be located anywhere within the height of a building.

Courtyards shall be a maximum of 23 m high, measured from the base of the courtyard to the opening at the top of the courtyard, and achieve a minimum of 6 m x 6 m in plan (see Figure B.48 where "h" is the height of the courtyard).

Buildings with courtyards greater than 15 m high, measured from the base of the courtyard to the opening at the top of the courtyard, shall be fully sprinkler protected in accordance with Ch. 9 of UAE FLSC [Ref. B.1].

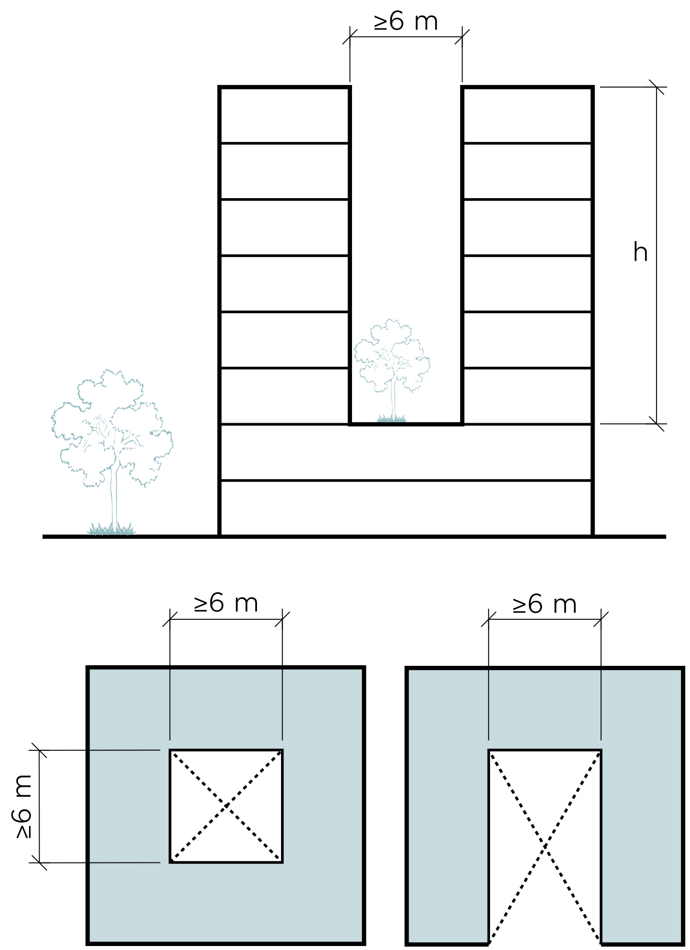


Figure B.48 Courtyard dimensions

Courtyards with in plan dimensions less than 6 m x 6 m are not permitted unless the enclosing walls of the courtyard achieve the same fire resistance rating as the floor through which they pass, as required by Table 1.9, Ch. 1 and Table 10.2, Ch. 10 of UAE FLSC [Ref. B.1].

Courtyards may be shaded or covered by a light weight or translucent roofing system, provided that it is 50% perforate.

B.6.6.4 Shafts

Shafts passing through multiple floors for the passage of MEP services, elevator hoistways and stairs shall achieve the same fire resistance rating as the floor through which they pass, as required by Table 1.9, Ch. 1 and Table 10.2, Ch. 10 of UAE FLSC [Ref. B.1].

Shafts provided through buildings to give light to habitable or occupiable spaces remote from an external wall are not permitted unless the fire resistance rating of UAE FLSC [Ref. B.1] is achieved. This means that the shaft construction shall be fire resistance rated, and any window assemblies in the shaft shall be permanently closed and fire resistance rated in accordance with the fire testing and certification requirements given in Table 1.18, Ch 1 of UAE FLSC [Ref. B.1].

Glazed elevators contained entirely within an atrium or communicating space do not need to be fire resistance rated.

B.7 Building access and vehicular requirements

B.7.1 Building access

The following provisions shall be included when setting the building access strategy during the design process.

a) Public and service entrances shall be clearly located and identified with signage as in accordance with B.11. The location of car parking and the main entrance shall be clearly identified with signage in accordance with B.11.

b) Buildings shall allow for smooth pedestrian access with crossings and pathways. Pathways shall be provided for building entries from surrounding streets, parking bays and external sidewalk.

c) Accessible routes shall be provided in accordance with C.5.

d) Buildings providing pick-up and drop-off areas shall conform to Chapter 7.2 of Dubai access management manual requirements [Ref. B.37].

e) For mixed-use buildings containing residential occupancy and other public or business occupancies, the residential pedestrian access point and lobbies shall be separated from those serving public/business occupancies. For other mixed-use buildings, the segregation of pedestrian access points for different building occupancies is recommended for privacy and security.

f) The number and location of exits discharging directly from the building to outside shall be in accordance with B.4.3.1.

g) Access routes and accessways for fire trucks shall be provided in accordance with Ch. 2 of UAE FLSC [Ref. B.1]. Fire trucks shall be able to reach, within the required distances and as applicable, the building entry points, breeching inlets and the perimeter façade of the building.

h) Public roadways carrying heavy volumes of traffic shall not be used for access unless an alternative access point cannot be provided, and it is agreed with RTA and the Authority.

B.7.2 Vehicle access and movement

B.7.2.1 General requirements

Vehicle access shall be located away from any traffic intersections depending on road type, vehicle type and other factors as approved by RTA.

Vehicle access shall conform to RTA requirements. Public rights of way shall be designed in accordance with the RTA Dubai access management manual [Ref. B.37] and RTA Geometric design manual for Dubai roads [Ref. B.38].

Building developments which are deemed by the Authority to have an impact on the traffic generation for the surrounding roads and properties shall submit a traffic impact assessment (TIA) or traffic impact study (TIS) to the Authorities.

Vehicle access shall be separated from local road intersection or minor T junctions by not less than 15 m from the chamfered edge of the plot (see Figure B.49 and Figure B.50). For other road intersections, Dubai access management manual requirements [Ref. B.37] shall be followed.

If the building is facing more than one road, the vehicle access point should be from the secondary road, or as specified on the affection plan, as shown in Figure B.49.

Segregation between light and heavy vehicle parking areas inside plots shall be provided in accordance with B.7.3.

Vehicle access shall not be located opposite a T junction, as shown in Figure B.50.

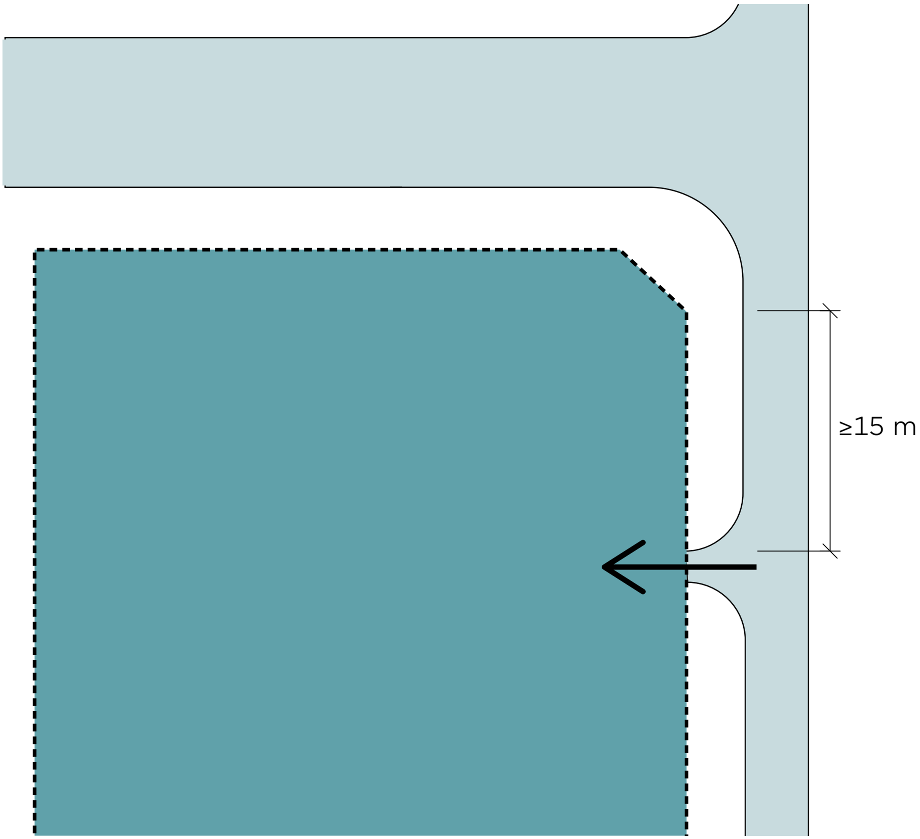


Figure B.49 Building vehicle access

Key
------ Plot limit

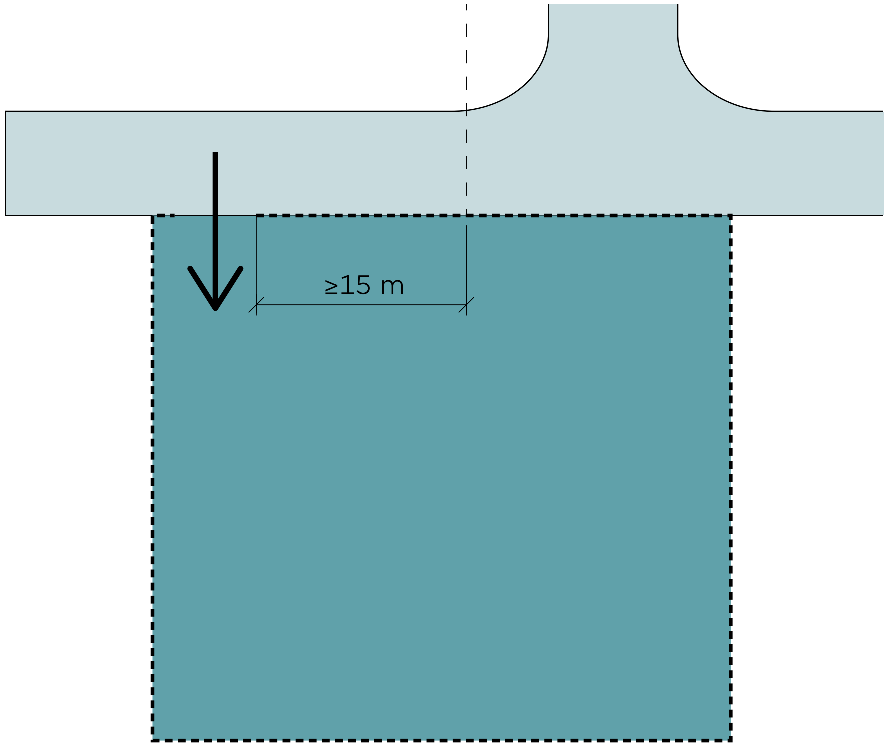


Figure B.50 T junction vehicle access

Key
------ Plot limit

Internal roads within plot limits shall be not less than:

a) 3 m clear width road or pavement for one-way traffic;

b) 6 m clear width road or pavement for two-way traffic.

All vehicular roadways and parking areas shall be provided with exterior lighting to illuminate the surface area in accordance with H.7. All internal roads or access to plots shall be lit to a CIE 115 (lighting class M5, $L_{av} \geq 0.5$ cd/m^2 with uniformity $U_0 \geq 0.35$) [Ref. B.39]. Lighting shall be designed, arranged and installed to confine direct rays onto the plots and to direct light away from adjacent structures or streets.

All parts of the site to which vehicles might have access shall be hard surfaced and drained.

All vehicular manoeuvring to take place within plot limits without impacting ROW

B.7.2.2 Vehicular ramps

Ramps allocated for vehicular access shall conform to Table B.9 and the following.

a) Curved and helical vehicular ramps are not preferred.

b) Any curved portion of vehicular ramps shall conform to the requirements for curved ramps.

c) Lane separation for ramps shall be provided through curbs, walls or other structural segregation.

d) Where a curb is used between lanes to separate traffic flows, each lane shall meet the minimum width requirement. Curbs shall be not less than 300 mm in width, and not less than 150 mm in height.

Ramp type	Maximum slope percentage	Minimum single lane width (m)	Minimum inner circle radius (m)	Minimum vertical clear height above any point (m)
Straight See Figure B.51	12%	3	-	2.4
Curved See Figure B.52	12%	3.5	4	2.4
Helical See Figure B.53	8%	5	6	2.4

Table B.9 Ramp slope and width

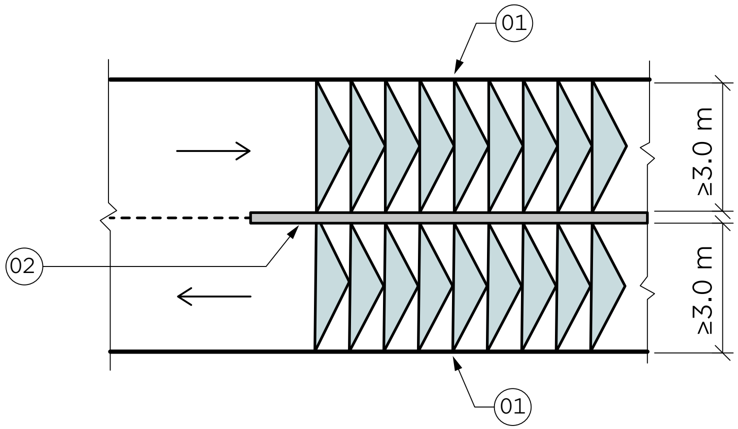


Figure B.51 Straight ramp

Key

01: Curb or structure

02: Lane separation

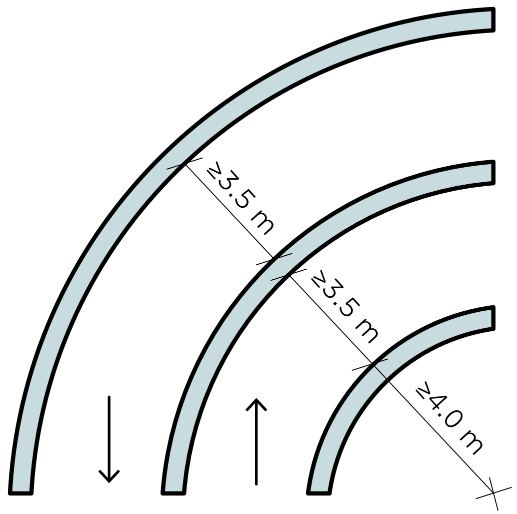


Figure B.52 Curved ramp

Vehicular ramps shall meet the following requirements.

1) Floor surfaces shall be of broom finish texture or provided with anti-slip treatment.
2) Ramps shall be free from any projections or obstacles that could obstruct safe movement or use.
3) Corners of structural elements adjacent to ramps shall be covered with protective materials.
4) Ramps shall be provided with reflective mirrors that are appropriately sized to enhance visibility at directional changes, turns and in areas where visibility is difficult.
5) Ramps shall be equipped with all necessary connections for rainwater drainage.
6) Floor surfaces shall be non-combustible, graded and equipped with drainage in accordance with Table 3.37, Ch. 3 of UAE FLSC [Ref. B.1].

Vehicular ramps shall not be used for means of egress, as specified in Table 3.37, Ch. 3 of UAE FLSC [Ref. B.1], with the following exception. For one level below or one level above discharge level of parking, vehicular ramps may be used as one of the means of egress, provided that no shutters or doors are installed in such ramps.

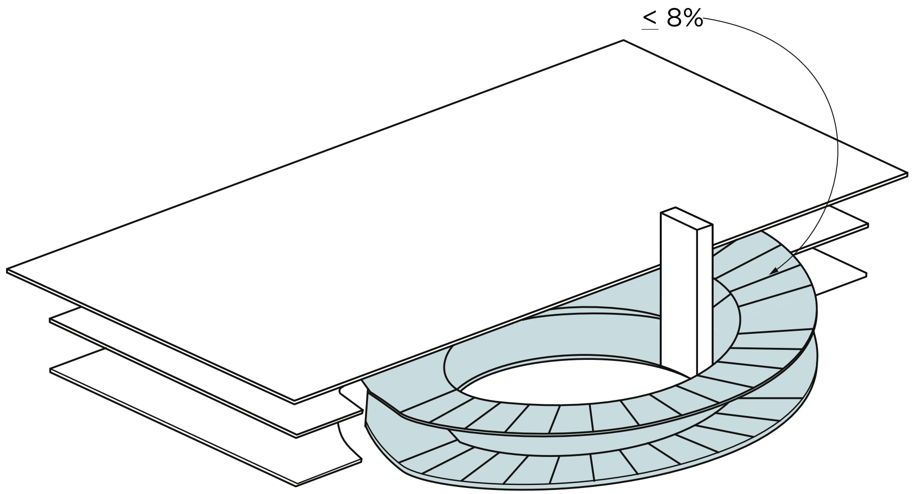


Figure B.53 Helical ramp

Ramp design should provide blended transitions to horizontal parking levels. The transition should be equal to half the percentage of ramp's slope, according to the dimensions given in Table B.10 and Figure B.54.

Ramp slope, *R	Transition slope, *T	Transition length, *L (minimum) (m)
12%	6%	3.6
10%	5%	3
8%	4%	2.4

Table B.10 Transition and ramp slopes recommendations

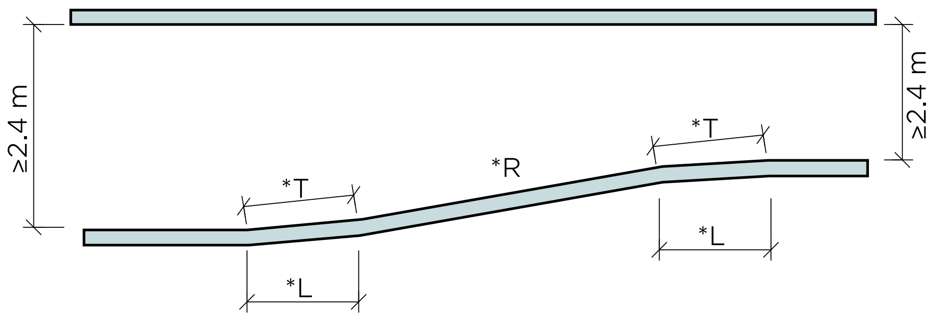


Figure B.54 Vehicle ramp slope transition

Mechanical parking can substitute for vehicular ramps, provided that following requirements are met.

i) A TIA shall be submitted.

ii) The system used shall be provided with an inspection certificate for installation and safety in accordance with BS EN 14010:2003+A1:2009.

iii) Building occupants shall not be able to access the structure. A suitable and airconditioned waiting area shall be provided adjacent to the parking exits.

iv) An emergency auto response system shall be provided, to enable continuity of use and avoid impact on ROW and traffic flow in the event of system failure.

v) The system shall be capable of operating at 25% minimum capacity through a standby generator in case of electrical outage.

vi) The net floor height of the parking levels shall match the system specification requirements, and may be less than the minimum clear heights given in B.5.3.

vii) The mechanical parking shall meet the fire safety requirements of UAE FLSC [Ref. B.1].

B.7.2.3 Parking floors and structures

B.7.2.3.1 General

Parking areas within a building shall be separated from other occupancies. Occupiable spaces adjacent to or within parking areas shall be provided with thermal and acoustic treatment. Ventilation separation conforming to Part H, and fire separation conforming to Table 1.9, Ch. 1 of UAE FLSC [Ref. B.1], shall be provided.

Parking areas clear height shall conform to B.5.3.

Floor surfaces shall be non-absorbent, non-combustible, graded and equipped with drainage in accordance with Table 3.37, Ch. 3 of UAE FLSC [Ref. B.1].

The area of floor used for parking of cars or other vehicles shall be sloped to facilitate the movement of liquids to a drain or toward the main vehicle entry doorway.

The slope in areas where vehicles are parked shall be not more than 4% (as shown in Figure B.55). Accessible parking slopes shall be limited to a maximum of 2%.

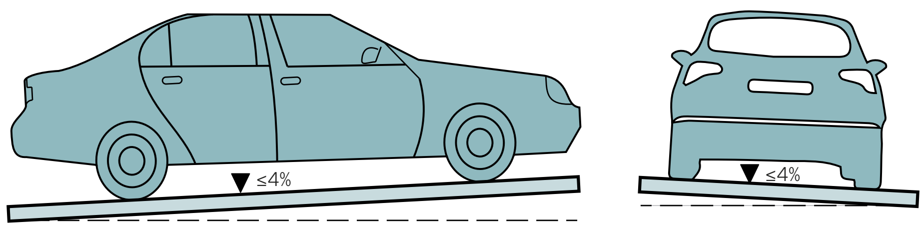


Figure B.55 Parking at slope

Vehicle guards not less than 1,200 mm in height shall be placed where the vertical distance from the floor of a drive lane or parking bay to the ground or surface directly below is greater than 300 mm, such as parking on podiums roof or adjacent to ramps. The guards shall conform to Clause 4.5.3 of ASCE/SEI 7-16. Mechanical parking facilities are exempt from this requirement.

B.7.2.3.2 Open versus enclosed parking

Open parking has permanent wall openings for natural ventilation at each parking level. The exterior sides of the structure shall have uniformly distributed openings on two or more sides. The area of such openings in external walls on a level shall be not less than 20% of the total perimeter wall area of each level. The aggregate length (i.e. total of widths) of the openings deemed to be providing natural ventilation shall be not less than 40% of the perimeter of the level. Open parking facilities shall conform to NFPA 88A for natural ventilation.

Parking facilities that do not meet the definition of open parking shall be designed as enclosed parking with mechanical ventilation as required by H.4.12.11.

B.7.2.3.3 Parking areas technical requirements

Parking areas (covered or uncovered) shall be provided for vehicles within the plot limits.

Parking shall not impede fire exit doors, their access and exit discharge path.

Wheel stoppers of a maximum height of 120 mm and a minimum width of 200 mm shall be installed as shown in Figure B.56 where parking bays are adjacent to fences, walls, buildings or walkways. Wheel stops should be avoided where they might be in the path of pedestrians moving to or from parked vehicles.

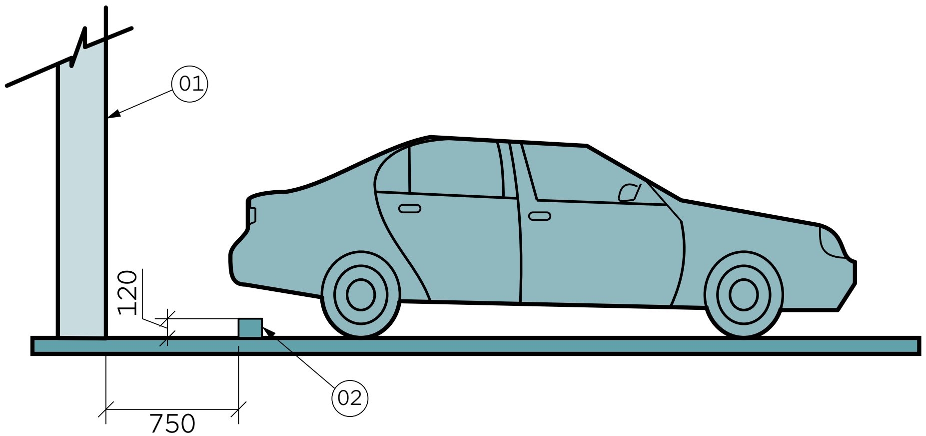


Figure B.56 Vehicle wheel stopper

Key
01: Wall/obstruction
02: Wheel stopper

For parking entry and exit, a straight, and preferably level, 6 m long access should be provided before vehicle access barriers as shown in Figure B.57. Parking areas shall be provided with directional arrows and traffic signs, as described in B.11.

A fixed mirror shall be provided for blind corners.

No parking area shall be allowed to be utilized as both a parking bay and a loading space.

Basement parking areas shall account for the presence of columns and adjacent walls, which shall be covered with protective angle guards of suitable material. Round columns do not require protective angle guards.

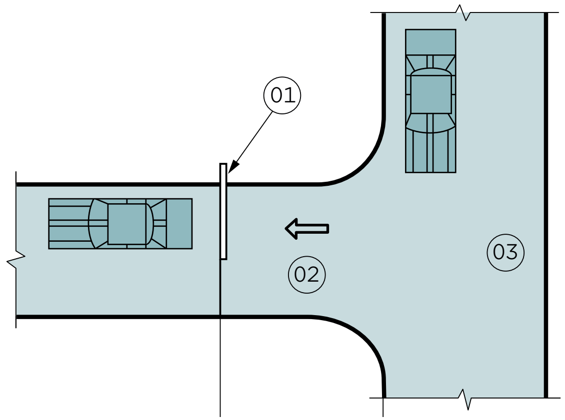


Figure B.57 Vehicle access barriers

Key
01: Entry or exit barrier
02: Entry or exit
03: Road

Dead-end driveways should be avoided. If they are to be included in design, they should serve a maximum of eight spaces with manoeuvring space provided (see Figure B.58). Tandem parking may be used in the following situations:

a) residential parking provision of the same residential unit, when the unit requires two parking bays according to B.7.2.6.1. Tandem parking shall be limited to two bays.

b) hotel facilities, for parking operated solely through a valet parking service. Tandem parking shall be limited to three bays.

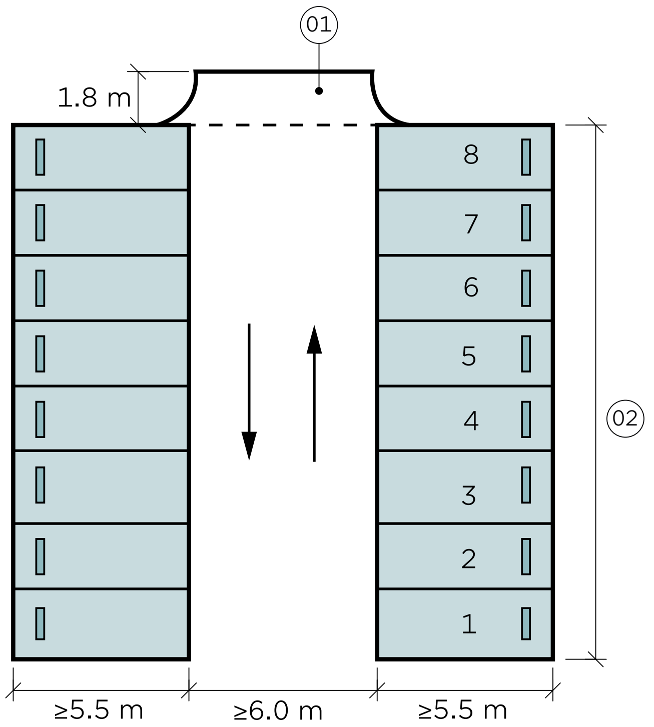


Figure B.58 Dead end parking

Key
01: Turning bay
02: Maximum eight parking spaces to dead end

B.7.2.4 Car parking bay dimensions

The dimension of car parking bays and driveways shall be not less than the minimum values given in Table B.11.

Parking type	Driveway type	Bay width (m)	Bay length (m)	Driveway width (m)
Parallel (See Figure B.59)	One way	2.5	6	3
45° (See Figure B.60)	One way	2.5	5.5	3.3
60° (See Figure B.61)	One way	2.5	5.5	3.8
75° (See Figure B.62)	One way	2.5	5.5	5.5
90°	One way	2.5	5.5	5.5
90° (See Figure B.63)	Two way	2.5	5.5*	6

* For perpendicular (90°) parking bays, the dimensions may be reduced to 5 m × 2.5 m in the following circumstances:

a) all perpendicular bays in plots less than 30 m in length;

b) up to 10% of perpendicular bays in plots of 30 m length or greater.

Table B.11 Minimum dimensions for parking

In designing parking spaces, bays bounded by building structural elements or walls shall have an additional space of 300 mm from the structural element if it interrupts the opening of vehicle doors or manoeuvring or at the end of the driveway.

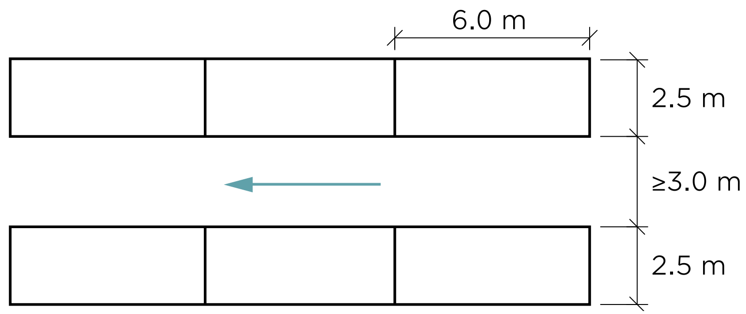


Figure B.59 Parallel parking

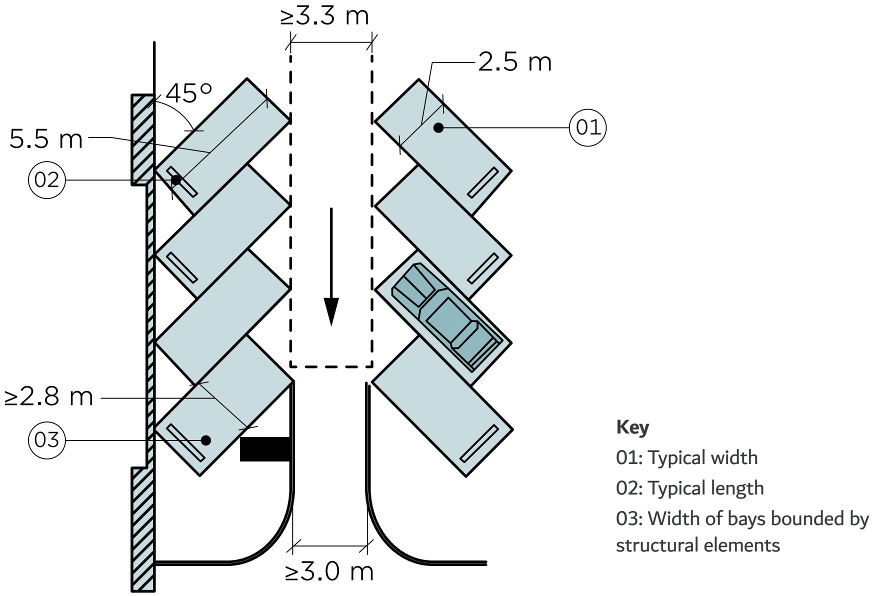


Figure B.60 45° angle parking

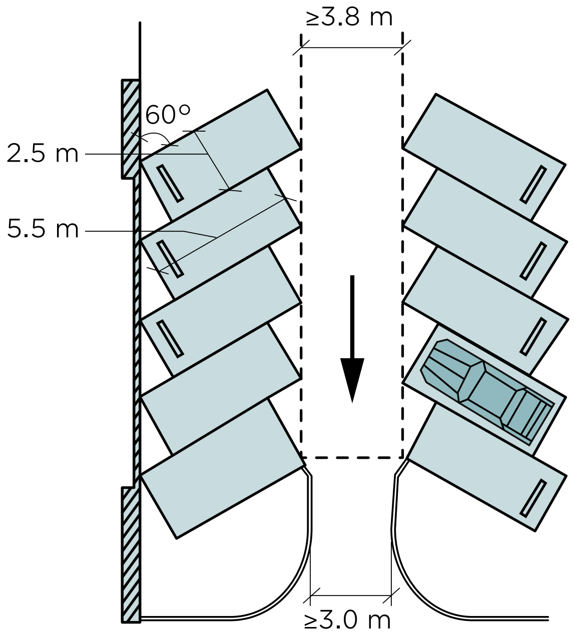


Figure B.61 60° angle parking

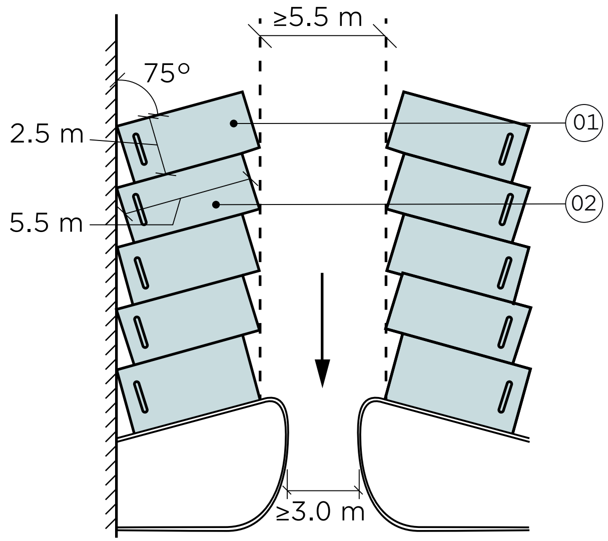


Figure B.62 75° angle parking

Key
01: Typical width
02: Typical length

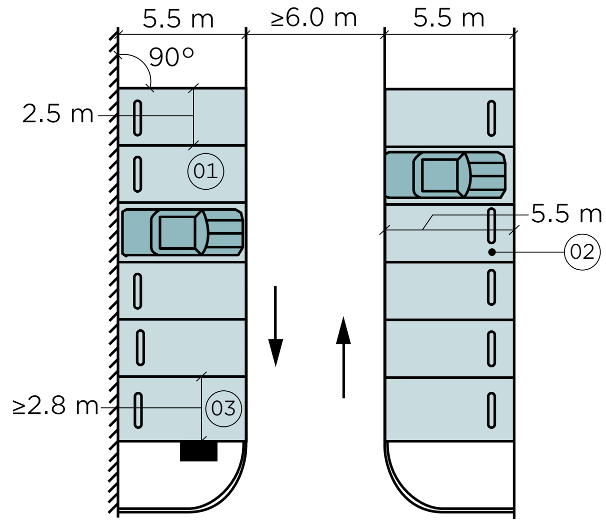


Figure B.63 90° angle parking

Key
01: Typical width
02: Typical length
03: Width of bays bounded by structural elements

B.7.2.5 Bus parking bays

Bus parking provisions within plot limits shall conform to Table B.12, Figure B.64 and Figure B.65.

The parking dimensions and manoeuvring clearances are based on a 12 m long bus. A vehicular manoeuvring analysis shall be conducted to determine requirements for alternative bus sizes and other parking angles.

Angle of parking	Bay width (m)	Bay length (m)	Transition length (m)	Manoeuvring width minimum (m)
Parallel to the road	4	13	16	4.5
Angular – 45°	4	13	-	8
Perpendicular	4	13	-	15

Table B.12 Bus parking dimensions

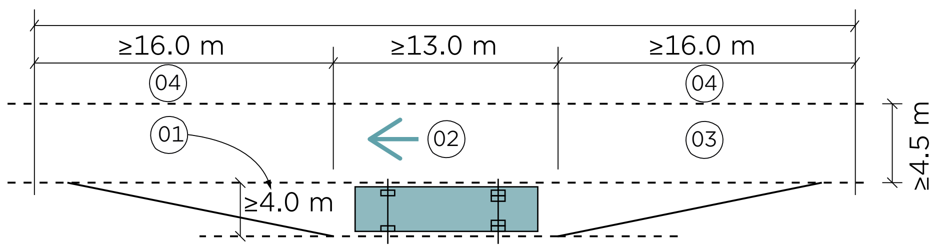


Figure B.64 Parallel bus parking

Key
01: Driveway curb line
02: One way
03: Driveway
04: Transition length

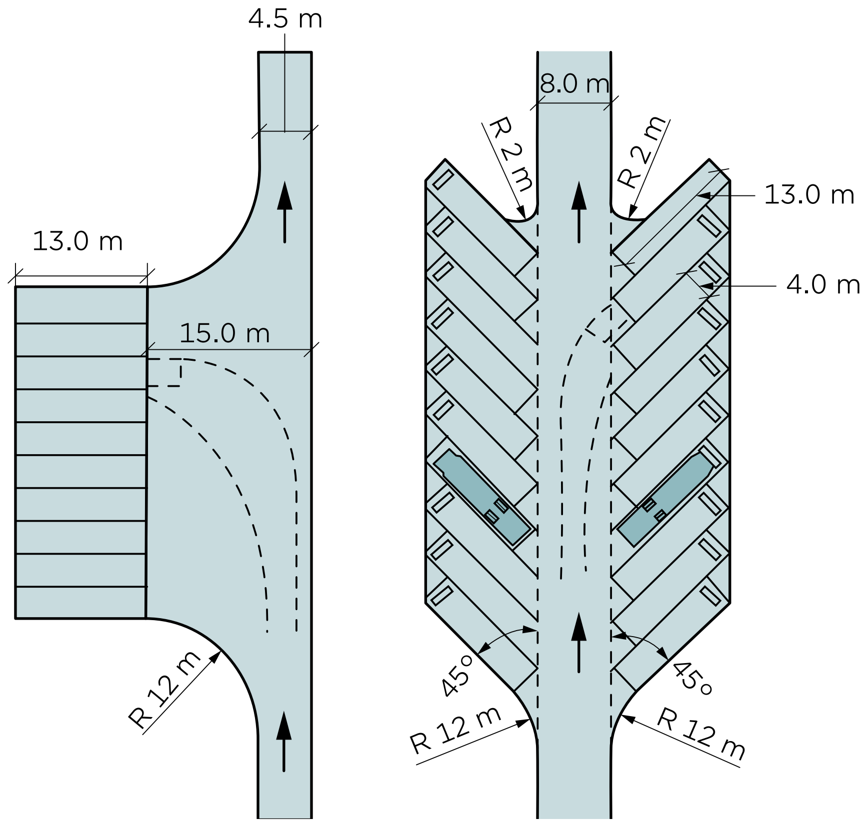


Figure B.65 Perpendicular and angular bus parking

B.7.2.6 Parking provisions in buildings

B.7.2.6.1 Parking ratios

Parking ratios shall be determined in accordance with Table B.13 for the relevant building occupancy. Parking requirements set out in the affection plan or DCR shall take precedent over Table B.13.

Occupancy	Use	Parking ratio
Assembly	Cinema	1 bay for every 50 m² of NA for staff office and food and beverage use 1 bay for every 70 m² of retail NA 1 bay for every 3 seats or 20 m² of NA of cinema screen viewing area, whichever is greater
	Exhibition/conference centre	1 bay for every 50 m² of exhibition/ conference NA
	Mosques – residential areas and suburbs	1 bay for every 18 worshippers
	Mosques – town centres, industrial areas and public spaces	1 bay for every 15 worshippers
	Library	1 bay for every 50 m² of library NA
Business	Office	1 bay for every 50 m² of office NA
	Government centre	1 bay for each 50 m² of office NA
Retail, malls	Retail shops	1 bay for every 70 m² of retail NA
	Mall	1 bay for every 50 m² of retail NA
Motor fuel dispensing facilities	Petrol/gas station	2 bays for petrol station 1 additional bay for every 70 m² of supporting services NA
Educational	Children nursery	1 bay per classroom 1 bay for every 50 m² of staff office NA 1 bus parking
Educational	Kindergarten	1 bay per classroom 1 bay for every 50 m² of staff office NA 1 bus parking for every 3 classrooms
	School	1 bay per classroom 1 bay for every 50 m² of staff office NA 1 bus parking for every 3 classrooms
	University	1 bay for every 50 m² of classroom NA excluding sports hall 1 bus parking for every 200 students 10% additional parking for visitors
	Educational institute	1 bay for every 50 m² of classroom NA
Residential	Studio	1 bay per unit
	1 Bedroom	1 bay per unit
	2 Bedroom	1 bay per unit
	3 Bedroom	2 bays per unit
	4 Bedroom	2 bays per unit
	5 Bedroom, duplex, penthouse	3 bays per unit
	Staff accommodation	1 bay for every 450m² of residential unit NA 1 bus parking for every 650 m² of residential unit NA
	Labour accommodation	Bus calculation based on total number of labours/2 shifts (depends on bus capacity)
	Student accommodation	1 bay for every 40 residents Bus parking for 50% of staff residing within complex

Table B.13 Parking ratios

Occupancy	Use	Parking ratio
Hotel establishment	Hotel – Standard room	1 bay for every 5 rooms
	Hotel – Suite room	1 bay for every 2 suites
	Hotel apartment	1 bay for every 1 apartment up to 150 m² 2 bays for every 1 apartment above 150 m²
	Hotel food and beverage, management office, retail	1 bay for every 50 m² of related space NA
	Hotel meeting, ballroom, function hall	1 bay for every 20 m² of related space NA
Healthcare	Refer to DHA guidelines, Part B [Ref. B.3 to Ref. B.18]	
	Healthcare centres	1 bay per each patient bed 1 bay per each 50 m² of NA for internal clinics, staff offices and all occupiable spaces
Industrial	Light medium industry	1 bay for every 70 m² of management office NA
	Heavy industry	1 bay for every 70 m² for office if area exceeds 10%
	Warehouse	1 bay for every 70 m² of management office NA

Table B.13 Parking ratios (continued)

Parking ratios for any building occupancy not listed in Table B.13 should be determined in accordance with RTA parking rates requirements [Ref. B.40].

When the building includes a mix of occupancies, the parking provided should conform to the requirement for each specific occupancy.

Parking for sport stadiums and event arenas shall be determined according to a transport study of the type of sport or event, the number of seats, visitors and the public parking and transportation network.

B.7.2.6.2 Preferred parking

For buildings that have more than 20 parking bays, designated preferred parking shall be provided for a combination of hybrid vehicles, electrical vehicles and carpool vehicles.

The number of preferred parking bays shall be calculated based on the total vehicle parking bays required for the building, as defined in B.7.2.6.1.

The percentage required for preferred parking is 5%. This percentage does not include parking bays provided for people of determination (see C.6.4).

B.7.2.6.3 Charging equipment for electrical vehicles in malls

For shopping malls, where preferred parking bays are provided in accordance with B.7.2.6.2, necessary charging equipment for electrical vehicles shall be provided for 20% of the total preferred parking bays. Charging equipment shall conform to G.5.

B.7.2.7 Bicycle parking provision in building

Bicycle parking should be located within the building or within a shaded area at ground level (see Figure B.66) in easily accessible locations within the plot limit and no more than 30 m from the building entrance.

Parking shall not impede fire exit doors, their access and exit discharge path.

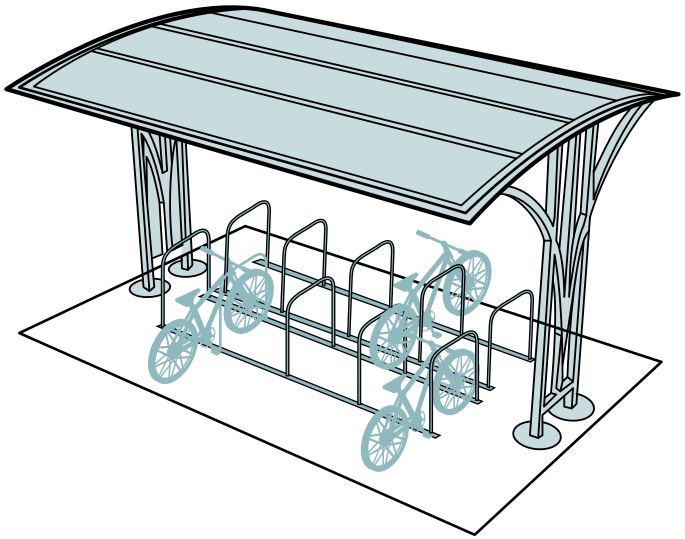


Figure B.66 Shaded bike areas and indoor bike rack area

For student accommodation and labour accommodation buildings, bicycle parking facilities shall be provided for 10% of building occupants.

Other buildings shall be provided with bicycle parking equivalent to 5% of the building car parking requirement as specified in B.7.2.6.1.

The dimensions for cycle stands shall be not less than the minimum values given in Table B.14 and Figure B.67.

Parking angle	Inclined stand width (X) (m)	Distance between two stands (D) (m)	Inclined stand depth (Y) (m)
25°	1.60	0.85	0.80
45°	1.45	0.60	1.45
90°	—	0.65	1.90

Table B.14 Bicycle stand minimum dimensions

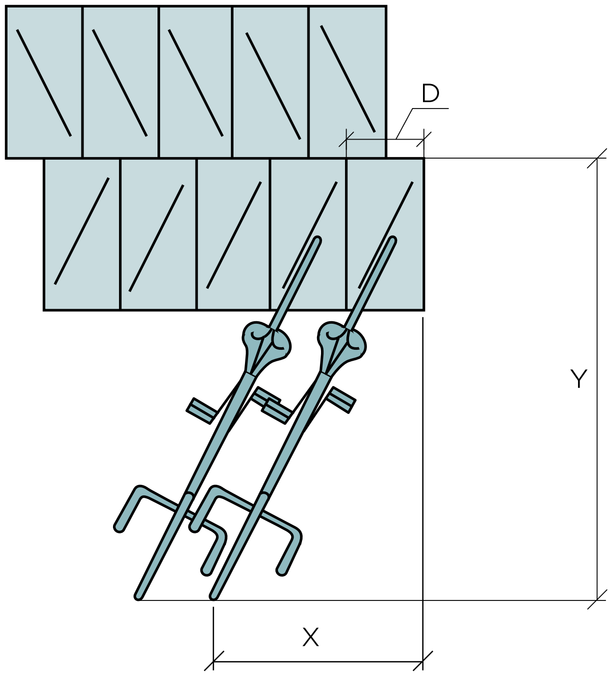


Figure B.67 Bicycle stand minimum dimensions

B.7.3 Service and maintenance access to buildings

B.7.3.1 Loading and unloading areas

B.7.3.1.1 General

The site layout shall allow for loading and unloading of vehicles to take place within the plot boundaries. Loading areas shall be located and designed such that the vehicle intended to use them can manoeuvre safely and conveniently to and from a ROW and can complete loading and unloading without obstructing or interfering with any ROW or any parking bay.

Loading and unloading spaces shall be provided for service vehicles within the plot limits off the public street/area.

The access driveway width for heavy vehicles shall be not less than 9 m two way. One way driveway and gates for truck access shall be not less than 4.5 m wide.

In general, off-street loading areas shall not be located in front of any type of building, including industrial buildings. Off-street loading areas shall be located on rear or side of buildings in accordance with the plot-defined access in the affection plan and DCRs.

All off-street loading areas shall be drained. They shall be lit in accordance with Part H.

Loading and offloading areas may be located in the facility basement levels, provided that appropriate clear height and manoeuvring clearances are maintained to suit the size of vehicles accessing the facility.

B.7.3.1.2 Minimum bays and areas clearances

The clearances for off-street loading and unloading shall be not less than the minimum values given in Table B.15 and shown in Figure B.68

Truck length (m)	Loading area width (m)	Loading bay size (m)	Height clearance (m)
12	4	4 x 4	4.5
15	4	4 x 4	5
20	4	4 x 4	5

Table B.15 Required clearances

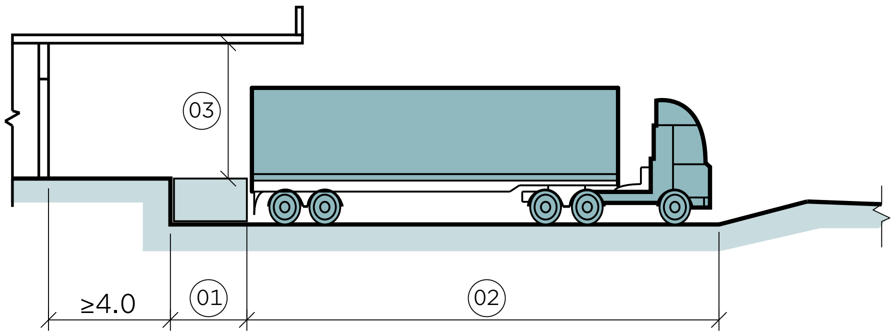


Figure B.68 Clearance requirements for loading areas

Key

01: Dock leveller

02: Loading area (Truck length)

03: Height clearance

B.7.3.1.3 Building types requirements

Space for loading and unloading should be provided for buildings based on the building occupancy and operations.

The off-street loading and unloading area provided for specific uses shall be determined according to the truck sizes as shown in Table B.16.

Use	Minimum loading area/truck size provision required
Hotels, malls	1 loading area for a 12 m truck
Industrial	1 loading area for a 15 m truck
Any other required off-street loading area	1 loading area for a 9 m truck

Table B.16 Loading truck size requirement based on use

B.7.3.1.4 Truck turning radii and clearances

For trucks and other heavy vehicles, shallow parking angles of 10° to 45° are generally appropriate. Aisle widths are dependent on the design of vehicles but typically around 15 m to 20 m.

The clearances for loading and unloading bays for 12 m and 15 m long vehicles shall conform to:

a) Figure B.69 and Figure B.70 for 90° loading and unloading bays; and

b) Figure B.71 and Figure B.72 for 10° and 45° loading and unloading bays.

If a vehicular manoeuvring analysis has been conducted, manoeuvring requirements based on analysis results can be used instead. For other types of vehicles, minimum turning radii shall be determined using a vehicular manoeuvring analysis.

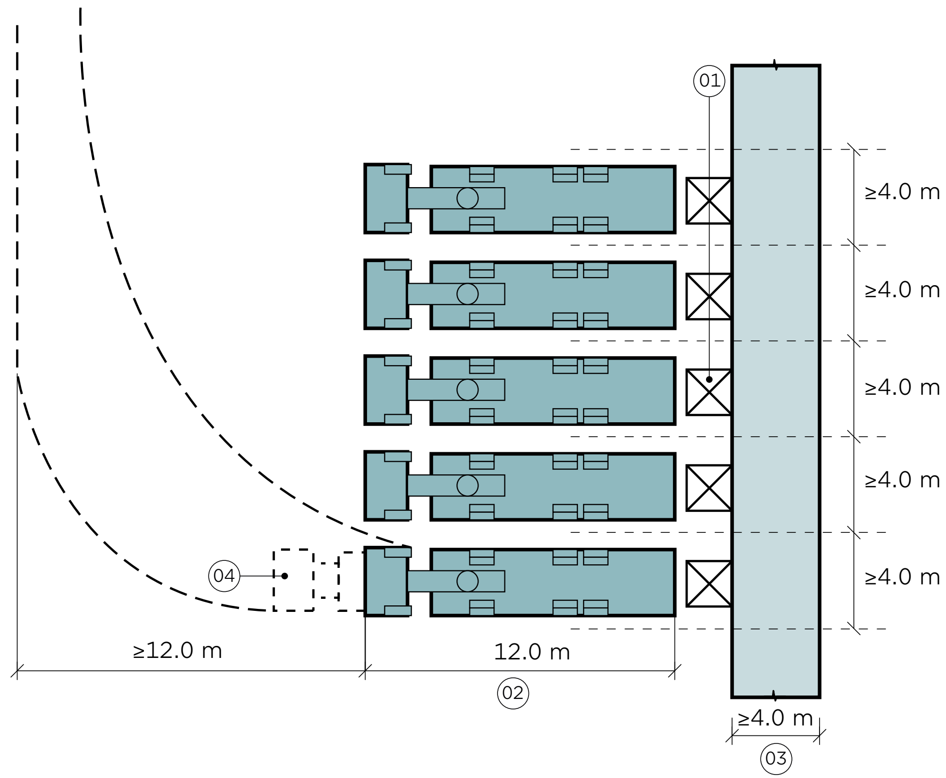


Figure B.69 Loading/unloading area with (90°) manoeuvring for 12 m long trucks

Key
01: Dock leveller
02: Loading area (Truck length)
03: Loading bay
04: Draw forward before turning

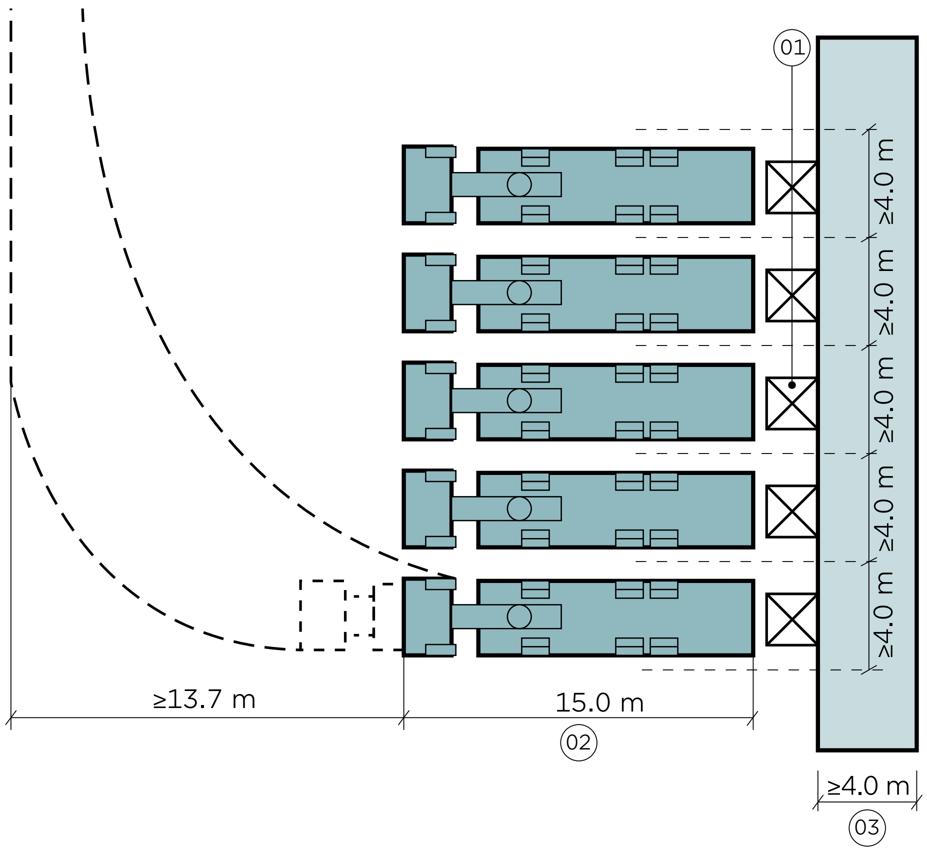


Figure B.70 Loading/unloading area with (90°) manoeuvring for 15 m long trucks

Key
01: Dock leveller
02: Loading area (Truck length)
03: Loading bay

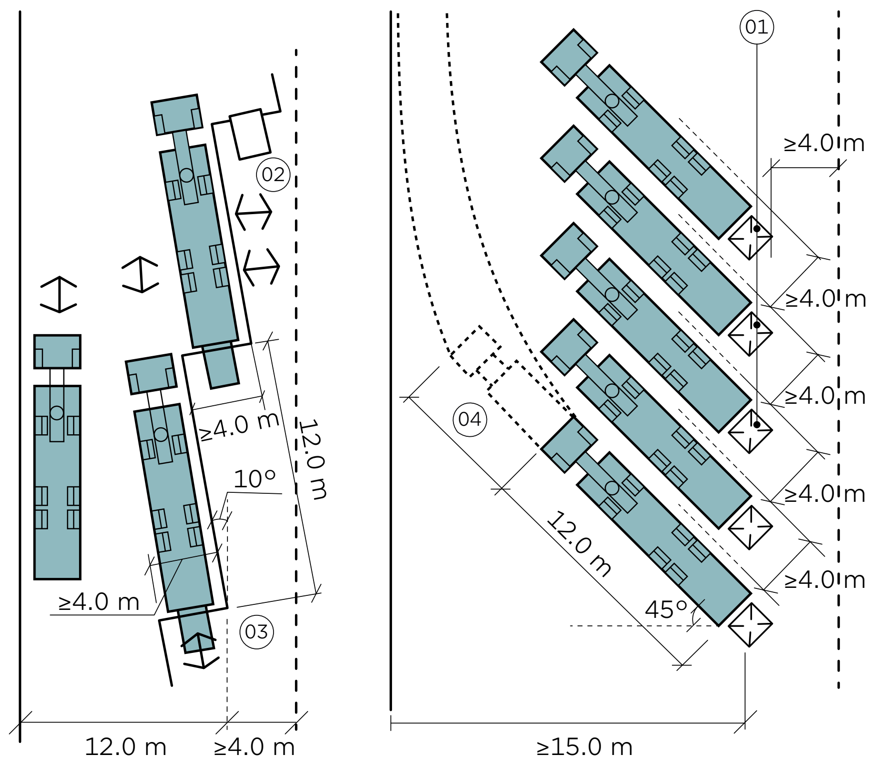


Figure B.71 Loading/unloading area with (10° and 45°) manoeuvring for 12 m long trucks

Key
01: Dock leveller
02: Side loading
03: End loading
04: Draw forward before turning

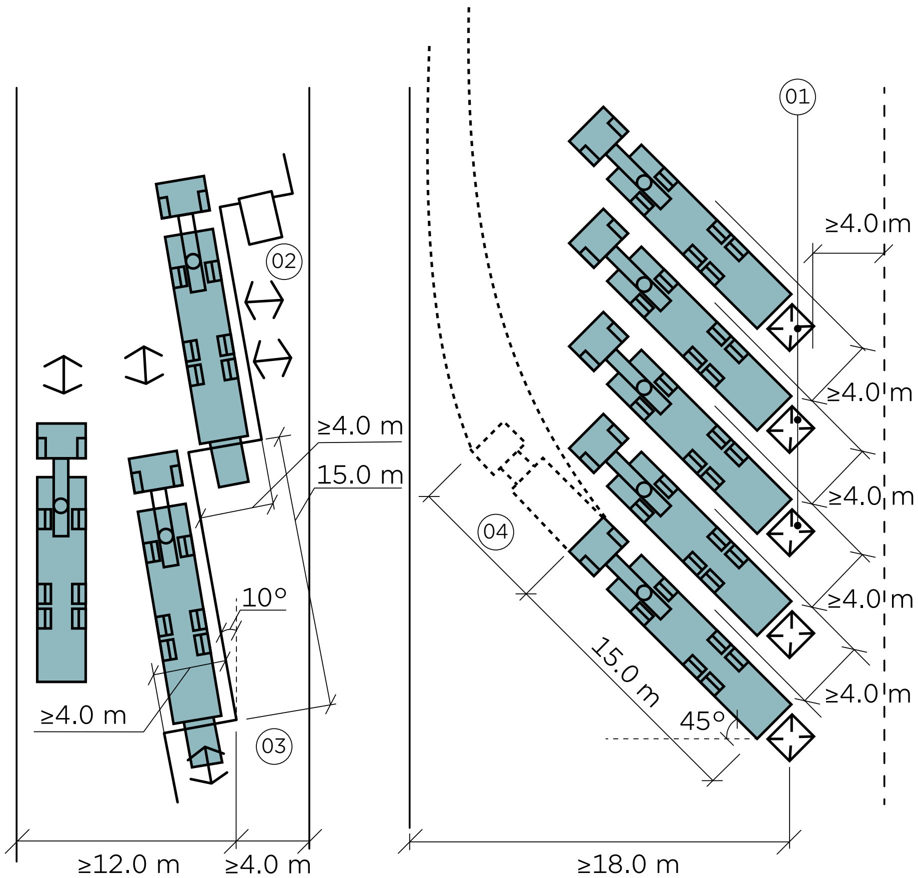


Figure B.72 Loading/unloading area with (10° and 45°) manoeuvring for 15 m long trucks

Key
01: Dock leveller
02: Side loading
03: End loading
04: Draw forward before turning

B.7.3.2 Service ramps

Service ramps shall have a width of not less than 1.2 m and a slope of not more than 8%. Service ramps used by waste containers shall be sized to allow for clear passage and manoeuvring of containers.

At the building entrance door, the ramp landing shall be level, with a 2% maximum slope where drainage is required.

Landing platforms shall be at least 1.2 m deep if doors swing inwards, and 1.5 m deep if doors swing outwards, as shown in Figure B.73.

If the vertical height requires two ramps to achieve the properly graded slope, the ramps shall be not longer than 10 m or provided with an intermediate landing. The two ramps shall be separated by a level-landing platform of at least 1.2 m long with 90° or 180° turns.

The ramp surface should be hard surfaced and anti-slip.

Handrails and fall protection shall be provided in accordance with B.6.4.1.7 and B.6.4.1.8.

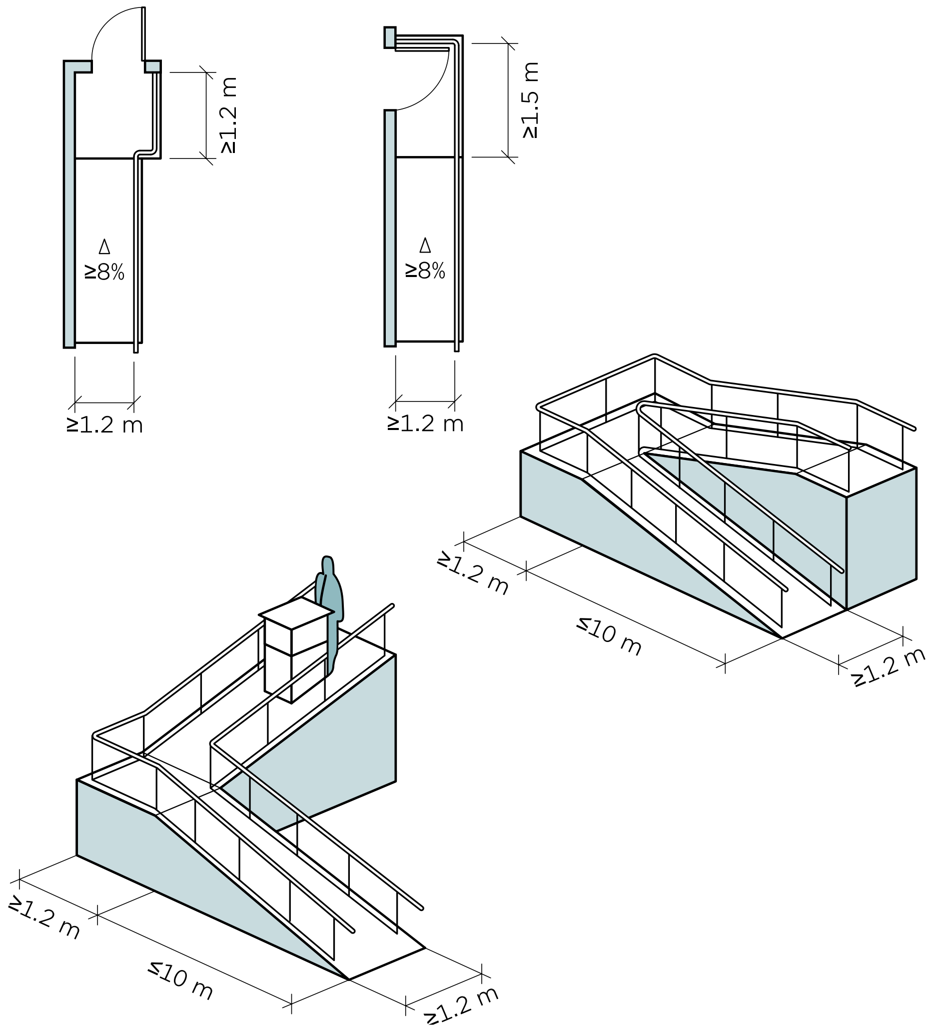


Figure B.73 Service ramp

B.7.3.3 Maintenance ladders

When a building space requires access by ladder, the ladder shall meet the following requirements.

a) Ladders inclined at an angle of 75° to 90° shall be provided with handrails on each side. The handrail shall extend not less than 900 mm above the platform, parapet wall or roof edge.

b) There shall be a clear width between handrails of not less than 500 mm.

c) Ladders with a climbing height of more than 6 m shall be provided with back guards, cages or self-retracting lifelines. The climbing height shall be measured to the top of the parapet wall or roof.

d) When cages are provided, they shall encircle the ladder entirely and have clear width of not less than 800 mm.

e) Ladders shall be protected from corrosion.

f) Ladders shall be provided with a clear bottom landing that is not less than 900 mm × 900 mm.

g) Ladders dimensions shall be not less than the minimum values given in Table B.17 and Figure B.74.

Maximum riser height, R (mm)	Minimum rung radius (mm)	Minimum ladder width, W (mm)	Minimum toe clearance (mm)	Minimum side clearance (mm)
350	20	800	150	400

Table B.17 Service ladder minimum dimensions

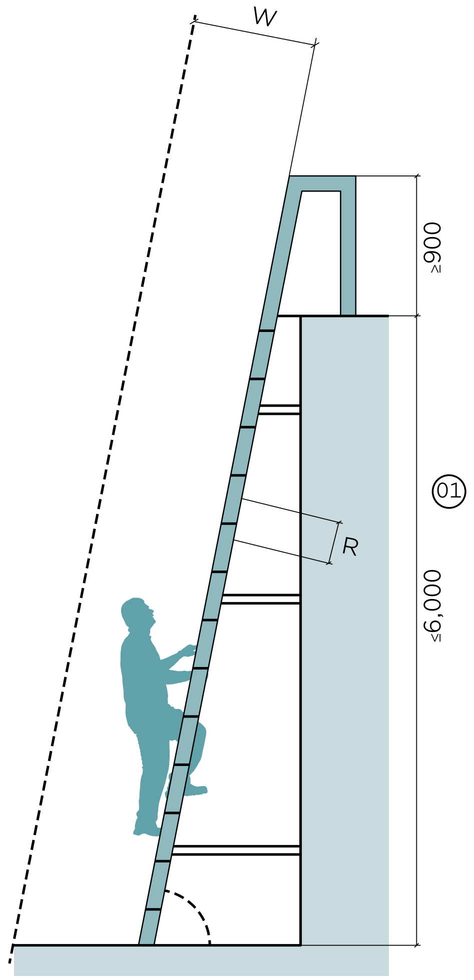


Figure B.74 Service ladder requirements

Key
01: Maximum height without cage

Ladders are permitted to provide access to the following areas only:

1) spaces frequented by personnel for maintenance, repair or monitoring of equipment;
2) non-occupiable spaces accessed only by catwalks and crawl spaces;
3) raised areas used primarily for purposes of security, life safety or fire safety including, but not limited to, observation galleries, prison guard towers, fire lookout towers or lifeguard stands; and
4) non-occupied roofs that are not required to have stairway access.

B.7.3.4 Access to utilities

UAE FLSC [Ref. B.1] does not permit ladder access in lieu of stairs to roofs, to liquefied petroleum gas (LPG) tanks on roofs, solar power generation systems on roofs or fire pump rooms.

At least one RCC protected exit stairway shall extend to all roofs.

At least one RCC protected exit stairway shall reach the level of an LPG tank installation. Cat ladders, alternate stairs and temporary stairs are not permitted (see Ch. 11 of UAE FLSC [Ref. B.1]).

Solar power generation systems on roofs shall be accessed by one RCC protected exit stairway in accordance with Ch. 14 of UAE FLSC [Ref. B.1].

A fire pump room shall be in the basements or the ground floor, within 6 m visibility of a protected exit stair leading to ground floor in accordance with Table 1.9, Ch. 1 of UAE FLSC [Ref. B.1]. Hatch entry, cat ladders, spiral stairs, winding stairs are not allowed to access the fire pump room.

B.8 Communal provisions in buildings

B.8.1 Sanitary facilities

B.8.1.1 General

Every occupiable building shall include sanitary facilities.

The use of common sanitary facilities for both sexes is not allowed, except for family and accessible toilets as specified in C.8.3 and Table C.20.

Sanitary facilities for people of determination and children shall be provided in accordance with C.8.

B.8.1.2 Sanitary finishes

Water closets, urinals, washbasins, showers and baths shall have a smooth and readily cleanable non-absorbent surface.

All sanitary fixture finishing materials and fixed fittings shall be moisture-proof and the floors of these fixtures shall be made of non-slip materials.

Walls, floors and partitions in sanitary facilities shall meet the following requirements.

a) In wet areas, floor finish material shall have a smooth, hard, non-absorbent and non-slip surface.
b) Intersections of floors with walls shall have a smooth, hard, non-absorbent vertical base that extents upward to the walls to a height of not less than 100 mm.
c) Walls and partitions within 600 mm of sanitary fixtures shall have a smooth, hard, non-absorbent moisture-proof surface, up to a height of not less than 1,200 mm above FFL.
d) Shower compartments, screens and walls around bathtubs shall be finished with a smooth, non-absorbent surface to a height of not less than 1,800 mm above the drain outlet.

Slip resistance shall conform to C.7.2.1.2.

B.8.1.3 Sanitary provisions and fixture calculations

B.8.1.3.1 Occupancy requirements

The minimum number of sanitary fixtures to be provided shall be calculated based on the occupant load factors given in B.5.1 and Table B.18.

The number of occupants of each gender is calculated by halving the total number of occupants and rounding up to the next whole number.

For calculations involving multiple occupancies, fractions of numbers for each occupancy shall first be summed and then rounded up to the next whole number.

Occupancy	Use	Water closets		Washbasins	
		Male	Female	Male	Female
Assembly	Restaurant, dining areas	1 per 75 for the first 300 occupants 1 per 200 occupants for the remainder exceeding 300	1 per 50 for the first 200 occupants 1 per 75 occupants for the remainder exceeding 200	1 per 75 for the first 300 occupants 1 per 200 occupants for the remainder exceeding 300	1 per 50 for the first 200 occupants 1 per 75 occupants for the remainder exceeding 200
	Ball rooms, multipurpose assembly hall, exhibition hall, production studios, art gallery, museums, exercise rooms, fitness centres, waiting areas	1 per 125 occupants	1 per 65 occupants	1 per 125 occupants	1 per 65 occupants
	Fixed seating spaces (cinemas, theatres and similar). Conference room, meeting rooms, library – reading area	1 per 125 occupants	1 per 65 occupants	1 per 125 occupants	1 per 65 occupants
	Amusement parks, indoor play areas, skating rinks	1 per 75 occupants for the first 1,500 1 per 120 occupants for the remainder exceeding 1,500	1 per 40 occupants for the first 1,600 1 per 60 occupants for the remainder exceeding 1,600	1 per 120 occupants	1 per 60 occupants
Business	Offices	1 per 20 occupants for the first 100 1 per 50 occupants for the remainder exceeding 100		1 per 20 occupants for the first 100 1 per 50 occupants for the remainder exceeding 100	
Retail, mall	Retail shops and malls	1 per 200 occupants	1 per 100 for the first 500 occupants 1 per 200 occupants for the remainder exceeding 500	1 per 200 occupants	1 per 100 for the first 500 occupants 1 per 200 occupants for the remainder exceeding 500
Healthcare	Hospitals	Requirements to be based on DHA regulations and guidelines [Ref. B.3 to Ref. B.18].			
	Clinics and outpatients' facilities	Requirements to be based on DHA regulations and guidelines [Ref. B.3 to Ref. B.18].			
Industrial and storage	Factories, workshops and warehouses	1 per 25 occupants	1 per 25 occupants	1 per 25 occupants	1 per 25 occupants

Table B.18 Minimum number of sanitary fixtures

Occupancy	Use	Water closets		Washbasins	
		Male	Female	Male	Female
Educational	Schools (students)	1 per one class, sized for children use		1 per one class, sized for children use	
	Schools (teachers and staff)	1 per 10 classes with minimum 2 for each gender		1 per 10 classes with minimum 2 for each gender	
	Kindergartens (students)	1 per one class with size suitable to children		1 per one class with size suitable to children	
	Kindergartens (teachers and staff)	1 per 10 classes with minimum 2 for each gender		1 per 10 classes with minimum 2 for each gender	
	Nurseries (children)	1 per 1 baby room		1 per 1 baby room	
	Nurseries (teachers and staff)	1 per 10 rooms with minimum 2 for each gender		1 per 10 rooms with minimum 2 for each gender	
Hotels	Hotels, resorts and hotel apartments	Requirements to be based on DTCM regulations [Ref. B.19 to Ref B.36]			
Residential	Labour accommodation	1 per 10 occupants		1 per 10 occupants	
		Water closets shall be separated from wash basins and bathtubs for consolidated services. Shower facility shall be provided at the rate of 1 per 10 occupants.			
	Student accommodation	1 per 10 occupants		1 per 10 occupants	
		1 shower facility per 8 occupants.			
Fuel dispensing facilities	Public and visitors	Minimum of 1 male and 1 female toilet with washbasin			
	Staff	1 per 20 occupants for the first 100 1 per 50 occupants for the remainder exceeding 100		1 per 20 occupants for the first 100 1 per 50 occupants for the remainder exceeding 100	

Table B.18 Minimum number of sanitary fixtures (continued)

In all occupancies expect residential, a maximum of 33% of the water closets in male toilet facilities may be substituted for urinals.

For any occupancy or space not listed in Table B.18, the minimum number of sanitary fixtures shall be determined in accordance with the IBC [Ref. B.41].

Each residential unit in a building shall be provided with the necessary sanitary facilities such as bathrooms, toilets, sinks, kitchen sinks. At least one bathroom shall be provided for every residential unit.

B.8.1.3.2 Mosques and prayer rooms

Sanitary services shall be provided according to the number of worshippers, in accordance with Table B.19.

Use	Water closets		Washbasins		Ablution spaces
	Male	Female	Male	Female	
Mosques, prayer rooms	1 per 100 worshippers		1 per 100 worshippers		1 per 50 worshippers

Table B.19 Minimum number of sanitary fixtures for mosques and prayer rooms

B.8.1.3.3 Swimming pools

Sanitary services shall be provided in accordance with Table B.20, with the following exception:
the number of showers in swimming pools intended for residents' exclusive use in residential buildings may be reduced by 50%, provided that there is at least one shower for each gender.

Use	Water closets		Washbasins		Shower and tap for washing feet	
	Male	Female	Male	Female	Male	Female
Swimming pools	1 per 75 for the first 1500 occupants 1 per 120 occupants for the remainder exceeding 1,500	1 per 40 for the first 1,600 occupants 1 per 60 occupants for the remainder exceeding 1,600	1 per 200 occupants	1 per 150 occupants	1 per 10 occupants	1 per 10 occupants

Table B.20 Minimum number of sanitary fixtures for swimming pools

B.8.1.4 Public toilets requirements

B.8.1.4.1 Minimum space dimensions for toilet stalls

Toilet stalls in public toilet shall have the minimum dimensions shown in Table B.21 and Figure B.75. The internal corridors in a public toilet shall be not less than 1.05 m in width. If accessible stalls are provided inside the public toilet block, they shall conform to C.8.3.

Door opening in stall	Width (mm)	Length (mm)
Inside	900	1,500
Outside	900	1,250

Table B.21 Minimum space dimensions

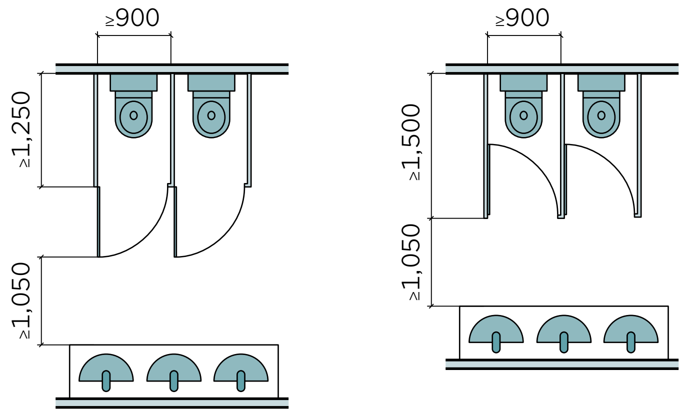


Figure B.75 Stall clearance dimensions

B.8.1.4.2 Privacy requirements for public toilets

The following requirements and recommendations apply to privacy for water closets and urinals.

a) In public toilets, required wash basins shall be located in the same toilet block as the required water closet.
b) Public toilets in buildings should not open directly to a ROW or sikka.
c) Public toilets, including their entry points and doors, should be designed to provide privacy, especially between men's and women's bathrooms.
d) Individual toilet stalls and single-user toilets shall be provided with locking or latching devices.
e) Stall partitions that are not the full height of the room shall meet the minimum requirements in Table B.22.
f) Urinals for public toilets shall be provided with walls or partitions that meet the minimum requirements in Table B.23.

Dimension	Requirement (mm)
Minimum clearance of partition from FFL	100
Maximum clearance of partition from FFL (except accessible stalls)	150
Minimum height for partitions if terminating below ceiling	2,000

Table B.22 Toilet stalls partitions

Dimension	Requirement (mm)
Maximum height from FFL to bottom of urinal partition	300
Minimum height from FFL to top of urinal partition	1,500
Minimum projection from wall surface	500
Minimum projection from outermost front lip of the urinal	1,500

Table B.23 Urinal partitions

B.8.1.5 Fixture clearances

Fixed fittings in sanitary facilities shall conform to the following requirements and to Figure B.76.

a) The centres of water closets, urinals, wash basins and faucets shall be not less than:
   1) 400 mm from any side wall, partition, vanity or other obstruction; and
   2) 750 mm from the centre of an adjacent fixture.

b) There shall be a 750 mm clearance in front of the water closet, urinal or wash basin to any opposite wall or door leaf, and 600 mm clearance to any opposite fixture.

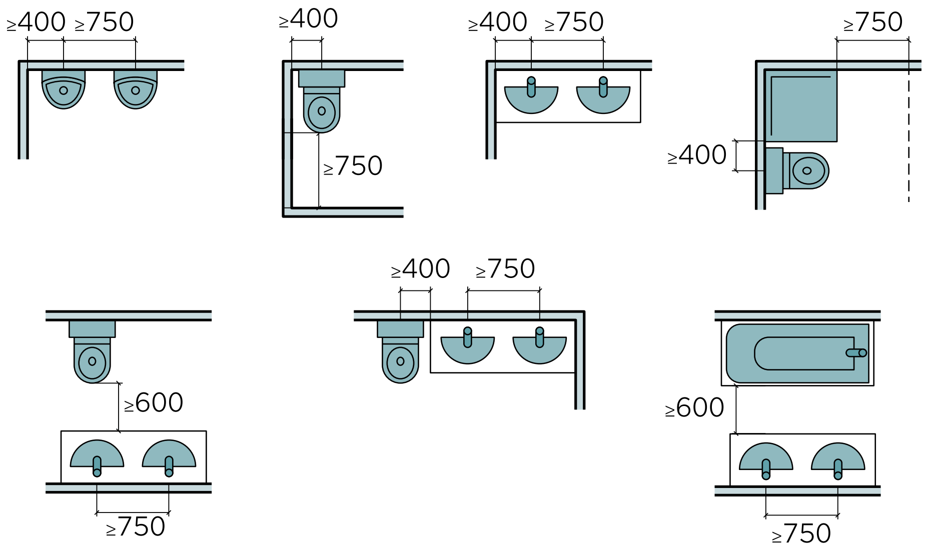


Figure B.76 Fixture clearances

B.8.1.6 Cleaner's room

Cleaner's rooms shall be provided in all buildings exceeding 100 m² of GA.

Cleaner's rooms shall have an area of not less than 1.5 m². They shall include:

a) a cleaner's sink or a bucket sink;

b) space for storage of cleaning appliances and materials; and

c) adequate ventilation (see H.4).

B.8.2 Facilities for building occupants

B.8.2.1 Drinking fountains

Drinking fountains shall be provided as shown in Table B.24. They shall not be installed in public restrooms. They shall be placed in safe and clean areas where they will not obstruct building circulation.

Occupancy	Space type	No. drinking fountains per occupant load
Assembly	Mosques and prayer rooms	As required by IACAD
	Restaurant, dining areas (where water is served in restaurants, drinking fountains are not required)	1 per 1,000
	Ballrooms, exhibition hall, multipurpose assembly halls, production studios, art gallery, museums	1 per 500
	Fixed seating spaces (cinemas, theatres and similar) Conference room, meeting rooms, library – reading areas	1 per 500
	Amusement spaces, gaming	1 per 1,000
	Swimming pools	1 per 1,000
Business	Offices	1 per 100
Retail, mall	Shops and malls	1 per 1,000
Industrial and storage	Factories, warehouse	1 per 500
Educational	Schools	1 per 100 students
	Kindergartens	1 per 100 students
	Nurseries	1 per 100 children
Residential	Labour accommodation	1 per 100
	Student accommodation	1 per 100

Table B.24 Drinking fountain requirements

B.8.2.2 Feeding rooms (lactation rooms)

Feeding rooms shall be provided in all malls and amusement parks exceeding 1,000 m^2 of GA and/or designed for more than 250 occupants.

At least one feeding room shall be provided within 300 m of any part of the building. It is recommended that one feeding room is provided for each block of public toilets.

Dual feeding rooms may be provided to account for up to 50% of the total number of feeding rooms required in the building.

A feeding room shall meet the following requirements.

a) Feeding rooms shall be designed to have sufficient space to facilitate ease of movement with a pram and a child in the arms.
b) Feeding rooms shall be accessible.
c) Feeding rooms shall have an area of not less than 4.5 m^2 and a dimension on both sides of not less than 2.1 m.

An example of an individual feeding room is given in Figure B.77 and a dual feeding room in Figure B.78.

B.8.2.3 First aid facilities

Public and business buildings shall be provided with first aid storage cupboards and first aid rooms in accordance with Dubai Municipality Health and Safety guidelines for first aid requirements [Ref. B.42].

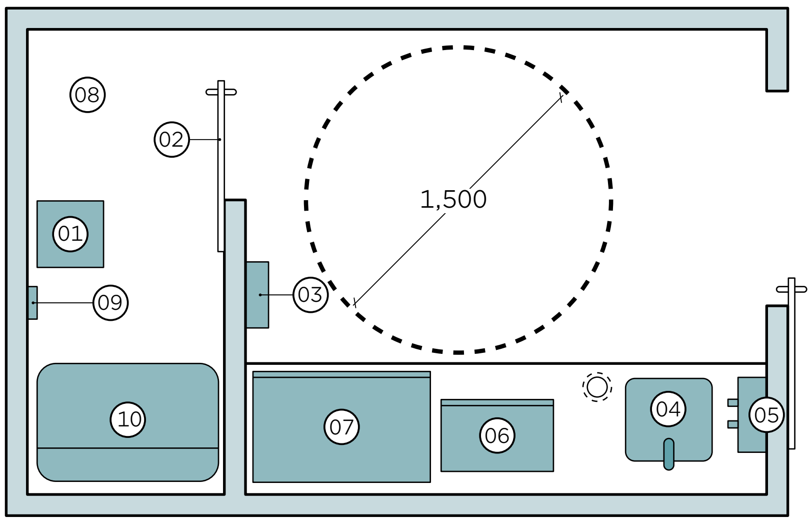


Figure B.77 Example of individual feeding room (plan)

Key

01: Moveable desk
02: Curtain or lockable door
03: Paper towel dispenser
04: Wash basin
05: Dispenser for hot and cold water
06: Microwave
07: Diaper changing station
08: Breastfeeding cubicle
09: Power socket for breast pump
10: Seat for nursing mother

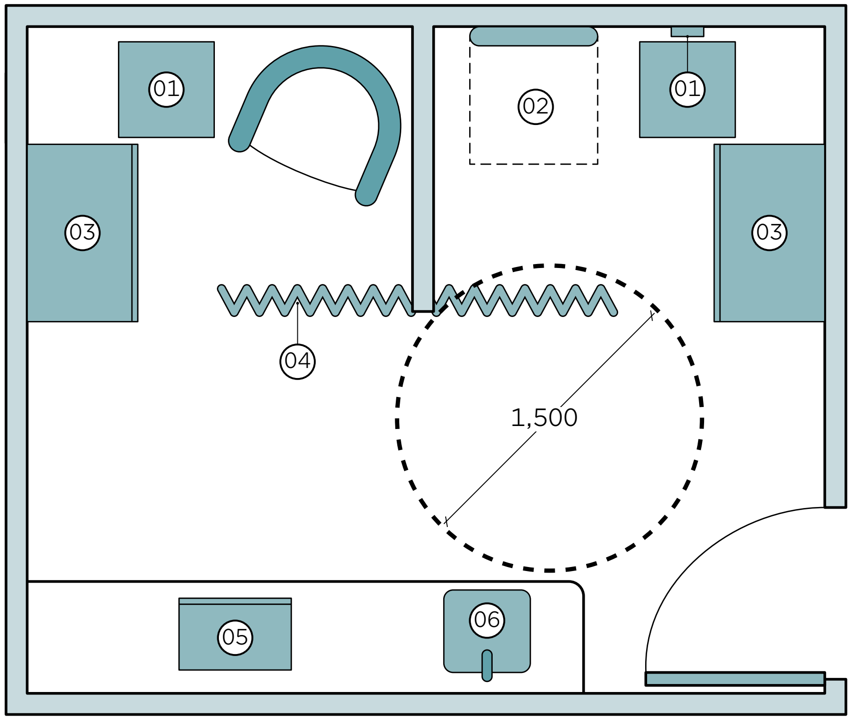


Figure B.78 Example of dual feeding room (plan)

Key

01: Power socket for breast pump
02: Foldable chair
03: Diaper changing station
04: Curtain
05: Microwave
06: Wash basin

B.8.3 Building amenities

B.8.3.1 Gymnasiums, exercise rooms and fitness centres

When fitness facilities are provided in buildings, they shall meet the following requirements.

a) Flooring and walls shall be acoustically insulated (see H.10.3.3), and if the gymnasium space is located on the roof deck or above the apartments, their floors and walls shall be treated with effective sound insulation materials. Acoustic isolation from adjacent habitable spaces and occupiable spaces shall be attained.

b) Exercise rooms which produce noises of vibrations (such as karate, weightlifting gymnasiums and similar) should be situated at the lower building levels or acoustically treated.

c) The number of changing rooms and lockers to be provided shall be determined according to the expected number of users. At least one changing room/locker shall be provided for both men and women.

B.8.3.2 Swimming pools

B.8.3.2.1 General requirements

Swimming pool designs shall conform to DM PH&SD guides [Ref. B.43 to Ref. B.45].

Swimming pools and decks shall be constructed of non-toxic, inert, impervious and durable materials.

A swimming pool shall be configured to be safely patrolled, maintained and cleaned and to provide good circulation of water.

Swimming pools shall be provided with lighting, both above and under the water surface in order to provide an adequate illumination for the overall area of the pool.

The design of outdoor swimming pools located at roof, podium roofs and other elevated locations shall provide privacy to adjacent buildings and shall be provided with fall protection in accordance with B.4.2.5.2.

Sanitary facilities should be provided in accordance with B.8.1. A minimum of one from each fixture type and one changing room shall be provided for each gender.

In accordance with Ch.3. of the UAE FLSC [Ref. B.1], two exits shall be provided from exterior swimming pool decks, jogging tracks and landscaping areas when the distance to a single exit exceeds 30 m.

B.8.3.2.2 Safety requirements

A suitable place for the lifeguard's highchair, and notice boards with the guidelines and policies for the swimmers to follow, shall be provided. A signboard showing water depth shall be fitted at the pool's edge. The signboard shall mark the location of slope changes showing the maximum and minimum depth.

Provide sufficient number of life saving devices (rings, etc.) in the area. All details shall be in accordance with swimming pools safety guidelines [Ref. B.43 to Ref. B.45].

The slope in the floor of the shallow area of the pool shall not exceed 10%.

The slip resistance of swimming pool floors shall conform to C.7.2.1.2.

Safety signage advising on the danger of diving into shallow areas and on the prevention of drowning shall be provided as mandated by relevant Authority as shown in Figure B.79.

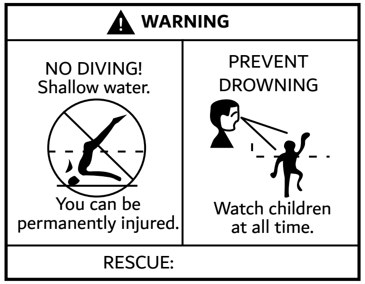


Figure B.79 Safety sign (© International Code Council 2014. Figure based on diagram of the 2015 International swimming pool and spa code. Washington, D.C.: International Code Council. Reproduced with permission. All rights reserved. www.ICCSAFE.org)

Swimming pools designated for children shall be separated from swimming pools designated for adults with protective barriers.

Pools and their surroundings shall be free of any dangerous obstacles.

Operable windows adjacent to the pool shall have a sill height of not less than 1,200 mm above the indoor FFL.

B.8.3.2.3 Swimming pool fences

Outdoor swimming pools shall be surrounded by a fence to protect against drowning.

The fence shall meet the following requirements:

a) The top of the fence shall be not less than 1,200 mm above FFL.
b) The vertical clearance between FFL and the bottom of the fence shall not exceed 50 mm.
c) Openings in the fence shall not allow the passage of a 100 mm diameter sphere.
d) The fence enclosure shall be equipped with self-closing and self-latching gates.
e) Gates in fences shall be equipped with a locking device. Gates shall open away from the pool.

The fence of a swimming pool shall be set back at least 1,200 mm from plot limits and adjacent structures.

Swimming pool fences are not required in the following conditions.

1) A swimming pool fence is not required where the walls of adjacent structures can perform as a fence or a protective barrier to the swimming pool. Doors with direct access to the pool through the wall shall be equipped with an audio alarm that provides an audio warning when the door is opened, or the door shall be self-closing with self-latching devices.
2) A swimming pool that has a power safety cover conforming to ASTM F1346 is not required to have a swimming pool fence.
3) Where the pool is adjacent to the edge of a natural body of water and public access is not allowed along the shoreline, a barrier is not required between the water body and the pool.
4) A swimming pool fence is not required where there are full-time lifeguards patrolling the pool, together with pool supervision systems in accordance with Public swimming pools safety guidelines [Ref. B.43].

B.8.3.2.4 Decks and walkways

Swimming pools shall be surrounded by a continuous unobstructed deck or walkway. It shall be not less than 1.2 m wide, excluding the width of the coping or the interior portion of a gutter. The walkway or deck shall be immediately adjacent to the pool as shown in Figure B.80.

The deck or walkway shall be constructed in impervious material with a smooth, non-slip and easily cleanable surface.

All decks and walkways shall have a 2% slope, in order to drain the water effectively to deck drains.

Allowance for infinity pools or non-fenced pools shall be made according to permitting Authorities' approval.

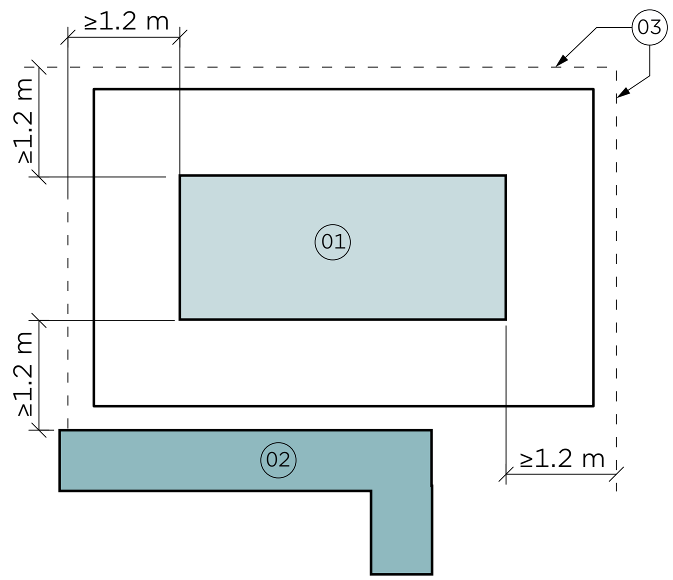


Figure B.80 Swimming pool setback and walkway requirements

Key

01: Swimming pool

02: Adjacent structure

03: Plot limit or adjacent obstruction

B.8.3.2.5 Ladders and steps

Pools shall have ladders or steps if the depth exceeds 600 mm.

At least one ladder shall be installed within each 30 m of the pool perimeter. There shall be at least one ladder located at the deep end, and a ladder or steps at the shallow end.

Material for the swimming pool ladder shall be corrosion-resistant and shall be provided with a non-slip stepping surface.

The ladder shall be separated from the pool wall or boundary by at least 100 mm.

If the steps into a swimming pool are recessed, the steps shall:

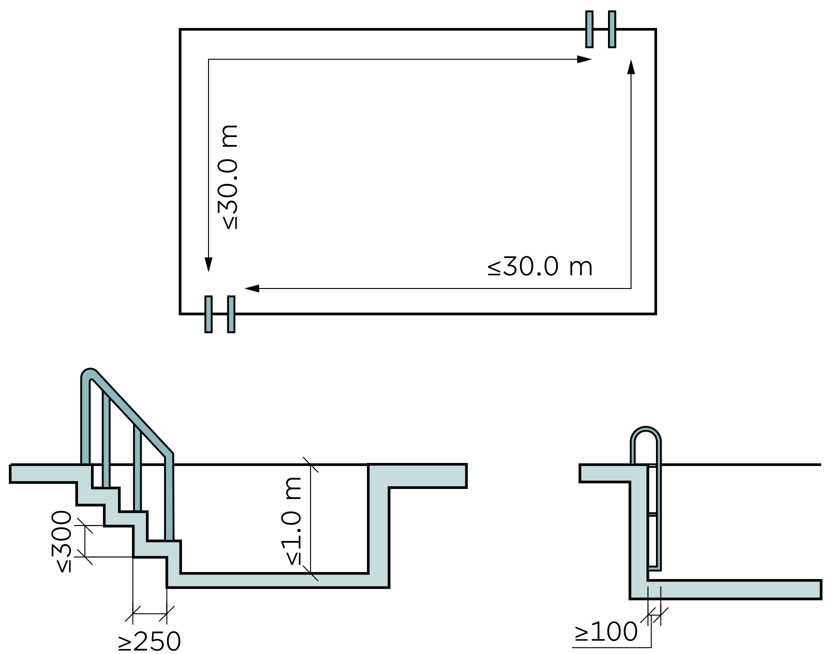
a) be anti-slip;
b) be provided with a drain to the pool;
c) be easily cleaned;
d) have a tread depth of at least 150 mm;
e) have a clear height between risers for each two recessed steps of not more than 300 mm; and
f) have a width of at least 400 mm.

Swimming pools with regular steps are permitted only if the following conditions are met:

1) the pool is shallow, with a depth not exceeding 1,000 mm at any point;
2) the steps are located at one of the corners of the pool, or within a special recess outside the pool boundaries, and do not encroach into the net area of the pool; and
3) each tread is not less than 250 mm in depth and not less than 600 mm in width. The riser shall be not more than 300 mm in height.

Swimming pool ladders shall be provided with side handrails that extend around the water surface on both sides of the ladder or the recessed wall steps.

Ladders and steps shall meet the requirements shown in Figure B.81.



(a) Pool with regular steps

(b) Pool with ladder

Figure B.81 Ladders and steps

B.8.3.2.6 Diving boards

A clear height of not less than 5 m shall be maintained above diving boards. The depth of water below diving boards shall be not less than the minimum values given in Table B.25.

Height of diving board above water surface (m)	Minimum water depth below diving board (m)
Less than or equal to 1	2.5
Greater than 1	2.5 + 0.3 for every additional 1 m of height (or part thereof) the board is above the water surface (see Figure B.82)

Table B.25 Minimum depth of water below diving boards

Diving boards shall be fully covered with anti-slip material. For diving boards more than 1.5 m above the pool deck, guardrails shall be provided on both sides of the diving board.

A horizontal space of at least 3 m shall separate adjacent diving boards, or diving boards and the side wall of the pool.

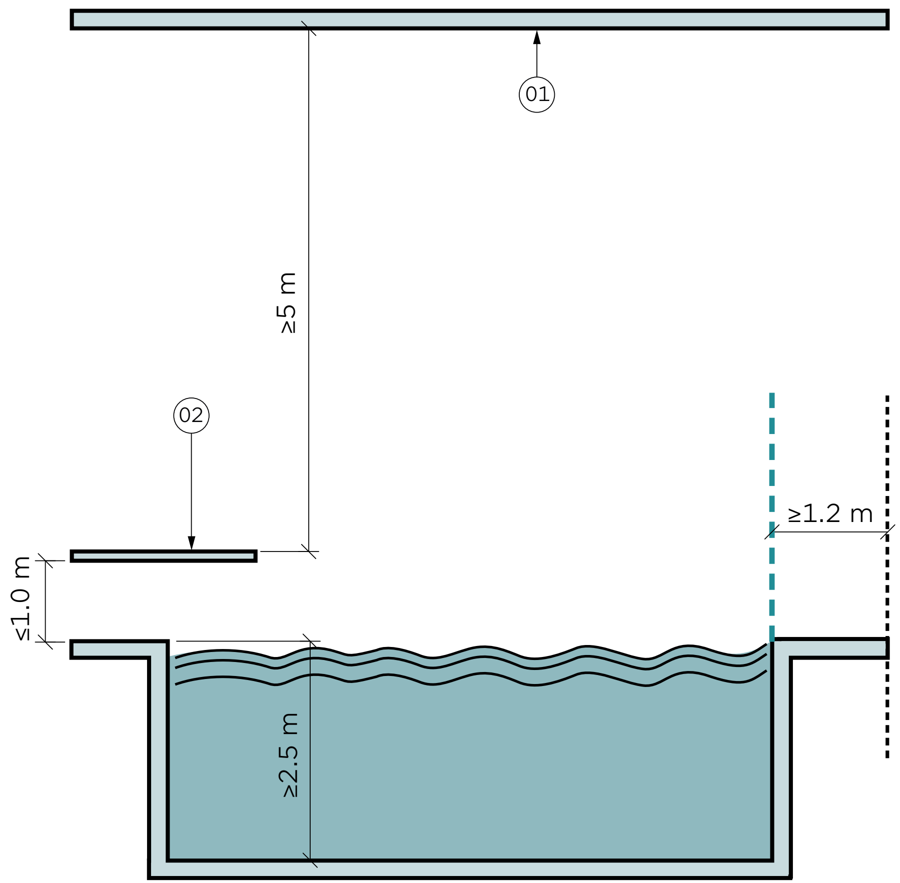


Figure B.82 Diving board clearance

Key
01: Ceiling or roof
02: Diving board
Plot limit or adjacent construction
Setback

B.8.3.3 Prayer rooms

All public use buildings, business buildings and hotel establishments shall provide prayer rooms for male and females with separate entrances and facilities. Labour and staff accommodation buildings shall provide prayer rooms for the residents.

An example of a prayer room is shown in Figure B.83.

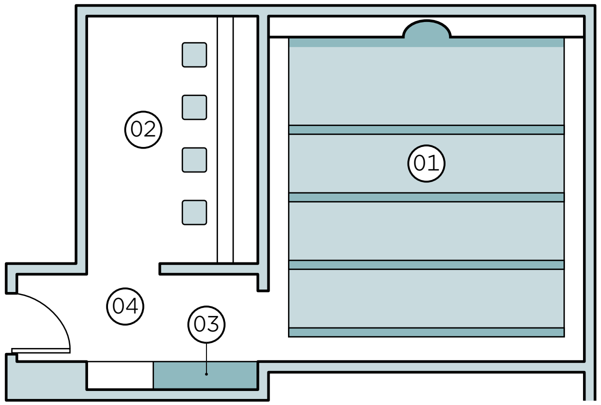


Figure B.83 Prayer room example

Key
01: Prayer room
02: Ablution
03: Shoe storage and bench
04: Prayer room lobby

The minimum capacity of prayer rooms shall be calculated using Table B.26.

Building occupancy	Minimum prayer room capacity
Less than 300 occupants	8%
300 or more occupants	5% (for all occupants exceeding the first 300 occupants)

Table B.26 Prayer room capacity

The ratio of male to female prayer rooms shall be based on occupancy estimates. Equal space shall be allowed for both genders (50% for each) unless otherwise justified by the expected occupancy (for example, if the building is specifically planned for a larger use of a single gender, such as single-gender schools).

Prayer rooms should conform to the mosque prayer hall requirements in B.9.4.4 in terms of orientation, provisions and layout. When the prayer room layout cannot be aligned to Qibla directions precisely, indication of Qibla through carpet lines and ornamental Mihrab is acceptable, although not preferred.

Prayer rooms shall be provided with ablution spaces in accordance with B.9.4.7. The number of ablutions spaces provided shall conform to B.8.1.3.2. Prayer rooms should provide adequate space for shoe storage and lobby area for prayer room access.

Prayer rooms do not require separate toilet facilities if the building provides adequate toilet facilities for the number of occupants as set in B.8.1.

Prayer rooms should be positioned in proximity to toilet facilities in the building to minimize travel distance between both facilities. If toilet facilities are not available nearby, additional toilet facilities may be provided that shall meet the following requirements.

a) Toilets shall not be set or located toward Qibla direction of the prayer rooms, according to the Islamic doctrine. No single praying space shall face toilet facilities.
b) The location and entrance of toilet facilities shall be separated from the prayer room and ablution areas.

B.8.3.4 Open spaces

When open spaces are provided, landscape species shall be selected in accordance with B.10.5.

Shading calculations and shading provisions in public areas conform to B.10.5.

B.8.4 Service facilities

Service rooms in the basements of buildings shall meet all of the requirements in Table 1.9, Ch. 1 of UAE FLSC [Ref. B.1].

Table 1.9, Ch. 1 of UAE FLSC [Ref. B.1] does not permit RMU rooms in the basements of buildings.

Transformer rooms, low voltage switchgear rooms, high voltage rooms and generator rooms are preferred at ground level, but are permitted in basements by Dubai Electricity and Water Authority (DEWA) and Dubai Civil Defence (DCD) provided that the design conforms to G.7.6 and Table 1.9, Ch. 1 of the UAE FLSC [Ref. B.1].

Waste rooms are preferred at ground level, but are permitted in basements by DCD provided that the design meets the following criteria.

a) The room is 1 h fire resistance rated, including a 1 h fire door and fire resistance rated opening protectives.
b) The room is no more than one level below ground level.
c) The room is provided with a dedicated mechanical ventilation system direct to outside to achieve 10 air changes/h, in accordance with Section 2.17, Ch. 10 of UAE FLSC [Ref. B.1].

B.8.5 Waste management

B.8.5.1 Waste management hierarchy

The waste management hierarchy (see Figure B.84) shall be followed when defining waste storage and management within buildings. This shall include the facilitation of material reuse, recycling and recovery wherever possible.

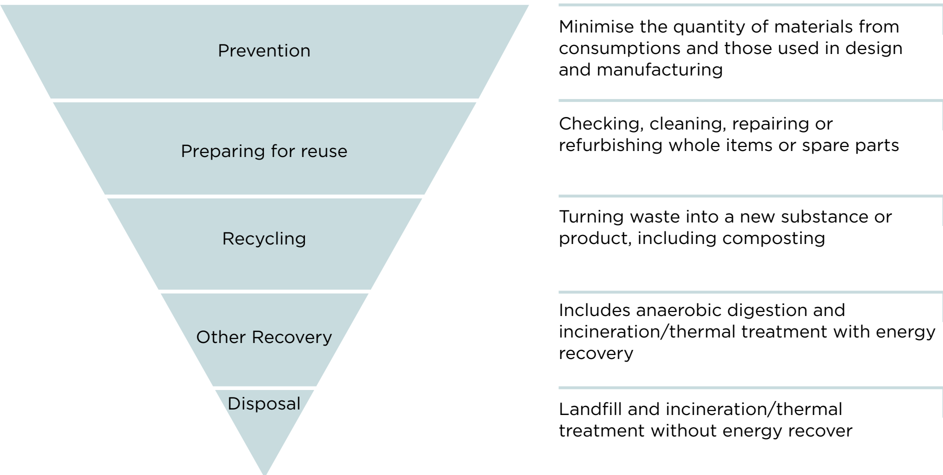


Figure B.84 Waste management hierarchy diagram

B.8.5.2 Waste storage rooms

B.8.5.2.1 General

All buildings shall be provided with suitable storage for general waste and recycling. This shall include the provision of:

a) Main waste storage room(s) for the final storage of waste and recycling prior to its collection and transfer offsite to a suitable treatment and/or disposal facility; and (if appropriate)

b) Interim waste storage room(s) which might be required for the temporary storage of waste and recycling within the development, prior to transfer to main waste storage room(s).

If it is not feasible to provide a waste storage room(s) inside the building, a separate onsite storage area(s) may be provided. This shall meet the relevant requirements for waste storage in B.8.5.2.2 and B.8.5.2.3 as well as the following additional requirements.

1) It shall not impede access points to and from a building.
2) It shall not be located less than 2.5 m horizontally and 5 m vertically from any openable windows of a living space such as a bedroom or living room.
3) It shall be located where interference with pedestrian traffic and other vehicle access is minimal.
4) It shall be roofed and have a concrete pad designed to handle the load of the bins.

NOTE: Separate onsite storage areas are generally only permitted when the GA of the largest storey of the building is less than 250 m^2, regardless of the height of the building.

B.8.5.2.2 Specification of waste storage rooms

Waste storage room(s) shall meet the following requirements.

a) Waste storage room(s) shall be situated within the boundary of the development and be easily accessible for both residents and tenants alike. Where access by a waste management contractor is required, suitable and unimpeded access shall be provided for waste collection vehicles to allow the easy removal of waste and recycling from the site. Where possible, the waste storage room(s) shall be located away from the ingress and egress of the development so as not to cause obstruction during times of collection.

b) If it is not possible to locate the waste storage room(s) at ground floor level, they may be placed no more than one level down from the ground floor, at the first basement level, and shall conform to DCD requirements as stated in B.8.4. A service elevator shall be provided to transfer waste and recycling to the waste storage rooms(s) as required. If waste collection occurs on the first basement level, it shall be designed with suitable access and clearance for a waste collection vehicle as appropriate.

c) Access to waste storage room(s) shall be sufficient to facilitate the easy entry, exit and manoeuvring of waste and recycling containers and waste collection operatives. Where a change in floor level exists, any longitudinal gradient falling away from the storage location shall not exceed 8.33% (1:12). The width of any passageway or access route which has to be passed through to reach the waste storage room(s) should be of a suitable width to allow waste containers to pass through easily, and not be less than 1.2 m. Access paths should be free of kerbs and steps, and avoid difficult turns and bends. Drop kerbs shall be provided where access paths meet roadways. Manual manoeuvring of waste containers from the interim storage point to the collection point;

   1) should be avoided for containers greater than 1,500 l in capacity;

   2) shall be limited to a step-free distance of 7 m and maximum slope of 8.33% (1:12) for containers up to 1,000 l in capacity;

   3) shall be limited to a step-free distance of 50 m and maximum slope of 8.33% (1:12) for containers up to 360 l in capacity.

d) The floor and wall surfacing shall be finished with non-slip concrete, ceramic tiles, or similar impervious and waterproof material to facilitate cleaning. Textured finishes should be avoided, as they attract dirt and detritus. The walls, floors and ceilings of the room shall be finished with a light colour.

e) A water supply and adequate drainage shall be provided to facilitate cleaning of the waste storage room(s) and waste containers. This may be provided direct from the water supply network or from a high-level tank. All drains and gullies should be connected to the drainage pipes of the development and have cleanable filters and/or grates to prevent blockages to the drainage system caused by waste residue.

f) Lighting shall be provided with sealed (ingress protection rated) bulkhead fittings to protect against water from cleaning and washdown.

g) An efficient ventilation system shall be provided to vent any odorous or dense flammable gases that might escape from the waste. Any waste rooms that contain organic waste shall be kept at a constant and cooled temperature, not higher than 18 °C, to prevent waste decomposition and associated odour. A lower temperature might be required depending upon the occupancy of adjacent spaces and the frequency with which the waste room door(s) will be accessed.

h) All windows shall be airtight and protected by a metal mesh wire screen in order to prevent insects and rodents from accessing the waste storage room(s).

i) All doors shall be made of anti-rust metal (e.g. aluminium) construction and provided with ventilation louvers or mechanical ventilation. Doors shall open to the outside and be fitted with automatic door closers. They shall be of a sufficient width to allow waste containers to pass into and out of the waste storage room(s).

B.8.5.2.3 Dimensions of waste storage rooms

Suitable storage space for waste and recycling shall be calculated and determined based on the type and number of containers required and the collection frequency. The storage space provision shall be sized for two days of waste and recycling generation as a minimum. This shall include an area appropriate for the storage of bulky and special waste, sorting of recyclables and any other relevant facilities or equipment which might be required.

Suitable clearance space shall be provided to enable manoeuvring of containers, easy access and use of the waste room for residents, tenants, and waste management contractors, as appropriate. Corridors and doors shall be wide enough to accommodate waste container sizes.

The required number of containers shall be calculated based on estimates of the potential waste and recycling quantity to be generated by the development, using suitable metrics for estimating the waste and recycling produced. Suggested waste generation rates for Dubai are as follows.

a) Residential use – at the rate of 12 kg for each 100 m^2 of NA.
b) Commercial use – at the rate of 12 kg for each 100 m^2 of NA.
c) Office use – at the rate of 5 kg for each 100 m^2 of NA.
d) Hotels – at the rate of 3 kg for each room and 5 kg for each suite.

To quantify the number of containers required, the total mass of waste shall be converted to volume using a waste density appropriate to the waste type being considered. The total volume of waste shall be divided by the volume of the container type selected to determine the number of containers.

In order to determine the area required for waste storage, the following requirements shall be met:

a) In buildings with a total GA of more than 230 - 460 m^2, a waste storage room of 1.2 m x 1.8 m shall be provided on the ground floor only.
b) In buildings with a total GA of more than 460 m^2, waste storage room(s) shall accommodate all required containers according to their standard size. The type of container required shall be determined based on the quantity of waste and recycling generated by the development, and the practicalities of access to the development and removal of waste and recycling by the waste management contractor.
c) Guideline dimensions and examples of typical containers are shown in Table B.27, Table B.28 and Figure B.85. Container sizes vary by manufacturer. Typical standards for waste containers are provided in BS EN 840-1 to BS EN 840-4 and BS EN 12574-1 and these shall be taken into account when determining the waste storage requirements.
d) Indicative waste storage rooms sizes are provided in Table B.29. The dimensions of the waste storage room(s) shall allow for manoeuvring of the required containers within the room so as to provide suitable access to the containers as well as easy removal and return to the waste storage room(s). This shall include:
    1) a minimum clearance of 150 mm between individual containers and between containers and surrounding walls of the waste storage room(s);
    2) a minimum clearance of 600 mm between individual containers and the front façade of the room, where the door that leads to the waste room is situated;
    3) a minimum door width of 1.2 m. Where utilized for movement of containers, this shall be of an appropriate size to allow for the easy entry and exit of the container type required;
    4) a minimum clear room height of 2.4 m. In all cases, this shall permit the lids of waste containers to be opened and closed in-situ.

Capacity (litres)	Capacity (m^3)	Width (W) (mm)	Length (L) (mm)	Height (H) (mm)
120	0.12	480	550	940
240	0.24	580	715	1,060
360	0.36	660	880	1,100

Table B.27 Wheeled bins

Capacity (litres)	Capacity (m^3)	Width (W) (mm)	Length (L) (mm)	Height (H) (mm)
660	0.66	720	1,250	1,320
1,100	1.1	980	1,250	1,355
2,500	2.5	1,370	2,040	1,540
4,500	4.5	1,700	2,040	1,800

Table B.28 Eurobins and bulk storage containers

Weight of waste	Room should accommodate the following containers:
Up to 100 kg	1 x 1.1 m^3
Up to 250 kg	1 x 2.5 m^3
Up to 500 kg	2 x 2.5 m^3
Up to 750 kg	3 x 2.5 m^3
Up to 1,000 kg	4 x 2.5 m^3
> 1,000 kg	A waste management consultant should advise
NOTE: A single container with a capacity of 4.5 m^3 may be used instead of two containers with a capacity of 2.5 m^3, provided that the waste storage room is directly overlooking the street or it is possible to easily transfer the 4.5 m^3 containers to the street.	

Table B.29 Recommended dimensions of waste collection rooms

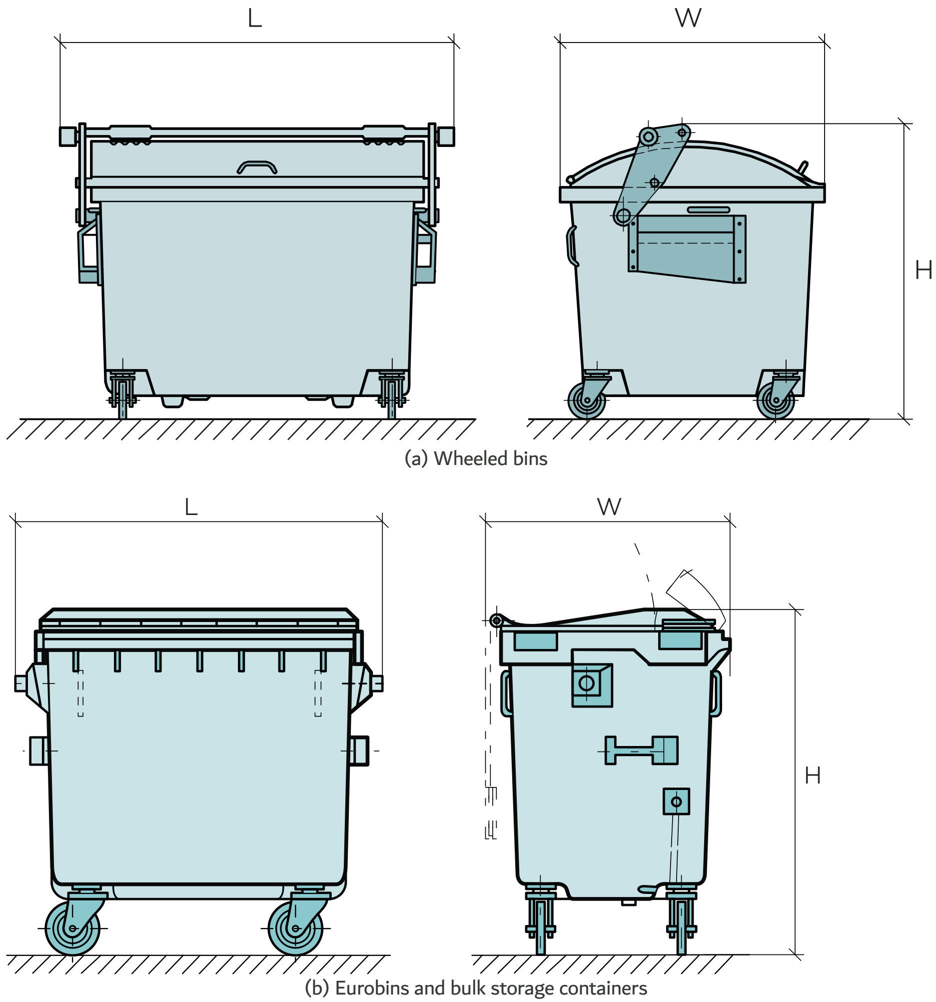


Figure B.85 Example containers and sizes in Table B.27 and Table B.28 (© British Standards Institute. Figures extracted from BS EN 840-2:2020 and BS EN 12574-1:2017. Permission to reproduce extracts from British Standards is granted by British Standards Institute (BSI). No other use of this material is permitted).

B.8.5.3 Recycling and segregation

A sorting area for recyclable waste shall be provided within the main waste storage area(s). This shall facilitate sorting of recyclables where segregation is not undertaken at source by a building's tenants. It is recommended that the floor area of the waste storage room(s) is increased by not less than 5 m^2, to allow for additional space and manoeuvrability for sorting recyclable waste.

B.8.5.4 Special and bulky waste

An area shall be provided for special and bulky wastes such as hazardous wastes, furniture and electrical appliances. This may be within the main waste storage room(s) or in a separate location as appropriate. The area shall be appropriately sized according to the size and type of the development and the expected quantities of special and bulky waste. It is recommended that an area of not less than 5 m^2 is provided. This storage area shall be easily accessible for residents, tenants and waste collection contractors alike and shall not restrict access to the building.

B.8.5.5 Chemical and toxic waste

Chemical wastes, toxic substances, chemical/toxic liquids and other dangerous materials shall not be disposed of in waste containers provided for general waste. If such wastes arise, they shall be stored in appropriate and separate waste storage containers, and removed from the development by an appointed and approved waste management contractor authorized to deal with such wastes by the concerned departments of the Authority.

If hazardous waste is to be stored, it might need to be separated from the rest of the waste storage room(s) by walls and/or bunding as required, depending upon the type and quantity of materials, materials composition and the waste container to be utilized. DCD, DM Environment Department and DM Public Health and Safety Department shall be consulted as necessary.

B.8.5.6 Hydraulic skip compactors

In all types of buildings and facilities, hydraulic skip compactors, either portable or static, are permitted for waste storage in lieu of the number of traditional waste containers, and where waste quantities are high enough to justify their use. Where skip compactors are used, at least two shall be provided to ensure facilitation of recycling; one for general waste and one for recyclables.

The type of compactor provided shall be suitable for the composition of waste and the amount of waste generated by the development, and shall be in accordance with the specifications of the Authority and DIN 30722-1 to DIN 30722-3 as appropriate.

The dimensions, manoeuvrability and collection methodology of skip compactors shall be accounted for in the design of the waste storage room(s) or any provided service bay(s) as well as the site access. Guideline dimensions and examples of typical portable skip compactors are shown in Table B.30.

Capacity (litres)	Add capacity (m^3)	Width (W) (mm)	Length (L) (mm)	Height (H) (mm)
10,000	1,000	2,015	4,400	2,500
20,000	2,000	2,550	6,390	2,560

Table B.30 Portable skip compactors

B.8.5.7 Refuse chutes

For residential buildings, where building height exceeds G+3 and the floor area of any storey exceeds 250 m^2, a refuse chute shall be provided. For the purpose of determining the number of floors, a mezzanine floor shall not be included where its functional use is connected with the ground floor. Other occupancies may utilize refuse chutes as appropriate.

In all cases where a refuse chute is required or provided, one of the following shall be included to facilitate recycling:

a) a second chute, or suitable automated separation system such as a bi-separator or tri-separator, to handle recyclable material. This shall discharge into a separate receptacle within the waste management area; or

b) waste rooms provided on each floor, where recyclable waste can be stored. The waste rooms shall comply with B.8.5.2.2 (d)-(g). The number of rooms provided shall be appropriate to the size and occupancy of the building. These shall have a floor area of not less than 2 m^2. Recyclable waste shall be collected by the building operator daily, transported in a service elevator and discharged into a designated receptacle within the waste management area.

All refuse chutes shall conform to BS 1703. Refuse chutes for collecting waste from floors to the collection room shall be not less than 600 mm in diameter. The material used shall resist corrosion, prevent dampness, be non-combustible and have a smooth inner surface. All refuse chutes shall be supplied with cleaning and fire protection systems.

An area of not less than 900 mm × 1,000 mm shall be included on each floor in order to provide access to the refuse chute. The door entrance shall be not less than 915 mm in width. Doors shall swing outwards and be fitted with automatic door closing mechanisms. For ground floor residents, suitable access shall be provided to the main waste storage room(s) or appropriate interim storage room(s) to facilitate disposal of waste and recycling.

Where the refuse chute is situated at a distance from the roads that surround the building, the main waste storage room(s) shall be situated near to the access roads and shall facilitate easy access by waste management contractors for removal of waste from the site.

Where suitable arrangements are in place for the transfer of waste to the main waste storage area, service elevators may be used in lieu of refuse chutes. These shall be located in an area that is isolated from the main passenger elevators and close to the main waste storage area of the building. In some situations, the use of passenger elevators is permissible for transfer of waste on a scheduled basis. This is subject to the occupancy type of the development and other factors including compliance with food safety regulations.

Interim waste storage rooms shall be provided as appropriate and conform with the requirements of B.8.5.2.

B.9 Architectural requirements for specific building types and spaces

B.9.1 General applicable requirements

This section details specific requirements for different building types.
These requirements shall be met in addition to all applicable requirements in the rest of Part B.

The fire safety aspects of building design shall be in accordance with Ch. 1 to Ch.3 of UAE FLSC [Ref. B.1], based on occupancy classification, building height and/or building depth, together with the occupancy-specific fire separation and egress requirements given in Section 5, Ch. 3 of UAE FLSC [Ref. B.1].

Building design shall also follow applicable health and safety requirements [Ref. B.42 to Ref. B.54].

B.9.2 Fire separating construction

Fire separating construction shall be provided in accordance with Table 1.9, Ch. 1 of UAE FLSC [Ref. B.1].

B.9.3 Cinemas, theatres and auditoria

The architectural design of mezzanines, balconies, aisles and seating arrangements in cinemas, theatres and auditoria shall conform to the minimum requirements given in Section 5.1, Ch. 3 of UAE FLSC [Ref. B.1].

Where there is a well-defined main entrance or exit from cinemas, theatres and auditoria, it shall be designed to accommodate two thirds of the total occupant load.

B.9.4 Mosques

B.9.4.1 General requirements

The following requirements and recommendations apply to the space planning of mosques.

a) The size of mosques should be sufficient for the population density they serve, taking into account the number of mosques within proximate locations, as well as the other plots reserved for mosque construction in the future.
b) Future expansions of mosque facilities should be taken into account.
c) Professionals involved in the design and construction of mosques shall have knowledge and experience of Islamic architecture.
d) The direction of prayer and flow of movement inside the mosque shall be taken into account.
e) Vehicular and pedestrian movement inside the mosque plot shall segregated to avoid interference with the movement of worshippers to and from the mosque's buildings and service blocks.

B.9.4.2 Mosque architecture

There are no restrictions on mosque design, provided that the following basic requirements and recommendations are met.

a) The mosque design should respect Islamic architecture principles and should be in harmony with local heritage and environment conditions of the region.
b) None of the design elements used shall contradict Islamic principles. This includes proposed geometry, zoning of spaces to the interior finishes and calligraphy.
c) The architectural style used in mosque design should be implemented consistently for all mosque elements including the dome and the minaret.
d) The mosque design shall include the aesthetic treatment of mosque spaces and elements including the internal treatment of prayer halls.
e) The height of mosque elements such as domes and minarets, shall be proportionate to the mosque general massing. The ratio of the minaret height to the mosque should be 3:1.

Window openings shall be positioned carefully and treated to avoid distraction of worshippers and sun glare effect, especially in the direction of prayer.

Examples of mosque design are given in Figure B.86. The mosque prayer hall shall be provided with a Mihrab for Imam's space and to indicate the direction of prayer.

Minbar for Friday prayers and Eid prayers shall be provided and should be appropriately sized and positioned to avoid restricting prayer space in the front lines. The minbar shall be positioned on the right side of the Mihrab as shown in Figure B.87.

The minaret shall be provided with a permanent stair constructed from durable materials, for access. As a minimum, the minaret shall have a spiral access stair from ground level to the roof. The radius of the spiral stair shall be not less than 900 mm and shall conform to the requirements for spiral stairs in B.6.4.1.12.

Minaret openings should be covered to reduce maintenance requirements.

Figure B.86 Mosque examples

Figure B.87 Mihrab and Minbar example

Implementation of green planted open spaces within the mosque plot is encouraged.

When the plot area allows, it is recommended that the mosque includes a library, storage spaces and learning spaces.

The materials used (such as prayer hall carpets, floor finishes and ceiling materials) shall have hygienic and eco-safety properties designed to prevent the accumulation of dust, mould, etc. Materials shall be appropriate to the holy nature of the mosque.

Finishes shall be selected to withstand the high frequency of mosque space use.

Acoustic treatment shall be included in the design of the prayer hall to suit the space and height (see H.10.4.1).

When the mosque requires fences for security or safety purposes, these fences should allow visibility into the mosque plot. Mosques located in industrial areas or areas under construction shall be provided with fences.

The mosque design should include courtyard spaces and an Iwan for prayer overspill as needed.

B.9.4.3 Mosque access strategy

The number and size of entrances to mosques should be proportionate to the area and expected number of worshippers, avoiding congestion that might occur during the access and exit of worshippers.

The entrance doors to prayer halls shall be sized proportionately to the number of worshippers and should be not less than 3 m in height.

Prayer hall door positions shall be carefully planned to avoid impacting prayer space or creating queues during access or exit. Doors should always be located in the rear of the prayer hall. Doors shall be provided with vision glass panels.

A separate entrance into the prayer area shall be provided for the Imam from the Mihrab side. The entrance door shall open towards the direction of egress.

Roof access for maintenance shall be provided with protective ladders for ascending heights of up to 6 m. If the required ascending height exceeds 6 m, an access stair should be provided.

B.9.4.4 Mosque prayer hall arrangement

Prayer hall areas shall be planned to accommodate the total number of worshippers in accordance with the occupant load factor in B.5.1.

Prayer lines shall be 1,330 mm in length, with each line indicated through carpet patterns. Each person in the mosque is assumed to occupy 675 mm of the line width.

The prayer halls should be rectangular in shape, with the longest edge perpendicular to the Qibla. Irregular angles, protrusions or recesses within the prayer halls should be avoided. An example of a general prayer hall arrangement is shown in Figure B.88.

Intermediate structural elements inside prayer halls that impact the continuity of prayer lines should be avoided.

A 600 mm space shall be provided on the sides of the prayer hall in Jumaa mosques to facilitate movement and exit from prayer hall.

The net height of prayer halls shall be proportionate to the expected number of worshippers and to the architectural style chosen. The height of the prayer hall shall be not less than the minimum value given in B.5.3.

Space for shoe storage shall be provided prior to accessing the prayer hall. The space shall be adequately sized to serve the expected number of worshippers and shall be positioned so as not to conflict with prayer hall access.

Prayer halls lighting intensity and homogeneity should be taken into consideration.

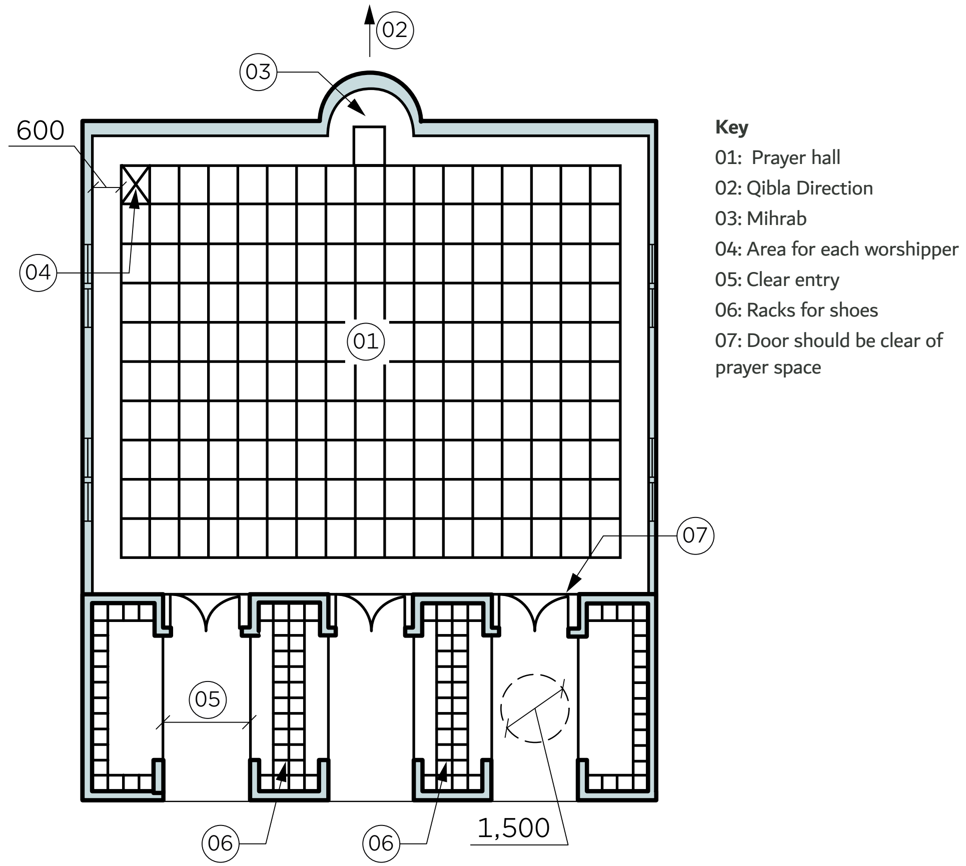


Figure B.88 Prayer hall general arrangement example

B.9.4.5 Women's prayer halls in mosques

All mosques (except for those located in industrial areas) shall provide a women's prayer hall with the required number of sanitary facilities and ablution spaces.

The area of women's prayer halls shall be sufficient to the expected number of female worshippers and shall be sized to accommodate at least 20% of the total planned number of worshippers.

The position of women's prayer halls shall be planned such that the Imam position is in front of all of the praying group. The prayer hall shall not be adjacent to men's toilet blocks or located in a remote area of the mosque (see Figure B.89).

Privacy of the women's entrance and prayer hall shall be taken into account. Provision shall be made for direct and private circulation between the women's prayer hall and women's facilities in the mosque (see Figure B.89).

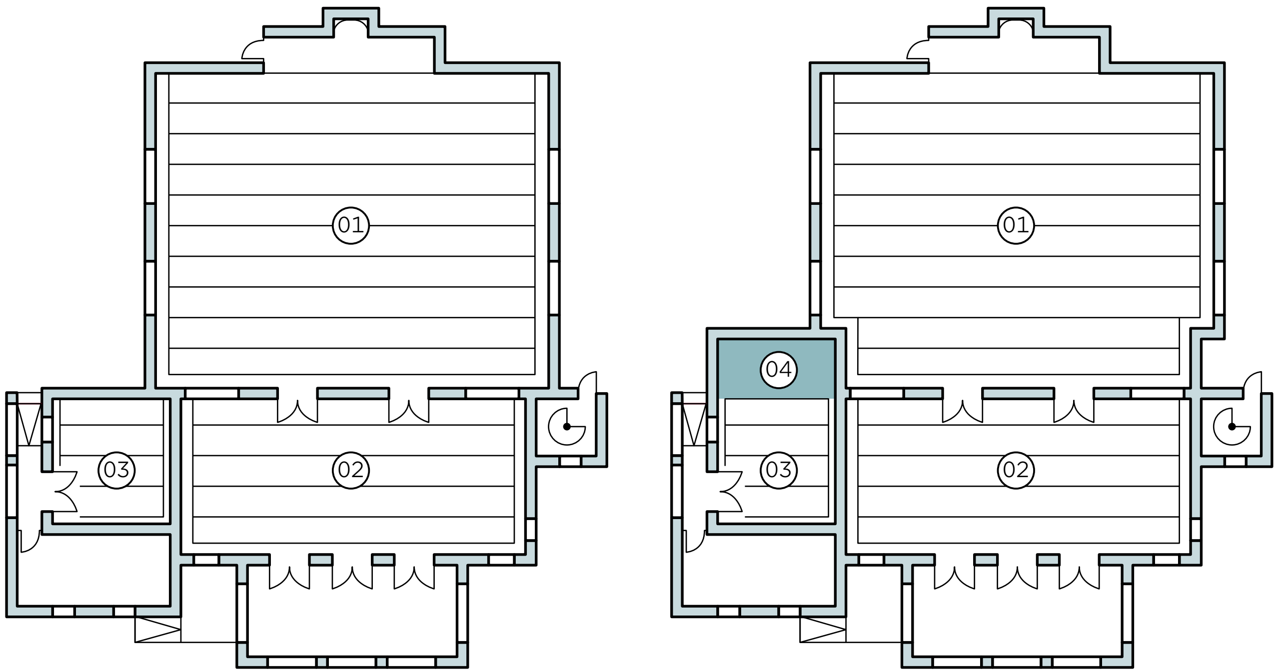


Figure B.89 Prayer hall general arrangement example

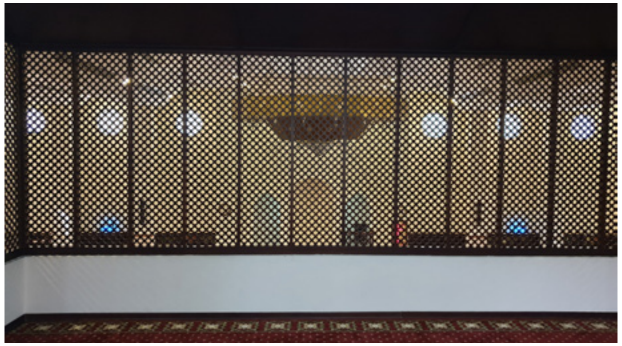
Key
01: Men main prayer hall
02: Men secondary prayer hall
03: Women prayer hall
04: Prayer prohibited in this area when the Imam is in the secondary prayer hall

The women's prayer hall shall be located near to the main road access and parking areas and shall not be allocated in the mosque basement floor.

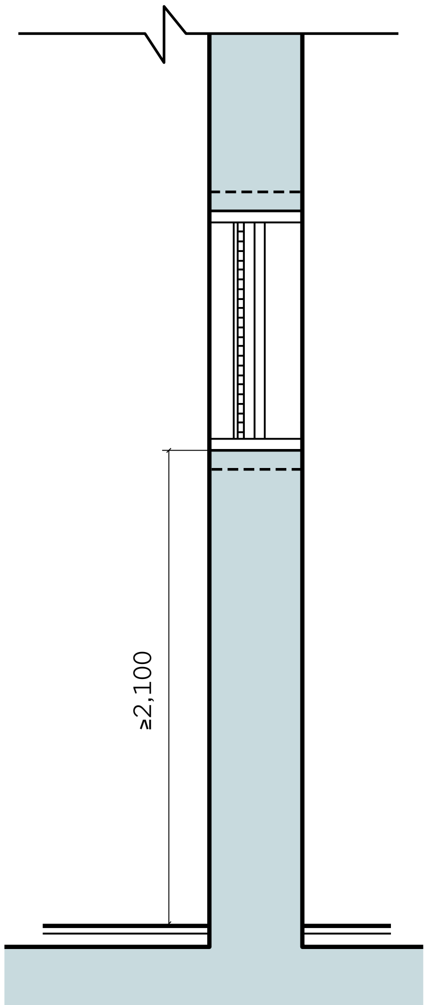
An indicative mihrab or wall recess should be provided to inform Qibla direction.

Visual and audio connection between women's and men's prayer halls shall be provided. Audio systems shall provide appropriate sound levels into the women prayer room.

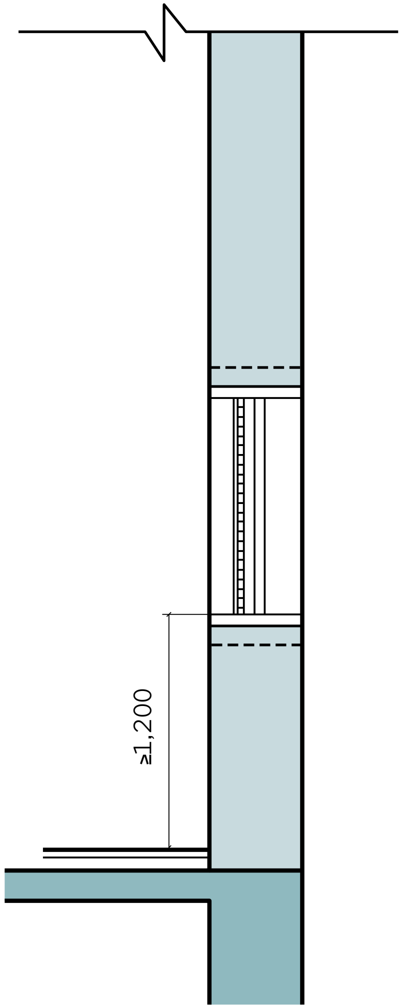
The connection can be provided through perforated screen or openings as shown in Figure B.90. The screen or opening shall be placed at a minimum height of 2.1 m if both prayer halls are located on the ground floor or at 1.2 m minimum when the female prayer hall is on the upper level above the male prayer room and overlooking it.



(a) Screen



(b) 2.1 m high screen when both prayer halls are at ground floor



(c) 1.2 m high screen when women's prayer hall is above men's prayer hall

Figure B.90 Visual and audio connection between women's and men's prayer halls

B.9.4.6 Specific requirements for mosque types

B.9.4.6.1 Awqat mosques (daily prayers mosque)

Awqat mosques shall:

a) accommodate 100 to 300 male worshippers (assumed to be 80% of the total number of planned worshippers);

b) provide prayer rooms for women accommodating 20% of the total number of planned worshippers.

An example of Awqat mosque layout is provided in Figure B.91.

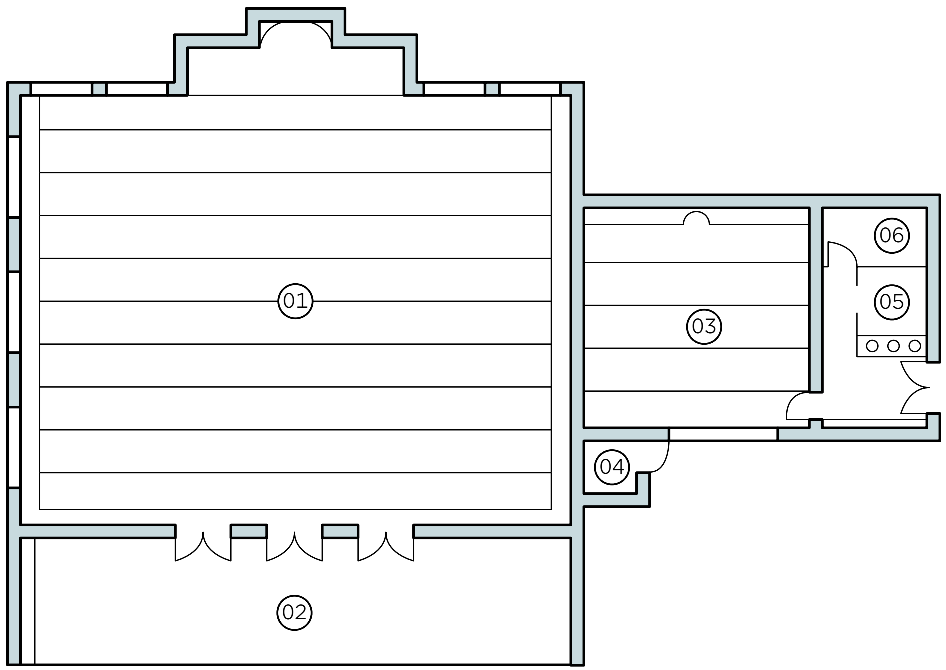


Figure B.91 Awqat mosque layout example

Key

01: Men prayer hall

02: Iwan

03: Women prayer hall

04: Minaret

05: Ablution

06: Toilet

B.9.4.6.2 Jumaa mosque (Friday prayer)

Jumaa mosques shall:

a) accommodate more than 300 male worshippers (assumed to be 80% of the total number of planned worshippers);
b) provide prayer rooms for women accommodating 20% of the total number of worshippers.

Jumaa mosques accommodating more than 500 worshippers shall provide a secondary prayer hall for the daily prayers. The following requirements and recommendations apply to the secondary prayer hall.

1) The secondary prayer hall shall be one third of the overall men's prayer hall area.
2) The secondary prayer hall should be provided with a Mihrab, as shown in Figure B.88.
3) The division between the main and secondary prayer halls shall be through solid construction that provides thermal separation properties for air-conditioning, and maintains visual connection between the two halls when both spaces are used. Glazed walls may be provided.

An example of Jumaa mosque layout is provided in Figure B.92.

B.9.4.6.3 Eid Mussalla

The space provided for performing Eid al-Fitr and Eid al-Adha prayers shall be as required by IACAD.

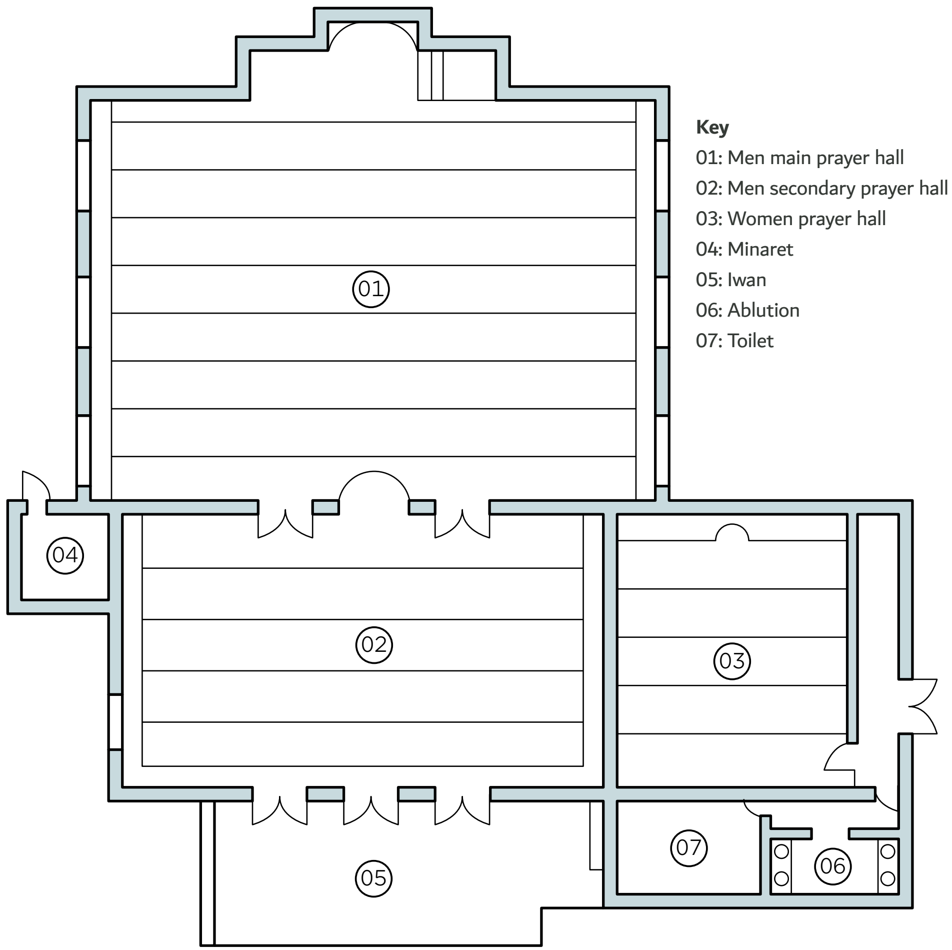


Figure B.92 Jumaa mosque layout example

B.9.4.7 Ablution spaces

Ablution spaces shall be well planned to avoid restriction of movement during ablution. Fixture clearances shall conform to B.8.1.5.

Ablution spaces shall meet the following requirements.

a) The required number of ablution spaces (calculated in accordance with B.8.1.3.2) shall be provided with fixed seats or height adjustable rotatable stools.

b) Accessible ablution spaces shall be provided in accordance with C.8.6.

c) The ablution areas shall be separated from the toilet blocks, see Figure B.93.

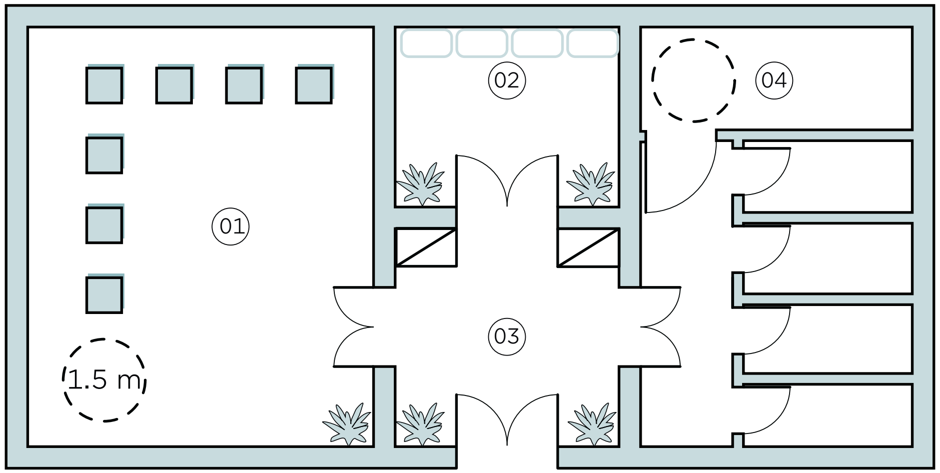


Figure B.93 Example of ablution area separation from toilets

Key
01: Ablution
02: Wash basins
03: Entrance lobby
04: Toilet

Ablution wash basins and standing ablution spaces with faucets are optional.

The convenience of users and comfortable reach ranges shall be taken into account when determining the appropriate fixture heights according to the model of ablution chosen. The clearances allowed shall be not less than the minimum values shown in Figure B.94.

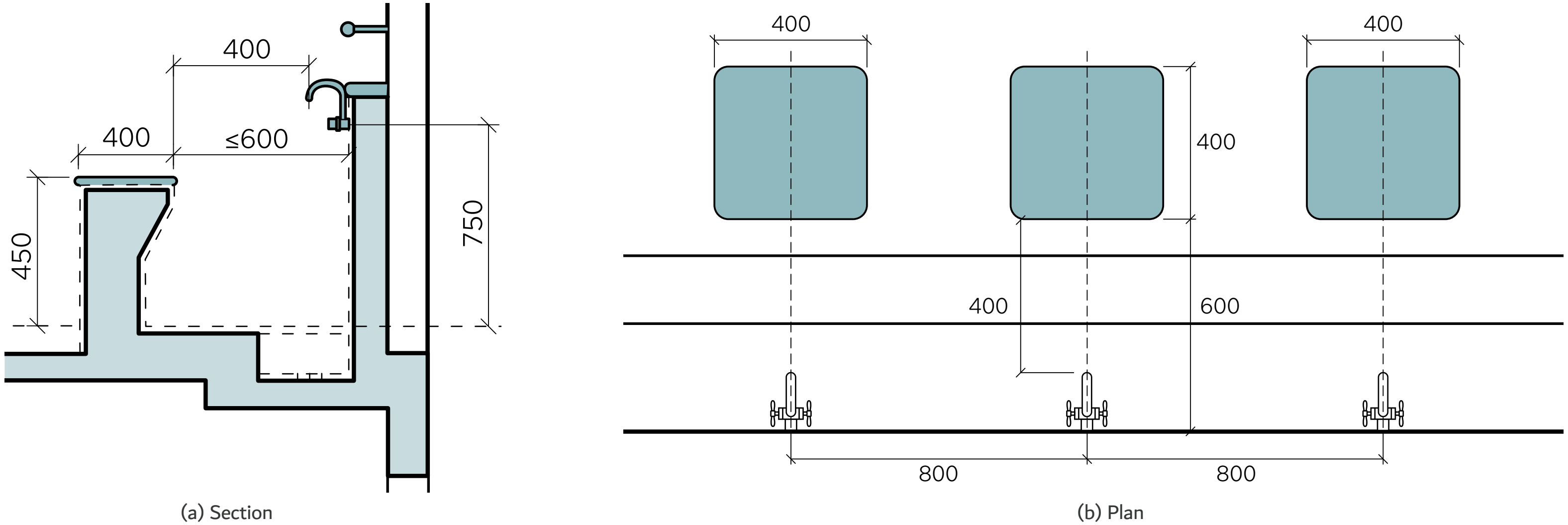


Figure B.94 Ablution seat clearance section

B.9.4.8 Mosque accommodation

For a residence associated with a mosque, the area of a bedroom shall be not less than 15 m^2.

The location of accommodation shall provide privacy to the residents. The residence block shall be separate from the mosque main mass and positioned away from heavy mosque traffic.

Residence units should be adjacent to each other, in order to minimize impact on mosque outdoor areas or any planned future expansion of the mosque.

An assigned parking bay for the mosque Imam and Moazen shall be provided with an indicative designated parking board.

Mosque accommodation shall meet the following minimum requirements.

a) Awqat mosque.
   1) Mosque cleaner/keeper: the accommodation shall consist of a studio unit with kitchen and toilet. The unit shall be positioned in proximity to mosque service blocks.
   2) Imam residence: the accommodation shall consist of a minimum two-bedroom unit with a living room, an enclosed kitchen and three toilets. One of the bedrooms shall be an en-suite bedroom.
   3) Imam residences shall be provided with dedicated outdoor open space or courtyard.

b) Jumaa mosque.
   1) Mosque cleaner/keeper: the accommodation shall consist of a studio unit with kitchen and toilet. The unit shall be positioned in proximity to mosque service blocks.
   2) Imam residence: the accommodation shall consist of a minimum two-bedroom unit with a living room, an enclosed kitchen and three toilets. One of the bedrooms shall be an en-suite bedroom.
   3) Moazen residence: the accommodation shall consist of a minimum one-bedroom unit with a living room, an enclosed kitchen and a toilet.
   4) Imam and Moazen residences shall each be provided with dedicated outdoor open space or courtyard.

B.9.4.9 Mosque-specific sanitary requirements

The positioning of mosque toilets shall be planned carefully with cognisance of the wind direction. Toilets shall not be positioned in front of or adjacent to the prayer hall. The entrance of toilets shall be separated from ablution spaces to maintain purity of ablution spaces.

Mosques shall be provided with a combination of western and eastern water closet. At least 25% of the total number of male and female toilets shall be eastern style water closet, or as requested by IACAD depending on the mosque location.

The cleaner's room shall be provided in proximity to the toilet blocks.

Toilet compartments in a mosque shall be made of solid construction partitions. Each compartment shall be not less than 1,100 mm × 1,500 mm.

Mosque sanitary provisions shall conform to B.8.1.

B.9.5 Restaurants and food facilities

B.9.5.1.1 General

The requirements in this subsection apply to the following spaces:

a) restaurants;
b) food services and beverage sales outlets such as:
    1) coffee shops;
    2) juice serving outlets;
    3) grocery shops;
    4) farm and fruit slate outlets;
    5) sweet refreshment;
    6) flour mills;
    7) roasters;
    8) frozen and chilled cold stores for food facilities storage;
    9) bakeries and pastries;
    10) retail supermarkets; and
    11) sea food sales outlets.

Spaces shall be equipped with the necessary sanitary, health and safety facilities and minimum kitchen areas in accordance with health and safety requirements issued by DM, General Conditions for Licensing of Food Establishments [Ref. B.55].

B.9.5.1.2 Food preparation

Food preparation areas shall be designed based on the food and beverage items to be offered and the flow of food between the preparation area and the diner.

The design process in PD ISO/TS 22002-2 shall be followed to control the operational conditions within a food establishment and to promote environmental conditions that are favourable for the production of safe food.

Operator brand standards (e.g. hotels, schools) shall be followed where applicable.

Food preparation areas in healthcare facilities shall conform to the DHA regulations and guidelines [Ref. B.3 to Ref. B.18].

The intersection between the walls, the floors and the ceiling shall be sealed and rounded to facilitate the cleaning process.

B.9.5.1.3 Kitchen requirements

The floors, walls and ceilings of kitchens shall be made of a smooth material that is non-absorbent, non-combustible, non-toxic, crack-free and easily cleaned.

Floors shall be hard-surfaced, non-absorbent and drained. They shall be constructed with waterproof, non-absorbent washable materials without fissures or crevices.

Wall finishes shall be smooth, waterproof, resistant to fracture, light-coloured and readily cleanable.

Working surfaces for preparation of food shall be manufactured from stainless steel or other approved impervious material to facilitate cleaning and maintenance of hygienic conditions.

Gas supplies shall be in accordance with Ch. 11 of UAE FLSC [Ref. B.1].

Kitchen hoods and associated kitchen extract ductwork shall be provided to all areas involving cooking activities, i.e. stoves, gas rings, tandoors, etc.

Kitchen hoods and associated kitchen extract duct work shall be designed and installed in accordance with H.4.12.15 and UAE FLSC [Ref. B.1].

Chimneys installed in bakeries, restaurants and roasteries shall be located on the rear side of the plot, or inside shafts and ducts.

The position, height and ventilation of chimneys shall be determined in accordance with H.4.12.18.

Cold stores and freezers doors shall be openable from both sides. Safety releases shall be provided on the insides of doors to avoid risk of accidental entrapment.

B.9.6 Educational facilities

B.9.6.1 General requirements

The requirements in this subsection apply to all educational facilities.

Educational facilities shall be located in designated plots in accordance with the affection plan, land use classification and DCRs. Building heights and number of floors allowed shall conform to planning regulations.

Educational buildings shall be designed in accordance with the DM PH&SD guides [Ref. B.49, Ref. B.50].

Educational facilities shall meet the following requirements.

a) Daylighting provisions and acoustical treatment shall be prioritized for classrooms and teaching spaces.
b) Educational facilities shall be equipped with a health clinic conforming to DHA school clinic regulations [Ref. B.9].
c) Facilities shall include rooms for management staff, teachers, administrators and supervisors, and waiting areas for parents. The areas of these rooms shall be suitable for the number of staff in the facility.
d) The number of students permitted in each classroom shall be determined in accordance with DM planning guidelines for public amenities [Ref. B.56] and the Ministry of Education requirements.
e) Segregation of vehicular and pedestrian movement shall be provided inside the facility to avoid intersection with movement of students to and from the facility's buildings. Bus pick-up and drop-off areas shall be located in a safe area, away from vehicular traffic, for student circulation.
f) Separate parking areas should be provided for school buses and cars
g) Sanitary requirements for students shall be based on the fixture dimensions defined in C.8.3.4.4 and the reach ranges defined in C.5.7.3.

B.9.6.2 Schools

Natural and artificial lighting shall be configured to avoid glare on vertical writing surfaces and on students' desks. For window orientation, it is preferable that window openings face the left side of classrooms.

The school shall have a library, with adequate area to accommodate the number of students in the school.

The school shall include sports courts according to the requirements applied by the Ministry of Education.

The school shall have at least one canteen or dining hall. The canteen shall be of an adequate size to serve the students.

The school shall have adequate number of laboratories, computer rooms, and activities hall (multipurpose hall or auditorium).

School shall have allocated area for playing fields and open spaces. These areas should not be less than 200% of the area allocated to classrooms, with 30% of these spaces shaded. A mast for the flag should be provided.

First grade student classrooms shall be located on the ground floor.

Laboratory facilities shall be distanced from classroom areas.

Laboratories shall be provided with sufficient means of exhaust systems when the facility is planned to be used for conducting chemical experiments.

Stairways for regular use by school students shall conform to B.6.4.1.6.

Minimum fire separation and egress requirements for schools are provided in Section 5.3.2, Ch. 3 of UAE FLSC [Ref. B.1].

B.9.6.3 Kindergartens

Kindergartens shall have playgrounds and open space of an area not less than 200% of the area allocated to classrooms. At least 30% of this area shall be shaded. Part of this area shall be planted and part of it shall be provided with sand/playground areas. Play equipment and recreational facilities shall be provided for children.

Kindergartens shall have at least one canteen and a multipurpose hall. The canteen shall be of an adequate size to serve the students and shall conform to health and safety requirements [Ref. B.50, Ref. B.55].

Kindergarten classrooms shall be provided at ground level only.

Minimum fire separation and egress requirements for kindergartens are provided in Section 5.3.1, Ch. 3 of UAE FLSC [Ref. B.1].

B.9.6.4 Nurseries

The clear distance between beds in the nursery rooms shall be not less than 1,000 mm.

Nurseries shall be provided with a large shaded and planted playground including a sand pit, covering an area that is suitable in proportion to the number of children enrolled, with a minimum area of 0.6 m^2 per child

Nurseries shall be located at the ground level only.

Minimum fire separation and egress requirements for nurseries are provided in Section 5.3.1, Ch. 3 of UAE FLSC [Ref. B.1].

B.9.7 Residential buildings

B.9.7.1 Apartment buildings

Apartment buildings shall be located in designated plots in accordance with the affection plan, land use classification and DCRs.

Minimum fire separation and egress requirements for apartment buildings are provided in Section 5.5.1, Ch. 3 of UAE FLSC [Ref. B.1].

All dwelling units in apartments shall be separated by 1 h fire resisting construction as required by Table 1.9, Ch. 1 of UAE FLSC [Ref. B.1].

B.9.7.2 Labour accommodation

B.9.7.2.1 General building requirements

Labour accommodation shall be located in designated plots in accordance with the affection plan, land use classification and DCRs.

Labour accommodation shall be constructed from permanent use, durable and sustainable materials. Temporary installations shall not be used.

The accommodation buildings shall be separated from kitchens, workshops and stores in accordance with UAE FLSC [Ref. B.1].

Prayer rooms shall be provided in accordance with B.8.3.3. Prayer rooms shall be accessible to all occupants, with proximity to other communal amenities.

All residential rooms, kitchens, dining rooms and halls shall be provided with ventilation and air conditioning according to H.4.

Minimum fire separation and egress requirements for labour accommodation are provided in Section 5.5.3, Ch. 3 of UAE FLSC [Ref. B.1].

B.9.7.2.2 Labour accommodation rooms

The number of workers in each room shall not exceed 8 workers.

A supervisor's room shall be provided for every 40 labourers. The room shall include separate sanitary facilities for the supervisor.

Doors to rooms shall not open directly into the road or sikka. The building's main entrance shall be accessible within plot limits.

If double-deck bunks are used, the clear distance between the lower and upper bunk shall be not less than 0.9 m. Triple-deck bunks shall not be used.

Toilets and bathroom blocks shall be provided with all necessary fixtures. Water tanks shall be covered with sun protection to provide room temperature water in summer.

All sleeping units in labour accommodation shall be separated by 1 h fire resisting construction as required by Table 1.9, Ch. 1 of UAE FLSC [Ref. B.1].

B.9.7.2.3 Labour accommodation amenities

Labour accommodation amenities shall meet the following requirements.

a) Multipurpose halls (dining and TV) shall have areas proportionate to the number of workers, accommodating at least 30% of building occupants at a single time. These halls shall be provided with furniture and equipment for its intended purpose, as follows.
   1) An adequately sized kitchen shall be provided for food preparation with a total area not less than one third of the dining hall area. Kitchens shall be located such that they are accessible to all users on the ground floor of the building.
   2) The dining halls shall be located on the ground floor and connect directly to the kitchen. The design and furnishings of the kitchen shall meet the general criteria for licensing food facilities [Ref. B.55].
b) Indoor recreational facilities shall occupy not less than 25% of the total net area.
c) Space provisions for each of these amenities shall conform to B.5.1.
d) The travel distance between water fountains shall be not more than 30 m.
e) A first aid room with an area of not less than 10 m^2 shall be provided at the rate of one per thousand workers and at a minimum of one per labour accommodation building. The room shall conform to the DM PH&SD guidelines for first aid [Ref. B.42].
f) A room for workers' equipment shall be provided at the rate of 0.1 m^2 per worker and an area of not less than 10 m^2.
g) A laundry tray or tub for every 30 persons shall be provided, along with places for drying laundry.

B.9.7.3 Staff accommodation

Staff accommodation shall be located in designated plots in accordance with the affection plan, land use classification and DCRs.

Staff accommodation shall be of permanent construction. Temporary structures shall not be used.

Each floor for staff accommodation shall be provided with communal kitchen, dining area, and lounge. The dining and lounge area shall be able to accommodate one third of the floor occupants at a single time. At least one kitchen and one lounge shall be provided for every 400 m^2 of NA. The kitchen area shall be not less than 25 m^2.

Rooms shall be limited to single or double occupancy. Each room shall have an attached toilet.

Rooms sizes for staff accommodation shall conform to Table B.31.

Room type	Minimum area (m^2)	Minimum dimensions (m)
Single occupancy – inclusive of en-suite toilet	13	2.7
Double occupancy – inclusive of en-suite toilet	20	2.7

Table B.31 Rooms sizes for staff accommodation

Minimum fire separation and egress requirements for staff accommodation are provided in Section 5.5.2, Ch. 3 of UAE FLSC [Ref. B.1].

All sleeping units in staff accommodation shall be separated by 1 h fire resisting construction as required by Table 1.9, Ch. 1 of UAE FLSC [Ref. B.1].

B.9.7.4 Student accommodation

Student accommodation shall be located in designated plots in accordance with the affection plan, land use classification and DCR.

Rooms sizes for student accommodation shall conform to Table B.32.

Room type	Minimum area (m^2)	Minimum dimensions – length and width of a room (m)
Single occupancy – exclusive of toilet area	7	2.4
Shared occupancy – exclusive of toilet area	5 for each student	2.4

Table B.32 Rooms sizes for student accommodation

The sanitary fixtures numbers specified in Table B.18 shall be provided as a minimum. Rooms may be provided with separate attached toilets.

Space planning of student accommodation shall take into account safety and security.

Privacy of accommodation shall be provided. Male and female residences shall be segregated.

B.9.8 Industrial and warehouse facilities

Industrial/factory/workshop and warehouse/storage buildings shall be located in a designated industrial plot in accordance with the affection plan, land use classification and DCRs.

Setbacks for industrial and warehouse plots shall conform to affection plans and DCRs.

Office space within industrial and warehouse buildings shall be provided according to planning Authority's allowance and shall be limited to a maximum of 20% of the total GA.

When the operation of the building expects a large quantity of heavy vehicle access of more than one trip per 100 m^3 of GA at peak hour [Ref. B.40], segregated access points should be provided for light vehicles and heavy vehicles or trucks.

No doors shall open directly into roadway side, except for emergency exit doors, which shall be set at a minimum of 2 m from the roadway edge. A landing shall be provided on the exterior side of the exit door at the same height as the door in accordance with Table 3.1, Ch. 3 of UAE FLSC [Ref. B.1].

Vehicular entrances shall lead to loading/unloading areas.

Loading and unloading areas may be open to sky or covered. The manoeuvring area in the loading and unloading areas shall conform to B.7.3 or be based on specialist traffic and manoeuvring analysis.

The net internal height of any factory/workshop or warehouse/storage shall be sufficient to support the processes occurring within.

Adequate space shall be provided for staff dining rooms, pantries and changing facilities, accommodating at least 25% of staff at the same time.

Kitchen facilities shall be separated from factory/workshop or warehouse/storage as mandated by UAE FLSC [Ref. B.1].

Minimum fire separation and egress requirements for warehouse/storage buildings are provided in Section 5.14, Ch. 3 of UAE FLSC [Ref. B.1].

Minimum fire separation and egress requirements for industrial/factory/workshop buildings are provided in Section 5.15, Ch. 3 of UAE FLSC [Ref. B.1].

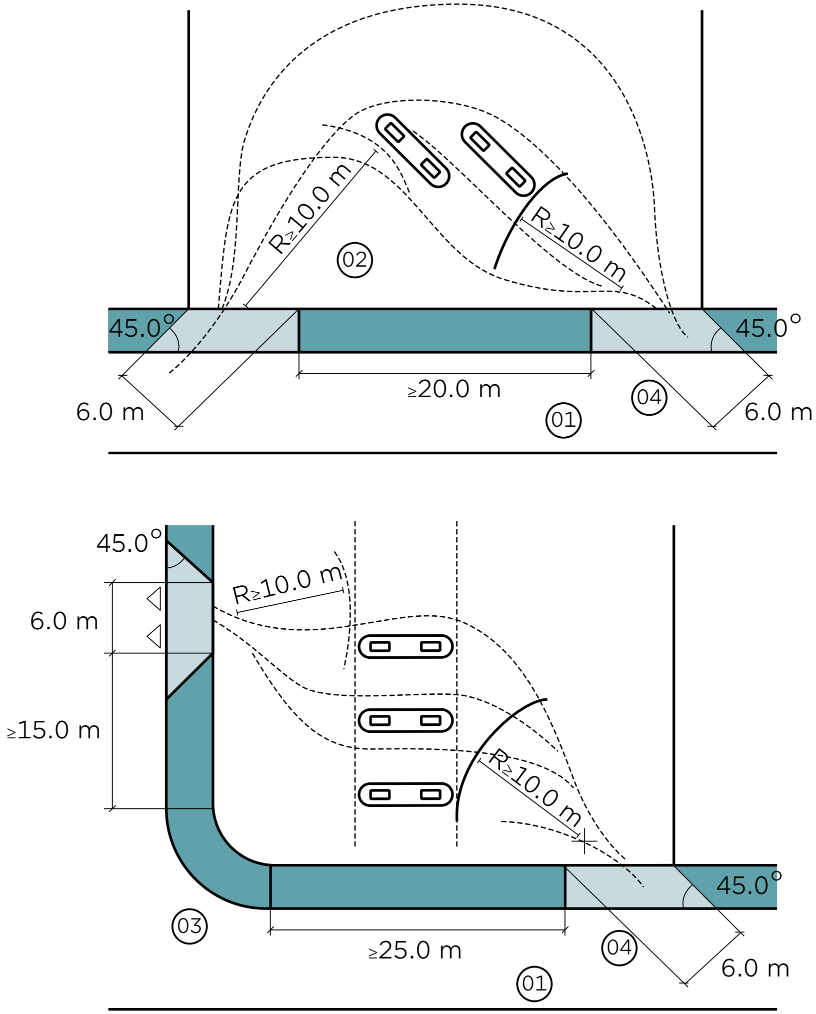
Multitenant warehouses shall be separated by 1 h fire resisting construction as required by Table 1.9, Ch. 1 of UAE FLSC [Ref. B.1].

B.9.9 Motor fuel dispensing facilities

Motor fuel dispensing facilities shall be located in a designated plot in accordance with the affection plan, land use classification and DCRs.

Motor fuel dispensing facilities shall conform to all applicable requirements of Section 3, Ch. 13 of UAE FLSC [Ref. B.1] and of the operator. All health and safety and security design requirements shall be fulfilled to ensure safety of users, workers and the facility itself.

Vehicle entrances and exits shall meet requirements for turning radius and dimensions as shown in Figure B.95.



Key

01: Road

02: Gas station with fuel pump islands obliquely angled (mainly for one-way traffic)

03: Access to corner gas station

Figure B.95 Access to fuel facility

The plot use shall be limited to motor fuel dispensing facilities and the following supporting facilities:

a) servicing sales outlets such as fast food refreshments, and convenience stores;
b) worker facilities with sanitary provision and accommodation rooms as necessary; and
c) visitors' toilets, prayer rooms and services.

Fuelling facilities on highways shall provide male and female prayer rooms to accommodate 15% of expected facility users during peak hour.

The width of the driveway between two gas station islands shall be not less than 5.5 m for islands with one pump each, and not less than 8 m for an island with two pumps, as shown in Figure B.96.

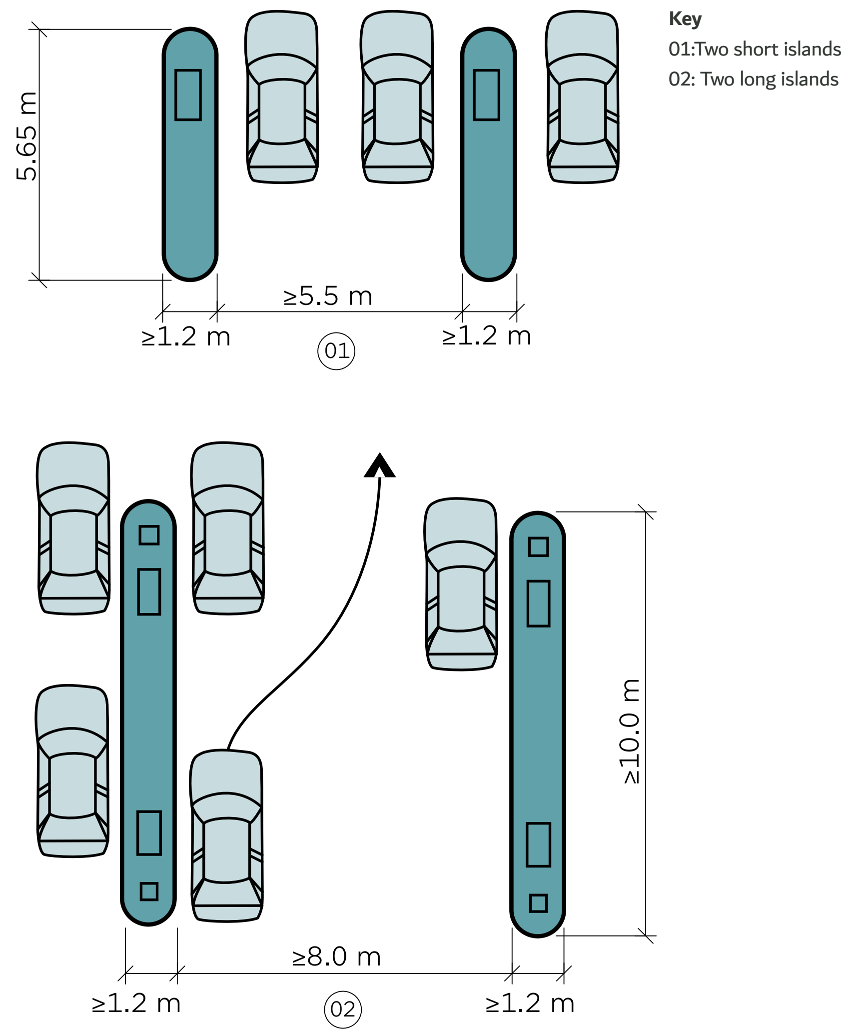


Figure B.96 Fuel station minimum dimensions

B.9.10 Healthcare facilities

Healthcare buildings shall be located in a designated plot in accordance with the affection plan, land use classification and DCRs.

Healthcare buildings, including but not limited to hospitals, outpatients' facilities, surgical centres, pharmacies and similar facilities, shall be designed according to DHA regulations and guidelines [Ref. B.3 to Ref. B.18] in addition to laws set out by the ministry of health and the DCD in UAE FLSC [Ref. B.1].

Design of healthcare facilities for Dubai Healthcare City Authority shall also follow the FGI guidelines [Ref. B.56].

The following requirements shall be met in the design of healthcare facilities.

a) The healthcare facility shall be designed ensuring independent access, amenities and building service systems. The same requirements apply to facilities located within mixed-use buildings and malls.
b) Prayer rooms shall be provided in healthcare facilities in accordance with B.8.3.3.
c) Privacy of treatment facilities and segregation of men and women shall be provided.

B.9.11 Hotel establishments

Hotels establishments should adhere to the classification criteria set by the Department of Tourism and Commerce Marketing (DTCM) according to the level of classification pursued [Ref. B.19 to Ref. B.36].

Minimum room areas and space provisions shall conform to DTCM requirements [Ref. B.19 to Ref. B.36].

Minimum fire separation and egress requirements for hotel accommodation are provided in Section 5.9, Ch. 3 of UAE FLSC [Ref. B.1].

Hotel suites and standard rooms shall be separated by 1 h fire resisting construction as required by Table 1.9, Ch. 1 of UAE FLSC [Ref. B.1].

Hotel apartments shall be separated by 1 h fire resisting construction as required by Table 1.9, Ch. 1 of UAE FLSC [Ref. B.1].

B.9.12 Utility buildings

The design of utility buildings, such as substations, waste water treatment plant and district cooling buildings, shall conform to the minimum requirements of Ch. 14 of UAE FLSC [Ref. B.1].

Table 14.1, 5 (viii), Ch. 14 of UAE FLSC [Ref. B.1] is amended by DCD to align with DEWA requirements for access around equipment. Batteries, relay and control panels and other equipment in the substation shall be arranged such that a minimum of 1,000 mm exit access width is available between such arrangements or between equipment and wall.

Detailed requirements for substations are given in G.7.

B.10 Buildings interaction with outdoor environment

B.10.1 Healthy entrances

To capture particulates from occupant shoes at all regularly used entrance(s) to the building, one of the following shall be installed:

a) A permanent entryway system, comprised of grilles, grates or slots that allow for easy cleaning underneath. The system shall be at least the width of the entrance and 3 m long in the primary direction of travel (sum of indoor and outdoor length);

b) rollout mats, at least the width of the entrance and 3 m long in the primary direction of travel (sum of indoor and outdoor length);

c) material manufactured as an entryway walk-off system, at least the width of the entrance and 3 m long in the primary direction of travel (sum of indoor and outdoor length).

An example of a healthy entrance is shown in Figure B.97.

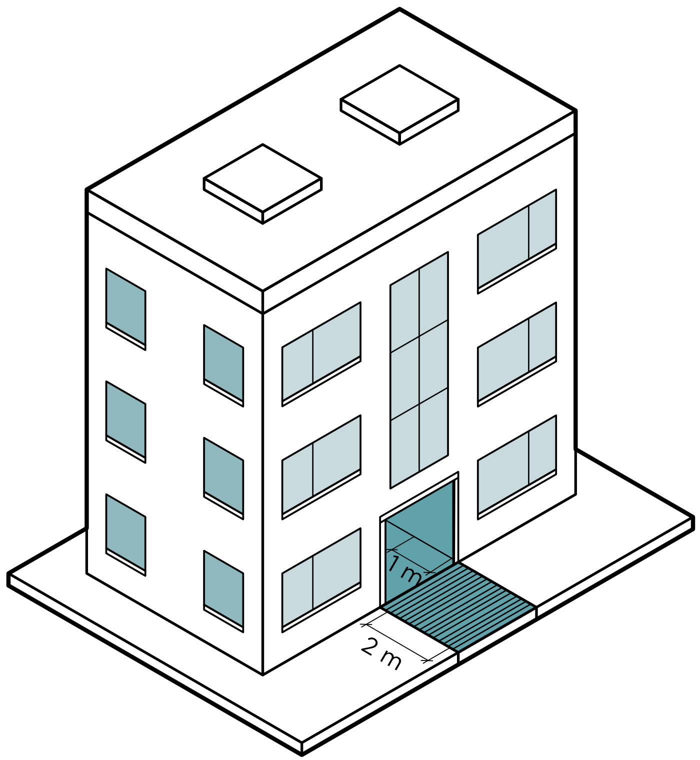


Figure B.97 Example of a healthy entrance

B.10.2 Screening of building equipment

All outdoor mechanical equipment, including antennas, rooftop equipment and refuse storage areas, should be concealed from public view by solid walls, screens, fences, parapet walls, enclosing structures or landscape.

B.10.3 Building fences and boundary walls

Building fences and boundary walls shall be provided according to each building or occupancy operational needs and as specified in affection plan or DCR.

When fences are provided, the fence height shall be limited to a maximum of 3 m, except for utility service buildings. Utility service building fences shall be provided according to the utility operational requirements.

B.10.4 Smoking areas

Smoking is strictly prohibited in all public areas in accordance with Local Order No 11 – 2003 [Ref. B.57].

Places where smoking is allowed shall be determined in accordance with the conditions listed in the Manual of regulating smoking in public places issued by the Authority [Ref. B.58]. This manual defines the public places where smoking is strictly prohibited and places where smoking is allowed under specific conditions.

Designated smoking areas shall be at least 7.5 m away (see Figure B.98) from the entrances of the building, doors and operable windows and outdoor air intakes of ventilation systems.

An annual permit is issued from the competent department of the Authority for all places where smoking is allowed, upon submission of all required documents and drawings mentioned in the guideline.

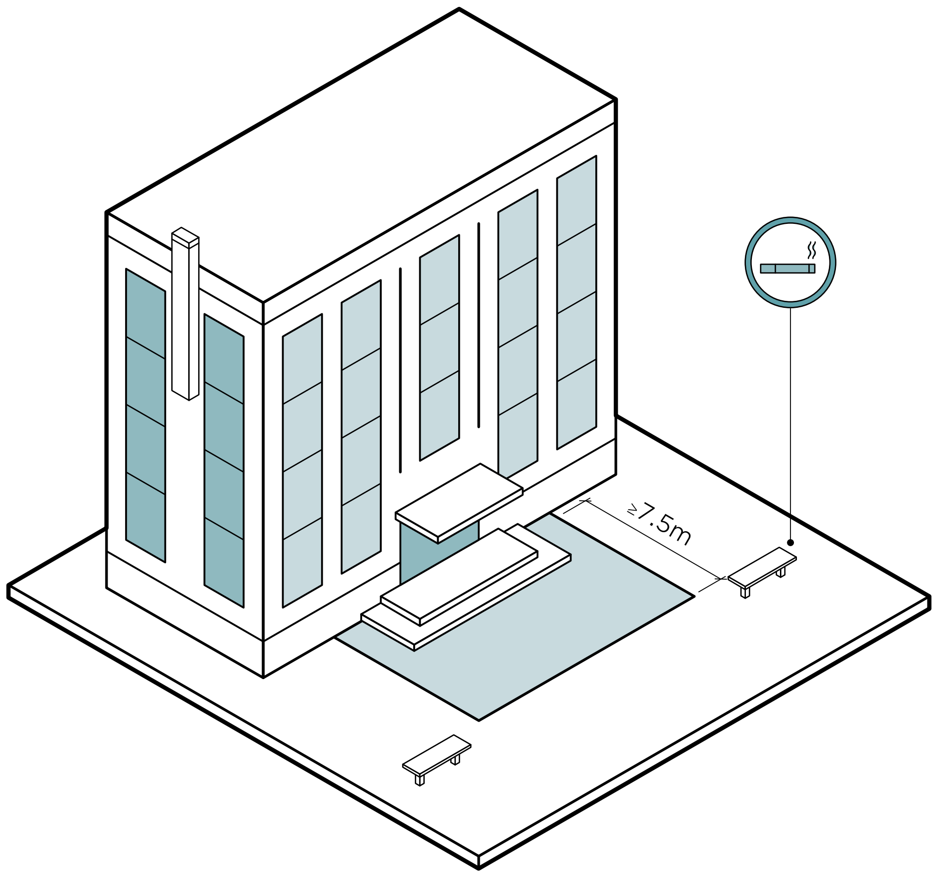


Figure B.98 Illustration of acceptable location of designated smoking area

B.10.5 Landscape and shading

B.10.5.1 Local species

At least 25% of the total planted area within the building plot (see Figure B.99), including green roofs, shall utilize indigenous plant and tree species, or species that can adapt to the environment of Dubai.

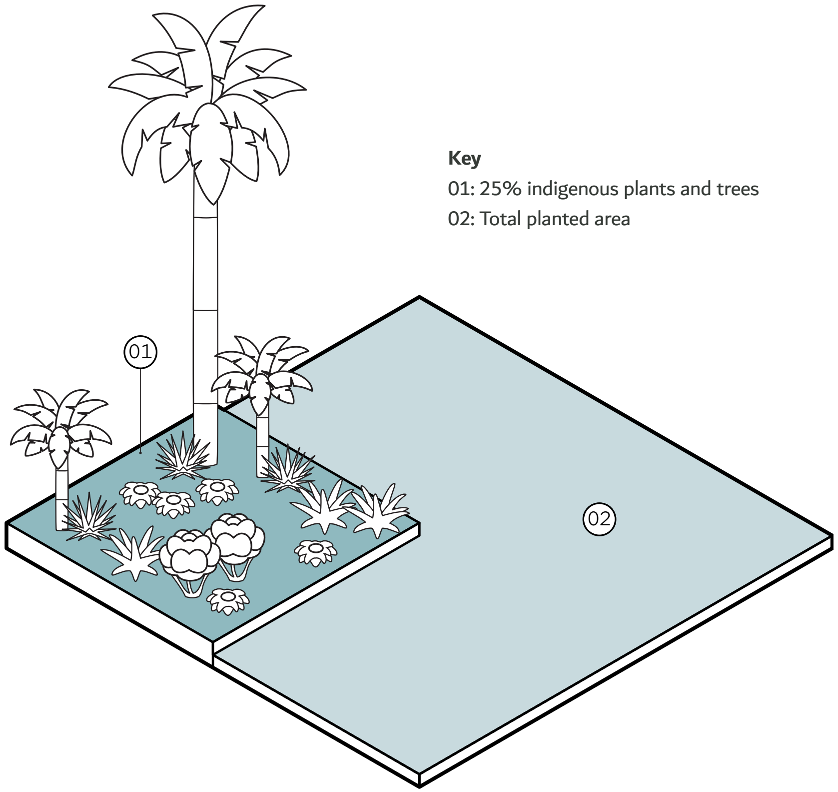


Figure B.99 Illustration showing ratio of indigenous plants in a provided planted area

B.10.5.2 Shading of public access

All pedestrian links within the plot area shall be shaded using materials that have a solar reflectance index (SRI) equal to or greater than those specified in Table B.33.

Element	Minimum SRI
Steep sloped shading device (slopes steeper than 1:6)	≥29
Flat and low sloped shading device	≥78

Table B.33 SRI requirements

B.10.5.3 Heat island effect reduction - surfaces shading

At least 50% of the hardscape of the development shall achieve at least one of the following:

a) demonstrate an SRI of at least 33;
b) use an open grid pavement system (see Figure B.100);
c) be shaded by vegetation;
d) be shaded by materials with an SRI equal to or greater than those specified in Table B.33; or
e) be shaded by solar panels.

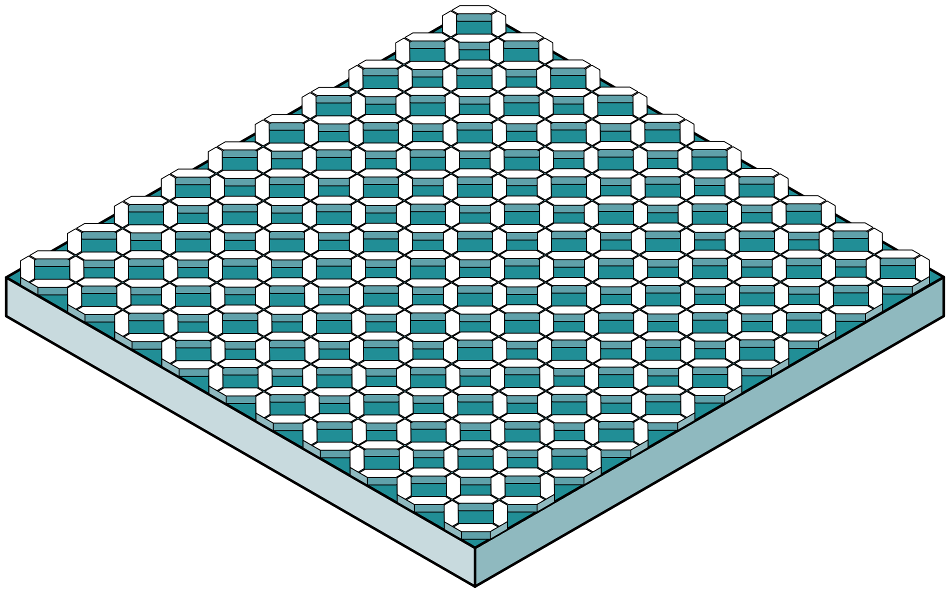


Figure B.100 Open grid pavement system

B.10.6 Sustainable materials

B.10.6.1 Recycled materials

Based on cost, recycled content (as defined in ISO 14021) shall constitute at least 10% of the total value of the materials in the project. This shall be calculated as follows:

Value of recycled content = (value of post-consumer recycled content) + half (value of pre-consumer recycled content)

If only a fraction of a product or material is recycled, then only that percentage (by weight) can contribute to the recycled content value.

Mechanical, electrical and plumbing components, as well as furniture and specialty items such as elevators, shall not be included in this calculation. Only materials permanently installed in the building shall be included.

B.10.6.2 Regional materials

Based on cost, at least 10% of building materials shall have been extracted, harvested or recovered, as well as manufactured, within 800 km of the project site.

If only a fraction of a product or material is extracted, harvested, or recovered and manufactured locally, then only that percentage (by weight) can contribute to the regional value.

Mechanical, electrical and plumbing components as well as furniture and specialty items such as elevators shall not be included in this calculation. Only materials permanently installed in the building shall be included.

B.10.6.3 Asbestos-containing materials

Asbestos-containing materials shall not be used.

B.10.6.4 Lead or heavy metals containing material

Paints or other materials that might contain a percentage of lead or other heavy metals that is more than the prescribed limits set by DM, shall not be used, unless the metal is encapsulated in systems such as a photovoltaic cell. All paints and materials containing lead or other heavy metals shall be accredited/certified from Dubai Central Laboratory or any source approved by the Authority.

B.10.6.5 Composite timber products

For composite timber products used in the interior of the building, the percentage of added urea-formaldehyde resins shall be within the limit prescribed by the Authority.

B.10.6.6 Certified/accredited timber

Based on volume, at least 25% of timber and timber-based products used during construction, and permanently installed in the building, shall be from a certified/accredited source, approved by the Authority.

B.10.7 Environmental impact assessment

An environmental impact assessment report (EIAR) and/or an environmental impact assessment summary (EIAS) shall be submitted to and approved by the environment department of the Authority in the following cases:

a) industrial buildings;
b) buildings with the potential to generate hazardous or toxic wastes, such as laboratories, waste recycling or waste treatment facilities;
c) buildings with a marina component;
d) buildings located adjacent to or within protected areas or ecologically sensitive areas; and
e) buildings requiring an environmental assessment where the relevant Authority requests it.

Some of the types of buildings that require an environmental assessment are illustrated in Figure B.101.

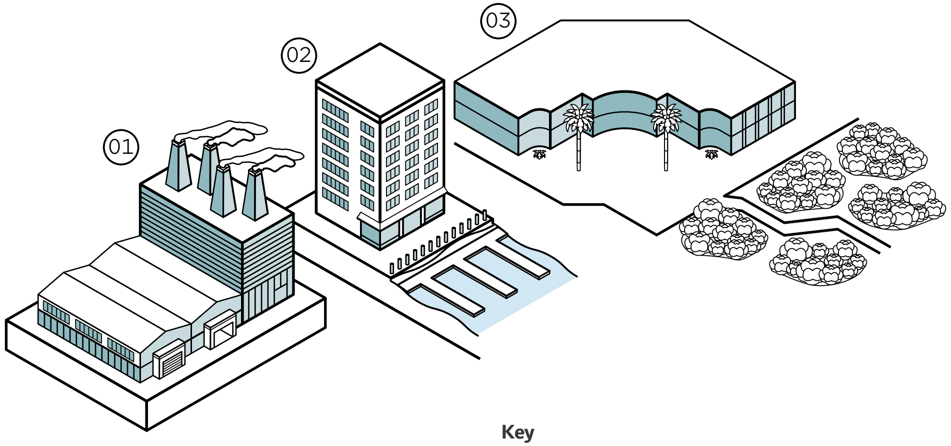


Figure B.101 Illustration of building types

Key
01: Industrial buildings and treatment facilities
02: Buildings with a marina component
03: Buildings adjacent to protected areas

The relevant Authorities' regulations or technical guidelines for the development of the EIA shall be followed.

Buildings in a development with an approved masterplan shall conform to the requirements in the approved EIA study and DM environmental clearance or other relevant Authority's certificate of environmental compliance as applicable.

B.11 Wayfinding in buildings

B.11.1 General

When there is a well-designed wayfinding system, people are able to understand their environment. This provides users with a sense of control and reduces anxiety, fear and stress.

From the user perspective, the wayfinding process involves four stages as given in Table B.34.

Stage of process	Description of stage
Orientation	The attempt to determine one's own location in a physical space in relation to the chosen destination.
Route decision	The selection of a course of direction to the destination.
Route monitoring	Checking to make sure that the selected route is heading towards to the destination.
Destination recognition	When the destination is recognized.

Table B.34 Wayfinding process

B.11.2 General requirements

The following requirements and recommendations apply to wayfinding elements, including visual, acoustic and tactile references.

a) People shall be able to identify their location in a building without walking more than 70 m in open spaces and 30 m inside buildings.

b) All business and administration buildings shall display the name of the building in the façade and shall provide a directory adjacent to the entrance which lists all facilities or services contained in the building. This building directory may be digital/dynamic or static.

c) Orientation signs to the exit, toilet and select destination or amenities shall be present at corridor intersections and at every 30 m.

d) Fire exit access and fire exits shall be identified by exit signs as mandated by Ch. 5 of UAE FLSC [Ref. B.1].

e) Visual clutter caused by inappropriately designed or located signage and other elements in the environment shall be avoided.

f) The environment's identity shall be clearly and consistently communicated through the design of graphic elements to increase the users' recognition during navigation.

g) Signage should be positioned at key decision-making points on the path of travel. It should be positioned over the path of travel at a height of not less than 2,100 mm, measured from FFL to the bottom of the sign, and high above head level in high pedestrian traffic areas. Signage should be positioned to avoid shaded areas and glare.

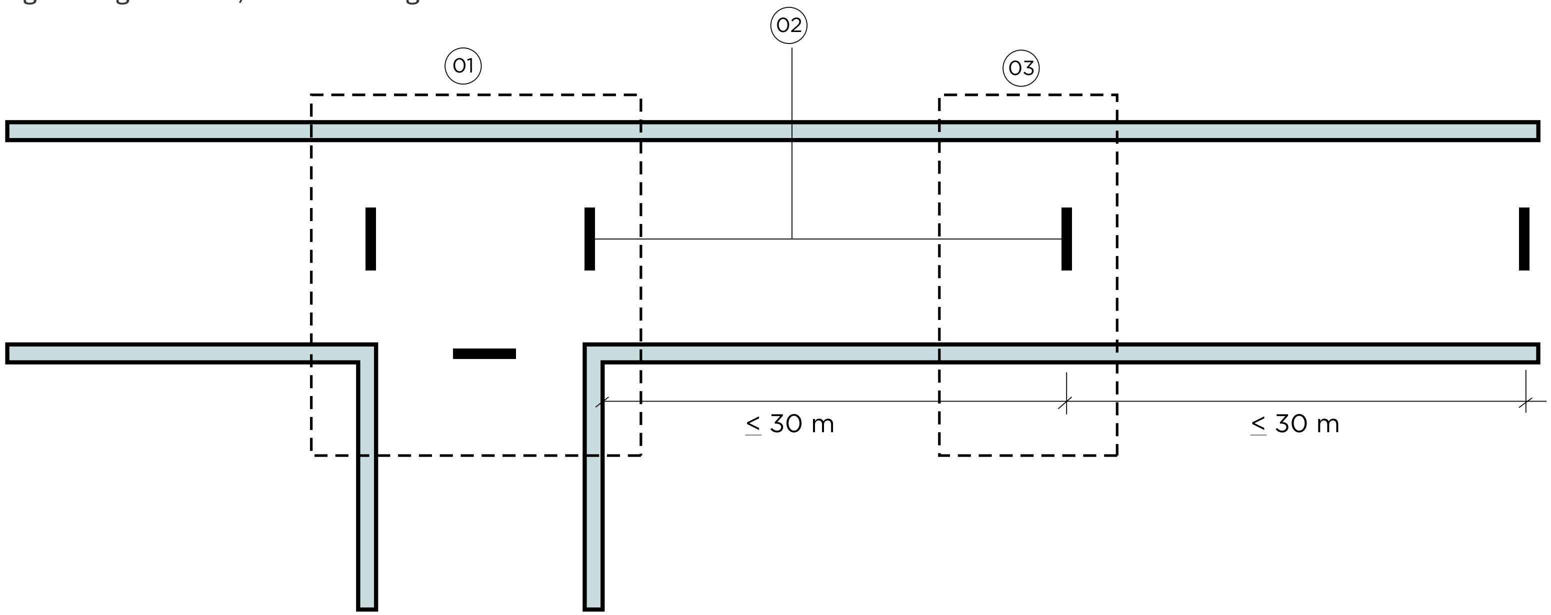
h) Information on signs should be kept to a minimum, without duplication. Complex information should be broken down, beginning with general information and moving towards more specific information.

i) Standardized nomenclature should be adopted to organize information in similar environments.

j) Signage should be provided with both English and Arabic text. Arabic, being the primary language texts, shall be aligned to the right.

B.11.3 Position

Directional signs on a long route should be repeated sequentially starting from the decision-making point/junction. These serve as confirmation signs and repeater signs along the route, as shown in Figure B.102.



Key
01: Route decision
02: Directional sign
03: Route monitoring

Figure B.102 Position of signs during navigation

Signs shall not be located such as to obstruct openings required for light and ventilation, any required means of egress or any required access.

An exterior sign shall not be located such as to overhang a sidewalk or other pedestrian walkway unless the vertical distance, measured from the bottom of the overhanging portion of the sign to the surface of the sidewalk, is at least 2,100 mm.

B.11.4 Signage types

B.11.4.1 Types

Fire exit access and fire exits shall be identified by exit signs as mandated by Ch. 5 of UAE FLSC [Ref. B.1].

Wayfinding signage is classified according to wayfinding processes as shown in Table B.35.

Wayfinding process	Sign type	Use of the sign
Orientation	Information	Indicates specific locations within an environment, helping in understanding.
Route decision and monitoring	Directional	Guides users through the environment to their destination.
Recognition	Identity	Displays necessary information for users to identify a place.
Advice	Advisory and regulatory	Draws attention to objects, situations or behaviours that might affect the wellbeing and convenience of users or activities in the environment.

Table B.35 Sign types

B.11.4.2 Information signs

Information displaying the nearest exit, nearest toilets and the distance to them shall be displayed at adequate intervals in buildings, but not more than 30 m apart.

All maps presented in open spaces shall be designed with the North in the upper part and displaying a North symbol.

Maps and directories shall be mounted in entrances to help building occupants to navigate.

Maps should be easy to understand, without too much information. They shall use contracted colours and symbols to aid understanding.

A graphic device such as a red star or red target symbol shall be used to indicate the user's positioning on the map.

B.11.4.3 Directional signs

Directional signs shall be used to give information to the users about how to reach their destination.

Arrows shall be designed with the shaft longer than the header stem. The thickness shall be the same in all arrow lines. Header lines shall have an angle of 45° (see Figure B.103). Arrow alignment, typology and hierarchy are shown in Table B.36. Examples of directional signs are given in Figure B.104.

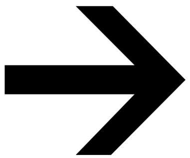


Figure B.103 Example of a good arrow design

Hierarchy	Arrows to be aligned on the left		Arrows to be aligned on the right	
Top of the sign	—	—	Straight up	
		To the left, then ahead	To the right, then ahead	
		Ahead, then to the left	Ahead, then to the right	
		Go up on the left	Go up on the right	
Bottom of the sign		Turn left	Turn right	
		Go down on the left (to be used with vertical transportation such as stairs or escalators)	Go down on the right (to be used with vertical transportation such as stairs or escalators)	
			Go down ahead (to be used with vertical transportation such as elevators, stairs or escalators)	

Table B.36 Arrow alignment, typology and hierarchy

Figure B.104 Examples of directional signs with the correct alignment and hierarchy of arrows

B.11.4.4 Identity signs

Identity signs are intended to identify a destination. They shall meet the following requirements.

a) All fenced open spaces, such as parks, golf courses and hotels, shall display their name at the entrance door.
b) All building façades shall display the name of the building as well as the Makani number.
c) All doorframes shall present information on the service(s) available in the space. Raised standardized pictograms and text with contrasted colour shall be used to identify the different services. Signage shall be mounted at a height between 1,200 mm and 1,600 mm on the left of the door.

B.11.4.5 Advisory signs

Advisory signs shall be mounted to indicate safety procedures such as fire escape routes, no smoking areas and other regulatory information.

Advisory signs such as evacuation plans, required by Ch. 5 of UAE FLSC [Ref. B.1] shall be provided.

Advisory signs shall also be placed at rest areas, elevators, access points, etc., to inform users about giving priority or give way to others (such as the elderly, people with prams, pregnant women and persons with disabilities).

B.11.4.6 Digital screens

Screens should be matte, with a wide angle of vision and providing a good contrast. In all instances, screens shall fulfil the following criteria.

a) Whenever installed in walls, screens should be visible at a height between 1,600 mm and 2,000 mm without interfering with the accessible route and with a slight inclination (15°to 30°).
b) Digital screens should be visible from a distance of not less than 1,000 mm.
c) An interaction space as noted in Part C shall be provided in front of the screen.

B.11.5 Typography

In public spaces, internationally recognizable icons and signs are preferred instead of text.

All relevant textual information shall be provided both in Arabic and English. When numerals are used, at least Arabic numerals shall be displayed.

A sign's font size should be adjusted according to reading distance, as shown in Table B.37.

Reading distance (m)	Minimum size (mm)	Recommended size (mm)
≥50	170	200
20	140	180
5	70	140
4	56	110
3	42	84
2	28	56
1	14	28
0.5	7	14

Table B.37 Accessible text according to reading distances

Signs should present chromatic contrast against their background, and between the texts or icons and the sign background, avoiding reflections.

Long texts should be aligned to the left in Latin languages and to the right in Arabic language.

For short texts, tactile format shall be used when the sign is located in the hand interaction space (in vertical parametrics, between 1,250 mm and 1,750 mm; in horizontal parametrics, between 900 mm and 1,250 mm).

B.11.6 Symbols

Standard symbols can be used independently or combined with text, where appropriate. Text may be incorporated to facilitate the understanding of less established symbols.

For short text, symbols shall be placed as a prefix to the description in text.

Examples of symbols are given in Figure B.105.

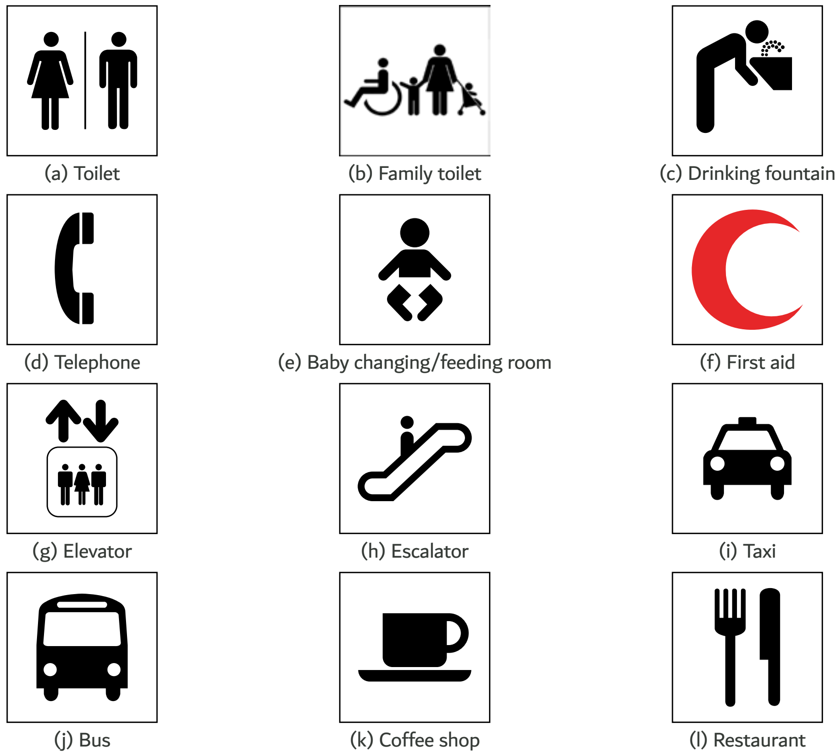
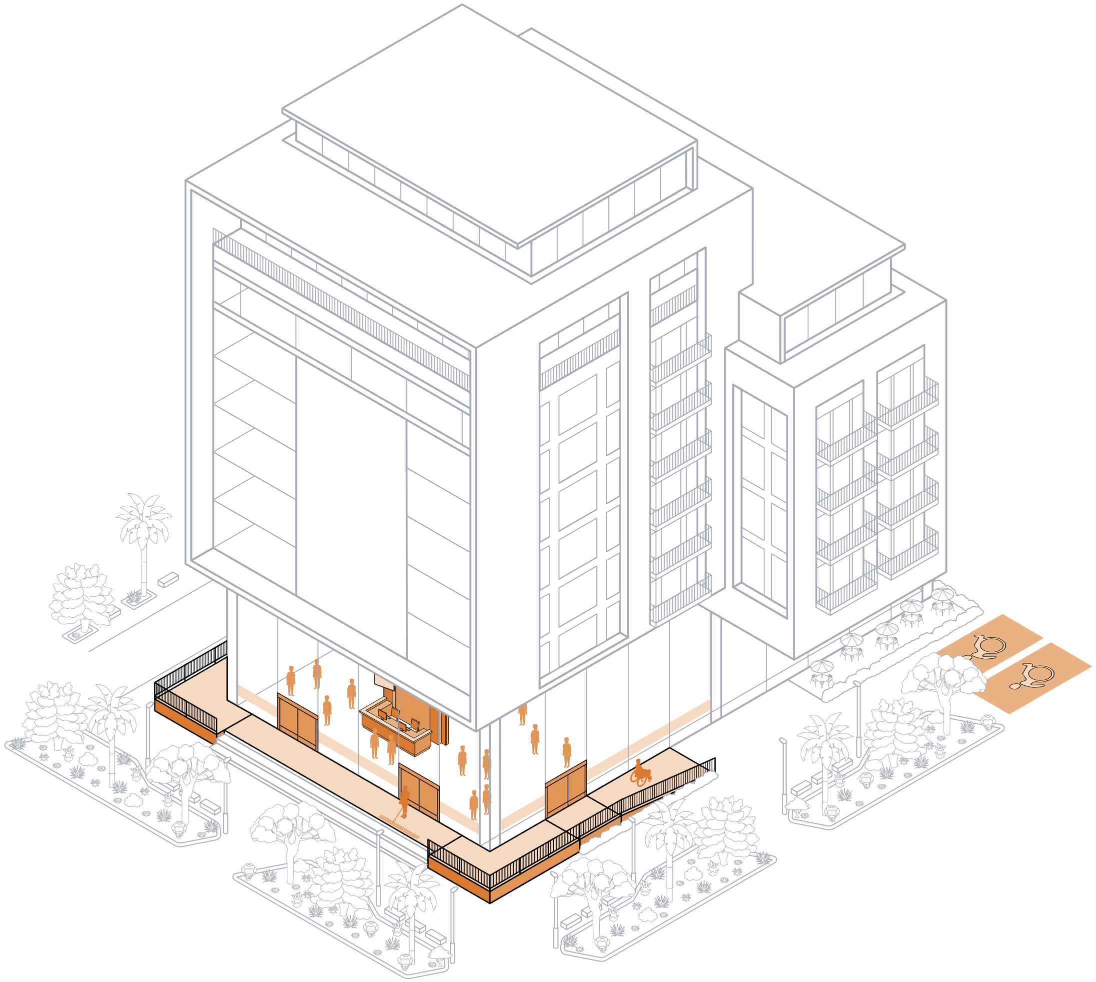


Figure B.105 Examples of symbols

Part C
Accessibility



C.1 Performance statements

Performance statement	The performance statement will be met by following the requirements of:
The building shall make reasonable provision for all people to gain access to and use the building and its facilities.	C.4 to C.11

C.2 Definitions

C.2.1 Terms

Access aisle: Clear, level area parallel to a parking space for people with additional mobility needs to get in or out of a passenger vehicle.

Accessibility: Ease of independent approach, entry, evacuation and/or use of a building and its services and facilities by all of the building's potential users, regardless of disability, age or gender, and with an assurance of individual health, safety and welfare.

Accessible: Site, building, facility or portion thereof that conforms to Part C.

Accessible route: Route that allows a continuous and barrier-free movement. Built elements combine to guarantee that anyone can enter, move, use, exit, orient themselves and communicate autonomously and comfortably, both in the public space and around and inside the buildings.

Ambulant disability: Disability that is either temporary or permanent in nature that result in unstable or slow movement, such that a sufferer is capable of walking without confinement to a wheelchair or bed, with or without support of other walking aids.

Assistive listening system (ALS): Amplification system utilizing transmitters, receivers and coupling devices to bypass the acoustical space between a sound source and a listener by means of induction loop, radio frequency, infrared or direct-wired equipment.

Bollards: Vertical posts that separate a pedestrian path from vehicular traffic.

Characters: Letters, numbers, punctuation marks and typographic symbols.

Children's use: Design of spaces and elements specifically for use primarily by people 12 years old and younger.

Clear width: Free unobstructed space for access.

Cross-slope: Slope that is perpendicular to the direction of travel.

Curb ramp: Element of an accessible pedestrian route that connects different levels through inclined planes, usually between the roadway and the sidewalk.

Detectable warning: Standardized surface feature built into or applied to walking surfaces or other elements to warn of hazards on a circulation route.

Flare: Sloped surface that flanks a curb ramp and provides a graded transition between the ramp and the sidewalk.

Functional limitations: Restrictions in performing fundamental physical and mental actions in daily life, such as mobility (physical) or memory (mental).

Gangway: Variable-sloped pedestrian walkway that links a fixed structure or land with a vessel.

Gross area (GA): Floor area within the inside perimeter of the exterior walls of a building. The measurement excludes shafts and courtyards, but includes corridors, stairways, ramps, closets, base of atria (or similar voids) and the thickness of interior walls, columns or other features.

Handrail: Horizontal or sloping rail intended for handhold and grasping by hand for guidance or support.

Interaction space: Space required by a person to interact with another person, furniture, appliance, machine or another item or to transfer from a wheelchair to a seat or a toilet or to park a pram.

Landing: Floor area at the top of a flight of stairs or between two flights of stairs, or a platform or part of a floor structure at the end of a ramp or at the entrance to an elevator car.

Light reflectance value (LRV): Proportion of visible light reflected by a surface at all wavelengths and directions when illuminated by a light source, expressed on a scale of 0 to 100, with a value of 0 for pure black and a value of 100 for pure white.

Luminance: Amount of light emitted from a surface or source in any given direction.

Manifestation: Clear markings on transparent glazing to enable occupants to see the glazing as a hazard to be avoided.

Manoeuvring space: Minimum three-dimensional space within which it is possible to complete a manoeuvre to gain access to a specific facility, component or fitting, in particular while using a wheelchair or a walking aid.

Mobility aid: Device used by persons with functional limitations to assist walking. Examples include canes, arm crutches and walkers.

Mobility device: Manual or motorized device used by persons with functional limitations in their mobility. Examples include manual and sports wheelchairs, electric powered wheelchairs, and three and four-wheeled mobility scooters.

Operable with the elbow: Range of manual operations that can be executed:

a) with one hand only;
b) without wrist turning;
c) without finger grip;
d) without very precise psychomotor skills; or
e) with low strength requirements.

Pendulum test value (PTV): Parameter that provides information about the slip resistance of a floor surface. Many floor manufacturers provide a PTV in the technical specifications of their products.

People of determination: People with specific needs or disabilities, who are suffering from a temporary or permanent, full or partial deficiency or infirmity in their physical, sensory, mental, communication, educational or psychological abilities.

Pictogram: Pictorial symbol that represents activities, facilities or concepts.

Power-assisted door: Swinging or sliding door which opens by reduced activation force on the door-operating hardware and closes automatically after the activation force is released and functions with decreased forces.

Public use: Availability of interior or exterior rooms, spaces or elements for use by the public. Public use can be provided at a building or facility that is privately or publicly owned.

Ramp: Inclined solid flat plane that is steeper than 5% from the horizontal.

Reflectance: Measure of light reflected in a given direction by a surface and which is expressed in a unit term from 0 to 100 scale, respectively, that represents a grey scale progression from the notional extremes of total light absorption (black) to total light reflection (white).

Riser: Near-vertical element in a set of stairs, forming the space between one step and the next

Running slope: Slope that is parallel to the direction of travel.

Service animal: Guide dog, signal dog or other animal individually trained to work or perform tasks for people of determination and identified with certification, including (but not limited to):

a) guiding individuals with impaired vision;
b) alerting individuals with impaired hearing to intruders or sounds;
c) providing minimal protection or rescue work;
d) pulling a wheelchair; and
e) fetching dropped items.

Site: Plot of land bounded by a plot line or a designated portion of a public right-of-way. A site can be a single plot or multiple plots together.

Tactile map: Map conveying information to people who are blind or have impaired vision through a raised surface perceptible by touch.

Tactile surfaces: Pavements and floors that are textured surfaces with contrasted colour, which are perceptible and identifiable by feel or cane or residual functional vision, that warn or inform people with visual impairment.

Visual contrast: Visual perception between one element of a building and another achieved by colour, textural or reflectance contrast.

Wayfinding: System of providing appropriate information to assist a person to pass through the built environment towards a specific destination. Wayfinding includes orienting oneself, knowing one's destination, following the best route, recognizing one's destination and finding one's way back out.

Wheelchair: Chair fitted with wheels and used as a means of transport by a person who is unable to walk as a result of illness, injury, or disability. This encompasses manual wheelchairs, sports chairs, electric powered wheelchairs and mobility scooters, unless otherwise stated.

C.2.2 Acronyms and abbreviations

ALS	assistive listening system
ADA	Americans with Disability Act
BS EN	British Standard European Norm
Ch.	chapter
DBC	Dubai Building Code
DHA	Dubai Health Authority
FFL	finished floor level
G	ground floor
GA	gross area
ISO	International Organization for Standardization
LRV	light reflectance value
PTV	pendulum test value
RTA	Roads and Transport Authority
UAE FLSC	UAE Fire and Life Safety Code of Practice

C.3 References

C.3.1 Essential references

BS 8300, Design of buildings and their approaches to meet the needs of disabled people – Code of practice

BS EN 13036-4, Road and airfield surface characteristics – Test methods – Part 4: Method for measurement of slip/skid resistance of a surface: The pendulum test

ISO 7000, Graphical symbols for use on equipment – Index and synopsis

ISO 23599, Assistive products for blind and vision-impaired persons – Tactile walking surface indicators.

Ref. C.1 UAE MINISTRY OF INTERIOR GENERAL COMMAND OF CIVIL DEFENCE, 2018. UAE Fire and Life Safety Code of Practice (UAE FLSC). United Arab Emirates: Ministry of Interior General Command of Civil Defence.

Ref. C.2 UNITED STATES OF AMERICA, 2010. Americans with Disability Act – Standards for accessible design 2010 (ADA). Washington: Department of Justice.

Ref. C.3 INTERNATIONAL PARALYMPIC COMMITTEE, 2015. Accessibility Guide. Germany: International Paralympic Committee.

Ref. C.4 GREAT BRITAIN, 2015. The Building Regulations 2010, Approved Document M: Access to and use of buildings – Volume 1: Dwellings. London: The National Building Specification (NBS).

Ref. C.5 DUBAI HEALTH AUTHORITY, 2012. Hospital regulations. UAE: Ministry of Health and Prevention.

Ref. C.6 DUBAI HEALTH AUTHORITY, 2012. Standards for day surgery centers. Dubai: Dubai Health Authority.

Ref. C.7 DUBAI HEALTH AUTHORITY, 2012. Outpatient care facilities regulation.

Ref. C.8 DUBAI HEALTH AUTHORITY, 2012. Clinical laboratory regulation. Dubai: Dubai Health Authority.

Ref. C.9 DUBAI HEALTH AUTHORITY, 2012. Diagnostic imaging services regulation. Dubai: Dubai Health Authority.

Ref. C.10 DUBAI HEALTH AUTHORITY, 2013. Dental laboratory regulation. Dubai: Dubai Health Authority.

Ref. C.11 DUBAI HEALTH AUTHORITY, 2014. School clinic regulation. Dubai: Dubai Health Authority.

Ref. C.12 DUBAI HEALTH AUTHORITY, 2016. Regulation for oncology services. Dubai: Dubai Health Authority.

Ref. C.13 DUBAI HEALTH AUTHORITY, 2016. Regulation for optical center and optometry services. Dubai: Dubai Health Authority.

Ref. C.14 DUBAI HEALTH AUTHORITY, 2013. Regulation for renal dialysis services. Dubai: Dubai Health Authority.

Ref. C.15 DUBAI HEALTH AUTHORITY, 2019. DHA Health facility guidelines – Part C – Access, mobility, OH&S. Dubai: Dubai Health Authority.

Ref. C.16 ROADS AND TRANSPORT AUTHORITY, 2014. Dubai Access management manual. Dubai: Roads and Transport Authority.

C.3.2 Further reading

GREAT BRITAIN, 2015. The Building Regulations 2010, Approved Document M: Access to and use of buildings – Volume 2: Buildings other than dwellings. 2015 ed. London: The National Building Specification (NBS).

CANADIAN HUMAN RIGHTS COMMISSION, 2006. International best practices in universal design, a global review. Ontario: Canadian Human Rights Commission.

C.4 Accessibility general requirements

C.4.1 General

This Part specifies requirements for building elements, assemblies and components that make up a building. The requirements relate to building use and circulation, and to some elements of the exterior building environment, such as the accessibility of public spaces.

This Part is applicable to common parts of multi-occupancy residential buildings and accessible residential units within. It is not applicable to individual dwellings, villas or townhouses. Requirements for individual dwellings are specified in Part K.

Stated dimensions are primarily based on adults, with additional specifications given to suit children and people of varying heights. Where a facility is intended to serve children, dimensions and other provisions can be adjusted to make them suitable for children.

All areas of newly designed and newly constructed buildings and facilities shall conform to these requirements.

Where a site, building, facility or space contains more than one use, each portion shall conform to the applicable requirements for that application.

C.4.2 Accessible emergency provisions

People of determination shall be provided with an equal level of emergency protection as others.

In addition to this Part, the provisions for emergency and alarm systems, refuge, evacuation and egress shall be in accordance with UAE FLSC [Ref. C.1].

C.4.3 Gender equality

Where a building features segregated use by gender, the same level of accessibility shall be provided for both genders.

C.5 Accessible routes and circulation

C.5.1 General principles

Accessible routes shall be provided in accordance with the following requirements.

a) Site arrival points. A minimum of one accessible route shall be provided to each building or facility's accessible entrance from any of the following that serve it:
   1) accessible parking spaces and accessible passenger loading zones (see Figure C.1);
   2) public streets and sidewalks; and
   3) public transportation stops.
b) Within a site. A minimum of one accessible route shall connect accessible buildings, accessible facilities, accessible elements and accessible spaces that are on the same site.
c) Building entrances shall be provided in accordance with C.5.4.
d) Multi-storey buildings and facilities. A minimum of one accessible route shall connect each story and mezzanine. Spaces exempted from the elevator provisions in C.5.9.3 shall also be exempted from the provision of accessible routes and other accessibility provisions.
e) Spaces and elements. A minimum of one accessible route shall connect the accessible entrances of a building or facility with all accessible spaces and elements within the building or facility.
f) Accessible routes shall be integrated with, or be located adjacent to, general circulation routes available to building users.
g) Signage indicating accessible and general circulation routes shall be provided in accordance with C.11.

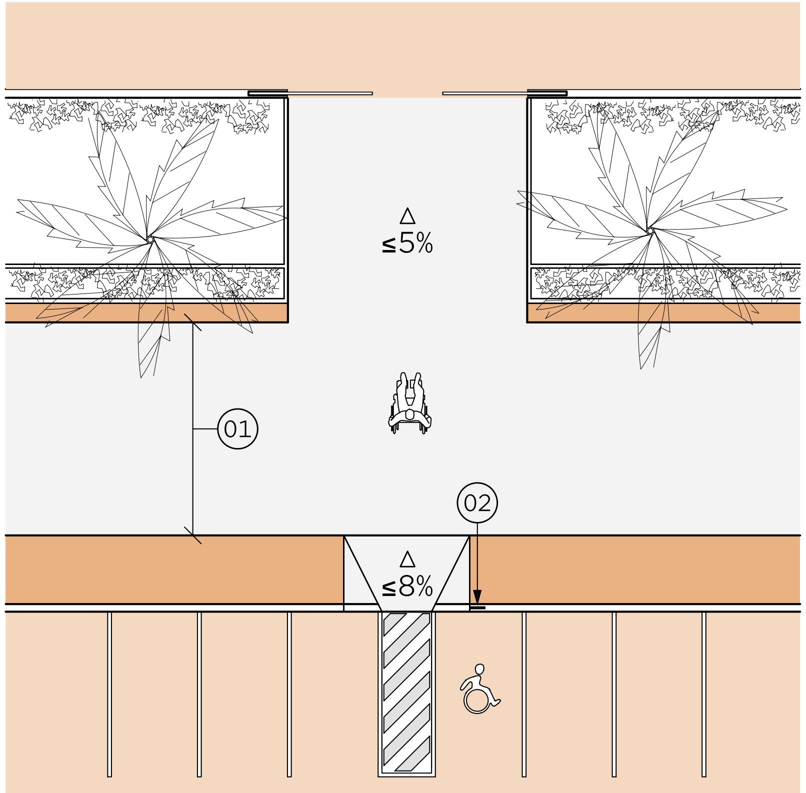


Figure C.1 Direct accessible route from parking area to building entrances

Key

01: Accessible route

02: Sign

C.5.2 General requirements for accessible routes

Accessible routes should be linear and continuous. Numerous directional changes along the path of travel should be avoided.

Accessible routes with a clear width less than 1,500 mm shall provide passing spaces as shown in Figure C.2. Passing spaces shall be a minimum of 1,500 mm × 1,500 mm, and spaced at maximum intervals of 50 m.

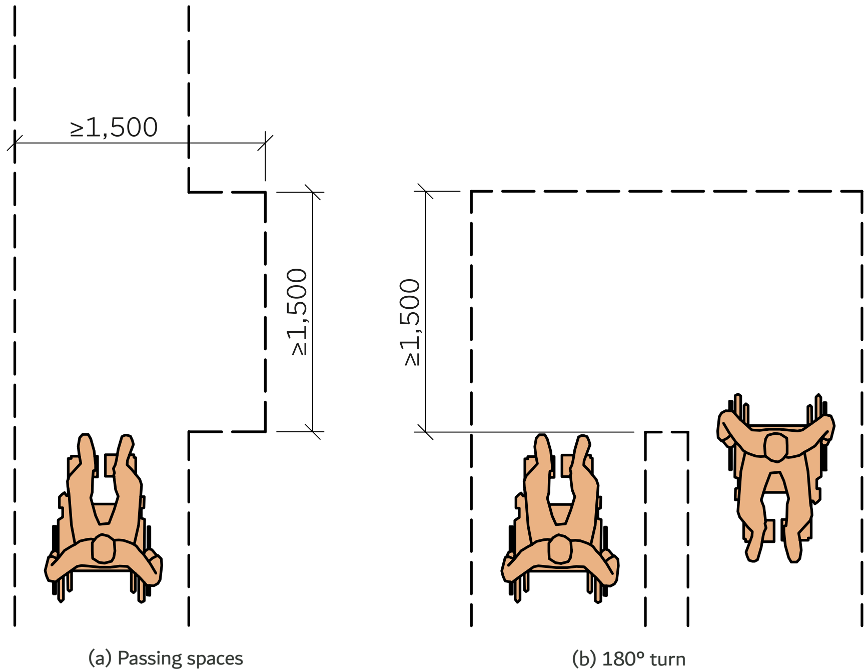


Figure C.2 Clear widths at turns and minimum dimensions of passing spaces (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 403.5.2)

The maximum running slope and cross-slope gradients in accessible routes shall be in accordance with Figure C.3. Slopes greater than 5% shall be designed as ramps conforming to C.5.9.1.

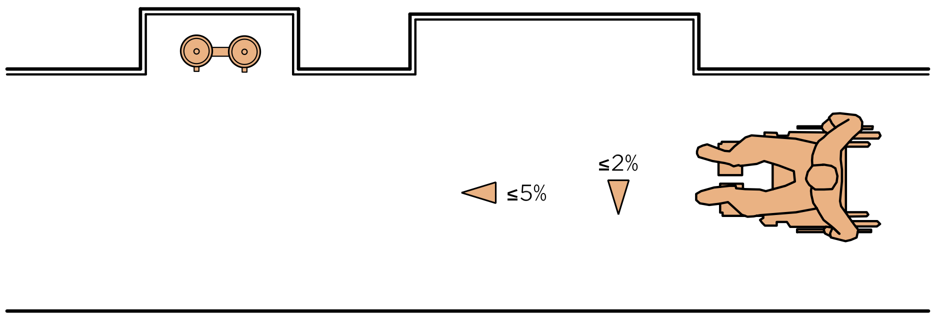
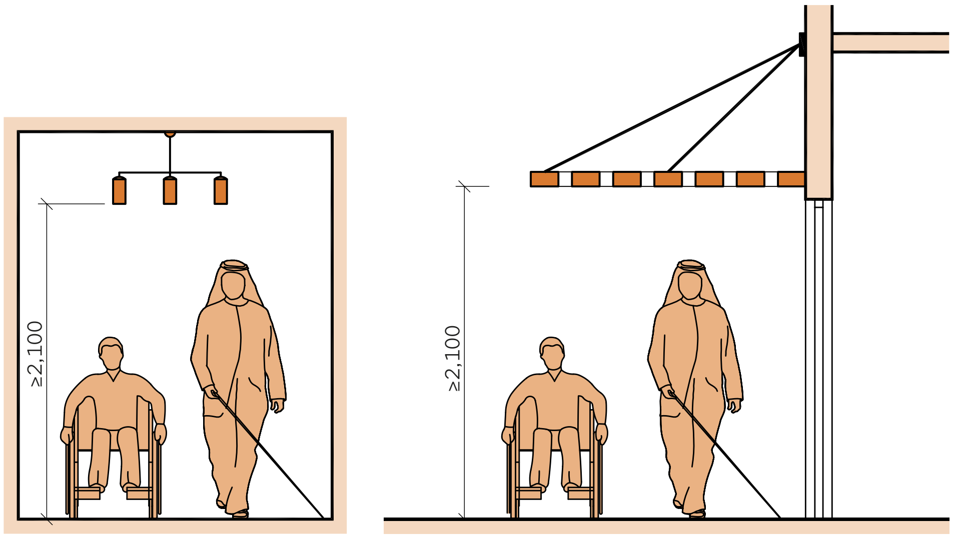


Figure C.3 Permitted slope gradient in accessible routes

A clear height of 2,100 mm shall be maintained along accessible routes in accordance with Figure C.4. The clear height shall be maintained under suspended elements.



(a) Internal (b) external

Figure C.4 Clear height of accessible route

Accessible routes shall have a minimum luminance of 100 lux. Lighting changes along an accessible route shall be gradual to prevent glare.

Floor surfaces shall conform to C.7.2.1.

Uneven surfaces in accessible routes should be avoided. The maximum height of any irregularity shall be 5 mm.

Accessible routes shall avoid unprotected level changes.

A tactile warning surface shall precede any sudden level change (see C.7.2.2).

Accessible routes intended for walking shall present a reflectance contrast with surfaces not intended for walking. The contrast shall be a minimum 30 points LRV and/or by a texture difference that is easily perceptible by foot or using a cane.

NOTE: LRV, also called Albedo, is usually provided for paints and flooring materials. It can be also measured with an app called Albedo with a balance calibration card with 18% grey.

C.5.3 External accessible routes

The clear width of external accessible routes should be determined using Table C.1, allowing for all pedestrians in all directions of travel.

The minimum width of accessible routes shall be kept free of protruding objects such as doors, vegetation, furniture, equipment and signs.

Route	Minimum width (mm)	Recommended width (mm)
External accessible route	1,200 (see Figure C.5)	1,800 for two-way movement or when heavy traffic is anticipated
Turning and change of direction	1,500 (see Figure C.2)	1,575 to accommodate varying types of wheelchairs

Table C.1 External accessible route widths

To avoid trip hazards, curb heights shall be a maximum of 150 mm and a minimum of 75 mm.

Where a height change occurs at a pedestrian crossing, curb ramps shall be provided (see C.6.2).

Vehicular accesses shall not modify the slope or width of an accessible route (see C.6.1).

Drain grids should not be installed on accessible routes, or on pedestrian crossings that form part of an accessible route.

Utility covers should not be installed on accessible routes intended for walking. If this is unavoidable, the maximum height difference between the utility cover and the accessible route shall be 5 mm.

If a pedestrian bridge forms part of an accessible route it shall be accessible by ramp (provided in accordance with C.5.9.1) or elevator (provided in accordance with C.5.9.3). The pedestrian bridge shall provide shade to users.

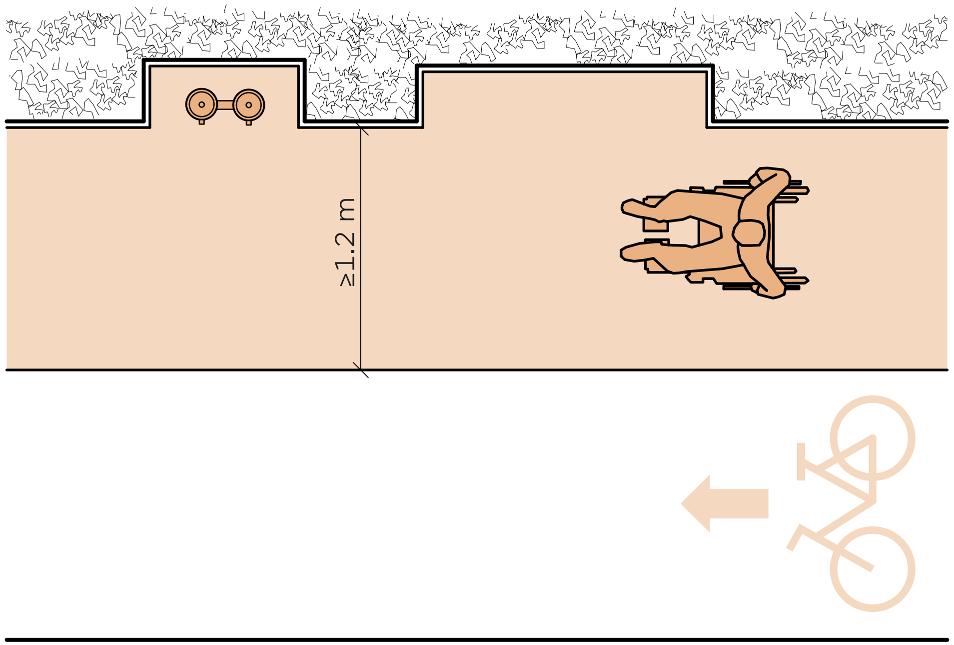


Figure C.5 Accessible route free of obstacles

C.5.4 Building entrances

C.5.4.1 Accessible entrances

Entrances to buildings shall be located and oriented to provide the shortest distance for pedestrians between all buildings, parks and beach facilities and public transportation modes.

The minimum number of accessible entrances shall be in accordance with Table C.2.

Building type or occupancy	Number of pedestrian entrances	Minimum number of accessible entrances
Residential, hotel, business, industrial	1 or 2	1
	3 or 4	2
	More than 4	50% of pedestrian entrances total
Assembly, mall, retail, educational, healthcare, and any other public use	1 or more	100% of pedestrian entrances total

Table C.2 External accessible route widths

It is recommended that the main entrances of all buildings are accessible. When the accessible entrance is not the main entrance, the direction to the accessible entrance shall be marked with the accessibility symbol (see Figure C.6).

The building entrance shall be provided with signage indicating the building name, identification number (Makani) and address.

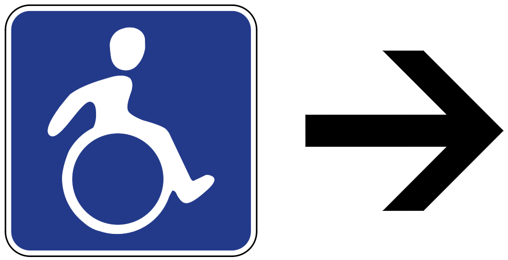


Figure C.6 Accessibility symbol with directional arrow

When queuing is required to enter or use a facility, a priority line shall be provided for people of determination.

C.5.4.2 Entrance doors

All accessible entrance doors shall conform to C.5.8. It is recommended that entrance doors are power-operated or assisted in accordance with C.5.8.4. For public building entrances, all accessible doors shall be power-operated in accordance with C.5.8.4.

Revolving entrance doors are not considered accessible and shall have an adjacent accessible door.

Doormats shall be level with the floor with a tolerance of ±5 mm.

An example of an accessible building entrance is shown in Figure C.7.

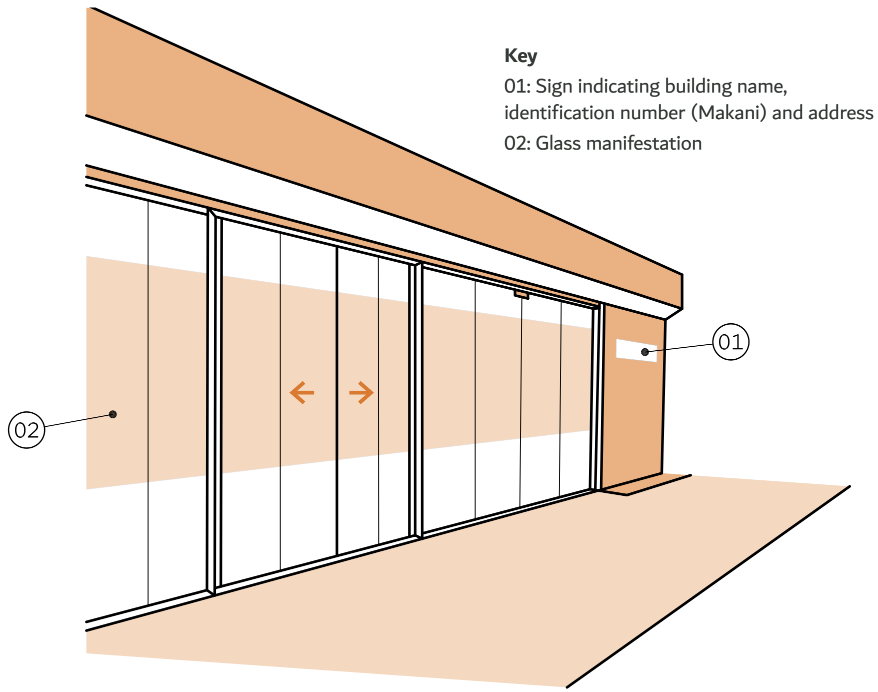


Figure C.7 Building entrance example

C.5.4.3 Access control barriers

Where access control barriers are required, a minimum of one gate shall have a width of 900 mm minimum in accordance with Figure C.8.

Turnstiles shall not be provided for the accessible gate.

If the access control barrier is glazed, manifestations shall be provided on the glass surface in accordance with C.7.2.3.

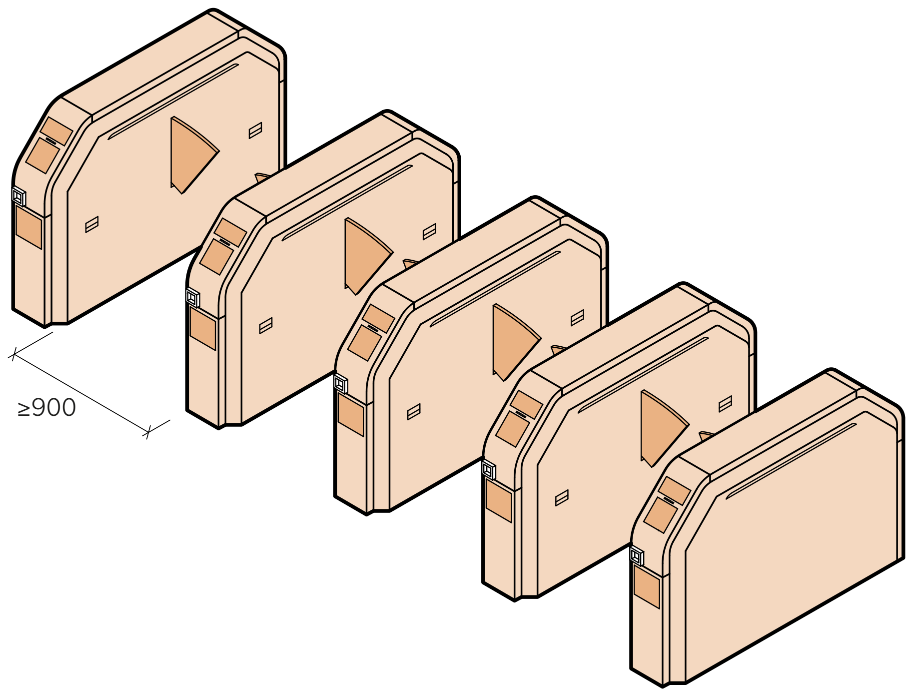


Figure C.8 Access control barriers with minimum one accessible gate

C.5.5 Internal accessible routes

The clear width of internal accessible routes should be obtained from Table C.3, allowing for all pedestrians in all directions of travel.

Route	Minimum width (mm)	Recommended width (mm)
Internal accessible route	1,000 (see Figure C.9)	1,200
Turning and change of direction	1,500 (see Figure C.2 and Figure C.10)	1,575 to accommodate varying types of wheelchairs

Table C.3 External accessible route widths

Access for wheelchair users shall be provided to all accessible rooms, spaces and elements. Wheelchair users shall be able to pass other people and, where necessary, turn through 180°. The minimum width of internal accessible routes shall be kept free of protruding objects such as doors, vegetation, furniture, equipment and signs.

Corridors in buildings shall conform to Part B and Ch. 3 of UAE FLSC [Ref. C.1] in addition to the accessible route minimum clear width requirements (see Figure C.10).

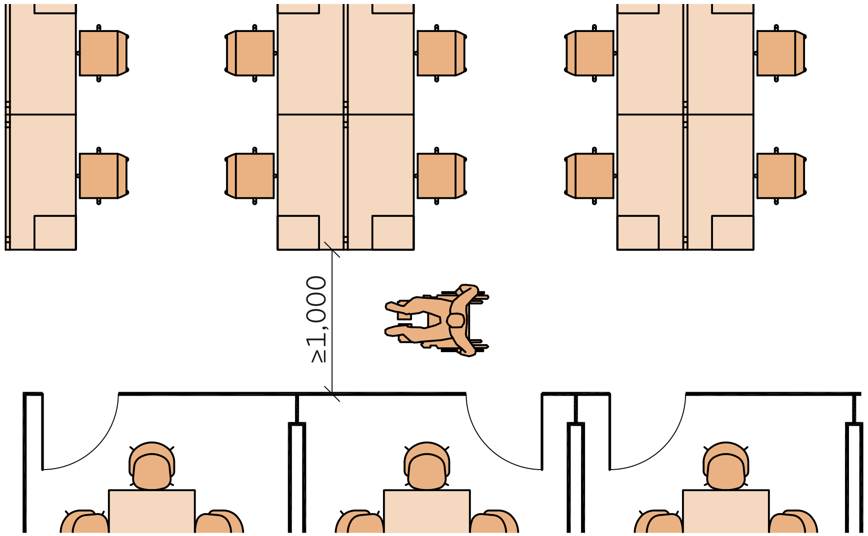


Figure C.9 Internal accessible route example

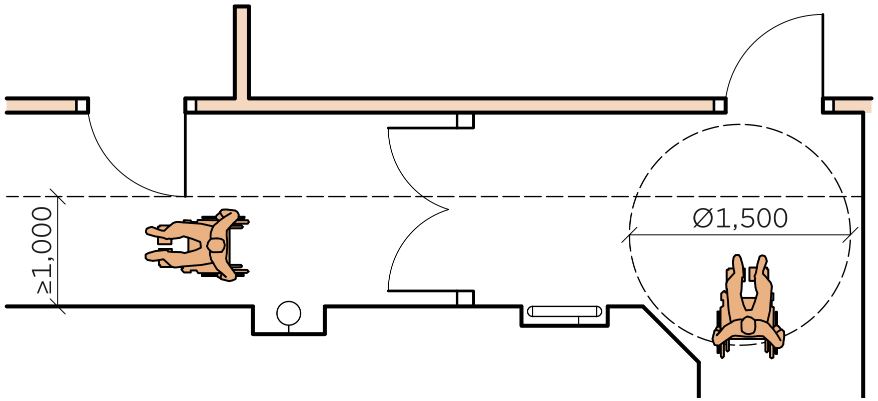


Figure C.10 Accessible route clearances within corridors (© British Standards Institute. Figure extracted from BS 8300. Permission to reproduce extracts from British Standards is granted by BSI Standards Limited (BSI). No other use of this material is permitted).

C.5.6 Minimum clearances

C.5.6.1 Interaction space

Interaction spaces shall be provided in accessible spaces and:

a) shall not encroach upon the accessible route;

b) shall be frontal or to the side as required; and

c) where face to face interaction is intended, shall have a knee clearance in accordance with C.5.6.2.

Interaction spaces shall conform to the dimensions in Table C.4. Examples of interaction spaces are shown in Figure C.11 and Figure C.12.

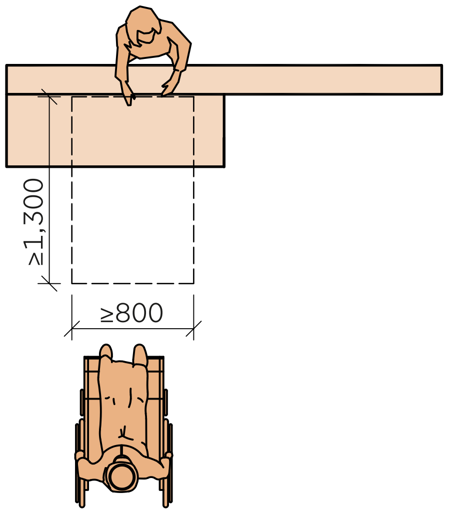


Figure C.11 Interaction space example: in front of a desk

Interaction space	Minimum dimensions (mm)	Recommended dimensions (mm)
In front of a desk	800 × 1,300	850 × 1,400

Table C.4 Interaction space dimensions

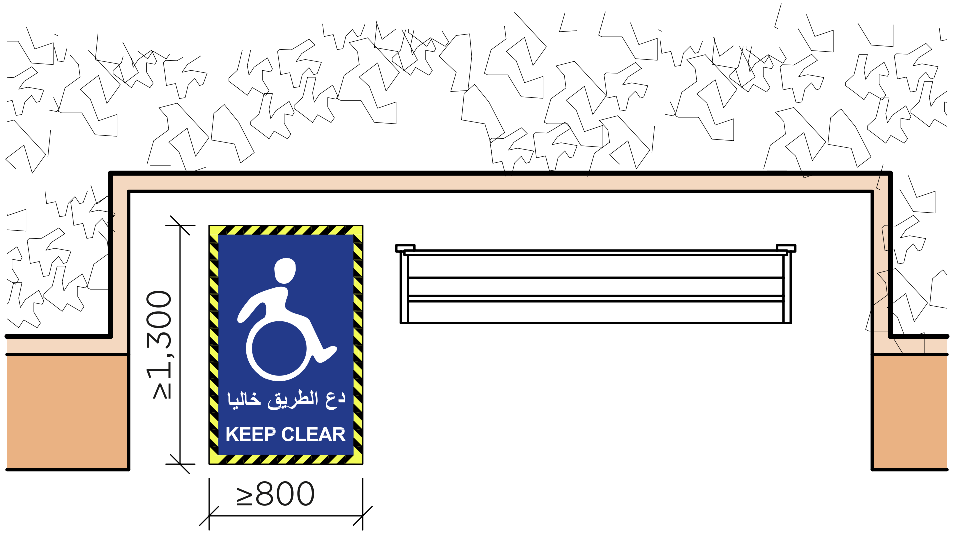


Figure C.12 Interaction space example: beside a bench

When objects have the potential to encroach upon an interaction space, the interaction space should be marked with a carpet or painting as shown in Figure C.13. Examples of encroachment include shoes in a prayer room entrance and a paper bin in the side approach space to a toilet.

Figure C.13 "Keep clear" area sign

C.5.6.2 Toe and knee clearance

Space for toe and knee clearance below an element shall be provided in accordance with the minimum dimensions shown in Table C.5 and Figure C.14.

Area of clearance	Toe clearance	Knee clearance
Space below an element	250 mm minimum above ground or floor surface	700 mm minimum above ground or floor surface
Minimum extension beneath the element	Minimum 450 mm deep	300 mm at 250 mm above ground or floor surface level; and 200 mm at 700 mm above ground or floor surface
Minimum width	800 mm	800 mm

Table C.5 Toe and knee clearance

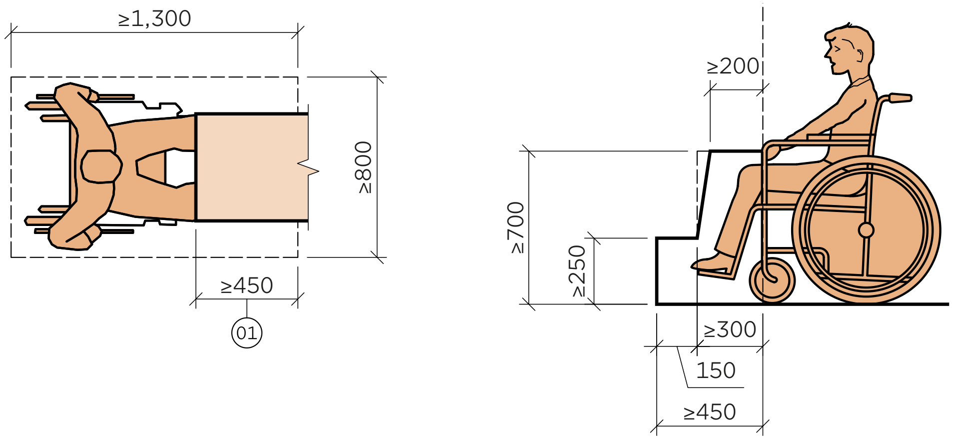


Figure C.14 Toe and knee clearance (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 306.2.)

Key

01: Toe clearance

C.5.6.3 Protruding objects

Objects lower than 2,100 mm above finished floor level (FFL) shall not protrude into the accessible route more than 100 mm. The minimum clear width of the accessible route shall also be maintained.

Where objects protrude more than 100 mm from façades, columns, walls, posts and building elements, the protruding edge shall extend to the floor or be a minimum of 300 mm above the floor (see Figure C.15).

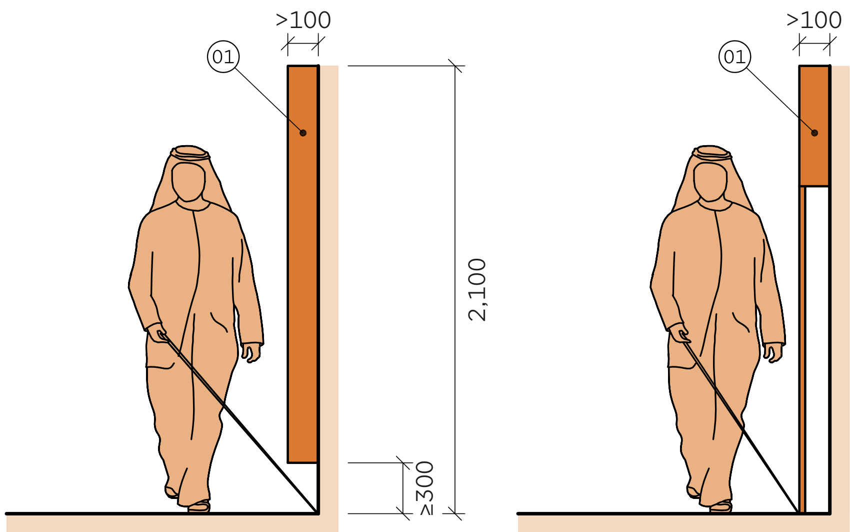


Figure C.15 Protruding object limits

Key
01: Obstruction

Where practical, vertical clearance shall be a minimum height of 2,100 mm. Any area with a vertical clearance of less than 2,100 mm shall be marked by a guardrail or barrier, as shown in Figure C.16. The leading edge of the guardrail or barrier shall be a minimum of 700 mm above the ground or FFL.

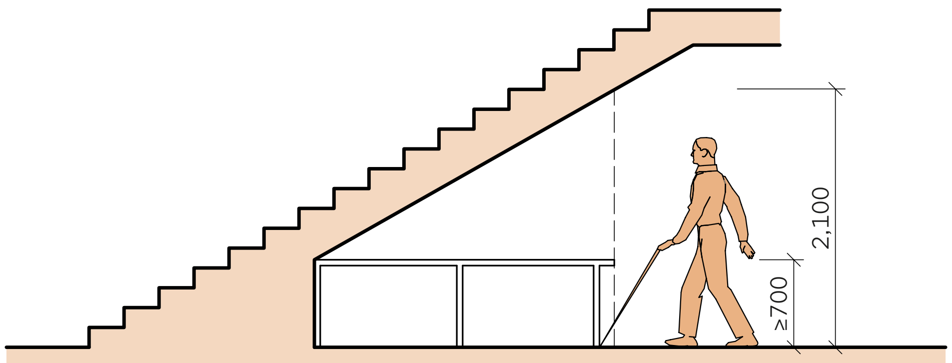


Figure C.16 Vertical clearance

C.5.7 Reachranges

C.5.7.1 Forward reach

C.5.7.1.1 Unobstructed forward reach

The range of unobstructed high and low forward reach shall be as shown in Table C.6 and Figure C.17.

Condition – Unobstructed	Height (mm)
High forward reach	1,200 max.
Low forward reach	400 min.

Table C.6 Unobstructed forward reach

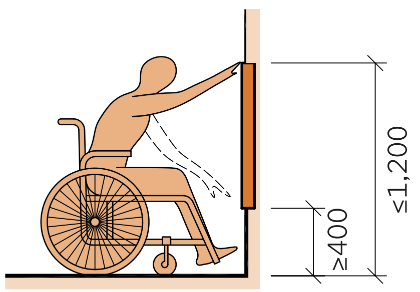


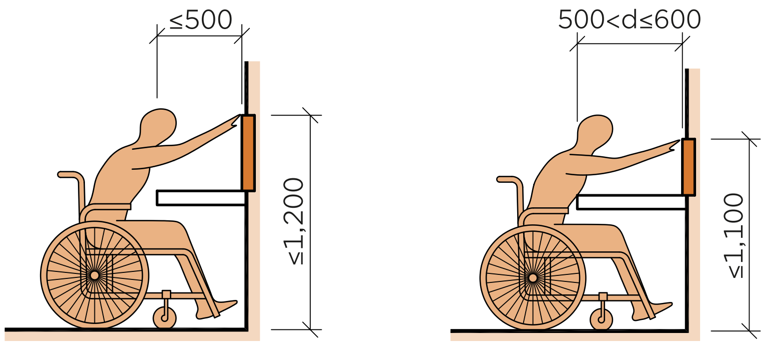
Figure C.17 Unobstructed forward reach (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 308.2.1.)

C.5.7.1.2 Obstructed forward reach

Where high forward reach is obstructed, clear floor space below the obstruction shall extend to a depth equal to or greater than the required reach depth over the obstruction. The range of high forward reach shall be as shown in Table C.7 and Figure C.18.

Condition – Obstructed	Reach depth (mm) (d)	Height (mm)
High forward reach (a)	500 max.	1,200 max.
High forward reach (b)	>500 up to 600 max.	1,100 max.

Table C.7 Obstructed forward reach



(a) 500 mm max.

(b) > 500 mm up to 600 mm max.

Figure C.18 Obstructed high forward reach (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 308.2.2.)

C.5.7.2 Side reach

C.5.7.2.1 Unobstructed side reach

Where clear space allows a parallel approach to an element, the range of unobstructed high and low side reach shall be as shown in Table C.8 and Figure C.19. The depth of any obstruction between the clear floor or ground space and the element shall not exceed 250 mm.

Condition – Unobstructed	Height (mm)
High side reach	1,200 max.
Low side reach	400 min.

Table C.8 Unobstructed side reach

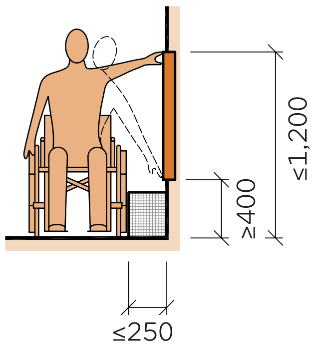


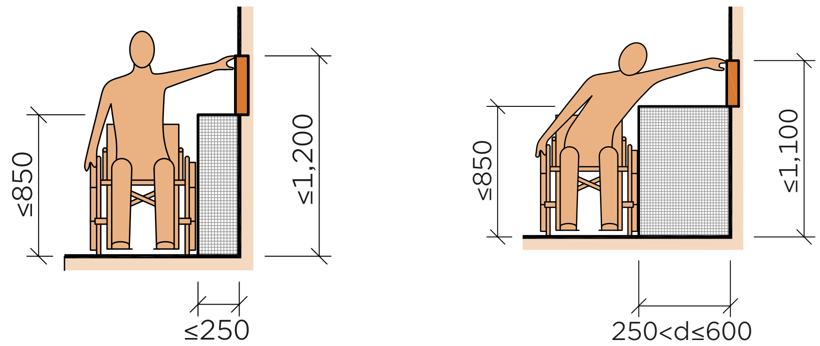
Figure C.19 Unobstructed side reach (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 308.3.1.)

C.5.7.2.2 Obstructed side reach

Where clear space allows a parallel approach to an element, the high side reach over an obstruction shall be as shown in Table C.9 and Figure C.20.

Condition – Obstructed	Reach depth (mm) (d)	Height of obstruction (mm)	Height (mm)
High side reach (a)	250 max.	850 max.	1,200 max.
High side reach (b)	>250 up to 600 max.	850 max.	1,100 max.

Table C.9 Obstructed side reach



(a) 250 mm max. obstruction

(b) >250 mm up to 600 mm max. obstruction

Figure C.20 Obstructed side reach (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 308.3.2.)

C.5.7.3 Children's reach ranges

Reach ranges for children in different age groups shall be as shown in Table C.10 and Figure C.21.

Forward or side reach	Reach ranges for ages 3 and 4 (mm)	Reach ranges for ages 5 through 8 (mm)	Reach ranges for ages 9 through 12 (mm)
High (max.) (Y)	900	1,000	1,100
Low (min.) (X)	500	450	400

Table C.10 Children's reach ranges

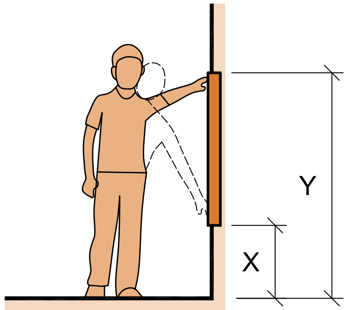


Figure C.21 Child reach range

C.5.7.4 Switches, controls and socket outlets

Switches, controls and socket outlets shall be installed between 400 mm and 1,200 mm above floor level (see Figure C.22). Controls requiring precise hand movement should be installed between 750 mm and 1,000 mm above floor level (see Figure C.22).

Switches and controls shall be located a minimum of 300 mm away from any corner (see Figure C.23).

Switch controls and socket outlets shall be installed in accordance with the reach ranges specified in C.5.7.1 and C.5.7.2.

Switch plates should have a minimum reflectance contrast of 30 points LRV compared to the surrounding wall.

It shall be possible to activate switches with an elbow or a closed fist as shown in Figure C.23.

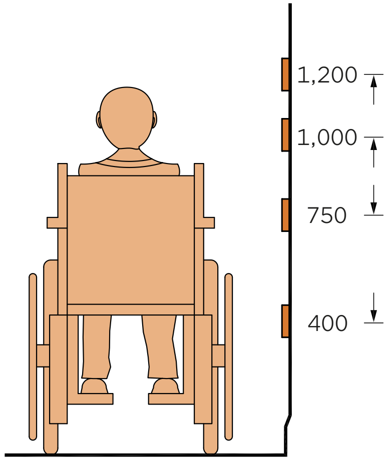


Figure C.22 Switch, control and socket outlet heights (© British Standards Institute. Figure extracted from BS 8300:2018. Permission to reproduce extracts from British Standards is granted by BSI Standards Limited (BSI). No other use of this material is permitted).

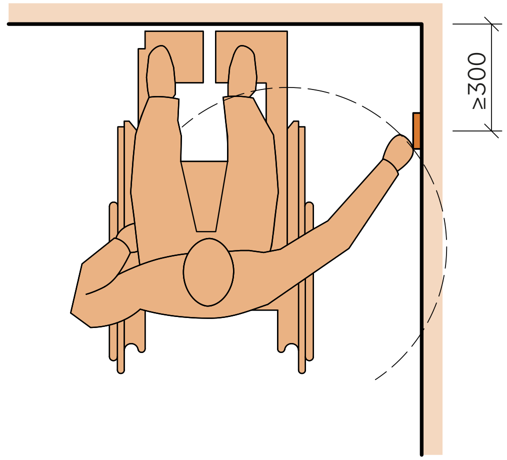


Figure C.23 Switch, control and socket outlet position at corners (© British Standards Institute. Figure extracted from BS 8300:2018. Permission to reproduce extracts from British Standards is granted by BSI Standards Limited (BSI). No other use of this material is permitted).

C.5.8 Accessible doors

C.5.8.1 Minimum accessible door requirements

NOTE: Doors can be manually operated, or power-assisted. Automatic doors are preferred for high pedestrian traffic areas.

The following requirements and recommendations apply to accessible doors.

a) Revolving gates, revolving doors and turnstiles shall not be part of an accessible route. Where they are used for general circulation, adjacent accessible doors shall be provided, and these shall be available for use at all times.

b) Where double-leaf doors and gates are provided, at least one active leaf shall have a clear width of 915 mm. The active leaf shall conform to the requirements of this subsection. Where the active leaf is in a bank of doors it shall be marked with the symbol for people of determination.

c) Single doors, except toilet doors, shall have a minimum clear width of 915 mm, measured between the face of the door and the face of the doorstop, with the door open 90° (see Figure C.24).

d) The opening space of a door shall not encroach upon manoeuvring spaces and accessible routes (see Figure C.10).

e) Floor surfaces at doors should be levelled to the floor. When levelling is not achievable, a raised threshold shall have a maximum height of 13 mm and be bevelled down to a height of 6 mm chamfered (see Figure C.25). The threshold shall have a maximum slope gradient of 50%.

f) The force required to open a door shall not exceed 25 N, unless the door is automatic/power-assisted.

g) Swinging door leaves shall be able to open 90 °.

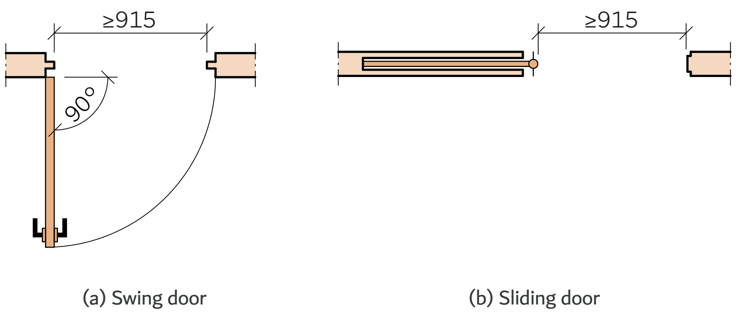


Figure C.24 Clear width of doors (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 404.2.3.)

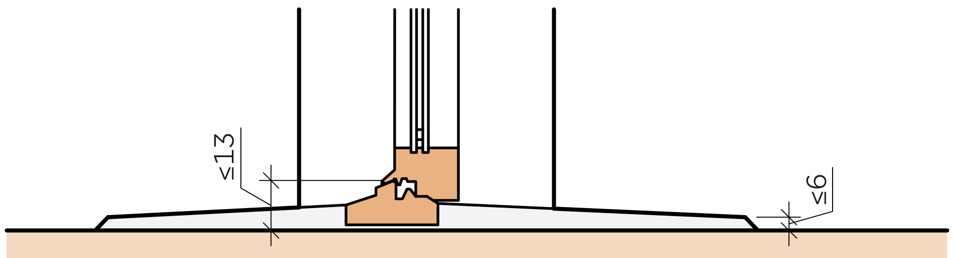


Figure C.25 Maximum threshold rise

C.5.8.2 Hardware requirements

C.5.8.2.1 Door opening hardware

Means of opening and closing (such as door handles, pull handles and push plates) shall be placed at a height between 865 mm and 1,220 mm. They shall be easy to grasp and use. Pressure mechanisms or levers shall be automatic, or easy to operate with the elbow or a closed fist as shown in Figure C.26.

Door levers and handles shall be separated from the door by a minimum of 40 mm (see Figure C.27 and Figure C.28).

To open sliding doors, a vertical fixed bar or pull handle shall be provided. The vertical bar or pull handle shall be installed between 865 mm and 1,220 mm above the floor (see Figure C.28).

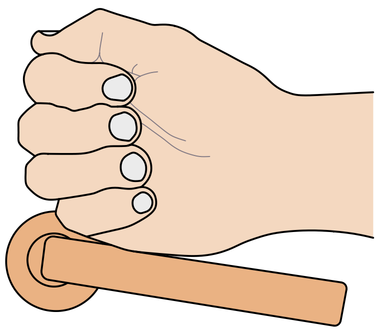


Figure C.26 Lever mechanism operated by a closed fist

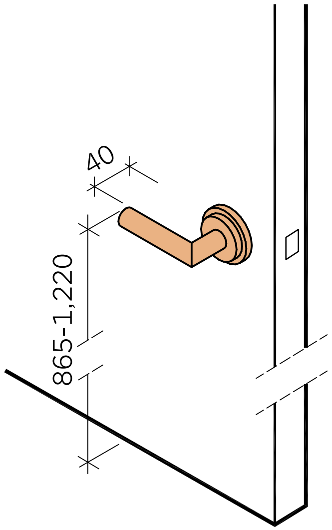


Figure C.27 Door lever

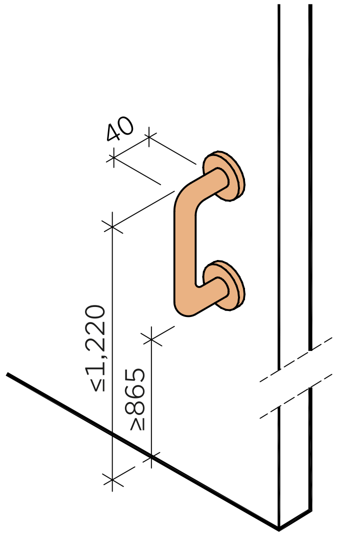


Figure C.28 Pull handle

Round knobs and thumb latches shall not be used because they require tight grasping and finger control. Doors equipped with closers shall have a minimum closing time of 5 s.

In high pedestrian traffic areas (such as washrooms), minimum 250 mm high kick plates are recommended.

C.5.8.2.2 Vision panels

It is recommended that vision panels are provided for doors in entrance lobbies and high traffic areas. Vision panels should be a minimum of 100 mm wide and should be positioned vertically in the viewing range of wheelchair users (as described in C.7.1).

The provision of vision panels in fire doors shall conform to Ch. 1 and Ch. 3 of UAE FLSC [Ref. C.1]. The guidance given in BS 8300 for door hardware, access control systems and vision panels should be followed.

C.5.8.3 Manoeuvring spaces at manual doors and doorways without doors

C.5.8.3.1 Manoeuvring spaces for swinging and sliding doors

Doors on accessible routes shall have a clear manoeuvring space on both sides. The manoeuvring space shall be free of obstacles and no other swinging doors shall open into it.

Manoeuvring spaces shall be designed with the dimensions shown in Table C.11.

Door type	Minimum clear floor space (mm)	Minimum space adjacent to leading edge of door (mm)
Swing – Front approach, pull side (Figure C.29)	1,500 wide	450 to 600
Swing – Front approach, push side (Figure C.29)	1,200 wide	300
Swing – Side approach, hinge pull side (Figure C.30)	1,500 wide	900
Swing – Side approach, hinge push side (Figure C.30)	1,050 wide	600
Swing – Side approach, latch pull side (Figure C.31)	1,200 wide	600
Swing – Side approach, latch push side (Figure C.31)	1,050 wide	600
Sliding – Both sides (Figure C.32)	1,200 wide	300

Table C.11 Door manoeuvring

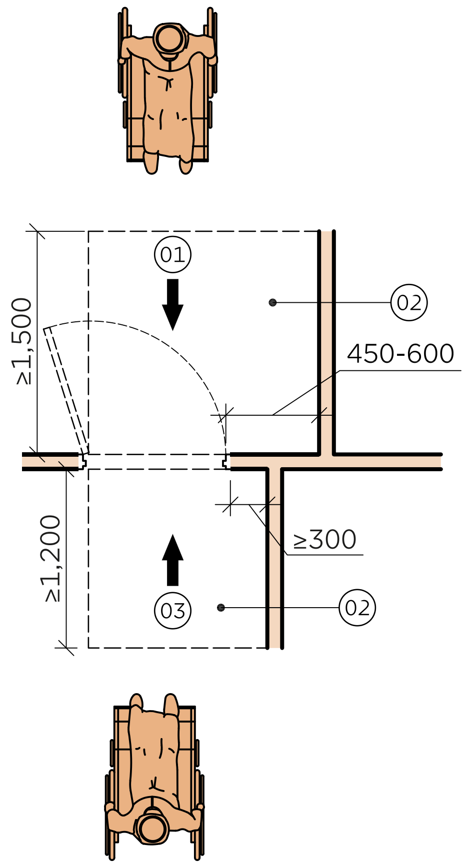


Figure C.29 Manoeuvring for swinging doors – Front approach

Key
01: Pull side
02: Minimum clear area
03: Push side

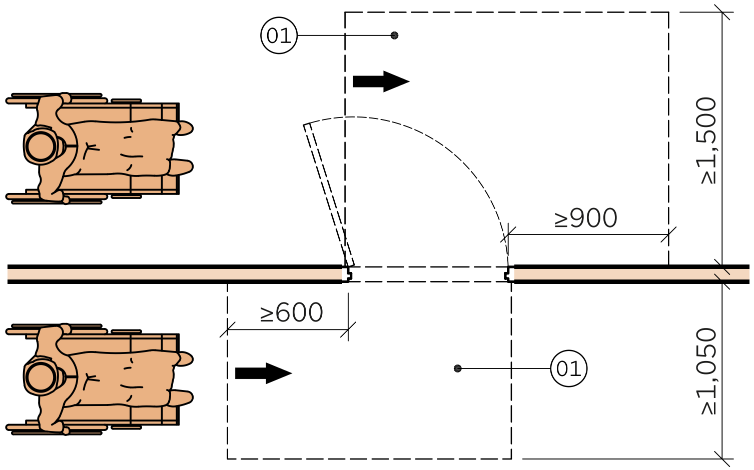


Figure C.30 Manoeuvring for swinging doors – Side approach – Hinge side

Key
01: Minimum clear area

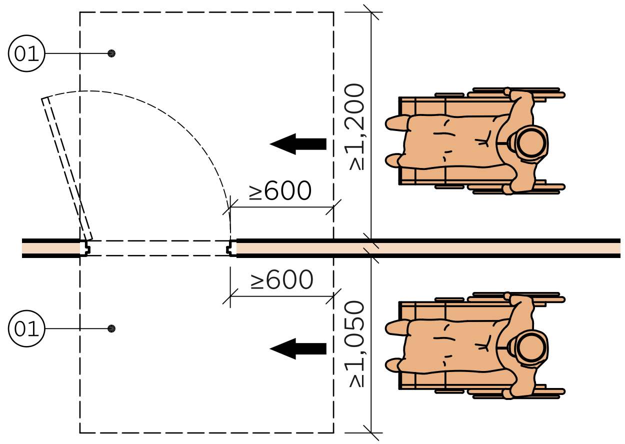


Figure C.31 Manoeuvring for swinging doors – Side approach – Latch side

Key
01: Minimum clear area

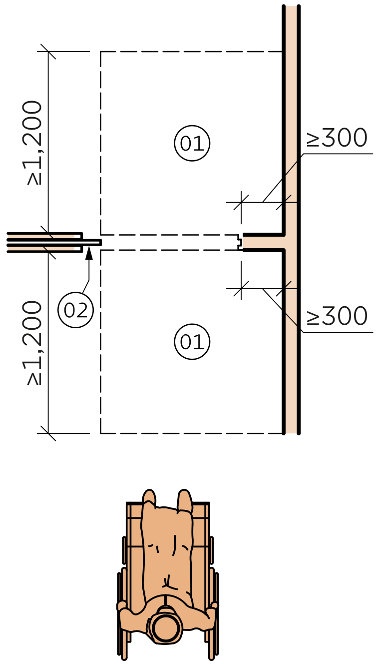


Figure C.32 Manoeuvring for sliding doors – Front approach

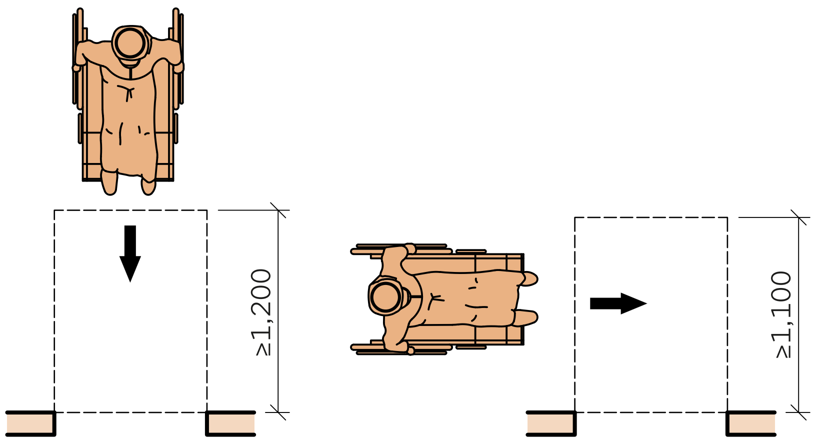
Key
01: Minimum clear area
02: Sliding door

C.5.8.3.2 Manoeuvring spaces for doorways without doors

Manoeuvring spaces shall be designed with the dimensions in Table C.12 and Figure C.33.

Approach direction	Minimum manoeuvring clearance as shown in Figure C.33	
	Perpendicular to doorway (mm)	Parallel to doorway (mm)
From front (a)	1,200	0
From front (b)	1,100	0

Table C.12 Manoeuvring clearances for doorway openings without doors



(a) Front approach

(b) Side approach

Figure C.33 Clearances for doorway openings without doors (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 404.2.4.2.)

C.5.8.3.3 Manoeuvring spaces for two doors in series

Two doors installed in series shall have a minimum space of 1,200 mm between them plus the width of the door swinging into that space. Two different arrangements are shown in Figure C.34 and Figure C.35.

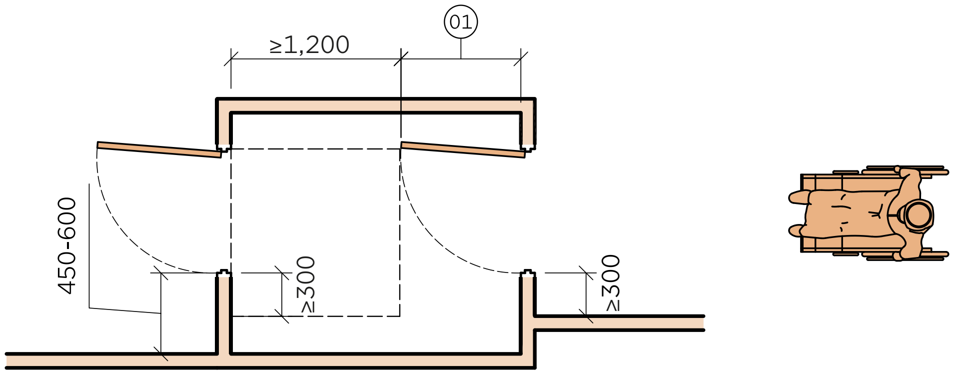


Figure C.34 Minimum manoeuvring space for two aligned doors in series

Key

01: Door width

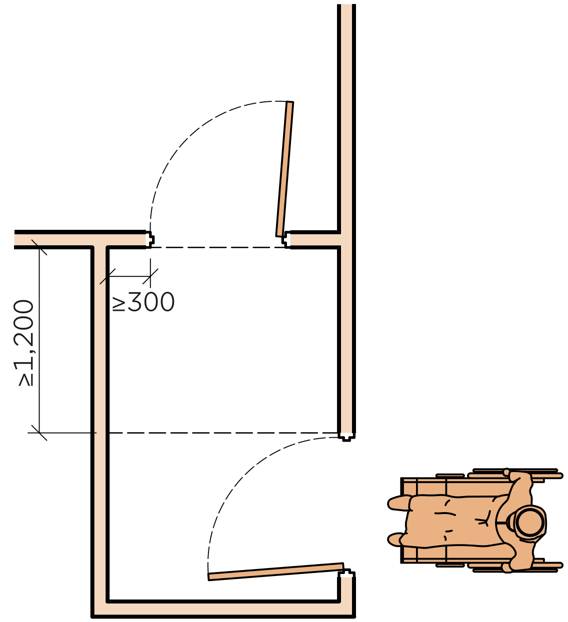


Figure C.35 Minimum manoeuvring space for two angled doors in series

C.5.8.4 Power-assisted and automatic accessible doors

Power-assisted and automatic accessible doors can be swinging or sliding. They can be activated in one of the following two ways:

a) manually: controlled by a push pad, coded entry system, card swipe or remote-control device; or

b) automatically: controlled by a motion sensor or hands-free proximity reader such as that shown in Figure C.36.

Figure C.36 Automatic door controlled by a sensor

Automatic sliding doors are preferable. They are most convenient to use and do not require guardrails for door-swing protection.

Power-assisted and automatic doors are not required to conform to the manual door requirements of C.5.8.3.

Where power-assisted swinging doors are selected, they shall:

1) take a minimum of 3 s to move from a closed to a fully open position;
2) remain fully open for a minimum of 5 s;
3) require a maximum force of 66 N to stop door movement; and
4) have one of the following to indicate a door opening into the path:
   i) a floor marking as shown in Figure C.37;
   ii) variation of floor surface materials; or
   iii) a guardrail.

The location of the door control panel shall be indicated before reaching the door.

The controls for opening the door shall:

i) be positioned clear of the door-swing and located between 900 mm and 1,200 mm above the floor;
ii) be positioned on the latch side of the door whenever possible, and adjacent to the door; and
iii) consist of activation pads that are operable with a closed fist, elbow, or one hand, and without twisting or turning.

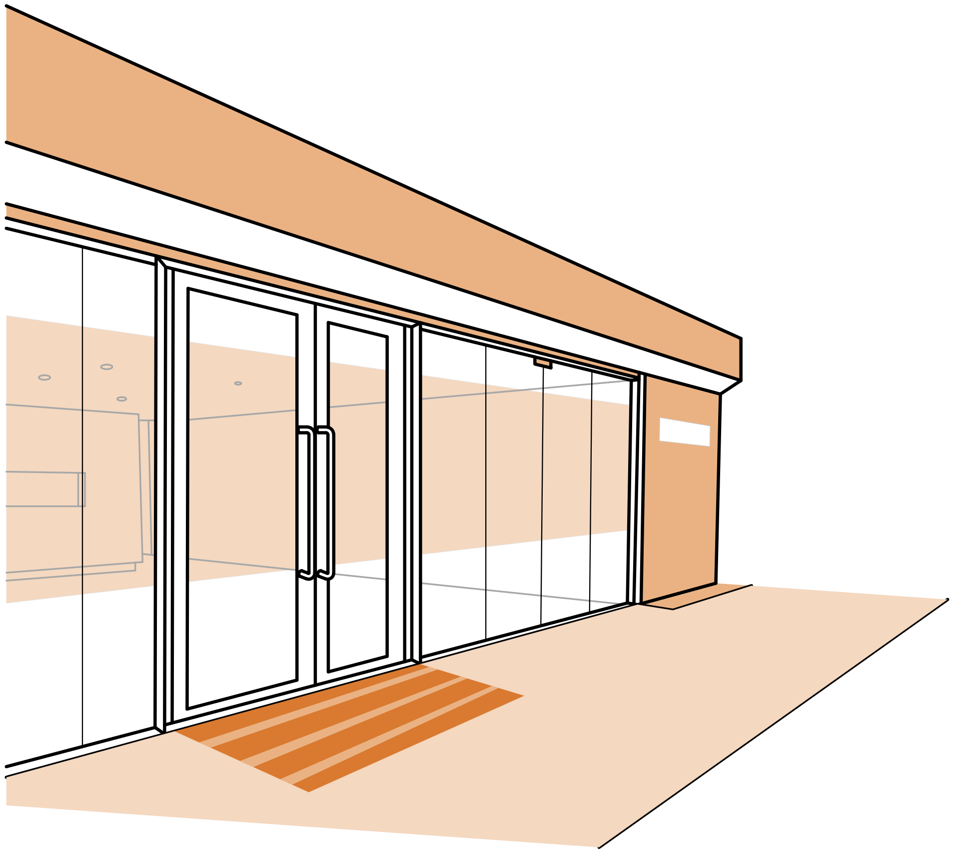


Figure C.37 Power-assisted door floor mark

C.5.9 Vertical circulation

C.5.9.1 Ramps

C.5.9.1.1 Accessible and pedestrian ramp requirements

The following requirements and recommendations apply to accessible and pedestrian ramps.

a) Where ramps are used for means of egress, the width and number of ramps required shall conform to with Section 3.7, Ch.3 of UAE FLSC [Ref. C.1].

b) Ramps shall be provided when a change in level has a gradient greater than 5%.

c) When ramps are provided, it is recommended that stepped access is also provided for use by people with an ambulant disability.

d) The slope of a ramp shall meet the specifications given in Table C.13.

e) The maximum cross-slope gradient shall be 2%.

f) Ramp landings shall be provided if the ramp run exceeds 10 m (see C.5.9.1.3).

g) If a series of ramp runs rises more than 2.4 m, an alternative means of step-free access, such as an enclosed elevator or a lift platform conforming to C.5.9.3, should be provided.

Ramp rise	Slope		Length between landings	
	Recommended (%)	Maximum (%)	Recommended (m)	Maximum (m)
More than 1,000 mm	5 to 6	8.33	4	10
500 mm to 1,000 mm	≤7	8.33		
Less than 500 mm	≤8	8.33		

Table C.13 Ramp rises

C.5.9.1.2 Ramp runs

Ramp runs shall be designed in accordance with Figure C.38 and Figure C.39. The following requirements and recommendations apply to ramp runs.

a) The usable clear width shall be a minimum of 1,000 mm when measured between handrails.

b) The ramp level change should be indicated through a tactile warning surface or change in the floor surface material with a difference of 30 points LRV.

c) Open ramps shall have outside edge protection as shown in Figure C.39.

d) Guardrails shall be provided in accordance with B.6.4.1.8.

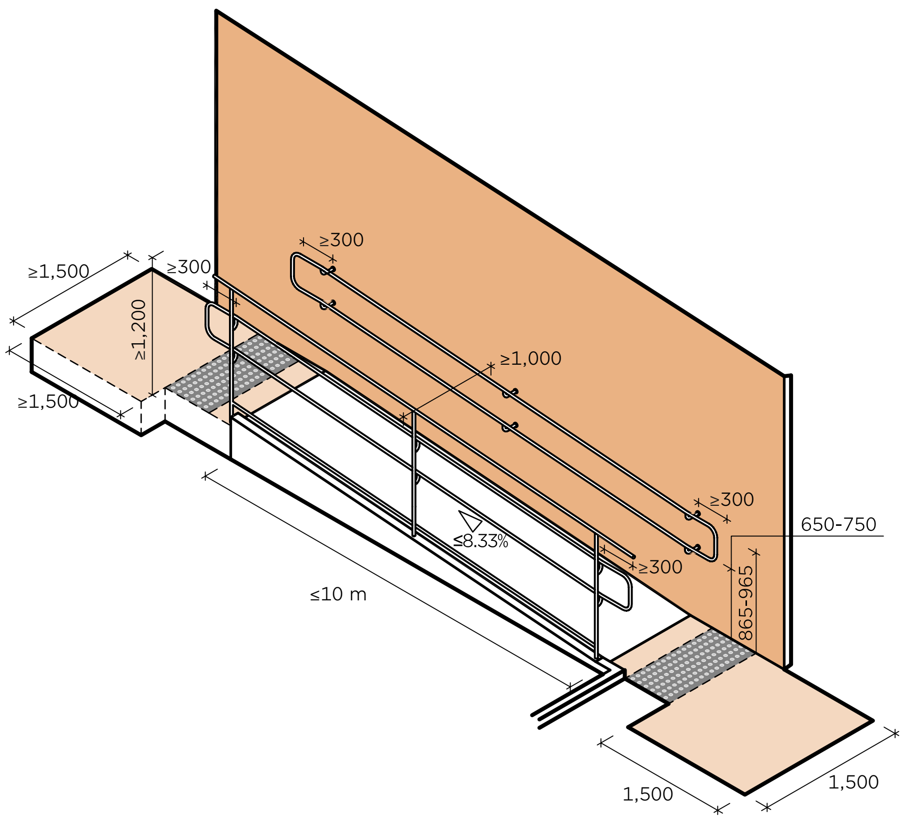


Figure C.38 Maximum rise and length for ramps

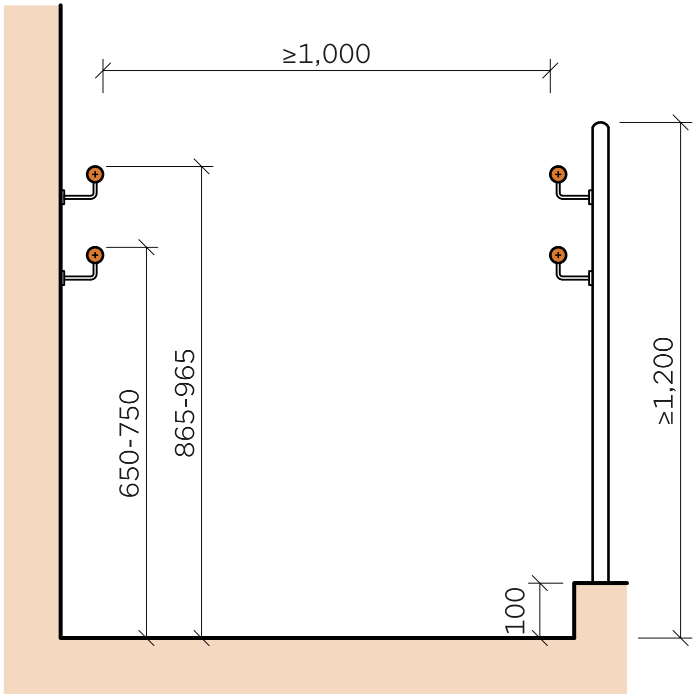


Figure C.39 Section of a ramp

C.5.9.1.3 Ramp landings

Landings shall be provided in accordance with Figure C.40 and Figure C.41, and shall conform to the following requirements.

a) A landing of not less than 1,500 mm × 1,500 mm shall be provided at both ends of a flight of ramps.

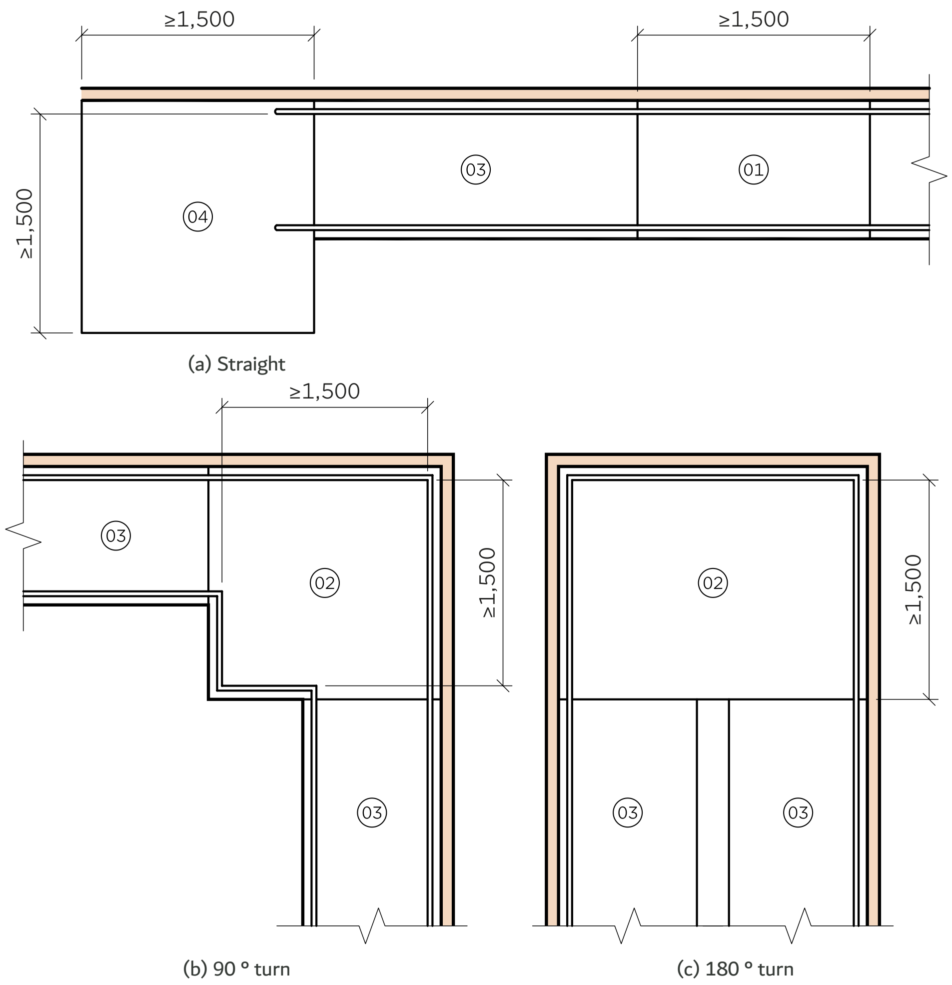
b) A landing of not less than 1,500 mm × 1,500 mm shall be provided where a ramp run changes direction.

c) Intermediate landings shall have a minimum length of 1,500 mm, and a minimum width equal to the width of the ramp.

d) Landings should be level, with a maximum 2% slope both in the direction of travel and as a cross-slope.

e) Doors and door swings shall be located a minimum of 1,500 mm away from the start or end of each ramp run, in accordance with Figure C.42.

f) Landings subject to wet conditions shall be designed to prevent the accumulation of water.



Key

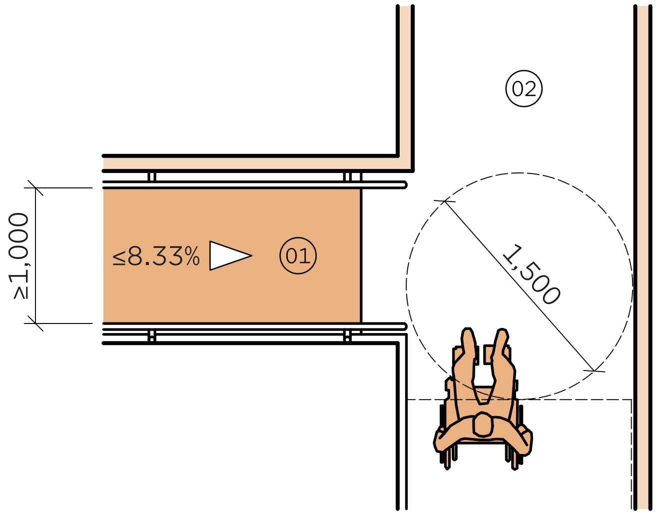
01: Landing, at least as wide as ramp run

02: Landing

03: Ramp run

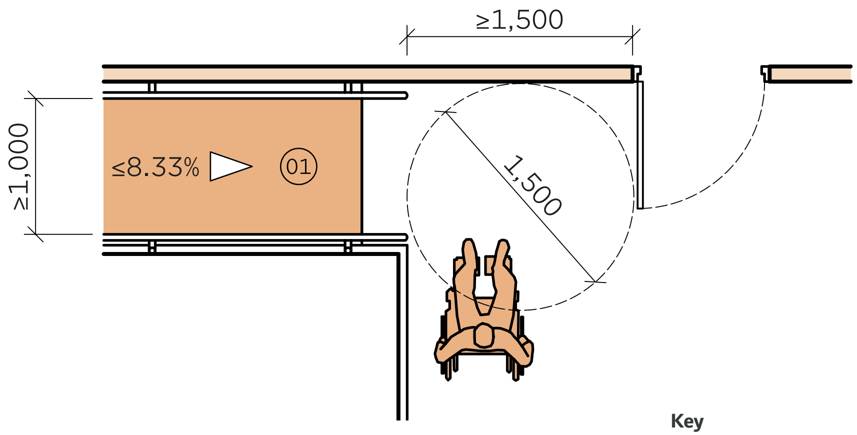
04: First or last landing

Figure C.40 Ramp landing arrangements (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 405.7.)



Key
01: Ramp
02: Corridor

Figure C.41 Ramp landing encroaching corridors



Key
01: Ramp

Figure C.42 Ramp landing near doors

C.5.9.1.4 Ramp edge protection

Ramps requiring handrails shall be designed with edge protection conforming to one of the following.

a) The floors or ground surfaces of ramp runs and landings shall extend a minimum of 300 mm beyond the inside face of a handrail (see Figure C.43).

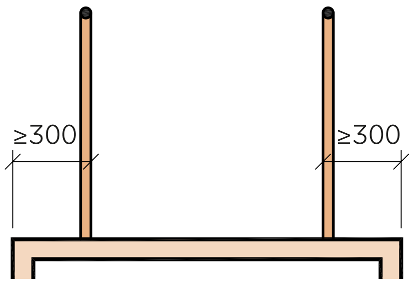


Figure C.43 Extended floor or ground surface edge protection (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 405.9.1.)

b) A curb or barrier shall be provided in accordance with Figure C.44. The curb or barrier shall prevent the passage of a 100 mm diameter sphere, where any portion of the sphere is within 100 mm of the finish floor or ground surface.

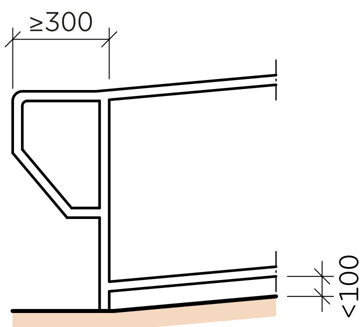


Figure C.44 Curb or barrier edge protection (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 405.9.2.)

C.5.9.1.5 Curved ramps

Circular curved ramps are not recommended as an accessible means of circulation, as they continually change direction. Curvilinear ramps with small radii can also create compound cross-slopes.

If curved ramps are provided, they shall be designed in accordance with Table C.14.

Ramp component	Minimum design criteria
Ramp run slope	5% max.
Cross-slope	2% max. at any point in the ramp surface
Min. clear width between handrails	1,500 mm
Min. interior radius of the ramp curve	1,500 mm, and increase according to the ramp height
Max. ramp run length between landings	10 m
Min. landing size	1,500 mm × 1,500 mm at the smallest dimension

Table C.14 Design criteria for curved ramps

A level landing shall be provided at the beginning and end of the ramp surface. Any crossfall shall be towards the centre of curvature (see Figure C.45).

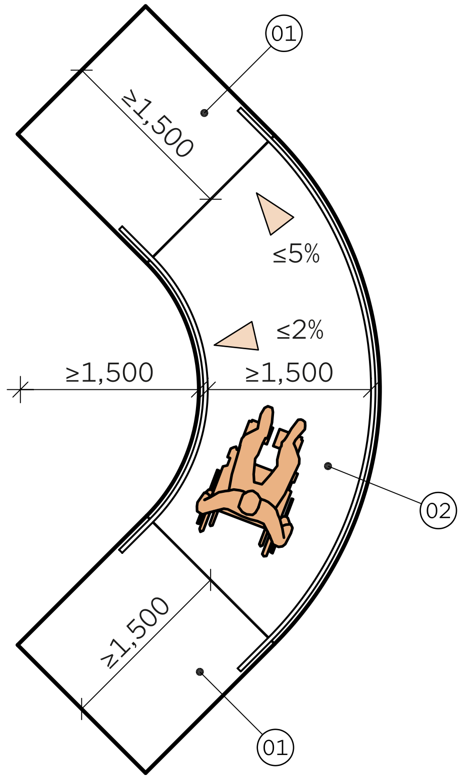


Figure C.45 Curved ramp

Key
01: Landing
02: Ramp run

C.5.9.1.6 Ramp handrails

Ramp handrails shall conform to the following requirements.

a) Handrails shall conform to B.6.4.1.7.

b) Ramps with a change in level greater than 300 mm shall have continuous handrails on both sides.

c) Any ramp wider than 2,100 mm shall have an additional intermediate handrail. Each segment of the ramp shall have a clear width of 1,000 mm.

d) Handrails shall be mounted at a height between 865 mm and 965 mm. All pedestrian ramps shall have an additional handrail, mounted at a height between 650 mm and 750 mm, to facilitate use by children and people of short stature (see Figure C.46). Handrail height shall be measured vertically from the finished ramp surface.

e) Handrails shall be safely secured. The handrail section and its mounting system should not interfere with the continuous gripping surface. The handrail shall be separated from the supporting wall by a minimum of 57 mm.

f) Handrails shall have a reflectance contrast of not less than 30 points LRV against their background.

g) Handrail materials exposed to the sun shall not reach temperatures that can harm the users.

h) Handrails shall extend horizontally above the landing for 300 mm minimum beyond the bottom and top of the ramp runs. Extensions shall return to a wall, guardrail, or the landing surface, or shall be continuous to the handrail of an adjacent ramp run.

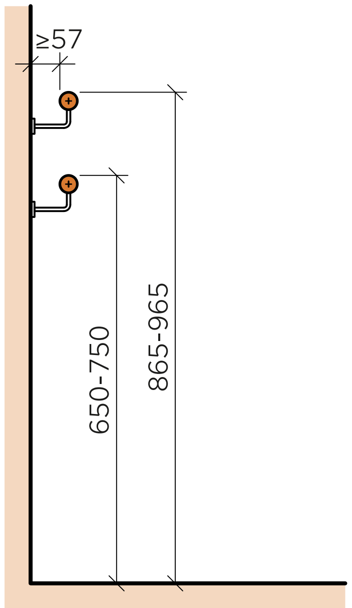


Figure C.46 Handrail heights

C.5.9.2 Stairs

Stairs shall conform to B.6.4.1.

C.5.9.3 Elevators

C.5.9.3.1 General

The location, arrangement and total number of elevators in a building shall conform to Part D.

As part of the overall elevator provision, at least one accessible elevator (or lift platform as described in C.5.9.4) shall be provided in every building with more than one floor, with the following exemptions:

a) two-storey restaurants, where an equal level of amenities, views, exterior terraces and seating options are provided on both storeys. Guest facilities on the accessible level (such as washrooms, food counters and stations) shall be accessible and connected to an accessible route. The non-accessible floor seating and dining area shall be not more than 30% of the overall dining area;

b) service and utility spaces not intended for occupancy, such as mechanical plant rooms;

c) two-storey buildings (G+1) where the non-accessible floor area is less than 250 m^2 of the gross area. The space shall not be used for retail, mall, healthcare or public transportation and shall not be intended for public use;

d) two-storey buildings with a maximum occupant load of five people on the non-accessible floor;

e) plot areas less than 250 m^2; and

f) mosques providing two levels of praying area, where the lower level provides accessible male and female prayer halls and the upper level serves as an extension to the praying area.

C.5.9.3.2 Accessible elevator requirements

Elevators serving public areas shall be accessible from the accessible entrance level. Where different means of vertical circulation are provided there shall be a sign indicating the direction to the accessible elevator

In addition to the minimum and recommended elevator specifications given in Part D, the following requirements and recommendations apply to accessible elevators.

a) Depending on the number and position of the doors, the dimensions of the elevator cabin shall be as shown in Table C.15, and the recommended cabin sizes in Part D depending on building occupancy.

Cabin type	Minimum (width × depth) (mm)	Recommended (width × depth) (mm)
One entrance cabin	1,200 × 1,500	1,500 × 1,500
Cabin with two opposing entrances	1,200 × 1,500	1,500 × 1,500
Cabin for stretchers	1,100 × 2,100	1,200 × 2,300

Table C.15 Dimensions of accessible elevator cabins

b) The dimensions should be appropriate for the intended number of users and in all instances shall be equal to or greater than the specified minimum dimensions of the cabin.

c) The number of elevators required and travel distance between elevators shall conform to Part D.

d) Wheelchair users should be provided with enough room to turn around inside the elevator and exit forwards. Where this is not possible, a mirror shall be installed inside the elevator to aid reversing out. The size and position shall be selected to be as non-visually distracting as possible.

e) The elevator doors shall have a minimum width of 900 mm and a minimum height of 2,100 mm (see Figure C.47).

f) The elevator doors shall be automatic and shall remain open for a minimum of 3 s. The doors shall present a colour contrast against the lobby walls.

g) Where a user is in the doorway, the door shall automatically reopen and shall not produce a force greater than 135 N. Sensors should be located at two levels so that lower items can be detected.

h) A minimum clear manoeuvring space of 1,500 mm × 1,500 mm shall be provided in front of the elevator access door and in front of the hall call button.

i) Floor indicators shall be located at a height range of 1,800 mm to 2,000 mm (see Figure C.47).

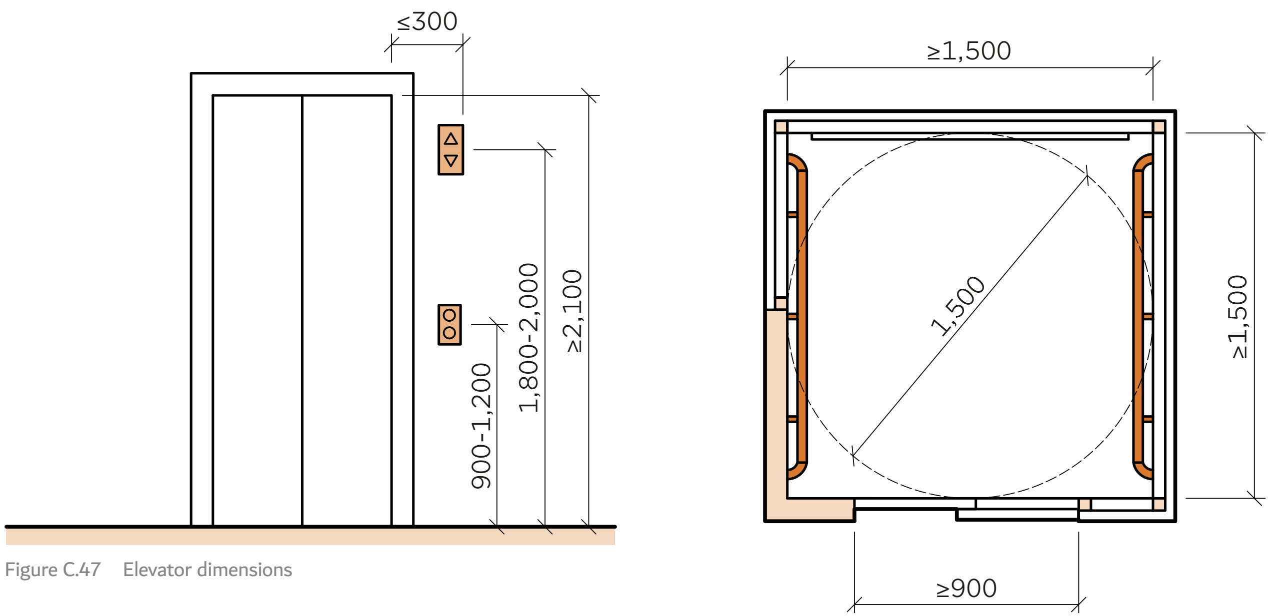


Figure C.47 Elevator dimensions

j) A minimum of two handrails shall be installed on each of the side walls at a height of 900 mm ± 100 mm from the floor.

k) Buttons shall be located at a height between 900 mm and 1,200 mm above the floor. They shall present high-embossed Arabic (0, 1, 2, 3 etc.) numerals (see Figure C.48 and Figure C.49). Braille numerals shall be located on the left lower side of each button in accordance with Figure C.48.

l) For elevators serving multiple floors, the keypad should be installed at a maximum height of 1,200 mm so that all floors can be called.

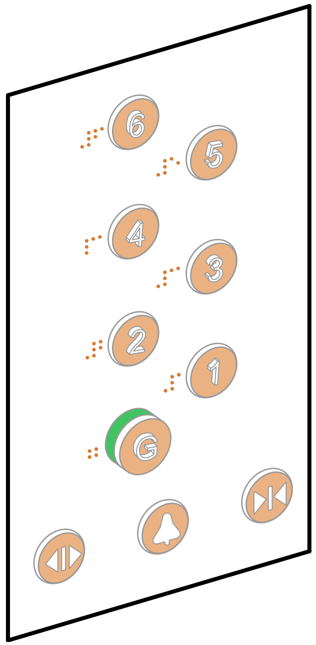


Figure C.48 Example of buttons path with Braille language

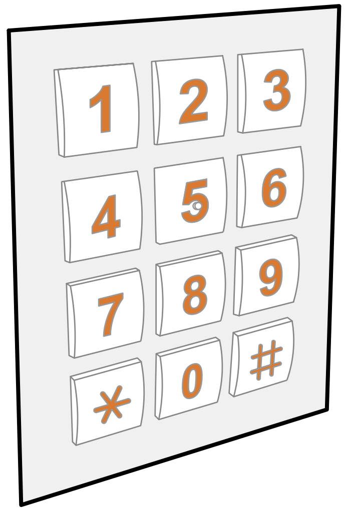


Figure C.49 Example of a keypad with raised dot in number five key

m) The button to reach the exit floor (usually ground floor) should be raised a minimum of 3 mm from the other buttons and be circled with a green line not less than 2 mm wide, as shown in Figure C.48.

n) Call buttons at each floor may contain tactile icons instead of digits. These should be colour-contrasted against the background.

o) Where touch screens or buttons are installed, a tactile button shall be included to activate an alternative interface for blind or visually-impaired passengers, e.g. an audible floor count system.

p) Braille and tactile signage shall be provided on the door jamb at a height of 1,500 mm.

q) The elevator shall have a hands-free intercom that allows two-way communication, enabling permanent contact between passengers in the elevator and a rescue service. The intercom shall have a sign (graphic and tactile) indicating the phone number of the alarm centre and the appropriate number to report an emergency.

r) Audible signals shall sound or an audible voice announcement shall be made when each floor is reached. Visual signals should be provided in public use buildings for hearing impaired people.

s) To allow users with hearing impairment to communicate in an emergency one of the following options shall be provided:

1) an audio/visual intercom; or

2) a means of sending and receiving emergency SMS text messages from inside the cab, either by maintaining the necessary network coverage or through an alternative system.

t) Lights should be installed to provide a uniform illumination of a minimum of 100 lux.

u) In panoramic elevators it is recommended that a full height opaque wall or corner section 800 mm wide is provided.

C.5.9.4 Lift platforms

For buildings other than private residences, lift platforms shall be installed only where restrictions in the building do not allow the installation of a passenger elevator (for example, in existing buildings to navigate changes in floor level).

The following requirements and recommendations apply to vertical lift platforms.

a) The lift platform shall have the minimum dimensions shown in Figure C.50.

b) A landing of 1,500 mm × 1,500 mm shall be provided to give access to the platform, and shall be kept free of obstacles.

c) A side interaction space in front of the lift-calling button shall be located at a height between 900 mm and 1,200 mm.

d) The platform access shall have a minimum clear width of 900 mm and be free of obstacles.

e) Side protection shall be provided to separate users from the walls of the lift platform shaft.

f) Inside the platform cabin, a minimum of two handrails shall be provided at a height between 865 mm and 965 mm from the floor.

g) The control buttons shall be located at a height between 900 mm and 1,200 mm. They shall have a continuous pressure button operation and shall be operable with the elbow or a closed fist.

h) There should be an additional external control for the platform that can be used by authorized personnel when necessary.

i) If the cabin is open or not fully enclosed with half height enclosure only reaching halfway up the cabin, the maximum travel height shall be 2,000 mm in public use buildings and 3,000 mm in private housing.

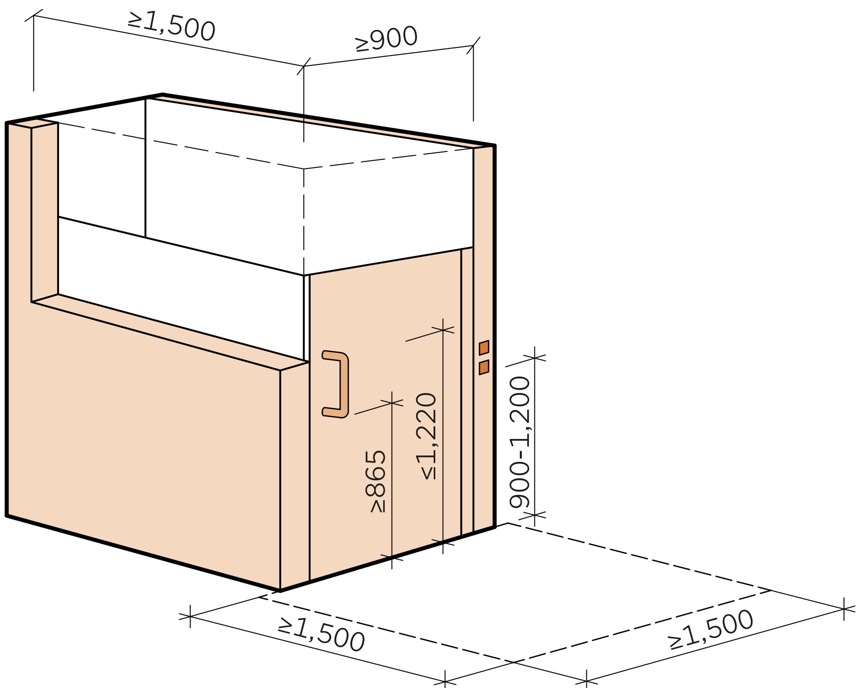


Figure C.50 Lift platform dimensions

C.5.9.5 Escalators and moving walks

C.5.9.5.1 General

Escalators and inclined moving walks are not usually considered part of an accessible route. However, they can be made more accessible. Signage leading to an accessible route shall be provided for escalators and moving walks.

Escalators and moving walks shall conform to Part D.

C.5.9.5.2 Escalators

Escalators shall include the following:

a) horizontal and vertical edges to the tread nosing of all steps, finished in yellow;
b) handrails that include colour contrast dots or similar;
c) clear information on the direction of travel (e.g. at traffic lights); and
d) approach route and exit area flooring that visually contrasts with the surrounding floor in texture and colour.

At both ends of the flight, the escalator shall move horizontally for a minimum of four treads before changing direction vertically.

An audio system indicating the start and end of escalators is recommended.

C.5.9.5.3 Moving walks

Moving walks are considered complementary elements of accessible routes and shall conform to the following requirements.

a) The moving surface shall present a maximum gradient of 5%.
b) The beginning and the end of the moving walk shall comprise a surface that visually contrasts with the surroundings.
c) The direction of travel shall be marked.

An audio system indicating the start and end of moving walks is recommended.

C.5.10 Temporary facilities in outdoor spaces

The following requirements and recommendations apply to temporary facilities and signs located on sidewalks, squares and other outdoor spaces (including signs and terraces for cafes and restaurants).

a) The minimum clear width and height requirements for accessible routes shall be maintained.
b) The facility shall not interrupt any guidance element (such as façades, walls and guardrails) without providing an alternative.
c) The facility should not encroach upon an accessible route. Where an accessible route is adjacent to a terrace, the perimeter of the terrace should be protected by a continuous element with a minimum height of 900 mm (except at the access to the terrace). The continuous element shall be detectable by people with visual impairment.
d) Where terraces are installed close to vehicular routes, elements such as traffic bollards and other rigid obstacles shall be installed at minimum intervals of 1,200 mm (see Figure C.51).

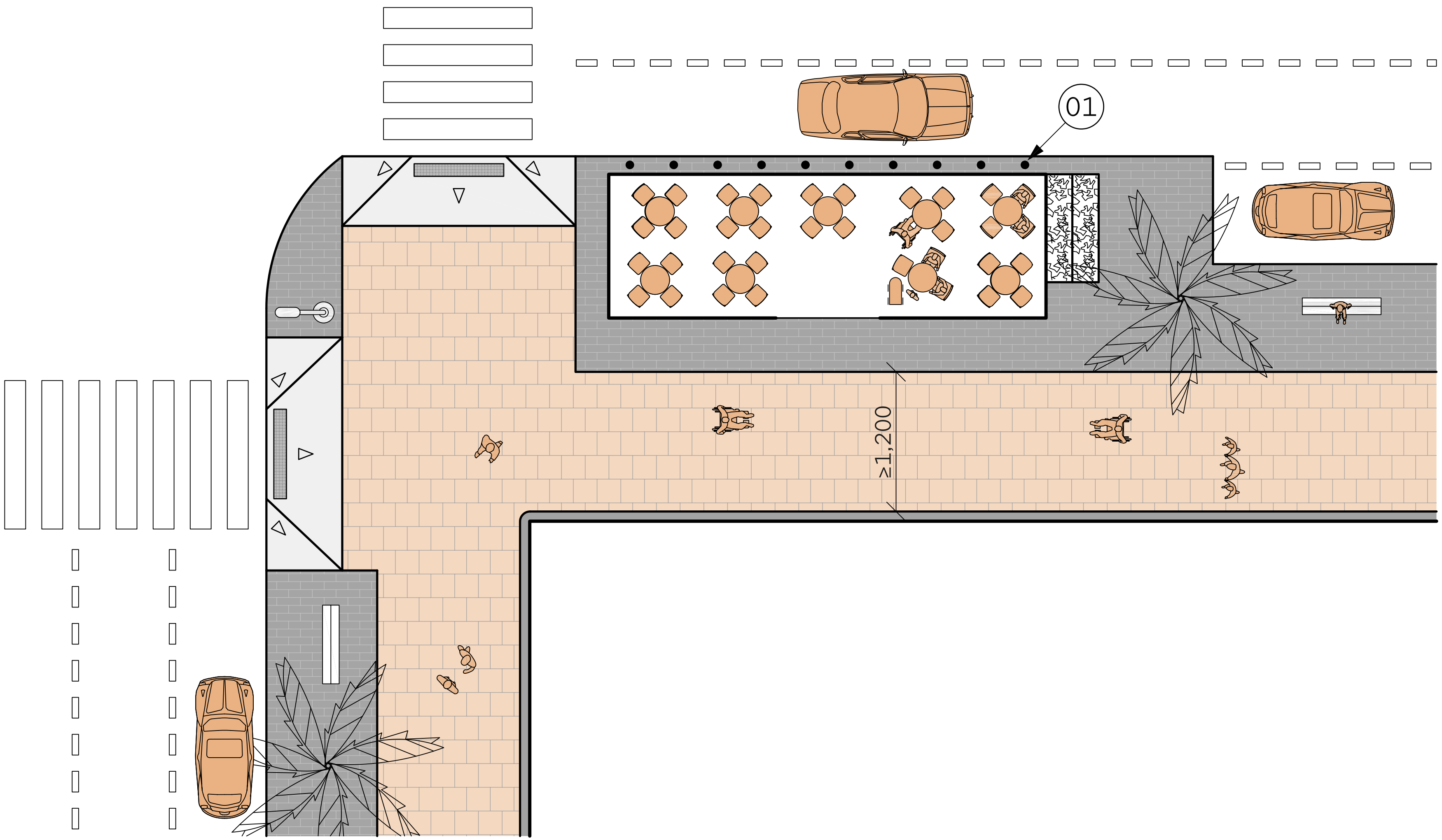


Figure C.51 Terrace on the sidewalk adjacent to an accessible route

C.6 Building access and vehicular requirements

C.6.1 Vehicular entries and accessible routes

The level and minimum width of an accessible route shall not be affected by a vehicular entry (see Figure C.52). The level difference between an accessible sidewalk and a vehicular access should be resolved as shown in Figure C.53 or Figure C.54.

Barrier access and queuing on a vehicular access shall not obstruct an accessible route.

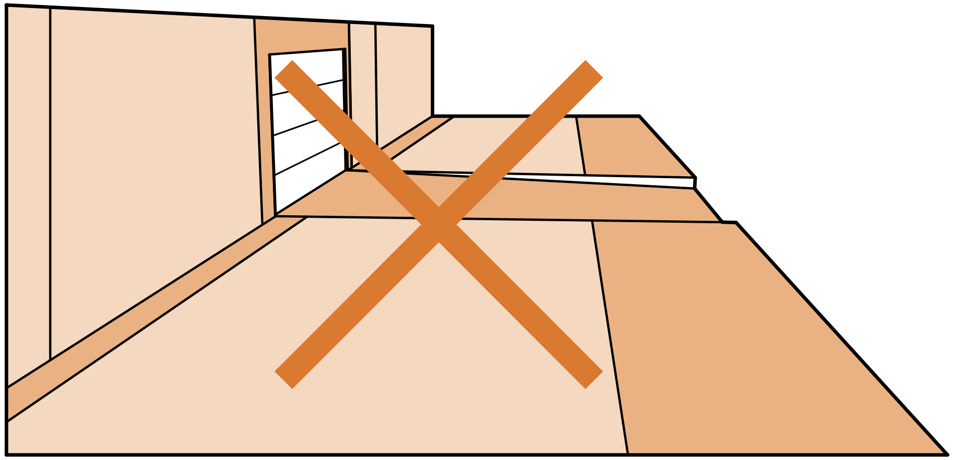


Figure C.52 Unacceptable vehicle entry

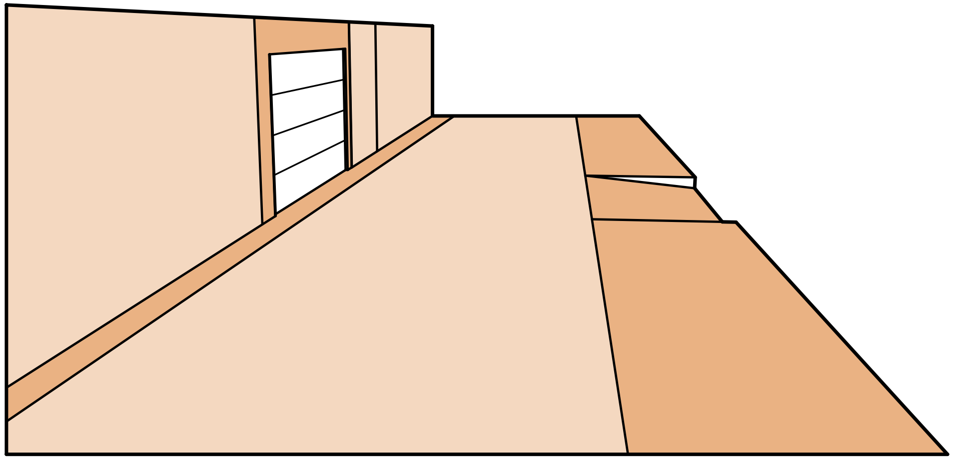


Figure C.53 Possible solution for vehicle entry

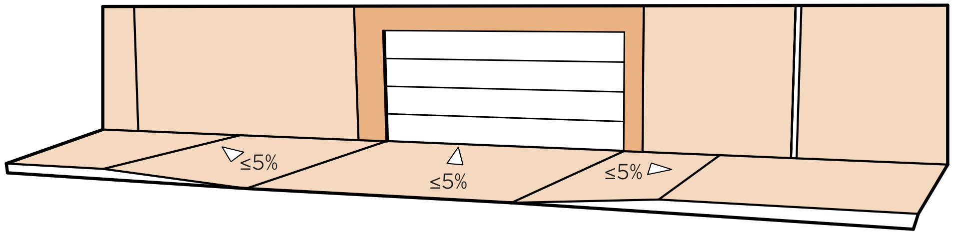


Figure C.54 Depression of sidewalk – Possible vehicle entry alternative

C.6.2 Curb ramps

C.6.2.1 General

All curb ramp types described in C.6.2.2 shall conform to the following.

a) The running gradient shall be not more than 8%. Depending on the height of the sidewalk, the length shall conform to Table C.16. The curb height shall be not less than 75 mm and not more than 150 mm.

b) The total width of curb ramps in pedestrian crossings shall be the same as that of the accessible route. The total width shall be not less than 1,200 mm, with no interruptions by any obstacle or raised pavement.

c) Curb ramps shall not interfere with the accessible route. Curb ramps shall be free of any obstruction such as signposts, traffic lights and similar items.

d) Curb ramps shall have tactile warning paving at 300 mm from the curb edge to driveways.

e) Curb ramp edge surfaces shall be completely level with the road.

f) The colour and texture of the curb ramp should be similar to the accessible route.

g) The surface of the curb ramp shall conform to C.7.2.1.

h) The maximum cross-slope gradient shall be 2%.

i) Curb ramps shall be located or protected to prevent obstruction by parked vehicles.

j) Curb ramps located on both sides of a street should align.

k) Visual, audible and tactile warning devices shall be provided when a pedestrian crossing is required.

Sidewalk height (mm)	Central passage dimensions			Flared sides	
	Length (mm)	Width (mm)	Max. gradient (%)	Length (mm)	Max. gradient (%)
100	1,250	Equal to crossing area width – 1,200 min.	8	1,250	8
150	1,875			1,875	
200 (only for existing sidewalks)	2,500			2,500	

Table C.16 Dimensions and gradients of curb ramps

C.6.2.2 Types of curb ramps

C.6.2.2.1 Curb ramps with flared sides

Curb ramps with flared sides are preferred. They shall have three slopes (see Figure C.55).

In exceptional cases, the flared sides of ramps located in parking and drop-off areas can have higher cross-slope gradients, but shall not exceed 12%.

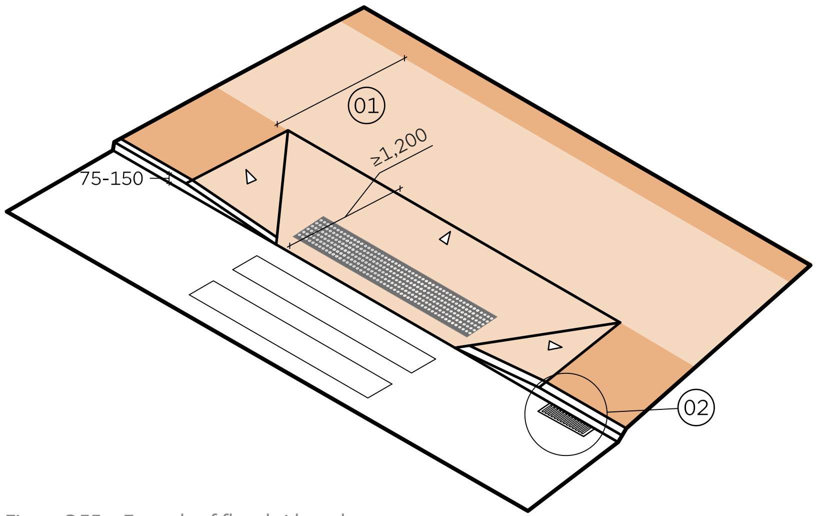


Figure C.55 Example of flared side curb ramps

Key
01: Accessible route
02: Drain grids outside the intersection

C.6.2.2.2 Returned curb ramps

Returned curb ramps comprise a single slope placed longitudinally from the crossing direction, creating two different levels of variable height on its sides (see Figure C.56).

The level change on the curb side edges should be protected by a barrier or urban furniture.

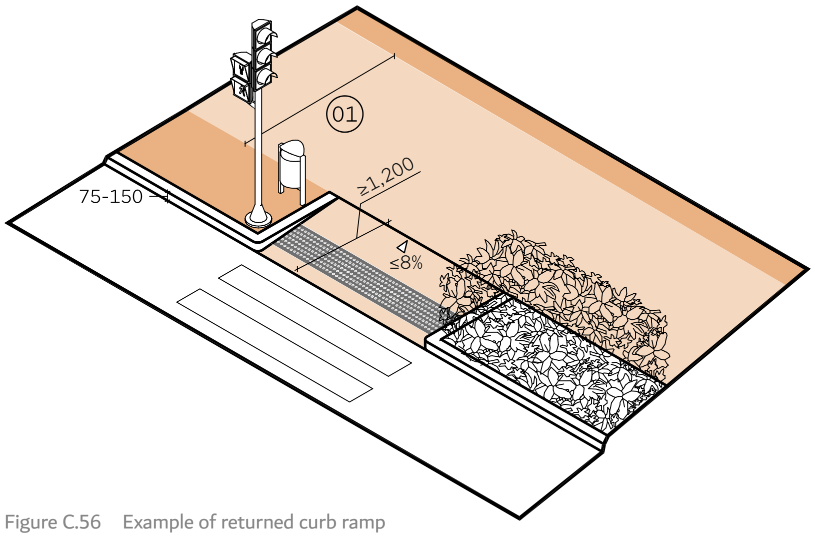


Figure C.56 Example of returned curb ramp

Key
01: Accessible route

C.6.2.2.3 Curb ramps in curb extensions

Curb ramps in curb extensions are appropriate when the sidewalk is narrow. Extensions in the street corners can be created to reduce the pedestrian crossing distance (see Figure C.57).

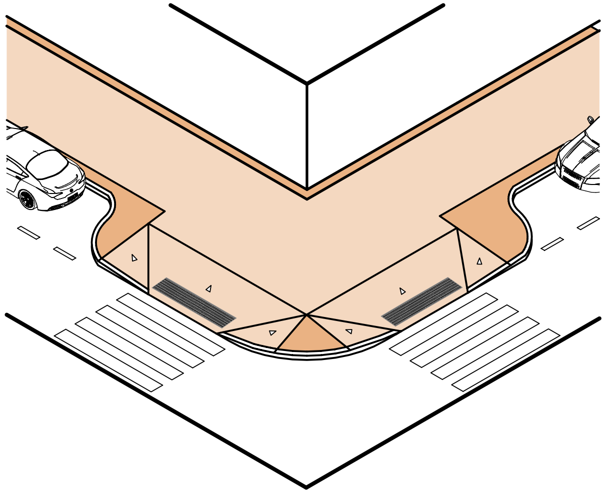


Figure C.57 Example of curb ramps in curb extensions

C.6.2.2.4 Lowered sidewalk curb ramps

Lowered sidewalk curb ramps are permitted when the sidewalk width does not allow the use of other curb cut types (see Figure C.58).

Two running slopes lower the sidewalk's full width to the roadway level. A minimum 1,200 mm long landing should be provided between the two slopes. The border level with the roadway shall include a tactile warning pavement.

This is the only curb ramp that is permitted to obstruct the pedestrian route.

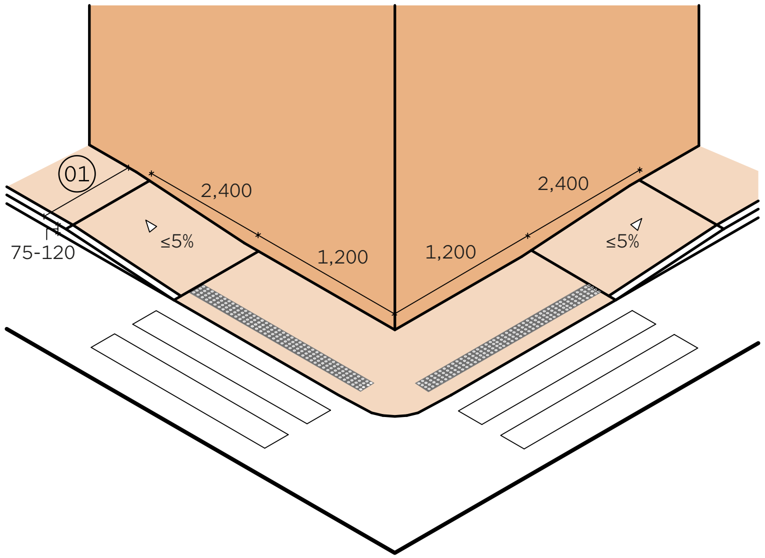


Figure C.58 Example of lowered curb cut in a corner

Key
01: Accessible route

C.6.3 Pickup and drop-off areas

Drop-off areas shall comply with Dubai Access Management manual requirements [Ref. C.16] Chapter 7.2. Accessible drop-off areas shall include curb ramps conforming to C.6.2.

Passenger drop-off and pickup areas shall provide a vehicular pull-up space in accordance with [Ref. C.16].

C.6.4 Accessible parking

C.6.4.1 Accessible parking provision

Public or private parking areas associated with a public street, open space or building shall have accessible parking spaces. These parking spaces shall be reserved for holders of accessible parking stickers issued by any authorized jurisdiction.

The number of accessible parking spaces shall be obtained from Table C.17.

For hospitals and healthcare facilities, 10% of the overall parking capacity should be accessible.

Accessible van parking should be provided at a rate of 10% of overall accessible parking count. At least one accessible van parking space should be provided for each building or facility.

Accessible parking spaces shall conform to the minimum dimensions in Table C.18.

Use of the building, establishment or area	Minimum number of accessible spaces	
All buildings except private housing	25 to 500 total parking spaces	2% of the total, and a minimum of one
	More than 500 total parking spaces	1% for additional parking spaces over 500
Buildings with reserved seating space for wheelchair users, such as cinemas and sport facilities	One for every two reserved seating spaces for wheelchair users	
Buildings and open spaces without parking facilities but with the following uses: a) administration headquarters; b) hospitals; c) education buildings; d) sport facilities; e) beaches with accessible routes; f) rehabilitation and day care centres; and g) clinics.	Two bays in the public areas, as close as possible to the building entrance (maximum 50 m)	

Table C.17 Minimum number of accessible parking spaces

Parking type	Parking space dimensions (m)
Car – angled and perpendicular	2.5 m × 5.5 m
Car – parallel – along the sidewalk	2.5 m × 6.0 m
Accessible van	3.35 m × 5.5 m

Table C.18 Parking dimensions

C.6.4.2 Location of accessible parking spaces

The following requirements and recommendations apply to accessible parking spaces.

a) Accessible parking spaces should be located as close as possible to public facilities.
b) Accessible parking spaces shall be located a maximum of 50 m from the building entrance. An accessible route shall provide access to the sidewalk from the road, or an accessible curb ramp shall be provided.
c) A minimum of one accessible parking space shall be provided adjacent to each accessible entrance.
d) Where a parking area is served by multiple accessible building entrances, accessible parking spaces shall be a maximum of 50 m from each accessible entrance. The distribution of accessible parking be such that all accessible parking spaces are not located in the same area.
e) When multi-level parking is provided, at least one accessible parking space shall be available at grade level whenever grade parking is provided.
f) Accessible parking spaces shall have an access aisle at least of 1,200 mm wide. The access aisle shall be connected to an accessible route. Angled parking spaces shall have a side access aisle, to allow for approach and transfer from the driver's side. A rear access aisle shall be provided to parking spaces along a sidewalk.
g) If an accessible parking aisle is shared between two vehicles parking adjacently, the aisle shall be centrally accessible for both vehicles (see Figure C.59).
h) The parking spaces shall be marked with the symbol for people of determination, painted on the ground and on a signpost. This sign should be visible from the driving position and mounted at a height of 2,100 mm (see Figure C.60).
i) For parking areas controlled by vehicle barriers, meters or ticket dispensers, the equipment shall be installed at an appropriate location and height for use by people of determination. The guidance given in BS 8300 on these provisions for people of determination should be followed.
j) Wayfinding signs conforming to C.11 shall be provided to indicate the location of accessible parking spaces.
k) For enclosed parking areas, wayfinding signs shall be provided at any directional change option inside the parking area. The signs should use the symbols and colours of each area and floor to help people find their cars, toilets and exits.
l) Pedestrian routes within parking areas shall be identified by floor painting with a reflectance contrast of 30 points LRV compared to the vehicular routes.

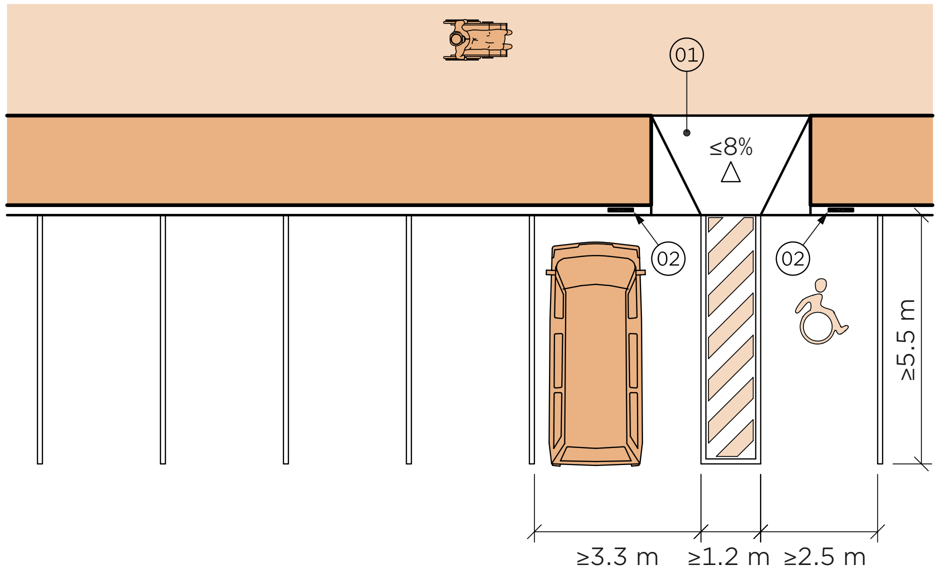


Figure C.59 Example of accessible parking spaces with side aisle

Key
01: Curb to parking
02: Sign

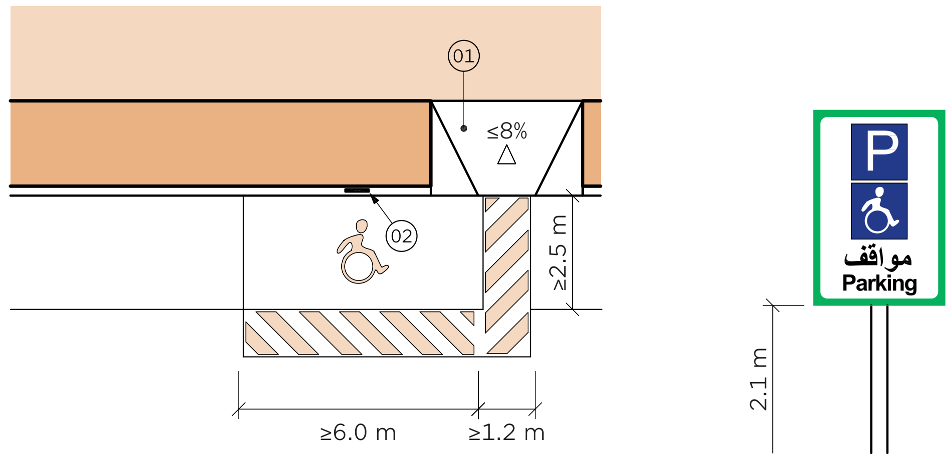


Figure C.60 Example of an accessible parking space along the sidewalk with sign on post

Key
01: Curb to parking
02: Sign

C.7 Accessible building elements

C.7.1 Windows and window hardware

The following requirements and recommendations apply to windows and window hardware.

a) Any opening window located externally or internally shall not project into accessible routes within 2,100 mm of FFL.

b) Window controls shall not require wrist turning. They should be easy to manipulate with one hand or an elbow, or be automatically operated. Windows shall be capable of being opened and closed using limited force. The force needed to open the window shall be not more than 22.2 N.

c) Window controls should contrast visually with their background for the benefit of partially sighted people. The controls should be within accessible reach ranges, mounted between 900 mm and 1,200 mm.

d) Design should prioritize similar levels of access to natural light for all building users.

e) To provide exterior views for children, people of short stature and wheelchair users, the bottom of any glazed opening should be a maximum of 900 mm above the internal floor level. To provide a minimum clear viewing range, no horizontal transoms should be positioned between 900 mm and 1,200 mm above floor level (see Figure C.61 and Figure C.62).

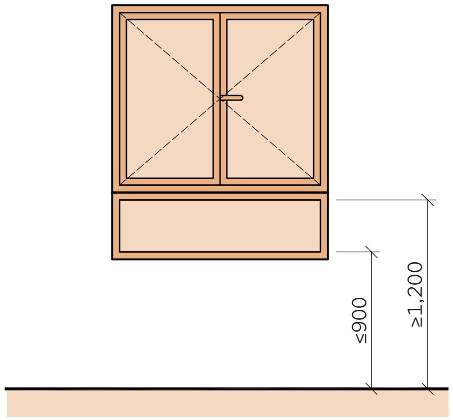
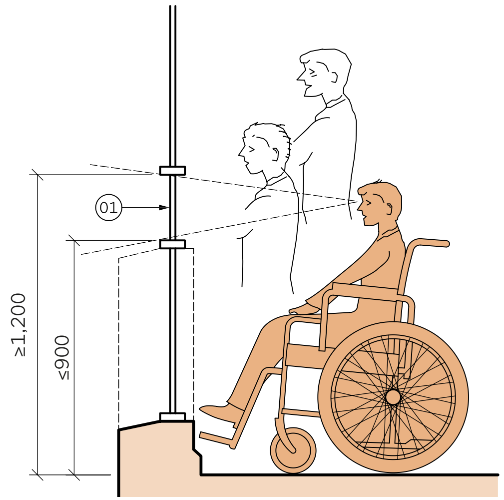


Figure C.61 Window viewing range



Key

01: Minimum clear viewing range

Figure C.62 Minimum clear viewing range (© British Standards Institute. Figure extracted from BS 8300:2018. Permission to reproduce extracts from British Standards is granted by BSI Standards Limited (BSI). No other use of this material is permitted).

C.7.2 Surfaces

C.7.2.1 Floor surfaces

C.7.2.1.1 Level change

Changes in level up to a maximum 13 mm shall be designed with a 25% maximum gradient slope as shown in Figure C.63. Changes in level greater than 13 mm shall be ramped in accordance with C.5.9.1, or a maximum slope gradient of 5% shall be provided.

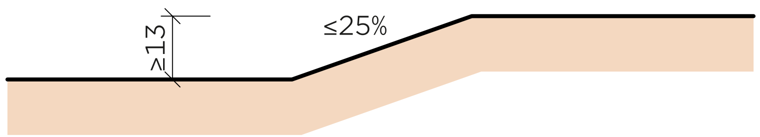


Figure C.63 Maximum gradient slope for changes in level

C.7.2.1.2 Slip resistance

Levels of slip resistance for accessible surfaces, as determined by pendulum testing (see BS EN 13036-4) shall conform to Table C.19.

Floor surface slopes	Pendulum test value (PTV)
Indoor – dry areas	
Level surface Inclined surfaces with slopes less than 5%	Between 15 and 35
Inclined surfaces with 5% slopes or greater	35 or more
Outdoor and wet areas	
Level surface	Between 35 and 45
Inclined surfaces with slopes less than 5%	
Inclined surfaces with 5% slopes or greater	45 or more
Streets pavement, swimming pools and showers	45 or more

Table C.19 Surface slip resistance

Wet areas such as toilets and swimming pools shall have non-slippery floor surfaces. PTVs shall take account of both shod and barefoot users.

The product provider shall provide technical slip resistance parameters in PTV units. If the data are not provided, the material should be tested in a laboratory before it is accepted.

C.7.2.1.3 Other requirements

Floor surfaces shall be firm, smooth and stable.

Tiles presenting rounded edges and excessive joints should not be used in accessible routes to prevent wheel vibration, tripping and noise.

Internal and external surfaces shall not have loose elements and shall allow for movement or dragging.

Rugs and carpets shall be firmly fixed to the floor and shall allow easy movement for wheelchair users. Rugs and carpets shall not increase the force required to roll over a ceramic pavement by more than 25%. This can be measured with a dynamometer comparing the effort required to move a person seating in a wheelchair on both surfaces. Pile height shall be a maximum of 13 mm. Exposed edges of carpet shall be fastened to floor surfaces and shall have a trim along the entire length of the exposed edge.

Carpets installed at entrance lobbies shall be limited to a maximum height difference of 5 mm from the surrounding floor finish.

Floor surfaces shall be finished with appropriate flooring materials or coatings that do not produce glare.

Floor patterning that could be mistaken for steps, e.g. stripes, should not be used in common circulation areas.

Lighting shall not be installed in floors if it produces glare in the area of accessible routes.

Lighting installed in floors shall not produce heat.

Imperfections or irregularities that create a level difference of more than 5 mm, or holes larger than 15 mm in diameter, shall not be allowed in a floor surface. Such differences can be avoided by careful selection of material and regular maintenance.

When grate openings are longitudinal, they shall be installed such that the length of the openings are perpendicular to the direction of travel over the grate (see Figure C.64 and Figure C.65).

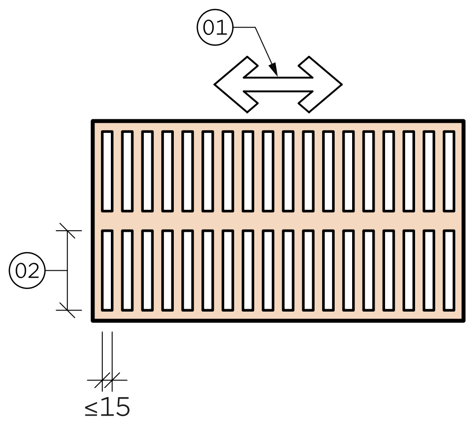


Figure C.64 Elongated openings in floor or ground surfaces (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 302.3)

Key

01: Dominant direction of travel

02: Long dimension perpendicular to dominant direction of travel

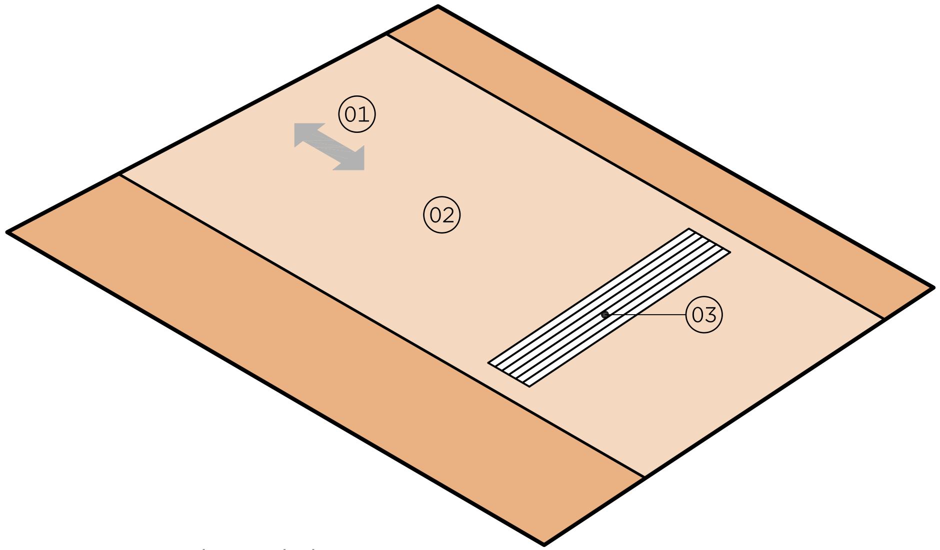


Figure C.65 Grate with perpendicular orientation

Key
01: Pedestrian direction of travel
02: Accessible route
03: Grate

Grates shall not be installed on curb cuts at pedestrian crossings.

Trees adjacent to an accessible route shall be protected with walkable grilles, especially when they are less than 1,800 mm from a building façade (see Figure C.66).

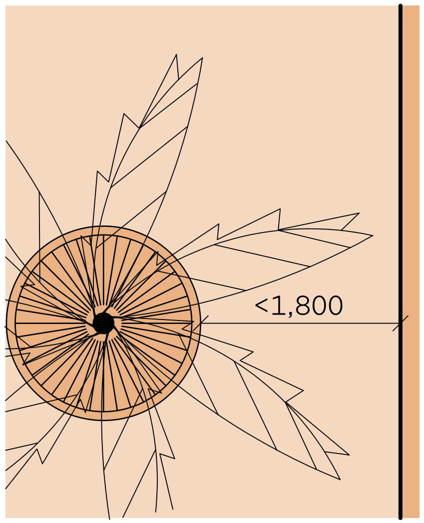


Figure C.66 Walkable grille in tree grate

C.7.2.2 Tactile systems

C.7.2.2.1 General

Tactile systems shall conform to ISO 23599 or be designed and installed to conform to C.7.2.2.2 to C.7.2.2.3.

C.7.2.2.2 Detectable warning surface

Detectable warnings surfaces are required for level change areas, including stairs, ramps, rail and port platform borders, and unprotected changes in level. They also warn of an obstacle on the course of travel.

Warning surfaces shall be constructed of truncated cones arranged in a square grid or diagonal rows and installed with bands oriented in the crosswise direction of the course of travel. A detectable warning surface shall be installed along the entire width of the level change area or obstacle at a minimum distance of 300 mm from the beginning of the hazardous edge. The warning surface shall have a minimum width of 300 mm (see Figure C.67).

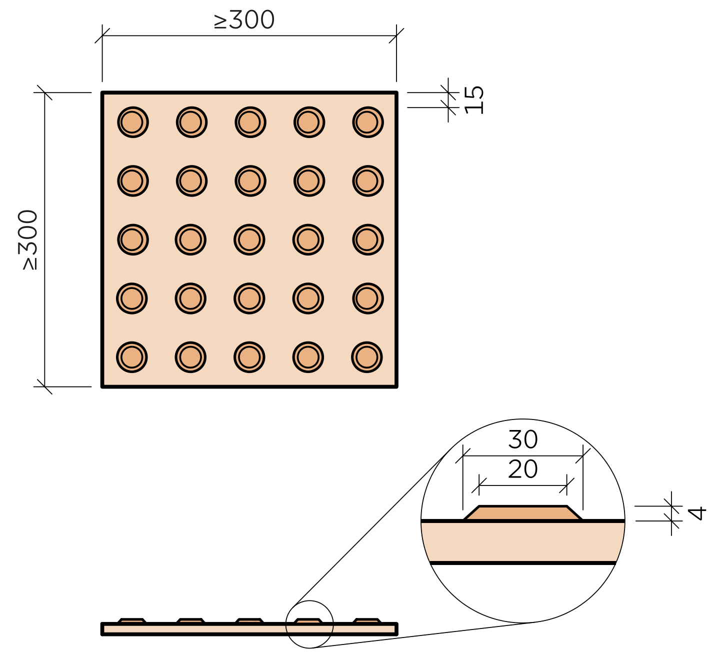


Figure C.67 Warning surface example

C.7.2.2.3 Tactile guiding surfaces

Tactile guiding surfaces are used as a directional aid to assist the independent mobility of people with visual impairment.

Guiding patterns should be constructed of flat-topped elongated strips which are oriented in the direction of the course of travel.

The tactile guiding surface shall have a minimum width of 400 mm. The distance between longitudinal strips shall not exceed 32 mm (see Figure C.68).

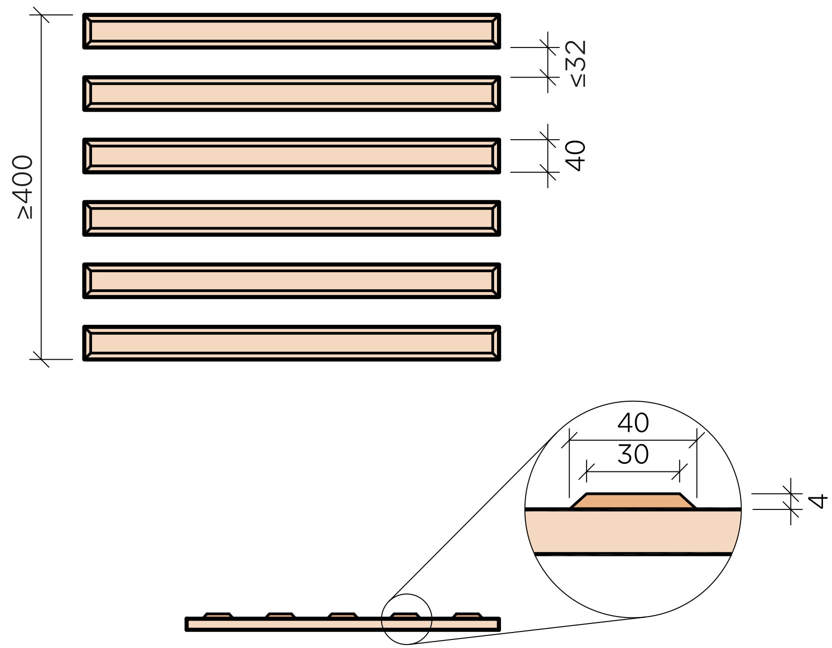
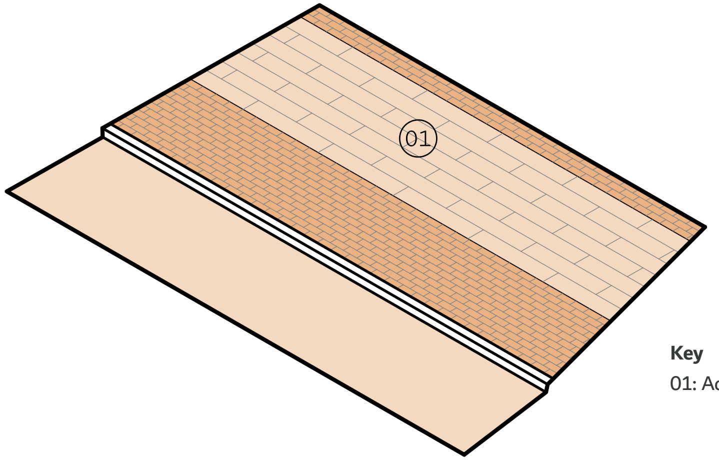


Figure C.68 Guiding surface example

Tactile wayfinding is very useful for people with impaired vision and people who are blind and use a mobility aid (e.g. white cane). Tactile references include walls, façades, doors and changes of texture in pavements and differences between tiles and grass as shown in Figure C.69.



Key
01: Accessible route

Figure C.69 Accessible route pavement with different texture from the surrounding pavement

When differences in surface treatments are not present, a guiding tactile pavement shall be provided.

Guiding surface pavements shall be provided in the following:

a) open squares without defined walking routes;
b) metro, tramway, ferry network stations and other transportation hubs; and
c) between building entrances and information or reception desks, and elevators in public administration buildings, as shown in Figure C.70.

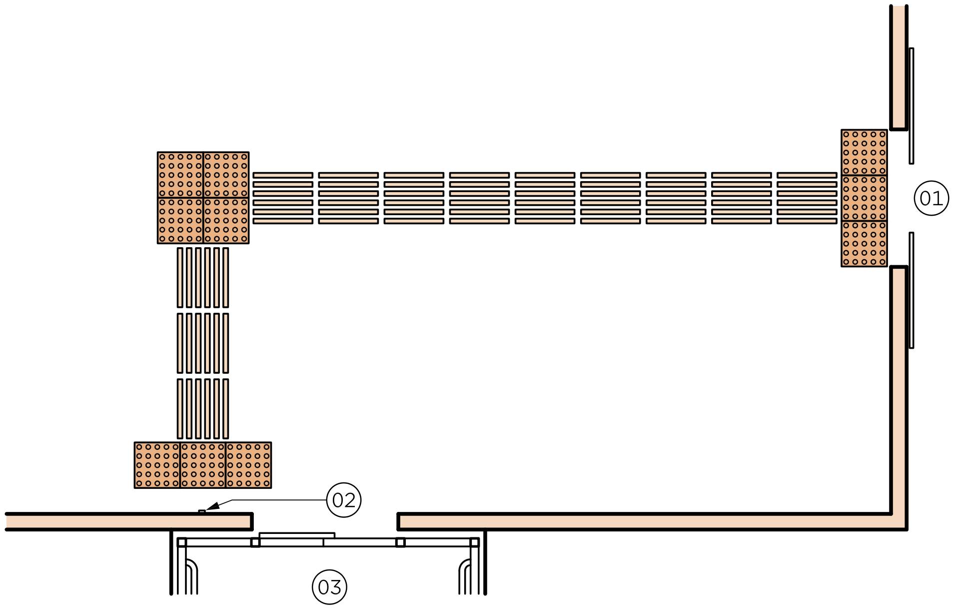


Figure C.70 Use of guiding tactile surfaces example

Key
01: Entrance
02: Elevator call button
03: Elevator

At public transportation stations and hubs, guiding tactile surfaces shall start at the entrance and be continued to all accessible services, to indicate the walking route. Warning tactile surfaces shall be provided at any direction change, at any level change, and in front of all the services provided.

C.7.2.3 Glass surfaces

Glass surfaces incorporated into accessible spaces should not create distracting reflections.

The following building elements shall contain manifestation or visual elements to enable them to be detected:

a) all glass surfaces that could be confused with doors or openings; and
b) glass doors that do not have identifiable elements such as frames or handles.

The zone for manifestation or visual detection elements is illustrated in Figure C.71. The zone shall:

1) be located between 750 mm and 1,500 mm above FFL;
2) occupy a minimum of 50% of the area horizontally at each 900 mm width interval, with minimum 50% opacity; and
3) contain visual elements of any type of bands or marks (such as logos and artistic illustrations).

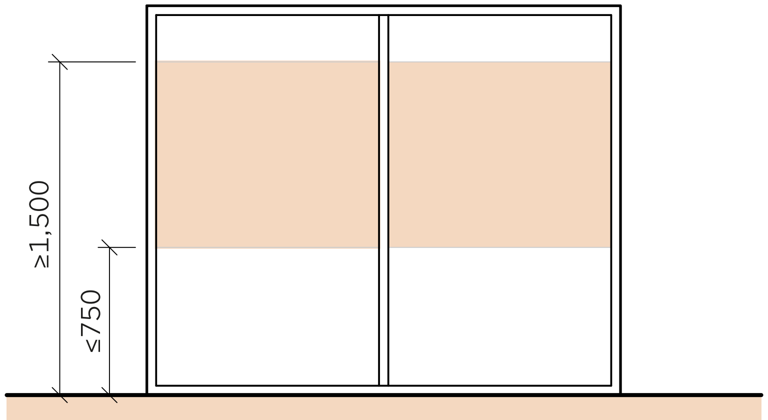


Figure C.71 Zone for glass manifestation

Manifestation and visual detection elements are not required in the following cases:

i) where a glass surface is less than 500 mm wide;
ii) where the glass surface does not extend more than 850 mm above FFL;
iii) where a fixed element in front of the glass surface blocks the entire approaching space;
iv) where façade glazing is in upper floors with no access from outside, and where there is no possibility of a user confusing it with access glazing.

C.7.2.4 Wall surfaces

Large, repeating patterns that incorporate bold colour contrast should be avoided for wall surfaces in parts of a building where visual precision is critical.

Service outlets and other functional elements on wall surfaces should be distinguishable from the wall, using visual contrast and textural contrast.

Protruding objects on walls should visually contrast with the background wall surface to facilitate detection.

C.7.3 Furniture and equipment

C.7.3.1 General

Furniture and equipment shall contain no sharp edges, protruding objects or burning surfaces and shall provide visual contrast with their background for ease of detection.

Materials that retain heat from sun radiation shall not be used for surfaces that are to be touched.

Furniture shall be made of non-toxic materials.

Accessible furniture and equipment shall be located adjacent to accessible routes, while avoiding obstruction of the minimum clear width.

C.7.3.2 Storage facilities

Where storage facilities are provided, 20% of shelves, boxes or lockers shall be within reaching distance for wheelchair users or people of short stature. They shall be located between 600 mm and 1,200 mm above the floor (see Figure C.72).

Storage facilities should include some knee spaces to allow the option of either frontal or sideways use from a sitting position. If benches are provided, they shall be moveable or separated from accessible lockers and storage units. A side approach interaction space is shown in Figure C.72.

Locker designations should provide visual and tactile contrast.

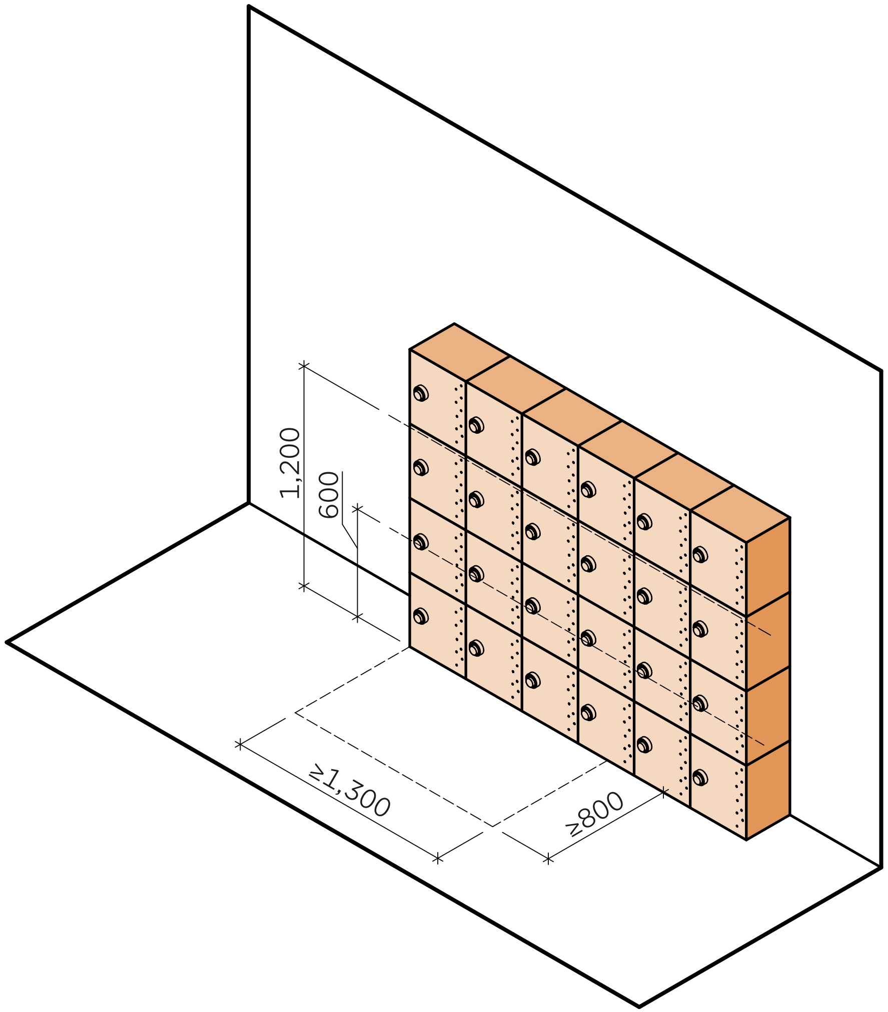


Figure C.72 Locker space with 20% of units between 600 mm and 1,200 mm

C.7.3.3 Tables

The tops of accessible tables shall be in accordance with the dimensions in Figure C.73. Accessible tables shall not feature integrated seats. Knee and toe clearance shall be provided in accordance with C.5.6.2.

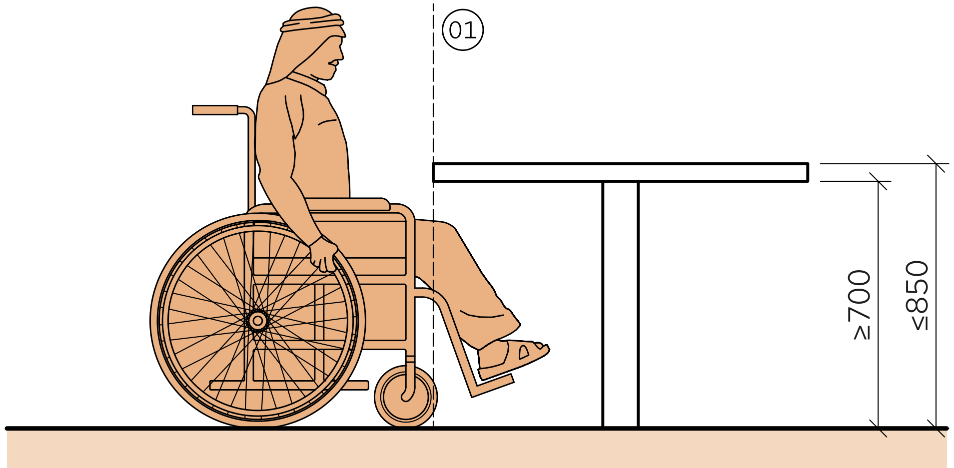


Figure C.73 Accessible table height

Key

01: Front of top table or bench

C.7.3.4 Chairs and benches

The following requirements and recommendations apply to accessible chairs and benches.

a) The seating height shall be between 430 mm and 480 mm above FFL. The seating depth shall be between 450 mm and 500 mm (see Figure C.74 and Figure C.75).

b) A backrest with a height of between 400 mm and 500 mm shall be provided.

c) Allowable stresses shall not be exceeded for materials used when a vertical or horizontal force of 113 kg (1,112 N) is applied at any point on the seat, fastener, mounting device or supporting structure.

d) A side interaction space shall be provided on at least one side, as shown in Figure C.74 and Figure C.75. The space shall not encroach on the accessible route.

e) A mixture of seating options (e.g. fixed or removable, with or without arms, wider seats) should be provided for customers or visitors to a building.

f) It is recommended that furniture with standing support is provided, in combination with benches of varied height, to allow use by a diverse group of people. Where possible, seats of varied height and width should be provided for people of large stature or those with restricted leg movements.

g) Seating should contrast visually with the surrounding surfaces for ease of identification.

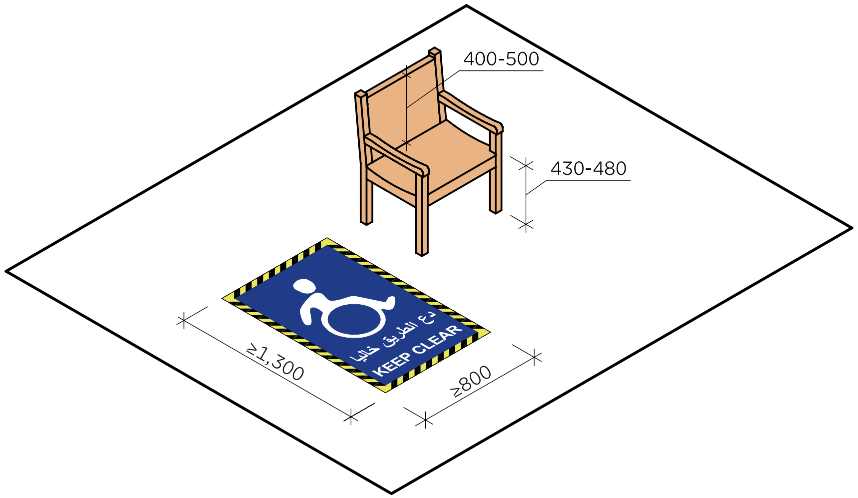


Figure C.74 Chair with side interaction area – with armrest

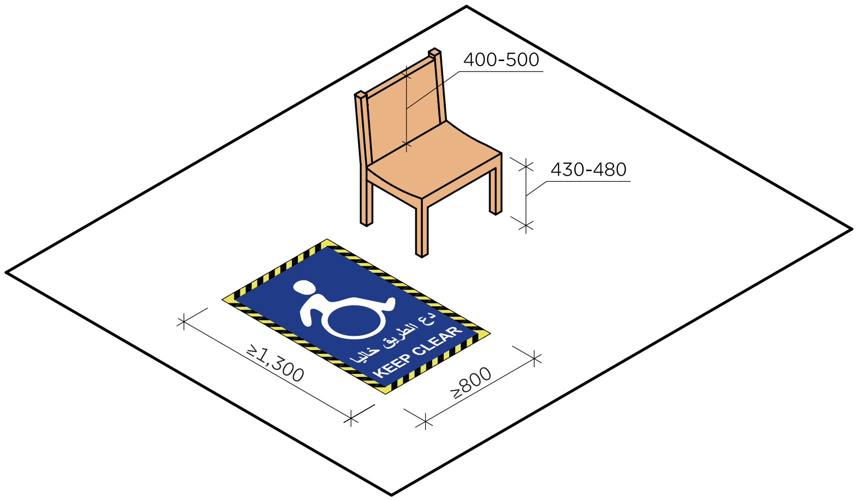


Figure C.75 Chair with side interaction area – without armrest

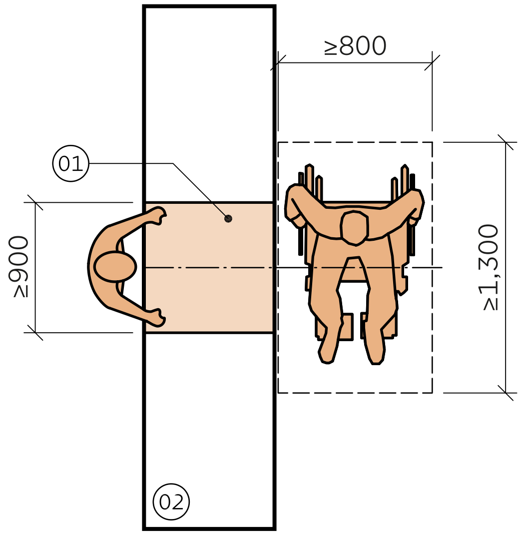
The following requirements and recommendations apply to seating, depending on the location where it is installed.

1) Where installed in wet locations, the surface of the seating shall be slip resistant and shall not accumulate water.
2) In urban spaces and parks, accessible benches or chairs should be provided every 100 m. In large buildings (such as shopping malls or airports) accessible benches or seats shall be provided every 50 m.
3) To assist users in transferring to seating, grab bars should be provided on the wall adjacent to seating where necessary. Grab bars should not be provided on the wall behind the seating. If provided, grab bars shall not obstruct transfer to the seating.

C.7.3.5 Counters and checkout aisles

The following requirements apply to checkout aisles, sales counters, service counters and food service.

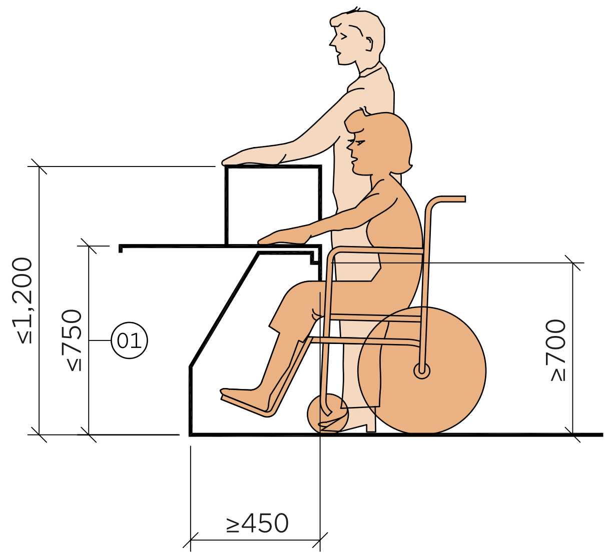
a) Where counters are provided, at least one of each type shall be accessible.
b) If the sales area exceeds 500 m^2, 20% of sales counters shall be accessible.
c) The accessible counter height shall not exceed 850 mm for a minimum width of 900 mm. The counter shall allow for a frontal or side interaction space as required (see Figure C.76).
d) Knee and toe clearance shall be provided to frontal interaction spaces.
e) Where counters or teller windows have security glazing to separate personnel from the public, a method to facilitate voice communication shall be provided.



Key
01: Counter area at ≤850 mm height
02: Counter

Figure C.76 Accessible counter interaction (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 904.4)

Counters should be capable of being staffed by a wheelchair user (see Figure C.77).



Key
01: Accessible counter height

Figure C.77 Accessible counters for staff in a wheelchair (© British Standards Institute. Figure extracted from BS 8300:2018. Permission to reproduce extracts from British Standards is granted by BSI Standards Limited (BSI). No other use of this material is permitted).

C.7.4 Reception and waiting areas

Reception desks should be located so that they are easily identifiable from a building entrance by visually impaired people. Noise levels should be taken into account when setting appropriate locations for reception areas (see Part H).

In addition to the requirements of C.5 and C.7.3, the following requirements and recommendations apply to reception and waiting areas.

a) In high traffic reception and waiting areas and where queues are expected, the reception space should be planned for wheelchair users to manoeuvre, move in both directions, and pass other persons in line if needed.

b) Reception desks shall feature interaction spaces with the dimensions shown in Figure C.78.

c) Counters and waiting areas shall contain seating places and clear spaces to accommodate wheelchairs, scooters or strollers.

d) Access to seating in general waiting areas should be direct and unobstructed.

e) Seating layouts should allow the option of two wheelchair users sitting next to each other, or a wheelchair user sitting next to a user of standard seating as a wheelchair user's companion (see Figure C.79).

f) In seating areas where public address systems are installed, appropriate acoustical treatment should be provided through space materials and ceilings.

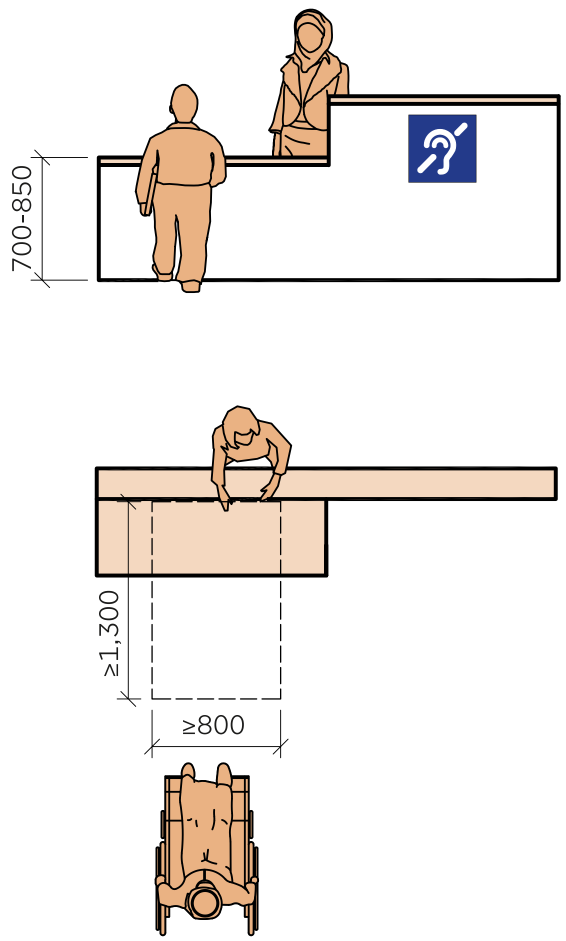


Figure C.78 Reception desk approach space

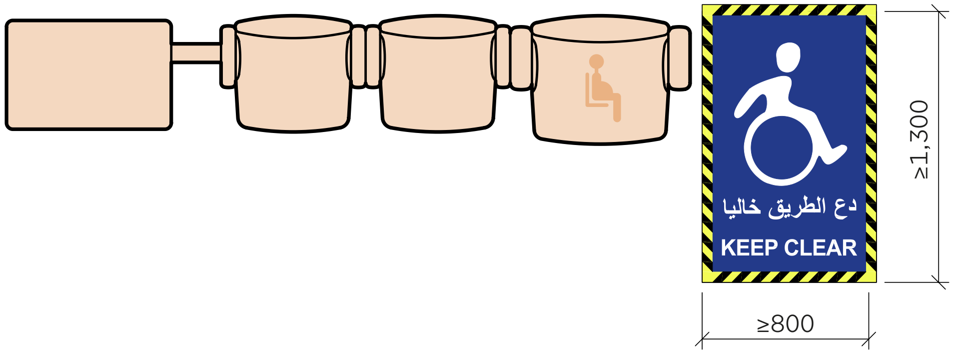


Figure C.79 Seating zone

The guidance given in BS 8300 for the provision of accessible reception areas, waiting areas and counter work surfaces should be followed.

C.7.5 Balconies

Terraces, verandas and balconies linked to accessible rooms, spaces and facilities shall be accessible to all people and shall conform to the following requirements.

a) Balcony doors shall conform to C.5.8.
b) The balcony exterior and interior levels shall be the same.
c) The minimum area of an accessible balcony shall be 1,500 mm × 1,500 mm (see Figure C.80).
d) Walking surfaces shall conform to C.7.2.1.

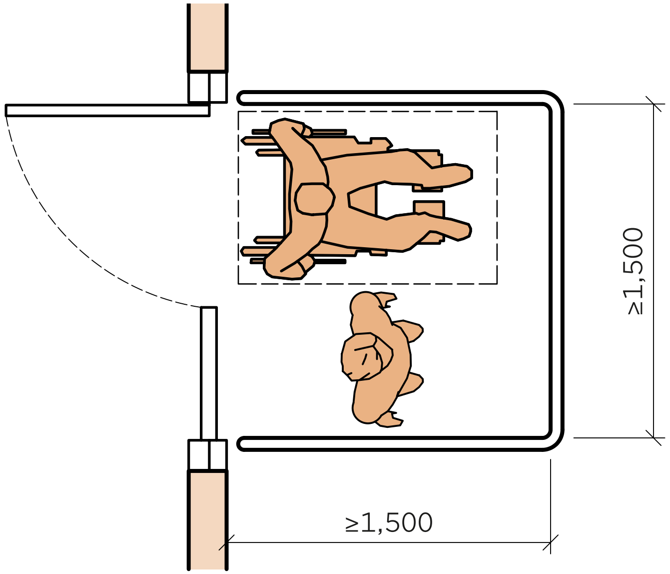


Figure C.80 Accessible balcony dimensions (© British Standards Institute. Figure extracted from BS 8300:2018. Permission to reproduce extracts from British Standards is granted by BSI Standards Limited (BSI). No other use of this material is permitted).

C.7.6 Accessible dressing or change rooms

In addition to the requirements of C.5, dressing and changing rooms shall conform to the following requirements.

a) Storage lockers shall conform to C.7.3.2.
b) The approaching space for lockers, benches and furniture shall have a minimum passageway width of 800 mm and shall connect to the accessible route.
c) If showers are provided, a minimum of one in every ten and a minimum of one in each location shall be accessible showers as described in C.8.
d) If toilets are provided, a minimum of one in every ten and a minimum of one in each location shall be accessible toilets as described in C.8.
e) Benches shall be provided with back support or shall be fixed to a wall. Back support shall be a minimum of 1,050 mm long and a minimum height of 450 mm above the seat surface.

It is preferable to provide changing places with combined toilet and shower facilities (see BS 8300).

C.7.7 First aid facilities

Any first aid facility shall conform to C.5. Signage indicating the facility's availability shall be provided.

Manoeuvring clearances shall be provided inside the first aid facility.

The first aid facility shall contain a changing table usable by adults.

If the first aid facility is equipped with a sink, this shall conform to C.8.3.6.

C.7.8 Kiosks

Accessible kiosks shall conform to the following requirements.

a) A customer counter, with a frontal or side interaction space which links to an accessible route, shall be provided.
b) The kiosk shall be equipped with a hearing enhancement system and a sign indicating such.
c) All controls shall be located at a height of between 900 mm and 1,200 mm.
d) All information shall be provided in audio and visual formats.
e) Information shall have visual contrast and be a minimum size of 14 pt.

Figure C.81 illustrates an example of accessible kiosk.

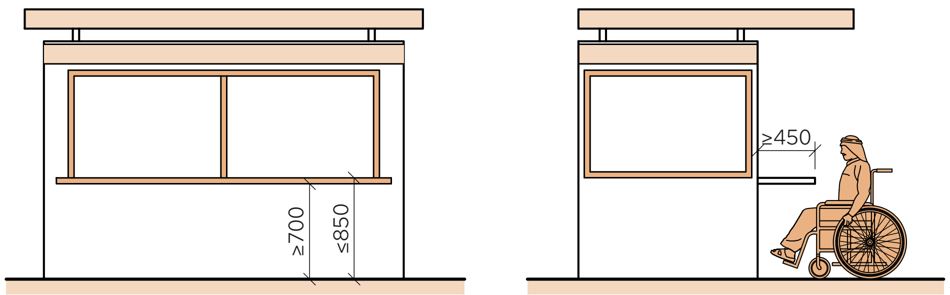


Figure C.81 Example of an accessible kiosk

C.8 Accessible sanitary

C.8.1 Minimum requirements

Buildings, public facilities and public spaces shall be provided with accessible toilet facilities. The minimum number of accessible toilets shall be in accordance with Table C.20.

<table>
<tr><th>Use of the building or area</th><th colspan="2">Minimum number of accessible toilet facilities</th></tr>
<tr><td>Public buildings</td><td>One wheelchair accessible toilet facility within 150 m of any part of the building or between toilets.</td><td rowspan="2">One wheelchair accessible toilet facility for each gender on every floor and in every toilets group.
or
One independent detached accessible toilet for both genders on every floor and in every toilets group</td></tr>
<tr><td>Public spaces: gardens, parks, beaches and playgrounds</td><td>One wheelchair accessible toilet facility within 400 m of any part of the building or between toilets.</td></tr>
</table>

Table C.20 Number of accessible toilets

If only one toilet for each gender is provided, both shall be accessible.

Accessible sanitary fixtures shall be provided in accordance with Table C.21

Sanitary fixture	Minimum requirement
Water closet	Where provided, at least one in each toilet group and not less than 5% of the overall number of water closets shall be wheelchair accessible (see C.8.3.4). Additional (optional) provision: Ambulatory toilet stalls
Urinals	At least one urinal in each urinal group shall be accessible (see C.8.3.5).
Sinks	At least one sink in each sink group shall be accessible (see C.8.3.6).
Bathing facilities (showers and bathtubs)	At least one accessible shower or accessible bathtub shall be provided in each bathing area (see C.8.3.8 or C.8.3.9).

Table C.21 Sanitary facility requirement

Where the gross area (GA) of a building exceeds 2,000 m^2 and the intended building users include children, 10% of sanitary fixtures provided shall be suitable for children below the age of ten. At least one toilet for children shall be provided in both male and female toilet facilities.

C.8.2 Toilet rooms doors

The following requirements and recommendations apply to toilet room doors.

a) Accessible toilet doors shall have a minimum clear width of 815 mm and conform to C.5.8.

b) Doors should open outwards or be sliding doors. For a door opening inwards, the clearances specified in C.5.8.3 shall be met.

c) Toilet doors shall not swing into the minimum required toilet area.

d) A horizontal grab bar shall be provided in accordance with Figure C.82.

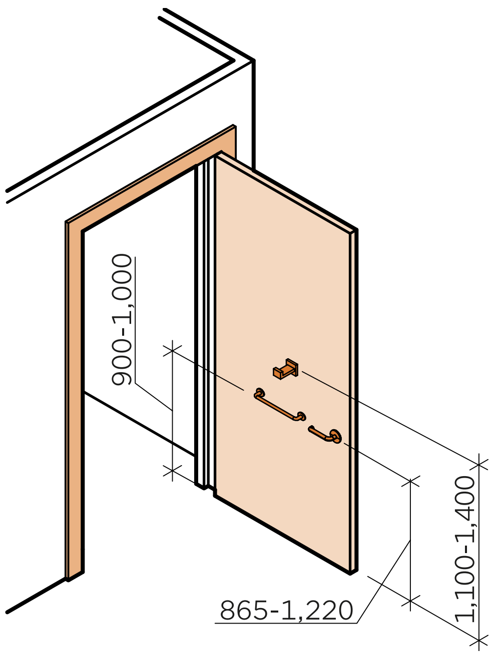


Figure C.82 Toilet door accessories position and mounting heights

Every toilet stall door shall be provided with a latch and a coat hanger in accordance with Figure C.83 and Figure C.84. The latch shall be operable with the elbow or with a closed fist.

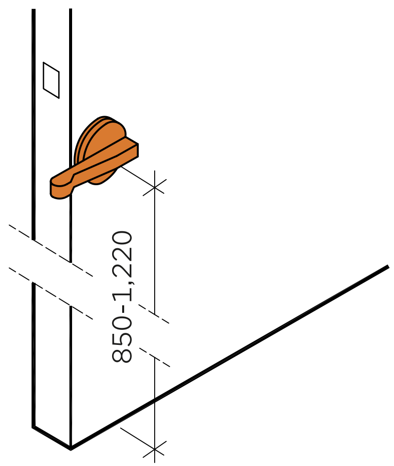


Figure C.83 Cabin latch example

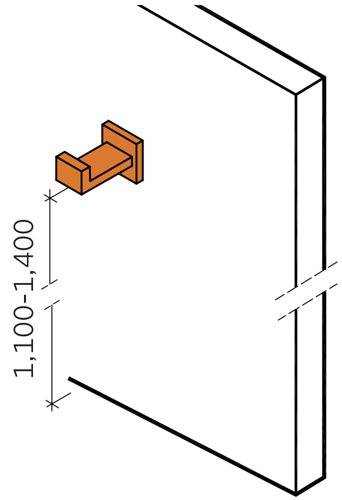
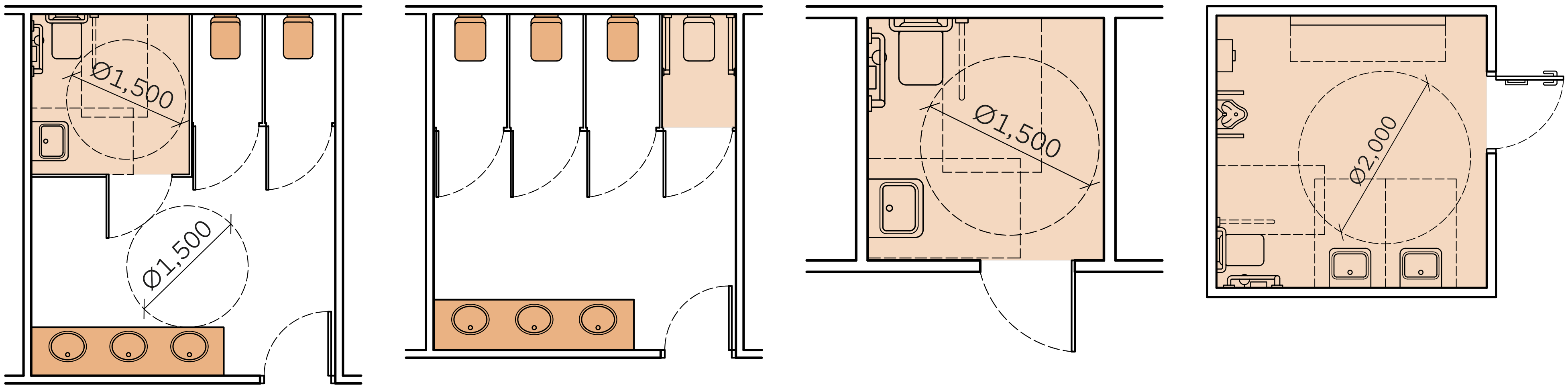


Figure C.84 Coat hanger

C.8.3 Accessible toilet arrangements

C.8.3.1 General

Wheelchair accessible toilet stalls can be provided as part of blocks of toilet facilities or separately. Family toilets (see C.8.4) should be located outside blocks of toilet facilities. Types of toilet stall arrangement are illustrated in Figure C.85.



(a) Wheelchair accessible toilet stall within a toilet block.
It is recommended that a separate accessible sink is provided inside the accessible toilet stall.

(b) Ambulant toilet stall within a toilet block that can be used by people with ambulant disabilities and non wheelchair uses.

(c) Detached wheelchair accessible toilet that can be used by both genders if needed.

(d) Family toilet.

Figure C.85 Types of toilet stall arrangements

Minimum dimensions for accessible toilets shall be in accordance with Table C.22.

Circulation spaces	Dimension or provision
Corridor widths in toilets, showers, lockers spaces, etc.	1,050 mm
Manoeuvring space diameter	1,500 mm
Accessible toilets and cubicles	
Diameter of manoeuvring space free of obstacles from 0 mm to 700 mm height of FFL	1,500 mm
Side interaction space	Minimum of one on either the left or right side of the water closet, and beside the shower where one is provided.

Table C.22 Minimum dimensional parameters for accessible toilets

C.8.3.2 Baby changing stations

Baby changing stations conforming to the following requirements shall be provided.

a) Both male and female toilet facilities shall include at least one baby changing table, clearly identified with English and Arabic text. The maximum distance between baby changing stations in a building shall be 150 m.

b) The changing station shall not encroach on the minimum manoeuvring requirements in Table C.22.

c) Where a baby changing station is provided inside an accessible toilet, it shall not encroach on the 1,500 mm minimum required clear manoeuvring space.

C.8.3.3 Approach and toe clearance

A minimum clear space of 1,050 mm shall be provided in front of wheelchair accessible toilet stall doors, as shown in Figure C.86.

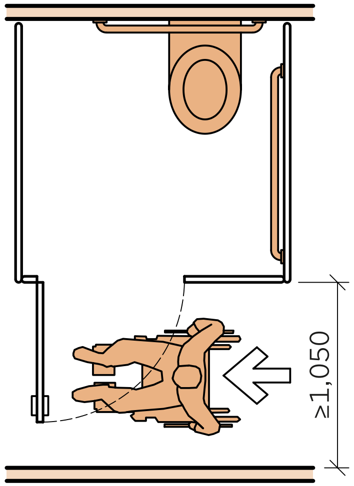


Figure C.86 Minimum clearance for accessing accessible toilet stall (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 604.8.1.2)

Toilet stalls shall be arranged for a left-hand or right-hand approach to the water closet, or for dual transfer.

Toe clearance is not required if the toilet stall dimensions are greater than 1,650 mm × 1,650 mm.

When the toilet clear space is less than 1,650 mm × 1,650 mm a minimum toe clearance of 250 mm in height shall be provided above the finish floor and a minimum 150 mm deep to the front partition and at least one side partition beyond the toilet stall-side face of the partition, exclusive of partition support members (see Figure C.87).

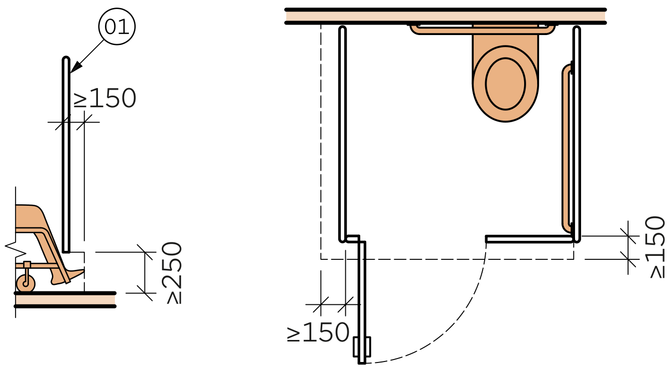


Figure C.87 Toe clearance (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 604.8.1.4)

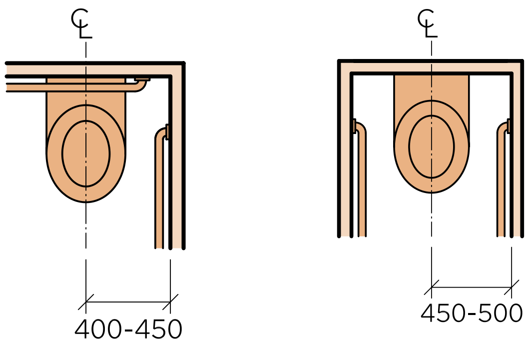
Key
01: Partition

C.8.3.4 Water closets

C.8.3.4.1 Position and arrangement of toilets

Depending on the type of water closet, the centre line of the toilet shall be positioned relative to the side wall or partition in accordance with Figure C.88.

Water closets shall be arranged for a left-hand or right-hand approach, or for dual transfer.



(a) Wheelchair accessible water closet

(b) Ambulatory accessible water closet

Figure C.88 Water closet location (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 604.2)

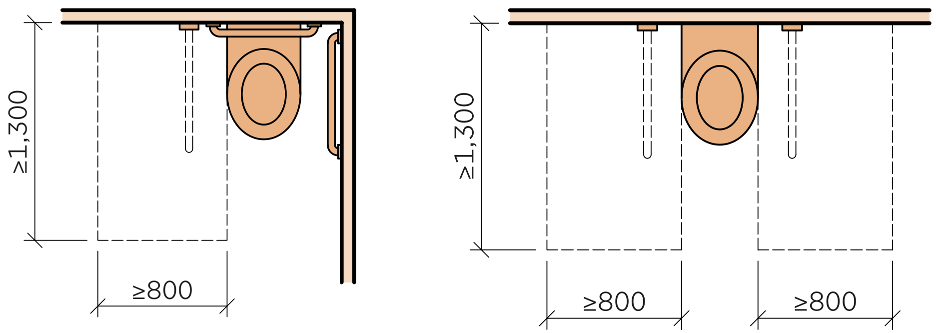
The seat height, measured from FFL to the top of the seat, shall be a minimum of 450 mm and a maximum of 500 mm. Seats shall not be sprung to return to a lifted position.

The flush controls shall be mounted on the transfer side of the toilet. The flush controls shall be hand operated or electronically controlled. Flush controls requiring hand operation shall be lever type.

C.8.3.4.2 Wheelchair accessible water closets

Wheelchair accessible water closets shall have a minimum clear interaction space measuring 800 mm perpendicular from the water closet edge, and 1,300 mm perpendicular from the rear wall [Figure C.89(a)].

Two side transfer water closets can also be used, provided an interaction space of 1,300 mm × 800 mm is provided on both sides of the water closet [Figure C.89(b)].



(a) Single side transfer (b) Double side transfer

Figure C.89 Clearance for water closets

C.8.3.4.3 Grab bars for water closets

Grab bars shall conform to the general requirements of C.8.3.9.

For the provision of grab bars, either a single-sided transfer approach or a double-sided transfer approach shall be used.

The following requirements and recommendations apply to single-sided transfer.

a) The minimum dimensions for toilets with single-sided transfer shall be in accordance with Figure C.90.

b) Transfer horizontal grab bars shall be provided on both the back side of the water closet and wall side, and shall:
   1) have a support length of 750 mm to 900 mm; and
   2) be mounted at a height of 700 mm to 850 mm.

c) The side wall grab bar shall have a maximum distance of 300 mm from the rear wall and shall extend 300 mm minimum in front of the water closet

d) An additional foldable horizontal bar should be provided, mounted at 400 mm to 450 mm from the water closet centre line, with a minimum length of 750 mm to 900 mm, and mounted between 700 mm and 850 mm from floor level. When a foldable horizontal bar is provided, the length of grab bar at the back of water closet can be reduced to 600 mm.

e) A vertical bar on the side wall shall be provided with a support length of 600 mm located at a minimum height of 800 mm from the floor as shown in Figure C.91. The vertical grab bar shall be positioned at a maximum distance of 300 mm in front of the toilet.

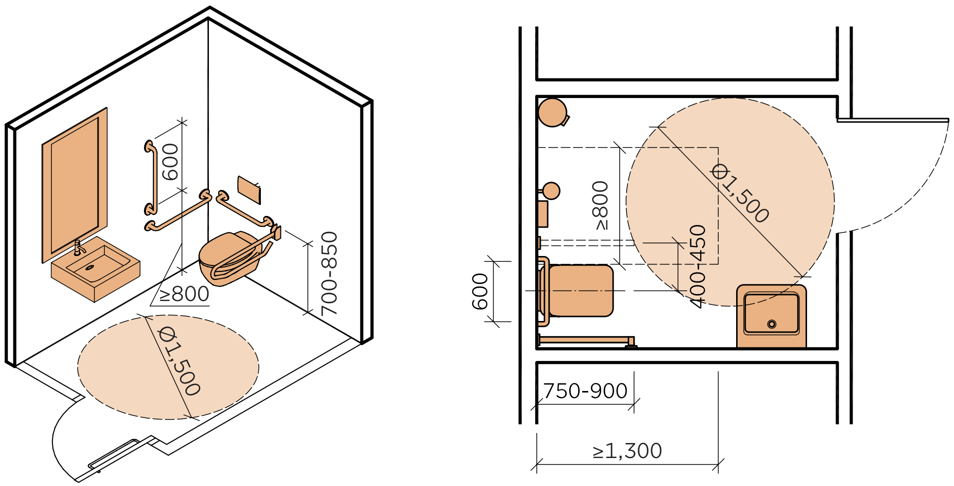


Figure C.90 Minimal dimensions for toilets with single-sided transfer

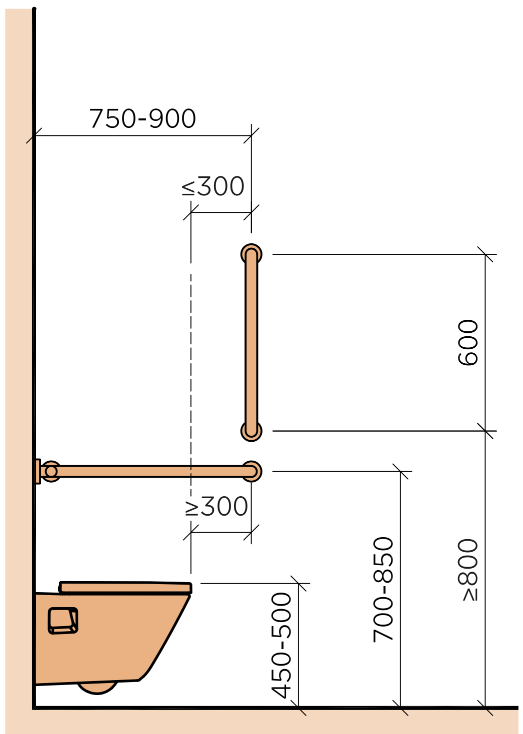


Figure C.91 Fixed bar positions for single-sided and double-sided transfer

The following requirements and recommendations apply to double-sided transfer.

a) The minimum dimensions for toilets with double-sided transfer shall be in accordance with Figure C.92.

b) Transfer horizontal grab bars shall be provided on both sides of the water closet and shall:

   1) have a support length of 750 mm to 900 mm; and

   2) be mounted at a height between 700 mm to 850 mm.

c) The distance between the transfer grab bars installed on both sides of the water closet shall be between 650 mm and 700 mm.

d) The vertical bars on the back wall shall be provided with the same dimension as single-sided transfer.

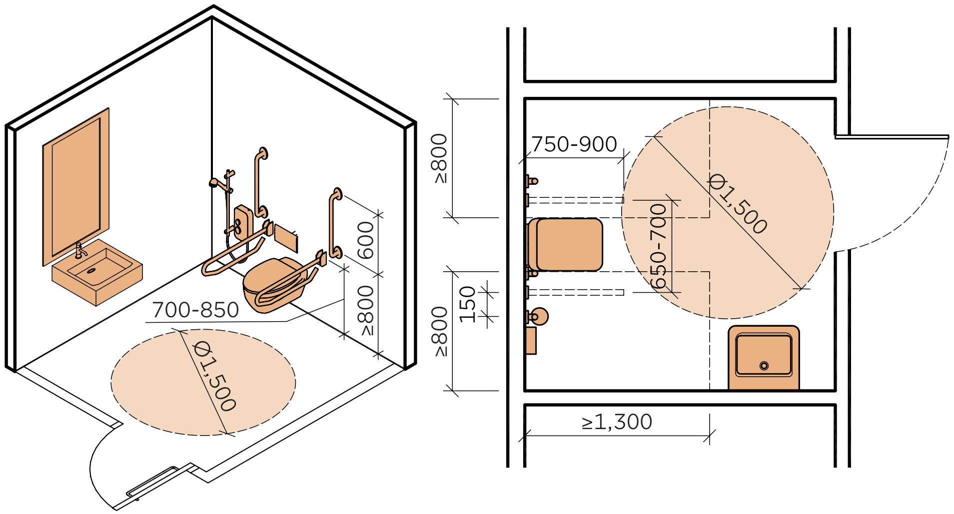


Figure C.92 Minimal dimensions for toilets with double-sided transfer

C.8.3.4.4 Children's water closets

Water closets for children's use shall conform to the ranges given in Table C.23.

Age ranges (years)	Water closet centre line (mm)	Toilet seat height (mm)	Grab bar height (mm)
3 to 4	300	280 to 300	450 to 500
5 to 8	300 to 380	300 to 380	500 to 630
9 to 12	380 to 450	380 to 430	630 to 680

Table C.23 Dimensions for children's water closets

C.8.3.5 Urinals

Stall type urinals reaching the floor and designed for all male heights are preferred.

Accessible urinals shall conform to the following requirements.

a) The bottom lip shall have a maximum height of 400 mm to allow for use by wheelchair users and children.
b) Urinals shall be a minimum of 350 mm deep, measured from the outer face of the urinal rim to the back of the fixture.
c) Urinal shall have a minimum clear interaction space in front of 800 mm × 1,300 mm.
d) The urinal flush controls shall be positioned at a maximum height of 1,200 mm.
e) Where privacy screens are provided there shall be a clearance of 900 mm between these.

Grab bars shall be provided on both sides of the urinal, a maximum of 380 mm from the centre line, as shown in Figure C.93. They shall be mounted vertically, with the lower edge at a maximum height of 600 mm, and have a minimum length of 600 mm. The grab bars shall conform to C.8.3.9.

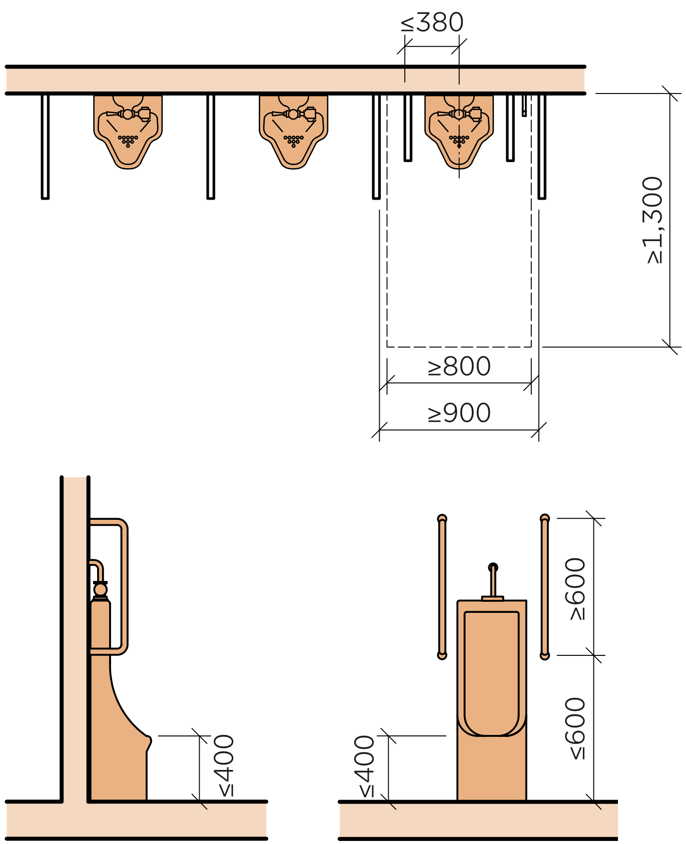


Figure C.93 Urinal dimensions and grab bars

C.8.3.6 Sinks and washbasins

The following requirements and recommendations apply to sinks.

a) A minimum clear knee space 700 mm high and 250 mm deep shall be provided beneath sinks, measured from the faucet to the edge. The usable surface height shall be between 800 mm and 850 mm (see Figure C.94).

b) A minimum clear interaction space of 800 mm × 1,300 mm shall be provided in front of the sink space (see Figure C.94).

c) The minimum distance between the centre line of the sink and the side wall shall be 450 mm (see Figure C.94).

d) For children's use, the usable surface height for a sink shall be 500 mm.

e) Faucets shall be operated by pressure with a lever handle or with a sensor. Turning or pressure systems that require significant effort to be operated shall not be used.

f) The distance from the sink edge to the faucet shall be less than 600 mm.

g) Vertical grab bars shall be provided at each side of the sink in standalone accessible toilets, with a distance between 600 mm and 700 mm from both sides of the sink (see Figure C.94). The provision of sink grab bars for other accessible toilets is recommended.

h) A minimum of one soap dispenser, paper towels/hand dryer shall be located not more than 600 mm from the accessible sink.

i) The pipes under the sink should be recessed or kept away from the required clearance specified in item a). Water supply and drainpipes under washbasins and sinks shall be insulated or otherwise configured to protect against contact.

j) There shall be no sharp or abrasive surfaces beneath washbasins and sinks.

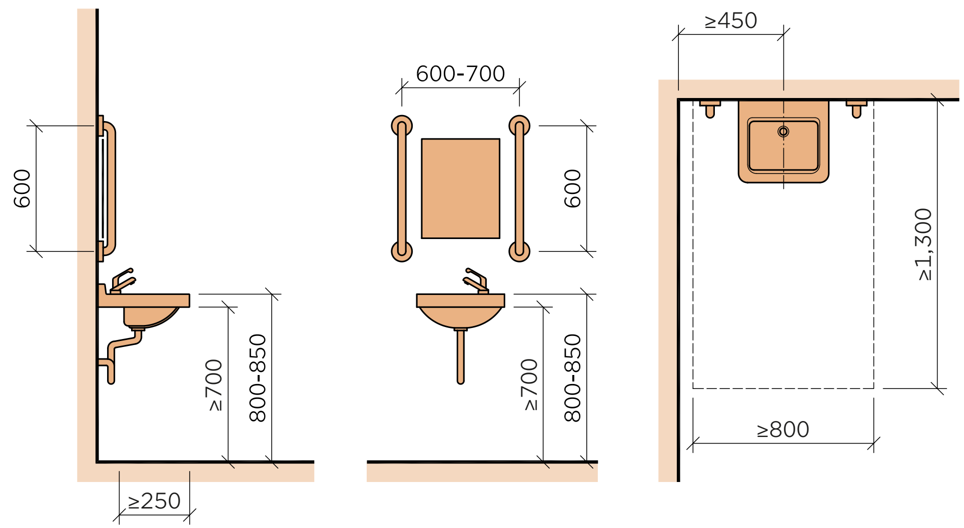


Figure C.94 Dimensions for sinks

C.8.3.7 Showers

C.8.3.7.1 Accessible showers

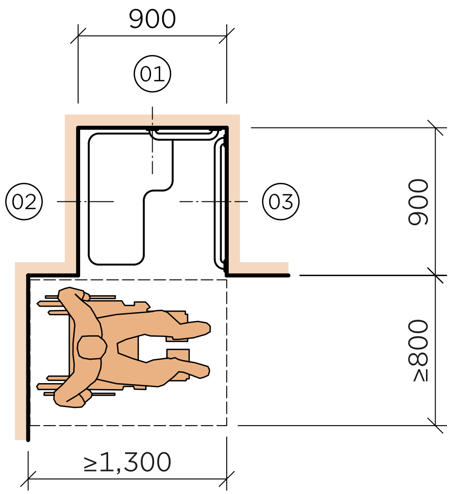
The following requirements and recommendation apply to showers.

a) The shower floor surface shall be flush with the level of the surrounding area. The maximum slope for water drainage is 4%. Level changes in showers shall be limited to 5 mm from the surrounding FFL or bevelled to a maximum height of 13 mm.

b) Controls should be located within 500 mm of the seat and placed according to the reach ranges specified in C.5.7.

C.8.3.7.2 Transfer type shower compartments

Transfer type showers shall have a clear area of 900 mm × 900 mm. An interaction space shall be provided adjacent to the transfer shower (see Figure C.95).

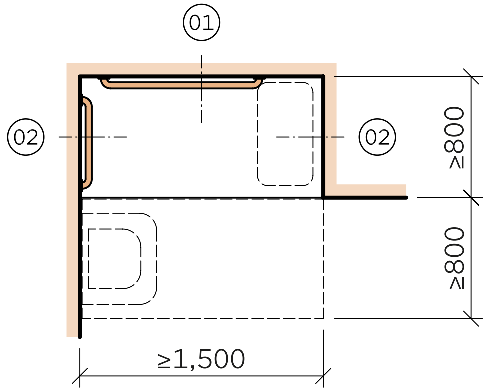


Key
01: Back wall
02: Seat wall
03: Control wall

Figure C.95 Transfer type showers (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 608.2.1)

C.8.3.7.3 Roll-in type shower compartment

Roll-in type showers shall have a minimum area of 800 mm × 1,500 mm (see Figure C.96).



Key
01: Back wall
02: Side wall

Figure C.96 Roll-in type showers (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 608.2.2)

C.8.3.7.4 Shower seats

Shower seats shall be provided for transfer type showers and are recommended for roll-in type showers.

When shower seats are provided, they shall have a minimum area of 400 mm × 400 mm.

A shower seat shall be located at a height between 450 mm and 500 mm from the floor and be separated from the wall by 150 mm to 200 mm.

The seat shall be free of sharp edges.

Adjustable height seats are preferred, especially in hotels and residences. Alternative systems such as bath chairs with the same features can be provided.

C.8.3.7.5 Grab bars for showers

Grab bars shall conform to the general requirements of C.8.3.9 and the dimensions in Figure C.97.

Accessible showers shall have horizontal grab bars on both the back wall and a minimum of one side wall to assist in transferring.

The horizontal grab bars shall:

a) have a length of 750 mm to 900 mm;

b) be mounted at a height of 700 mm to 850 mm from the floor level; and

c) be installed on both back and side walls.

A vertical grab bar shall also be provided for support.

The vertical bar shall have a length of 750 mm to 900 mm and shall be installed in the side wall at a height of 800 mm.

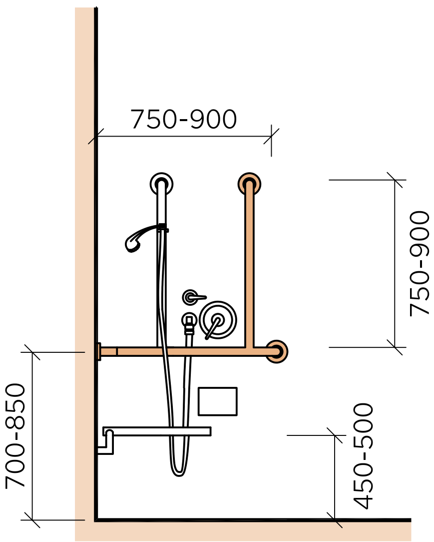


Figure C.97 Grab bars for showers

C.8.3.8 Bathtubs

C.8.3.8.1 Position and clearances

Clearances in front of bathtubs shall be as shown in Figure C.98 and shall extend the length of the bathtub. A sink may be provided at the control end of the clearance. Where a permanent seat is provided at the head end of the bathtub, the clearance shall extend a minimum of 300 mm beyond the wall at the head end of the bathtub (see Figure C.98).

A permanent seat at the head end of the bathtub, or a removable in-tub seat, shall be provided.

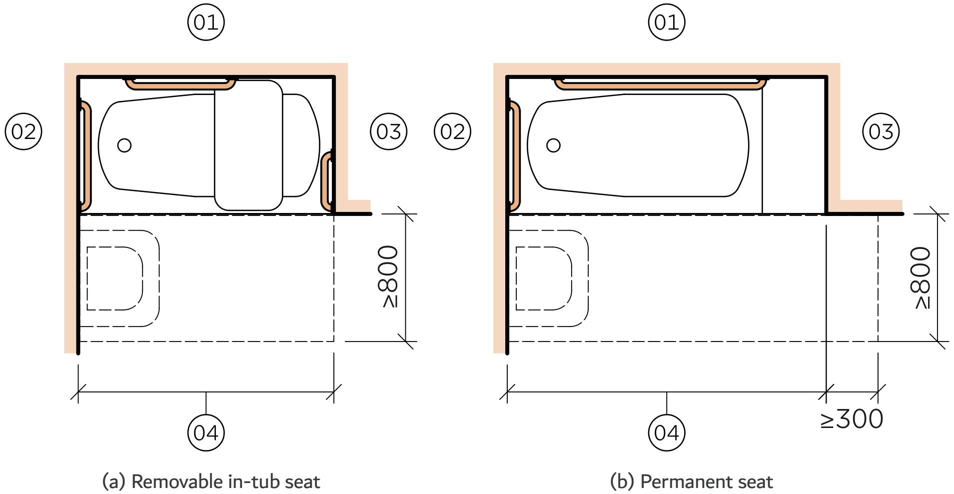


Figure C.98 Grab bars for bathtub (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 607.2)

Key

01: Back wall

02: Control end wall

03: Head end wall

04: Length of bathtub

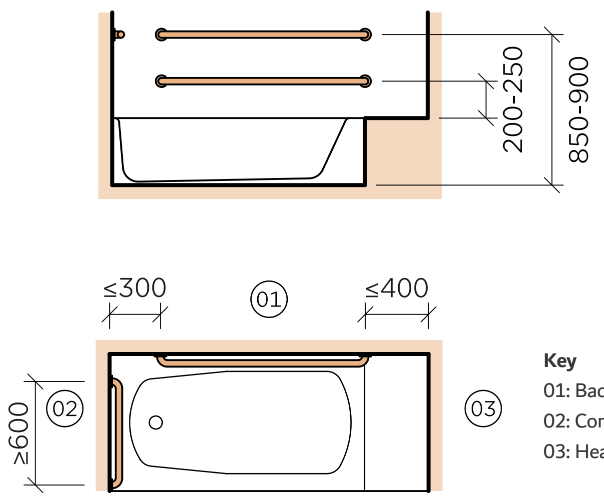
C.8.3.8.2 Grab bars for bathtubs with permanent seats

In addition to the general grab bar requirements of C.8.3.9, grab bars for bathtubs with permanent seats shall conform to the following requirements.

a) Two grab bars shall be installed on the back wall, one located at 850 mm to 900 mm from the floor and the other located a minimum of 200 mm and a maximum of 250 mm above the rim of the bathtub (see Figure C.99).

b) Each grab bar shall be installed a maximum of 400 mm from the head end wall and a maximum 300 mm from the control end wall (see Figure C.99).

c) A grab bar of a minimum 600 mm in length shall be installed on the control end wall at the front edge of the bathtub (see Figure C.99).



Key
01: Back wall
02: Control end wall
03: Head end wall

Figure C.99 Grab bars for bathtubs with permanent seats (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 607.4.1)

C.8.3.8.3 Grab bars for bathtubs without permanent seats

In addition to the general grab bar requirements of C.8.3.9, grab bars for bathtubs without permanent seats shall conform to the following requirements.

a) Two grab bars shall be installed on the back wall, one located 850 mm to 900 mm from the floor and the other located a minimum of 200 mm and maximum of 250 mm above the rim of the bathtub (see Figure C.100).

b) Each grab bar shall be a minimum 600 mm in length and shall be installed not more than 600 mm from the head end wall and not more than 300 mm from the control end wall (see Figure C.100).

c) A grab bar of a minimum length of 600 mm shall be installed on the control end wall at the front edge of the bathtub (see Figure C.100).

d) A grab bar of a minimum length of 300 mm shall be installed on the head end wall at the front edge of the bathtub (see Figure C.100).

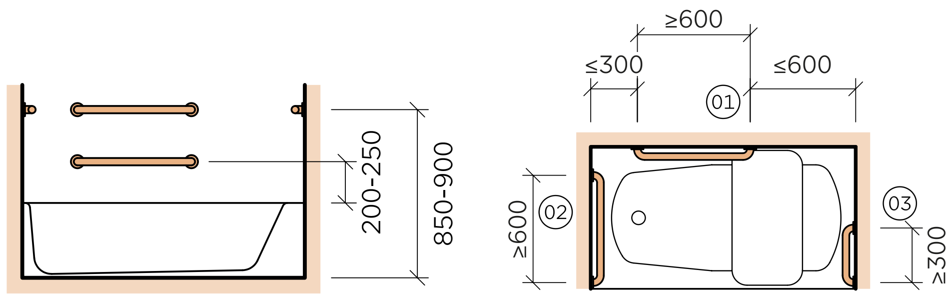


Figure C.100 Grab bars for bathtubs with removable seats (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 607.4.2)

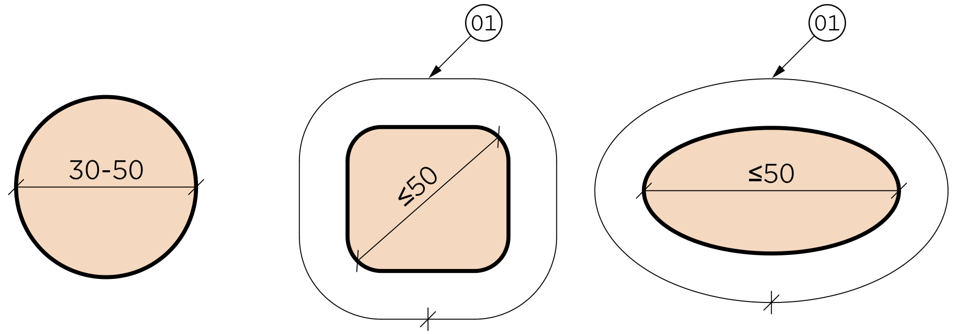
Key
01: Back wall
02: Control end wall
03: Head end wall

C.8.3.9 Grab bars

Grab bars shall conform to the following requirements.

a) Grab bars with circular cross-sections shall have an outside diameter of 30 mm minimum and 50 mm maximum, as shown in Figure C.101(a).

b) Grab bars with non-circular cross-sections shall have a maximum cross-section dimension of 50 mm and a perimeter dimension of 100 mm minimum and 160 mm maximum, as shown in Figure C.101(b) and Figure C.101(c).



(a) Grab bar with circular cross section

(b) Grab bar with non-circular (square) cross-section

(c) Grab bar with non-circular (oval) cross-section

Figure C.101 Grab bar cross-sections (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 609.2.2)

Key

01: 100 mm to 160 mm perimeter

Grab bars shall be structurally stable and separated from the wall by a minimum of 45 mm. They shall withstand a force of 1 kN in any direction.

C.8.4 Family toilets

It is recommended that one family toilet is provided for each block of toilets.
A minimum of one family toilet shall be provided within 300 m of any part of the building.

Family toilets shall be provided in malls, parks and amusement parks.

An accessible family toilet shall conform to the requirements specified for accessible toilets and the following (see Figure C.102).

a) It shall contain folding changing boards for adults and babies that do not interfere with any of the approaching manoeuvring and transfer spaces to the water closet and the sink. The board usable area shall be at a height of 500 mm from the floor.

b) It shall contain a second sink for children at a height of 500 mm from the floor.

c) A clear manoeuvring space of a minimum 2,000 mm diameter shall be provided that is free of obstacles.

d) In addition to the water closet, a urinal shall be provided with a usable height of 400 mm.

e) A full-length mirror shall be provided for ease of use by children.

f) An emergency call button shall be provided.

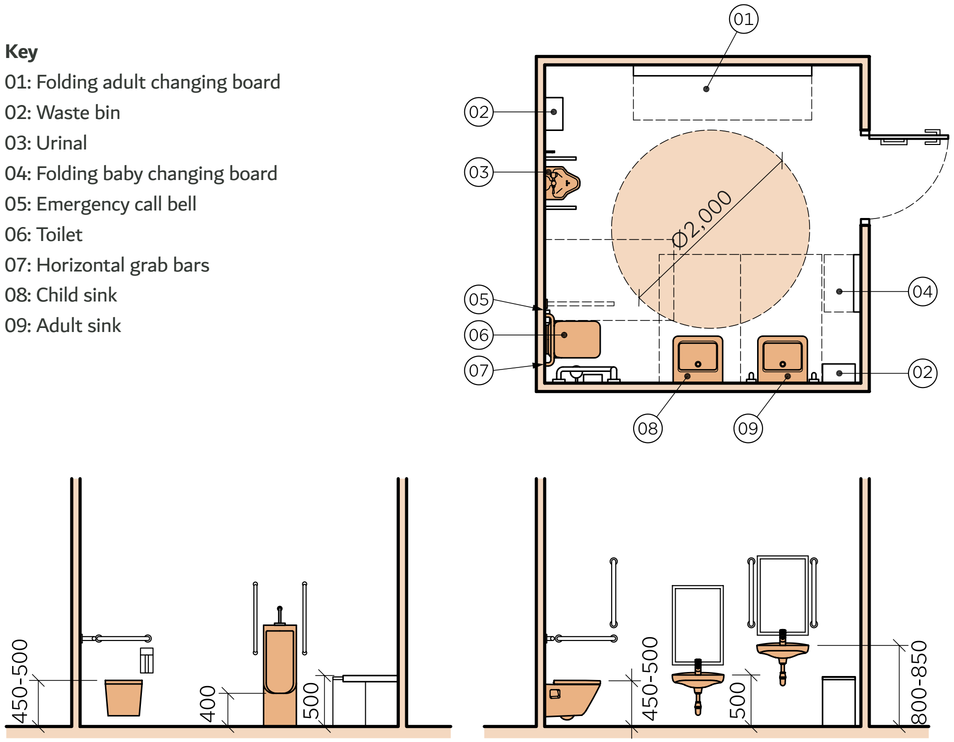


Figure C.102 Example of a family toilet

C.8.5 Controls and accessories

All controls and accessories shall conform to the following requirements.

a) Fixtures shall have a reflectance contrast with the walls of a minimum 30 points LRV.

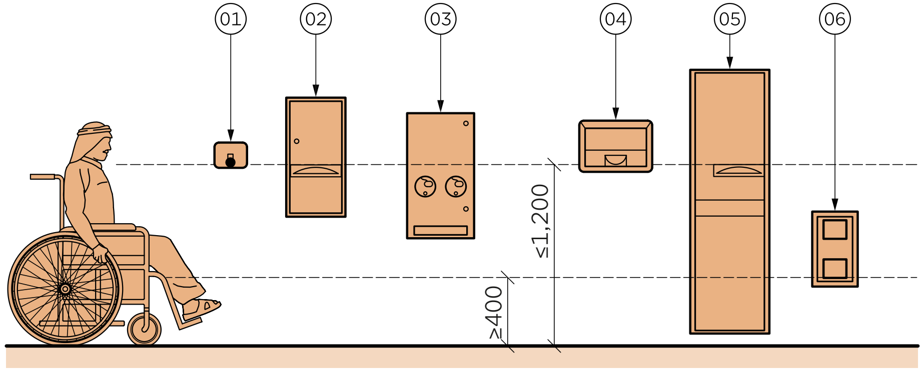
b) Flushing systems, which are operated by pressure or with a flush handle, shall be located on the open side of the toilet. Controls shall have a surface operable with only one hand, closed fist or elbow.

c) Controls and accessories shall be mounted at a height between 400 mm and 1,200 mm as shown in Figure C.103(a) and in accordance with the reach ranges specified in C.5.7.

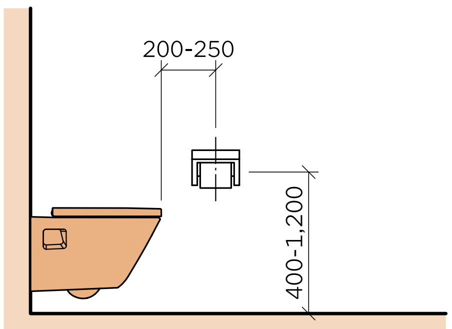
d) Dispensers located in toilet facilities for use by children shall align with the reach ranges of children specified in C.5.7.3.

e) Toilet paper dispensers shall be a minimum 200 mm and maximum 250 mm from the front of the water closet, measured to the centre line of the dispenser. The outlet of a dispenser shall be a minimum 400 mm and maximum 1,200 mm above the finish floor and shall not be located behind grab bars (see Figure C.103(b)). Dispensers shall not be of a type that controls delivery or that does not allow continuous paper flow.

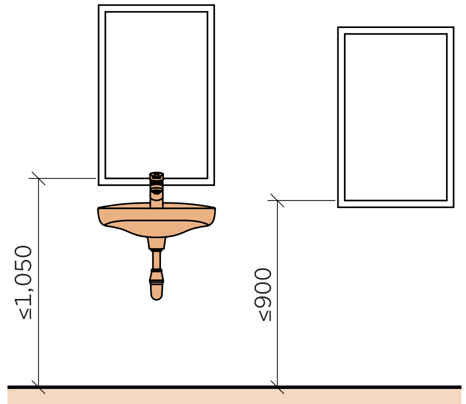
f) Mirrors located above washbasins or countertops shall be installed with the bottom edge of the reflecting surface a maximum 1,050 mm above the finish floor or ground. Mirrors not located above washbasins or countertops shall be installed with the bottom edge of the reflecting surface a maximum 900 mm above the finish floor or ground (see Figure C.103(c)).



(a) Controls and accessories



(b) Toilet dispensers



(c) Mirrors

Figure C.103 Mounting heights for restroom accessories

Key

01: Soap dispenser
02: Paper towel dispenser
03: Sanitary napkin dispenser
04: Hand dryer
05: Combined paper towel dispenser and waste bin
06: Toilet paper dispenser

C.8.6 Ablution areas

A minimum of one accessible ablution unit shall be available in each ablution area. Accessible ablution units shall be provided either as an accessible sink or through a clear approach to the ablution faucet.

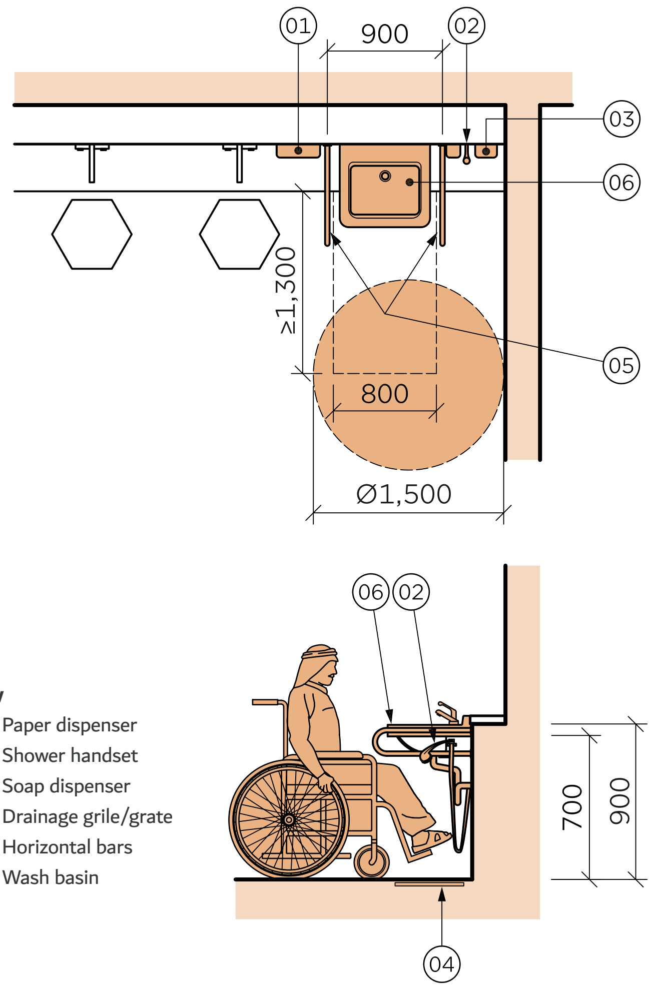
In addition to the dimensions and characteristics of the accessible sink specified in C.8.3.6, each ablution unit shall conform to Figure C.104 or Figure C.105 and the following requirements.

a) It shall be linked to an accessible route and shall be the closest sink to the entrance door.

b) Two horizontal grab bars shall be mounted each side of the ablution sink, between 850 mm and 900 mm above FFL. The grab bars shall have a support length equal to the length of the sink.

c) A hand spray system and soap and paper dispensers shall be mounted within reaching range of the sink. All accessories, including the bidet shower, should be mounted between 700 mm and 1,200 mm above FFL.

d) Ablution drainage grates shall be levelled with floor finish with a maximum level difference of 5mm.



Key

01: Paper dispenser
02: Shower handset
03: Soap dispenser
04: Drainage grile/grate
05: Horizontal bars
06: Wash basin

Figure C.104 Accessible ablution sink

For a level approach to an ablution unit, a wall-mounted grab bar between 850 mm and 1,050 mm above FFL is preferable, as shown in Figure C.105. An approaching free space of 1,300 mm length shall be provided.

Key
01: Wall mounted grab bar
02: Stainless steel grating

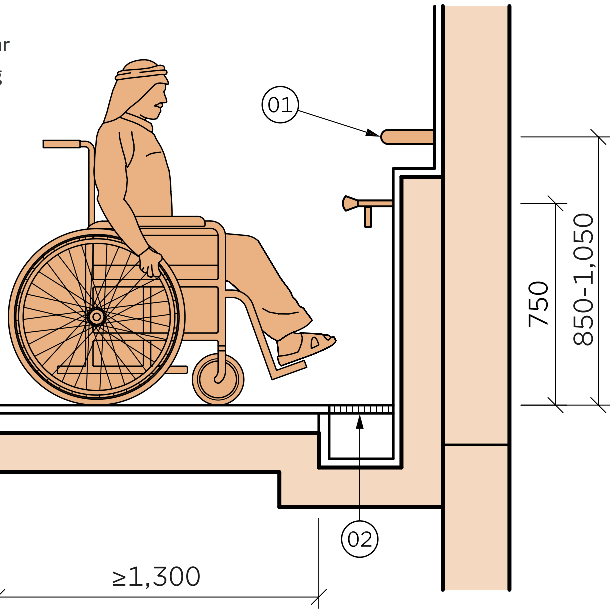


Figure C.105 Level approach to ablution faucet

C.8.7 Drinking fountains

For drinking fountains in urban spaces and buildings the following and Figure C.106 apply.

a) Two fountains with different heights shall be provided: one between 750 mm and 1,200 mm above the ground or FFL and an accessible fountain between 750 mm and 900 mm above the ground or FFL.

b) Drinking fountains shall allow a frontal approach and provide the knee and toe clearance specified in C.5.6.2.

c) If the push button is manual, it shall be an accessible mechanism that is easy to operate. It shall be positioned between 700 mm and 1,200 mm above FFL or ground level.

d) Water shall be attainable at a height of between 750 mm and 900 mm above FFL, and near to the approaching space (see Figure C.106). The design should prevent the user from getting wet during use.

e) The spout shall be located a minimum 400 mm from the back vertical support and a maximum 125 mm from the front edge of the fountain unit, including bumpers.

f) Drinking fountains should be provided with bottle fillers.

g) Where possible, drinking fountains should be located in an alcove to avoid a protrusion hazard.

h) Drinking fountains should be installed against a visually contrasting background to increase their visibility.

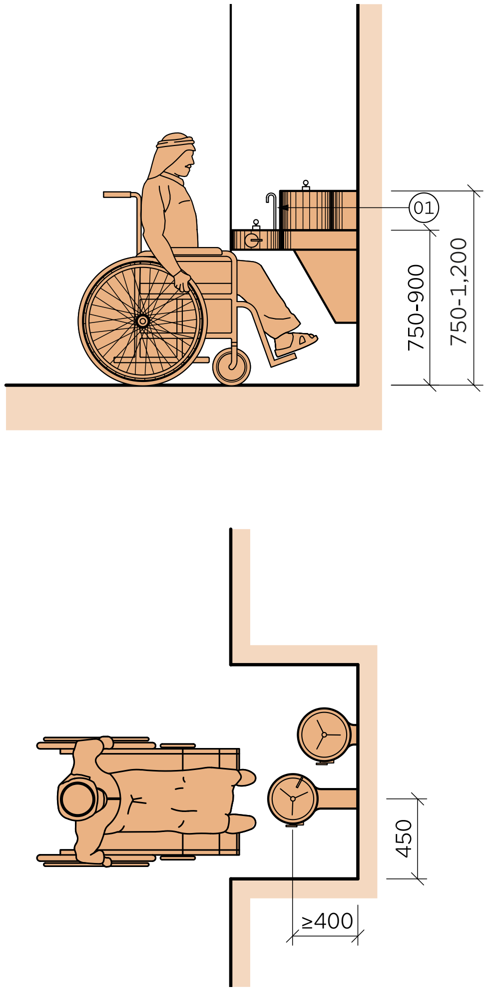


Figure C.106 Drinking fountain dimensions

Key
01: Bottle filler

C.9 Accessibility features in buildings

C.9.1 Hearing enhancement systems

Hearing enhancement systems that operate using induction loops, infrared or radio frequency are commonly used to provide enhanced levels of sound. They enable sound signals to be transmitted to persons using hearing aids without interference from background noise or excessive reverberation levels.

A hearing enhancement system shall be provided in the following building types and occupancies:

a) public use reception areas;
b) meeting rooms and waiting areas for more than 25 people;
c) auditoriums;
d) accessible service counters;
e) theatres;
f) mosques;
g) cinemas; and
h) concert halls.

Expert advice should be sought when selecting a hearing enhancement system appropriate for the situation and purpose.

The guidance on the provision of hearing enhancement systems given in BS 8300 should be followed.

Hearing enhancement systems are compatible with language translation systems. A sign should be posted indicating that an enhancement system is available. Where a hearing enhancement system is provided, the accessibility symbol for hearing impairment shall be provided.

To aid the effectiveness of a hearing enhancement system, rooms shall be designed with sound absorbing surfaces to reduce the transference of noise (see Part H).

Assistive listening receivers for a hearing enhancement system shall be provided in accordance with Table C.24. For induction loop systems, it is not mandatory to provide hearing aid compatible receivers.

Number of occupants	Minimum number of receivers	Minimum number of receivers to be hearing aid compatible
50 or less	2	2
51 to 500	2 plus 1 per 25 over 50	1 per 4 receivers
501 to 1,000	20 plus 1 per 50 over 500	1 per 4 receivers
1,001 and above	40 plus 1 per 100 over 1,000	1 per 4 receivers

Table C.24 Minimum number of receivers

C.9.2 Provisions for service animals

In theatres, cinemas, conference rooms, auditoriums and facilities where people are expected to sit or wait, some seats should have a space for a service animal near their owner.

In large buildings, such as shopping malls, leisure or entertainment facilities, and mass transport facilities, it is recommended that a relief facility is provided for assistance animals.

The following requirements and recommendations apply to the design of relief facilities.

a) They shall not connect directly to spaces used by persons but shall be connected to an accessible route.
b) They should have a minimum area of 3,000 mm × 4,000 mm and be surrounded by a 1,200 mm high fence. The entrance should be easy to find and operate by a visually impaired person. The surface should be cleanable, with a smooth finish and a slope for drainage.
c) A waste bin and a supply of plastic bags should be provided close to the entrance.
d) Relief facilities should have an accessible sign stating, “For service animals only”.

C.10 Accessibility requirements for specific building types and occupancies

C.10.1 General

This section specifies requirements for specific building types and occupancies. The requirements of C.4 to C.9 and C.11 shall be met in addition to the requirements of C.10.

C.10.2 Assembly buildings and spaces

C.10.2.1 Cultural buildings, libraries, museums and exhibition rooms

The following requirements and recommendations apply to cultural buildings, libraries, museums and exhibition rooms.

a) Exhibitions should be designed to allow exploration, discovery and enjoyment of different sensorial experiences by different abled people. Different users perceive information using different senses. Lights, smells, sounds, colours and other multi-sensorial elements can be used to assist visitors.

b) Audio guides should be provided for exhibitions to explain, guide and assist the visitors. Induction loops shall be provided when acoustic information is provided.

c) Visual displays shall conform to C.11.5.

C.10.2.2 Theatres, cinemas, conference rooms and auditoriums

Theatres, cinemas, conference rooms and auditoriums shall conform to the following requirements.

a) Venues shall have the capability to support subtitles, sign language and audio description where performances offer them.

b) Stages shall be accessible (see C.10.2.4).

c) Accessible toilets shall be located in proximity to seating areas, and not more than 150 m away.

C.10.2.3 Accessible auditorium seating spaces

C.10.2.3.1 General

The following requirements and recommendations apply to auditorium seating.

a) It shall be connected by an accessible route to the seating area, and an access aisle to the designated wheelchair spaces.

b) Accessible seating may be provided with either designated wheelchair spaces or removable seating that can be converted to wheelchair spaces.

c) Wheelchair spaces shall be provided according to Table C.25 and Figure C.107.

Criteria	Minimum dimensions (mm)
Width – single space	900
Width – two adjacent spaces	850
Length – front or rear approach	1,300
Length – side approach	1,500
Manoeuvring space	1,500 x 1,500
Seating access aisle	1,000

Table C.25 Wheelchair space requirements for auditoriums

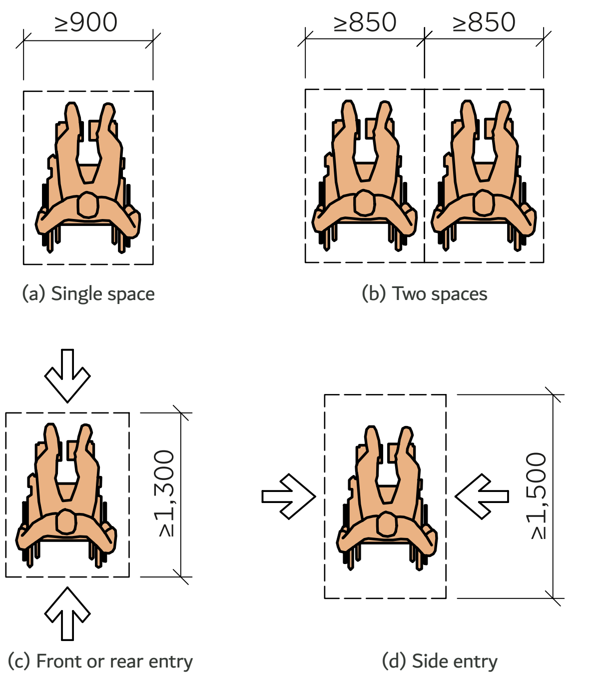


Figure C.107 Wheelchair space for auditoriums

A variety of seating locations shall be provided for wheelchair users and their companions, to allow choice of seating levels and comfortable line of sight. An example is shown in Figure C.108.

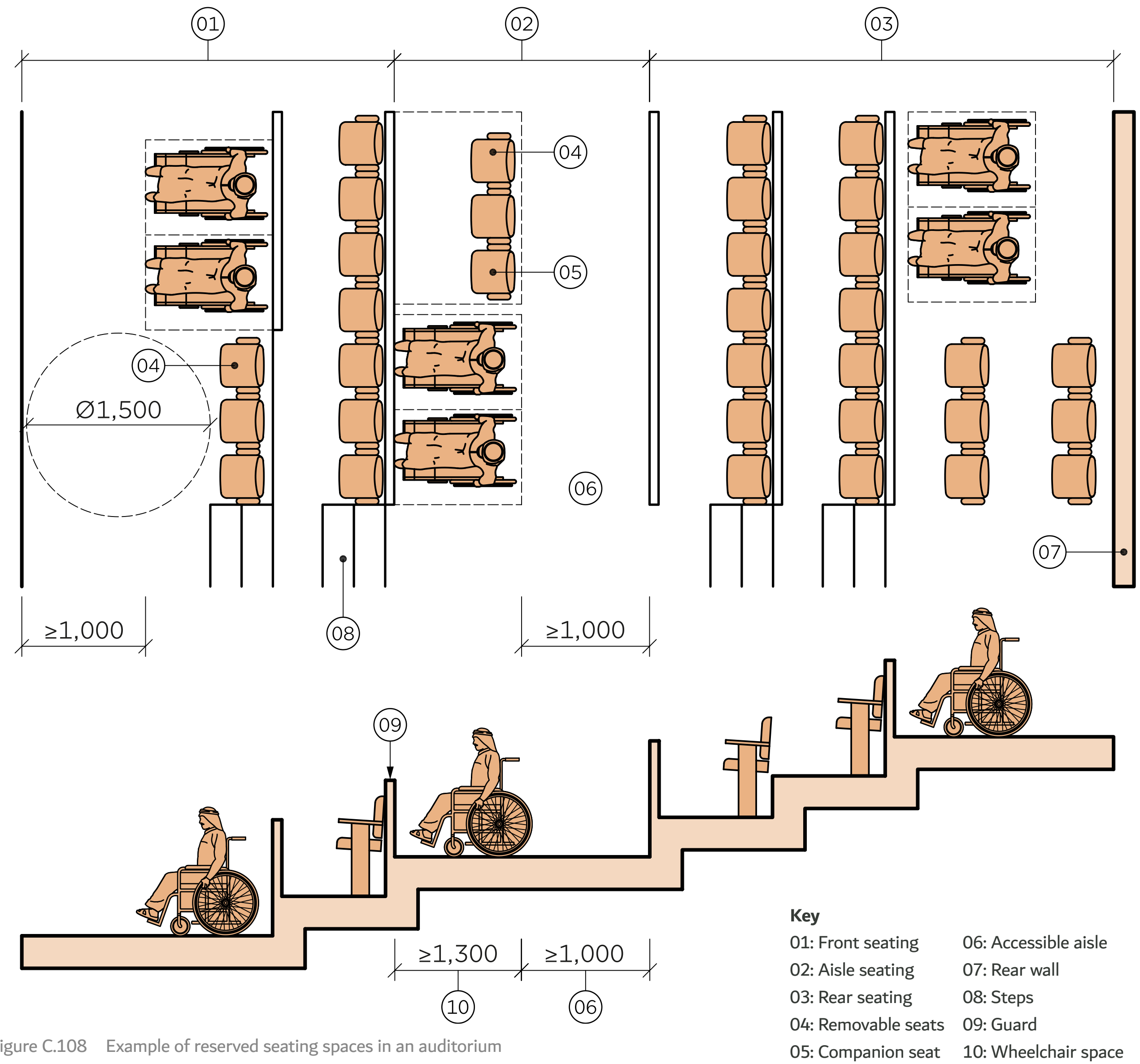


Figure C.108 Example of reserved seating spaces in an auditorium

The number of wheelchair spaces shall conform to Table C.26.

Number of wheelchair spaces	
One reserved wheelchair space	For every 50 seats or fraction thereof up to 500 seats
One reserved wheelchair space	For every 100 seats or fraction thereof above first 500

Table C.26 Required number of wheelchair spaces

Wheelchair sitting spaces shall not overlap the accessible aisle minimum width.

For facilities with fixed seats, it is recommended that wheelchair spaces are arranged into groups of a maximum two for 50% of the accessible seating capacity. Each group of wheelchair spaces can have at least an equal number of fixed seats, to allow a person accompanying a wheelchair user to be seated next to them.

Companion seats conforming to the following should be provided for 50% of wheelchair spaces.

1) In row seating, companion seats shall be located to provide shoulder alignment with adjacent wheelchair spaces.
2) The floor surface of the companion seats shall be at the same elevation as the floor surface of the wheelchair space.
3) Companion seats shall be equivalent in size, quality, comfort and amenities to the seating in the immediate area. Companion seats can be movable.

For removable or foldable seats provided in the designated wheelchair spaces, the conversion process shall be quick and easy.

Both the surface of wheelchair spaces and the clear manoeuvring space shall be level, having a maximum longitudinal gradient of 2%.

Aisle seats shall have foldable or retractable armrests.

In auditoriums with raked floors, wheelchair spaces should have a handrail and guardrails located at any change of level where no barrier is provided by other means.

A space at the front of the hall or room where a sign language interpreter can easily be seen shall have an independent overhead light.

A sufficient number of designated accessible seats for people with hearing impairments should be provided in front of the sign language interpreter.

Wheelchair designated sitting spaces shall be marked with the symbol for people of determination.

C.10.2.3.2 Lines of sight over seated spectators

Where spectators are expected to remain seated during events, spectators in wheelchair spaces shall be afforded lines of sight as shown in Figure C.109 and Figure C.110.

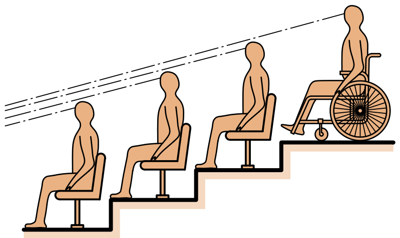


Figure C.109 Line of sight over the heads of seated spectators (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010. Figure 802.2.1.1.)

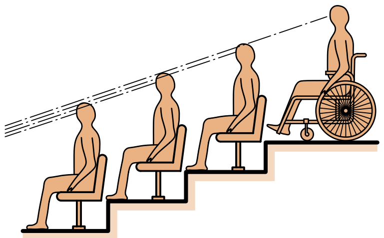


Figure C.110 Lines of sight between the heads of seated spectators (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 802.2.1.2.

C.10.2.3.3 Lines of sight over standing spectators

Where spectators are expected to stand during events, spectators in wheelchair spaces shall be afforded lines of sight as shown in Figure C.111 and Figure C.112.

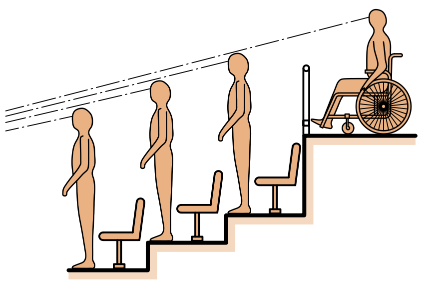


Figure C.111 Lines of sight over the heads of standing spectators (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 802.2.2.2.1.)

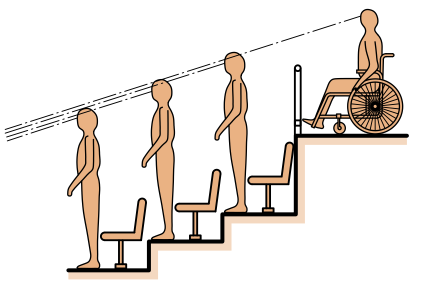


Figure C.112 Lines of sight between the heads of standing spectators (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 802.2.2.2.)

C.10.2.4 Stages and backstage

Stages shall be accessible to everyone via a ramp or lift. In an exceptional case a lift platform can be provided to make a stage accessible. The lift platform shall conform to C.5.9.4.

All controls to be operated by a speaker/performer shall be operable by a seated person.

It should be possible to use the assistive listening system on the stage.

The stage area shall contain space for wheelchair manoeuvring clearances.

Buildings for public events with a capacity of more than 300 spectators should have an accessible backstage area with an accessible toilet, including a shower, a changing room and a space with an accessible mirror.

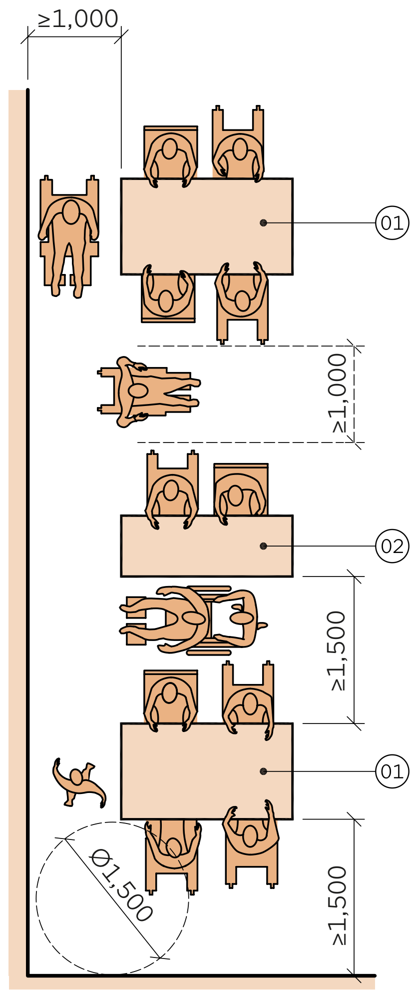
The route between the backstage and the stage shall be an accessible route.

C.10.2.5 Libraries and reading areas

Seating allocated to people of determination should be on a direct route, which is free of obstructions and located so that it is easily identifiable by visually impaired people. The aisle spacing for accessing the seating area shall be minimum of 1,000 mm (see Figure C.113).

Space should be provided nearby for storage of a wheelchair, to allow a wheelchair user to transfer from their wheelchair to a seat.

Seating designated for people of determination should not obstruct other users.



Key

01: Double side desk

02: Single side desk

Figure C.113 Circulation spaces between study tables/desks (© British Standards Institute. Figure extracted from BS 8300:2018. Permission to reproduce extracts from British Standards is granted by BSI Standards Limited (BSI). No other use of this material is permitted).

C.10.2.6 Mosques and prayer rooms

Mosques and prayer rooms shall conform to the following requirements.

a) In addition to the clear area provided at the entrance in accordance with C.5.6.1, a “KEEP CLEAR” mat shall be provided if the clear entrance is not guaranteed.

b) Seating shall be provided at entrances and at other locations where people are required to remove their shoes.

c) Seating should be provided within the prayer hall to accommodate people who cannot bend to pray.

d) The route to the designated area crossing the prayer hall’s carpeting shall have low pile carpeting or be level with circulation area (see C.7.2.1).

e) The accessible sanitary provision shall be a minimum of one accessible toilet and one accessible ablution space within each prayer room for each gender.

C.10.2.7 Public spaces

C.10.2.7.1 General

The following requirements and recommendations apply to public spaces, such as parks, beaches and open spaces for public use, including their facilities, services and urban furniture.

a) All urban furniture and signage shall not interfere with the accessible route.

b) Where a public space is designed exclusively or mainly for pedestrians, all areas between buildings or lots shall be as level as possible. A physical speed-calming element shall be installed at all entrances to the area to limit vehicles to 10 km/h.

c) In outdoor spaces it is recommended that resting places are located at maximum intervals of 100 m. Benches with and without arms should be provided to accommodate people of various sizes.

d) Publicly accessible toilets shall be installed near the accessible route (see C.8.1). It is recommended that they are located on the same level as the accessible entrance.

e) Electric mobility device chargers with an interaction space shall be installed in the following locations:

   1) accessible routes in the vicinity of park entrances;

   2) along public beaches;

   3) near tourist attractions;

   4) in shopping malls; and

   5) in other places as appropriate.

f) The provision of continuous shaded paths is encouraged. Shaded areas should be provided at minimum intervals of 50 m in streets and squares. Each second area should be provided with seating places and space for wheelchair users without invading the accessible route.

C.10.2.7.2 Parks, beaches and natural spaces

Information about the nearest publicly accessible toilets and interest points within a park or beach shall as a minimum be installed at every route intersection.

Supplementary routes can be provided at beaches and natural landscape areas where walking would be difficult.

A supplementary route shall conform to the following.

a) It shall have a minimum clear width of 1,500 mm and be free of obstacles.

b) Where the natural slope of the terrain allows it, the route's running gradient shall be not greater than 5% and the crossfall gradients shall be a maximum of 2%.

c) It shall reach as close as possible to the water's edge or natural landscape area (see Figure C.114).

d) There should be a minimum of one accessible unit of each utility (such as toilets, lounges, beach cafes and restaurants, showers, changing rooms, furniture and emergency services).

e) The utilities should be installed as close as possible to each other and shall be connected by an accessible route. Access to the utilities shall be via an accessible route from access point and from the accessible route to the water's edge or natural landscape area (see Figure C.114).

Key

01: Sign

02: Accessible route

03: Water closet

04: Shower

05: Café

06: Awnings area

07: Rope

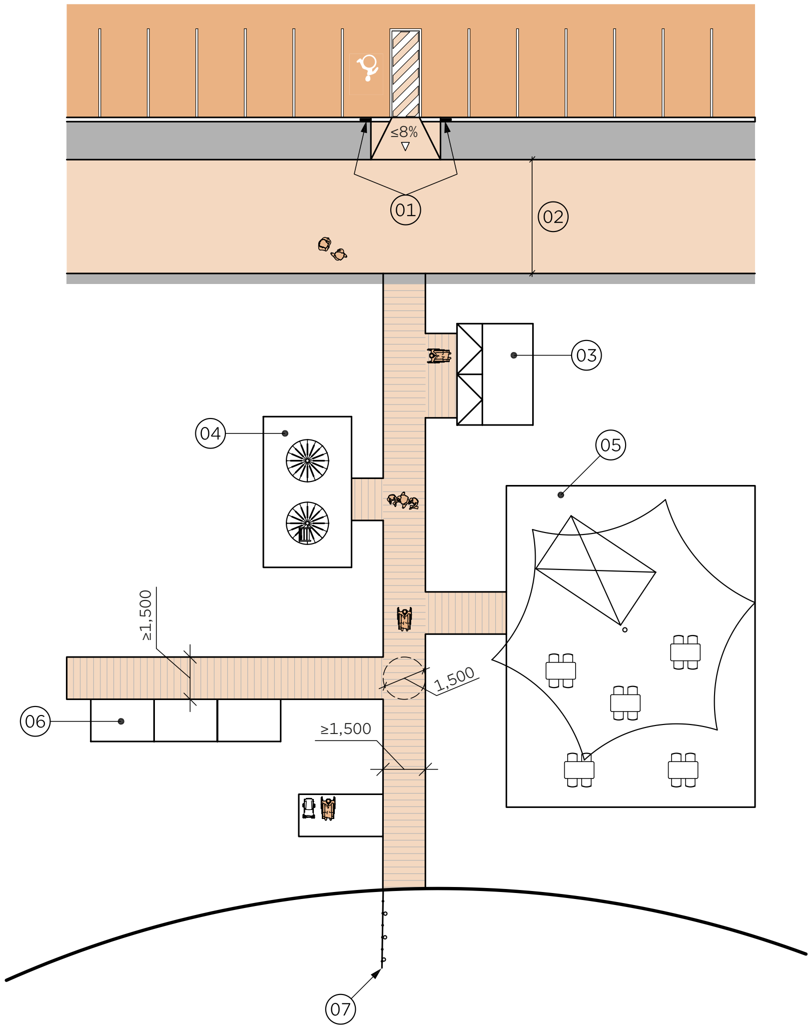
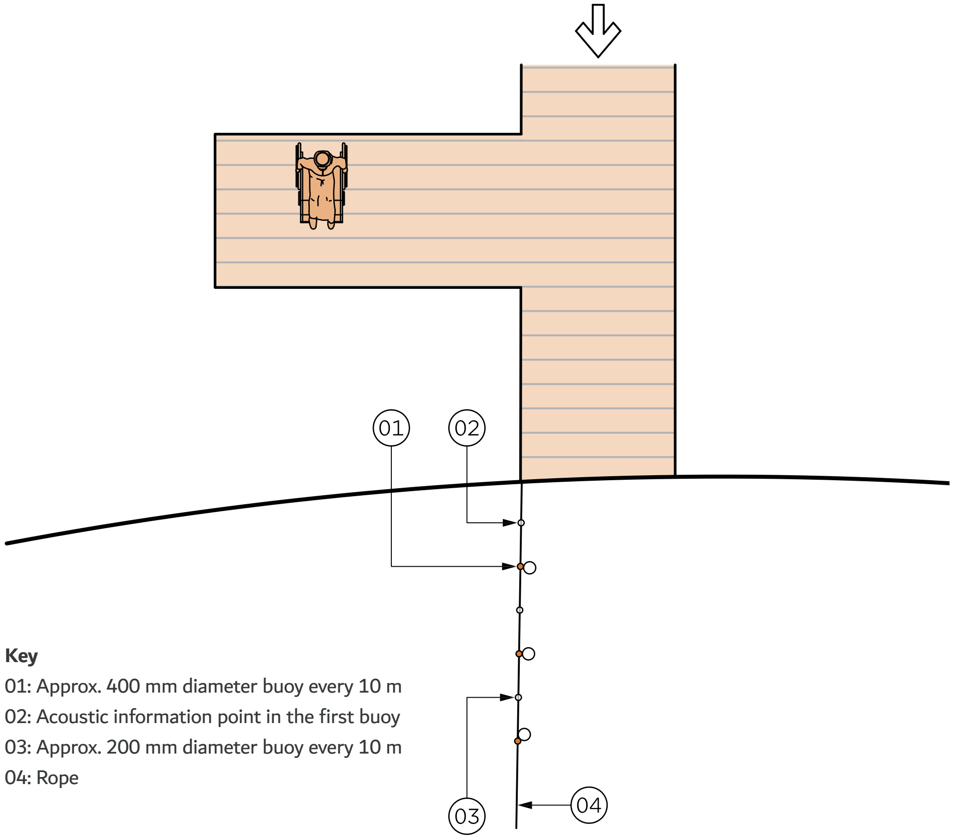


Figure C.114 Accessible route at a beach

C.10.2.7.3 Access to lakes and seas

An orientation rope shall be provided at the point of access into the water. This rope shall remain floating and its length be adapted to the specific conditions of each swimming area (see Figure C.115).



Key
01: Approx. 400 mm diameter buoy every 10 m
02: Acoustic information point in the first buoy
03: Approx. 200 mm diameter buoy every 10 m
04: Rope

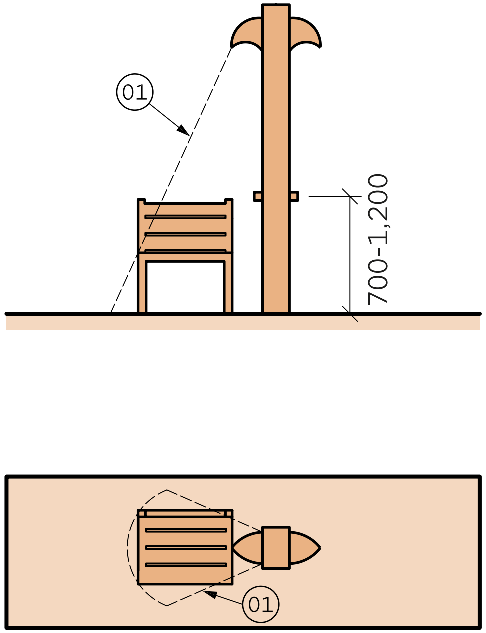
Figure C.115 Orientation rope

C.10.2.7.4 Outdoor showers

Outdoor accessible showers shall be provided at accessible beaches and swimming pools. A minimum of one shower shall be provided for every 150 m of beach length.

These showers shall be linked via an accessible route and interaction space. They shall be a minimum 1,800 mm in width and shall be provided with an accessible bench (see Figure C.116). The bench should be bolted to the floor to prevent overturning.

Each shower shall be controlled by a button placed between 700 mm and 1,200 mm above the floor surface. The button shall be operable with an elbow or a closed fist (see Figure C.116).



Key
01: Shower jet

Figure C.116 Outdoor shower

C.10.2.7.5 Playgrounds

Playgrounds that offer a variety of play options (visual, auditory and tactile) are preferred. To be accessible, a playground shall conform to the following requirements.

a) Each playground shall conform to the basic requirements for accessibility of fixed accessible furniture (see C.7.3).

b) Playground surfaces shall consist of rubber or compacted sand.

c) The surfaces shall be smooth, firm and free of any sharp objects or projections, in order to avoid injuries.

d) Playgrounds shall be designed to allow all children, regardless of their functional limitations, and according to the age group for which the playgrounds are intended, to enjoy and use a minimum of 50% of individual and group expected activities.

e) All materials exposed to sun radiation shall not reach temperatures that can harm the users.

f) Materials used to construct children's games (especially sliding ones) shall not contain plastics or metals that produce electrostatic discharges that can deprogram hearing aids. Any existing playground that produces this effect shall be marked with a magnetic warning sign (see Figure C.117).

The provisions of the Americans with Disability Act (ADA) [Ref. C.2] should be followed.

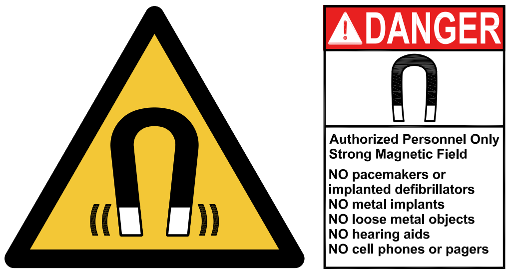


Figure C.117 Example of ISO and ANSI magnetic warning signs

C.10.2.8 Swimming pools

C.10.2.8.1 General

For a public use swimming pool, an accessible deck shall be provided on at least two sides of the pool. An accessible route shall link the pool with facilities and common areas.

For a residential pool serving multiple units, the pool deck and amenities should be accessible. Other private use swimming pool accessibility provisions should be according to operation and users' needs.

Public use swimming pools longer than 25 m, and other bathing pools, shall have a minimum of one accessible means of entering the water.

Access to the water shall be by sloped entry or assisted elevation chair if the pool length exceeds 25 m.

Communication shall be provided in visual and audio format simultaneously.

The ADA [Ref. C.2] requirements for accessible swimming pools should be followed.

The following accessibility features shall also be provided:

a) a safety ladder;

b) underwater illumination if the pool will be used at night; and

c) connection of the swimming pool to an accessible changing room for each gender in accordance with C.7.6.

C.10.2.8.2 Sloped entries

Sloped entries shall extend to a depth of not less than 600 mm and not more than 750 mm below the stationary water level (Figure C.118).

Handrails shall be provided on the sloped entry.

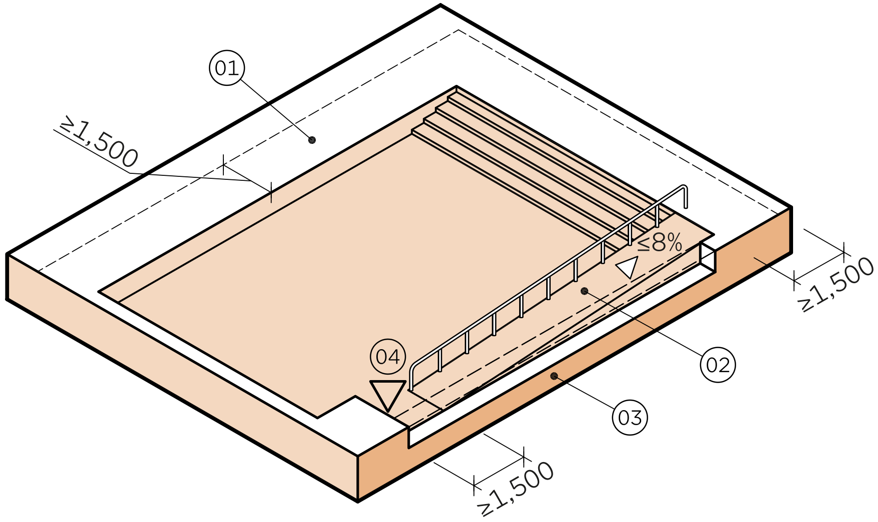


Figure C.118 Swimming pool with sloped access

Key
01: Accessible peripheral circulation
02: Maximum gradient of 8%
03: Section of the swimming pool wall
04: Depth at sloped entry extension to be 600 mm to 750 mm

C.10.2.8.3 Pool chair lifts

Pool chair lifts shall be located where the water level does not exceed 1,200 mm within the swimming pool area.

Pool chair lifts shall be located over the deck and at a minimum of 400 mm from the edge of the pool.

A clear deck space of 1,500 mm × 1,500 mm shall be provided parallel to the seat (see Figure C.119).

The height of the chair lift seat shall be between 400 mm and 500 mm from the pool deck level when in the raised position.

Seat width shall be a minimum of 400 mm.

Seats shall be at a minimum depth of 450 mm below the stationary water level when submerged.

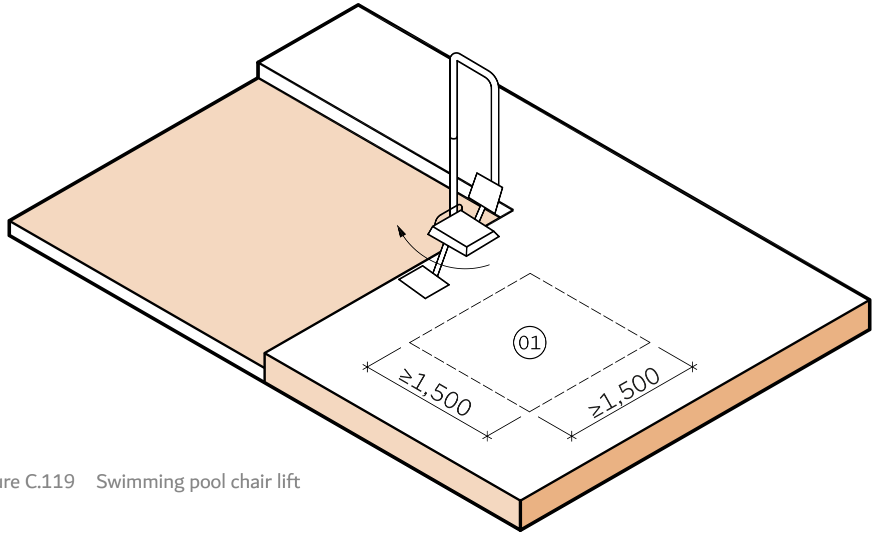


Figure C.119 Swimming pool chair lift

Key
01: Minimum required space

C.10.2.9 Recreational buildings and amusement parks

The following requirements and recommendations apply to recreational buildings and amusements parks.

a) When the nature of the facility requires auditorium seating places, accessible seating spaces shall be provided. These seating spaces shall conform to the requirements for auditorium seating spaces in C.10.2.3.

b) Amusement facilities should provide equal use for people of determination.

c) Where providing different amusement facilities in the same recreational building or amusement park, at least 50% of them should be accessible.

d) Amusement facilities shall have wheelchairs or other personal mobility devices available for users.

The ADA [Ref. C.2] requirements for the provision of recreational facilities, including amusement rides, boating facilities, fishing piers, golf facilities and spas, should be followed.

C.10.2.10 Dining spaces

The following requirements and recommendations apply to dining rooms.

NOTE: An example accessible dining room is shown in Figure C.120.

a) An accessible route shall be provided to at least half of the dining areas.

b) Illumination of a minimum 100 lux shall be provided in at least 10% of the dining room.

c) Acoustic treatment should be incorporated into dining rooms.

d) At least 10% of the tables shall conform to C.7.3.3 and shall be connected by an accessible route.

e) An accessible route with a minimum clear width of 1,000 mm shall be provided to reach the accessible tables, all food service areas, condiments and utensils.

f) Where self-service aisles or counters are provided, all food, condiments and cutlery shall be within the reach ranges specified in C.5.7. Counters shall conform to C.7.3.5.

g) For heavy traffic areas and expected two-way passage, a minimum clear passage of 1,500 mm should be maintained.

h) Space for children strollers and mobility devices shall be provided.

i) A minimum of 10% of seats shall be movable.

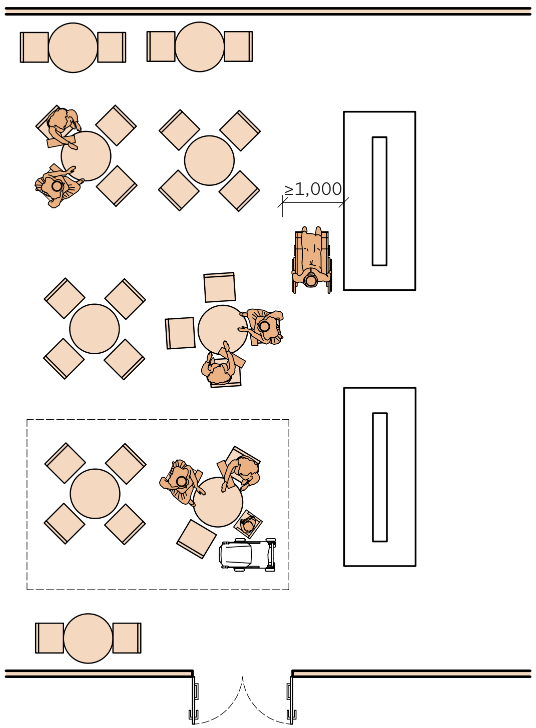


Figure C.120 Example of an accessible dining space

C.10.2.11 Kitchen and kitchenettes

C.10.2.11.1 General

Kitchen work surface shall have sections of a maximum depth of 600 mm and maximum height of 850 mm above finish floor for wheelchair users. These sections shall be kept clear of floor-mounted cupboards, equipment or legs.

Kitchens shall conform to the clearances specified in either C.10.2.11.2 or C.10.2.11.3.

C.10.2.11.2 Pass-through kitchen

In pass-through kitchens (see Figure C.121) a minimum clearance of 1,200 mm shall be provided.

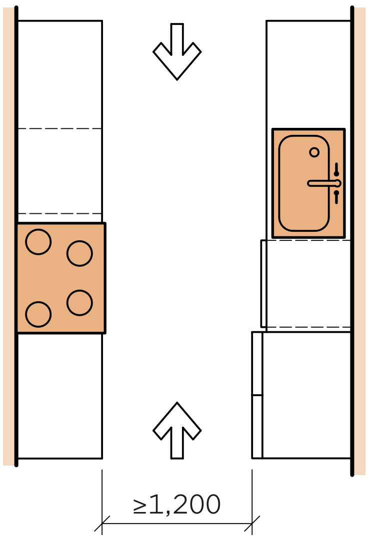


Figure C.121 Clearance for pass-through kitchens (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 804.2.1.)

C.10.2.11.3 U-shaped kitchen

In U-shaped kitchens (see Figure C.122) a manoeuvring clearance of 1,500 mm shall be provided.

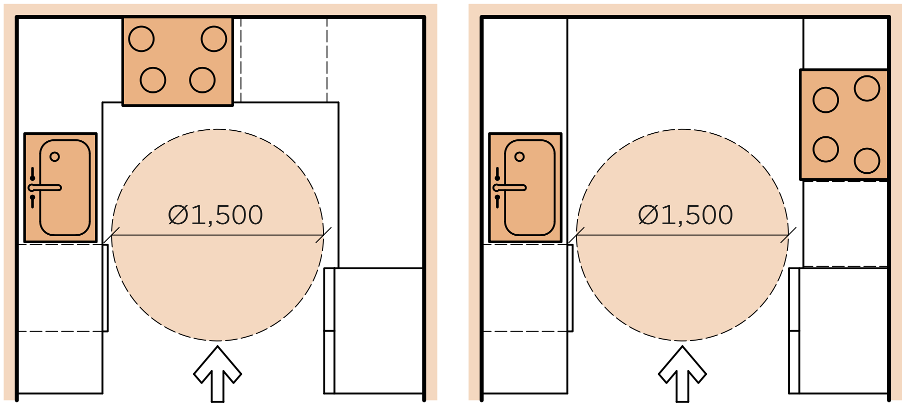


Figure C.122 Manoeuvring clearance for U-shaped kitchens (modified figure based on 2010 ADA Standards for Accessible Design, US Department of Justice 2010, Figure 804.2.2.)

Kitchens should be designed in accordance with the ADA [Ref. C.2] and BS 8300.

C.10.2.12 Transport buildings, stations and terminals

C.10.2.12.1 General

This subsection specifies general accessibility requirements for transport related buildings such as:

a) railway and metro stations;

b) underground railway and rapid transit stations;

c) airports and terminals; and

d) sea terminals.

All platforms and waiting areas shall be connected by accessible routes. Accessible ticket sales and information counters and seating areas shall be provided. Audio and visual communication systems shall be provided.

In addition, accessible transportation facilities should be designed in accordance with the ADA [Ref. C.2] and BS 8300.

C.10.2.12.2 Bus shelters

A bus shelter shall conform to the following requirements.

a) The location of the shelter shall not encroach upon the accessible pedestrian route, public space or transportation platform.

b) An accessible route shall be provided, free of protruding obstacles on both sides and with a minimum clear height of 2,100 mm. The route shall have a minimum clear width of 1,200 mm.

c) There shall be no obstacle between the space covered by the bus shelter and the transport vehicle.

d) Any glazed walls shall be marked (see C.7.2.3).

e) A minimum of one fixed bench shall be provided.

f) A minimum of one standing support shall be provided, located at a height between 700 mm and 750 mm above the floor surface and separated from the wall or vertical enclosure by a minimum of 200 mm.

g) The bus shelter shall have a minimum average illumination of 50 lux, measured at ground level, during off-service hours. The minimum average illumination shall be 100 lux at the boarding time.

h) The boarding area platform shall have a detectable warning surface.

i) Bus signposts shall not obstruct the accessible routes. No elements shall protrude below the accessible route clear height requirement.

C.10.2.12.3 Gangways

A gangway shall be used for embarking and disembarking from a berth and to and from a vessel.

A gangway shall have a maximum gradient of 8%, measured from the vessel or berth surface to the gangway's intersection with the berth surface or vessel landing deck (see Figure C.123).

The width of the gangway should be appropriate to the vessel infrastructure, but shall be not less than 1,000 mm. It is recommended that this is increased to 1,800 mm for vessels with high pedestrian traffic (see Figure C.124).

The gangway/ramp interface with the berth surface and the vessel landing deck should be levelled and not exceed a vertical gap of 13 mm chamfered.

A gangway/ramp run with a rise greater than 150 mm should have handrails on both sides and be of a uniform height above the floor.

The handrails should extend horizontally at least 300 mm beyond the top and bottom of the gangway/ramp and return to the wall, or post.

An upper and lower handrail should be provided on each side of the gangway/ramp. The upper handrail should be 865 mm to 965 mm and the lower handrail 650 mm to 750 mm above the gangway/ramp surface to the top of the handrail.

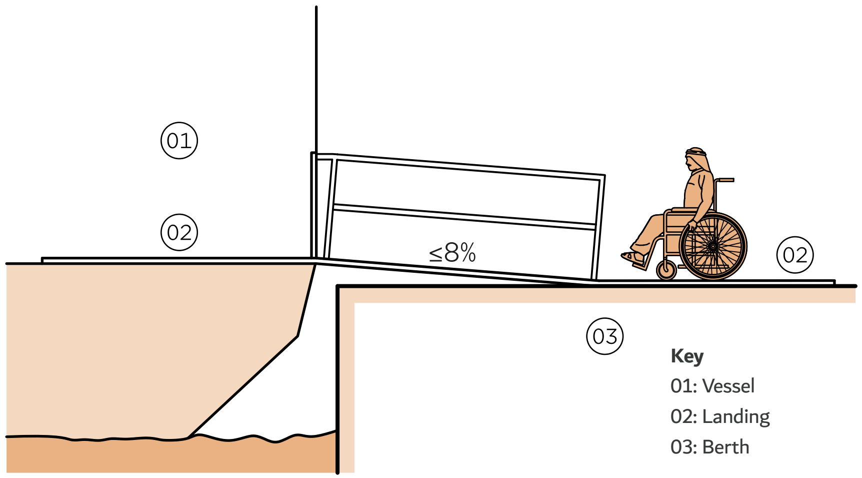
Handrails shall have:

a) a circular section with an outside diameter of 30 mm to 40 mm; and

b) a reflectance contrast of at least 30 points LRV.

The full run of the gangway/ramp, including all landings, should be evenly illuminated to at least 100 lux at all interior and exterior gangway/ramps and landings.

The gangway/ramp shall have an anti-slip and non-reflective surface.



Key
01: Vessel
02: Landing
03: Berth

Figure C.123 Gangway ramp

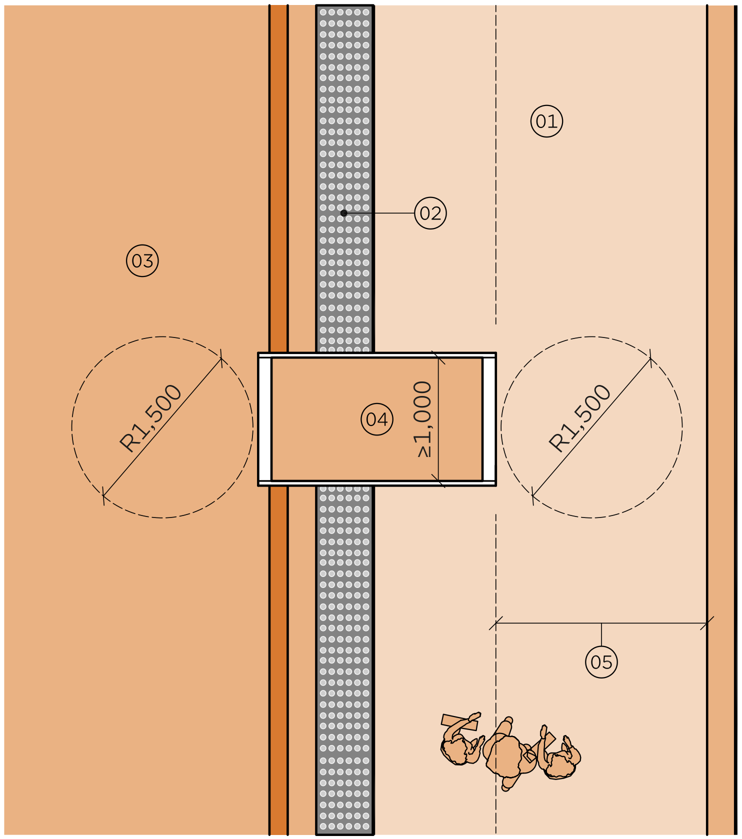


Figure C.124 Access to vessel

Key
01: Berth
02: Tactile warning strip
03: Vessel
04: Boarding ramp
05: Accessible route

C.10.2.13 Sport buildings and exercise rooms

C.10.2.13.1 Exercise rooms

An accessible route shall be provided between equipment in sports and exercise rooms.

Exercise machines and equipment shall have a clear interaction space. Interaction spaces shall be provided on the access side of the equipment to allow transfer. One interaction space can be shared between two pieces of equipment.

C.10.2.13.2 Sport buildings

Accessible sports facilities shall conform to the International Paralympics Committee's requirements [Ref. C.3].

For sports facilities, an accessible route shall be provided to connect the boundary of each activity area.

For court sports, at least one accessible route shall connect both sides of the court.

Where bowling lanes are provided, a minimum of 5%, but not less than 1, shall be on an accessible route conforming to C.5.

Tiered auditorium seating for sports facilities shall conform to C.10.2.3.

C.10.3 Residential buildings

C.10.3.1 General

Apartment buildings, staff accommodation and labour accommodation buildings shall have an accessible route for accessing the buildings and residential amenities.

A video doorbell should be provided to facilitate communication with residents for people of determination.

C.10.3.2 Adaptable units in residential buildings

For new housing developments with more than ten units, a minimum of 2% of the total units and all common spaces in the building should be adaptable to meet the accessibility needs and conform to the accessibility requirements of this Part.

This allows low-cost conversion of a house to meet the accessibility needs of any future residents who are persons of determination.

Volume 1, Section 2 of Approved Document M [Ref C.4] provides guidelines for designing adaptable accessible units.

All adaptable accessible units in new housing buildings shall conform to the following requirements.

a) The entrance and internals doors shall conform to C.5.8.
b) Wall-mounted switches and socket outlets shall conform to C.5.7.4.
c) The bathroom shall contain sufficient space clearances to contain a minimum of one accessible bathtub or shower, accessible sink and water closet with appropriate space clearances.
d) All walls, ducts and boxings shall be strong enough to support grab rails, seats or other adaptations that could impose a load up to 1.5 kN/m^2.

e) In accessible residential units with more than one level, at least the kitchen, one bathroom and one living room or bedroom shall be accessible from the entrance door without any level changes.

f) Inside an adaptable accessible unit, manoeuvring space inside the kitchen shall be a minimum 1,200 mm free of door openings and fixed elements, and 1,500 mm where turning is required as shown in Figure C.125.

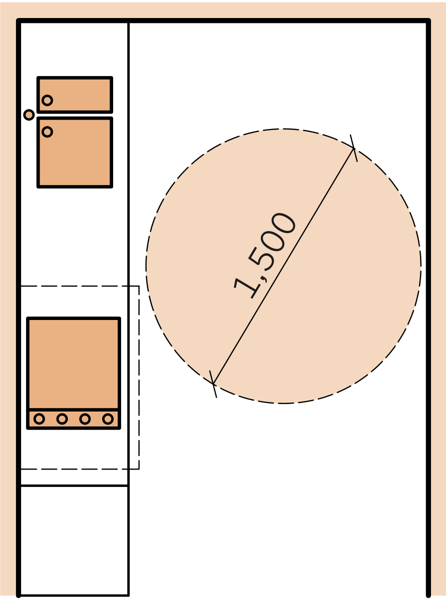


Figure C.125 Manoeuvring space in an adaptable kitchen

Inside an adaptable accessible unit, at least one bedroom shall conform to the following requirements and Figure C.126.

1) A clear access route of 1,000 mm shall be provided from the doorway to the window or balcony.
2) A clear access zone of 1,000 mm shall be provided to one side and the foot of the bed.
3) A clear space of 1,200 mm × 1,200 mm shall be provided at direction changes.

In duplexes and units of two or more levels a lift platform may be provided.

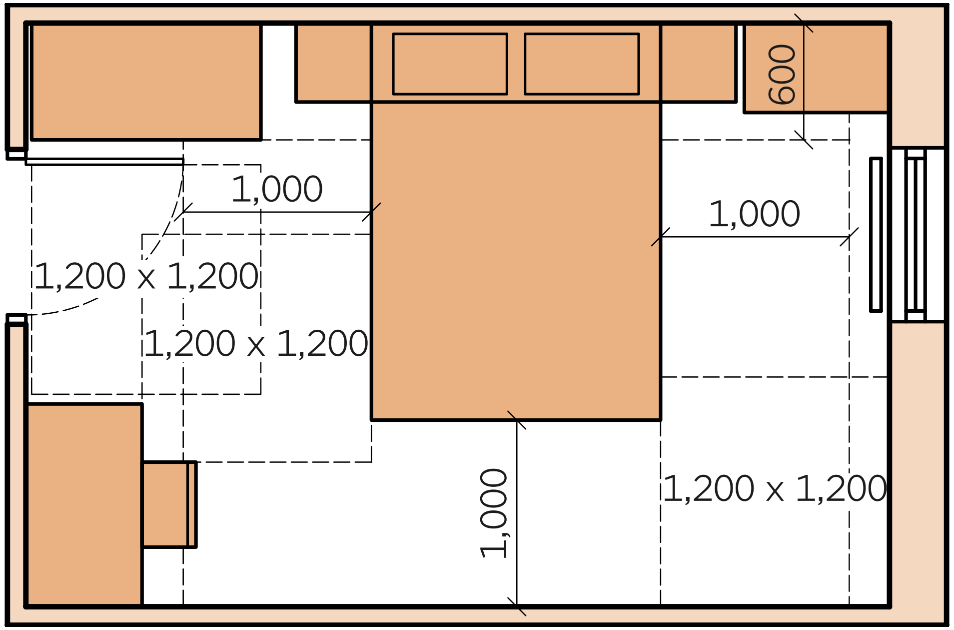


Figure C.126 Manoeuvring space in a bedroom in an adaptable unit (© Crown Copyright 2015. Figure based on Diagram 3.9 of the Building Regulations (2010), Approved Document Part M, Volume 1, 2015 Edition with 2016 amendments. Contains public sector information licensed under the Open Government Licence v3.0)

C.10.4 Hotel buildings

C.10.4.1 General

All common spaces in hotel establishment shall be accessible.

Accessible hotel rooms should be dispersed between different hotel room types as necessary in accordance with C.10.4.2 and C.10.4.3.

C.10.4.2 Accessible guest room with mobility features

A minimum number of accessible guest room with mobility features shall be provided in accordance with Table C.27.

Hotel rooms count	Accessible guest rooms with mobility features
50 to 500	2% of total number of rooms
Above 500	1% for additional rooms over 500

Table C.27 Number of accessible guest room with mobility features

Accessible rooms should be located at the lower levels of the hotel, preferably in the first three guest room floors of the building.

An accessible toilet with grab bars, an accessible shower and a sink shall be provided (see Figure C.127 and Figure C.128).

50% of the accessible hotel rooms shall contain roll-in showers. The other 50% shall contain accessible bathtubs (see Figure C.129). An alarm string shall be provided at the shower or tub.

The accessible rooms shall be provided with audible and visual fire alarms in accordance with Ch. 8 of UAE FLSC [Ref. C.1].

Controls shall be placed at a height of 400 mm to 1,200 mm, except for those to be used from the bed. These should be placed within ready reach of occupants. Electric outlets shall conform to the ranges and locations specified in C.5.7.

A clear route shall be provided to the bed with a minimum clear space of 1,500 mm × 1,500 mm beside the bed not obstructed by any furniture (see Figure C.130).

The bed shall have a maximum height of 500 mm.

A dressing mirror shall be provided, in which the user can see their reflection from a distance of 250 mm to 2,000 mm.

Shelves and drawers shall be provided between 700 mm and 1,200 mm from the floor. Clothes hangers should be provided between 1,100 mm and 1,400 mm above the floor.

A minimum illumination of 200 lux shall be provided in the guest room area.

Connecting rooms shall have accessible doors.

A viewing device should be provided in the door, with its bottom at a height of between 900 mm and 1,200 mm.

Changes in level or lip in the washroom or shower area shall be limited to a maximum 5 mm.

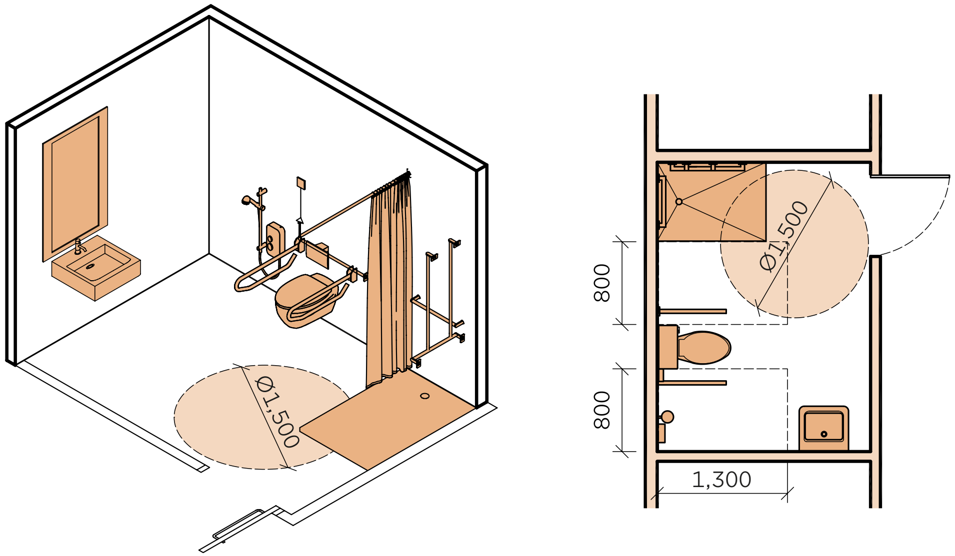


Figure C.127 Example of double-sided transfer toilet with roll-in shower

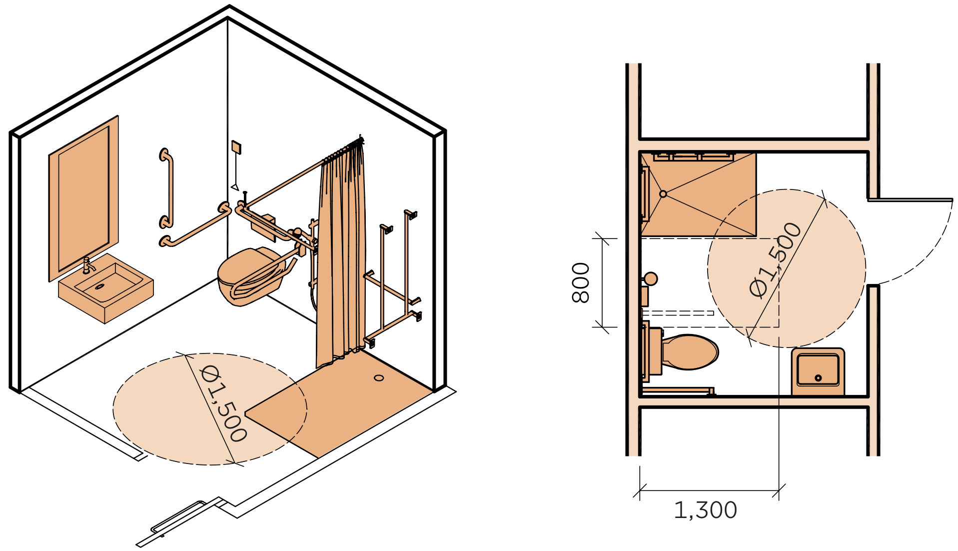
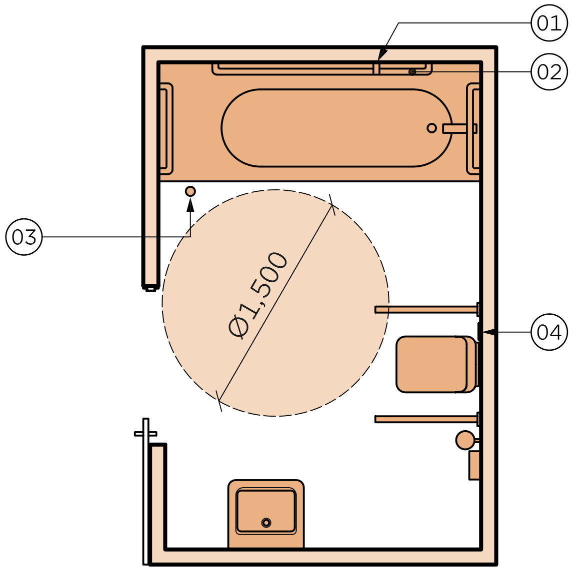


Figure C.128 Example of single-sided transfer toilet with roll-in shower



Key
01: Vertical grab bars
02: Horizontal grab bars
03: Emergency pull chord
04: Emergency call bell

Figure C.129 Accessible guest bathroom with bathtub

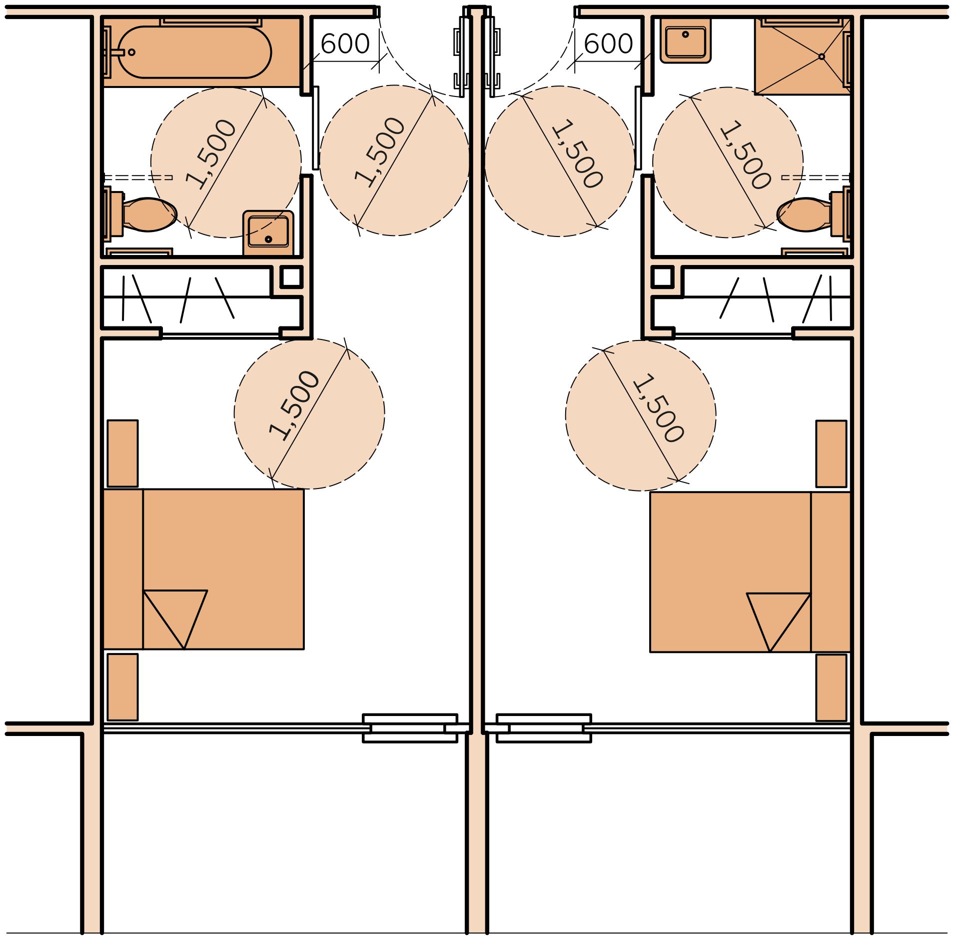


Figure C.130 Example of two accessible guest rooms, one with roll-in shower and the other with accessible bathtub

C.10.4.3 Accessible guest rooms with communication features

It is recommended that a minimum number of guest rooms with communication features are provided in accordance with Table C.28. This provision can be separate from that specified in C.10.4.2 and is not required to conform to C.10.4.2.

Hotel rooms count	Accessible guest rooms with communication features
50 to 500	4% of total number of rooms
Above 500 rooms	2% for additional rooms over 500

Table C.28 Number of accessible guest rooms with communication features

Where provided, such a guest room shall:

a) provide compatibility with adaptive equipment used by people with hearing impairments;
b) contain telephone interface jacks that are compatible with both digital and analogue signal use;
c) contain visible notification devices to alert room occupants of incoming telephone calls and a door knock or bell; and
d) contain telephones with volume controls compatible with the telephone system.

The ADA [Ref. C.2] requirements for the provision of guest rooms with communication features and telephones should be followed.

C.10.5 Education buildings

The following requirements and recommendations apply to education buildings, as necessary.

a) At building entrances, an accessible route shall be provided, segregated from vehicle circulation.
b) There should be an accessible route from the bus yard to the building entrance.
c) Seats with different characteristics should be provided dependent on the students' needs. Space flexibility shall be provided to guarantee that places can be provided for wheelchair users, left-handed users, and people of large stature, limited mobility or breathing, and their communication accessories.
d) Accessible seats at desks shall be removable and the dimensions of the desks shall allow use by people in wheelchairs.
e) In children's schools and nurseries, toilets and furniture of the appropriate height shall be provided (see C.8.3.4.4).
f) Accessible toilets shall be provided for teachers, students and visitors.
g) For students using assistive devices such as computers or optical character recognition systems, electrical socket outlets should be provided as close as possible to their seats. The cables between the devices and the socket outlets shall not obstruct the circulation routes.

C.10.6 Healthcare buildings

In addition to accessibility and design requirements imposed by DHA regulations and guidelines [Ref. C.5 to Ref. C.15], the following requirements and recommendations apply to health and social care buildings.

a) Horizontal and vertical circulation should be designed to ease the movement of beds and gurneys, particularly at changes of directions, at access to rooms from corridors, and in the dimensions of elevator cabins.

b) Corridors shall have handrails along their entire lengths.

c) All private patient rooms shall be accessible.

d) A minimum of one accessible toilet room for each gender shall be provided in each department or area.

C.10.7 Business and industrial buildings

All offices, industrial and laboratory facilities including common areas shall be accessible.

Accessible workstations shall be provided and adapted individually for employees with functional limitation. Offices, industries and laboratory facilities shall conform to the following requirements for accessible working areas.

a) The access aisles to workstations shall allow for an accessible route with a minimum clear width of 1,000 mm.

b) Manoeuvring space shall be provided for persons in wheelchairs to approach the accessible working area.

c) Work counters used by people of determination shall conform to C.7.3.5.

d) Lighting levels at work areas shall be a minimum of 200 lux.

e) Information on visual displays shall be supplemented by tactile and/or auditory information, colour contrasted, and located on a glare-free surface.

C.11 Signage and wayfinding accessibility requirement

C.11.1 Wayfinding guidance for accessibility

Wayfinding can be particularly challenging for some people of determination.

EXAMPLE: Someone who has hearing impairment will rely on visual information but might not be able to hear someone providing directions. Someone who is blind will not be able to see a directory, but if it is in a predictable location and has information in a tactile format, they can read it and use sound and even smell to gather more information about their environment.

It is important to provide wayfinding information in a variety of different formats: visual, auditory, olfactory and physical. All people use different forms of information gathering to find their way to their destination, but this is especially important for people of determination.

Depending on the diversity of the population, visual, acoustic and tactile references shall be used to guide a person to avoid risks and to reduce confusion.

C.11.2 General requirements

Signs with texts and symbols, visual references and tactile information like high-embossed characters or Braille text shall be provided.

Signs provided to assist a person in the wayfinding process shall conform to the following requirements.

a) Colour coding shall be used to differentiate zones or hierarchies of text messages. Colours that create confusion for the colour-blind should be avoided. For example, red and green should not be used together where contrasting colours are required.
b) Signage shall be positioned in a manner that wheelchair users or children can see it easily.
c) Letters, numbers, symbols and pictographs shall be glare-free and presented in high reflectance contrast.
d) Signage with text shall be provided in English and Arabic languages.
e) The colour contrast between text and its background shall have a minimum clear reflectance contrast of 50 points LRV.
f) Accessibility pictograms shall conform to ISO 7000.

The ADA [Ref. C.2] requirements for accessible signage and wayfinding should be followed.

C.11.3 Tactile maps and signage

C.11.3.1 General features

Tactile maps that offer embossed visual information and acoustic information should be provided when possible.

Tactile maps should include only essential information: location of services and routes, and position of elements such as information, main services and toilets.

Terms and concepts used should be easy to understand.

Graphic plane representation (lines, surfaces) should be defined through embossment, textures and colour contrasts.

The signs and lettering of the map shall be represented through visual contrast between fonts and background colours. The font size should be a minimum of 20 mm in a sans serif type font. The information shall also be represented in Braille.

The maximum area of horizontal fixed tactile maps should be 800 mm × 450 mm.

The symbols used shall be clearly differentiated (by form, colour and texture) and shall be easily associated with their representation.

For complex tactile maps, buttons for oral information shall be provided.

C.11.3.2 Location of tactile maps

When a tactile map is provided, it shall be located within the accessible route and its location shall be indicated with a tactile orientation and warning surface. A map should be located in a well-lit area. Obstacles in front of a tactile map, such as glass protections, shall be avoided.

When mounted in a busy public place, a tactile map shall include sound information.

In a large building or open space for public use (park, beach), a tactile map shall be located in proximity to the main entrance area. In a building with more than one floor, it shall be located near the stairs or the elevator.

When fixed to a vertical surface, a tactile map shall be centred between 1,250 mm and 1,750 mm above the floor. On horizontal or inclined surfaces, the height shall be between 900 mm and 1,200 mm from the floor and the inclination shall be between 30º and 45º from the horizontal level.

C.11.3.3 Raised characters for tactile signage

Tactile signage should be provided. Letters, numbers, symbols and pictographs should be raised a minimum of 0.8 mm and should be between 16 mm and 50 mm high. If a tactile sign is mounted on a wall, its centre should be at a maximum height of 1,500 mm above the floor.

Long messages should be avoided for letters and symbols in high embossment.

Raised characters should be provided for rooms' or spaces' identification signage. This signage shall preferably represent a single icon or character, for example, the number of an elevator floor, restrooms icon.

High embossment characters shall be sans serif upper case.

The tactile signage shall be in high embossment and not engraved.

Symbol height shall be not less than 30 mm. The embossment thickness shall be between 2 mm and 5 mm for letters and 2 mm for symbols.

Tactile surfaces shall have a reflectance contrast with the surrounding surfaces of a minimum 50 points LRV.

C.11.4 Braille

Braille dots shall have a domed or rounded shape (see Figure C.131).
The indication of an upper case letter or letters shall only be used before the first word of sentences, proper nouns and names, individual letters of the alphabet, initials and acronyms.

Braille characters should be located beneath the corresponding text, at a minimum distance of 10 mm from the edge of the sign.

Braille characters shall be separated 10 mm minimum from any other tactile characters or borders.

The ADA [Ref. C.2] requirements for Braille signage may be followed.

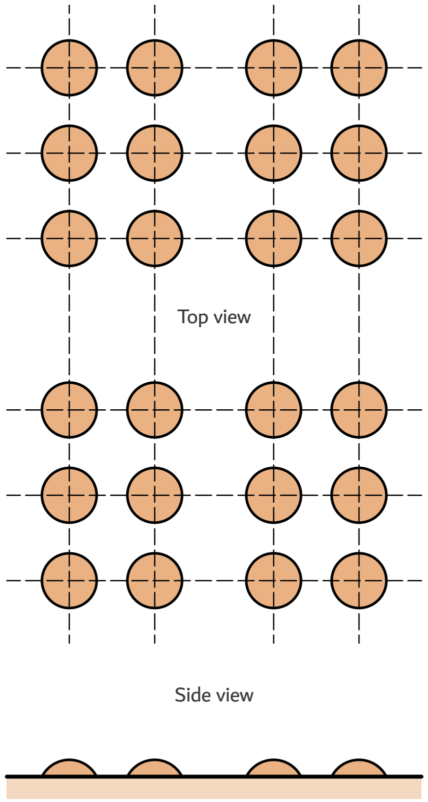


Figure C.131 Example of Braille characters

C.11.5 Position of signage

Signs shall be mounted outside the accessible route.

Signs shall be well illuminated at all times and be positioned such that lighting and sunshine do not produce shadows or glare on the signs.

Backgrounds of signs in reflective or strong visual textures should be avoided.

Obstacles between signs and the observers shall be avoided.

Signs on walls should be centred at a height of 1.5 m. If this space is intended for use mainly by children, the bottom edge of any sign should be at a maximum height of 1.25 m (see Figure C.132 and Figure C.133).

When the sign is mounted on a horizontal or inclined plane, inclination should be between 30 º and 45 º from the horizontal level (see Figure C.134).

Interior signage at doors should be positioned at the latch side of the door.

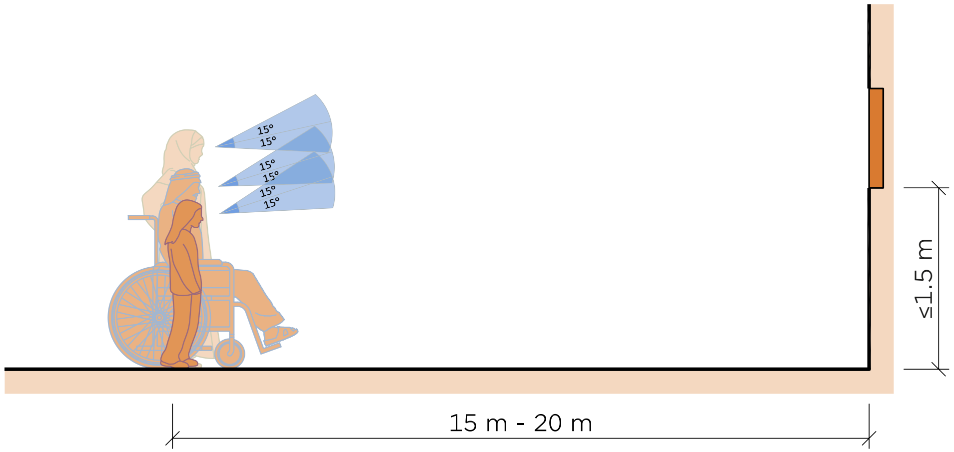


Figure C.133 Vertical visual reach – Far distance

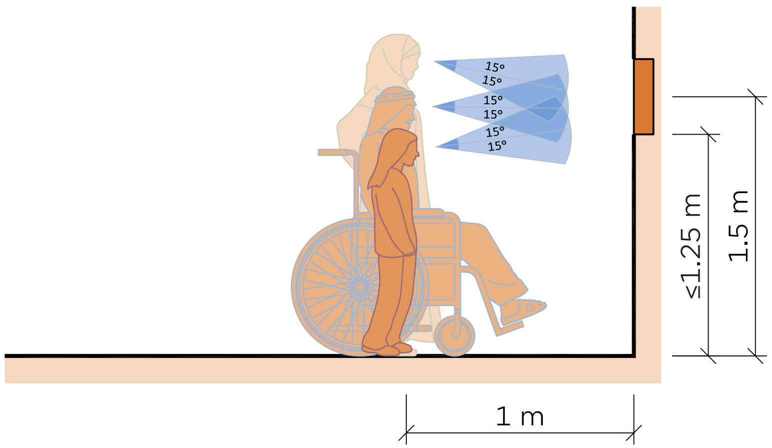


Figure C.132 Vertical visual reach – Close distance

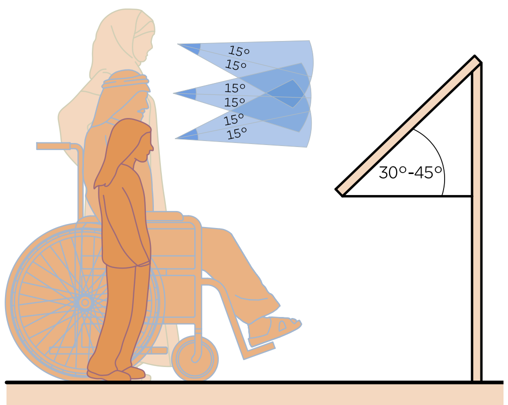


Figure C.134 Inclined sign and tactile maps

C.11.6 Accessibility signs and symbols

Signs to facilities should incorporate the approved accessibility symbols for people of determination in UAE (see Figure C.135).

Signs should be provided to inform people who have hearing impairment of locations in the building where hearing enhancement systems are installed, and where they can obtain the necessary equipment for them.

Accessibility Symbol representing people of determination which is to be used for any information and/or service for the group, including wayfinding, and to indicate all accessibility in the built environment.

Visual impairment symbol to indicate services, aids and equipment and facilities that support the specific group.

Hearing impairment symbol to indicate services, aids and equipment and facilities that support the specific group, such as induction loops.

Figure C.135 Accessibility symbols (© British Standards Institute. Figure extracted from BS 8300:2018. Permission to reproduce extracts from British Standards is granted by BSI Standards Limited (BSI). No other use of this material is permitted).

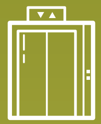
C.11.7 Combination of communication processes

To ensure an accessible communication process, a combination of different communication channels shall be provided depending on the building type or occupancies. The communication shall include a minimum of two of the three channels of communication: acoustic, visual and tactile.

Several possible valid combinations of an accessible communication process are shown in Figure C.136.

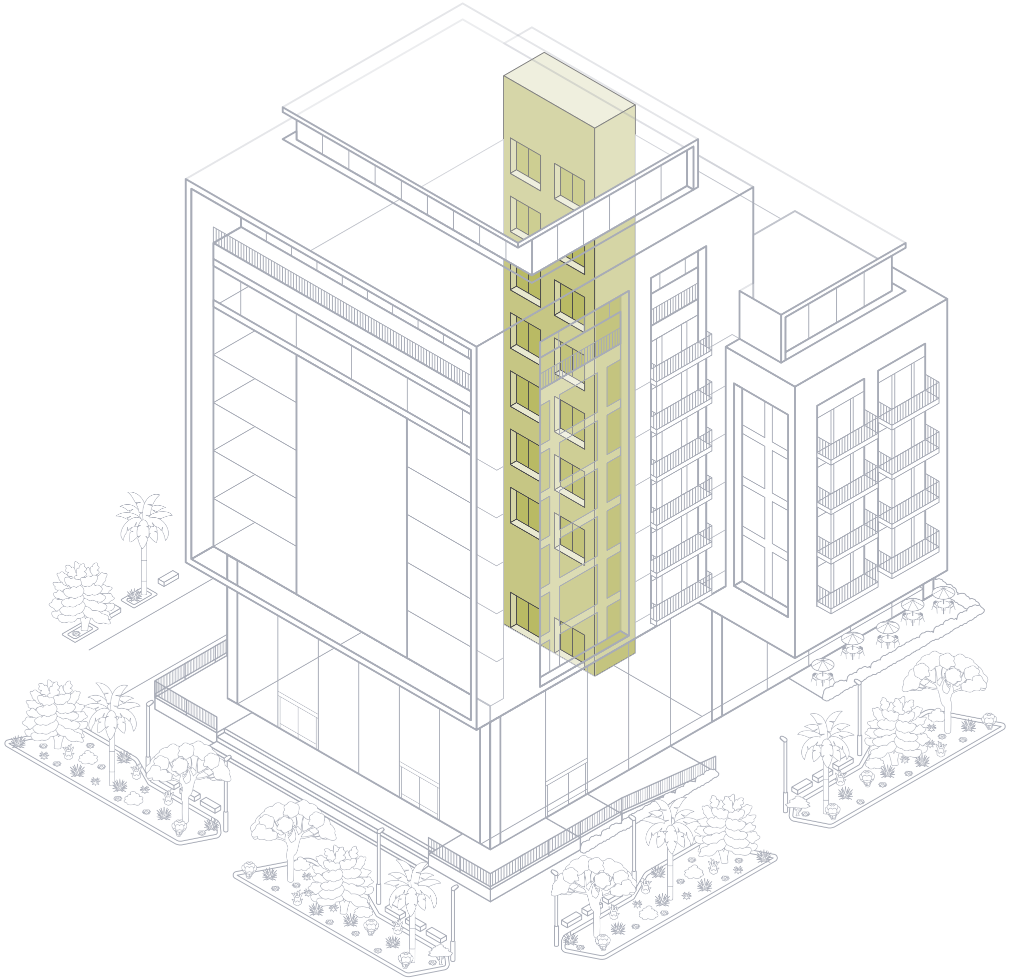
Alphabetical and symbolic writing	+	Tactile references/guiding tactile pavement	+	Braille
Alphabetical and symbolic writing	+	Alphabetical and symbolic embossed writing	+	
Alphabetical and symbolic writing	+	Alphabetical and symbolic embossed writing	+	
Alphabetical and symbolic writing	+	Oral information	+	
Alphabetical writing	+	Braille	+	
Light signal	+	Simultaneous sound signal	+	
Oral communication	+	Sign language/written text	+	

Figure C.136 Accessible communication combinations



Part D

Vertical transportation



D.1 Performance statements

Performance statement	The performance statement will be met by following the requirements of:
The building shall provide a safe, sustainable, adequate and effective vertical transportation service.	D.4 to D.9

D.2 Definitions

D.2.1 Terms

Acceleration: Rate of change of speed or velocity of an elevator (m/s²).

Arrival rate: Rate at which passengers arrive for service by an elevator system, in persons per 5 min or percentage of building population per 5 min.

Average time to destination: Average period of time (s) from when a passenger either registers a landing call or joins a queue until the responding elevator begins to open its doors at the destination floor.

Average waiting time: Average period of time (s) from when a passenger either registers a landing call or joins a queue until the responding elevator begins to open its doors at the boarding floor.

Boarding floor: Floor that provides entry into a building, including ground floors, basements, parking, podium parking, and connections between towers and car parks at high level.

Capacity factor: Filling rate of an elevator during each trip, measured in percentage to rated load.

Door closing time: Period of time (s) measured from the instant the car doors start to close until the doors are locked.

Door dwell time: Period of time (s) the elevator doors are open for a fixed length of time (dwell) after an elevator arrives at a floor. Passengers can then alight or board. These times are different to the landing calls and car calls.

Door opening time: Period of time (s) measured from the instant the car doors start to open until they are 800 mm apart.

Door pre-opening time: Time-saving feature allowing the elevator doors to open in the safe zone while arriving at landing within 200 mm from the landing level.

Flight time: Time between the instant the car doors are locked and the time when the elevator is level at the next adjacent floor.

Grouping: Elevators in a common lobby serving all or part of the floors as one group.

Gross area (GA): Floor area within the inside perimeter of the exterior walls of a building. The measurement excludes shafts and courtyards, but includes corridors, stairways, ramps, closets, base of atria (or similar voids) and the thickness of interior walls, columns or other features.

Handling capacity (HC5): Average number of passengers that an elevator or group of elevators can transport in a period of 5 min.

Handling capacity (HC5%): Percentage of the occupant load that an elevator group can transport in a period of 5 min.

High depth: A building more than 7 m below or more than two basements below the level of exit discharge, measured in accordance with the UAE FLSC [Ref. D.1]. A more detailed definition is given in UAE FLSC.

High-rise building: Building height greater than or equal to 23 m and up to 90 m, measured in accordance with the UAE FLSC [Ref. D.1]. A more detailed definition is given in UAE FLSC.

Jerk: Rate of change of acceleration (m/s³).

Occupant load: Total number of persons that might occupy a building or portion thereof.

Occupiable floor: Floor designed for human occupancy in which individuals congregate for accommodation, amusement, work, educational or similar purposes.

Rated capacity: Load (kg and number of people) for which an elevator has been built and at which it is designed to operate.

Rated speed (v): Speed (m/s) for which an elevator has been built and at which it is designed to operate.

Super high-rise building: Building height greater than 90 m, measured in accordance with the UAE FLSC [Ref. D.1]. A more detailed definition is given in UAE FLSC.

Swing mode elevator: Elevator that is used for multiple purposes, e.g. passenger/service, passenger/fire/service, or fire/service.

Zoning: Virtual separation of the floors in the buildings based on the elevator groups, such that the elevators serving one zone do not serve the other zone.

D.2.2 Acronyms and abbreviations

AC	alternating current
ASME	American Society of Mechanical Engineers
BS EN	British Standard European Norm
Ch.	chapter
CSA	Canadian Standards Association
d	depth
DBC	Dubai Building Code
DCD	Dubai Civil Defence
DCS	destination control system
DD	destination dispatch
GA	gross area
h	height
HC	handling capacity
HCDC	hall call destination control
RCC	reinforced concrete
s	seconds
UAE FLSC	United Arab Emirates Fire and Life Safety Code of Practice
VT	vertical transportation
VVVF	variable voltage and variable frequency
w	width

D.3 References

ASME A17.1/CSA B44, Safety code for elevators and escalators

ASME A17.2, Guide for inspection of elevators, escalators and moving walks

ASME A17.3, Safety code for existing elevators and escalators

ASME A17.4, Guide for emergency personnel

ASME A17.5/CSA B44.1, Elevator and escalator electrical equipment

ASME A17.6, Standard for elevator suspension, compensation and governor systems

ASME A17.7/B44.7, Performance-based safety code for elevators and escalators

BS EN 81-20, Safety rules for the construction and installation of lifts – Lifts for the transport of persons and goods – Part 20: Passenger and goods passenger lifts

BS EN 81-21, Safety rules for the construction and installation of lifts – Lifts for the transport of persons and goods – Part 21: New passenger and goods passenger lifts in existing building

BS EN 81-22, Safety rules for the construction and installation of lifts – Lifts for the transport of persons and goods – Part 22: Electric lifts with inclined path

BS EN 81-28, Safety rules for the construction and installation of lifts – Part 28: Remote alarm on passenger and goods passenger lifts

BS EN 81-31, Safety rules for the construction and installation of lifts – Lifts for the transport of goods only – Part 31: Accessible goods only lifts

BS EN 81-40, Safety rules for the construction and installation of lifts – Special lifts for the transport of persons and goods – Part 40: Stairlifts and inclined lifting platforms intended for persons with impaired mobility

BS EN 81-41, Safety rules for the construction and installation of lifts – Special lifts for the transport of persons and goods – Part 41: Vertical lifting platforms intended for use by persons with impaired mobility

BS EN 81-50, Safety rules for the construction and installation of lifts – Examinations and tests – Part 50: Design rules, calculations, examinations and tests of lift components

BS EN 81-58, Safety rules for the construction and installation of lifts – Examination and tests – Part 58: Landing doors fire resistance test

BS EN 81-70, Safety rules for the construction and installation of lifts – Particular applications for passenger and goods passenger lifts – Part 70: Accessibility to lifts for persons including persons with disability

BS EN 81-71, Safety rules for the construction and installation of lifts – Particular applications to passenger lifts and goods passenger lifts – Part 71: Vandal resistant lifts

BS EN 81-72, Safety rules for the construction and installation of lifts – Particular applications for passenger and goods passenger lifts – Part 72: Firefighters lifts

BS EN 81-73, Safety rules for the construction and installation of lifts – Particular applications for passenger and goods passenger lifts – Part 73: Behaviour of lifts in the event of fire

BS EN 81-76, Safety rules for the construction and installation of lifts – Particular applications for passengers and goods passenger lifts – Part 76: Evacuation of persons with disabilities using lifts

BS EN 81-77, Safety rules for the construction and installations of lifts – Particular applications for passenger and goods passenger lifts – Part 77: Lifts subject to seismic conditions

BS EN 81-80, Safety rules for the construction and installation of lifts – Existing lifts – Part 80: Rules for the improvement of safety of existing passenger and goods passenger lifts

BS EN 81-82, Safety rules for the construction and installation of lifts – Existing lifts – Part 82: Rules for the improvement of the accessibility of existing lifts for persons including persons with disability

BS EN 115-1, Safety of escalators and moving walks – Part 1: Construction and installation

Ref. D.1 UAE MINISTRY OF INTERIOR GENERAL COMMAND OF CIVIL DEFENCE, 2018. UAE Fire and Life Safety Code of Practice (UAE FLSC). United Arab Emirates: Ministry of Interior General Command of Civil Defence.

D.4 General

Vertical transportation includes elevators, escalators and moving walks. This section prescribes the international standards to be followed for the safety, reliability and energy conservation of vertical transportation (VT) systems.

It also sets out the following acceptable design methods for establishing the minimum number of passenger elevators in different building types:

a) design method 1 – prescriptive design using predefined numbers of passenger elevators for single occupancy building types (e.g. an apartment building with associated parking and retail at ground floor) (D.8); and

b) design method 2 – design parameters for use in performance-based vertical transportation design by VT Consultants (D.9).

The accessibility requirements for vertical circulation, including the provision of accessible elevators, are defined in C.5.9.3.

D.5 Safety and reliability

Vertical transportation shall be designed, installed, tested, commissioned and maintained in accordance with one of the following suites of standards:

a) ASME A17 suite of standards; or

b) BS EN 81 suite of standards.

One suite of standards shall be selected for a project. The suites of standards shall not be used interchangeably.

Elevators required for firefighting shall conform to Section 2.9, Ch. 2 and Section 3.9, Ch. 3 respectively of UAE FLSC [Ref. D.1], in addition to the chosen suite of standards.

In addition, enhanced handrail protection shall be provided at the entry to escalators and moving walks as shown in Figure D.1.

Figure D.1 Escalator with enhanced protection to handrail

D.6 Energy conservation

D.6.1 Elevators

Elevators in new buildings shall include controls to conserve energy. The following features shall be incorporated in traction drive elevators:

a) AC variable voltage and variable frequency (VVVF) drives on non-hydraulic elevators;

b) energy-efficient lighting, including controls that turn off lights when the elevator has been inactive for a maximum of 5 min. The energy-efficient lighting shall provide an average luminous efficacy greater than 70 lumens per circuit Watt inside the elevator; and

c) a standby condition for off-peak periods.

NOTE: Regenerative drives should be used where they are shown to save energy.

D.6.2 Escalators and moving walks

Escalators and moving walks in new buildings shall include the following features to conserve energy.

a) Reduced speed control. When no activity has been detected for a maximum of 3 min, the escalator or moving walk shall reduce to a slower speed.

b) Use on demand. When no activity has been detected for a maximum of 15 min, the escalator or moving walk shall shut down. On-demand escalators and moving walks shall feature energy efficient soft-start technology.

For both features, photocell activation detectors shall be placed at the top and bottom landing areas as shown in Figure D.2.

Figure D.2 Escalator with detectors at top and bottom landing areas

D.7 Location and arrangement of passenger elevators

D.7.1 General

The location and arrangement of passenger elevators is common to both design methods (D.8 and D.9) for establishing the minimum number of passenger elevators in different building types.

D.7.2 Location of passenger elevators

D.7.2.1 General

Passenger elevators and multipurpose (e.g. passenger and service) elevators shall be located in the entrance lobby, near to the main entrance(s) of the building.

The noise from elevator hoist-ways shall not be heard in adjacent accommodation, in accordance with **H.10.**

Elevators shall be separated from enclosed parking areas by an air-conditioned lobby. The provision of air conditioning and ventilation shall be in accordance with **H.4.**

Doors from apartments or other residential accommodation (as described in D.8.8 to D.8.13) shall not open directly into an elevator lobby.

D.7.2.2 Horizontal distances

Elevator lobbies shall be located in different building types in accordance with Table D.1.

Building type	Maximum travel distance (m)	Measured between
Accommodation and residential	60 (see Figure D.3)	Elevator lobby and the entrance door of the accommodation unit furthest away from the elevator
Open plan office	60	Elevator lobby and the furthest point on the office floor
Retail (e.g. malls, shopping centres)	150	Elevator lobby and any point on the floor
Assembly (e.g. indoor amusement parks, arenas)	150	Elevator lobby and any point on the floor
Educational	150	Elevator lobby and any point on the floor
Hotel	60	Elevator lobby and the entrance door of the guest bedroom furthest away from the elevator

Table D.1 Maximum horizontal travel distance from elevator lobbies

NOTE: Buildings with a large footprint might require multiple building entrances and elevator lobbies.

Figure D.3 Floor plan with elevator lobby showing maximum travel distance to an elevator

D.7.3 Arrangement of passenger elevators

D.7.3.1 General

A maximum of four elevators shall be accommodated in one elevator core.

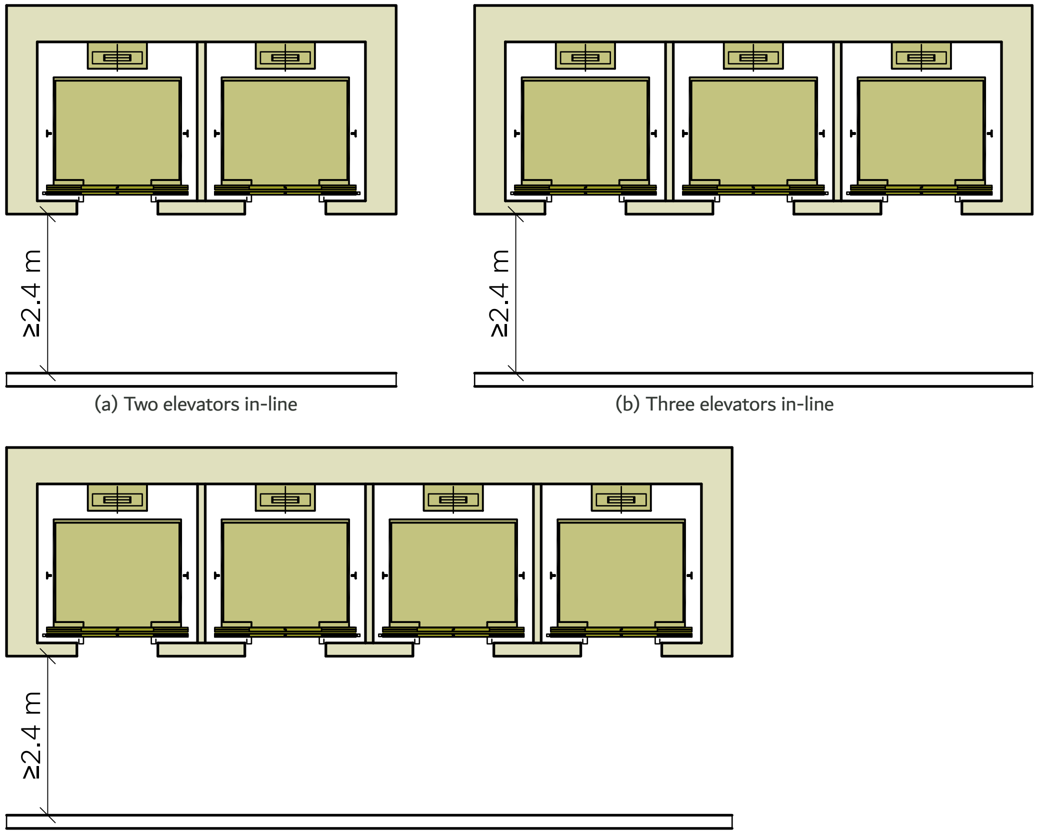
A maximum of eight elevators shall share one elevator lobby when used with a conventional control system.

D.7.3.2 Elevators in-line

Elevator grouping in a line shall be arranged as shown in Figure D.4, up to a maximum of four elevators, with the following exception.

With the exception of residential buildings, the distance in front of an elevator in a single sided lobby shall be a minimum of 2.4 m. In the typical floors (e.g. not entrance lobby) of residential buildings, the distance can be reduced to the width of the corridor leading to the elevator lobby or 1.8 m whichever is greater.

NOTE: If an elevator in the group is sized for stretchers then a lobby of 1.8 m width might not be sufficient.



(a) Two elevators in-line

(b) Three elevators in-line

(c) Four elevators in-line

Figure D.4 In-line lobby arrangement (not more than four elevators)

D.7.3.3 Elevators facing each other

Elevator grouping featuring elevators facing each other shall be arranged as shown in Figure D.5, up to a maximum of eight elevators. The distance between the two elevator cores shall be:

a) whichever is greatest of:
   1) a minimum of 2.4 m; or
   2) two times the depth of the deepest passenger elevator cabin; or
   3) 1.5 times the depth of the firefighting elevator cabin; and

b) not greater than 4.5 m.

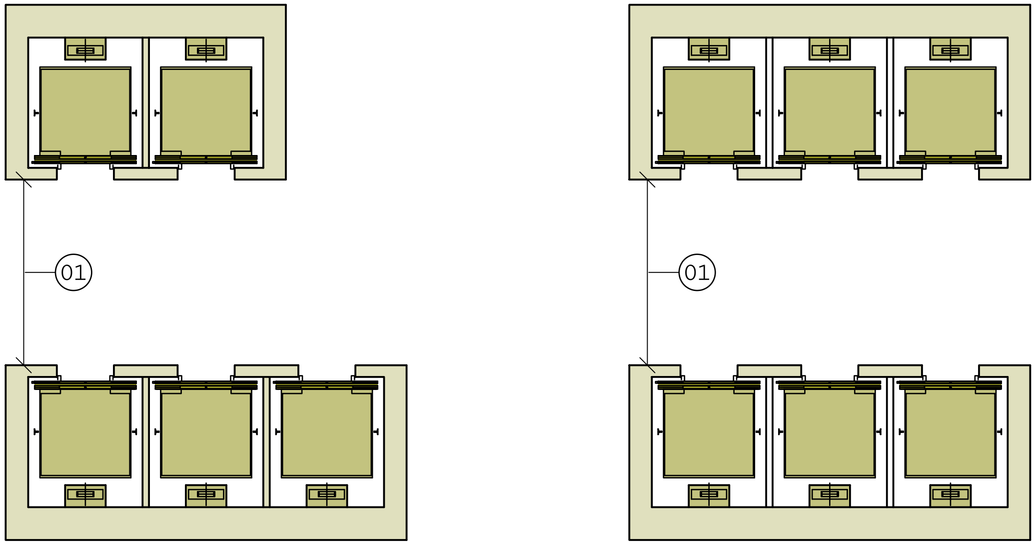


Figure D.5 Permitted distances between elevator cores

Key

01: Maximum 4.5 m and minimum 2.4 m, or a multiplier of the depth of the deepest elevator cabin

D.8 Design method 1: prescriptive design using predefined numbers of passenger elevators

D.8.1 General

Design method 1 allows designers to establish the minimum number of passenger elevators required for different single-occupancy building types, based on the following parameters:

a) building type;

b) population;

c) number of floors occupied by people;

d) number of boarding floors;

e) elevator grouping.

NOTE 1: Design method 1 is appropriate for single occupancy buildings with associated facilities such as parking or ground floor retail. Design method 2 is required for mixed use buildings such as a tower comprising 50% hotel and 50% office.

NOTE 2: The minimum number of passenger elevators can be influenced by other parameters. It is the design team's responsibility to include elevators for other services, not limited to firefighting elevators (see Section 2.9, Ch. 2 of UAE FLSC **[Ref. D.1]**), evacuation elevators (see Section 3.9, Ch. 3 of UAE FLSC **[Ref. D.1]**), service elevators (D.8.2) and waste elevators, as required by building operators, the DBC and the Authorities.

NOTE 3: Design method 2 is required for buildings whose height or population exceeds those given in the method 1 tables.

NOTE 4: Report templates for design method 1 and design method 2 are given in D.10.1 and D.10.2. A summary of the minimum information required in the design method 2 report is given in D.10.3.

Firefighting and service elevators are permitted to be used as passenger elevators provided that they are located within a group of passenger elevators.

D.8.2 Service elevators

D.8.2.1 Number of service elevators

The minimum number of service elevators serving all floors shall be selected using Table D.2. Any additional elevators to meet the design intent or the requirements of relevant Authorities shall be included as necessary.

Any authority requirement for clean and dirty elevators shall be met accordingly.

Building type	Classifications	Minimum	Remarks
Residential	—	One	The firefighting elevator or one of the passenger elevators could be used as a service elevator. Where a passenger elevator is used as a service elevator, scheduled operation for service mode is required.
Hotel	1- and 2-star	One	For keys more than 250, add one elevator for every 200 keys.
	3-star	Two	—
	4- and 5-star	Two	For keys more than 500, add one elevator for every 200 keys.
Hotel apartment	—	One	—
Office	—	One	The firefighting elevator or one of the passenger elevators could be used as a service elevator. Where a passenger elevator is used as a service elevator, scheduled operation for service mode is required.
Retail/shopping centres/malls	—	One	For buildings with more than 75 outlets, add one elevator for every 100 retail outlets.
NOTE: Minimum and recommended specifications for service elevators in different buildings types are given in D.8.8 to D.8.18.			

Table D.2 Number of service elevators

D.8.2.2 Rated speed

The rated speed of service elevators shall be selected using Figure D.6. Where a service elevator is grouped with passenger elevators, the rated speed shall be selected in accordance with D.8.6.

NOTE: It is recommended that service elevators reach the uppermost floor of a building within 60 s.

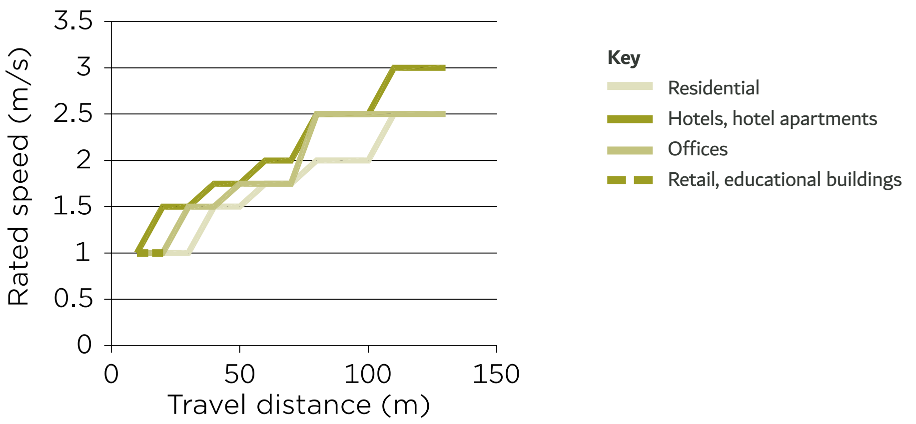


Figure D.6 Rated speed selection for service elevators

D.8.3 Firefighting elevators

D.8.3.1 Firefighting elevators

Section 2.9, Ch. 2 of UAE FLSC requires at least one firefighting elevator in a mall, a multi-storey amusement park and any building which is high-rise, super high-rise or high depth. Firefighting elevators in super high-rise shall comply with D.8.3.3.

Section 2.9, Ch. 2 of UAE FLSC [Ref. D.1] requires each firefighting elevator to have access to every floor of the building.

As specified in Ch. 1 Table 1.9 of UAE FLSC [Ref. D.1], either the firefighting elevator hoistway shall be located within a fire rated shaft constructed of reinforced concrete (RCC) or all elevators in a common RCC shaft shall be designed as firefighting elevators.

Firefighting elevators are permitted to be used as passenger elevators provided that they are located within their own dedicated RCC shaft and are in a group of passenger elevators (see D.8.7).

Section 2.9, Ch. 2 of UAE FLSC [Ref. D.1] permits firefighting elevators to be used as service elevators. Firefighting elevators are not permitted to be used as goods lifts.

D.8.3.2 Rated speed of firefighting elevators

The travel time for firefighting elevators to reach the uppermost floor of a building shall be determined using the suite of standards chosen in D.5.

UAE FLSC [Ref. D.1] requires that firefighting elevators serve all floors of a building.

D.8.3.3 Firefighting elevators in super high-rise buildings

A firefighter's elevator lobby [minimum gross area (GA) of 9 m^2] shall be provided to the firefighting elevator in super high-rise buildings (see Section 2.9, Ch. 2 and Table 1.9, Ch. 1 of UAE FLSC [Ref. D.1]). The firefighting elevator lobby shall have direct access to the firefighting elevator and a fire-rated exit stair.

Where a firefighting elevator has two doors, the second entrance is not required to open into the firefighting lobby, but it shall be protected by an alternate 1 h fire-rated lobby.

D.8.4 Minimum number of passenger elevators

The minimum number of passenger elevators shall be established based on estimated population and the number of boarding floors for each building type (see D.8.8 to D.8.18), as shown in Figure D.7.

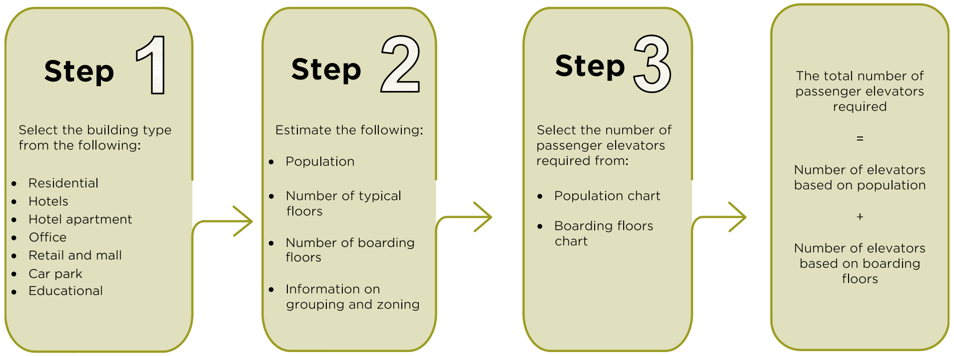


Figure D.7 Illustration for estimation of number of passenger elevators

For values beyond those shown in the charts and tables for each occupancy type, a VT Consultant shall be appointed to design a VT system based on design method 2 (see D.9).

D.8.5 Grouping of passenger elevators and population estimation

D.8.5.1 Single grouping and one floor zone

For buildings with a single elevator grouping and with one zone of floors served as shown in Figure D.8, the population shall be estimated using the occupancy rates in D.8.8 to D.8.18.

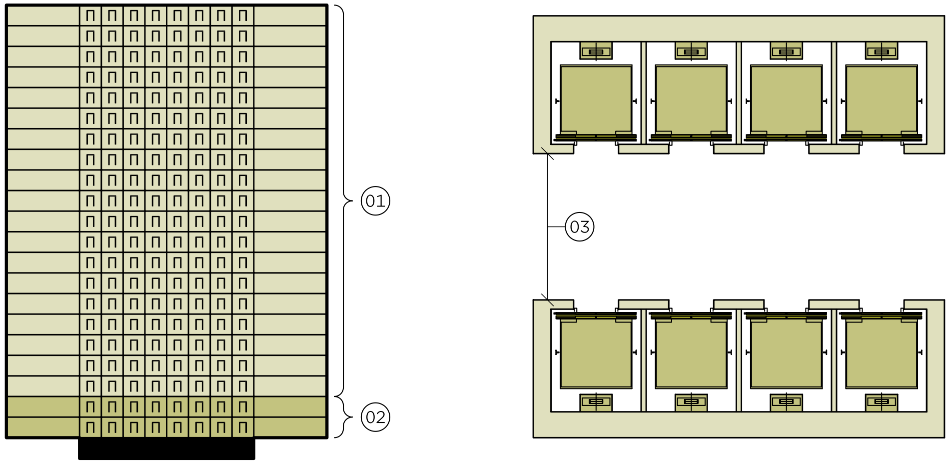


Figure D.8 One grouping-one zone

Key
01: Occupied floors
02: Boarding floors
03: Permitted distance between elevator cores

D.8.5.2 Multiple lobbies serving one zone

For buildings where two elevator groupings serve the same zone of floors, the groupings shall be located as shown in Figure D.9, based on the proximity of the lobbies to the individual units (as described in D.7.2.2).

When undertaking traffic analysis, the uneven distribution of building occupants between the two groupings shall be allowed for. The overall population used in the analysis shall be 120% of the actual building population.

The population for each elevator grouping shall be distributed based on Figure D9 and the ratios shown in Table D.3.

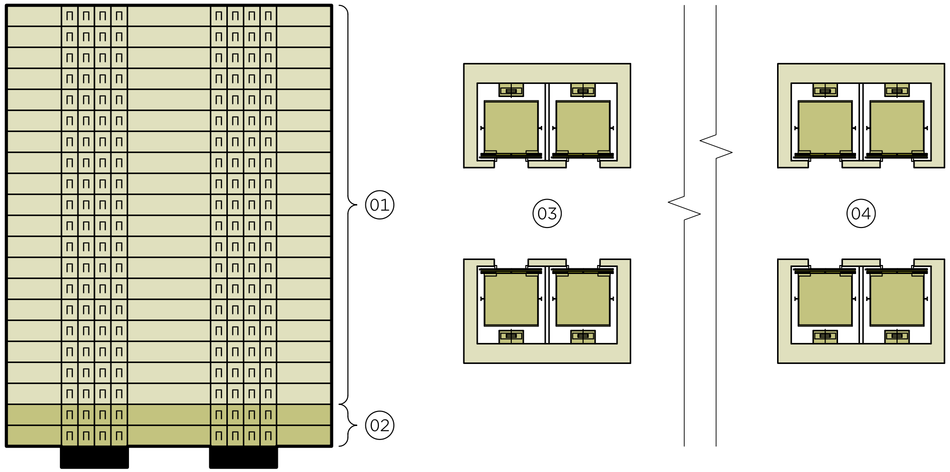


Figure D.9 Two groupings – one zone

Key
01: Occupied floors
02: Boarding floors
03: Elevator lobby group 1
04: Elevator lobby group 2

Grouping	Ratio 1		Ratio 2		Ratio 3		Ratio 4	
	Actual pop.	Pop. for traffic study	Actual pop.	Pop. for traffic study	Actual pop.	Pop. for traffic study	Actual pop.	Pop. for traffic study
Grouping 1	50%	60%	60%	70%	70%	80%	80%	90%
Grouping 2	50%	60%	40%	50%	30%	40%	20%	30%

Table D.3 Ratio of population for buildings with two elevator groupings

EXAMPLE: The actual population of a residential building is approximately 500 people. Due to its large footprint, the building has two groups of elevators. There is no definite estimation of the population using each entrance. Under these conditions, the population for each group shall be estimated as below.

Actual population = 500 people

Weighted population = 500 × 120% = 600 people

Population for traffic analysis for each group = 600/2

Population for traffic analysis for each group = 300

The number of passenger elevators for each grouping shall be selected based on the charts in D.8.8 to D.8.18.

Where more than two elevator groupings are required, a VT Consultant shall be appointed.

D.8.5.3 Multiple groupings serving different floor zones

Where multiple elevator groupings serve different floor zones, such as in Figure D.10, the population for each grouping shall be estimated based on the occupancy rates of the floors served.

When reading passenger elevator selection charts for the high zone, the low zone floors (not served) shall be included.

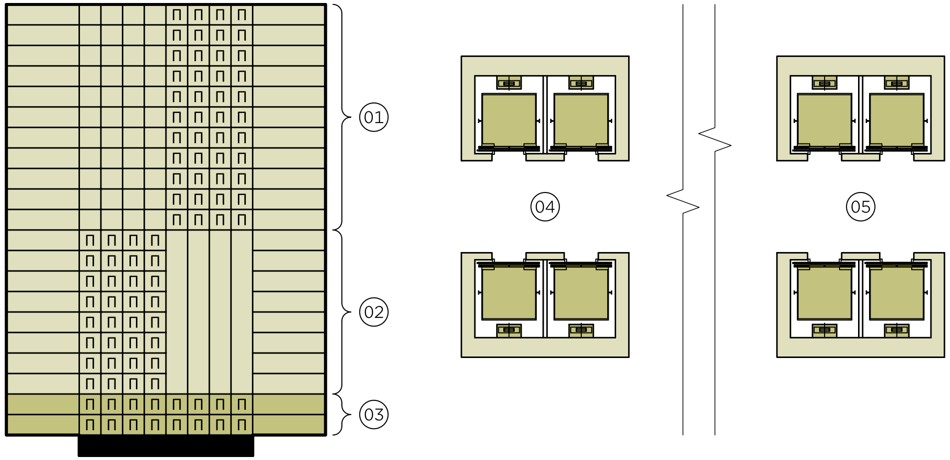


Figure D.10 Two groupings – two zones

Key

01: High zone occupied floors
02: Low zone occupied floors
03: Boarding floors
04: Elevator lobby group 1
05: Elevator lobby group 2

D.8.6 Rated speed of passenger elevators

The rated speed of passenger elevators (see Figure D.11) shall be calculated as the travel distance between the top most and bottom-most floor divided by the minimum travel time.

The minimum travel time for different building types shall be determined from Table D.4.

Building type	Classification	Travel time (s)
Residential	Apartments	40 to 45
	Accommodation buildings	50 to 60
Hotel	1- and 2-star	35 to 40
	3-star	25 to 30
	4- and 5-star	20 to 25
Hotel apartments	—	25 to 30
Office	Regular	25 to 30
	Concentrated	30 to 35
Healthcare	Clinics and hospitals	25 to 30
Retail	Retail, shopping centres and malls	25 to 30
Educational	Schools and universities	25 to 30

Table D.4 Minimum travel time for different building types

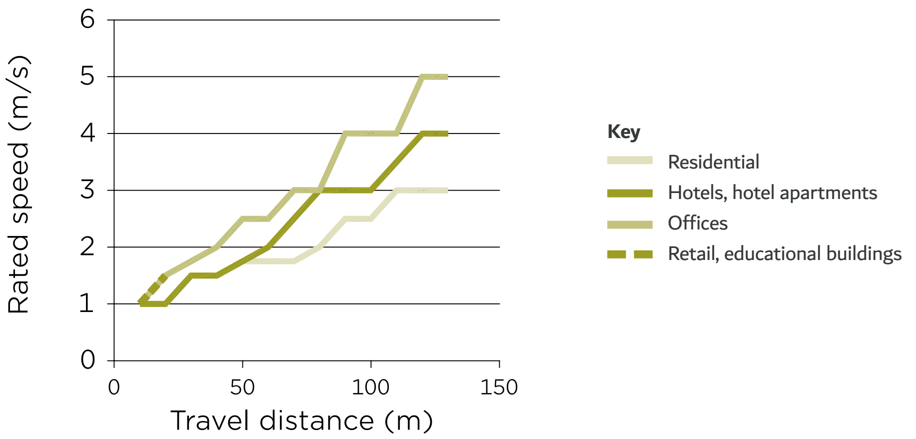


Figure D.11 Rated speed selection for passenger elevators

D.8.7 Passenger elevators serving as multipurpose or swing mode elevators

Some elevators are designed as passenger elevators, while also meeting the requirements for a firefighting elevator or the functional requirements of a service elevator. When these elevators are part of a passenger elevator grouping, they shall be included in calculations for the minimum number of passenger elevators.

Figure D.12 shows a multipurpose elevator in a passenger elevator grouping.

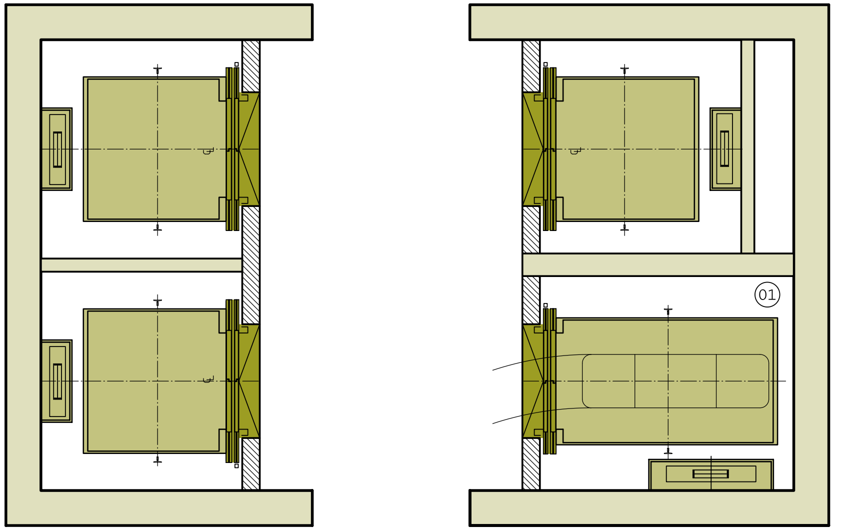


Figure D.12 Passenger, service and fire-fighting elevator in a passenger elevator grouping

Key

01: Firefighting passenger-service elevator

Table 1.9, Ch. 1 of UAE FLSC [Ref. D.1] requires that the firefighting elevator is located within its own fire-rated RCC shaft.

D.8.8 Passenger elevators in residential apartments

D.8.8.1 Population estimation

For buildings with one elevator grouping, the population shall be estimated based on the occupancy rates in Table D.5.

Apartment type	Occupancy rate (persons)
Studio	1.5
1 bedroom	1.8
2 bedrooms	3
3 bedrooms	4
4 bedrooms	5
For each additional bedroom/live-in housekeeper room	1

Table D.5 Occupancy rate for residential apartments

For buildings with more than one elevator grouping, the population shall be estimated in accordance with D.8.5.

D.8.8.2 Passenger elevator selection charts

The minimum number of passenger elevators shall be determined from Figure D.13.

Occupied floors / Population	≤200	201-300	301-400	401-500	501-600	601-700	701-800	801-900	901-1,000	1,001-1,200
31-35		3	3	4	4	5	5	5	6	6
26-30	3	3	3	3	4	4	5	5	5	6
21-25	2	3	3	3	4	4	4	5	5	6
16-20	2	3	3	3	3	4	4	4	5	5
11-15	2	2	2	3	3	3	4	4	4	5
6-10	2	2	2	2	3	3	3			
1-5	1	1	2	2						

Figure D.13 Elevator chart for population – residential apartments

The minimum number of passenger elevators shall be taken as the sum of the numbers obtained from Figure D.13 and Figure D.14.

Occupied floors	1	2	3	4	5	6
31-35	0	0	1	1	2	2
26-30	0	0	1	1	2	2
21-25	0	0	1	1	1	1
16-20	0	0	1	1	1	1
11-15	0	0	0	1	1	1
6-10	0	0	0	1		
1-5	0	0	0			

Boarding floors

(a) for population >700

Occupied floors	1	2	3	4	5	6
31-35	0	0	1	1	1	1
26-30	0	0	1	1	1	1
21-25	0	0	1	1	1	1
16-20	0	0	1	1	1	1
11-15	0	0	0	1	1	1
6-10	0	0	0	1		
1-5	0	0	0			

Boarding floors

(b) for population ≤700

Figure D.14 Elevator chart for boarding floors

D.8.8.3 Minimum elevator specifications

Elevators shall meet the minimum specifications given in Table D.6.

Attribute	Passenger elevators			Service elevators	
	Minimum for floors ≤10	Minimum for floors >10	Recommended for floors >10	Minimum	Recommended
Rated capacity (kg)	750	1,050	1,350	1,275	1,600
Rated capacity (persons)	10	14	18	17	21
Number of car doors	One	One	One	One	One
Cabin size, w × d (mm)	1,200 × 1,500	1,600 × 1,500	2,000 × 1,500	1,200 × 2,300	1,400 × 2,400
Cabin height, h (mm)	2,300	2,300	2,300	2,500	2,500
Door size, w × h (mm)	900 × 2,100	1,100 × 2,100	1,100 × 2,100	1,100 × 2,100	1,200 × 2,100
Door type	Two-panel centre opening			Two-panel centre opening	

Table D.6 Minimum specifications for elevators in residential apartment buildings

D.8.9 Passenger elevators in staff accommodation

D.8.9.1 Population estimation

For buildings with one elevator grouping, the population shall be estimated based on the occupancy rates in Table D.7. If the population required by the owner/developer and approved by the Authority is higher, the higher requirement shall be followed.

Apartment type	Occupancy rate (persons)
Studio	2
1 bedroom	2
2 bedrooms	4
3 bedrooms	6
For each additional bedroom	2

Table D.7 Occupancy rate for staff accommodation

For buildings with more than one elevator grouping, the population shall be estimated in accordance with D.8.5.

D.8.9.2 Passenger elevator selection chart

These requirements assume that staff accommodation buildings are a maximum of two storeys. The minimum number of passenger elevators shall be determined from Figure D.15.

Occupied floors \ Population	≤200	201-300	301-400	401-500	501-600	601-700	701-800	801-900	901-1,000
26-30					4	4	4	5	5
21-25				3	3	4	4	5	5
16-20			3	3	3	4	4	4	5
11-15		2	2	3	3	3	3	4	4
6-10	1	1	2	2	2	3	3		
1-5	1	1	2	2					

Figure D.15 Elevator chart for population – staff accommodation

D.8.9.3 Minimum elevator specifications

Elevators shall meet the minimum specifications in Table D.8.

Attribute	Minimum	Recommended
	Passenger	Passenger and service
Rated capacity (kg)	750	1,275
Rated capacity (persons)	10	17
Number of car doors	One	One
Cabin size, w × d (mm)	1,200 × 1,500	1,200 × 2,300
Cabin height, h (mm)	2,300	2,500
Door size, w × h (mm)	900 × 2,100	1,100 × 2,100
Door type	Two-panel centre opening	Two-panel side opening

Table D.8 Minimum specifications for elevators in staff accommodation

D.8.10 Passenger elevators in labour accommodation

D.8.10.1 Population estimation and passenger elevator selection

These requirements assume that labour accommodation buildings have a maximum of six occupiable floors and that stairs are the primary means of circulation.

The population shall be estimated based on a rate of eight persons per room, or the rate required by the owner/developer and permitted by the Authorities.

The provision shall be the higher of either:

a) one elevator for every 1,000 labourers; or

b) one elevator for every two entrances to the building.

D.8.10.2 Minimum elevator specifications

Elevators shall meet the minimum specifications in Table D.9.

Attribute	Minimum	Recommended
	Passenger	Passenger and service
Rated capacity (kg)	750	1,275
Rated capacity (persons)	10	17
Number of car doors	One	One
Cabin size, w × d (mm)	1,200 × 1,500	1,200 × 2,300
Cabin height, h (mm)	2,300	2,500
Door size, w × h (mm)	900 × 2,100	1,100 × 2,100
Door type	Two-panel centre opening	Two-panel side opening

Table D.9 Minimum specification for elevators in labour accommodation

D.8.11 Passenger elevators in student accommodation

D.8.11.1 Population estimation

The population shall be estimated based on the occupancy rates in Table D.10. If the population required by the owner/developer and permitted by the Authorities is higher, the higher requirement shall be used.

Apartment type	Occupancy rate (persons)
Studio	2
1 bedroom	2
2 bedrooms	4
3 bedrooms	6
For each additional bedroom	2

Table D.10 Occupancy rate for student accommodation

D.8.11.2 Passenger elevator selection chart

The minimum number of passenger elevators shall be determined from Figure D.16.

Occupied floors \ Population	≤200	201-300	301-400	401-500	501-600	601-700	701-800
16-20			3	4	4	4	5
11-15		3	3	4	4	4	4
6-10	2	2	3	3	3	3	4
1-5	1	2	2	2			

Figure D.16 Elevator chart for population – student accommodation

D.8.11.3 Minimum elevator specifications

Elevators shall meet the minimum specifications in Table D.11.

Attribute	Minimum	Recommended
	Passenger	Passenger and service
Rated capacity (kg)	750	1,275
Rated capacity (persons)	10	17
Number of car doors	One	One
Cabin size, w × d (mm)	1,200 × 1,500	1,200 × 2,300
Cabin height, h (mm)	2,300	2,500
Door size, w × h (mm)	900 × 2,100	1,100 × 2,100
Door type	Two-panel centre opening	Two-panel side opening

Table D.11 Minimum specifications for elevators in student accommodation

D.8.12 Passenger elevators and escalators in hotels

D.8.12.1 Population estimation

Hotel buildings include guest rooms and common spaces. The guest population shall be estimated based on the occupancy rates in Table D.12.

Building type	Occupancy rate (persons)
4- and 5-star	1.8 per room
3-star	1.5 per room
1- and 2-star	1.5 per room

Table D.12 Guest occupancy rate for hotels

It is highly recommended to provide separate elevators for use by the public. Where there is no provision for public elevators, public populations shall be added to the hotel guest population and access control measures shall be added to elevator controls to ensure authorized access to the guest floors/rooms.

The public population shall be estimated based on the occupancy rates in Table D.13.

Public areas	Occupancy rate (m^2 per person)
Meeting rooms	1.2
Ballrooms	1.5
Restaurants	1.5
Food and beverage outlets	1.5

Table D.13 Occupancy rate for public areas

For buildings with more than one elevator grouping, the population shall be estimated in accordance with D.8.5.

D.8.12.2 Passenger elevator selection chart

The minimum number of passenger elevators shall be determined from Figure D.17, Figure D.18 or Figure D.19, depending on the hotel's star rating.

Occupied floors	≤200	201-300	301-400	401-500	501-600	601-700	701-800	801-900	901-1,000
26-30					4	5	6	6	7
21-25			3	4	4	5	5	6	6
16-20			3	4	4	4	5	5	6
11-15		3	3	3	4	4	5	5	
6-10	2	2	3	3	3	4	4	4	
1-5	2	2	2						

Population

Figure D.17 Elevator chart for population – 1- and 2-star hotels

Occupied floors	≤200	201-300	301-400	401-500	501-600	601-700	701-800	801-900	901-1,000
26-30				4	5	5	7	7	8
21-25				4	5	5	6	6	7
16-20			3	4	4	5	5	6	6
11-15		3	3	4	4	4	5		
6-10	2	2	3	3	4	4	4		
1-5	2	2	2						

Population

Figure D.18 Elevator chart for population – 3-star hotels

Occupied floors	≤200	201-300	301-400	401-500	501-600	601-700	701-800	801-900
26-30					6	6	7	7
21-25				5	5	6	6	7
16-20				4	5	5	6	7
11-15		3	3	4	4	5	5	6
6-10	2	3	3	4	4	5	5	5
1-5	2	2	2					

Population

Figure D.19 Elevator chart for population – 4- and 5-star hotels

D.8.12.3 Minimum elevator specifications

Elevators shall meet the minimum specifications in Table D.14, Table D.15 or Table D.16, depending on the hotel's star rating.

J.5 describes access control requirements between hotel floors.

Attribute	Passenger elevators		Service elevators	
	Minimum	Recommended	Minimum	Recommended
Rated capacity (kg)	1,050	1,350	1,275	1,600
Rated capacity (persons)	14	18	17	21
Number of car doors	One	One	One	One
Cabin size, w × d (mm)	1,600 × 1,500	2,000 × 1,500	1,200 × 2,300	1,400 × 2,400
Cabin height, h (mm)	2,300	2,300	2,500	2,500
Door size, w × h (mm)	1,100 × 2,100	1,100 × 2,100	1,100 × 2,100	1,300 × 2,300
Door type	Two-panel centre opening		Two-panel side opening	

Table D.14 Minimum specifications for elevators in 1- and 2-star hotels

Attribute	Passenger elevators		Service elevators	
	Minimum	Recommended	Minimum	Recommended
Rated capacity (kg)	1,350	1,600	1,600	1,600
Rated capacity (persons)	18	21	21	21
Number of car doors	One	One	One	One
Cabin size, w × d (mm)	2,000 × 1,500	2,100 × 1,600	1,400 × 2,400	1,400 × 2,400
Cabin height, h (mm)	2,300	2,500	2,500	2,500
Door size, w × h (mm)	1,100 × 2,100	1,100 × 2,300	1,300 × 2,300	1,300 × 2,300
Door type	Two-panel centre opening		Two-panel side opening	

Table D.15 Minimum specifications for elevators in 3-star hotels

Attribute	Passenger elevators		Service elevators	
	Minimum	Recommended	Minimum	Recommended
Rated capacity (kg)	1,350	1,600	1,600	2,000
Rated capacity (persons)	18	21	21	26
Number of car doors	One	One	One	One
Cabin size, w × d (mm)	2,000 × 1,500	2,100 × 1,600	1,400 × 2,400	1,500 × 2,700
Cabin height, h (mm)	2,400	2,600	2,500	2,800
Door size, w × h (mm)	1,100 × 2,100	1,100 × 2,100	1,300 × 2,300	1,400 × 2,300
Door type	Two-panel centre opening		Two-panel side opening	

Table D.16 Minimum specifications for elevators in 4- and 5-star hotels

D.8.12.4 Minimum escalator specifications

Escalators providing circulation between public floors shall meet the minimum specifications in Table D.17.

Attribute	Minimum	Recommended
Practical capacity (people per hour)	4,500	4,500
Number of flat steps*	Floor height ≤6 m: Two	Three
	Floor height >6 m: Three	
Step width (mm)	1,000	1,000
Angle of inclination	Floor height ≤6 m: 35°	30°
	Floor height >6 m: 30°	
*Steps refers to the depth of an escalator step or equivalent length of moving walk.		

Table D.17 Minimum specifications for escalators

D.8.13 Passenger elevators in hotel apartments

D.8.13.1 Population estimation

The population shall be estimated based on the occupancy rates in Table D.18.

Apartment type	Occupancy rate (persons)
Studio	1
1 bedroom	1.5
2 bedrooms	2.5
3 bedrooms	3.5
For each additional bedroom	1

Table D.18 Guest occupancy rate for hotel apartments

D.8.13.2 Passenger elevator selection charts

The minimum number of passenger elevators shall be determined from Figure D.20.

Occupied floors \ Population	≤200	201-300	301-400	401-500	501-600	601-700	701-800	801-900	901-1,000
26-30			3	4	4	5	5	6	6
21-25		3	3	3	4	4	5	5	6
16-20		3	3	3	3	4	4	5	5
11-15	2	3	3	3	3	4	4	4	5
6-10	2	2	3	3	3	4			
1-5	2	2	2	3	3	3			

Figure D.20 Elevator chart for population – hotel apartments

The number of additional passenger elevators for the number of boarding floors shall be determined from Figure D.21. The minimum number of passenger elevators shall be taken as the sum of the numbers obtained from Figure D.20 and Figure D.21.

Occupied floors \ Boarding floors	1	2	3	4	5
26-30	0	0	1	1	2
21-25	0	0	0	1	2
16-20	0	0	0	0	1
11-15	0	0	0	0	0
6-10	0	0	0		
1-5	0	0			

(a) for population >700

Occupied floors \ Boarding floors	1	2	3	4	5
26-30	0	0	1	1	1
21-25	0	0	0	1	1
16-20	0	0	0	0	1
11-15	0	0	0	0	0
6-10	0	0	0		
1-5	0	0			

(b) for population ≤700

Figure D.21 Elevator chart for boarding floors – hotel apartments

D.8.13.3 Minimum elevator specifications

Elevators shall meet the minimum specifications in Table D.19. **Part J** describes access control requirements between floors.

Attribute	Passenger elevators		Service elevators	
	Minimum	Recommended	Minimum	Recommended
Rated capacity (kg)	1,050	1,350	1,600	1,600
Rated capacity (persons)	14	18	21	21
Number of car doors	One	One	One	One
Cabin size, w × d (mm)	1,600 × 1,500	2,000 × 1,500	1,400 × 2,400	1,400 × 2,400
Cabin height, h (mm)	2,300	2,300	2,500	2,500
Door size, w × h (mm)	1,100 × 2,100	1,100 × 2,100	1,200 × 2,300	1,300 × 2,300
Door type	Two-panel centre opening		Two-panel side opening	

Table D.19 Minimum specifications for elevators in hotel apartments

D.8.14 Passenger elevators and escalators in office buildings

D.8.14.1 Passenger elevator selection

For buildings with one elevator grouping, the number of passenger elevators shall be determined based on the number of boarding floors, the number of occupiable floors and GA, using Figure D.22.

Boarding floors		1	2-4	5-8	1	2-4	5-8	1	2-4	5-8	1	2-4	5-8	1	2-4	5-8	1	2-4	5-8	1	2-4	5-8	1	2-4	5-8	1	2-4	5-8	1	2-4	5-8
Occupied floors	19-20										4	6	6	5	7	7	6	8	8	7	9	9	8	10	11	8	11	12	9	12	13
	17-18										4	6	6	5	7	7	6	7	8	6	8	9	7	10	10	8	11	11	9	12	13
	15-16										4	5	6	5	6	7	5	7	8	6	8	9	7	9	10	8	10	11	9	12	12
	13-14										4	5	6	5	6	7	5	7	8	6	7	8	7	8	10	7	9	10	9	10	11
	11-12							3	5	5	4	5	6	4	5	6	5	6	7	6	7	8	6	7	9	7	9	10	9	10	11
	9-10				3	4	4	3	5	5	4	5	6	4	5	6	5	6	7	6	7	8	6	7	8	7	9	10	8	10	11
	7-8				2	3	3	3	4	4	3	5	5	4	5	6	5	6	7	5	7	8	5	7	8						
	5-6	2	2	3	2	3	3	2	3	3	3	4	5	4	5	5	4	6	6												
	3-4	1	2		2	3		2	3		3	4																			
	1-2	1	2		2	2																									
GA in m^2		≤2,500			2,501-5,000			5,001-7,500			7,501-10,000			10,001-12,500			12,501-15,000			15,001-17,500			17,501-20,000			20,001-22,500			22,501-25,000		

Figure D.22 Elevator chart for office building

Figure D.22 assumes an occupancy rate of 10 m^2 per person on 80% of the GA. For higher occupancy, a VT Consultant shall be appointed.

For buildings with more than one elevator grouping serving all floors or zones, a VT Consultant shall be appointed.

D.8.14.2 Minimum elevator specifications

Elevators shall meet the minimum specifications in Table D.20.

Attribute	Passenger elevators				Service elevators	
	Minimum		Recommended		Minimum	
	≤5 floors	>5 floors	≤5 floors	>5 floors	≤5 floors	>5 floors
Rated capacity (kg)	1,050	1,275	1,350	1,600	1,275	1,600
Rated capacity (persons)	14	17	18	21	17	21
Number of car doors	One	One	One	One	One	One
Cabin size, w × d (mm)	1,600 × 1,500	1,900 × 1,500	2,000 × 1,500	2,100 × 1,600	1,200 × 2,300	1,400 × 2,400
Cabin height, h (mm)	2,300	2,300	2,300	2,300	2,400	2,600
Door size, w × h (mm)	1,100 × 2,100	1,100 × 2,100	1,100 × 2,100	1,100 × 2,100	1,100 × 2,100	1,200 × 2,300
Door type	Two-panel centre opening				Two-panel centre opening	

Table D.20 Minimum specifications for elevators in office buildings

D.8.14.3 Minimum escalator specifications

When escalators are used for occupant circulation between parking floors and office floors, they shall meet the minimum specifications in Table D.21.

Attribute	Minimum	Recommended
Practical capacity (people per hour)	4,500	4,500
Number of flat steps*	Floor height ≤6 m: Two	Three
	Floor height >6 m: Three	
Step width (mm)	1,000	1,000
Angle of inclination	Floor height ≤6 m: 35°	30°
	Floor height >6 m: 30°	
*Steps refers to the depth of an escalator step or equivalent length of moving walk.		

Table D.21 Minimum specifications for escalators

D.8.15 Circulation in retail, shopping centres and malls

D.8.15.1 Primary and secondary modes of circulation

Escalators are used by approximately 80% of people. Where shopping trolleys will be used, inclined moving walks shall be provided instead of escalators. Where moving walks are not feasible, elevators of sufficient capacities to accommodate passengers with trolleys and return of trolleys may be provided.

Elevators are a secondary mode of circulation, used by people with specific requirements. Elevators shall be located next to escalators and moving walks. The maximum distance between sets of elevators/escalators/moving walks shall be 100 m.

Escalators and moving walks shall not replace elevators as the means of circulation for people of determination using wheelchairs.

D.8.15.2 Population estimation

The population shall be estimated based on a rate of one person per 5 m^2 of gross leasing area and public circulation area.

D.8.15.3 Selection tables

The minimum number of escalators and elevators shall be determined from Table D.22.

Population (persons)	Escalator	Elevator
Less than 600	Optional	One set of two elevators
600 to 4,500	One group	One set of two elevators
4,501 to 8,000	Two groups	Two sets of two elevators
For every additional 4,000	Add one group	Add one set of two elevators

Table D.22 Escalator and elevator selection chart for retail

The minimum number of moving walks and elevators shall be determined from Table D.23.

Population (persons)	Moving walk	Elevator
Less than 600 + trolley movement	Yes	One set of two elevators
600 to 3,600	One group	One set of two elevators
3,601 to 7,200	Two groups	Two sets of two elevators
For every additional 3,000	Add one group	Add one set of two elevators

Table D.23 Moving walks and elevator selection chart for retail

D.8.15.4 Minimum specifications

Escalators shall meet the minimum specifications in Table D.24.

Attribute	Minimum	Recommended
Practical capacity (people per hour)	4,500	4,500
Number of flat steps*	Floor height ≤6 m: Two	Three
	Floor height >6 m: Three	
Step width (mm)	1,000	1,000
Angle of inclination	Floor height ≤6 m: 35°	30°
	Floor height >6 m: 30°	
*Steps refers to the depth of an escalator step or equivalent length of moving walk.		

Table D.24 Minimum specifications for escalators

Moving walks shall meet the minimum specifications in Table D.25.

Attribute	Minimum	Recommended
Practical capacity (people per hour)	3,600 minimum	3,600
Number of flat steps*	Not applicable	Three
Pallet width (mm)	1,000 minimum	1,000
Angle of inclination	12° maximum	10° or 11°
*Steps refers to the depth of an escalator step or equivalent length of moving walk.		

Table D.25 Minimum specification for moving walks in retail buildings

Elevators shall meet the minimum specifications in Table D.26.

Attribute	Passenger elevators		Passenger elevators for trolley circulation		Service elevators		
	Minimum	Recommended	Minimum	Recommended	Minimum	Recommended	
Rated capacity (kg)	1,600	2,000	2,500	3,200	1,600	2,000	2,500
Rated capacity (persons)	21	26	33	43	21	26	33
Number of car doors	One	One	One	One	One	One	One
Cabin size, w × d (mm)	2,100 × 1,600	2,350 × 1,700	2,000 x 2,400	2,200 x 3,000	1,400 × 2,400	1,500 × 2,700	1,800 × 2,700
Cabin height, h (mm)	2,400	2,400	2,400	2,400	2,500	2,500	2,500
Door size, w × h (mm)	1,100 × 2,100	1,200 × 2,100	1,500 x 2,100	1,600 x 2,100	1,200 × 2,100	1,400 × 2,300	1,600 × 2,300
Door type	Two-panel centre opening		Four-panel centre opening		Two-panel centre opening		Four-panel centre opening

Table D.26 Minimum specifications for elevators in retail buildings

D.8.16 Passenger elevators in car parking buildings

D.8.16.1 Population estimation

These requirements assume that car parking buildings have a maximum of five floors above or below ground. The population shall be estimated based on the car occupancy rates in Table D.27.

For car parking connected to retail/shopping centres/malls with multi-level entries, a VT Consultant shall be appointed.

Types of car parking facility	Occupancy rate (persons)
Independent car parking building	1.5 per car
Parking in retail/shopping centre/mall	3.0 per car

Table D.27 Occupancy rate for car parking building

For buildings with more than one elevator grouping, the population shall be estimated in accordance with D.8.5.

D.8.16.2 Passenger elevator selection chart

The minimum number of passenger elevators shall be determined from Figure D.23.

Parking floors	≤200	201-300	301-400	401-500	501-600	601-700	701-800	801-900	901-1,000
9				3	3	3	4	4	4
8				3	3	3	3	4	4
7			3	3	3	3	3	3	4
6		2	2	3	3	3	3	3	3
5	1	2	2	2	3	3			
4	1	1	2	2	2				
3	1	1	1	2					
2	1	1	1						
1	1	1							

Population

Figure D.23 Elevator chart for car parking building

D.8.16.3 Minimum elevator specifications

Elevators shall meet the minimum specifications in Table D.28.

Attribute	Minimum	Recommended
Rated capacity (kg)	1,275	1,600
Rated capacity (persons)	17	21
Number of car doors	One	One
Cabin size, w × d (mm)	1,200 × 2,300	1,400 × 2,400
Cabin height, h (mm)	2,300	2,500
Door size, w × h (mm)	1,100 × 2,100	1,200 × 2,100
Door type	Two-panel side opening	Two-panel side opening

Table D.28 Minimum specifications for passenger elevators in car parking buildings

D.8.17 Passenger elevators in schools

These requirements assume that the school building is a maximum of five storeys, and elevators are for service applications and people of determination only. Two elevators that meet the minimum specifications in Table D.29 shall be provided.

Attribute	Minimum	Recommended
Rated capacity (kg)	750	1,275
Rated capacity (persons)	10	17
Number of car doors	One	One
Cabin size, w × d (mm)	1,200 × 1,500	1,200 × 2,300
Cabin height, h (mm)	2,300	2,500
Door size, w × h (mm)	900 × 2,100	1,100 × 2,100
Door type	Two-panel centre opening	Two-panel centre opening

Table D.29 Minimum specifications for passenger elevators in schools

D.8.18 Passenger elevators in universities

These requirements relate to multi-storey classroom buildings. For other university building types, the minimum number and specifications for elevators shall be in accordance with D.8.8 to D.8.17 as required.

The minimum number of elevators shall be determined from Table D.30. Where classroom buildings have multiple entrances, a minimum of two elevators shall be provided at each entrance.

Number of people	Number of elevators
For first 400 people	Two elevators
For every additional 300 people	One additional elevator

Table D.30 Number of passenger elevators in classroom buildings of universities

Elevators shall meet the minimum specifications in Table D.31.

Attribute	Passenger elevators		Service elevators	
	Minimum	Recommended	Minimum	Recommended
Rated capacity (kg)	1,350	1,600	1,600	2,000
Rated capacity (persons)	18	21	21	26
Number of car doors	One	One	One	One
Cabin size, w × d (mm)	2,000 × 1,500	2,100 × 1,600	1,400 × 2,400	1,500 × 2,700
Cabin height, h (mm)	2,400	2,400	2,500	2,500
Door size, w × h (mm)	1,100 × 2,100	1,100 × 2,100	1,200 × 2,100	1,400 × 2,300
Door type	Two-panel centre opening		Two-panel side opening	

Table D.31 Minimum specifications for elevators in university classroom buildings

D.9 Design method 2: design parameters for use in performance-based vertical transportation design

D.9.1 General

Design method 2 relies on a series of interrelated parameters, all of which shall be included in the VT design.

It is the design team's responsibility to include elevators for other services, not limited to firefighting and evacuation elevators (D.8.3), service elevators (D.8.2) and waste elevators, as required by building operators, the DBC and the Authorities.

NOTE: A report template for design method 2 is given in D.10.2. A summary of the minimum information required in the report is given in D.10.3.

D.9.2 Population estimation

D.9.2.1 General

The occupancy rate tables referred to in D.8.8 to D.8.18 guide the estimation of population for various building types. The VT Consultant shall use the most appropriate method for estimating population.

If the population required by the owner/developer and permitted by the Authority is higher, the higher requirement shall be followed.

D.9.3 Handling capacity and traffic pattern

D.9.3.1 Handling capacity

The handling capacity of elevators shall not exceed the values given in Table D.32 and Table D.33.

Type	Classification	Handling capacity HC5%
Residential	Apartments	7%
	Student accommodation	8%
	Staff accommodation	6%
Hotel	1- and 2-star	10%
	3-star	11%
	4- and 5-star	12% to 15%
Hotel apartment	Hotel apartment	10%
Car parking	Office/mall	8% to 10%
Office	Regular	12%
	Concentrated	12%
Healthcare	Clinics and hospitals	8% to 10%
Educational	Universities	16% to 20%
Retail	Retail, shopping centres and malls	8% to 10%

Table D.32 Handling capacity (HC5%)

Type	Classification	Handling capacity HC5%
Office	Regular	13%
	Concentrated	13%

Table D.33 Handling capacity (HC5%) during lunch break

D.9.3.2 Traffic pattern

Different building types experience different circulation patterns at different times of day. The traffic pattern adjustments given in Table D.34 shall be used in the design.

Building type	Classification	Traffic pattern
Residential	Morning	35% up/65% down
	Evening	50% up/50% down
Hotel	Morning	50% up/50% down
	Evening	50% up/50% down
Hotel apartment	Evening	50% up/50% down
Car parking	Evening	50% up/50% down
Office	Morning peak – single tenant	85% up/10% down/5% inter-floor
	Morning peak – multi-tenant	85% up/15% down
	Lunch peak – single tenant	45% up/45% down/10% inter-floor
	Lunch peak – multi-tenant	50% up/50% down
Healthcare	Patients	50% up/50% down
	Visitors	50% up/50% down
	Staff	40% up/40% down/20% inter-floor
Educational	Morning	100% up
	Breaks	40% up/40% down/20% inter-floor
Retail	Weekend evening	40% up/40% down/20% inter-floor

Table D.34 Traffic pattern

D.9.4 Average waiting time

The values in Table D.35 shall be used as the basis for elevator specifications.

Building type	Classification	Average waiting time (s)
Residential	Apartment	≤40
	Student accommodation	≤45
	Staff accommodation	≤45
Hotel	1- and 2-star	≤40
	3-star	≤35
	4- and 5-star	≤30
	Hotel apartments	≤35
Car parking	Parking in malls/offices/residences	≤40
Office	Regular	≤35
	Concentrated	≤35
Healthcare	Clinics and hospitals	≤40
Educational	Universities	≤40
Retail	Retail, shopping centres and malls	≤40

Table D.35 Average waiting time

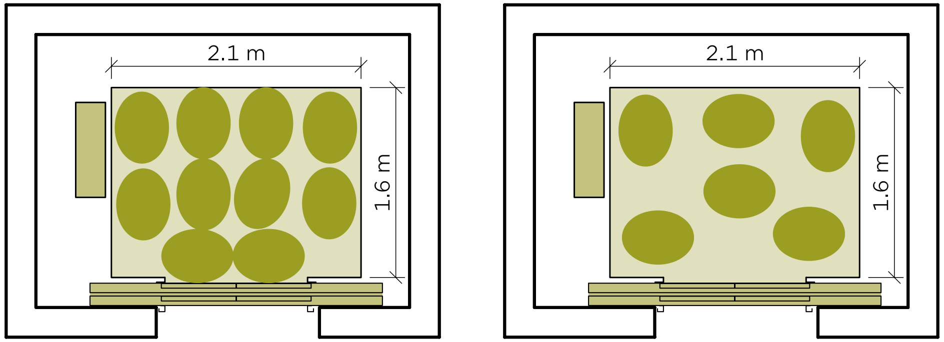
D.9.5 Capacity factor

The capacity factor of elevator cars shall not exceed the values in Table D.36. A maximum capacity factor of 70% shall be used for panoramic elevators.

Figure D.24 illustrates elevator car capacity factors.

Building type	Classification	Recommended
Residential	Apartments	60% to 80%
	Accommodation	80%
Hotel	1- and 2-star	80%
	3-star	60%
	4- and 5-star	50%
	Hotel apartments	60%
Car parking	Parking in malls/offices	80%
Office	Regular	80%
	Concentrated	80%
Healthcare	Clinics	60% to 80%
	In-patient facilities	50%
Educational	Universities	80%
Retail	Retail, shopping centres and mall	50%

Table D.36 Capacity factor



(a) overcrowded car with capacity factor approx. 80%

(b) less crowded car with capacity factor approx. 60%

Figure D.24 Occupancy in elevator car

D.9.6 Boarding floors

Car parking floors above or below the main boarding floor become boarding floors for car occupants and distribute the total building population. The population of podium and basement parking floors shall be estimated based on a rate of 1.5 persons per car.

Table D.37 gives an example population distribution for a residential building with a total population of 1,000 people and four parking floors (100 parking spaces each).

Boarding floors	Number of parking spaces	Population	Boarding bias
Podium 2	100	150	15%
Podium 1	100	150	15%
Basement floor B1	100	150	15%
Basement floor B2	100	150	15%
Ground floor	—	1,000 minus the sum of above	40%

Table D.37 Example population distribution at boarding floors

D.9.7 Magnet floors

A magnet floor is a floor likely to attract traffic from multiple other floors. Examples include staff dining rooms, restaurants, gyms and conference suites.

NOTE: Magnet floors should have dedicated elevators. If dedicated elevators are not provided, the population of the magnet floors shall be estimated and added to the building population to help determine the required number of passenger and service elevators.

Access control to residential and office floors in the building shall be provided.

D.9.8 Factors influencing VT system efficiency

D.9.8.1 Door timing

Shorter door timings improve the efficiency of an elevator. The most efficient door parameters shall only be included in the design calculations when they can be fulfilled by the manufacturer.

NOTE: Table D.38 gives door timings for different elevator operations.

<table>
<tr><th rowspan="2">Building type</th><th rowspan="2">Classification</th><th colspan="4">Door timing (s)</th></tr>
<tr><th>Door open</th><th>Door close</th><th>Dwell time</th><th>Pre-opening*</th></tr>
<tr><td rowspan="4">Residential</td><td>Apartments <120 m in height</td><td>2.2</td><td>3.2</td><td rowspan="15">3 to 5</td><td rowspan="7">0</td></tr>
<tr><td>Apartments ≥120 m in height</td><td>1.9</td><td>2.8</td></tr>
<tr><td>Student accommodation</td><td>2.2</td><td>3.2</td></tr>
<tr><td>Staff accommodation</td><td>2.2</td><td>3.2</td></tr>
<tr><td rowspan="5">Hotel</td><td>1- and 2-star</td><td>2.2</td><td>3.2</td></tr>
<tr><td>3-star</td><td>1.9</td><td>2.8</td></tr>
<tr><td>4- and 5-star</td><td>1.9</td><td>2.8</td></tr>
<tr><td>Hotel apartments <120 m in height</td><td>2.2</td><td>3.2</td><td rowspan="3">0</td></tr>
<tr><td>Hotel apartments ≥120 m in height</td><td>1.9</td><td>2.8</td></tr>
<tr><td>Car parking</td><td>Mall/residences/offices</td><td>2.2</td><td>3.2</td></tr>
<tr><td rowspan="2">Office</td><td>Regular</td><td>1.9</td><td>2.8</td><td rowspan="2">0.5</td></tr>
<tr><td>Concentrated</td><td>1.9</td><td>2.8</td></tr>
<tr><td>Healthcare</td><td>Clinics and hospitals</td><td>2.2</td><td>3.2</td><td rowspan="3">0</td></tr>
<tr><td>Educational</td><td>Schools and universities</td><td>2.2</td><td>3.2</td></tr>
<tr><td>Retail</td><td>Retail, shopping centres and malls</td><td>2.2</td><td>3.2</td></tr>
<tr><td colspan="6">* This is generally recommended in office buildings. This is not recommended in hotels and residential buildings considering the comfort levels of elders and children.</td></tr>
</table>

Table D.38 Door timing based on two-panel centre opening (900 mm wide to 1,100 mm wide)

D.9.8.2 Acceleration and jerk

Lower acceleration and jerk values provide better perceived comfort for passengers. Table D.39 gives recommended maximum values.

For bed elevators, acceleration shall not exceed 0.6 m/s^2 and jerk shall not exceed 1.0 m/s^3.

Speed (m/s)	Acceleration (m/s^2)	Jerk (m/s^3)
1	0.7	0.8
1.5 to 1.75	0.8	0.9
2.0 to 2.5	0.9	1
3.0 to 4.0	1	1.1
≥5	1.2	1.4

Table D.39 Recommended maximum acceleration and jerk at a given speed

D.9.8.3 Destination control systems

Conventional elevator control systems are the most user-friendly, but they can be less efficient compared to destination dispatch (DD)/hall call destination control (HCDC), or a destination control system (DCS).

Figure D.25 illustrates a conventional control system and Figure D.26 illustrates a DCS. In a DCS, the passenger enters the destination floor before entering the cabin. The terminal shows floor numbers or a telephone keypad.

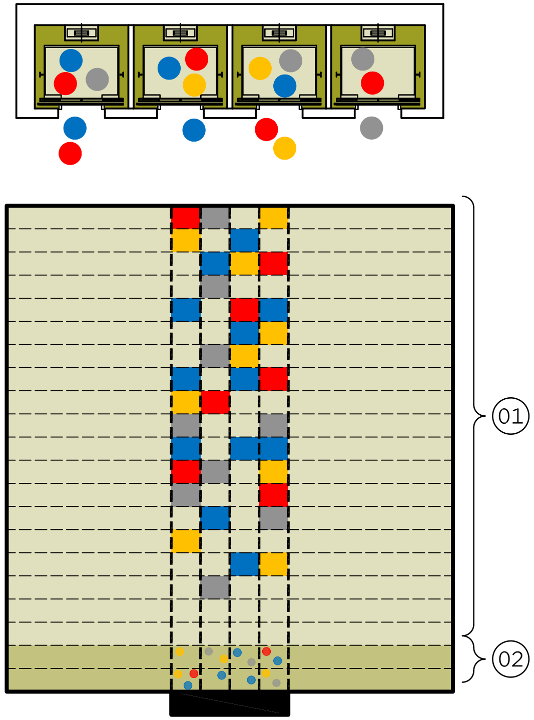


Figure D.25 Conventional control system

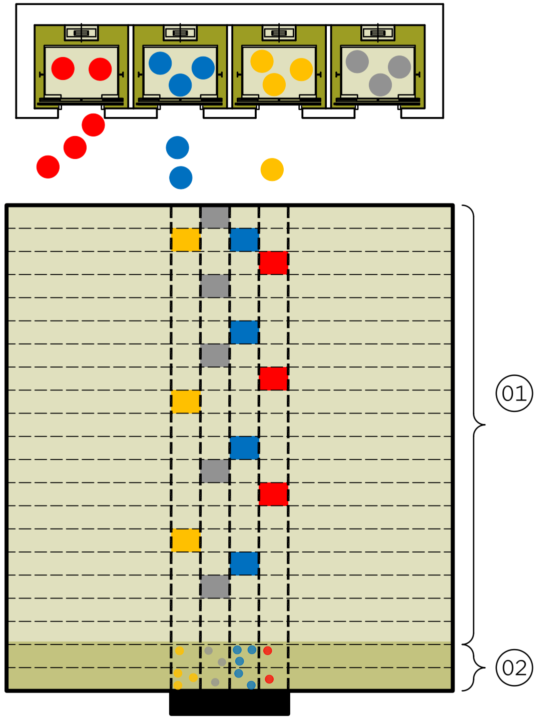


Figure D.26 Destination control system

Key

01: Typical floors

02: Boarding floors

A DCS is preferred under the following conditions.

a) The elevators in the group do not serve an equal number of stops/floors.
b) The up-peak traffic is demanding.
c) There are multiple function areas in floors/mixed use buildings.
d) Tenants and visitors enrol to get into the building/office premises.

A DCS offers the following advantages over a conventional control system.

1) It improves the time to destination by grouping people travelling to the same floors at learned intervals.
2) It results in organized lobby space, allowing more people to wait in the lobby.
3) It is able to perform express travel with fewer intervening stops.
4) It improves system efficiency and handling capacity, allowing a group of elevators to transport more passengers in a fixed period of time.
5) It allows terminals to be mounted away from the elevator lobby, reducing congestion in the elevator lobbies.

A DCS offers the following disadvantages over a conventional control system.

i) It has a relatively lower performance during the lunchtime peak.
ii) For correct and efficient operation of a DCS, each passenger needs to enter their destination and not tail-gate. Groups of people tend to allow one person to enter the destination floor, which means the DCS computes that there is only one person when there could be two, three or more persons.
iii) It is not user-friendly for people unfamiliar with the system. A passenger getting into the wrong elevator has to exit and take another elevator to reach their destination.

Table D.40 sets out building types that benefit from a DCS compared to a conventional control system.

Building type	Conventional system	Destination control system
Residential apartment – occupants are familiar with the elevator system	✓	✓
Office – occupants are familiar with the elevator system	✓	✓ ✓
Hotel – occupants are unfamiliar with the elevator system	✓	-
Hotel apartment – occupants are unfamiliar with the elevator system	✓	-
Educational building – stairs are relied upon to move between classes	✓	-
Healthcare building (staff area) – occupants are familiar with the elevator system	✓	✓
Healthcare building (all other areas) – mixture of occupants who are familiar and unfamiliar with the elevator system	✓	-

Table D.40 Recommendations for destination control systems in buildings

D.9.8.4 Hybrid systems

A hybrid system (historically called an up-peak booster) combines destination control at the main boarding floor with conventional elevator controls at other floors. A hybrid system should be used where it is necessary to overcome lag in a DCS during peak lunchtime occupant circulation.

D.10 Annex: Vertical transportation design summaries and report template

D.10.1 Vertical transportation selection summary – Design method 1

Vertical transportation selection summary (Design method 1)				
Project name			Form number	
Location			Date	
Plot no.				
Client				
Architect				
Project type				
Project classification				
	Design	Authority		
Estimated population				
Number of groups				
Occupiable floors				
Boarding floors including main lobby				
Number of passenger elevators based on population				
Number of passenger elevators based on boarding floors				
Number of dedicated firefighting elevators				
Number of dedicated service elevators				
Number of other elevators				
Total elevators in the project				
Number of escalators in the project				
Number of moving walks in the project				
Authority section				
Comments				
Reviewed by				

D.10.2 Vertical transportation design summary – Design method 2

Vertical transportation performance approval summary (Design method 2)								
Project name				Plot #			Form #	
Location							Date	
Client								
Architect								
Project type								
Project classification								
Is there a VT Consultant involved?		yes	no		Group 1			
						Morning peak	Lunch peak	Evening peak
Estimated population				Handling capacity HC5%				
Occupiable floors				Average waiting time (s)				
Boarding floors including main lobby				Average destination time (s)				
	Group 1	Group 2	Group 3		Group 2			
						Morning peak	Lunch peak	Evening peak
Capacity				Handling capacity HC5%				
Speed				Average waiting time (s)				
Door open time				Average destination time (s)				
Door closing time								
Acceleration								
Jerk								

					Group 3			
Number of passenger elevators						Morning peak	Lunch peak	Evening peak
Number of passenger elevators/ fire/service elevators				Handling capacity HC5%				
Number of dedicated firefighting elevators				Average waiting time (s)				
Number of dedicated service elevators				Average destination time (s)				
Number of other elevators								
Total elevators in the project								
Total number of escalators in the project								
Total number of moving walks in the project								
Declaration: The vertical transportation system in the project is designed within the recommended parameters, and the parameters selected shall be met by suppliers approved in the UAE.								
Remarks by VT Consultant/Lead Consultant								
Authority section								
Comments:								
Reviewed by				Approved by				

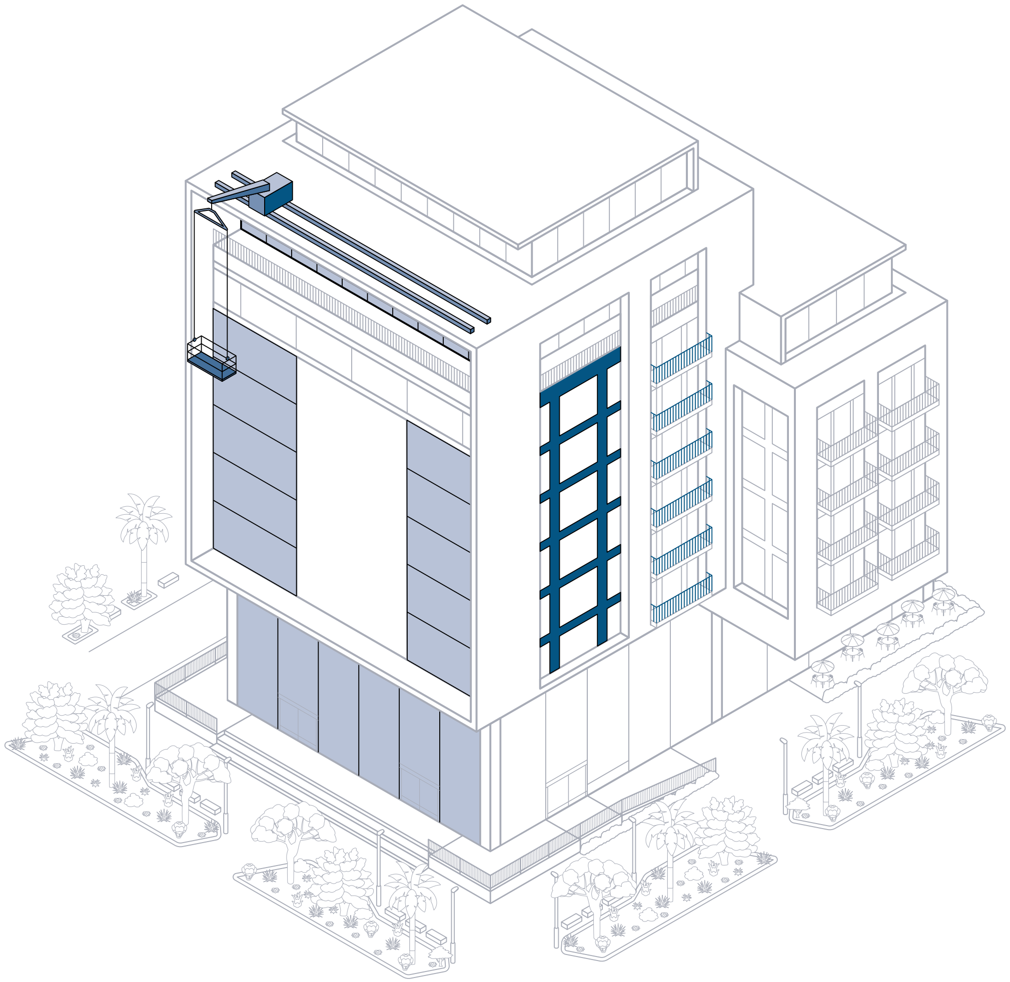
D.10.3 Vertical transportation report template for VT Consultants

Table D.41 gives a summary of the minimum information required in the report.

Summary of vertical transportation (VT) design report	
Section A	Main report
A1	Purpose of the report
A2	Project overview
A3	Assumptions
A4	Design of vertical transportation (VT) system
A5	Design elements for residences
A6	Definitions of design parameters
A7	Selection of passenger elevators
A8	Selection of firefighting elevator
A9	Selection of service and other elevators
A10	Conclusions and recommendations
Section B	Annexures
B1	Codes and requirements of Authorities
B2	Traffic analysis
B3	Planning information
B4	Requirements from Authorities

Table D.41 Summary of vertical transportation (VT) design report

Part E
Building envelope



E.1 Performance statements

Performance statement	The performance statement will be met by following the requirements of:
The building envelope shall safely resist the loads imposed upon it.	E.4
The building envelope shall reduce the energy required to cool the building.	E.5
The building envelope shall control moisture to protect the building, its users, its mechanical systems and its contents from physical or chemical damage.	E.7
The building envelope shall provide external noise protection to occupants.	E.8
The building envelope shall provide glazing that safely resists impact, whilst incorporating measures to prevent occupants colliding with the glazing.	E.9
The building envelope shall provide a safe means of opening and closing windows.	E.9
The building envelope shall adequately guard against the spread of fire.	E.10
The building shall provide safe access for cleaning and maintenance of the building envelope.	E.12

E.2 Definitions

E.2.1 Terms

Building elevation: View showing the image of one side of the building. A flat representation of one façade.

Building envelope: Physical barrier between the exterior and the conditioned environment of a building to resist air, water, moisture, heat, cold, light, and noise transfer. For an air-conditioned building, the building envelope comprises the elements of a building that separate conditioned spaces from the exterior. Crown extensions to the façade to cover plant screen cladding are part of the building envelope. The building envelope does not include the physical barrier below ground.

Building maintenance unit: Permanently installed unit that provides easy and safe access to the building envelope for maintenance, inspections and cleaning.

Containment: Glass barrier resisting penetration and preventing people from falling even after failure or breakage.

Damp-proof course: Layer of waterproof material or construction in the wall of a building near the ground, primarily to prevent rising damp.

Damp-proof membrane: Material applied to prevent moisture transmission.

Drained air space: Air layer within a wall that allows any entering water or moisture to be drained out.

Glazed element: Individual element within a building envelope that lets in light, including windows, plastic panels, clerestories, skylights, doors that are more than one half glass, and glass block walls.

Glazing: Glass that is installed as one of the components of a wall, floor, ceiling or roofing system.

Gross wall area: Area of the wall that provides the thermal barrier of the building. It includes the solid area and any openings in the wall, such as doors or windows. It is the actual measured area, not the projected area on a drawing.

Groundwater pressure: Pressure of groundwater held within a soil or rock, in gaps between particles.

Guardrail: Vertical protective barrier erected along elevated walking surfaces, exposed edges of stairways, balconies and similar areas that minimizes the possibility of fall from elevated surfaces to lower level.

High-rise building: Building height greater than or equal to 23 m and up to 90 m, measured in accordance with the UAE FLSC [Ref. E.1]. A more detailed definition is given in UAE FLSC.

Interstitial condensation: Condensation which occurs within or between layers of a construction.

Light transmittance: Percentage of incident light that passes through the glazed elements. When this percentage increases, the amount of daylight that passes into the building will increase.

Low-rise building: Building height less than or up to 15 m, measured in accordance with the UAE FLSC [Ref. E.1]. A more detailed definition is given in UAE FLSC.

Manifestation: Clear markings on transparent glazing to enable occupants to see the glazing as a hazard to be avoided.

Mid-rise building: Building height greater than 15 m but less than 23 m, measured in accordance with the UAE FLSC [Ref. E.1]. A more detailed definition is given in UAE FLSC.

Moisture: Water or other liquid diffused in a small quantity as vapour, within a solid, or condensed on a surface.

Mould: Type of fungus that grows on damp or decaying material surfaces.

Operational forces: Forces sustained by the building envelope during operation of the building, e.g. impact from equipment or occupants.

Rope access or abseiling: Form of work positioning that allows rope access technicians to descend, ascend and traverse ropes for access and work while suspended by their harness.

Shading coefficient (SC): Ratio of solar heat gain at normal incidence through glazing to that occurring through an approximately 3 mm thick clear float glass.

Shading device: Projecting fixture that extends outside the external wall of any building, or a cover (such as a louver), to protect any door or window from rain or solar effect.

Skylight or overhead glazing: Glass or other transparent or translucent glazing material installed at a slope of 15° or more from vertical.

Solar reflectance index (SRI): Index that combines reflectivity and emissivity, measuring a material's ability to reject solar heat. SRI is defined such that a standard black (reflectance 0.05 and emittance 0.90) is 0 and a standard white (reflectance 0.80 and emittance 0.90) is 100. Materials with higher SRI absorb less heat and can reduce heat island effect.

Solid metal panels: factory manufactured panel consisting of solid metal skin or skins without a core. Solid metal panels could be aluminium, steel, copper, zinc, stainless steel, titanium, etc.

Surface condensation: Condensation which occurs on a visible surface within a building.

Super high-rise building: Building height greater than 90 m, measured in accordance with the UAE FLSC [Ref. E.1]. A more detailed definition is given in UAE FLSC.

Thermal bridge: Component or assembly of components penetrating through an otherwise continuous thermal line through which heat is transferred at a substantially higher rate than through the surrounding envelope areas. Examples could be a metal fastener, concrete beam, balcony slab or column.

Thermal insulation: Materials/products or the methods and processes used to reduce heat transfer. Heat energy can be transferred by conduction, convection or radiation. The flow of heat can be delayed by addressing one or more of these mechanisms and is dependent on the physical properties of the material employed to do this.

Thermal transmittance: Rate of transfer of heat through a material(s) or assembly, expressed as a U-value.

Vapour resistance layer: Material layer within a wall or roof build-up with a high resistance to moisture vapour.

Window-to-wall ratio (WWR): Percentage determined by dividing the glazed area by the total external wall area of the building envelope. WWR can be calculation per orientation or per entire building.

E.2.2 Acronyms and abbreviations

ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
ASTM	ASTM International
BMU	building maintenance unit
BRE	Building Research Establishment
BS	British Standard
BS EN	British Standard European Norm
CFR	Code of Federal Regulations
Ch.	chapter
CPSC	Consumer Product Safety Commission
CWCT	Centre for Window and Cladding Technology
DCD	Dubai Civil Defence
ETA	European technical assessment
FFL	finished floor level
FM	Factory Mutual
IBC	International Building Code
IRATA	Industrial Rope Access Trade Association
ISO	International Organization for Standardization
NFPA	National Fire Protection Association
PV	photovoltaic
SRI	solar reflectance index
TN	technical note
UAE FLSC	UAE Fire and Life Safety Code of Practice
UL	Underwriters Laboratories
WWR	window to wall ratio

E.3 References

E.3.1 Essential references

ANSI Z97.1, Safety glazing materials used in buildings

ASCE/SEI 7-16, Minimum design loads and associated criteria for buildings and other structures

ASHRAE 90.1:2019, Energy standard for buildings except low rise residential buildings

ASTM D1929, Standard test method for determining ignition temperature of plastics

ASTM E1300, Standard practice for determining load resistance of glass in buildings

ASTM E108, Standard test methods for fire tests of roof coverings

ASTM E119, Standard test methods for fire tests of building construction and materials

BS 5250, Code of practice for control of condensation in building

BS 6262-4, Glazing for buildings – Part 4: Code of practice for safety related to human impact

BS 8102, Code of practice for protection of below ground structures against water from the ground

BS 8414-1, Fire performance of external cladding systems – Part 1: Test method for non-loadbearing external cladding systems fixed to, and supported by, a masonry substrate

BS 8414-2, Fire performance of external cladding systems – Part 2: Test method for non-loadbearing external cladding systems fixed to and supported by a structural steel frame

BS EN 12600, Glass in building – Pendulum test – Impact test method and classification for flat glass

BS EN 13501-1, Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests

BS EN 13501-5, Fire classification of construction products and building elements – Part 5: Classification using data from external fire exposure to roofs tests

BS EN 1364-3, Fire resistance tests for non-loadbearing elements – Curtain walling – Part 3: Full configuration (complete assembly)

BS EN 1364-4, Fire resistance tests for non-loadbearing elements – Curtain walling – Part 4: Part configuration

FM 4881, Evaluating exterior wall systems

ISO 13785-2, Reaction-to-fire tests for façades – Part 2: Large-scale test

NFPA 256, Standard methods of fire tests of roof coverings

NFPA 276 Standard method of fire test for determining the heat release rate of roofing assemblies with combustible above-deck roofing components

NFPA 285, Standard fire test method for evaluation of fire propagation characteristics of exterior wall assemblies containing combustible components

UL 263, Standard for fire tests of building construction and materials

UL 790, Standard for standard test methods for fire tests of roof coverings

Ref. E.1 UAE MINISTRY OF INTERIOR GENERAL COMMAND OF CIVIL DEFENCE, 2018. UAE Fire and Life Safety Code of Practice (UAE FLSC). United Arab Emirates: Ministry of Interior General Command of Civil Defence.

Ref. E.2 CENTRE FOR WINDOW AND CLADDING TECHNOLOGY, 2005. Standard for systemised building envelopes. Bath: CWCT.

Ref. E.3 INSTITUTION OF STRUCTURAL ENGINEERS, 2014. Structural use of glass in buildings. 2nd ed. London: IStructE Ltd.

Ref. E.4 EUROPEAN ORGANISATION FOR TECHNICAL APPROVALS, 2011. Guideline for European technical approval for structural sealant glazing systems (SSGS). ETAG 002. Brussels: EOTA.

Ref. E.5 INTERNATIONAL CODE COUNCIL, 2015. International Building Code. Section 1404, Section 1405 and Ch. 20 to 24. Washington: ICC.

Ref. E.6 CENTRE FOR WINDOW AND CLADDING TECHNOLOGY, 2012. Impact performance of building envelopes: Guidance on specification. Technical note 75 (TN 75). Bath: CWCT.

Ref. E.7 CENTRE FOR WINDOW AND CLADDING TECHNOLOGY, 2012. Impact performance of building envelopes: Method for impact testing cladding panels. Technical note 76 (TN 76). Bath, UK: CWCT.

Ref. E.8 BUILDING RESEARCH ESTABLISHMENT, 2006. Assessing the effects of thermal bridging at junctions and around openings. IP 1/06. Bracknell: BRE.

Ref. E.9 CONSUMER PRODUCT SAFETY COMMISSION, 2016. Safety standard for architectural glazing materials. 16 CFR 1201. Bethesda: CPSC.

Ref. E.10 CENTRE FOR WINDOW AND CLADDING TECHNOLOGY, 2019. Safety and fragility of glazed roofing: Guidance on specification. Technical note 66 (TN 66). Bath: CWCT.

Ref. E.11 CENTRE FOR WINDOW AND CLADDING TECHNOLOGY, 2010. Safety and fragility of glazed roofing: Testing and assessment. Technical note 67 (TN 67). Bath: CWCT.

Ref. E.12 BUILDING RESEARCH ESTABLISHMENT, 2013. Fire performance of external thermal insulation for walls of multi-storey buildings. BR 135. Watford: BRE.

Ref. E.13 CENTRE FOR WINDOW AND CLADDING TECHNOLOGY, 2016. Assessing cradle and suspended access equipment. Technical note 96 (TN 96). Bath: CWCT.

Ref. E.14 INDUSTRIAL ROPE ACCESS TRADE ASSOCIATION (IRATA), 2014. International Code of Practice. Kent: IRATA International.

E.3.2 Further reading

INSTITUTION OF STRUCTURAL ENGINEERS, 2020. Structural aspects of cladding. London: IStructE Ltd.

GREAT BRITAIN, 2013. The Building Regulations 2010, Approved Document C: Site preparation and resistance to contaminants and moisture. 2004 ed. with 2010 and 2013 amendments. London: The National Building Specification (NBS).

GREAT BRITAIN, 2013. The Building Regulations 2010, Approved Document K: Protection from falling collision and impact. 2013 ed. London: The National Building Specification (NBS).

E.4 Structural

E.4.1 Strength and stability

E.4.1.1 General

Any part of the building envelope presents a hazard if it becomes detached from the building. The building envelope and associated openings shall be designed and constructed to safely resist the loads required by **Part F** and those mentioned in this section.

The building envelope shall:

a) be capable of safely sustaining, and transmitting to the supporting structure of the building, all static and dynamic design loads (i.e. dead, imposed, thermal, seismic, wind, etc.) without fracture or permanent deterioration of its performance;

b) be securely fixed to and supported by the structure of the building. This shall comprise both vertical support and horizontal restraints;

c) be made, where necessary, to accommodate differential movement of the cladding and the supporting structure of the building (such as differential settlement, inter-storey drifts, etc.);

d) be of durable materials/products. The service life of the fixings shall be not less than the building envelope design life. Fixings shall be corrosion-resistant and of a material type appropriate for the local environment and exposure conditions;

e) not fully or partially detach from the building (although it may break under the life safety structural performance level as described in **F.7.13**); and

f) not be a source of noise or be at risk of resonant excitation caused by wind.

E.4.1.2 Wind loadings

Wind load shall be calculated in accordance with **Part F** or by wind tunnel testing carried out in accordance with **Part F**.

Test loads simulating wind loading shall be applied perpendicularly to the building envelope at its weakest point.

NOTE: Pressure coefficients often vary across the building envelope. Higher pressure is expected at corners.

E.4.1.3 Permanent fixture loading

Building envelopes which are intended to support permanent fixtures and/or building maintenance equipment attached to either internal or external faces shall be capable of withstanding, without excessive deflection or permanent deterioration of its performance, the forces arising from these fixtures, including during use.

E.4.1.4 Operational forces

The building envelope shall be capable of sustaining and transferring the following loads without any reduction in its performance:

a) a horizontal load applied on the surface of panels or on framing members in accordance with Section 4.5.1 of ASCE/SEI 07-16;

b) a uniformly distributed load of 0.6 kN/m^2 or a 1 kN vertical load, whichever is the most onerous, applied anywhere on internal ledges, horizontal framing members or horizontal surfaces; and

c) loads resulting from the operation of cleaning cradles, anchor restraint points, equipment or operators.

Parts of the building envelope protecting occupants from a change in level greater than 760 mm shall either be designed to withstand the forces given in Section 4.5.1 of ASCE/SEI 7-16 or be provided with a guardrail in accordance with B.4.2.5.2.

Balustrades and guardrails at balconies, terraces, roofs and changes in level greater than 760 mm shall conform to B.4.2.5.2.

E.4.1.5 Thermal movements

The building envelope shall be capable of accommodating changes in dimension and shape of its components resulting from changes in service temperatures, and from differential service temperatures between the inside and outside of the building, without any reduction in its performance.

E.4.1.6 Deflection

Under the action of the most onerous combination of loads, the deflections of building envelope components shall be limited such that no defect occurs, and deflections are fully recovered after removal of loads.

The allowable limit deflection shall be determined by material properties, the distance between points of attachment and the methods of attachment.

NOTE: The deflections given in Table E.1 are generally acceptable in line with Part 3 of the CWCT Standard for systemised building envelopes [Ref. E.2].

Component	Measurement	Maximum deflection
Storey-height assemblies, other than masonry	Between points of attachment to structure	1/200 for span ≤ 3,000 mm 5 mm + 1/300 for 3,000 mm < span < 7,500 mm 1/250 for span ≥ 7,500 mm
Opaque infill panels in secondary framing, excluding glass	Between points of support	1/360 for brittle material such as stone 1/90 for non-brittle materials such as aluminium or steel Manufacturer recommendation shall also be sought.
Framing containing glass: Single glass Insulating glass units	Between ends of frame Between ends of unit	1/125 span of member 1/175 span of double-glazed unit Manufacturer recommendation shall also be sought.

Table E.1 Maximum recoverable deflection under design load

Deflection limits of main structural elements are given in F.8.

E.4.1.7 Fixings

Fixings to secure the building envelope shall be selected based on the proven performance of the fixing. Manufacturer test data is generally determined using a European technical assessment (ETA), a British Standard (BS), a European Norm (EN) or an ASTM International (ASTM) standard.

The strength of fixings shall be selected based on tests using materials representative of the material into which the fixing is to be anchored, taking account of any inherent weaknesses that might affect the strength of the fixing (e.g. cracks in concrete due to shrinkage and flexure, or voids in masonry construction).

The design of any component shall address the consequences of failure of any individual fixing.

Fixings shall not be welded.

E.4.2 Structural use of glass

Glass used structurally, or glass that is not supported by load-bearing framing or that is providing in-plane restraints to components, shall be designed with redundancy in the system. The redundancy shall be such that if failure or breakage of the glass occurs, the loading is shared by adjacent components.

NOTE: The Institution of Structural Engineer's report on structural use of glass in buildings [Ref. E.3] gives further guidance.

E.4.3 Structural use of silicone

The structural use of silicone in the building envelope shall be in accordance with ETAG 002 [Ref. E.4].

E.4.4 Materials

Building envelope materials and components shall meet the requirements given in F.6 and IBC [Ref. E.5], Section 1404, Section 1405 and Ch. 23 to Ch. 26.

The properties of glass used in the structural design shall be in accordance with ASTM E1300.

E.4.5 Impact resistance

The building envelope shall be capable of withstanding applied or transferred impacts that might occur during normal use (whether accidental, e.g. an object being kicked, or deliberate, e.g. during maintenance) without sustaining damage that is not repairable and without deterioration of its performance.

The test energy impacts for opaque areas should be not less than those given in Table E.2, in accordance with CWCT TN 75 [Ref. E.6].

Soft and hard body testing shall follow the procedures in CWCT TN 76 [Ref. E.7].

Areas of exposure	Description	Soft body		Hard body	
		Safety	Serviceability	Safety	Serviceability
Areas within 1.5 m of ground or adjacent finished floor level (FFL)	Area accessible to the public and building users. Chance of accident occurring and of misuse.	500 J	120 J	10 J	10 J
	Other accessible areas. Some chance of accident occurring or of misuse.	500 J	120 J	10 J	6 J
Areas between 1.5 m to 6 m above ground or above adjacent FFL	Area liable to impacts from thrown or kicked objects. Might also be subject to impact during maintenance which might impose a higher impact energy.	350 J	120 J	10 J	6 J
Areas more than 6 m above ground or above adjacent FFL	Area mainly subject to impact during maintenance which might impose a higher impact energy.	350 J	120 J	3 J	3 J

Table E.2 Exposure categories and minimum impact test energy for opaque areas

When subjected to the serviceability impact in Table E.2, materials and products used in the building envelope shall achieve the following performance.

a) Brittle materials shall present no failure or damage.

b) Other materials shall present no harm to surface finish, no indentation or damage.

Serviceability impacts shall not adversely affect the structural safety of the building, or damage any part of the building such that it could fall or cause serious injury to people inside or outside the building.

The impact strength for glazing and plastic glazing sheet materials shall be obtained from the safety and security recommendations in BS 6262-4.

E.4.6 Load combination

Load shall be factored and combined in accordance with ASCE/SEI 7-16.

E.5 Energy conservation

E.5.1 Energy compliance method

There are two compliance routes for energy performance, as shown in Figure E.1.

Where the performance method in Figure E.1 is to be used, the reference building shall be equal in shape, size, orientation and operational patterns to the proposed building. Calculation shall be determined in accordance with ASHRAE 90.1:2019, Appendix G, except for the minimum requirements for building envelope, equipment efficiencies and other parameters and conditions that are listed in the elemental method in Figure E.1.

Compliance will be demonstrated if the annual energy consumption of the proposed building is equal to or lower than the annual energy consumption of the reference building.

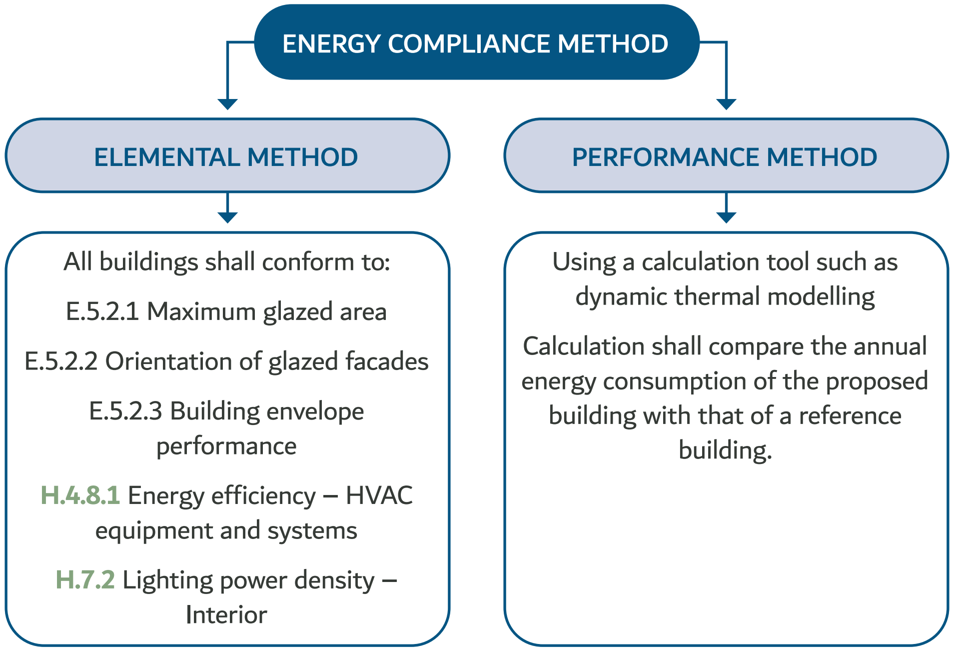


Figure E.1 Flow chart for energy compliance method

E.5.2 Elemental method requirements

E.5.2.1 Maximum glazed area

Except for shopfronts, the total WWR of glazed façades for conditioned spaces shall not exceed:

a) 40% of the gross wall area for residential buildings; and

b) 60% of the gross wall area for all other building types.

E.5.2.2 Orientation of glazed facades

For every orientation of the building, the percentage of the building elevation that is glazed shall not exceed the values in Table E.3. Orientation shall be defined by the angles in Table E.3 and as shown in Figure E.2.

Orientation of glazed element	Perpendicular angle from North (α)	Percentage of glazing per building elevation
North	–22.5° ≤ α < 22.5°	≤80%
Northeast	22.5° ≤ α < 67.5°	≤70%
East	67.5° ≤ α < 112.5°	≤60%
Southeast	112.5° ≤ α < 157.5°	≤40%
South	157.5° ≤ α < 202.5°	≤40%
Southwest	202.5° ≤ α < 247.5°	≤40%
West	247.5° ≤ α < 292.5°	≤60%
Northwest	292.5° ≤ α < 337.5°	≤70%

Table E.3 Window to external wall ratio based on orientation

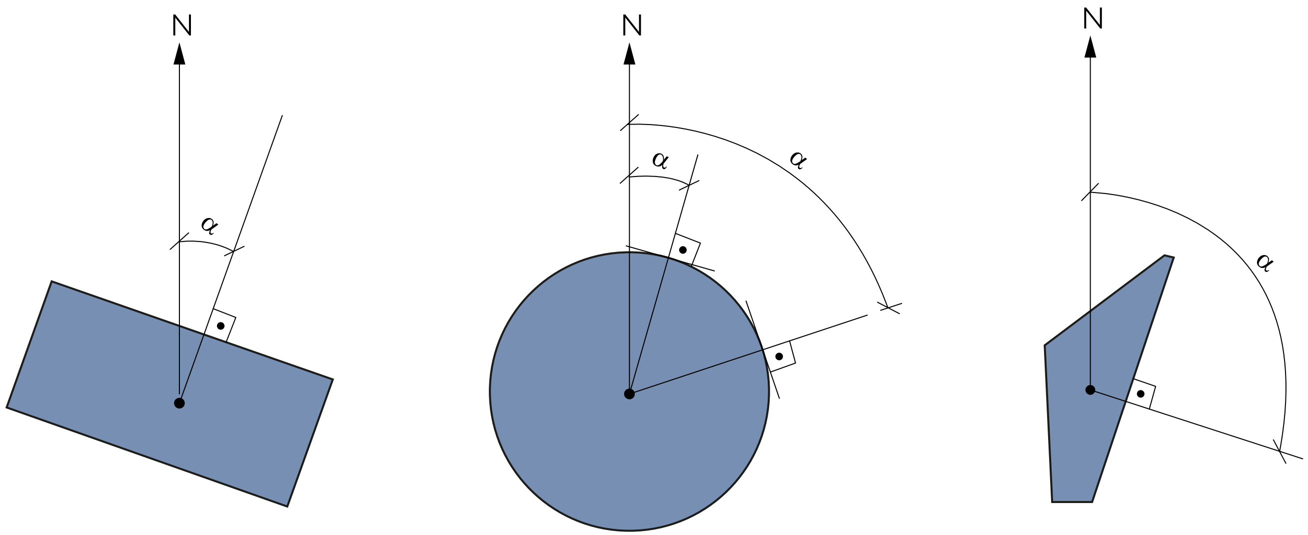


Figure E.2 Orientation of glazed façade

E.5.2.3 Building envelope performance

E.5.2.3.1 Non-glazed elements

With the exception of non-conditioned enclosed parking areas, the average thermal transmittance for external walls, roofs, and exposed floors (the underside of the floor is exposed to ambient conditions) shall not exceed the values in Table E.4 and Figure E.3.

Element	Average thermal transmittance (W/m²K)
Roof	≤0.3
External wall and exposed floor	≤0.57

Table E.4 Thermal transmittance for non-glazed elements of roof, external wall and exposed floor

While the U-value for external walls can be achieved using aerated concrete blocks, the use of insulation for the entire building envelope is recommended. Insulation materials shall conform to Sections 4 to 7, Ch. 1 of UAE FLSC [Ref. E.1].

For the floor area that is in contact with the ground, the thermal transmittance requirement shall be achieved by installing 1 m of perimeter insulation as shown in Figure E.3.

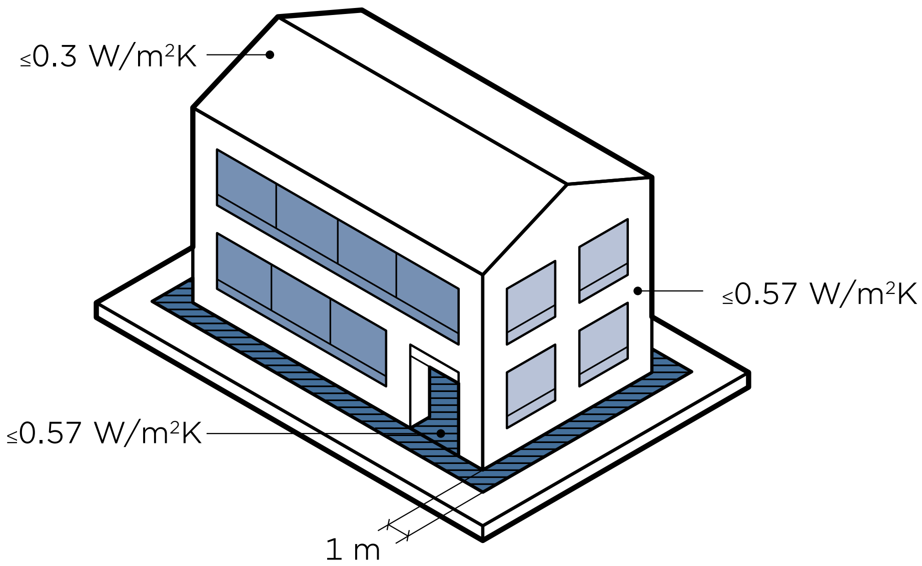


Figure E.3 Thermal transmittance for non-glazed elements of roof, external wall and exposed floor

E.5.2.3.2 Glazed elements

The glazed elements shall meet the performance criteria in Table E.5. The total glazed façade shall conform to E.5.2.1.

Glazed vertical surfaces	Total glazed area		
	<40%	40% to 60%	>60%
Thermal transmittance (U-value) in W/m²K	≤2.1	≤1.9	≤1.7
Shading coefficient	≤0.4	≤0.32	≤0.25
Light transmittance	≥40%	≥32%	≥25%

Table E.5 Performance criteria for glazed vertical surfaces based on total glazed area

For shopfronts and showrooms, other than those at ground floor level, glazed elements shall meet the performance criteria in Table E.6.

Shopfronts and showrooms	Required performance criteria
Thermal transmittance (U-value) in W/m²K	≤1.9
Shading coefficient	≤0.76

Table E.6 Performance criteria for glazed shopfronts and showrooms, except ground floor

For skylights, the performance criteria in Table E.7 shall be met depending on the area of glazing over the total roof area.

Skylights	Percentage of glazed roof based on total roof area	
	≤10%	>10%
Thermal transmittance (U-value) in W/m²K	≤1.9	≤1.9
Shading coefficient	≤0.32	≤0.25
Light transmittance	≥32%	≥25%

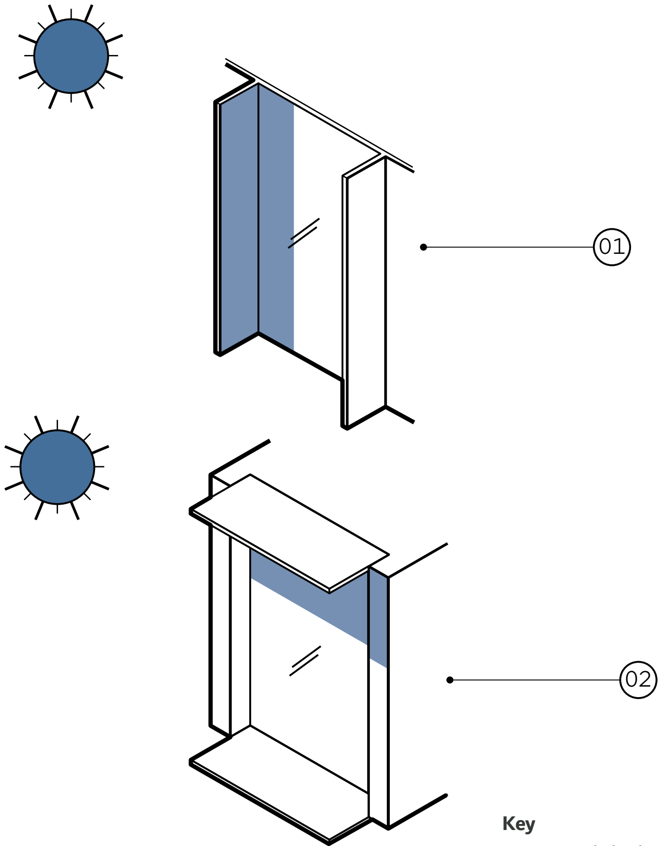
Table E.7 Performance criteria for a glazed roof based on total roof area

Thermal transmittance values are overall U-values for the glazed elements. Overall U-values shall be calculated as the area-weighted averages of the centre of pane U-value (glazing and panel) and frame U-value, including all edge effects (spacer and frame) and thermal bridges. Glazed elements having back-insulated panels shall also meet the thermal transmittance requirement, including framing, edges effects and thermal bridges.

NOTE: The thermal transmittance of an insulating glass unit is higher when the glazing is installed horizontally instead of vertically.

E.5.3 Shade effect calculation

The use of external shading is recommended. The impact of external shading (where used) and adjacent buildings can be taken into account when calculating external load criteria. Examples of shading devices are shown in Figure E.4.



Key
01: Vertical shading
02: Horizontal shading

Figure E.4 Examples of shading arrangements

The impact of external shade factors on the building's thermal load shall be calculated when the performance method (see E.5.1) is used to verify energy compliance.

E.5.4 Thermal bridges

For all new air-conditioned buildings, thermal bridges shall be either eliminated or insulated to reduce the amount of heat transfer. Thermal bridging can occur at connection points between concrete or steel beams, external walls and columns, and around doors and windows (see Figure E.5).

NOTE: The BRE publication on assessing the effects of thermal bridging at junctions and around openings **[Ref. E.8]** gives further details.

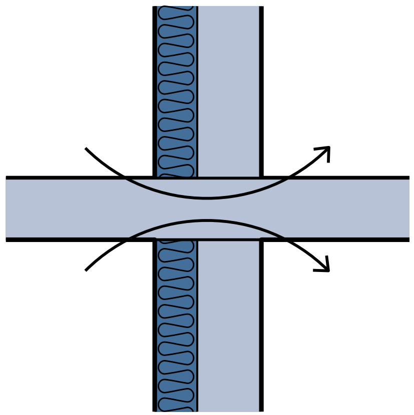


Figure E.5 Example of linear thermal bridge in buildings

E.5.5 Durability

The building envelope shall be designed and specified to limit degradation due to environmental factors throughout the design life of the building.

E.5.6 Sealing of windows and doors

Doors and window frames on the building exterior shall be sealed.

Sealing materials shall conform to Sections 4 to 7, Ch. 1 of UAE FLSC [Ref. E.1]. They shall also prevent the transmission of air and sound that might occur as a result of pressure differences across the exterior of the building. Air leakage shall be controlled in accordance with Part H.

E.5.7 Heat island effect reduction

Opaque building envelope surfaces shall have a solar reflectance index (SRI) value not less than that shown in Table E.8 and Figure E.6, for a minimum of 75% of the roof area.

Element	SRI value
Steep sloped roofs (slopes steeper than 1:6)	≥29
Flat and low sloped roofs (slopes lower than or equal to 1:6)	≥78
External walls	≥29

Table E.8 Building envelope SRI value requirements

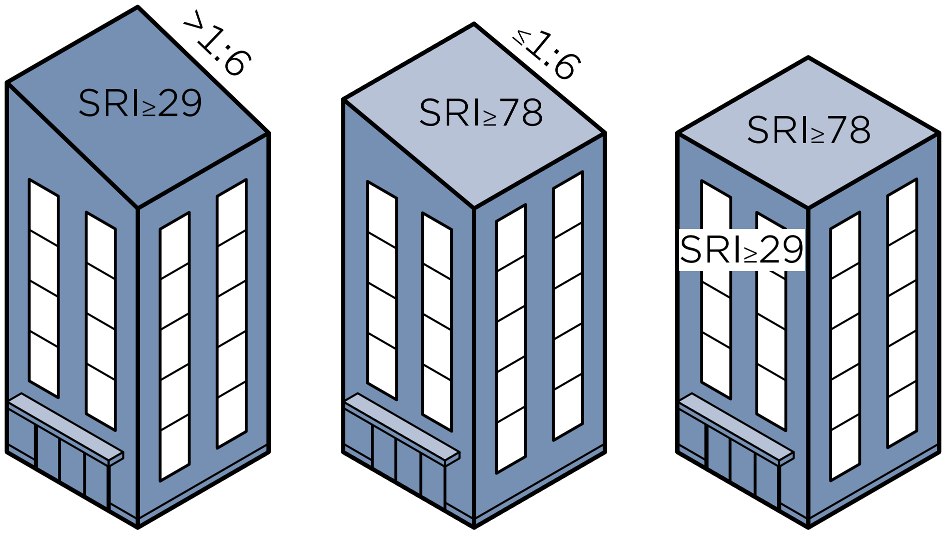


Figure E.6 Illustration of SRI value requirements based on slope of roof

E.5.8 Exterior light power, pollution and controls

The average lighting power density for the exterior connected lighting load for building envelopes shall not exceed 2.2 W/m^2 for each illuminated wall or surface area or 16.4 W/linear metre for each illuminated wall or surface length.

Permanently installed exterior lighting shall meet the following requirements.

a) All exterior light fixtures on the building site, other than architectural accent lighting (see E.5.8b) and Civil Aviation safety lighting, shall be shielded, such that the full light emitted by the fixture, either directly or indirectly by reflection or by refraction from any part of the fixture, is projected below the horizontal plane passing through the lowest part of the fixture (see Figure E.7).

NOTE: Civil Aviation safety lighting is not covered in this Part.

b) Architectural accent lighting shall be aimed or shielded to prevent the lighting of the night sky. Wall washing lights shall spill no more than 10% of the lighting past the building façade.

c) Downward directed lighting shall be used for lighting of signage.

d) All exterior lighting shall be fitted with automatic controls, so that the lights can be set not to operate during daylight hours.

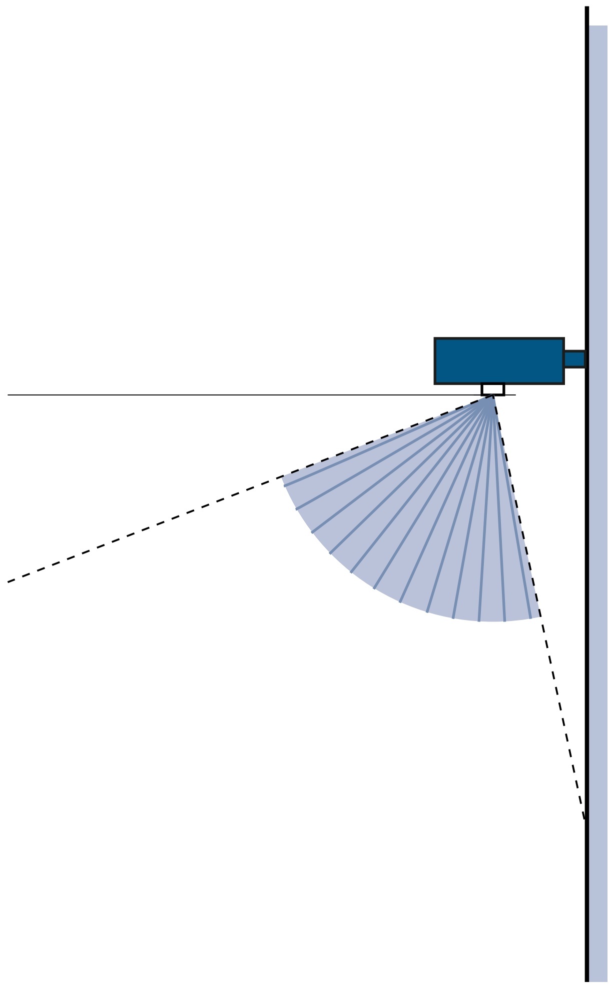


Figure E.7 Example of downward directed lighting projected below the horizontal plane of the lowest part of the fixture

E.6 Sustainable materials

Construction materials shall be chosen in accordance with B.10.6.

E.7 Moisture

E.7.1 General

Moisture control is fundamental to the functioning of any building. Controlling moisture is important to protect occupants from adverse health effects and to protect the building, its mechanical systems and its contents from physical or chemical damage.

The building envelope shall protect the building and occupants from:

a) harmful effects caused by ground moisture;
b) precipitation (including windblown spray); and
c) the risk of interstitial or surface condensation.

E.7.2 Ground moisture

The building envelope walls shall:

a) resist the passage of moisture from the ground to the inside of the building;
b) not be damaged by moisture from the ground; and
c) not carry moisture from the ground to any part of the building which could be damaged.

For building envelope walls that are not subject to groundwater pressure, a damp-proof course shall be provided at least 150 mm above the level of the adjoining ground, as shown in Figure E.8, unless there is a part of the building design that protects the wall. The damp-proof course shall be continuous with any damp-proof membrane in the floor.

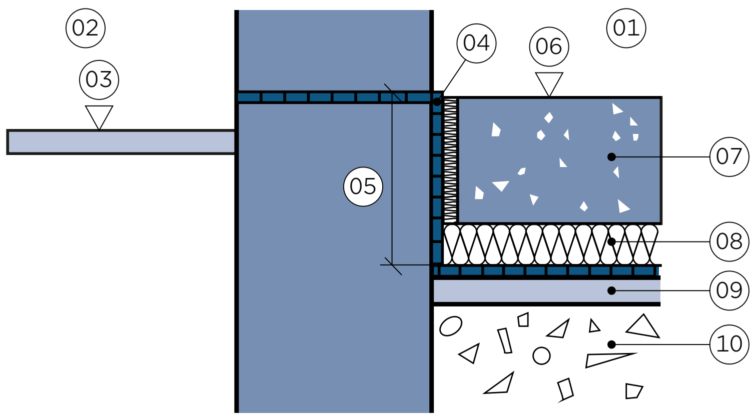


Figure E.8 Minimum height for damp-proof course at ground level (© Crown Copyright, 2013. Figure based on Diagram 8 of the Building Regulations (2010), Approved Document Part C, 2004 Edition with 2010 and 2013 amendments. Contains public sector information licensed under the Open Government Licence v3.0)

Key
01: Out
02: In
03: Internal ground floor
04: Continuous damp proof course between wall and floor membrane
05: At least 150 mm if wall is an external wall
06: External ground floor
07: External pavement
08: Insulation
09: Compacted soil
10: Soil

Guidance on protection for building envelope walls that are subject to groundwater pressure can be found in BS 8102.

E.7.3 Precipitation including windblown spray

E.7.3.1 General

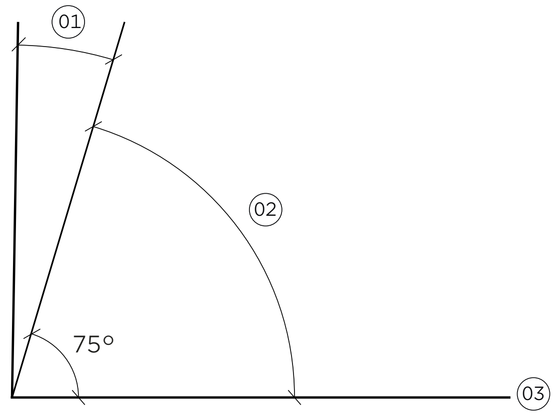
The building envelope shall resist the penetration of precipitation:

a) to the inside of the building; and
b) to any part of the building envelope that might be damaged by moisture.

E.7.3.2 Horizontal and inclined surfaces

Horizontal surfaces or inclined surfaces within the building envelope (see Figure E.9) shall:

a) be jointless and impermeable to moisture; or
b) have sealed joints and be impermeable to moisture; or
c) have overlapping joints and either be impermeable to moisture or be backed by a material that directs precipitation towards the outer face.



Key
01: Vertical surfaces
02: Inclined surfaces
03: Horizontal surfaces

Figure E.9 Horizontal, inclined or vertical surfaces

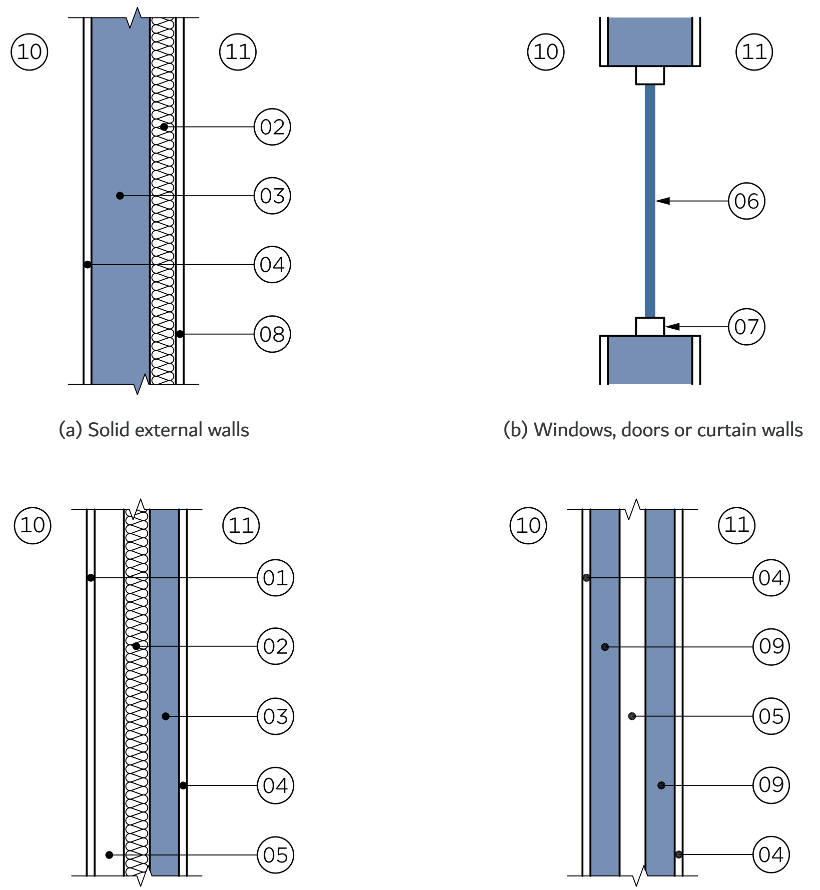
E.7.3.3 Vertical surfaces

Vertical surfaces within the building envelope (see Figure E.9) shall meet the following requirements as appropriate to the external wall build-up type. Examples of external wall build-up types are given in Figure E.10.

a) Solid external walls: The wall shall hold moisture arising from rainwater until the moisture can be released in a dry period, without penetrating to the inside of the building or causing damage to the building. If the wall is insulated, the insulation shall provide resistance to the ingress of moisture to keep the wall dry.

b) Solid external walls with air cavities or with rainscreens: The outer leaf of an external cavity wall shall either be separated from the inner leaf by a drained air space, or prevent the precipitation from being carried to the inner leaf.

c) Curtain walling, doors and windows: Joints between curtain walling, doors, windows and interfaces with other walls shall resist the penetration of precipitation to the inside of the building. Joints shall not permit moisture to reach any part of the building which could be damaged.



(c) Solid external walls with rainscreens

(d) Solid external walls with cavaties

Key
01: Cladding
02: Thermal insulation layer (vapour resistance layer on the outer face)
03: Block wall
04: Plaster
05: Cavity
06: Glass
07: Framing
08: Plaster or gypsum board
09: Aerated blockwork
10: Out
11: In

Figure E.10 Examples of external wall build-up types

E.7.3.4 Flashing

Flashing shall be installed to prevent moisture from entering the building envelope or redirect moisture to the exterior. Flashing shall be installed at:

a) perimeters of exterior door and window assemblies;
b) penetrations and terminations of exterior wall assemblies;
c) exterior wall intersections with roofs, balconies and similar projections; and
d) built-in gutters from which moisture could enter the wall.

E.7.4 Risk of interstitial or surface condensation

The building envelope shall:

a) be designed and constructed such that its structural and thermal performance is not adversely affected by interstitial condensation; and
b) not promote surface condensation or mould growth, for the given occupancy conditions.

Technical solutions to minimize condensation risk depend on the wall type.

1) Curtain wall, skylight, doors and windows can incorporate thermal breaks in the glazed framed systems.
2) Roofs and solid external walls can include a vapour resistance layer.
3) Interfaces and junctions between different elements of the building envelope (such as windows) can ensure continuity of the vapour resistance layer by extending and overlapping the vapour resistance layer between elements.

NOTE: BS 5250 gives further guidance on control of condensation in buildings. While the guidance provides principles to control condensation, some commentary and forms of construction given in the annexes might not be applicable to Dubai climate.

E.8 Acoustics

The building envelope shall meet the acoustic requirements given in H.10.

E.9 Protection from falling, collision and impact

E.9.1 Protection against impact with glazing

Safety glazing shall be installed in critical locations in doors, side panels and low level glazing, as shown in Figure E.11 and Figure E.12.

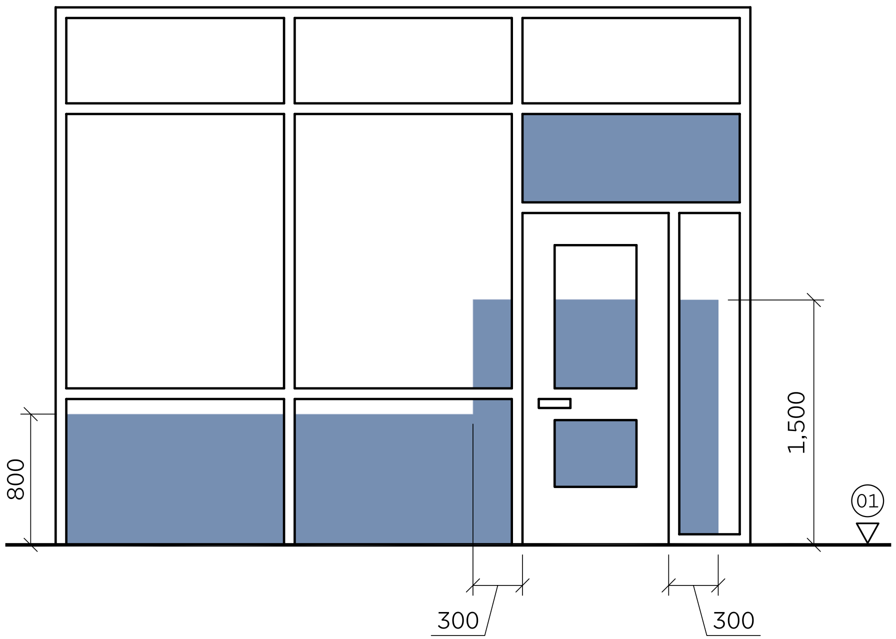


Figure E.11 Safety glazing at door and adjacent areas (© Crown Copyright, 2013. Figure based on Diagram 5.1 of the Building Regulations (2010), Approved Document Part K, 2013 Edition. Contains public sector information licensed under the Open Government Licence v3.0)

Key

01: FFL

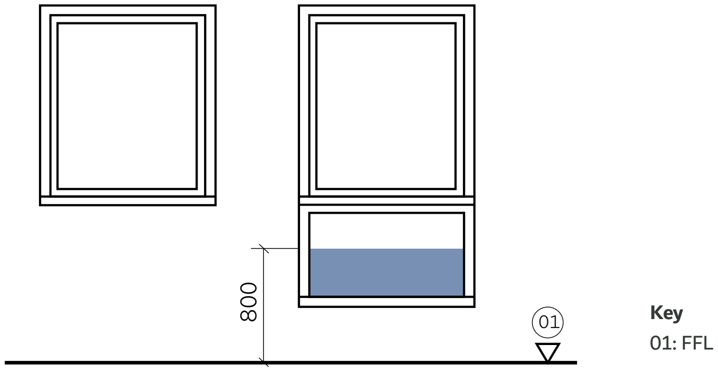


Figure E.12 Safety glazing at windows (© Crown Copyright, 2013. Figure based on Diagram 5.1 of the Building Regulations (2010), Approved Document Part K, 2013 Edition. Contains public sector information licensed under the Open Government Licence v3.0)

In accordance with the Section 5, Ch. 1 of UAE FLSC **[Ref. E.1]**, safety glazing for use in critical locations shall conform to the minimum classifications in either Table E.9 or Table E.10.

Critical location	Height	Classification in test standard BS EN 12600
Low level areas	All heights	Class 1
Doors	Below 900 mm from FFL	Class 2
Doors side panel	Above 900 mm from FFL	Class 3

Table E.9 Minimum classification for safety glazing

Area of glazing in critical location (m²)	Classification in test standard	
	ANSI Z97.1	CPSC 16 CFR 1201 [Ref. E.9]
≤0.9	A	I
>0.9	B	I

Table E.10 Minimum classification for safety glazing

E.9.2 Containment

Glazing at areas lower than 800 mm from FFL and protecting a change in level greater than 760 mm shall provide containment, as shown in Figure E.13.

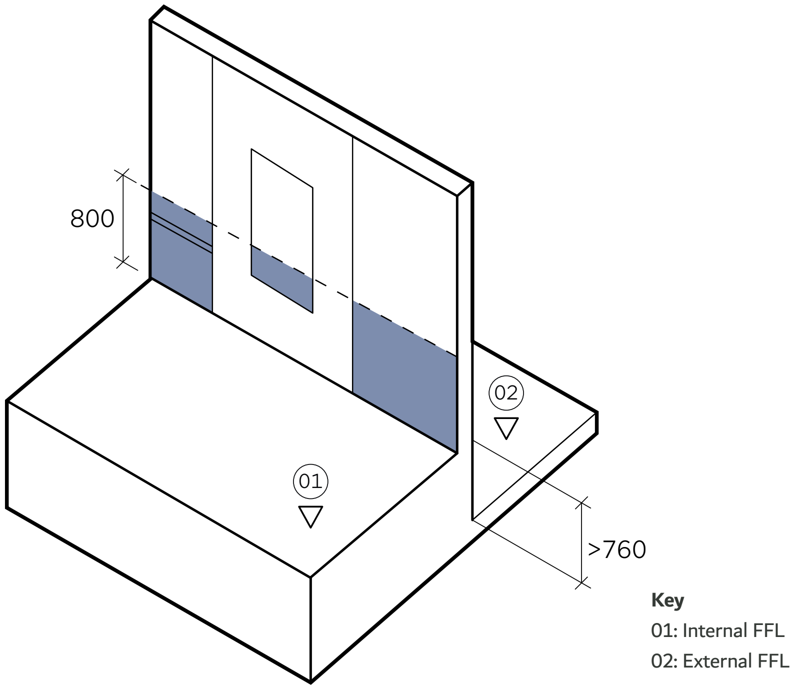


Figure E.13 Examples of glazed areas that need to provide containment

If a glazing panel covers areas above and below 800 mm from FFL, the entire glazing panel shall provide containment.

E.9.3 Manifestation

Transparent glazing in the following locations shall incorporate manifestation features:

a) adjacent to doors;

b) in doors without frames or handles; and

c) in other areas where occupants might inadvertently come into contact with the glazing.

The manifestation shall:

1) be located between 750 mm and 1,500 mm above FFL;
2) occupy a minimum of 50% of the area horizontally at each 900 mm width interval, with minimum 50% opacity; and
3) contain visual elements of any type of bands or marks (such as logos and artistic illustrations).

The manifestation should be permanent if possible, e.g. etching of the glazing, but alternatively, if applied materials are used, they should be durable and not easily removed.

Manifestation and visual detection elements are not required in the following cases:

i) where a glass surface is less than 500 mm wide;

ii) where the glass surface does not extend more than 850 mm above FFL;

iii) where a fixed element in front of the glass surface blocks the entire approaching space; and

iv) where façade glazing is in upper floors with no access from outside, and where there is no possibility of a user confusing it with access glazing.

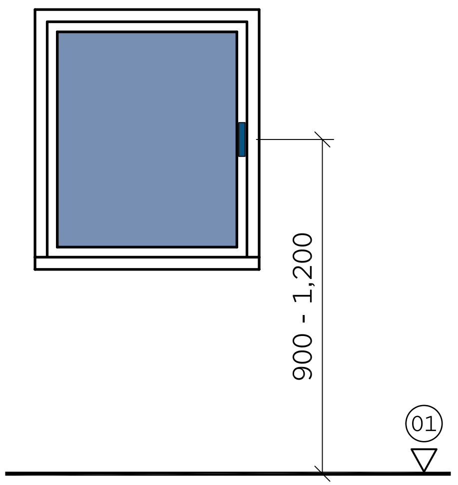
E.9.4 Safe opening and closing of windows

Sliding and operable windows shall be located at a height not less than 900 mm from FFL.

Operable windows shall be restrained to limit the opening to 100 mm to prevent falls.

There shall not be any construction features at the bottom of the window that can be exploited as a ladder or climbing feature.

Operable windows, skylights and ventilators shall be constructed or equipped such that they can be opened, closed and adjusted safely. Wherever practicable, the height of controls or handles shall be in accordance with Part C as indicated in Figure E.14. If controls or handles cannot be positioned as indicated in Figure E.14, a manual or electrical means of remote operation shall be provided in that location instead.



Key
01: FFL

Figure E.14 Height of controls or handles

E.9.5 Overhead glazing

Overhead glazing shall be laminated. It shall include a post-breakage containment system, such that if the glass breaks, the glass is held in place until it can be replaced.

The safety and fragility of overhead glazing shall be determined in accordance with CWCT TN 66 [Ref. E.10].

Overhead glazing shall be tested in accordance with CWCT TN 67 [Ref. E.11].

E.10 Fire safety

E.10.1 General

The fire safety of the façade and roof elements of the building envelope shall conform to Ch. 1 of UAE FLSC [Ref. E.1] and the specific requirements of this section.

To prevent external fire spread, the building shall be physically separated from adjacent plots/buildings or the building envelope shall be fire resistance rated (see Sections 2.7 and 2.8, Ch. 1 of UAE FLSC [Ref. E.1]).

The requirements for guardrails and balustrades as described in Section 2.17, Ch. 1 of UAE FLSC [Ref. E.1] are superseded by B.4.2.5.2.

The requirements for safety glazing in Sections 5.4.2 to 5.4.4, Ch. 1 of UAE FLSC [Ref. E.1] are superseded by E.9.

E.10.2 Sprinklers

Sprinklers on balconies, as mentioned by Ch. 9 of UAE FLSC [Ref. E.1], are not mandated by Dubai Civil Defence (DCD), provided that the materials of construction of the balcony conform to Ch 1. of UAE FLSC [Ref. E.1].

Sprinklers on the inside of rainscreen/glazing/curtainwall, as mentioned by Ch. 9 of UAE FLSC [Ref. E.1], are not mandated by DCD.

E.10.3 Spandrels

The fire resistance rated spandrel required by Section 2.8.10, Ch. 1 of UAE FLSC [Ref. E.1] may be less than 915 mm, provided that the perimeter barrier system in Section 3.2.4d is tested, certified and listed with the intended spandrel specifications, complete with installation guidelines.

E.10.4 Fire testing of non-fire resistance rated, non-loadbearing façades and aesthetic features/mashrabiya

The requirements in Section 4.2.1, Ch. 1 of UAE FLSC [Ref. E.1] shall be met, with the following amendments.

a) The exceptions listed in Section 4.2.1, Ch. 1 of UAE FLSC [Ref. E.1] are expanded to include concrete, terracotta, glass, ceramics and mineral wool.
b) In addition to the materials listed in Section 4.2.1, Ch. 1 of UAE FLSC [Ref. E.1], solid metal panels conforming to E.10.5 may be used.

The requirements in Section 4.5, Ch. 1 of UAE FLSC [Ref. E.1] shall be met, with the following amendments.

1) Steel flashing is not required around window openings.
2) Flashing shall match the flashing included in the NFPA 285 fire test(s) forming the basis of the fire safety design(s) of the façade.

E.10.5 Solid metal panels

Solid metal panels (including any coatings) shall conform to Sections 4 to 7, Ch. 1 of UAE FLSC [Ref. E.1]. They shall also achieve the fire safety classifications and fire safety performance criteria shown in Table E.11 to Table E.13 where applicable.

Occupancy and type of building	Fire testing required for solid metal panel	Fire testing required for façade assembly
Super high-rise buildings High-rise buildings Malls Theme parks Schools Hospitals Assembly	Panel shall be tested in the thickness intended to be used, including any coatings to BS EN 13501-1 with pass criteria A1 or A2-s1-d0.	BS 8414-1 or BS 8414-2 with pass criteria in accordance with BR 135 [Ref. E.12] or NFPA 285 with pass criteria “pass” or FM 4881 with pass criteria “pass” or ISO 13785-2 with pass criteria “pass”
Low-rise buildings Mid-rise buildings Warehouses Industrial	Panel shall be tested in the thickness intended to be used, including any coatings to BS EN 13501-1 with pass criteria B-s1-d0.	BS 8414-1 or BS 8414-2 with pass criteria in accordance with BR 135 [Ref. E.12] or NFPA 285 with pass criteria “pass” or FM 4881 with pass criteria “pass” or ISO 13785-2 with pass criteria “pass”

Table E.11 Fire test requirements for solid metal panels on non-fire resistance rated and non-load-bearing building envelope and aesthetic features/mashrabiya

Occupancy and type of building	Fire testing required for solid metal panel	Fire testing required for façade assembly
Any building with any height and any occupancy	Panel shall be tested in the thickness intended to be used, including any coatings to BS EN 13501-1 with pass criteria A1 or A2-s1-d0.	ASTM E119 with pass criteria 1 h or 2 h or 3 h as per required fire rating of the wall or UL 263 with pass criteria 1 h or 2 h or 3 h as per required fire rating of the wall or BS EN 1364-3 with pass criteria 1 h or 2 h or 3 h as per required fire rating of the wall or BS EN 1364-4 with pass criteria 1 h or 2 h or 3 h as per required fire rating of the wall

Table E.12 Fire test requirements for solid metal panel on a fire resistance rated exterior wall assembly

Applications	Exterior fire exposure to roofing assemblies	Interior or under deck fire exposure to roofing assemblies
Roofing in sprinklered buildings Roofing in buildings protected with fire suppression systems.	NFPA 256 with pass criteria Class B or ASTM E108 with pass criteria Class B or BS EN 13501-5 with pass criteria Class BROOF(t4) or UL 790 with pass criteria Class B	
Roofing in non-sprinklered buildings Roofing in buildings without fire suppression. Roofing in buildings less than 6 m from an adjacent building. Roofing in malls, assembly, hospitals and educational.	NFPA 276 with pass criteria Class 1 or ASTM E108 with pass criteria Class A or BS EN 13501-5 with pass criteria Class BROOF(t4) or UL 790 with pass criteria Class A or FM 4470 or FM 4471 with pass criteria “Pass”	FM 4450 with pass criteria Class I or UL 1256 with pass criteria "pass" Structural metal panel roof systems shall be tested with FM 4471 Roof systems with modified bitumen and other types of membrane roof systems shall be tested with FM 4470

Table E.13 Fire test requirements for solid metal panel in roofing

E.10.6 Fire resistance rated glazing assemblies

Fire resistance rated glazing assemblies shall conform to Sections 5.3 and 5.4, Ch. 1 of UAE FLSC **[Ref. E.1]**.

E.10.7 Roof assemblies

Roof assemblies shall conform to the performance requirements of Section 6, Ch. 1 of UAE FLSC **[Ref. E.1]**. They shall have the fire resistance periods specified in Section 6, Ch. 1 of UAE FLSC **[Ref. E.1]**.

E.10.8 Roof and façade assemblies

Materials used both on the façade and the roofing shall be fire tested in both configurations in accordance with Sections 4 and 6, Ch. 1 of UAE FLSC **[Ref. E.1]**.

If the roof is not horizontal then it shall be fire tested as a façade system in accordance with Section 4, Ch. 1 of UAE FLSC **[Ref. E.1]**.

E.10.9 Signboards and billboards

Signboards and billboards on façades shall conform to Section 4, Ch. 1 of UAE FLSC [Ref. E.1].

When the cumulative surface area of signboards/billboards on a façade is greater than 50 m^2, or the signboard/billboard straddles more than one storey, then they shall be fire tested as part of the façade system in accordance with Section 4, Ch. 1 of UAE FLSC [Ref. E.1].

E.10.10 Solar panels

Photovoltaic (PV) cells or panels installed on roofs or façades shall conform to Section 2.2, Ch. 14 of UAE FLSC [Ref. E.1]. If PV panels are attached to or integrated with the façade then they shall also be tested in accordance with Section 4, Ch. 1 of UAE FLSC [Ref. E.1].

E.11 Screening of building equipment

In accordance with B.10.2, all outdoor mechanical equipment (including antennas, rooftop equipment and refuse storage areas) should be concealed from public view by solid walls, screens, fences, parapets, enclosing structures or landscaping.

E.12 Maintenance

E.12.1 General

A method of safely maintaining the building envelope shall be provided. Manually operated systems (e.g. rope access) or power operated systems (e.g. cleaning cradles) and building maintenance units (BMUs) shall conform to E.12.

E.12.2 Rope access

Rope access or abseiling systems shall have permanent dedicated fixed anchors.

E.12.3 Imposed loading

Loading of permanent building maintenance equipment attached to either roof or façades shall be included as permanent fixture loading (see E.4.1.3).

E.12.4 Cable stabilization and anchors

Hanging lifelines and all untensioned cables of the working platform shall be stabilized when vertical travel exceeds an initial 61 m, and at further intervals of 61 m or less. Hanging cables, other than suspended wire ropes, that are in constant tension shall be stabilized when the vertical travel exceeds an initial 183 m distance, and at further intervals of 183 m or less.

The building anchors and components of the intermittent stabilization system shall be capable of sustaining without failure at least four times the maximum anticipated load applied or transmitted to the anchors and components. The design wind load for each anchor shall be not less than 1,334 N or the design wind load of the building, whichever is higher.

If there are two anchors on one attachment point, the wind load may be shared.

The building anchors and stabilizer ties shall be capable of sustaining anticipated horizontal and vertical loads from winds which might act on the platform and wire ropes if the platform is stranded on a building face. If the building anchors have different spacing to that of the suspension wire rope, or if the building requires different suspension spacings on one platform, one building anchor and stabilizer tie shall be capable of sustaining the wind loads.

Building anchors that extend beyond the face of the building shall be free of sharp edges or points. Where cables, suspension wire ropes and lifelines might be in contact with the building face, external building anchors shall not interfere with their handling or operation.

Tie-down anchors fasteners, and affected structures shall be resistant to corrosion.

E.12.5 Power circuit and operation

The equipment power circuit of power-operated systems shall be an independent electrical circuit. It shall remain separate from all other equipment within or on the building (other than power circuits for hand tools that will be used in conjunction with the equipment).

The equipment power circuit may be connected to an emergency power system, if the building has one. The power circuit shall be provided with a disconnect switch that can be locked in the “OFF” and “ON” positions. The switch shall be located in the primary operating area of the equipment in a convenient position to allow the operators of the equipment access to the switch. The disconnect switch for the power circuit shall be locked in the “ON” position when the equipment is in use.

An effective two-way voice communication system shall be provided between the equipment operators and persons stationed within the building being serviced. The communications facility shall be operable and shall always be manned by persons stationed within the building whenever the equipment is being used.

E.12.6 Protection from impact on building envelope

Hard or sharp components of the maintenance equipment shall be covered with soft protection to prevent the building envelope from being impacted.

The energy impact that the maintenance equipment or operator might exert on the building envelope shall be calculated. The building envelope shall be capable of withstanding applied or transferred impacts that might occur during maintenance without sustaining damage that is not repairable and without deterioration of its performance.

NOTE: CWCT TN 96 **[Ref. E.13]** gives guidance to assess cradle and suspended access equipment loads.

E.12.7 Health and safety

E.12.7.1 Rope access

Rope access systems shall follow safety guidelines such as IRATA **[Ref. E.14]**.

A back-up fall arrest system shall be provided.

Back-up fall arrest system may be achieved by using two ropes: a working line and a safety line.

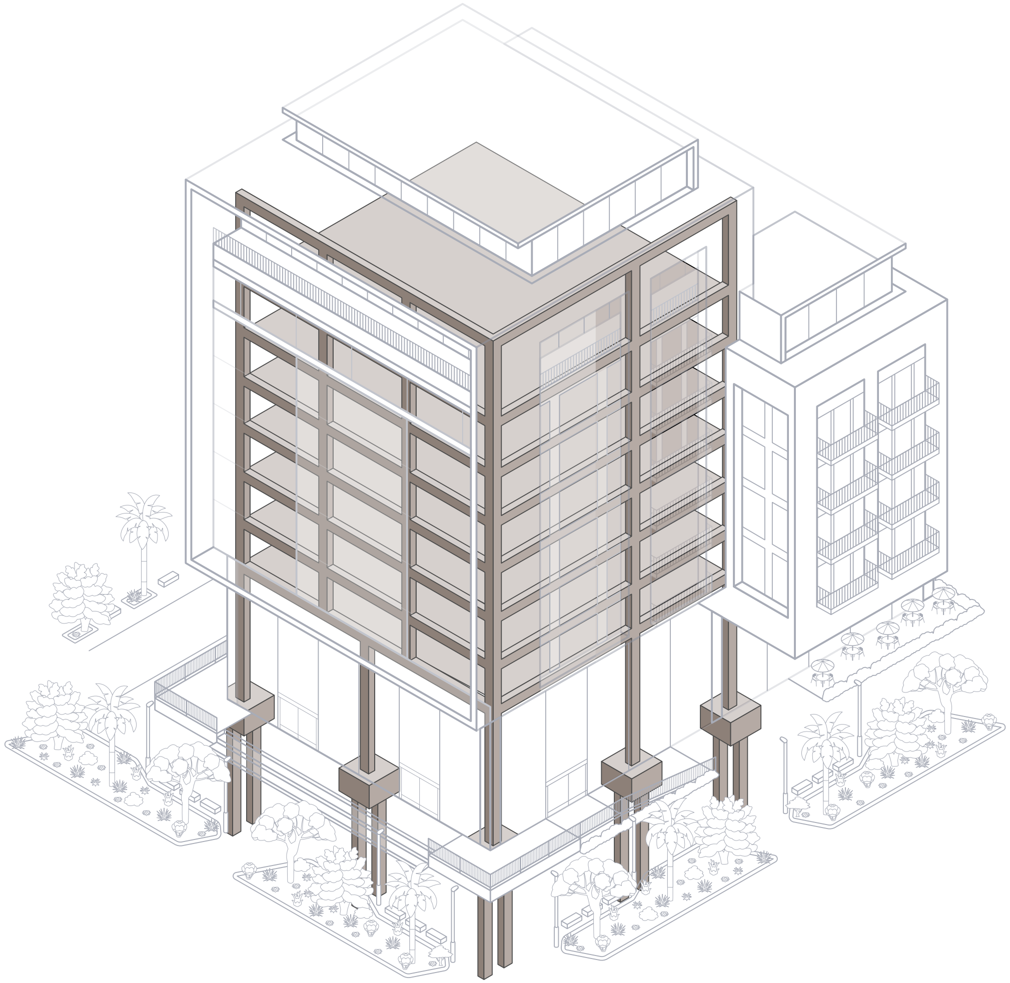
E.12.7.2 Power-operated systems

Means shall be provided to traverse all carriages and their suspended equipment to a safe area for maintenance and storage. The working platform shall, as part of its normal operation, be capable of being lowered to a safe surface for access and egress of the personnel. The working platform shall be provided with a safe means of access and egress to the lower safe surface.

The following non-exhaustive list of safety features shall be included before installation of building maintenance unit/glass cleaning cradle:

a) provisions in case of power failure;
b) overload safety device;
c) wire rope equalizer limit switch;
d) emergency stop;
e) secondary brake with over-speed protection (mechanical);
f) slack rope device;
g) lanyard restraint trip assembly;
h) rotational slew limits;
i) factor of safety for wire rope;
j) cradle details (i.e. anti-collision bar, handrail/mid rail height, etc.);
k) horizontal traversing wheel locking device; and
l) working environment (i.e. weather conditions such as temperature, humidity, wind speed, etc.).

Part F
Structure



F.1 Performance statements

Performance statement	The performance statement will be met by following the requirements of:
The building structure shall safely sustain and transmit to the ground the combined dead, imposed, thermal, wind and seismic load conditions for its intended life.	F.5 to F.9
The building structure shall provide a structure that protects other property from physical damage.	F.8 and F.9
The building structure shall provide a structure that does not sustain damage or collapse to an extent that is disproportionate to the cause.	F.5.5

F.2 Definitions

F.2.1 Terms

Floor height: Distance between adjacent floor levels measured from the top of the floor to the top of the floor above.

Geotechnical laboratory: Physical or legal entity in charge of carrying out geotechnical soil investigations and licensed to practice investigation activities in Dubai in accordance with the applicable legislation.

Geotechnical Specialist Contractor: Physical or legal person in charge of carrying out specialist geotechnical works and design, and licensed to practice geotechnical construction and design activities in Dubai in accordance with the applicable legislation.

Ground level: Average level of the ground surface or sidewalk at the centre of all exterior walls of a building.

Serviceability: Condition beyond which a structure or member becomes unfit for service and is judged to be no longer useful for its intended use.

Strand: High strength steel wires wound around a central wire, typically a seven-wire strand, which can be used as a prestressing reinforcement in tendons.

Tendon: Complete assembly consisting of anchorages, prestressing reinforcement, and sheathing with coating for unbonded applications or ducts filled with grout for bonded applications.

F.2.2 Acronyms and abbreviations

ACI	American Concrete Institute
AISC	American Institute of Steel Construction
ASCE	American Society of Civil Engineers
ASTM	ASTM International
ATC	Applied Technology Council
AWS	American Welding Society
BS	British Standard
BS EN	British Standard European Norm
Ch.	chapter
CHS	circular hollow section
CIRIA	Construction Industry Research and Information Association
CRSI	Concrete Reinforcing Steel Institute
Cm	cementitious materials
CPT	cone penetration test
CRR	cyclic resistance ratio
CSR	cyclic stress ratio
DBC	Dubai Building Code
DCD	Dubai Civil Defence
DM	Dubai Municipality
DMD	Dubai Municipality datum
DSCB	Dubai sustainable concrete baseline
EIAC	Emirates International Accreditation Centre
FS	factor of safety
G	ground level floor
GGBS	ground granulated blast-furnace slag
GIFR	geotechnical investigation factual report
GIR	geotechnical interpretative report
HSS	hollow structural section
IBC	International Building Code
ICE	Institution of Civil Engineers
ISO	International Organization for Standardization
LCA	lifecycle assessment
MEP	mechanical, electrical and plumbing
MRI	mean recurrence interval
NOC	no objection certificate
OPC	ordinary Portland cement (CEM I as defined in BS 8500-1:2015)
MPa	megapascal
PCI	Precast/prestressed Concrete Institute
PGA	peak ground acceleration
PGD	peak ground displacement
PGV	peak ground velocity
psi	pound per square inch
PT	post-tensioned
PTI	Post-tensioning Institute
PTP	preliminary test pile
RHS	rectangular hollow section
SCI	Steel Construction Institute
SHS	square hollow section
SPT	standard penetration test
SPERWall	specification for piling and embedded retaining walls
TMS	The Masonry Society
UAE FLSC	United Arab Emirates Fire and Life Safety Code of Practice
UFC	Unified Facilities Criteria
UK NA	UK National Annex to Eurocode
w/c	water/cement ratio
WAI	weighted average impact

F.2.3 Notation

A_{cf}	gross cross-sectional area of concrete elements
A_s	area of steel in concrete
B	building width
B_{av}	average building width normal to the wind direction over the top height of the building
b_w	width of the column face through which the reinforcement passes
C_d	deflection amplification factor
E_c	modulus of elasticity of concrete
E_s	modulus of elasticity of soil
EI	stiffness
F_a	short period site coefficient at 0.2 s period
F_{PGA}	site coefficient for peak ground acceleration
f_{cu}	compressive cubic strength of concrete at 28 days
f'_c	compressive cylindrical strength of concrete at 28 days
f_y	yield strength
H	total height of building
H_s	floor to floor height measured from the top of the floor to the top of the floor above.
h	thickness of concrete slab
h_D	hydrostatic pressure
h_w	thickness of concrete wall
I_e	importance factor
K_0	coefficient of soil pressure at rest
K_d	wind directionality factor
K_h	horizontal modulus of sub-grade reactions
K_v	vertical spring constants
K_s	piles stiffness
L_A	span of slab
MCE_R	risk-targeted maximum considered earthquake
MCE_G	maximum considered earthquake geometric mean
n_h	constant of horizontal sub-grade reaction
PGA_M	MCE_G peak ground acceleration adjusted for site effects (F_{PGA})
S_1	MCE_R, 5% damped spectral responses acceleration parameter at a period of 1s
S_{D1}	design, 5% damped, spectral response acceleration parameter at a period of 1 s
S_{DS}	design, 5% damped, spectral response acceleration parameter at a short period
S_{M1}	MCE_R, 5% damped, spectral response acceleration parameter at a period of 1 s adjusted for site class effect
S_{MS}	MCE_R, 5% damped, spectral response acceleration parameter at a short period adjusted for site class effect
S_S	MCE_R, 5% damped spectral responses acceleration parameter at short period
$S_{S\,LS}$	life safety, 5% damped spectral responses acceleration parameter at short period
$S_{1\,LS}$	life safety, 5% damped spectral responses acceleration parameter at a period of 1 s
$S_{1\zeta}$	adjusted damping parameter at a period of 1 s
$S_{S\zeta}$	adjusted damping parameter at short period
T	fundamental period of the building (s)
T_L	long-period transition period (s)
V_{ref}	reference wind speed (m/s) in accordance with ASCE/SEI 7-16 (i.e. 3 s gust speed at 10 m above the ground in exposure category C)
w_k	crack width limit
β_1	damping adjustment factor for long-period
β_S	damping adjustment factor for short period
δ_{MT}	total maximum displacement
δ_{max}	maximum deflection at the location required by this section determined by an elastic analysis
δ_M	maximum inelastic response displacement of a structure
Φ	steel reinforcement bar diameter
ζ	damping coefficient
∑	sum of

F.3 References

F.3.1 Essential references

F.3.1.1 General

ASCE/SEI 7-16, Minimum design loads and associated criteria for buildings and other structures

ASCE 37, Design loads on structures during construction

ASCE 41, ASCE 41, Seismic evaluation and retrofit of existing buildings

ISO 10137, Bases for design of structures – Serviceability of buildings and walkways against vibrations

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F.3.1.2 Concrete

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ACI 117-10, Specification for tolerances for concrete construction and materials and commentary

ACI 209.2R, Guide for modelling and calculating shrinkage and creep in hardened concrete

ACI 215R, Considerations for design of concrete structures subjected to fatigue loading

ACI 216.1, Code requirements for determining fire resistance of concrete and masonry construction assemblies

ACI 224R, Control of cracking in concrete structures

ACI 315R, Guide to presenting reinforcing steel design details

ACI 318-19, Metric building code requirements for structural concrete

ACI 363R-10, Report on high-strength concrete

ACI 408.2R, Report on bond of steel reinforcing bars under cyclic loads

ACI 435R, Control of deflection in concrete structures

BS EN 206, Concrete – Specification, performance, production and conformity

BS 8500-1:2015, Concrete – Complementary British Standard to BS EN 206 – Part 2: Method of specifying and guidance for the specifier

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F.3.1.3 Steel

AISC 341, Seismic provisions for structural steel buildings

AISC 360, Specification for structural steel buildings

ASTM A307, Specification for carbon steel bolts, studs, threaded rods and similar externally fasteners with tensile strength between 60 to 100 ksi

ASTM A36M, Standard specification for carbon structural steel

ASTM A53M, Standard specification for pipe, steel, black and hot-dipped, zinc-coated, welded and seamless

ASTM A500, Standard specification for cold-formed welded and seamless carbon steel structural tubing in rounds and shapes

ASTM A501, Standard specification for hot-formed welded and seamless carbon steel structural tubing

ASTM A992M, Standard specification for structural steel shapes

ASTM F1554, Standard specification for anchor bolts, steel, 36, 55 and 105 ksi yield strength

AWS D1.1, Structural welding code – Steel

BS EN 206, Concrete – Specification, performance, production and conformity

BS EN 10025-1, Hot rolled products of structural steels – General technical delivery conditions

BS EN 12944 (all parts), Paints and varnishes – Corrosion protection of steel structures by protective paint system

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F.3.1.4 Masonry

BS EN 1996-1, Eurocode 6 – Design of masonry structures – General rules for reinforced and unreinforced masonry structure

BS EN 1996-2, Eurocode 6 – Design of masonry structures – Design considerations, selection of materials and execution of masonry

BS EN 1996-3, Eurocode 6 – Design of masonry structures – Simplified calculation methods for unreinforced masonry structures

TMS 402/602, Building code requirements and specifications for masonry structures

F.3.1.5 Geotechnics

F.3.1.5.1 Geotechnics investigation and testing

BS 1377, Methods of test for soils for civil engineering purposes

BS 5930, Code of practice for ground investigations

BS 10175, Investigation of potentially contaminated sites – Code of practice

BS EN ISO 14688, Geotechnical investigation and testing – Identification and classification of soil

BS EN ISO 14689, Geotechnical investigation and testing – Identification, description and classification of rock

BS EN ISO 17892, Geotechnical investigation and testing – Laboratory testing of soil

BS 22475, Geotechnical investigation and testing – Sampling methods and groundwater measurements

BS EN ISO 22476, Geotechnical investigation and testing – Field testing

BS EN ISO 22282, Geotechnical investigation and testing – Geohydraulic testing

F.3.1.5.2 Geotechnical design

BS 6031, Code of practice for earthworks

BS 8081, Code of practice for grouted anchors

BS 8102, Code of practice for protection of below ground structures against water from the ground

BS EN 1997-1:2004+A1:2013, Eurocode 7 – Geotechnical design – General rules

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BS EN 1997-2:2007, Eurocode 7 – Ground investigation and design – Ground investigation and testing

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BS EN 1993-5:2007, Eurocode 3 – Design of steel structures – Piling

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Ref. F.21 CIRIA, 2016. C750, Groundwater control – Design and practice. London: CIRIA.

F.3.1.5.3 Execution of geotechnical works

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ASTM D5778 Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils

BS EN 1536, Execution of special geotechnical works – Bored piles

BS EN 1537, Execution of special geotechnical works – Ground anchors

BS EN 1538, Execution of special geotechnical works – Diaphragm walls

BS EN 12063, Execution of special geotechnical works –Sheet pile walls

BS EN 12699, Execution of special geotechnical works – Displacement piles

BS EN 12715, Execution of special geotechnical works – Grouting

BS EN 12716, Execution of special geotechnical works – Jet grouting

BS EN 14199, Execution of special geotechnical works – Micro piles

BS EN 14475, Execution of special geotechnical works – Reinforced fill

BS EN 14490, Execution of special geotechnical works – Soil nailing

BS EN 14679, Execution of special geotechnical works – Deep soil mixing

BS EN 14731, Execution of special geotechnical works – Ground treatment by deep vibrations

BS EN 15237, Execution of special geotechnical works – Vertical drains

F.3.2 Further reading

F.3.2.1 Concrete

ACI 301, Specifications for structural concrete

ACI 350, Code requirements for environmental engineering concrete structures

F.3.2.2 Geotechnics

ACI 543R, Guide to design, manufacture, and installation of concrete piles

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F.3.2.3 Seismic

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F.4 Framework

F.4.1 Application

This Part applies to the design and construction of buildings, and structures or appurtenances connected to a building. Structures that require special consideration of their characteristics, functions and environment as listed in **Part A** are not covered herein.

Villas and townhouses shall be designed in accordance with **Part K**.

In calculations, drawings, specifications and basis of design reports, the Engineer shall state the codes and standards that are adopted as the basis for the design and specification of materials and workmanship. Codes and standards shall be specified by document number and title, including version/revision and, where applicable, the units (i.e. metric).

Where there is conflict between this Part and referenced codes or standards, the most restrictive requirements shall be met.

F.4.2 Units

Units shall be in accordance with **A.12.2**.

F.5 Structural system requirements

F.5.1 General conditions

The structural design of buildings shall be undertaken by the Engineer.

The Engineer shall only use appropriate structural analysis and design software, approved by the Authority.

The design shall facilitate safe fabrication, transport, handling and erection of structural elements and materials, with due regard to site-specific conditions. As far as is reasonably practicable, it shall also take account of the needs of maintenance, final demolition, recycling and reuse of materials.

Typical design issues are presented in Figure F.1 for inclusion in the design stages.

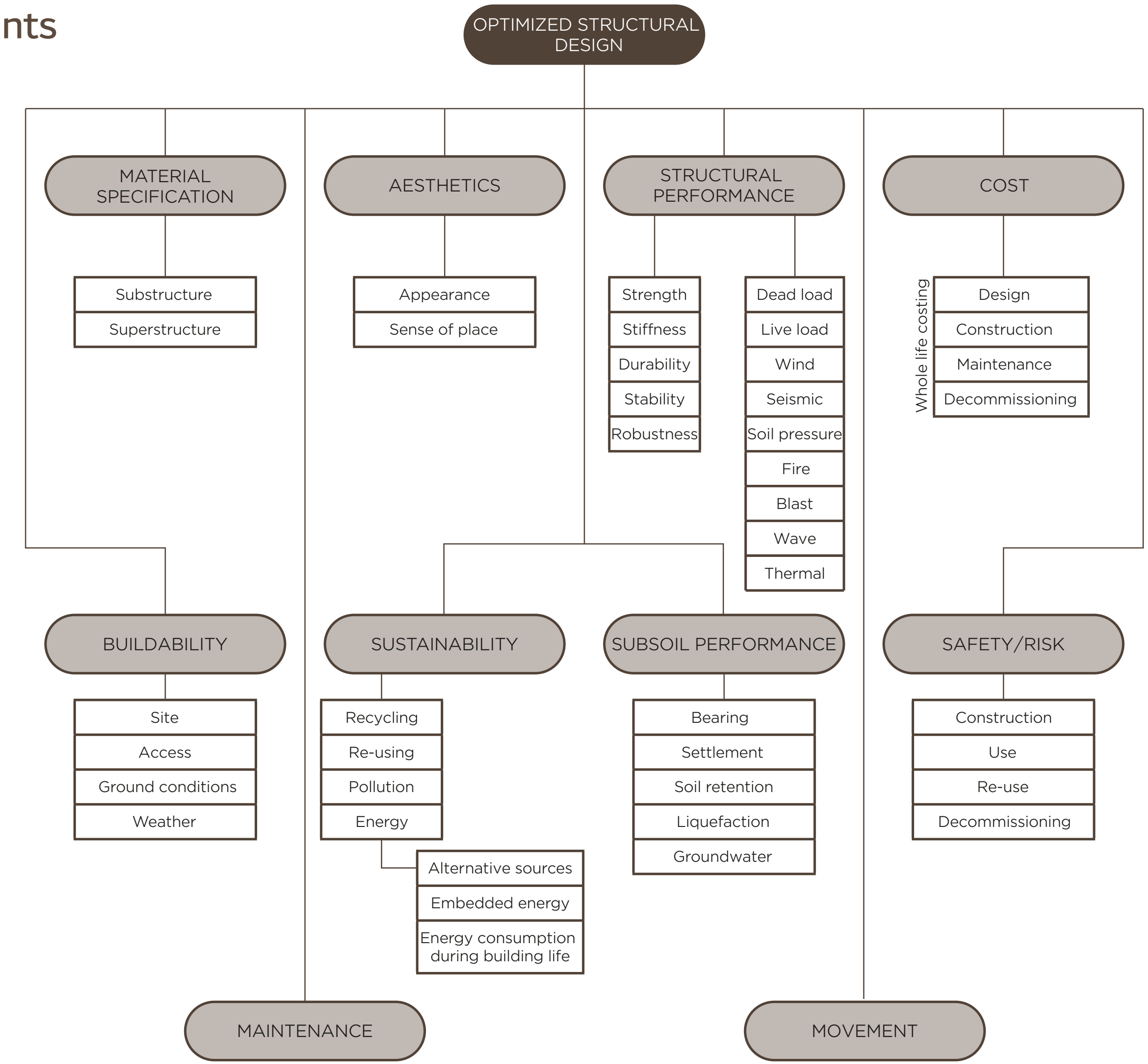


Figure F.1 Typical issues in relation to structural design requirements

F.5.2 Design life

Design life shall be specified by the Engineer based on the minimum recommended values in Table F.1. The design life of the project shall be agreed between the Engineer, the Owner and the Authority prior to commencing design.

Structure type	Design life
Temporary structures	10 years
Replaceable structural parts (i.e. bearings, gantry)	10 to 25 years
Agricultural and similar	15 to 30 years
Buildings	50 years
Special structures (i.e. buildings higher than 300 m, monumental building or structures designated as essential for the community)	100 years

Table F.1 Recommended minimum design life

F.5.3 Design acceptance criteria

The design shall honour all design acceptance criteria defined by the design basis codes and standards.

Ordinarily, these acceptance criteria are defined as limit states. As applicable, designs shall include:

a) strength limit states including general yielding, rupture, buckling and transformation into a mechanism;

b) serviceability limit states including member and global deflections, vibration and occupancy comfort;

c) stability against overturning and sway;

d) fracture due to fatigue and brittle fracture;

e) corrosion and durability;

f) fire; and

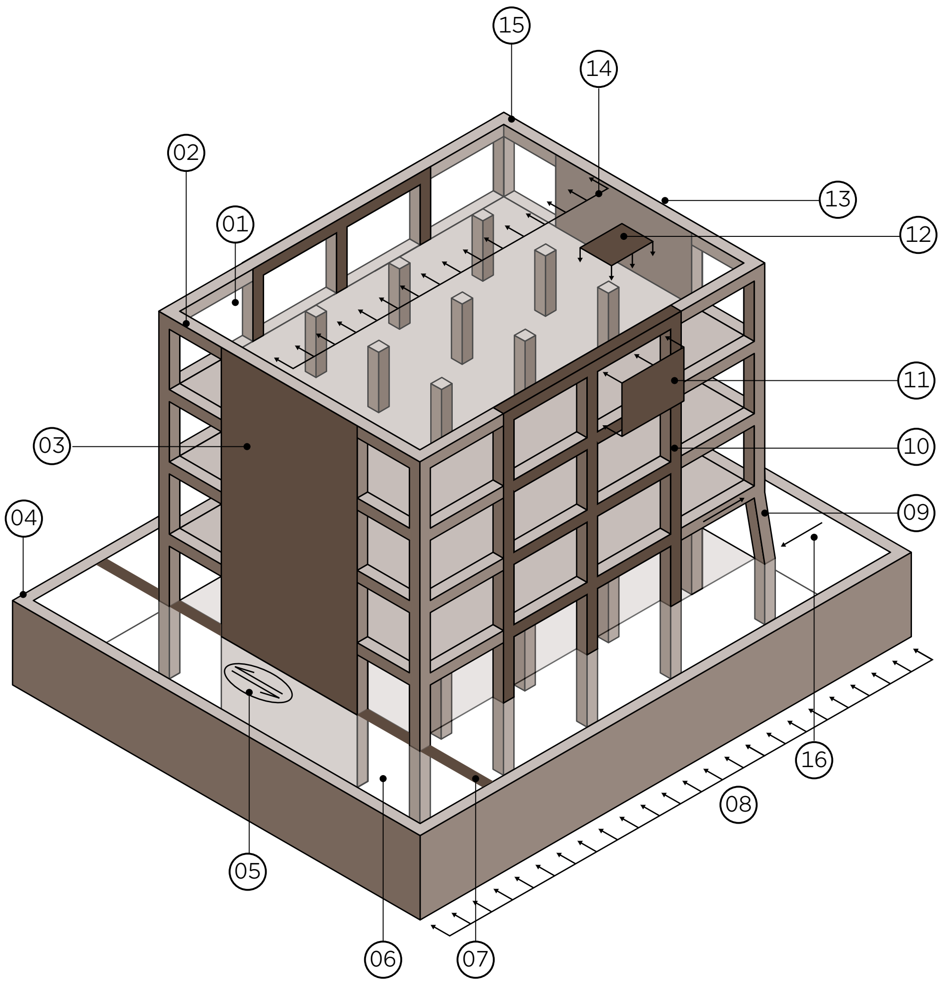
g) accidental loads (blast, impact, etc.).

F.5.4 Structural stability

Measures shall be taken to ensure that the building is stable under the design basis load conditions. Where necessary, these measures shall also allow for the maximum credible loads for which the collapse limit state might be chosen as being applicable.

Any features of the structure that have a critical influence on its overall stability shall be identified and included in the design, including all members that provide restraint to critical members in compression.

A structure shall provide continuous load paths transferring actions from their point of application to the ground (see Figure F.2).



Key

01: Diaphragm
02: Collector
03: Structural (shear) wall
04: Basement wall
05: Shear transfer in diaphragm
06: Transfer slab/diaphragm
07: Distributor
08: Below grade soil pressure
09: Inclined column
10: Moment resisting frame
11: Out-of-plane wind pressure or inertial loads
12: Gravity loads
13: Structural (shear) wall
14: In-plane inertial loads
15: Collector
16: Thrust

Figure F.2 Typical actions and structural system (© ACI. Modified figure based on Figure R12.1.1, ACI 318-19, pg.176)

F.5.5 Robustness against disproportionate collapse

Measures shall be taken to ensure that the building is robust and resistant to disproportionate collapse under the specified load conditions. One of the following approaches shall be used.

a) Direct design: Explicit consideration of resistance to progressive collapse during the design process through either:
   1) tie forces method (see Figure F.3);
   2) alternate path method; or
   3) enhanced local resistance method.

Further details on the direct design methods can be found in UFC 4-023-03 **[Ref. F.1]**.

b) Indirect design: Implicit consideration of resistance to progressive collapse during the design process through the provision of minimum levels of strength, continuity, and ductility.

Further details on the indirect design method can be found in Appendix C of ASCE/SEI 7-16.

It is recommended that the direct design approach is undertaken in accordance with UFC 4-023- 03 **[Ref. F.1]**, as illustrated in Table F.2.

Risk category (per table 1.5-1 of ASCE/SEI 7-16)	Design requirement
I	No specific requirements.
II	Indirect design approach. OR Direct design option 1: Tie forces for the entire structure and enhanced local resistance for the corner and penultimate columns or walls on the first storey. OR Direct design option 2: Alternate path for specified column and wall removal locations.
III	AP for specified column and wall removal locations and enhanced local resistance for all perimeter first storey columns or walls.
IV	Tie forces and alternate path for specified column and wall removal locations and enhanced local resistance for all perimeter first storey columns or walls.

Table F.2 Risk category and design requirements

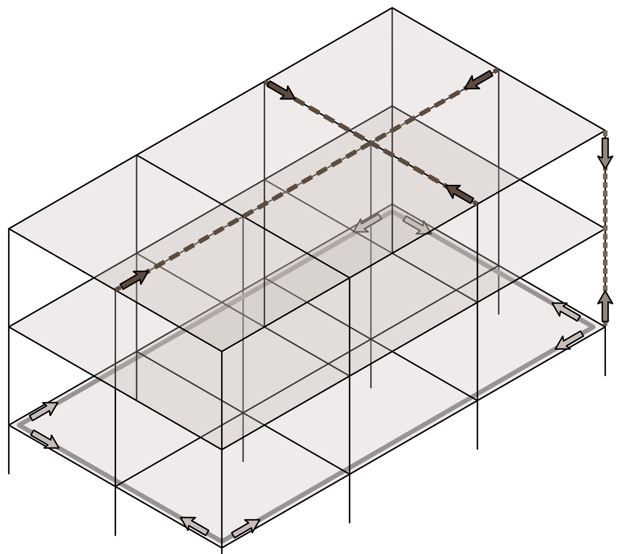


Figure F.3 Tie forces method for disproportionate collapse

Key

Peripheral ties
Vertical ties
Longitudinal ties

F.5.6 Durability

F.5.6.1 General

All elements shall be designed with appropriate detailing and material specifications to achieve the specified design life, considering the environment of the project.

F.5.6.2 Concrete structures

The recommendations of BS 8500-1 shall be implemented in the design and specifications of concrete structures. Concrete mixes shall conform to the minimum requirements listed under F.11.

A project-specific durability design report shall be provided when one of the following conditions is met:

a) structures with a designated design life of more than 50 years;
b) structures exposed to design sulphate class DS-4 or greater (as defined in Table A.2 of BS 8500 1:2015);
c) structures exposed to design chlorides class XD-3 (as defined in Table A.2 of BS 8500-1:2015); and
d) structures exposed to design chlorides (from sea water) class XS-2 or greater (as defined in Table A.2 of BS 8500-1:2015).

Service life modelling may be used at the preliminary design stage as part of the durability study. Additional protection measures should be included in the durability design report. Appropriate provision shall also be made to enable inspection and maintenance to be carried out.

F.5.6.3 Steelwork structures

The Engineer shall provide the steelwork material specifications, stating the steel grades and protective paint systems which are durable and compatible with the climate of Dubai.

The protective paint coatings for steelwork shall be specified in accordance with BS EN 12944 as a minimum, with additional requirements to address the susceptibility of the protective coatings to ultra violet degradation.

The material specifications shall also state the inspection and maintenance requirements with definition of the expected coating life.

F.5.7 Fire resistance

The construction type and fire resistance rating of structural elements shall be determined based on the type of building, its height/size and occupancy in accordance with Section 2, Ch. 1 of UAE FLSC **[Ref. F.2]**.

All proposed fire protection products and systems shall be tested and certified by accredited laboratories and approved by Dubai Civil Defence (DCD).

The fire resistance rating of the main structural elements shall be taken into account in the structural design and clearly stated in the structural drawings.

Fire resistance of concrete and masonry elements shall conform to the requirements of ACI 216.1.

Fire resistance of steel structures shall conform to the requirements of the AISC Design Guide 19 **[Ref. F.14]**.

F.5.8 Sustainability

Sustainability standards shall be observed when designing the structure, during the building's lifecycle.

The design of the permanent works, together with the construction operations shall fulfil resource efficiency standards in terms of materials. Concrete mixes shall conform to F.11.

F.6 Materials

F.6.1 General

This section provides the minimum requirements for the design and construction of building and structural components using reinforced concrete, post-tensioned (PT) concrete, precast concrete, steel and masonry.

For other materials, such as aluminium, timber, gypsum board, glass and plastic, the structural requirements stated under Ch. 23 to Ch. 26 of the IBC **[Ref. F.3]** shall be followed. These materials shall only be used where also permitted by Sections 2, 4, 6 and 7, Ch. 1 of UAE FLSC **[Ref. F.2]**.

The specification of all constituent materials of the structural system shall be compatible with the specified codes and clearly detailed in the design documentation.

The design shall take into account how the strength, stiffness and durability of all materials changes over time.

F.6.2 Structural concrete

F.6.2.1 Design basis

The design of concrete for structural purposes, including plain concrete and concrete containing non-prestressed reinforcement, prestressed reinforcement or both, shall conform to the requirements of ACI 318-19 including standards referenced therein.

F.6.2.2 Concrete strength

The concrete used for structural elements shall have compressive strength not less than f_{cu} = 35 N/mm^2 and f'_c = 28 N/mm^2.

Concrete for blinding and screeds shall have compressive strength not less than f_{cu} = 20 N/mm^2.

All concrete in contact with the ground shall be designed for the aggressiveness of the contact soil (refer to F.5.6.2).

F.6.2.3 Concrete mixes

The design and technical specification of concrete mixes shall conform to either Table F.3 or the alternative Dubai sustainable concrete baseline (DSCB) described in F.11.

Table F.3 sets the minimum requirements for cement/binder content, type of cement/binder, and maximum water/cement (w/c) ratio for different grades of concrete used in substructures and superstructures.

For any mix design to be used as an alternative to those in Table F.3, the concrete mix shall be submitted to the Dubai Municipality (DM) for approval.

The mixes in Table F.3 and F.11 have been developed by DM to account for the conditions of Dubai and the durability requirements stipulated under BS EN 206 and BS 8500-1.

The DM mixes provide the minimum durability specifications for concrete structures. The Engineer shall modify the durability specification based on the structural design (service life, exposure conditions, concrete grade, concrete cover, etc.).

NOTE: The following notes are applicable to both (Table F.3 and F.11) mix design approaches.

a) Silica fume may be added to the concrete mixes to achieve the required strength and/or durability requirements of any project.
b) Testing of concrete specimens at 56 days for compressive strength may be allowed for mixes with high percentages of cement replacements.
c) Temporary works (such as shoring, shotcrete, etc.) do not need to conform to this specification.
d) Screed not providing structural protection does not need to conform to this specification.
e) The use of a high percentage of ground granulated blast-furnace slag (GGBS) in concrete mixes may cause difficulties in handling concrete (pumping, placing, finishing, etc.). It is therefore recommended to specify and accept higher slumps for such mixes in order to avoid any addition of water to the concrete mix on the construction site.
f) The minimum recommended clear concrete cover to reinforcement for substructures is 50 mm/75 mm (50 mm for concrete cast against blinding; 75 mm for concrete cast directly against soil) and 30 mm for superstructures. The final concrete cover shall be specified by the Engineer based on the structural and durability considerations of the building.

Substructures				
Options	Maximum w/c ratio	Minimum combination content (kg/m³)	Composition	
1	0.45	360	OPC with 66% to 80% GGBS	
2	0.40	380	OPC with 36% to 55% fly ash	
3	0.35	380	OPC with 36% to 65% GGBS or 26% to 35% fly ash	
Superstructures				
Options	Compressive strength (cylinder/cube) (N/mm²)	Maximum w/c ratio	Minimum combination content (kg/m³)	Composition
4	≥ C45/55	0.35	380	OPC with 26% to 35% GGBS
5	≥ C45/55	0.35	380	OPC with 16% to 20% fly ash
6	C40/50	0.35	380	OPC with 36% to 65% GGBS
7	C40/50	0.35	380	OPC with 26% to 35% fly ash
8	C32/40	0.40	380	OPC with 66% to 80% GGBS
9	C32/40	0.40	380	OPC with 36% to 55% fly ash
10	C32/40	0.45	360	OPC with 36% to 65% GGBS
11	C25/30	0.50	340	OPC with 66% to 80% GGBS
12	C25/30	0.50	340	OPC with 36% to 55% fly ash
13	Blinding concrete	0.55	202	OPC with 36% to 65% GGBS
14	Blinding concrete	0.55	202	OPC with 26% to 35% fly ash
NOTE 1: The specifications are based on the requirements of BS 8500-1. NOTE 2: The minimum cement/combination content specified is for 20 mm aggregate size. NOTE 3: OPC is ordinary Portland cement (CEM I).				

Table F.3 Green concrete combinations

F.6.2.4 Modulus of elasticity

The modulus of elasticity of concrete (E_c) shall be calculated in accordance with 19.2.2.1 of ACI 318-19. For high strength concrete (f'_c > 55 N/mm²), the Engineer shall specify a range of acceptable E_c values at a specified test age in accordance with ACI 318-19. The assumed values should be verified by testing on-site during construction. In the absence of testing, the Engineer shall adopt equation 6-1 of ACI 363R-10. Values adopted in the design shall be stated by the Engineer in the design drawings.

F.6.2.5 Section properties

Moment of inertia and cross-sectional areas for linear elastic first order analysis shall be defined in accordance with 6.6.3 of ACI 318-19.

For non-linear response history analysis, the cracked section properties shall be defined in accordance with Appendix A of ACI 318-19.

For thermal non-elastic modelling, the effective cracked cross-sectional area of axial members under tension should be calculated by the Engineer.

In the case of members with direct tension only, reference should be made to ACI 224.2R-92 for axial stiffness calculations.

F.6.2.6 Detailing of reinforcement

Detailing of reinforcement shall be in accordance with ACI 318-19 Ch.25 and ACI 315R.

The reinforcement limits shall be within the minimum and maximum limits specified in the clauses listed in Table F.4.

Structural element	Reinforcement limits requirement	Remarks
One-way slab	7.6 of ACI 318-19	-
Two- way slab	8.6 of ACI 318-19	-
Beams	9.6 of ACI 318-19	-
Columns	10.6 of ACI 318-19	-
Walls	11.6 of ACI 318-19	The Engineer should check the effect of creep and shrinkage.
Diaphragms	12.6 of ACI 318-19	-
Foundations	Section 13 of ACI 318-19	-

Table F.4 Reinforcement limits requirements

The fire resistance of the concrete elements (cover to reinforcing) shall conform to the reinforcement requirements specified in ACI 216.1.

NOTE: The Engineer and the Contractor are responsible for avoiding reinforcement congestion that would otherwise lead to poor concrete compaction or similar.

F.6.3 Post-tensioned concrete

F.6.3.1 Design basis

PT concrete elements shall be designed and specified in accordance with ACI 318-19 including standards referenced therein.

NOTE: Further guidance is given in TR43 **[Ref. F.11]**. The main steps to be followed are shown in Figure F.4.

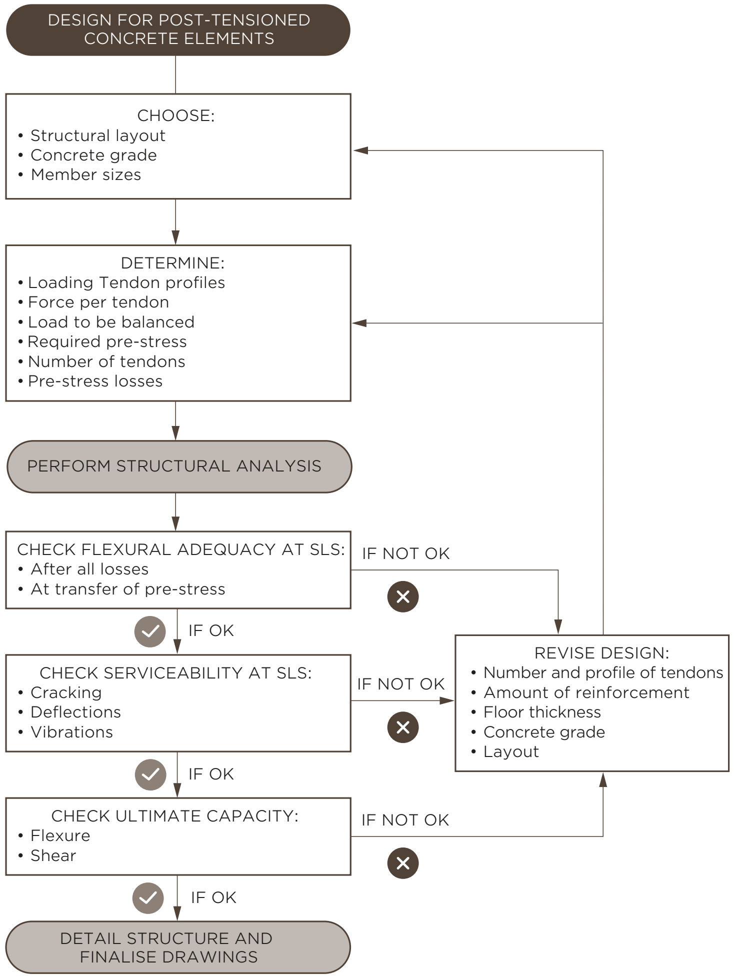


Figure F.4 Design flow chart for post-tensioned concrete elements (© The Concrete Society. Post-tensioned Concrete Floors - Design Handbook, Technical Report 43 2nd Edition, pg.22. The Concrete Society, Camberley, 2005 **[Ref. F.11]**)

F.6.3.2 Additional design requirements for post-tensioned concrete

In addition to the requirements specified in ACI 318-19, the following requirements shall be met in the design of the PT concrete elements.

a) If the structural analysis assumes that a slab provides torsion resistance ("twisting moments") in plane, this moment shall be included in the reinforcement design for the slab and its connections to resisting structures. Otherwise, the slab shall be taken as a non-torsion element and no torsional stiffness shall be included in the analysis.

b) For slabs with pre-compression in excess of 2.0 N/mm^2 (as an average over an area away from concentrations) or a dimension in one direction more than 50 m, or more than one point of stiff restraint, the following shall be taken into account:

   1) elastic shortening due to prestressing force;

   2) creep (including shortening due to prestress force); and

   3) drying shrinkage of concrete.

c) For heavily stressed members (such as transfer beams) where the pre-compression exceeds 3.0 N/mm^2, the Engineer shall account for the consequence of shortening of the member. This shall include the effect of the shortening on connections and design of the supporting elements (typically columns and walls).

d) The minimum thickness of slabs depends on the type of PT concrete system adopted. It is recommended to keep a minimum slab thickness of 200 mm with localized thickness reduction, provided that the PT systems can be accommodated.

e) The designer shall verify that the proposed PT system fits within the slab depth considering the bursting reinforcement with appropriate concrete cover.

f) For two-ways slabs with varying cross sections along the slab span, the tendons shall provide an effective pre-compression of 0.9 N/mm^2 in accordance with ACI 318-19.

F.6.3.3 Concrete

The concrete used in PT slabs and beams shall have a compressive strength at 28 days, not less than f_{cu} = 40 N/mm^2 or f'_c = 32 N/mm^2.

Concrete strengths lower than f_{cu} = 40 N/mm^2 may only be used when it can be demonstrated that a lower strength is suitable and accepted by the Authority, making sure the effects of creep and shrinkage are included.

F.6.3.4 Concrete mixes

Concrete mix designs shall be in accordance with F.6.2.3.

F.6.3.5 Tendons

Only tendons with a nominal tensile strength of 1,860 MPa and approved by Dubai Central Laboratory shall be used.

The jacking force shall not exceed 80% of a tendon's tensile strength.

F.6.3.6 Ducts

Ducts for grouted multiple wire, multiple strand, or multiple bar tendons shall have a minimum internal cross-sectional area of two times the cross-sectional area of the post-tensioning steel.

The wall thickness of metal ducts shall not be less than 0.4 mm.

The profile of the tendons shall conform to the following tolerance levels:

a) vertical tolerance: ±5 mm; and

b) horizontal tolerance: ±100 mm.

F.6.3.7 Grout

Grouts shall have a strength not less than the strength of the concrete at 28 days and shall contain additives to compensate for and/or minimize shrinkage.

F.6.3.8 Permissible stresses in post-tensioning steel

The maximum jacking stress for post-tension elements shall be the lesser of 0.80 f_{pu}, or the maximum jacking stress recommended by the system supplier.

Immediately after force transfer, the tendons shall have a maximum stress of 0.70 f_{pu} at anchorages, points and couplers.

F.6.3.9 Minimum bonded reinforcement for post-tensioned concrete

In addition to the requirements of ACI 318-19, a minimum area of bonded un-tensioned reinforcement shall be provided in all flexural members, as follows.

a) Negative moment areas at column supports in flat slabs.

1) The minimum area of top un-tensioned reinforcement A_s in each direction shall be computed by $A_s = 0.00075\ A_{cf}$ where A_{cf} is the gross cross-sectional area of the concrete slab-beam strips in each of the two orthogonal equivalent frames intersecting at a column, in a two-way slab.
2) This reinforcement shall be distributed across an effective width, extending 1.5 h beyond opposite faces of the supporting column, where h is slab thickness (see Figure F.5).
3) The spacing of un-tensioned reinforcement shall not exceed 350 mm centres.
4) The minimum length of un-tensioned reinforcement in negative moment areas shall extend one-fifth the clear span, on each side of the support.
5) Non-tensioned reinforcement shall only consist of fully bonded deformed bars.

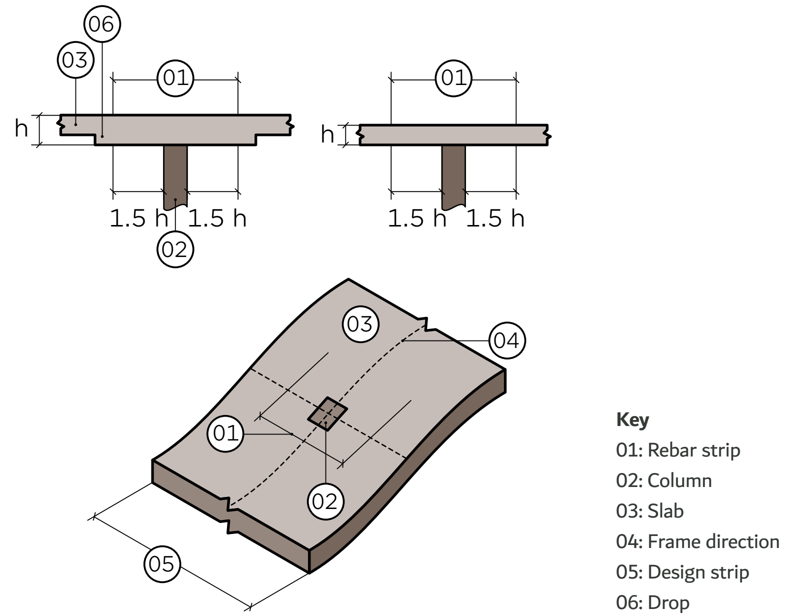


Figure F.5 Strip for top reinforcement (Modified figure based on Figure 3.1.3, Aalami, Dr B, (2000) Layout of Post-tensioning and passive reinforcement in floor slabs. PTI Technical Notes, Issue 8, pg. 7)

b) Thermal and shrinkage reinforcement.
   1) The minimum thermal and shrinkage reinforcement shall be in accordance with ACI 318-19. For slab thicknesses of 200 mm or less, the minimum reinforcement shall be provided at the bottom layer. For thicker slabs, the minimum reinforcement can be split between top and bottom layers.
   2) The bottom reinforcement mesh shall run through the column location.

c) Integrity reinforcement. At the member supports, at least one tendon comprising at least two strands shall pass through the columns or walls. The following shall be observed.
   1) If the tendon is not passing through the columns or walls, then a minimum amount of bottom un-tensioned reinforcement shall be provided for structural integrity.
   2) Minimum bottom un-tensioned reinforcement shall be the lower of either 150% of the minimum calculated flexural reinforcement, or ($2.1\ b_w\ h/f_y$) where b_w is the width of the column face through which the reinforcement passes.
   3) Un-tensioned reinforcement bars passing through the column shall extend beyond the column or shear cap face by a minimum distance equal to or greater than the bar development length.

d) Edge reinforcement.
   1) Un-tensioned reinforcement shall be provided in accordance with ACI 318-19 to resist spalling and longitudinal edge tension forces induced by the anchorage devices. The quantity shall be calculated for the anchorage arrangement. The effects of abrupt changes in section and the stressing sequence shall also be included.
   2) The area of tension reinforcement (and/or prestressed tendons) provided parallel to the slab edge shall resist bending moments from the ultimate vertical loads calculated for a continuous slab, spanning "L_A". This reinforcement shall be evenly distributed across a width equal to 0.7 L_A and shall be continuous along the edge (see Figure F.6).
   3) The area of reinforcement placed perpendicular to the slab edge shall be the greater of thermal and shrinkage minimum reinforcement, or a quarter of the reinforcement provided parallel to the edge. It shall be placed evenly between anchorages and extend the greater of L_A or 0.7 L_A plus a full anchorage length into the slab.

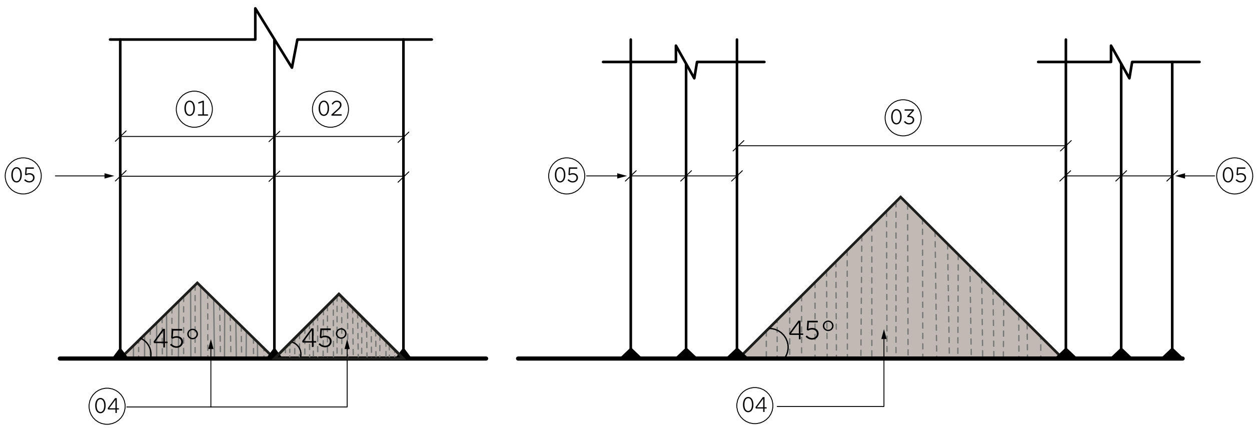


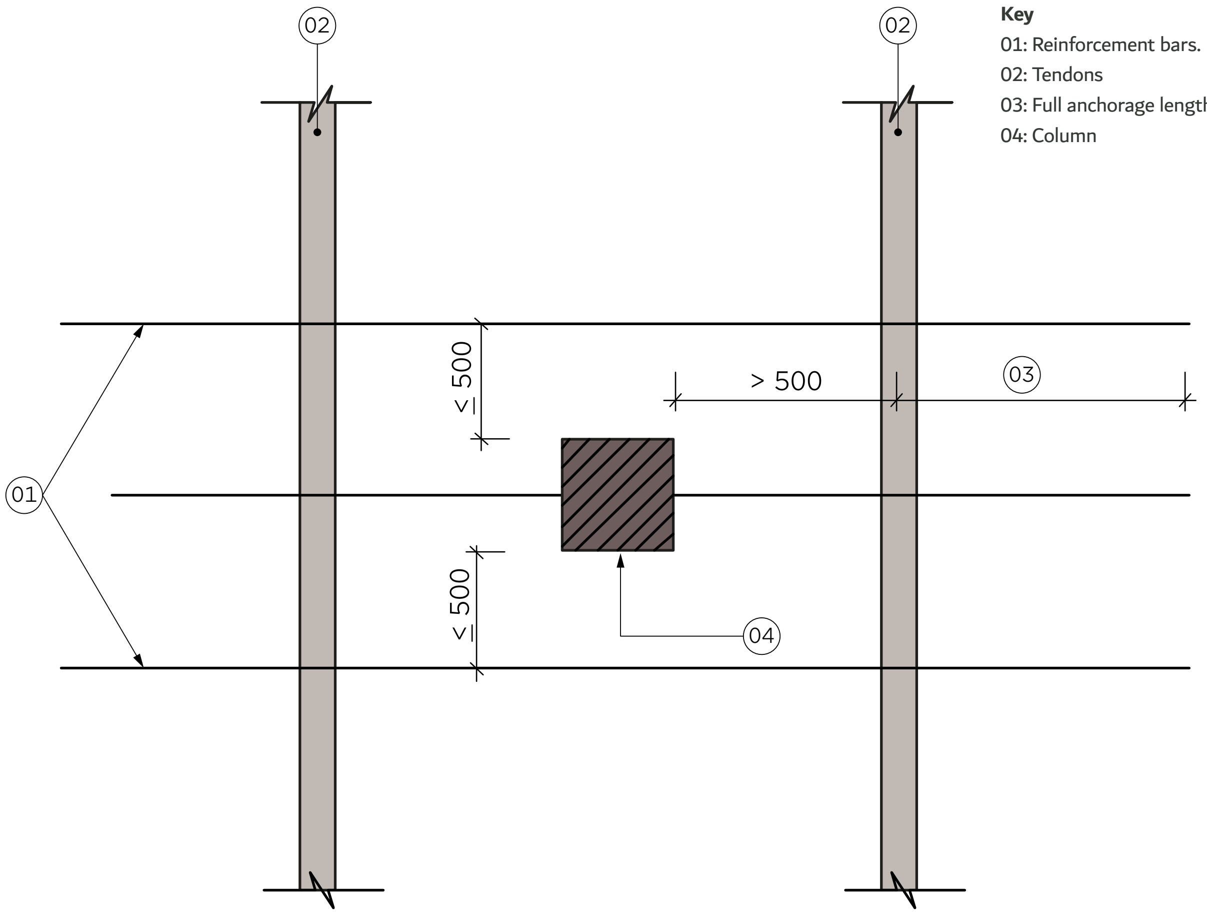
Figure F.6 Unstressed areas between tendons requiring reinforcement (© The Concrete Society. Post-tensioned Concrete Floors - Design Handbook, Technical Report 43 2nd Edition, pg.40. The Concrete Society, Camberley, 2005 **[Ref. F.11]**)

F.6.3.10 Post-tensioned concrete reinforcement detailing

Reinforcement and PT tendons shall be detailed in accordance with ACI 318-19 and with the requirements stipulated herein.

For situations where it is not feasible to place the prestressing tendons within 0.5 h from the column face, un-tensioned reinforcement shall be placed to bridge the vertical force from the adjacent tendon to the columns, as shown in Figure F.7 and Figure F.8. At least one reinforcement bar should pass over the column. Reinforcement bars should be positioned below the pre-stressed tendon (see Figure F.8).

These un-tensioned reinforcement bars shall extend beyond the column or shear cap face by a minimum distance equal to or greater than the bar development.



Key
01: Reinforcement bars.
02: Tendons
03: Full anchorage length
04: Column

Figure F.7 Additional reinforcement required where tendons are not within 0.5 h from the column (© The Concrete Society. Post-tensioned Concrete Floors - Design Handbook, Technical Report 43 2nd Edition, pg.42. The Concrete Society, Camberley, 2005 **[Ref. F.11]**)

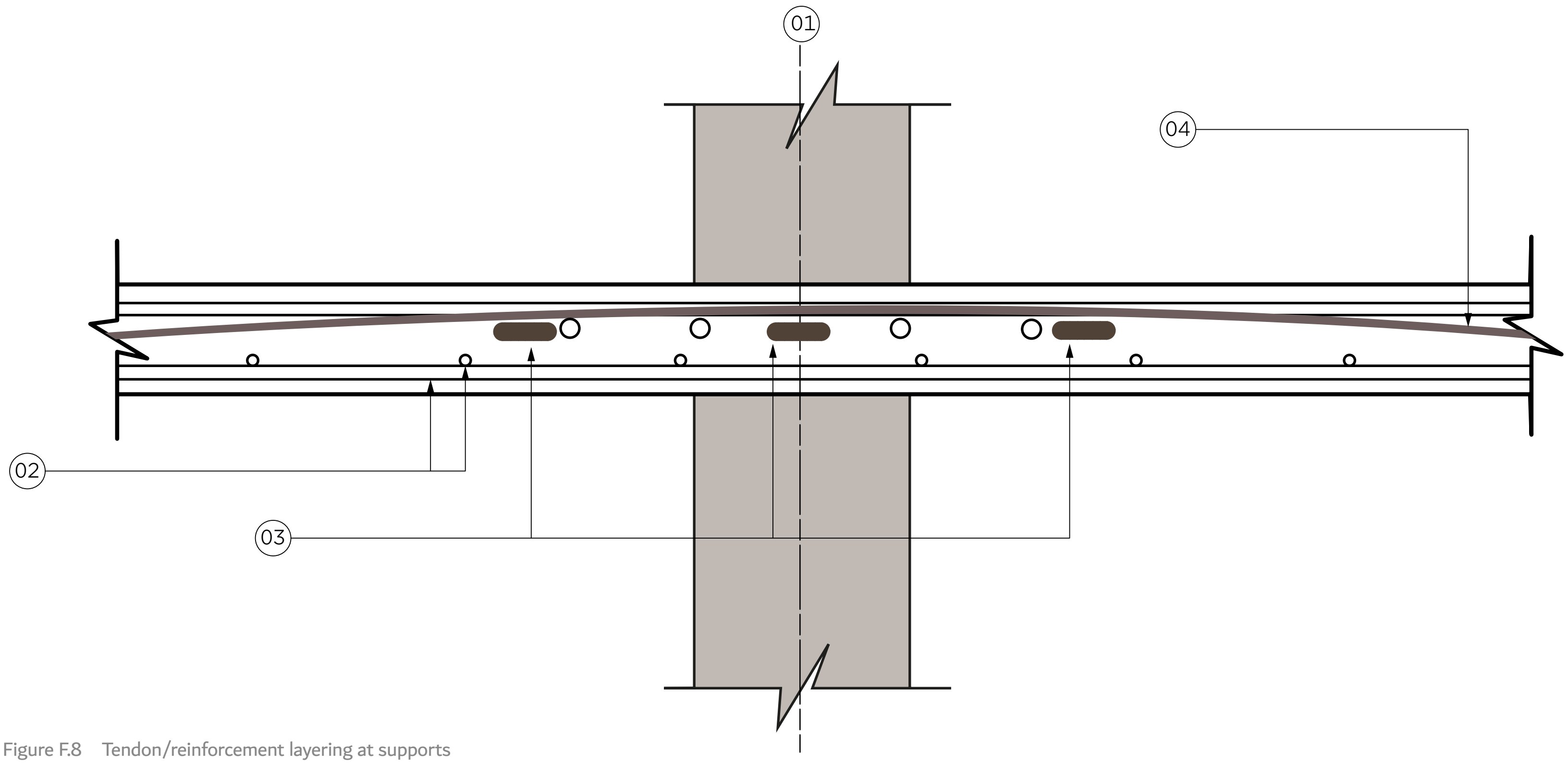


Figure F.8 Tendon/reinforcement layering at supports

Key

01: Column centre line

02: Slab bottom reinforcement

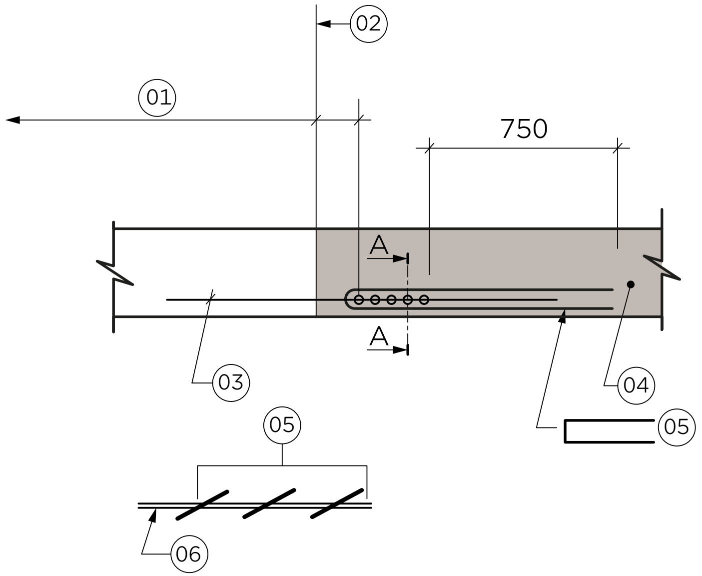
03: Banded tendons

04: Distributed tendon

Additional un-tensioned reinforcement is required where tendons are not within 0.5 h from the column. This reinforcement shall:

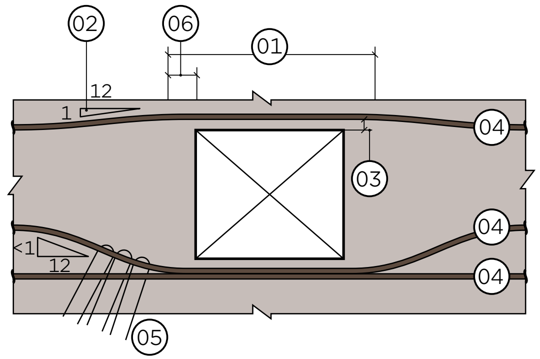
a) be placed under the prestressing tendons;
b) have sufficient area to transmit the vertical component of the prestressing from the tendon to the column;
c) extend a full anchorage length beyond the tendon; and
d) lie within 0.5 h of the column and at least one bar shall pass over the column.

Additional reinforcement is required in areas of openings in the concrete. For curved tendons and tendons near the openings, see Figure F.9, Figure F.10 and Figure F.11.



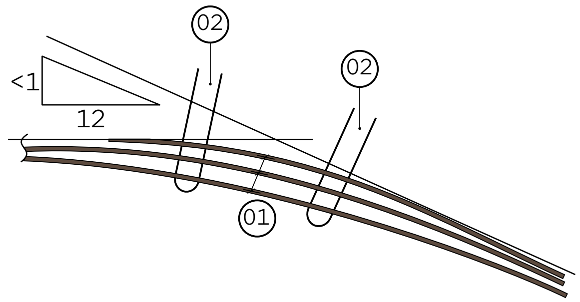
Key
01: Opening or centre of tendon turn
02: Edge of opening where it occurs
03: PT tendon
04: PT slab
05: 12 mm hairpin placed radially to hold tendons in plane of slab. Place over curved length of tendon at (2,000 mm/number of strands) mm on centre but not more than 450 mm apart
06: Section A-A

Figure F.9 Tendon placement at opening



Key
01: 900 mm minimum straight
02: Maximum curvature typical
03: 75 mm minimum cover
04: Tendon
05: Hairpin
06: 300 mm minimum

Figure F.10 Tendon placement for turns > 1:12



Key
01: Where tendon turn is greater than 1:12:
- keep tendons minimum 50 mm apart at turn for unbonded tendons;
- place hairpin.
02: Hairpin

Figure F.11 Typical hairpin at tendon turns

F.6.4 Precast concrete

F.6.4.1 Design basis

Precast concrete elements, including those that are normally reinforced and/or prestressed, shall be designed and specified in accordance with this subsection, supplemented by the requirements given in ACI 318-19 and Precast/prestressed Concrete Institute (PCI) design handbook [Ref. F.12].

F.6.4.2 Concrete

Reinforcement and prestressed strands shall conform to the requirements stated under Section 1 of the PCI design handbook [Ref. F.12].

The concrete used for precast structural elements shall have a compressive strength of not less than f_{cu} = 40 N/mm^2 measured at 28 days. A lower strength may only be used if its suitability can be demonstrated and it is accepted by the Authority.

The minimum transfer strength (when prestress force is transferred to the concrete) shall be 25 N/mm^2, unless the adequacy of a lower strength can be demonstrated in the design, making sure the effects of creep and shrinkage are included.

F.6.4.3 Concrete mixes

Concrete mix designs shall be in accordance with F.6.2.3.

F.6.4.4 Reinforcement and strands

Reinforcement and prestressed strands shall conform to the requirements stated under Section 1 of the PCI design handbook [Ref. F.12].

Precast floor slabs acting compositely with topping concrete shall have reinforcement in the topping not less than Φ8 at 200 mm mesh.

In order to allow for composite action of the precast slab and concrete topping, the Engineer shall specify that any conduits and pipes shall be installed within the screed rather than within the structural topping. Where the above conditions are not met, the composite action shall not be considered in the design. The Contractor shall ensure that the surface of the precast slab is prepared and cleaned before concrete topping is cast on-site.

Integrity ties shall be provided in accordance with 16.2 of ACI 318-19 (see Figure F.12).

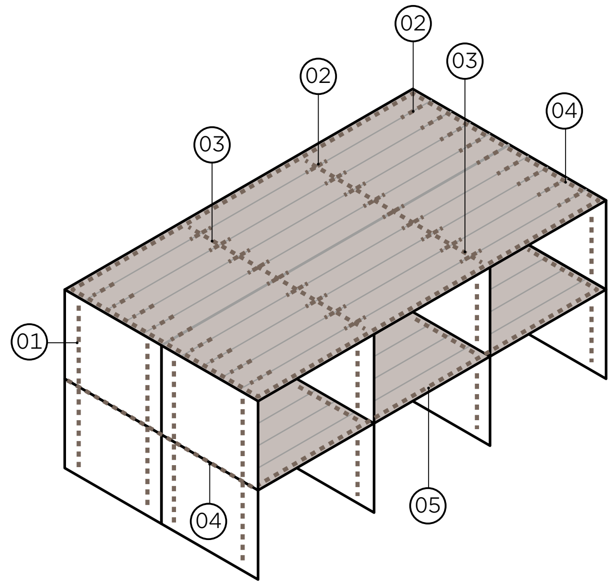


Figure F.12 Integrity ties in large precast panel structures
(© ACI. Modified figure based on Figure R16.2.5, ACI 318-19, pg. 221)

Key

01: Vertical ties
02: Longitudinal ties
03: Transverse ties
04: Perimeter transverse ties
05: Perimeter longitudinal ties

F.6.4.5 Storage, transportation, handling and erection

Precast and prestressed elements often require a separate analysis of the loading scenarios during storage transportation and handling. The design under these conditions shall be undertaken in accordance with Section 5 of the PCI design handbook [Ref. F.12].

In particular, the following requirements shall be included during the design of the temporary conditions.

a) Precast units shall be designed to resist all stresses induced by storage, handling, transport and erection, without permanent deformation. They shall be braced for handling and transportation when necessary.
b) Each element shall be stable after erection and resist wind, accidental impact and loads that might be imposed due to other construction operations.
c) Surfaces shall remain free of discernible cracks by limiting the elastic flexural tension to the modulus of rupture, modified by a suitable safety factor.
d) The arrangement of temporary bracing shall not interfere with adjacent erection and other construction processes. Bracing shall be maintained until permanent connections are completed.
e) The method used for transporting precast concrete products shall be included in the structural design including size and weight limitations and the dynamic effects imposed by road conditions.
f) Temporary handling load conditions are the responsibility of the Contractor. However, for structures where construction-stage loads might be particularly onerous and/or govern, the Engineer shall include the implications of one or more viable construction procedures on the precast concrete component design.
g) The Engineer shall communicate any assumptions they make for the construction to the Contractor as part of the submission. This is particularly important when combining precast concrete with steelwork and/or in-situ concrete.

F.6.4.6 Connections

Typical connections for precast elements shall be designed in accordance with Section 6 of the PCI design handbook [Ref. F.12] and Ch. 16 of ACI 318-19 (see Figure F.13 for typical bearing support).

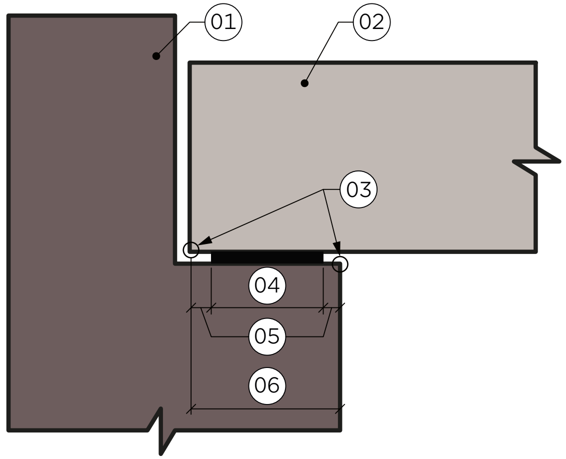


Figure F.13 Typical bearing support (© ACI. Modified figure based on Figure R16.2.6, ACI 318-19, pg. 222)

Key
01: Support
02: Precast member
03: Unreinforced edge
04: Bearing length
05: 25 mm minimum and not less than the size of the chamfer
06: Clear span/180 ≥ 55 mm (slabs)
Clear span/180 ≥ 80 mm (beams)

In particular, the following requirements shall be included during the design of the permanent and temporary conditions.

a) Connections shall have adequate strength to transfer the forces to which they are subjected during their lifetime.
b) The stresses across connections caused by restraint of creep, shrinkage and temperature change (volume change) shall be included in the design.
c) Connections shall meet the durability and fire resistance requirements of the connecting elements.
d) Connections shall be checked for all load scenarios including horizontal forces arising from earthquake and wind events.
e) Precast members shall have positive connections (ties) to the supporting structures unless seating lengths are greater than maximum expected movements.

F.6.4.7 Precast staircase

Precast staircases may be included in buildings if they are not part of the lateral load resisting structural frame.

The design of precast stairs shall be in accordance with ACI 318-19 and the PCI handbook [Ref. F.12]. They shall be designed in such a way that they can be safely incorporated into the structure. Additional design recommendations are provided in F.12.

F.6.5 Structural steel

F.6.5.1 Design basis

The design of structural steel shall be in accordance with AISC 360 including codes and standards referenced therein. Seismic design shall follow AISC 341.

Compatible materials shall be specified in accordance with standards set by the ASTM International (ASTM). Welding shall be specified in accordance with standards set by the American Welding Society (AWS).

F.6.5.2 Steel grades

Table F.5 and Table F.6 summarize the steel grade that shall be adopted in the design. Steel sections can be selected in accordance with either American or British specifications. The Engineer is responsible for ensuring compatibility of the material specification with the design basis, including detailing requirements and ductility in general.

Type of section	Material specification	f_y N/mm^2
Wide flange	ASTM A992M	345
Channels	ASTM A36M	250
Angles	ASTM A36M	250
Plates	ASTM A36M	250
Built-up sections	ASTM A36M	345
Hollow structural section (HSS) rectangular or square	ASTM A500 Grade B	240
HSS round	ASTM A500 Grade B	240
Pipe	ASTM A501	240
Pipe (alternate)	ASTM A53M, Grade B Type E or S	240
Anchor rods	ASTM F1554	380, with supplemental requirement for weldability f_y = 517
Headed shear stud	AWS D1.1, Type B	345

Table F.5 Steel grades based on American specifications

Type of section	Material specification	f_y N/mm^2
Beam	BS EN 10025-1 Grade 355J0 or Grade 275J0	295 to 355 (based on thickness) 225 to 275 (based on thickness)
Universal column	BS EN 10025-1 Grade 355J0 or Grade 275J0	295 to 355 (based on thickness) 225 to 275 (based on thickness)
Angles	BS EB 10056-2 Grade S275	275
Bars and plates	BS EN 10025-1 Grade S275 or Grade S355	295 to 355 (based on thickness) 225 to 275 (based on thickness)
Hot-finished square, rectangular and circular hollow sections (SHS, RHS and CHS)	BS EN 10210 Grade S355J2H	240
Cold-formed SHS, RHS and CHS	BS EN 10219 Grade S355J2H	240

Table F.6 Steel grades based on British specifications

In addition to the steel grades listed above, high strength steel grades with minimum yield strength of 460 N/mm^2 can be adopted in accordance with the requirements of BS EN 10025-4:2019.

F.6.5.3 Plate thickness

Steel plate for built-up sections shall have a minimum thickness of 6 mm.

F.6.5.4 Structural connections

F.6.5.4.1 Bolted connections

Bolted connections shall be designed and constructed in accordance with AISC manual of steel construction [Ref. F.15] including AISC specification for structural joints using ASTM A325 or A490 bolts [Ref. F.16]. For higher strength applications (> 60,000 psi), ASTM A307 shall be followed.

F.6.5.4.2 Welded connections

Welding design and procedures shall be in accordance with AWS D1.1 or BS EN ISO 15614.

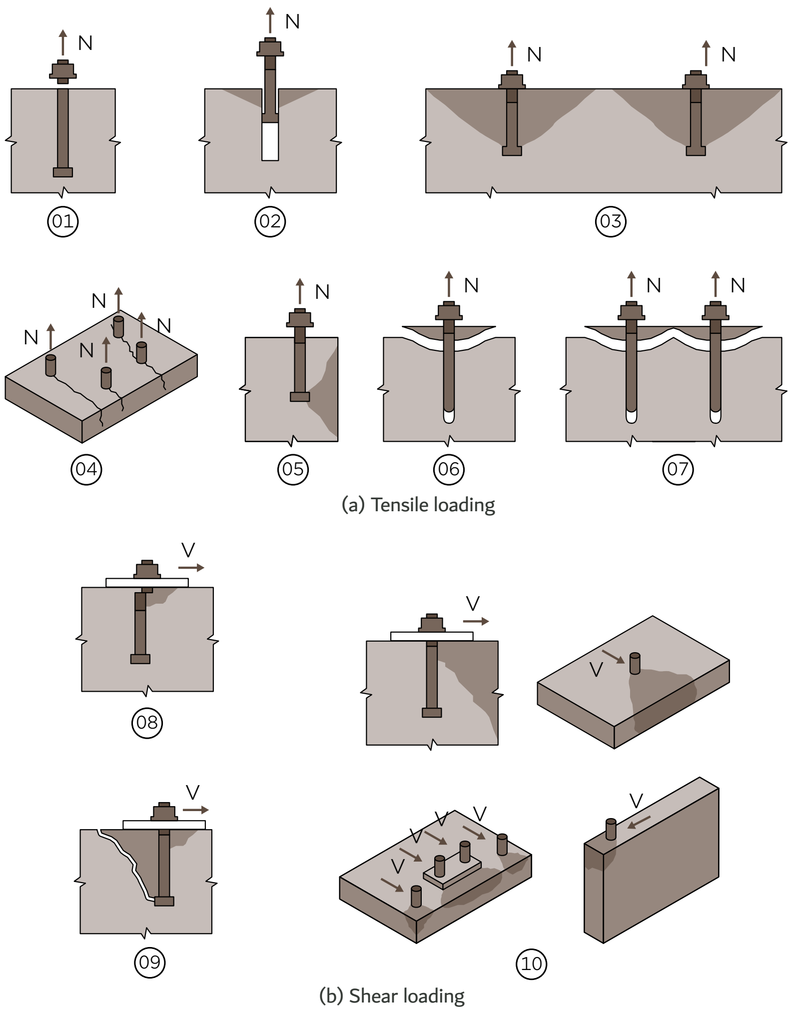
Welding should not be undertaken on-site. If unavoidable, the detailed method of work with the necessary certificates and tests shall be submitted for approval. In addition, welding procedures shall be implemented by accredited welders in accordance with relevant AWS requirements.

Connections shall not be detailed to rely on the combined strength of welding and bolting at the same time under any circumstances.

F.6.5.4.3 Post-installed anchors

Post-installed anchors into reinforced concrete elements may be used for the purpose of supporting steelwork where it is impractical to install cast-in anchors.

Post-installed anchors shall be designed based on the provisions of ACI 318-19, with consideration for all conceivable failure mechanisms (see Figure F.14).



Key
01: Steel failure
02: Pullout
03: Concrete breakout
04: Concrete splitting
05: Side-face blowout
06: Bond failure – Single
07: Bond failure – Group
08: Steel failure preceded by concrete spall
09: Concrete pryout for anchors far from a free edge
10: Concrete breakout

Figure F.14 Failure modes for anchors (© ACI. Modified figure based on Figure R17.5.1.2, ACI 318-19, pg. 238)

F.6.6 Masonry

F.6.6.1 Design basis

The design of load-bearing masonry walls shall be in accordance with TMS 402/602 including codes and standards referenced therein.

The design of non-load-bearing masonry walls which are not part of the main structural frame, shall be in accordance with either TMS 402/602 or BS EN 1996-1, BS EN 1996-2 and BS EN 1996-3.

F.6.6.2 Wall panels

Wall panels shall be constructed with suitable strength bricks or concrete blocks, arranged in an interconnected manner, typically using cement mortar.

Wall panel dimensions between movement joints and/or lateral supporting structures shall not exceed the capacity of the wall panel. Wall panels shall be tied to all vertical and horizontal supporting structures. Supporting structures shall have sufficient strength and stiffness to provide the support required by the wall panel without incurring movement that would cause distress.

Any cuts/chases into wall panels shall be included in the calculations by the Engineer.

F.6.6.3 Brick and block strengths

Solid bricks and blocks for load-bearing wall panels shall have a compressive strength of not less than 9 N/mm^2. Bricks and blocks (including hollow blocks) in non-load bearing walls shall have a compressive strength of not less than 6 N/mm^2.

F.7 Loads

F.7.1 General

Loads shall be defined in accordance with ASCE/SEI 7-16 and this section.

F.7.2 Load combinations

Loads shall be factored and combined in accordance with Ch. 2 of ASCE/SEI 7-16. The results from compatible linear analyses of load cases acting individually may be combined and summed algebraically.

F.7.3 Dead loads

Dead loads shall be calculated using the densities and volumes of the materials making up the construction. Default densities of common materials are scheduled in Table F.7.

NOTE: More refined densities and the densities of other materials can be sourced from the referenced codes and standards, material data sheets, or obtained via testing. The Engineer is responsible for ensuring the densities assumed in design align with those of the specified construction materials.

Description	Load (kN/m^3)
Concrete (normal weight, including allowance for reinforcement)	25
Concrete (lightweight, including allowance for reinforcement)	18
Concrete blockwork (normal weight)	20
Concrete blockwork (autoclave aerated block)	7
Steel	78
Screed and blinding	20
Float glass	25

Table F.7 Default material densities

Where appropriate, dead loads shall make provision for additional weight concentrated at structural connections.

F.7.4 Superimposed dead loads

The Engineer is responsible for determining the superimposed dead loads for components not included as either live or dead loads (including the anticipated internal partitions, floor and ceiling finishes, facades and external cladding). Loads shall be defined as concentrated point loads, uniform loads on plan, and/or uniform loads on elevation, as appropriate.

The following minimum load allowances (defined as average uniform loads on plan) shall be adopted for the purpose of evaluating the maximum load effect:

a) internal drywall partitions: 0.75 kN/m^2;

b) suspended services with ceiling finishes: 0.50 kN/m^2; and

c) suspended services without ceiling finishes: 0.30 kN/m^2.

When minimum load effect is critical (e.g. buoyancy check), an appropriate minimum load criterion shall be assumed. The minimum load for features that are easy or likely to be removed should be zero (0.0 kN/m^2).

The Engineer shall provide detailed calculations supporting the superimposed dead load assumptions. If supporting calculations are not provided, the vertical load listed in Table F.8 shall be included for the partition assumptions.

Type of wall	Superimposed dead load applied vertically, including finishes (kN/m^2)
Lightweight block wall	4.5
Normal weight block wall	5.5
Drywall	4.0

Table F.8 Minimum superimposed dead load

Loading plan drawings showing the load provision should be submitted for approval.

The design assumptions shall be validated against the systems installed. Any late amendments and/or retrospective changes shall not be made without new approval.

F.7.5 Live loads

Minimum uniform live loads shall not be less than those listed in Ch. 4 of ASCE/SEI 7-16. The following requirements shall also be applied.

a) Concentrated live load shall be evaluated for objects creating significant point loads, including machinery, vehicles and storage racks.
b) The minimum live load for garage and car parking is 3.5 kN/m^2 which should be validated based on the type of vehicles accessing the facility. The Engineer shall also take into account the load imposed by emergency vehicles along the designated route.
c) The live load for drained areas of floor surrounding a swimming pool is 2 kN/m^2. Pool tanks and other areas susceptible to flooding are to be designed for a load not less than the maximum retained head of water.
d) The Engineer shall design the supporting structure to withstand the loading imposed by the mechanical, electrical and plumbing (MEP) equipment in the designated areas and along the proposed equipment access route.

F.7.6 Soil loads and hydrostatic pressure

Minimum soil and hydrostatic pressure loads shall not be less than those listed in Table F.9. Lower values shall not be used without project-specific justification.

Description	Minimum load (kN/m^3)
Soil for planters (saturated)	19
Compacted soil for trafficable areas	22
Water	10
Brackish water	10.3

Table F.9 Material densities

In addition to the geotechnical requirements specified in F.9, the Engineer shall include the following in the design of permanent structures.

a) All foundation elements and retaining walls shall be designed following the recommendations given in the geotechnical interpretive report (GIR).
b) The design water table shall be established in the GIR considering the fluctuation of the water table level during the design life of the structure. In particular, the effect of dewatering in the neighbouring areas, the seasonal variation of the water table, future developments (such as canal, water bodies, landscaping and similar) and potential impact of climate change shall be included in the definition of the design groundwater level. The design groundwater level and its fluctuations shall be stated by the Engineer in the design drawings and agreed with the Authorities.
c) In any case, the minimum water table level shall be assumed as follows.
    1) In proximity to bodies of water: ±0.00 m Dubai Municipality datum (DMD) plus 1.0 m for seasonal and tidal variations.
    2) Away from bodies of water: actual water table level with dewatering taken into account, as defined in the GIR, plus 1.0 m for seasonal and tidal variations.
d) For structures below the water table, hydrostatic uplift and lateral pressures shall be checked in accordance with Section 10 of BS EN 1997-1:2004 and the associated United Kingdom National Annex (UK NA). Any dewatering system, whether used for construction or throughout the design life, is temporary unless the system can be demonstrated to be reliable throughout the design life.
e) Where construction of the project is staged, or in case of construction on an adjacent plot, any possibility of unbalanced lateral soil load shall be included.
f) Any retaining wall assumed to be subjected to lateral pressure during construction shall be designed according to possible surcharge and hydrostatic loading. The lateral soil pressure arising from compacted soil placement shall be included where this exceeds the at rest or passive pressure (as relevant).

g) Bracing conditions of the retaining structure and construction sequence shall be carefully captured in the analysis and design.
h) Uplift due to heave shall also be included for both permanent and temporary conditions whenever applicable.

F.7.7 Construction load

Minimum design load requirements during construction of buildings shall be defined in accordance with ASCE 37.

Construction-stage loads, including locked in stresses arising from the construction sequence and affecting the overall behaviour of the structure, shall be included by the Engineer.

The Engineer shall clearly state the construction load assumptions on the detailed design drawings and verify that the structural system can withstand these loads during all stages of construction.

Any departure from the Engineer’s assumptions by the Contractor’s construction sequence shall be assessed.

F.7.8 Accidental impact load

Structural elements shall be designed to resist accidental impact loading conditions specified under Section 4.6 of ASCE/SEI 7-16. A secondary protection system should be provided to all primary structural members to avoid accidental impact load.

F.7.9 Helipad and heliport loads

The minimum live load allowance for helipad and heliports shall be in accordance with Section 4.11 of ASCE/SEI 7-16.

F.7.10 Self-straining forces

Structures shall be designed to resist any self-straining forces arising from the contraction or expansion of structural elements.

Such volume changes can result from shrinkage, creep and/or moisture change in component materials, including the soil. It might occur at any stage in the structure’s lifecycle.

The use of details to alleviate self-straining forces may be used when practical and when not in violation of any assumed load paths. Such details, where permanent, shall be durable and have provision for maintenance.

F.7.11 Thermally induced forces

Thermally induced forces shall be derived considering the structural restraints, and the changes in temperature of structural members arising across the construction/operational phases, seasonal and daily variations.

For effects on covered concrete structural members, mean monthly temperatures should be used to establish an appropriate temperature range. A default thermal range of ±20 °C may be used for exposed elements above ground level and ±15 °C for non-exposed elements (i.e. basement). Gradient thermal analysis (non-uniform) shall be applied for permanently exposed slabs like roofs and exposed last podium floors.

For steel structural members and structural members exposed to solar radiation, a range equivalent to the maximum temperature swing is appropriate. A default thermal range of ±25 °C may be used for protected steel elements. For exposed steelwork, this can arise from hourly maxima and minima. The Engineer shall assess the thermal range and assess the thermally induced forces on a case by case basis considering the construction stages, exposure and when the steel structure is locked in the final configuration.

NOTE: For further guidance, the mean monthly temperatures and relative humidity values for specific sites are available from the National Centre for Meteorology and Seismology website (www.ncms.ae/) **[Ref. F.4]**. Figure F.15 and Figure F.16 show air temperature data and relative humidity data, respectively, from the National Centre for Meteorology and Seismology.

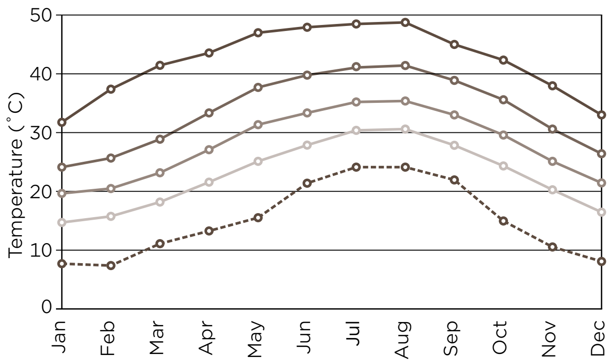


Figure F.15 Air temperature data from National Centre for Meteorology and Seismology

Key

- Maximum temperature
- Mean maximum temperature
- Mean temperature
- Mean minimum temperature
- Minimum temperature

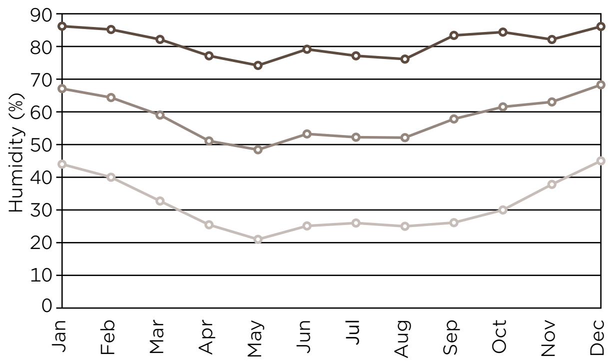


Figure F.16 Relative humidity data from National Centre for Meteorology and Seismology

Key

- Mean maximum relative humidity
- Mean relative humidity
- Mean minimum relative humidity

F.7.12 Design for wind loading effects

F.7.12.1 Design basis

The Engineer shall calculate the effects of wind loading on buildings. The calculation shall take into account strength for life safety, and serviceability for buildings movements affecting cladding or building occupant comfort. Calculations for wind design shall be based on ASCE/SEI 7-16. The Engineer shall also use supporting information and additional rules for application in Dubai from the DBC.

NOTE: The rules are intended to fully cover buildings of the kind envisaged in the writing of a code of practice. For unusual constructions, additional studies are expected, such as wind tunnel testing, and might result in a need for an appropriate variation of the rules.

F.7.12.2 Wind pressures

This clause provides the basis for calculation of wind pressures to be used with ASCE/SEI 7-16. The wind speeds of Table F.10 shall be used instead of the wind maps in Section 26.5 of ASCE/SEI 7 16.

The 50 MRI wind speed stated in Table F.10 shall only be used in accordance with Clause 5.3.5 of ACI 318-19.

ASCE/SEI 7-16 MRI (years)	Reference wind speed for 3 s gust at 10 m height on open terrain, $V = V_{ref}$ (m/s)	Application
1	22	Serviceability – occupancy comfort (refer to F.7.12.4.2)
10	30	Serviceability – displacement (refer to F.7.12.4.1)
50	38	Strength in accordance with Clause 5.3.5 of ACI 318 19
300	44	Strength – category I
700	47	Strength – category II
1,700	51	Strength – category III
3,000	53	Strength – category IV

Table F.10 Reference wind speeds per risk category as defined in Clause 1.5 of ASCE/SEI 7-16 and mean recurrence interval (MRI) as defined in the RWDI report **[Ref. F.5]**

Where wind tunnel testing is used together with up-crossing or storm-passage methods to account for directionality, the wind directionality factor (K_d) shall be taken as 1.0.

In all cases, the design wind pressure shall be not less than 1 kN/m^2.

F.7.12.3 Wind tunnel testing

F.7.12.3.1 Requirements for testing

The wind behaviour of buildings meeting any of the following criteria shall be wind tunnel tested:

a) taller than 120 m;
b) the height of the building is greater than five times its average width normal to the wind direction over the top of the building (i.e. an aspect ratio, $H/B_{av} > 5$);
c) of unusual shape or surroundings not covered by the wind loading provisions of ASCE/SEI 7-16 or other reliable published data, and which cannot be designed safely with conservative wind loads; or
d) any other building where the designer wishes to better establish the wind behaviour.

Wind tunnel testing shall follow the wind tunnel procedure described in Ch. 31 of ASCE/SEI 7-16.

F.7.12.3.2 Wind direction factors

Wind climate information used for directional evaluation of wind strengths shall be provided in any wind tunnel reports where these are used.

F.7.12.3.3 Peer review of wind tunnel testing

The Authority might require a peer review for wind tunnel testing of unusual buildings or where testing provides results which are not readily comparable to codified values.

Suitable reviewers shall have a recognized engineering qualification and at least 15 years of full-time experience in relevant wind engineering education and practical application.

F.7.12.4 Allowable building movements for wind

F.7.12.4.1 Allowable displacement

Building overall displacements shall be calculated using 10-year return (MRI) wind pressures and total building height (H).

Building inter-storey shear shall be calculated using 10-year return (MRI) wind pressures and floor to floor height (H_s).

These two calculations shall meet the limits given in Table F.11.

Description	Deflection limit
Overall displacement	H/500
Inter-storey drift	between $H_s/400$ and $H_s/600$

Table F.11 Displacement limits

The purpose of the overall displacement calculation is to control displacements of the building which might cause overstress or fatigue damage or loss of effectiveness to cladding, internal partitions or other non-structural components of buildings.

Inter-storey displacement may be estimated from inter-storey drift or calculated to include other deformations of the structure.

F.7.12.4.2 Motions affecting occupant comfort

Accelerations of the uppermost occupied floor shall be assessed for return periods of 1 year and 10 year return with the structural damping described in F.7.12.5.

The motions shall be compared with internationally recognized criteria such as those of ISO 10137 (see Figure F.17) or as described in ASCE guide wind-induced motion of tall buildings: designing for habitability **[Ref. F.6]**.

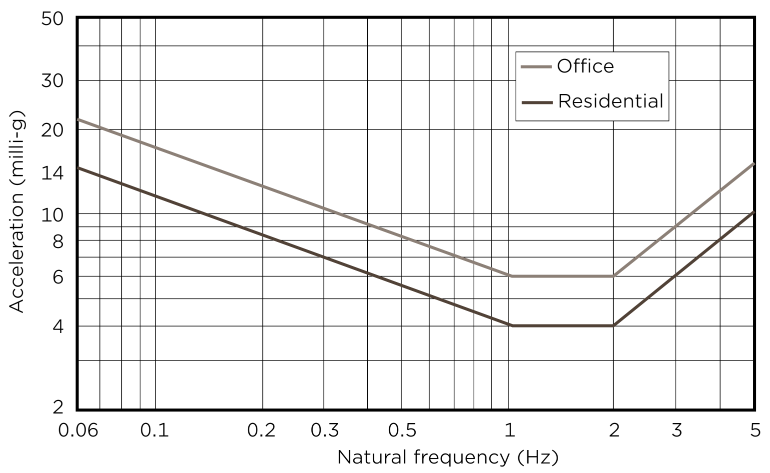


Figure F.17 Horizontal motion limits from ISO 10137 (Modified figure based on ISO 10137:2007, Bases for design of structures - Serviceability of buildings and walkways against vibration. Reproduced with the permission of the International Organization for Standardization, ISO.

Motions of a building due to the wind might affect occupants directly or cause motion of contents such as hanging objects and water, which can also cause concern to some individuals. Motions should be kept within an appropriate limit, noting that acceptability of motions is subjective and that other factors, including noises resulting from building movement, can also trigger concerns.

F.7.12.5 Structural damping for assessment of wind responses

Unless design measures or special construction provide additional damping, the estimates of structural damping of Table F.12 shall be used to assess motions under serviceability conditions and for strength design. Values are given for buildings with main lateral load resisting structure of steel or concrete. For composite steel/concrete constructions, intermediate values should be used.

Design condition	Percent of critical damping	
	Concrete structures	Steel structures
Serviceability	1% to 2%	0.75% to 1%
Strength design	1.5% to 2.5%	1% to 1.5%

Table F.12 Percentage of critical damping for normal buildings

The final damping values chosen shall be based on studies carried out by the Engineer and wind specialist.

Where additional damping is provided by moving mass dampers, strength shall be verified taking account of the risk of non-operation. The motions of the damper at beyond service design limits shall be limited in order to maintain safety in extreme events.

F.7.13 Design for earthquake effects

F.7.13.1 Scope

Every structure, and portion thereof (including non-structural components that are permanently attached to structures, and their supports and attachments) shall resist the effects of earthquake motion in accordance with ASCE/SEI 7-16.

Where any building is modified and there is change to the stiffness or mass of more than 10%, the seismic behaviour shall be reconfirmed and ASCE/SEI 7-16 requirements shall not be followed (refer to F.7.13.13).

F.7.13.2 Seismic performance criteria

Following the requirements of ASCE/SEI 7-16 would meet the life safety structural performance level for a probabilistic ground motion, with a 2% probability of exceedance within a 50-year period. The enhanced ground motion parameters given in Table F.13 shall be used for design of building structures (refer also to F.10).

Where the Owner requires a specific level of seismic performance (such as the immediate occupancy structural performance objective), the structural and non-structural components shall be explicitly analysed and evaluated in line with the requirements of Section 1.3.1.3 of ASCE/SEI 7-16. Both the proposed target performance level and ground motion parameters shall be accepted by the Authority.

The performance of the building is dependent on the adequate performance of both the structure and the non-structural components (e.g. MEP system, façade and vertical transportation systems, etc.). All the structure and the non-structural components shall be included in the seismic design process, in line with the requirements of ASCE/SEI 7-16.

F.7.13.3 Seismic ground motion values

F.7.13.3.1 Near-fault sites

There are no known active faults mapped within 15 km of Dubai, so near-fault effects do not need to be assessed. It is assumed that the West Coast Fault is not an active seismotectonic structure **[Ref. F.7]**.

F.7.13.3.2 Dubai acceleration parameters

In line with F.7.13.2, the seismic design criteria shall be modified as given in Table F.13. These are hazard values and shall be used in ASCE/SEI 7-16 directly. No corrections to adjust for risk-targeted ground motion shall be carried out.

Location	S_S	S_1	T_L (s)
Dubai	0.51	0.18	24

Table F.13 Enhanced performance seismic ground motion parameters for Dubai (site class B)

F.7.13.4 Site class

Based on the site soil properties, assessed in accordance with F.9, the site shall be classified as either site class A, B, C, D, E or F in accordance with Ch. 20 and Table 20.3-1 of ASCE/SEI 7-16. If the soil properties are not known in enough detail to determine the site class, site class D shall be used unless the Authority or geotechnical data determines that site class E or F soil is likely to be present at the site.

F.7.13.5 Site coefficients and risk-targeted maximum considered earthquake (MCE_R) spectral response acceleration parameters

The MCE_R spectral response acceleration parameters for short periods (S_{MS}) and at 1 s (S_{M1}), adjusted for site class effects, shall be determined by Eq. F.1 and Eq. F.2 respectively.

$$S_{MS}=F_a\ S_s \qquad \text{Eq. F.1}$$

$$S_{M1}=F_y\ S_1 \qquad \text{Eq. F.2}$$

where:

S_S is the MCE_R spectral response acceleration parameter at short periods as taken from Table F.13;

S_1 is the MCE_R spectral response acceleration parameter at a period of 1 s as taken from Table F.13; and site coefficients F_a and F_y are defined in Table F.14.

F.7.13.6 Design spectral acceleration parameters

Design earthquake spectral response acceleration parameters at short periods, S_{DS}, and at 1 s periods, S_{D1}, shall be determined from Eq. F.3 and Eq. F.4, respectively. Where the alternate simplified design procedure of Section 12.14 of ASCE/SEI 7-16 is used, the value of S_{DS} shall be determined in accordance with Section 12.14.8.1 of ASCE/SEI 7-16, and the value for S_{D1} need not be determined.

Site class	Short-period F_a	Long-period F_y
A	0.80	0.80
B	0.90	0.80
C	1.296	1.50
D	1.392	2.24
E	1.684	See F.7.13.9
F	See F.7.13.9	See F.7.13.9

Table F.14 Short- and long-period site coefficients for building design in Dubai

$$S_{DS}=2/3\ S_{MS} \qquad \text{Eq. F.3}$$

$$S_{D1}=2/3\ S_{M1} \qquad \text{Eq. F.4}$$

F.7.13.7 Design response spectrum

Where a design response spectrum is required by this Part and site-specific ground motion procedures are not used, the design response spectrum curve shall be developed as indicated in Figure 11.4-1 of ASCE/SEI 7-16 and Section 11.4.6 of ASCE/SEI 7-16.

F.7.13.8 Risk-targeted maximum considered earthquake (MCE_R) response spectrum

Where an MCE_R response spectrum is required, it shall be determined by multiplying the design response spectrum by 1.5.

F.7.13.9 Site-specific ground motion procedures

A site response analysis shall be performed in accordance with Section 21.1 of ASCE/SEI 7-16 for structures on-site class F sites.

A site response study or a ground motion hazard analysis is not required in any other circumstances unless specifically requested by the Authority.

F.7.13.10 Seismic design category

Structures shall be assigned a seismic design category in accordance with Section 11.6 of ASCE/SEI 7-16 and Table F.15. Each building and structure shall be assigned to the more severe seismic design category in accordance with Table F.15, irrespective of the fundamental period of vibration of the structure, T. The provisions in Ch. 19 of ASCE/SEI 7-16 shall not be used to modify the spectral response acceleration parameters for determining seismic design category.

Short period value S_{DS}	Risk level		Long-period value S_{D1}	Risk level	
	I, II & III	IV		I, II & III	IV
$S_{DS} < 0.167$	A	A	$S_{D1} < 0.067$	A	A
$0.167 \le S_{DS} < 0.33$	B	C	$0.067 \le S_{D1} < 0.133$	B	C
$0.33 \le S_{DS} < 0.50$	C	D	$0.133 \le S_{D1} < 0.20$	C	D
$0.50 \le S_{DS}$	D	D	$0.20 \le S_{D1}$	D	D

Table F.15 Seismic design category based on short- and long-period response acceleration parameters

F.7.13.11 Geological hazards and geotechnical investigation

Liquefaction shall be assessed in accordance with F.9.4.5.

F.7.13.12 Damping

Damping shall be adjusted for the analysis of structures where non-linear or soil structure interaction analysis methods are required. A damping value of 0.5% shall be used for the convective (sloshing) component of tanks or pools. The coefficients in Table F.16 shall be used together with Eq. F.5 and Eq. F.6 to generate design parameters for damping other than within 5% of critical.

$$S_{S\zeta} = S_S / \beta_S \quad \text{Eq. F.5}$$

$$S_{1\zeta} = S_1 / \beta_1 \quad \text{Eq. F.6}$$

where:

$S_{1\zeta}$ is the adjusted damping parameter at a period of 1 s;

$S_{S\zeta}$ is the adjusted damping parameter at short-period;

β_1 is the damping adjustment factor for long-period; and

β_S is the damping adjustment factor for short-period.

Damping coefficient (ζ)	β_S	β_1
0.5	0.47	0.54
2.0	0.72	0.78
5.0	1.00	1.00
10.0	1.40	1.30
20.0	1.90	1.70

Table F.16 Damping adjustment factors for short- and long-period values in Dubai

F.7.13.13 Cracked section stiffness

Stiffness properties of concrete and masonry elements shall include the effects of cracked sections. Recommendations for computing cracked section properties for non-linear response history analysis can be found in Appendix A of ACI 318-19. Where necessary, detailed section analysis can be carried out to determine cracked section stiffness for reinforced concrete sections.

F.7.13.14 Seismic assessment of existing buildings

The seismic assessment of existing buildings shall be carried out following the guidelines of ASCE 41. The seismic criteria shall be derived as stated in F.7.13.2.

F.8 Performance and serviceability requirements

F.8.1 Design basis

The basis of design shall include these aspects as a minimum:

a) strength;
b) deflection control in concrete and steel structures;
c) crack control in concrete structures;
d) building movement and motions due to wind;
e) building movement due to seismic;
f) movement joint and building separation;
g) vibration;
h) lateral acceleration;
i) fatigue; and
j) additional requirements for transfer elements.

F.8.2 Strength

Buildings, other structures, and parts thereof, shall be designed and constructed to support safely the factored loads in load combinations defined in this Part without exceeding the appropriate strength limits states for the construction material.

F.8.3 Deflection control

F.8.3.1 General

Deflection limits shall be adopted that enable functional requirements to be maintained. Limits may be governed by the requirements of internal and/or external furniture, finishes, fixtures and fittings.

Vertical and horizontal deflections shall be within the limits specified in the referenced design standards, as applicable, and the project-specific requirements dictated by features such as the cladding, crane girders, members supporting sensitive machinery, etc.

When checking for deflections the most adverse realistic combination and arrangement of serviceability loads shall be included.

The Engineer shall verify that the adopted deflection limits will enable the functional performance of the building to be maintained.

F.8.3.2 Concrete beam and slab deflection

Deflection limits for concrete slabs and beams shall be in accordance with Section 24.2.2 of ACI 318-19. The value of the incremental deflection (δ_{INC}) shall not exceed 20 mm after the installation of partitions and finishes and shall be calculated in accordance with ACI 435R and ACI 318-19.

The incremental deflection limits do not consider pre-cambering which may be used to reduce the effect of total deflection as deemed necessary.

When evaluating the deflection of concrete structures, the detrimental effects of cracking shall be included by modifying the stiffness (EI) for areas which have exceeded the allowable tensile stresses. The modified EI shall be chosen based on the extent of cracking under the design load. Default stiffness modifiers given in ACI 318-19 may be followed for regular structures subject to approximately uniform loads.

F.8.3.3 Steelwork deflection limits

Deflection limits for steel structures shall conform to the requirements stipulated in the AISC 360 and AISC design guide 3 **[Ref. F.17]**.

The following points should also be taken into account.

a) For cantilever elements the span length can be equal to double the cantilever length.
b) The deflection limits do not take into account pre-cambering, which may be used to reduce the effect total deflection as deemed necessary.

F.8.3.4 Post-tensioned concrete deflection control

Design for strength and serviceability requirements of members shall conform to ACI 318-19.

Structural calculations shall verify that short- and long-term deflections, camber, vibration frequency and amplitude are within permissible limits.

Effects of cracking should be included by modifying the stiffness EI properties as detailed in ACI 318-19.

Most PT concrete structures combine non-prestressed reinforced concrete, un-cracked PT and cracked PT sections. The design method shall capture the real behaviour of the structural system by taking into consideration the stiffnesses of the cracked and un-cracked sections.

F.8.4 Crack control in concrete structure

The significance of cracking is contained within three categories.

a) Cracks that lead to durability problems and consequently a reduction in structural capacity.
b) Cracks that lead to a loss of serviceability of the structure (e.g. the leakage of water or damage to finishes).
c) Cracks that are aesthetically unacceptable.

Crack widths shall be controlled in accordance with maximum crack widths defined in the referenced codes and standards. The Engineer shall perform crack width calculation checks in accordance with ACI 224R.

It is also recommended that basements and liquid retaining structures be classified in relation to the degree of protection against leakage. An appropriate limit to cracking depending on the classification should be selected by the Engineer and Owner's representative, paying due regard to the required function of the structure, the intrinsic durability requirements, and soil and water properties.
CIRIA C766 **[Ref. F.10]** provides guidance on aesthetically acceptable crack widths.

In the absence of more specific requirements, the following maximum crack width limits shall be adopted.

1) For sections of the structure in contact with groundwater, the crack width limits (w_k) are defined as a function of the ratio of the hydrostatic pressure, h_D to the wall thickness of the containing structure, h_w.
   i) For h_D/h_w <5, w_k = 0.2 mm.
   ii) For h_D/h_w >35, w_k = 0.05 mm.
2) For intermediate values of h_D/h_w, linear interpolation between 0.2 mm and 0.05 mm shall be used.
3) Section of the structure not in contact with water, w_k = 0.3 mm.
4) Structural elements (such as piles) under permanent tension loads, w_k = 0.1 mm.

The above listed limits may be adopted providing that they do not contradict the requirements of ACI 224R and that a proprietary waterproofing system is provided for structural elements in contact with water in accordance with BS 8102.

F.8.5 Crack control in restrained members

Where structural walls, columns and piles provide significant restraint to shrinkage and temperature movements, the reinforcement provisions should be verified against the requirements stated under either ACI 89-S15 (as in R24.4.2 of ACI 318-19) or CIRIA C766 **[Ref. F.10]**.

F.8.6 Drift and deformation of buildings

F.8.6.1 General

The Engineer shall assess the drift and deformation of the building considering the whole life of the structure, including the construction stages.

F.8.6.2 Drift due to permanent gravity load

The Engineer and Contractor shall verify that any deviation from plumbs for the building and cores, under permanent gravity loads only, conforms to the limits stated in Section 7 of ACI 117-10.

If necessary, the Engineer shall specify any correction in the setting out of the building. This should be validated by the Contractor, taking into account the sequence and method of construction.

F.8.6.3 Drift and deformation due to differential vertical shortening

A non-linear static construction sequence analysis should be performed to assess deflection and drift due to differential vertical shortening. At a minimum, the analysis shall be performed by the Engineer and/or Contractor for the following structures:

a) multi-storey buildings with different stresses between the core and perimeter columns;
b) structures with an asymmetrical structural plan layout and/or asymmetrical massing;
c) buildings with stepped setbacks;
d) buildings with outriggers.

The Engineer shall assess the impact of the following design aspects:

1) elastic shortening;
2) creep and shrinkage of concrete structures where the Engineer shall refer to ACI 209.2R and the environmental conditions of Dubai as discussed in F.7.11;
3) foundation settlements;
4) transfer elements, as discussed in F.8.10; and
5) construction stages.

The analysis methodology and parameters adopted shall be discussed and agreed with the Authority. The Contractor shall review and validate the differential vertical shortening analysis as it is strongly dependent on the construction stages sequence.

The Contractor shall submit the type of corrections to be implemented on-site to the Engineer and Authority, for review and approval.

F.8.6.4 Drift and deformation due to wind

Drift and deformation due to wind shall be assessed in accordance with F.7.12.4.

F.8.6.5 Drift and deformation due to seismic

Movements of buildings due to earthquake effects shall conform to the requirements stipulated under Section 12.12 of ASCE/SEI 7-16.

F.8.7 Movement joints and building separation

Movement joints shall be provided, where necessary, to address the requirements of expansion and/or deflection under load for above-ground structures. The minimum separations between a structure and any surrounding obstructions shall not be less than the total maximum displacement (δ_{MT}) as specified in Section 12.12 of ASCE/SEI 7-16:

$$\delta_{MT}=\sqrt{((\delta_{M1})^2+(\delta_{M2})^2)} \quad \text{Eq. F.7}$$

Where δ_{M1} and δ_{M2} are the maximum inelastic response displacements of the adjacent structures at their adjacent edges.

$$\delta_M=(C_d\,\delta_{max})/I_e \quad \text{Eq. F.8}$$

Where:

C_d is the deflection amplification factor in Table 12.2-1 of ASCE/SEI 7-16;

δ_{max} is the maximum deflection at the location required by this section, determined by an elastic analysis; and

I_e is the importance factor determined in accordance with 11.5.1 of ASCE/SEI 7-16.

Movement joints are a common source of water infiltration. Structures should be designed below ground level, without movement joints to mitigate the risk of water ingress. Design for construction without permanent joints below ground level can be achieved by following the recommendations provided in the CIRIA C766 **[Ref. F.10]**.

F.8.8 Vibration

F.8.8.1 Steelwork

The natural frequency of steelwork floor systems for normal occupancy shall be evaluated in accordance with AISC design guide 11 **[Ref. F.18]** or SCI P354 **[Ref. F.19]**.

F.8.8.2 Concrete

Cast-in-place floor systems designed in accordance with the minimum thickness and deflection requirements of ACI 318-19, have generally been found to provide vibration performance suitable for human comfort under typical service conditions. However, there might be situations where serviceability conditions are not satisfied. For example:

a) long spans and open floor plans;
b) floors with strict vibration performance requirements such as precision manufacturing and laboratory spaces; and
c) facilities subject to rhythmic loadings or vibrating mechanical equipment.

Further guidance can be sought in the ATC Design Guide 1 **[Ref. F.13]**.

The performance of PT concrete floors may follow the recommendation of TR43, Table 1 **[Ref. F.11]**. For those PT concrete floors that do not follow these recommendations, their performance should be assessed in accordance with the dynamic assessment method defined in TR43, Appendix G **[Ref. F.11]**.

Precast concrete structures shall be checked for vibration as detailed in Section 9.7 of PCI design handbook **[Ref. F.12]**.

F.8.9 Fatigue

Structural members that support vibrating machinery, vehicles or plant should be checked for fatigue resistance.

Stress changes due to normal fluctuations in wind loading do not need to be included in the fatigue check. However, where aerodynamic instability can occur, account should be taken of wind-induced oscillations.

Where fatigue is critical, the design shall be checked in accordance with the following codes:

a) Appendix 3 of AISC 360 for steel; and
b) ACI 318-19, ACI 215R and ACI 408.2R for concrete.

All design details shall be fully defined, including clear specification of the workmanship and quality assurance tests.

F.8.10 Transfer elements

Any beam, slab or truss structure used to redirect the vertical gravity or lateral load path of upper stories to the vertical structure of the lower stories shall be treated as a transfer element.

Such elements are typically used where a change of use on a floor dictates a different column or wall arrangement, or to accommodate architectural features.

Transfer structures have significant design, cost, material and construction schedule implications, requiring careful consideration of construction logistics, as well as consideration of the impact of long-term deflections of the transfer members and supporting elements. As such, transfer structures should be avoided where possible.

The following shall be included in the design of transfer elements.

a) Transfer beams are to be supported on at least two direct supports.
b) Eccentricity between the column axis and the longitudinal axis of the beam is not permitted. The load transferred to the planted column, transfer beam or slab shall not be less than the loads calculated by manual method (tributary area).
c) Any structural elements supporting planted/floating columns that might cause a progressive collapse are to be included as a key element. Reinforcement shall be detailed to facilitate robustness by means of provision of adequate peripheral, vertical and horizontal ties.
d) The entire length of the supporting columns shall be included as critical length and the stirrups shall be spaced closely to provide effective confinement for the columns.
e) Structural systems elements of the planted portions of the structure shall have redundancy to provide alternative load paths in the case of failure of any structural member, as discussed under F.5.5.
f) Any structural members or element that do not fall under the purview of this part should be analysed and designed for various possible critical combinations.
g) Transfer structure shall be capable of withstanding the reactions from any attached building components. The reactions should be the maximum values that might reasonably be transmitted considering the strength of the attached component and its connection.
h) The Engineer shall check that the deflections of the structural members supported by the transfer elements are within the deflection limits specified in F.8.3.

F.9 Geotechnics

F.9.1 Introduction

This section provides minimum geotechnical requirements that are appropriate for the geology, stratigraphy, geotechnical and groundwater conditions of Dubai. A major characteristic of the ground in Dubai is its calcareous origin for both soils (e.g. calcareous sand) and soft calcareous rocks, with clay minerals of various expansion potential. Groundwater is saline with chlorites and sulphates that make a very aggressive environment for concrete and reinforcement in the ground.

The geotechnical requirements and design aspects are discussed in F.9.3 to F.9.5.

The geotechnical design of buildings shall be based on the requirements stated herein and the referenced standards (see Figure F.18). This section should be also read in conjunction with all the other relevant sections of this Part.

Additional studies are expected for unusual constructions, and might result in a variation from these requirements which would require approval from the Authority.

Geotechnical design and construction shall conform strictly to the current health and safety regulations issued by the Authority.

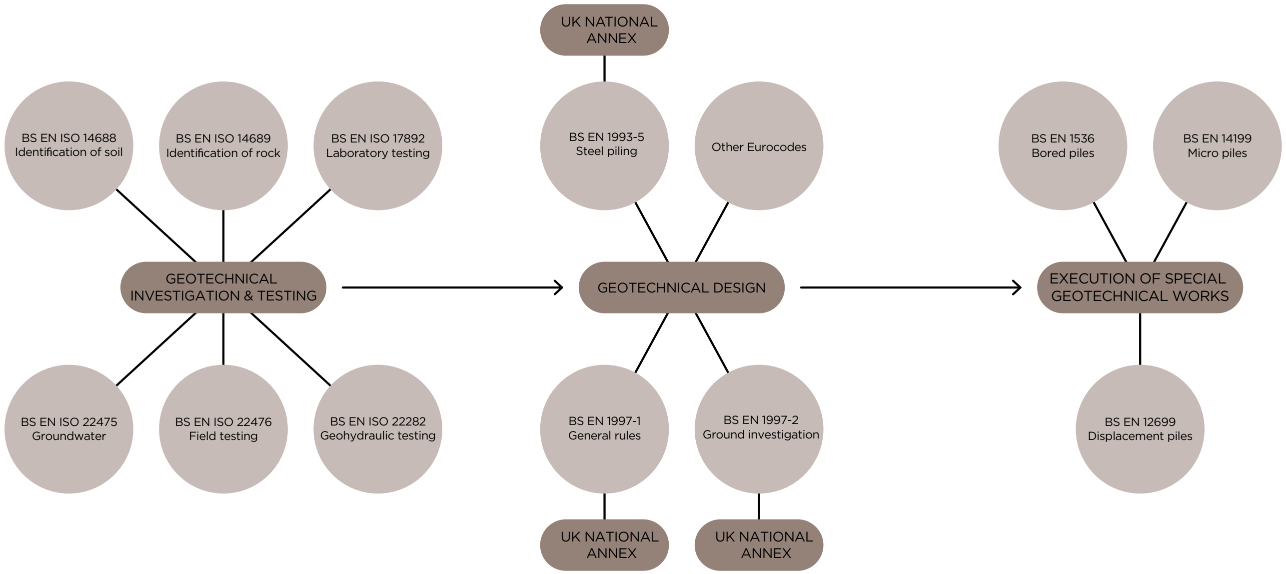


Figure F.18 Suite of standards for geotechnical investigation and testing, design and execution of piling works.

The geotechnical site investigations and testing shall be undertaken by the geotechnical laboratory. All geotechnical reports submitted by the geotechnical laboratory shall be reviewed and approved by the Engineer who witnessed the execution of soil testing.

Any geotechnical design packages submitted and executed by the Geotechnical Specialist Contractor shall be reviewed and approved by the Engineer.

All the geotechnical design works and site investigation reports shall be submitted to the Authority for the necessary approval.

All the geotechnical design and execution packages shall be undertaken by a qualified Geotechnical Civil Engineer.

F.9.2 Standards

Geotechnical site investigations and geotechnical works shall be designed to meet or exceed the minimum requirements of the codes and standards listed in F.3.

F.9.3 Geotechnical site investigation

F.9.3.1 General

Geotechnical site investigations shall be planned and carried out in accordance with BS 5930, BS EN 1997-2:2007 and the associated UK NA, BS 1377 and BS 10175.

As indicated in BS 5930, the primary objectives of a geotechnical investigation are as follows:

a) to assess the general suitability of the site for the proposed works;

b) to enable an adequate and economic design to be prepared;

c) to foresee and provide against difficulties that may arise during construction due to ground and local conditions; and

d) to predict any adverse effect of the proposed construction on neighbouring structures.

A schematic representation of the geotechnical site investigation is illustrated in Figure F.19.

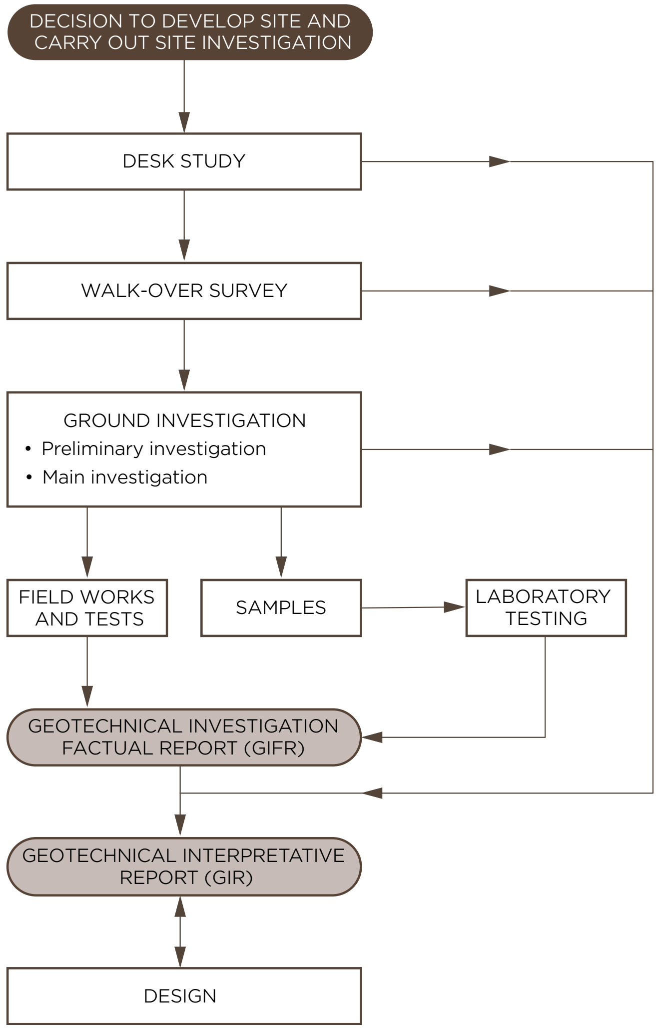


Figure F.19 Schematic organization of a site investigation

F.9.3.2 Geotechnical desk study

The geotechnical desk study shall provide a conceptual model of the site based on all the available morphological, geological, hydrological, geotechnical information, and land use history from public sources and technical literature. The extent of the study will vary according to the nature of the project and the anticipated ground conditions.

F.9.3.3 Planning geotechnical investigation

The extent of the geotechnical investigation is dependent on the complexity, size and criticality of the development. Guidance on the spacing and depth of the investigation points is given in Annex B of BS EN 1997-2:2007, and the associated UK NA. Soil investigation for any building shall be defined by:

a) the location of the building;
b) the magnitude of the imposed loads;
c) the number of floors;
d) the shape of the building;
e) previous uses of the land;
f) terrain surface features;
g) geological features; and
h) surface water drainage.

F.9.3.4 Geotechnical on-site investigations

The requirements for geotechnical soil investigations are provided in BS EN 1997-2 and the associated UK NA and BS 5930. As a minimum, the investigations shall include the following:

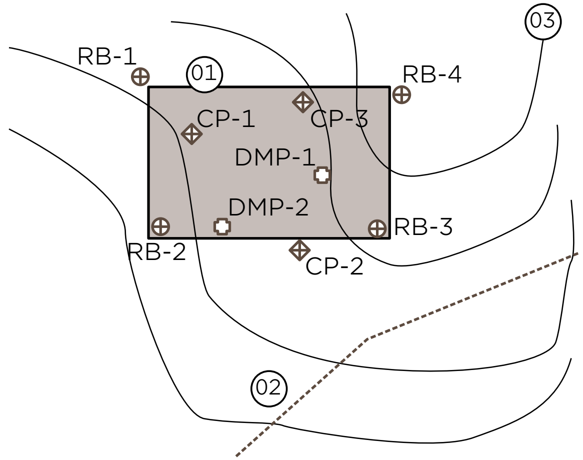
a) non-intrusive investigations (mapping, geophysics);
b) intrusive investigations (boreholes, trial pits, observation wells);
c) sampling of soils, rocks and groundwater;
d) in-situ testing including:
   1) standard penetration test (SPT);
   2) cone penetration test (CPT);
   3) pressure meter;
   4) permeability;
   5) in-situ strength; and
   6) deformability.

The depth of investigation shall extend to at least three times the shortest plan dimension of the proposed foundation as specified in Annex B of BS EN 1997-2:2007.

The minimum number of boreholes shall conform to BS EN 1997-2:2007, the associated UK NA and the following:

1) for high-rise buildings: more than G+12, one borehole per 750 m^2 and a minimum of five boreholes;
2) for buildings: less than G+12, one borehole per 750 m^2 and a minimum of three boreholes; and
3) for large structures: 60 m grids between boreholes required.

An example of the organization and phasing of the on-site investigation is given in Figure F.20.



Key
⊕ Soil test boring with SPT
⊕ CPT
○ Dilatometer test
01: Building Layout
02: Utilities line
03: Topographical contour line

Figure F.20 Typical organization and phasing of on-site investigation

F.9.3.5 Geotechnical laboratory testing

The requirements for geotechnical soil investigations shall conform to BS 1377, BS EN 1997-2:2007 and the associated UK NA and BS 5930. The following list indicates a minimum level of laboratory testing:

a) soil classification/index tests;
b) soil engineering properties tests (strength, stiffness, deformability);
c) rock classification/index tests;
d) rock engineering properties tests; and
e) soil, rock and groundwater chemical tests.

Soil tests shall be conducted in laboratories licensed and approved by the EIAC. All soil tests shall conform to EIAC approved standards.

F.9.3.6 Geotechnical reporting

Throughout, and particularly at the end of the investigation, the geotechnical laboratory shall issue the geotechnical investigation factual report (GIFR) and geotechnical interpretative Report (GIR), which are then reviewed and approved by the Engineer.

For major developments and special projects, the GIR should be issued by the Engineer based on the GIFRs issued by the geotechnical laboratory.

The following items shall be as a minimum included in the GIFR:

a) clear definition of the site, general topography;
b) site plan/drawing with all as-completed investigation location coordinates;
c) time and duration of on-site investigations;
d) meteorological/weather conditions at the time of investigations;
e) the use and state of the site at the commencement of the on-site investigation;
f) accurate account of the equipment specified, mobilized and used for the on-site investigation and in-situ testing including the methodologies and standards adopted;
g) all levels of topography including any lidar scans or other means of obtaining point cloud data, all site investigation points (e.g. trial pits, boreholes, CPTs, SPTs), all stratigraphic levels, groundwater levels recorded and similar, to be specified in the DMD;
h) groundwater monitoring level, period and frequency;
i) groundwater temperature;
j) borehole and trial pit logs with coordinates and description of encountered strata, levels and types of all specimens taken (soil, rock and groundwater);
k) qualitative and quantitative description of boring (e.g. rock quality designation, total core recovery, etc.);
l) levels and results of all in-situ tests (e.g. SPT);
m) borehole logs shall be supplemented with all relevant laboratory tests that facilitate classification of strata (e.g. uniaxial compressive strength);
n) colour photos of borehole cores, including depth labels and colour chart;
o) full documentation of all performed laboratory tests, with suitable illustrative plots/diagrams;
p) ground profile plot with key information of stratigraphy and groundwater level (see Figure F.21).

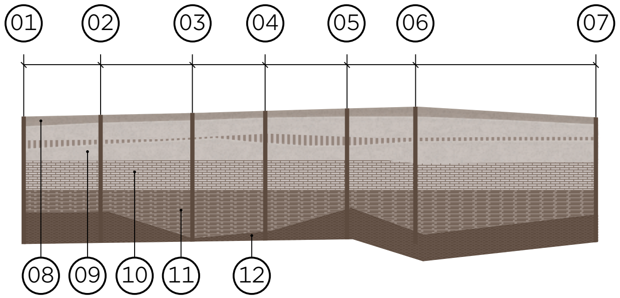


Figure F.21 Typical geological section

Key
01-07: Boreholes
08: Ground fill
09: Sand
10: Sandstone
11: Conglomerate
12: Calcisiltite

The GIR shall include the following details as a minimum when submitted to the Authority:

1) details of the recommended foundation system, with allowable bearing capacity, modulus of sub-grade reaction and allowable settlement;
2) provision to mitigate the effects of expansive and collapsible soils in accordance with the recommendations provided in Ch. 32 and 33 of the ICE Manual of geotechnical engineering (vol. I) **[Ref. F.20]**;
3) provision to mitigate the effect of soil liquefaction, which shall be assessed as stipulated in F.9.4.5;
4) provision to mitigate the effect of soil settlement and loads from adjacent plots;
5) various seismic parameters for the uppermost 30 m, in accordance with the specified codes;
6) piles working load capacity under compression and tension for different sizes, at varying depths and effective length (all levels should be in DMD);
7) if applicable, recommendations for pile groups with modification factors for load and settlement;
8) values of modulus of elasticity of soil (E_s);
9) horizontal modulus of sub-grade reactions (K_h);
10) constant of horizontal sub-grade reaction (n_h);
11) vertical spring constants (K_v);
12) Poisson's ratio;
13) piles stiffness (K_s);
14) optimal spacing between piles within a pile group;

15) soil parameters required for shoring and basement wall design, such as:
    i) average bulk density;
    ii) angle of shearing resistance;
    iii) cohesion;
    iv) coefficients of soil pressure at rest (K_0) pressure; and
    v) coefficient of active and passive soil pressure for all soil layers.
16) soil classification and index test results (particle size distribution, plasticity chart);
17) rock classification and index test results;
18) permeability of soil and rock layers;
19) plan showing boreholes, in-situ test location and coordinates;
20) water table level (in DMD) and temperature;
21) laboratory test results on soil and groundwater samples for the presence and concentration of pH, sulphate and chloride, or any other chemicals or components that might affect the structure;
22) type of cement based on the chemical test results of soil types;
23) summary of soil parameters;
24) subsoil conditions and description;
25) recommendation on the earth work, excavation, filling and compaction; and
26) recommendations for suitability of site material to be used as fill material.

F.9.4 Geotechnical design

F.9.4.1 Earthworks (excavation and filling)

Excavation works shall be designed in accordance with BS EN 1997-1:2004 and the associated UK NA and BS 6031. The design recommendations of Ch.23 of the ICE manual of geotechnical engineering (vol. I) **[Ref. F.20]** should also be followed for the slope stability analysis.

The Geotechnical Specialist Contractor shall provide slope stability analysis for any open cut excavation (see Figure F.22).

Figure F.22 Open cut excavation

The Geotechnical Specialist Contractor shall design remedial actions when slopes display signs of instability or the geotechnical analysis confirms the risk of failing. The list below presents some of the common slope stabilization techniques which may be used in Dubai.

a) Regrading of the slope. If the available land plot permits, the slope can be regraded to reduce the slope angle.

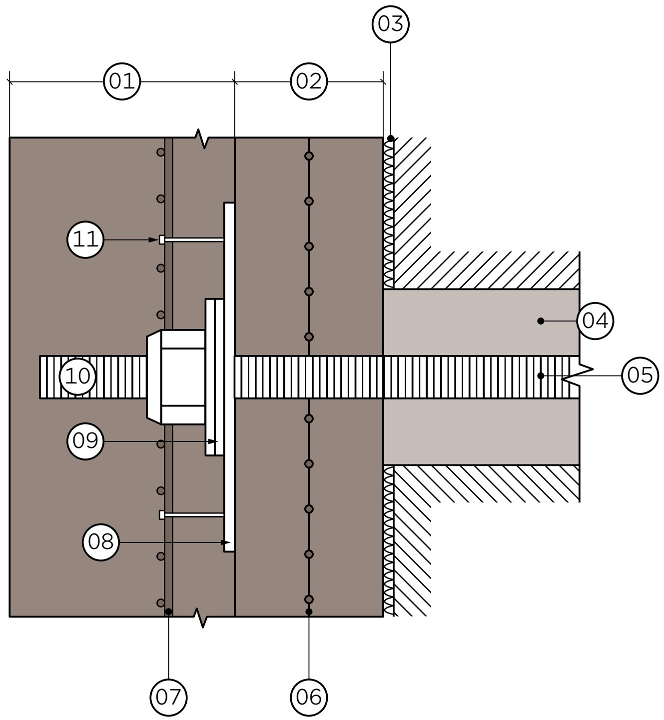
b) Drainage. Deep drains are perforated plastic tubes that can be embedded into the slope to reduce the pore water pressure.

c) Retaining wall. Retaining walls shall be designed in accordance with F.9.4.3.

d) Soil nailing. An in-situ reinforcement technique consisting of drilling or driving steel bars into the soil mass (see Figure F.23 and Figure F.24). The soil nails are secured to steel plates at the surface and optional erosion and vegetation control geosynthetic mesh can be placed over the slope face. If the soil is loose on the surface, concrete can be sprayed to cover the slope face (see Figure F.23). Further guidance can be sought in Ch. 74 of the ICE manual of geotechnical engineering (vol. II) **[Ref. F.20]**.

e) Filling material. The material used for backfilling purposes shall be of selected fill composed of a sand/granular mixture. The plasticity index of the backfill material should not exceed 10%. The maximum particle size of backfill material shall not exceed 75 mm. The percentage passing through a 75 mm sieve shall not exceed 20%. The organic materials content shall not exceed 2% and the water-soluble salt content shall not exceed 5%

f) Compaction. The backfill materials shall be placed in layers of thickness 150 mm to 250 mm and compacted to not less than 95% of the maximum dry density. The Engineer shall state whether the material available on site could be used for general backfilling or not after performing the necessary analysis.



Key

01: Permanent facing (e.g. cast-in-place reinforced concrete)

02: Temporary facing (shotcrete)

03: Geocomposite strip drain

04: Grout

05: Steel bar

06: Welded wire mesh

07: Reinforcement

08: Bearing plate

09: Washers

10: Nail head

11: Studded head

Figure F.23 Soil nailing detail (Modified figure based on Figure 2.1 from CIR 7 FHWAO-IF-03-017, Geotechnical Engineering Circular No.7, Soil Nail Walls, 2003, United States Department of Transportation Federal Highways Administration)

Figure F.24 Installation of soil nailing system

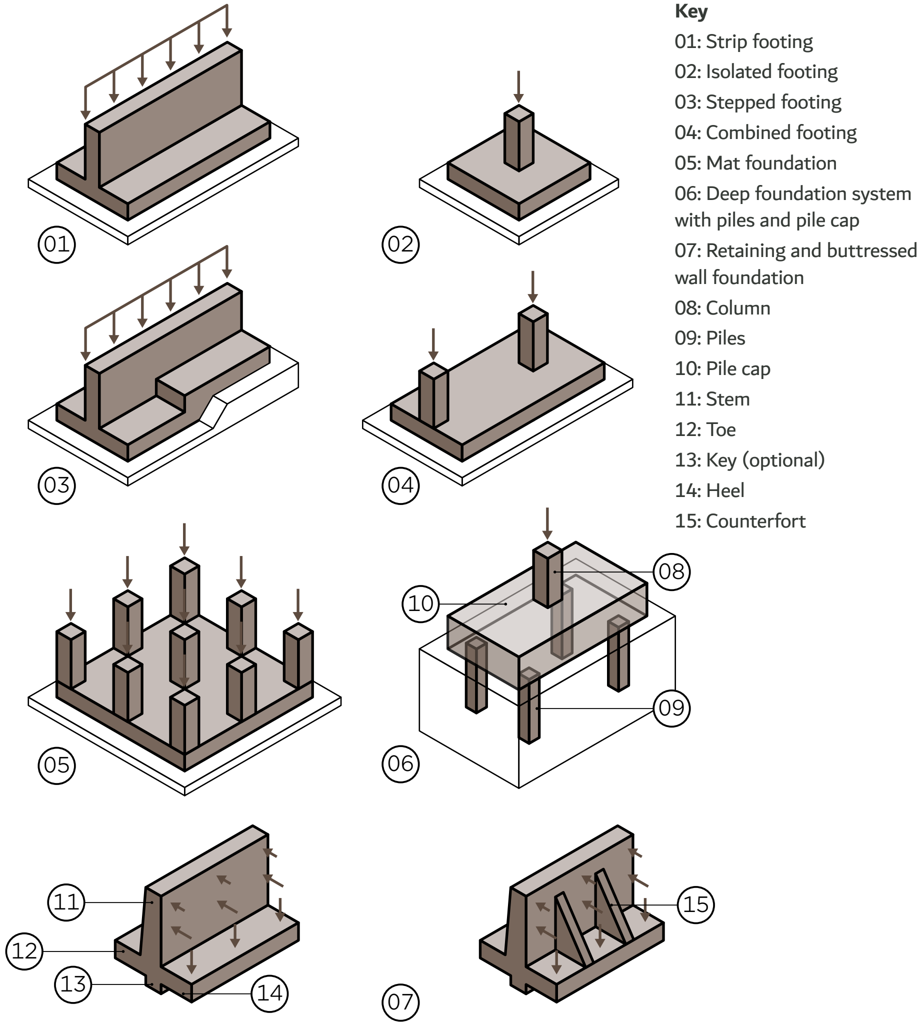


Figure F.25 Types of foundation (© ACI. Modified figure based on Figure R13.1.1, ACI 318-19, pg.192)

F.9.4.2 Foundations design

F.9.4.2.1 General

The geotechnical design of foundations shall be undertaken in accordance with BS EN 1997-1:2004 and the associated UK NA.

The typical foundation systems in Dubai are illustrated in Figure F.25

F.9.4.2.2 Shallow and raft foundations

The geotechnical design of shallow foundations (i.e. isolated, strip, stepped, combined footing and raft) shall be in accordance with Section 6 of BS EN 1997-1:2004 and the associated UK NA.

The most common limit states for spread foundations are:

a) loss of overall stability;
b) bearing resistance failure (the equations for bearing capacity are given in Annex D, BS EN 1997-1:2004 and the associated UK NA);
c) failure by sliding;
d) combined failure in the ground and in the structure;
e) structural failure due to foundation movement;
f) excessive settlements (refer to Annex H of BS EN 1997-1:2004 and the associated UK NA);
g) excessive heave due to swelling, frost and other causes; and
h) unacceptable vibrations.

Design of the permanent concrete structural elements shall follow F.6, F.8 and ACI 318-19.

Raft foundations shall be designed as “rigid” unless a specific geotechnical model and calculation are adopted to validate the design approach.

F.9.4.2.3 Deep and piled foundations

The geotechnical design of deep and piled foundations shall be in accordance with Section 7 of BS EN 1997-1:2004 and the associated UK NA.

The following limit states shall be included in the design of deep foundations:

a) loss of overall stability;
b) bearing resistance failure of the pile foundation;
c) uplift or insufficient tensile resistance of the pile foundation;
d) failure in the ground due to transverse loading of the pile foundation;
e) structural failure of the pile in compression, tension, bending, buckling or shear;
f) combined failure in the ground and in the pile foundation;
g) combined failure in the ground and in the structure;
h) excessive settlement;
i) excessive heave;
j) excessive lateral movement;
k) unacceptable vibrations; and
l) liquefaction effects on piles.

The load-bearing mechanism (i.e. end bearing, friction, friction with end bearing piles) shall be recommended in the GIFR. In particular, the end bearing capacity shall be agreed with the Authority before the design is commenced.

Design of the permanent concrete structural elements shall be in accordance with F.6, F.8 and ACI 318-19.

The design criteria listed in Table F.17 are applicable to reinforced concrete foundations on piles.

Design criterion	Minimum requirement
Pile design: general	Ensure pile design allows for both gravity and lateral loads. Piles to be designed for out of verticality tolerance of 1/75. Piles to be designed for eccentricity of vertical load of 75 mm. Factor of safety shall be at least 2.5, unless geotechnical model and geotechnical calculations based on the geotechnical site investigation are provided. Minimum rock socket length of three times pile diameter. The use of bentonite is not recommended. If it is used, the shaft capacity shall be reduced. Pile caps shall be designed in accordance with the requirements specified under ACI 318-19 and the CRSI design handbook **[Ref. F.8]**.
Crack width limit for tension piles (w_k)	0.2 mm considering the tension load. 0.1 mm considering the uplift load due to permanent tension load (i.e. groundwater uplift, out of balance gravity loads).
Geotechnical design parameters	The recommendations provided in the GIR shall be followed unless a specific geotechnical model and geotechnical calculation are developed.
Materials test reports (aggregate, steel, concrete, etc.)	To be implemented by laboratories approved by DM or EIAC.
Minimum bar diameter	12mm
Minimum number of bars	Six bars evenly spaced.
Minimum percentage of reinforcement	To be provided for the full length of the piles in order to provide ductility and in accordance with Table 18.13.5.7.1 of ACI 318-19.
Minimum stirrup reinforcement	Bars of 10 mm diameter for all the piles. The top region of the pile below the caps or raft, shall be confined effectively with closely spaced stirrups, for a length of three times the pile diameter. Stirrup reinforcement shall be in accordance with Table 18.13.5.7.1 of ACI 318-19.
Minimum design of horizontal/ lateral force	For the lateral pile design, the following requirements shall be included: a) minimum 5% of pile capacity and not less than the horizontal loads resulting from the superstructure and foundation analysis; b) moments due to out of position (75 mm) piles; and c) horizontal force due to verticality (1/75). The above design (a) may be excluded if geotechnical calculations and geotechnical models are provided and the following items are included in the design: 1) isolated temperature changes within raft, and temperature distribution from column to raft; 2) detailed pile group assessment considering soil-structure interaction, building stiffness and foundation stiffness; 3) moments due to slab dishing; 4) kinematic effects of earthquake loading; 5) sensitivity checks should piles be constructed out of position; 6) embedment of raft; and 7) lateral load path analysis and load transfer into the raft slab.
Rational study of pile spacing not available	Minimum pile spacing shall be 2.5 times the diameter.
Pile stress under compression load	Maximum 25% of concrete strength.
Lateral stiffness of piles	50% to 100% of vertical stiffness. Any other percentage (such as 10% to 15% of vertical stiffness) shall be justified by geotechnical models and calculations including the piles lateral group effect.
Vertical stiffness of piles	The impact of subsidence of the piles group on vertical stiffness, as well as its effect on the raft and piles, shall be validated by geotechnical models and calculations.

Table F.17 Piles foundation minimum design criteria

F.9.4.3 Shoring and earth retaining system

F.9.4.3.1 General

The geotechnical design of earth retaining systems shall be performed in accordance with Section 9 of BS EN 1997-1:2004+A1:2013 and the associated UK NA. Design of the concrete structural elements shall follow F.6, F.8 and ACI 318-19.

Shoring systems and retaining structures are deemed to be temporary if the design life of the system is less than two years. They shall not be deemed to be part of the permanent structures and a physical segregation shall be provided between temporary and permanent structural systems.

The shoring and retaining systems shall be designed to retain the soil and actual groundwater pressure (including tidal effect).

NOTE: Shoring and earth retaining systems typically used and accepted in Dubai are as follows:

a) non-watertight shoring systems:
   1) soldier piles with lagging system/king post walls;
   2) contiguous pile walls;
   3) slurry walls;
b) watertight shoring systems:
   1) secant pile walls;
   2) diaphragm walls;
   3) sheet piles;
c) bracing for temporary earth retaining systems:
   1) anchors;
   2) rakers; and
   3) struts.

Alternative techniques specified in accordance with international codes and standards may also be accepted.

The shoring and bracing systems are further described in Ch. 62, 63 and 64 of the ICE manual of geotechnical engineering (vol. II) **[Ref. F.20]**.

F.9.4.3.2 Required shoring systems

Table F.18 should be followed for different depths of excavation and site conditions.

Type of shoring system	Permitted under following criteria
All types	up to 5 m deep excavation; one basement.
All types, except soldier pile with lagging	up to 9 m depth and no buildings in the adjacent plots.
Shoring system preventing water leakage	presence of buildings in the adjacent plots; high groundwater level; proximity to water bodies.

Table F.18 Type of shoring system

It is possible to adopt shoring systems other than those in Table F.17, based on the soil examination report, groundwater level, presence of water sources, adjacent buildings and surrounding constructions.

The minimum requirements listed in Table F.19 shall be included in the design of temporary shoring systems.

Design criteria	Minimum requirement
Minimum additional loads	Additional uniform distributed load of 20 kN/m^2 shall be taken into consideration in proximity to roads and land plots. The additional surcharge load needs to be assessed based on the actual conditions on-site and adjacent structures.
Minimum distance between anchors	1.2 m
Maximum length of anchors	10 m
Minimum length of anchors	3 m
Maximum lateral displacement	40 mm
Unplanned excavations	Retaining walls shall be designed assuming presence of unplanned excavations in front of the wall, with depth of not less than 10% of the total height of vertical walls, or 10% of vertical distance between the lowest anchor and the bottom of the excavation, but not less than 0.5 m.
Heave	The geotechnical design shall assess heave if swelling and collapsible soils have been identified in the GIFR. Further guidance can be sought in Ch. 32 and 33 of the ICE Manual of geotechnical engineering (vol. I) [Ref. F.20].

Table F.19 Minimum requirements for earth retaining system

F.9.4.3.3 Permanent earth retaining system

Any retaining structure is deemed to be permanent if the design life of the system is more than two years. The permanent retaining system shall be designed to retain the soil and future groundwater pressure (including tidal effect) without allowing for the temporary retaining system.

The temporary retaining structures listed under the NOTE to F.9.4.3.1 may be designed as permanent structures, provided they are included in the analysis of the overall structure. The same design life, performance and durability requirements shall be applied to both the main structural system and the permanent retaining system.

In addition to the requirements for temporary retaining systems stipulated under F.9.4.3.2, the Engineer shall design the retaining system with consideration for the intended design life. In particular, the Engineer shall consider the applicable performance, serviceability and durability requirements stated in F.5.6 and F.8.

The geotechnical design of permanent earth retaining systems (including counterfort/buttressed wall systems) shall be performed in accordance with Section 9 of BS EN 1997-1:2004 and the associated UK NA. Design of the concrete structural elements shall be in accordance with F.6, F.8 and ACI 318-19.

F.9.4.3.4 Basement walls

A permanent basement concrete wall should be provided in front of the temporary retaining systems detailed in F.9.4.3.2. The permanent basement wall shall be designed to retain the soil and future groundwater pressure (including tidal effect) without considering the temporary retaining system.

The permanent basement wall shall be fully integrated with the main structural system of the building. The same design life, performance and durability requirements shall be applied to the main structural system and the basement walls.

The geotechnical design of permanent basement walls shall be performed in accordance with Section 9 of BS EN 1997-1:2004 and the associated UK NA. Design of the concrete structural elements shall follow F.6, F.8 and ACI 318-19.

F.9.4.4 Groundwater control and dewatering

Dewatering systems shall be designed in accordance with BS EN 1997-1:2004, and the associated UK NA and CIRIA C750 **[Ref. F.21]**, taking into account the following.

a) All existing facilities shall always be protected.
b) The dewatering system shall reduce the loss of soft materials in the soil and any effect on the surrounding structures. The hydrogeological model shall identify and assess any piping effect (see Figure F.26).
c) The depth of shoring systems and internal excavations shall prevent soil heave. This is to avoid the possibility of seepage, and to ensure compatibility between the designs of the shoring systems and the dewatering system (see Figure F.27).
d) A seepage analysis and groundwater/hydrogeological model shall be prepared for at least 20 m below the bottom of the excavation. The model shall determine the following:
    1) type of soil and rocks;
    2) horizontal permeability of each layer;
    3) incoherent or gypsum soils; and
    4) other areas exposed to water leakage under the surface.

Figure F.28 shows the permeability of different soil types and recommended dewatering systems.

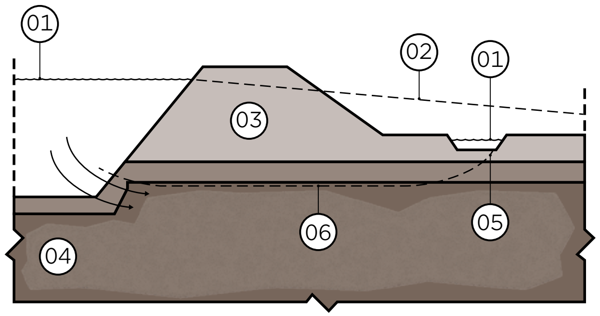


Figure F.26 Example of situations that might cause piping (© British Standards Institute. Figure extracted from BS EN 1997-1:2004. Permission to reproduce extracts from British Standards is granted by BSI Standards Limited (BSI). No other use of this material is permitted).

Key

01: Free water level

02: Piezometric level in the permeable subsoil

03: Low permeability soil

04: Permeable soil

05: Possible well; starting point for pipe

06: Possible pipe

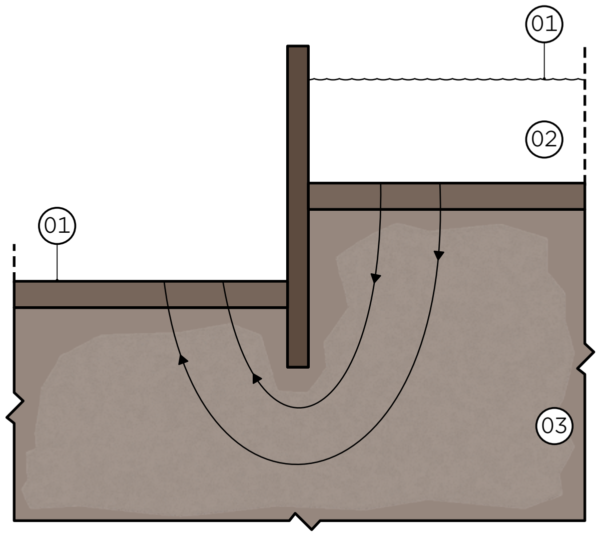


Figure F.27 Example of a situation where heave might be critical (© British Standards Institute. Figure extracted from BS EN 1997-1:2004. Permission to reproduce extracts from British Standards is granted by BSI Standards Limited (BSI). No other use of this material is permitted).

Key

01: Excavation level (left); free-water level (right)

02: Water

03: Sand

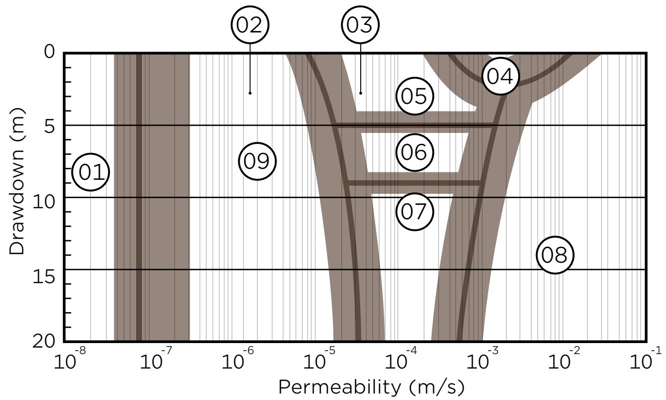


Figure F.28 Permeability of soil and dewatering systems

Key

01: Dewatering not feasible and may not be necessary
02: Vacuum necessary
03: Vacuum beneficial
04: Sump pump
05: Single stage well point system
06: Two stage well point system/deepwell system
07: Deepwell systems
08: Excessive seepage flows: cut-off or wet excavation may be necessary
09: Ejectors

F.9.4.5 Liquefaction

This section shall be read in conjunction with F.7.13 and Section 11.8 of ASCE/SEI 7-16.

The 2% probability of exceedance within a 50-year period hazard parameters are given in Table F.20. Specifically, the values of peak ground acceleration (PGA) and the life safety, 5% damped spectral responses acceleration parameter at short period ($S_{S\,LS}$) and at a period of 1s ($S_{1\,LS}$) are given. The long-period transition period (T_L) is also provided.

Location	PGA	$S_{S\,LS}$	$S_{1\,LS}$	T_L (s)
Dubai	0.13	0.33	0.11	24

Table F.20 Life safety seismic ground motion parameters for Dubai (site class B)

The following amendments to Section 11.8 of ASCE/SEI 7-16 shall be used.

a) Section 11.8.1 of ASCE/SEI 7-16 does not apply to Dubai.
b) Liquefaction shall be assessed using a PGA determined on the basis of either (1) a site-specific study considering soil amplification effects as specified in F.7.13.9 or (2) the PGA_M, from Eq. F.9.

$$PGA_M = F_{PGA} . PGA \quad \text{Eq. F.9}$$

where, PGA is the MCE_G peak ground acceleration taken from Table F.20 and F_{PGA} is the site coefficient from Table F.21.

Site class	Short period F_{PGA}
A	0.80
B	0.90
C	1.27
D	1.54
E	2.25
F	See F.7.13.9

Table F.21 PGA site coefficient F_{PGA} for liquefaction assessment in Dubai

The factor of safety (FS) against the occurrence of earthquake-induced liquefaction shall be defined as the available soil resistance to liquefaction, the cyclic resistance ratio (CRR) divided by the cyclic stress generated by the design event, the cyclic stress ratio (CSR) as shown in Eq. F.10. The FS shall not be less than 1.5.

$$FS \geq 1.5(CRR/CSR) \qquad \text{Eq. F.10}$$

The groundwater level shall be selected based on the peak over the design period, which allows natural changes (such as the "spring" tide peak), land use changes and considerations for global warming.

In calculating the CSR, a magnitude of 6.2 shall be used for Dubai.

When assessing the potential for liquefaction any published and internationally accepted methodology can be used provided it is internally consistent. It is recommended to use the "Idriss Boulanger Method" **[Ref. F.9]**. The impact of carbonate sands on the liquefaction potential should also be included.

The requirements for foundations design in liquefiable sites shall follow the requirements in Section 12.13.9 of ASCE/SEI 7-16 and associated subclauses. This shall include consideration of the following issues regarding liquefaction, namely:

a) lateral spreading;
b) global and differential settlements;
c) provision of ties between individual foundations; and
d) negative skin friction (i.e. downdrag) on vertical capacity of piles.

Where the impact of liquefaction exceeds the requirements of ASCE/SEI 7-16 (Table 12.13-2 for lateral spreading and Table 12.13-3 for differential settlement thresholds), then suitable ground improvement shall be required.

F.9.4.6 Ground improvement

Ground improvement shall be designed according to BS EN 1997-1 and the ICE Manual of geotechnical engineering (vol. I) Ch.25 **[Ref. F.20]**.

NOTE: The following ground improvement techniques are accepted in Dubai (see Figure F.29):

a) dynamic compaction;
b) vibro-compaction;
c) soil replacement;
d) soil mixing;
e) grouting; and
f) vertical drains.

Alternative techniques specified in accordance with international codes and standards may also be accepted.

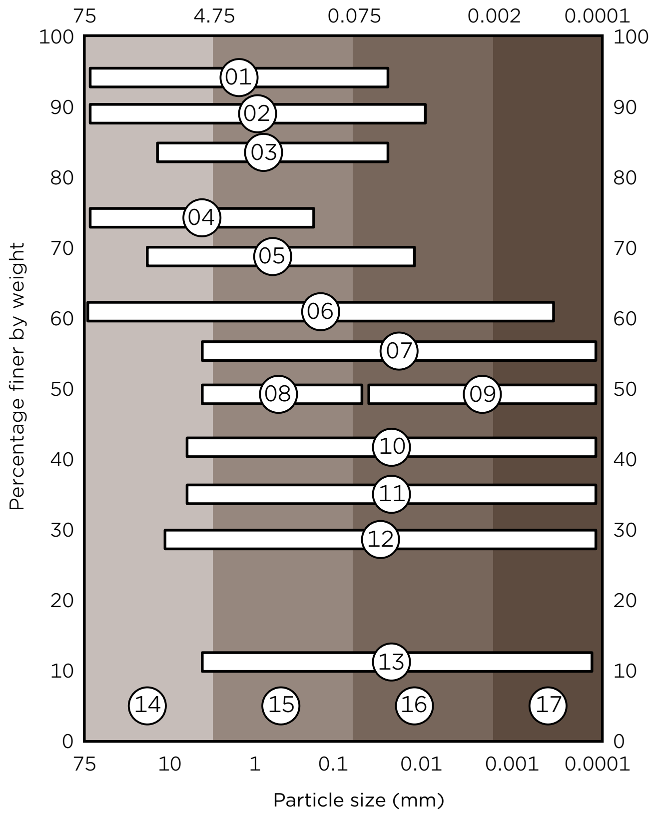


Figure F.29 Type of ground improvement systems and type of soil

Key

01: Explosive compaction

02: Deep dynamic compaction

03: Vibratory probes

04: Particulate (cement) grout

05: Compaction grouting

06: Jet grouting

07: Vibro replacement

08: Drains for liquefaction

09: Drains for compaction

10: Compaction piles

11: Admixtures

12: Deep soil mixing

13: Remove and replace

14: Gravel

15: Sand

16: Silt

17: Clay

Figure F.30 illustrates the indicative range of soil type (particle size sieve analysis) suitable for compaction techniques.

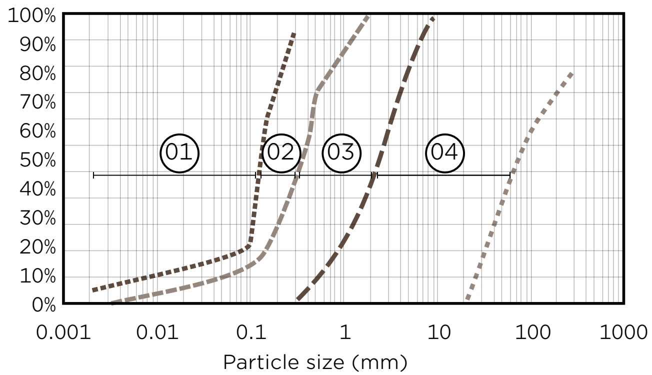


Figure F.30 Indictive range of soil type (particle size sieve analysis)

Key

01: Stone columns are a solution for a foundation in these soils. There is a resulting increase in bearing capacity and reduction on total and differential.

02: Compaction is only possible by adding suitable backfill (material from zones 03 or 04) from the surface (stone columns or sand columns).

03: The soils in this zone are suited for vibro compaction. They have a fines content of less than 10%.

04: The soils of this zone are very well compactable.

The right borderline indicates an empirically found limit where the amount of cobbles and boulders prevents compaction because the vibroprobe cannot reach the compaction depth.

F.9.5 Execution of geotechnical works

F.9.5.1 General

Geotechnical works shall be carried out in accordance with the BS EN standards listed in F.3.1.5. The Engineer and Geotechnical Specialist Contractor shall also conform to the following clauses.

F.9.5.2 Earthworks (excavation and filling)

In addition to the requirements of BS EN 6031, the following requirements shall be included in the execution of excavation and backfill activities.

a) The materials used for backfilling purposes shall consist of selected materials such as sand/granular mixture free from organic materials or other biodegradable materials. The Engineer shall determine whether excavated materials can be used in general backfilling works after conducting the necessary testing.
b) All excavations exceeding 1.2 m in depth require an excavation permit issued by the Authority.
c) All health and safety requirements shall be strictly followed while executing any excavation works.
d) All excavation activities shall be carried out inside the plot limits only. A no encroachment, no parking, and no stopping zone with a minimum width of 1 m shall be provided in proximity to the excavated area.
e) For any works required outside of the plot limits, no objection certificate (NOC) /approval from all the relevant Authorities, departments or plot Owners shall be submitted.
f) Execution of excavation and filling activities shall conform to the requirements stipulated in Ch.75 of the ICE manual of geotechnical engineering (vol. II) **[Ref. F.20]**.
g) Installation of soil nails shall conform to the requirements of BS EN 14490. Further guidance can be sought in Ch. 88 of the ICE manual of geotechnical engineering (vol. II) **[Ref. F.20]**.

F.9.5.3 Shoring retaining systems

In addition to the requirements of BS 8081, BS EN 1536, BS EN 1537, BS EN 1538 and BS EN 12063, the following requirements shall be included in the construction of earth retaining structures.

a) All existing structures and utilities shall always be protected.
b) All works of shoring systems shall be carried out within the land plot. The Geotechnical Specialist Contractor shall obtain all required approvals from all concerned Authorities and Owners of the adjacent plots regarding any shoring system or anchors protruding outside the land plot limits.
c) The top 2 m of the shoring systems on the roads or services side shall be removed upon completion of the basement wall works.
d) All works of shoring systems shall be continuously monitored by the Geotechnical Specialist Contractor.
e) Anchors can be removed on-site only after obtaining the written consent of the Engineer.

F.9.5.4 Foundations

It is envisaged that the following foundation systems will be typically provided for buildings in Dubai:

a) shallow foundations;
b) deep foundations; and
c) raft foundations.

In addition to the requirements of BS EN 1536, BS EN 12699 and BS EN 14199, the minimum testing criteria listed in Table F.22 shall be followed during and after the execution of reinforced concrete foundations on piles.

Test	Minimum requirement
Static test on working piles	Minimum 1% of all piles and each different diameter
Dynamic test on working piles	5% of all piles
Cross-hole sonic logging (for more than 1 m diameter and 20 m length)	10% of all piles 900 mm or greater with minimum four tubes/holes and minimum three tubes for 750 mm. Minimum length of testing 20 m or full length if shorter. End bearing piles full length testing
Integrity test working piles	100%
Cubes test (concrete)	as per technical specification
Reinforcement test	as per technical specification

Table F.22 Minimum testing requirements for pile foundation

It is the responsibility of both the Engineer and the Geotechnical Specialist Contractor to select a test location which does not interfere with the location of the permanent structural piles of the main structure. The Geotechnical Specialist Contractor may propose test locations to be reviewed by the Engineer who may accept them or propose alternative locations. Non-working preliminary test pile (PTP) location and arrangement shall be submitted officially to the Authority during the design stage and shall at least include the following.

1) Detailed drawings that clearly show the location of the test pile and instrumentation.
2) Information detailing the planned duration of the PTP.
3) An official covering letter from the Engineer and/or the Geotechnical Specialist Contractor.
4) Minimum 1No. PTP for each project. The maximum diameter and length of pile should be considered, assuming that they are the most suitable for the site.

PTP results shall be used to optimize the pile design in accordance with BS EN 1997-1:2004 and the associated UK NA.

F.9.5.5 Groundwater control and dewatering

In addition to the requirements given in CIRIA C750 **[Ref. F.21]**, the following requirements shall also be included during the execution of dewatering on-site.

a) All existing facilities and utilities shall always be monitored and protected by the Geotechnical Specialist Contractor.
b) A network shall be developed to monitor the groundwater pressure/piezometric pressure separated from the dewatering system, the vertical groundwater gradients as well as the horizontal gradients, and the water rises inside and outside the excavations/the shoring systems.
c) Dewatering works shall not be stopped without the written approval of the Engineer, after achieving balance between water pressure and the weight of construction. The factor of safety shall be at least 1.1, irrespective of the friction between walls and soil.
d) Care shall be taken during the dewatering process to ensure that fine particles soil is not removed during pumping, as this may lead to unexpected subsidence in the surrounding lands and the associated structures.

F.9.5.6 Ground improvement

Ground improvement shall be executed in accordance with BS EN 12715, BS EN 12716, BS EN 14199, BS EN 14475, BS EN 14679, BS EN 14731 and BS EN 15237.

In addition to the requirements specified in the referenced codes and standards, the following requirements shall also be included during the execution of ground improvement on-site.

a) A technical design shall be prepared by the Geotechnical Specialist Contractor and approved by the Engineer prior to submission to the Authority.

b) Tests shall be conducted before and after the ground improvement activities. Tests shall be proposed by the Geotechnical Specialist Contractor, reviewed by the Engineer and approved by the Authority. The Geotechnical Specialist Contractor should perform the following tests as minimum.

   1) **Bearing capacity:**

      i) One plate load test per each 750 m^2 area (minimum one test for each building) to be carried out in accordance with ASTM D1195M.
      The recommended acceptance criterion is to achieve the targeted bearing pressure with total settlements less than 25 mm.

      ii) One zone load test in accordance with ASTM D1195M shall be required for major developments comprising more than one building and special structures.

   2) **Improvement to mitigate liquefaction risk:** The efficiency of the improvement shall be verified with CPT readings (in accordance with ASTM D5778 or BS EN ISO 22476-1:2012). The pre-improvement CPT tests should be carried out every 900 m^2 maximum (or as stipulated in project specifications) to compare the results with the post-improvement CPT tests. The locations of post-improvement CPT tests should be selected at the central points between the improved points. Weighted average of CPT tip resistance for near and far tested point, should not be less than 6.0 MPa for shallow foundations.

   3) **Deep piled foundation:** It is recommended that, after completion of the ground improvement, the weighted average of the CPT tip resistance profile is at least 8.0 MPa.

c) A ground improvement report, based on tests conducted after performing the ground improvement, shall be approved by the Engineer and submitted to the Authority.

d) All existing facilities and utilities shall always be monitored and protected by the Geotechnical Specialist Contractor.

e) All activities are to be carried out inside the plot limits only. For any activity outside of the plot limits, a NOC from all of the relevant Authority departments (e.g. DEWA, RTA, etc.) or plot Owners should be submitted to the Authority.

F.10 Annex: Seismic acceleration and damping parameters

F.10.1 Seismic hazard in Dubai

A seismic hazard assessment for Dubai was commissioned by DM and carried out by StrongMotions Inc. [Ref. F.22], for the purposes of supporting the seismic regulations in this Part.

The acceleration parameters used are taken directly from Malhotra [Ref. F.22]. In this Annex the values are compared with other published studies for the region (see Table F.23). There is consistency between several studies, but other studies indicate higher seismicity in Dubai. Those studies have been reviewed by several authors and are proposed to be inappropriate for the reasons highlighted in the table.

Reference	Return periods			Comment
	475 years	975 years	2,475 years	
Malhotra [Ref. F.22]	0.05	0.06	0.08	-
Irfan et al. [Ref. F.23]	0.06	-	0.12	Consistent with Malhotra [Ref. F.22].
Shama [Ref. F.24]	0.17	-	0.33	Includes the West Coast Fault as an active structure in their model.
Aldama et al. [Ref. F.25]	0.05	0.06	0.09	Consistent with Malhotra [Ref. F.22].
Pascucci et al. [Ref. F.26]	0.06	-	0.11	Consistent with Malhotra [Ref. F.22].
Musson et al. [Ref. F.27]	0.05	-	-	Consistent with Malhotra [Ref. F.22]. Only presents results for one return period.
Sigbjornsson and Elnashai [Ref. F.28]	0.16	0.18	0.22	Includes the West Coast Fault as an active structure in their model.
Abdalla and Al Homoud [Ref. F.29]	0.14	-	-	Source zone model allows seismicity from Iranian coastline up to the UAE coast.
Grünthal et al. [Ref. F.30]	0.32	-	-	Regional study. The result was not calculated but extrapolated across the UAE.
Al-Haddad et al. [Ref. F.31]	< 0.05	-	-	Consistent with Malhotra [Ref. F.22], but only a limited regional study.

Table F.23 Comparison of geometric mean PGA (g) calculated from various references (results to two decimal places)

F.10.2 Seismic parameters for ASCE/SEI 7-16

F.10.2.1 Component of ground motion

ASCE/SEI 7-16 defines the seismic parameters using the maximum rotated component of ground motion rather than geometric mean component of ground motion. To account for this variation the component of ground motion, Malhotra **[Ref. F.22]** recommends the ratios in Table F.24. The proposed values are consistent with similar published factors (e.g. Beyer and Bommer **[Ref. F.32]**).

Parameter	Ratio
PGA	1.20
PGV	1.22
PGD	1.25

Table F.24 Resultant/geometric mean ratios (Malhotra, 2020)

ASCE/SEI 7-16 also adjusts the seismic hazard to ensure risk-consistent hazard parameters for typical USA building stock following the procedure proposed by Luco **[Ref. F.33]**. Malhotra **[Ref. F.22]** recommends that this adjustment is not made, since the building stock in Dubai is considerably different to the USA and the uncertainty in the methodology is large.

F.10.2.2 Return period

ASCE/SEI 7-16 defines the hazard in terms of a 2% probability of exceedance in 50 years, otherwise known as a return period of 2,475 years. As discussed in Malhotra **[Ref. F.22]**, a factor of two-thirds is applied to approximate the hazard in the USA to approximate a return period of 475 years, as used in the previous degeneration of seismic codes. This is an arbitrary requirement, which is country specific.

In contrast the Canadian building Code uses a 2,475-year return period directly. The reason is because this lower probability is considered to provide a more uniform margin of collapse, one that is much nearer to the probability of structural failure. Similarly, the UK National Annex to BS EN 1998-1 also uses a 2,475-year return period. This is to ensure seismic design is applied to the most critical structures in what is generally a region of very low seismicity.

Since Dubai is principally affected by large distant events in Iran, it is considered appropriate not to reduce the seismic hazard level using the arbitrary two-thirds factor used in the USA, but ensure seismic design caters for these larger events. This should not increase the seismic demand compared to current design practice.

F.10.3 West Coast Fault

The West Coast Fault is presented as a structure on the tectonic map of the Arabian Peninsula in Johnson (1998) **[Ref. F.36]**. The interpretation was based on figures presented by Murris **[Ref. F.34]** and Hancock et al. **[Ref. F.35]**. Both references show the West Coast Fault as a right lateral strike slip fault running along the coast from Abu Dhabi through Dubai and Sharjah to Ras Al Khaimah, whereas Johnson **[Ref. F.36]** shows this as a left lateral strike slip fault. They also both focus on the Dibba line as the principal fault within the UAE and do not even discuss the West Coast Fault.

The existence of the West Coast Fault is at best contentious. Some tectonic and seismic hazard studies of the region do not include this fault as a local tectonic feature (e.g. Pascucci et al., 2008, Aldama-Bustos et al. **[Ref. F.25]**). Other seismic hazard studies include the West Coast Fault as a seismic source (e.g. Sigbjornsson and Elnashai **[Ref. F.28]**); however details regarding the modelling parameters are poorly defined.

A study was undertaken by Megahed et al. **[Ref. F.37]** on behalf of the Abu Dhabi Department of Municipal Affairs to determine the threat posed to the UAE by the West Coast Fault. The findings of this study rejected the existence of the West Coast Fault. This agrees with the conclusions of the geological mapping of the area by the British Geological Survey **[Ref. F.27]**.

F.11 Annex: Dubai sustainable concrete baseline (DSCB)

F.11.1 General

Dubai sustainable concrete baseline (DSCB) is an alternative approach to the minimum requirements for concrete mixes in F.6.2.3.

DSCB represents the allowable upper limit for the environmental weighted average impact (WAI) of concrete mixes which was based on an industry-wide lifecycle assessment (LCA) and environmental product declaration conducted for the most common concrete mixes used in building construction in Dubai.

The WAI is calculated from the normalized LCA indicators/factors for each concrete mix including global warming potential, acidification potential, eutrophication potential, abiotic depletion potential fossil, blue water consumption, reused water for washing and water for washing.

Table F.25 lists all the concrete mixes forming DSCB. Full details about the concrete mix proportions, environmental impacts, and WAI can be accessed through a web-based concrete calculator.

DSCB does not consider the durability aspects for any one of the concrete mixes listed in Table F.25. It is recommended to consult a design engineer for the right durability specification for every project based on the prevailing conditions of the structure (service life, exposure conditions, concrete grade, concrete cover and any other relevant parameter affecting durability) and in line with F.5.6.

The aim is to encourage the industry to produce more sustainable concrete, eventually resulting in lowering the impact of concrete construction on the environment. It is essential to balance the specification of concrete for sustainability while ensuring other performance parameters are optimized. Engineers are urged not to over-specify concrete strength and/or durability parameters and to permit flexibility in designing the concrete mixes in a way that encourages the production of more sustainable concrete.

F.11.2 DM concrete calculator

DM concrete calculator serves as a tool to help members assess their concrete mixes against DSCB by changing different parameters and prior to submitting for DM approval.

DM concrete calculator is a web-based application and includes all the baseline mixes in its data base.

NOTE: To subscribe to DM concrete calculator, contact Research and Building Systems Section at dscb@dm.gov.ae.

F.11.3 Standard concrete mixes

A ready-mixed concrete company operating in Dubai might have their standard concrete mixes approved to be used. For any standard mix to be approved, it needs to have a WAI less than that of a corresponding baseline mix (see Table F.25) of the same grade.

Preliminary comparisons may be carried out by the client using DM concrete calculator. Final approval for every mix is issued by Research & Building Systems Section of the Building Permits Department.

Proposed mixes are compared to the WAI of the baseline mixes of equivalent grade.

Compressive strength (cylinder/cube) (N/mm^2)	Mix description	Total cement/ Cm content (kg/m^3)	Cement (OPC) (kg/m^3)	GGBS (slag) (kg/m^3)	Silica fume (kg/m^3)	w/c ratio
C12/15, C16/20, C20/25 (blinding)	OPC + 36% GGBS	280	179	101	0	0.55
C24/30	OPC + 36% GGBS	360	230	130	0	0.44
C28/35	OPC + 36% GGBS	380	243	137	0	0.42
C32/40	OPC + 36% GGBS	400	256	144	0	0.38
C36/45	OPC + 36% GGBS	410	262	148	0	0.37
C40/50	OPC + 36% GGBS	420	269	151	0	0.36
C44/55	OPC + 26% GGBS + 5% SF	430	397	112	21	0.35
C48/60	OPC + 26% GGBS + 5% SF	440	303	115	22	0.34
C52/65	OPC + 26% GGBS + 6% SF	450	306	117	27	0.33
C56/70	OPC + 26% GGBS + 6% SF	460	312	120	28	0.33
C60/75	OPC + 26% GGBS + 7% SF	470	315	122	33	0.32
C64/80	OPC + 26% GGBS + 7% SF	490	329	127	34	0.31
C68/85	OPC + 26% GGBS + 8% SF	500	330	130	40	0.30
C72/90	OPC + 26% GGBS + 8% SF	510	336	133	41	0.29

Table F.25 Concrete mixes of DSCB by concrete compressive strength

F.11.4 New sustainable materials

The DSCB mixes are proportioned using the materials specified in F.6.2.3 including GGBS, fly ash and silica fume. Other sustainable materials are permitted provided that:

a) the material performance conforms to a standard specification and it is verified against that specification; and
b) the material has an LCA report and data set submitted to DM for evaluation and approval.

Once the material is approved, it is added to DSCB environmental impacts model and DM concrete calculator. Accordingly, it may be used in concrete mixes provided that those mixes have lower WAIs than those of the corresponding baseline mixes.

F.11.5 Concrete mixes for a specific project

This service permits, for a specific project, the use of mixes different from those specified in F.6.2.3 The mixes may exceed the WAI of the corresponding baseline mixes provided that the total WAI for all the concrete mixes used in the project is less than that of the baseline mixes, as shown in the following equation.

Eq. F.11

$$\sum(\text{WAI of proposed mix . quantity of mix}) \leq \sum(\text{WAI of baseline mix . quantity of mix})$$

NOTE: Further information on submitting applications can be obtained from Research and Building Systems Section at dscb@dm.gov.ae.

F.12 Annex: Precast stairs

The design of precast stairs should take into account the following.

a) Where precast stair flights are supported on in-situ landings, the landings should be cast against the precast flight. This avoids the problems of tolerances where precast flights are placed on previously cast in-situ landings.
b) The design should take into account how the stair is tied to the main structure, the sequence of construction and the temporary works involved.
c) Ties between precast stair and precast supports are a critical aspect of the design. Recommended types of connections are illustrated in Figure F.31 and Figure F.32.
d) Precast staircase flight may be supported by steel beams, providing the shear studs are welded to the steel beam and holes in the precast unit are located over the studs and then grouted, as shown in Figure F.33.
e) Ties between precast stairs and in-situ concrete landings as shown in Figure F.34 and Figure F. 35.

When landings are cast in-situ after placement of the precast stair flights, the stair should be propped. It is important that the temporary braced props are supported by permanent rather than temporary structures.

Typical connections are shown in Figure F.31, Figure F.32, Figure F.33, Figure F.34 and Figure F.35. The Engineer can provide alternative details as long as the strength and serviceability requirements are satisfied.

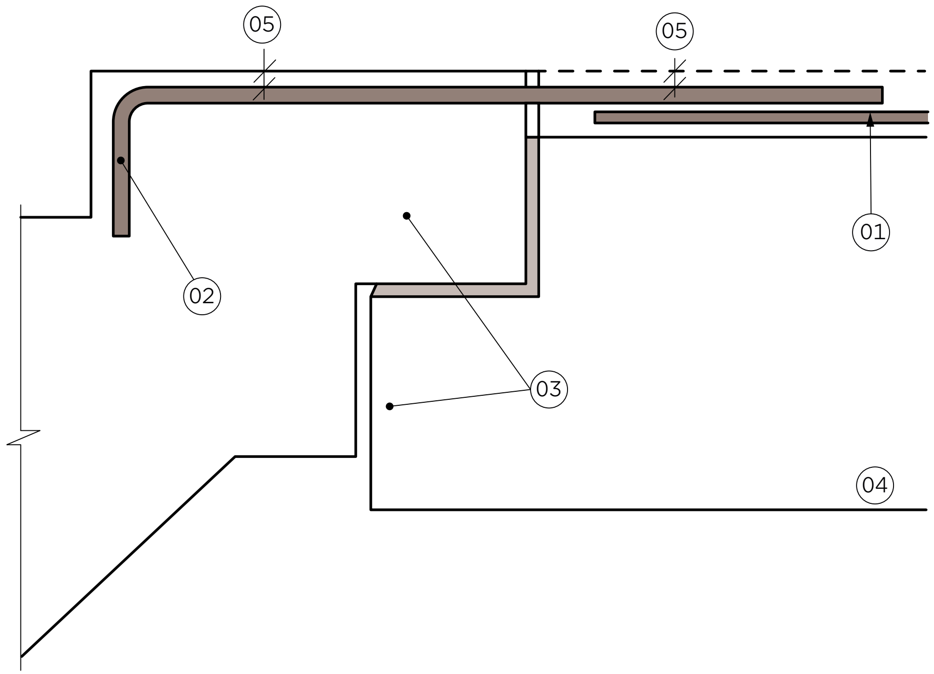


Figure F.31 Recommended connection between precast flight and precast landing – Lapped horizontal connection with reinforcement in the topping tied into the structure

Key

01: Reinforcement in structural topping
02: Bar incorporated with reinforcement in precast staircase
03: Nib sized to ensure safety during construction
04: Precast landing
05: Minimum cover

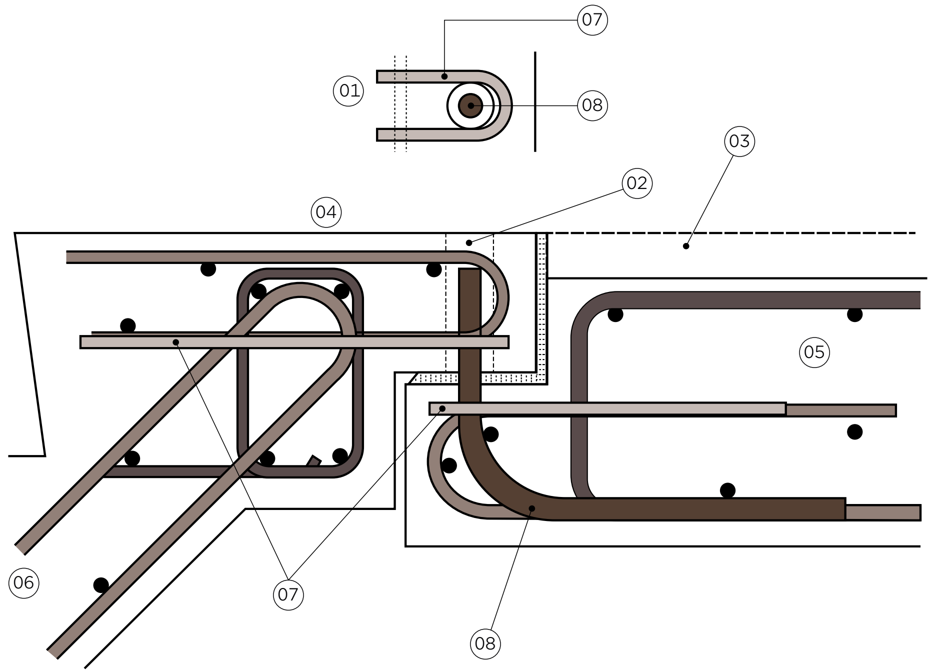


Figure F.32 Recommended connection between precast flight and precast landing with a dowel tie

Key

01: Part plan of nib
02: Grouted clearance hole
03: Screed
04: Side section of connection
05: Precast landing
06: Precast stair flight
07: U-bar links
08: Dowel

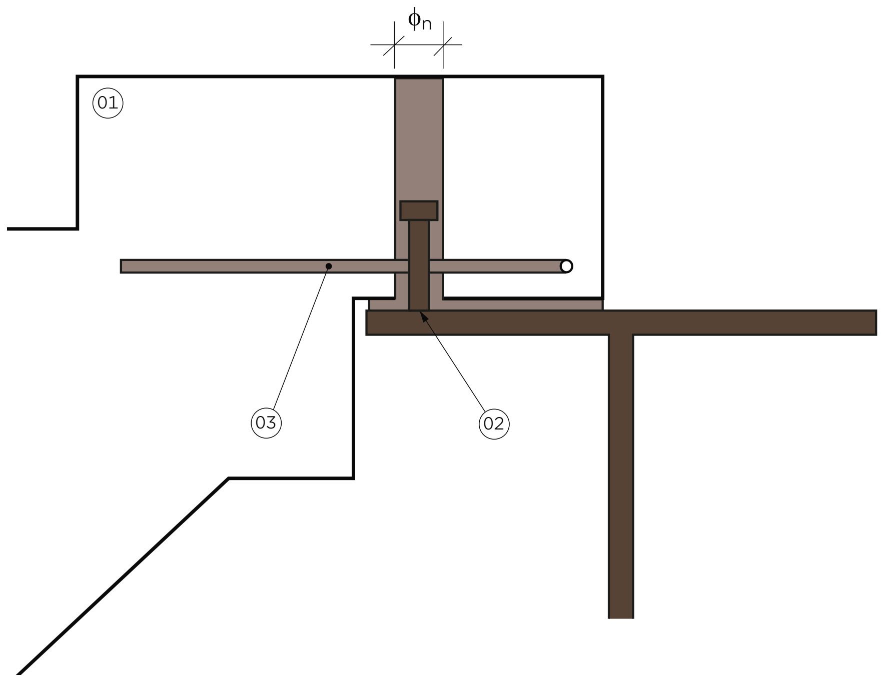


Figure F.33 Recommended connection between precast stair and steel beam with a shear stud tie

Key

01: Precast stair flight
02: Welded connection
03: U-bar link

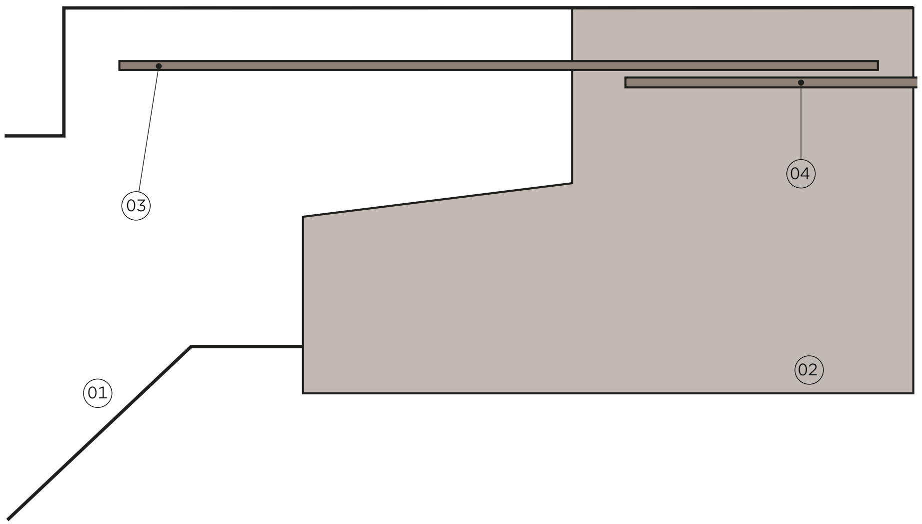


Figure F.34 Recommended connection between precast flight and in-situ landing with a single rebar and nib (NOTE: Other rebars omitted for clarity)

Key
01: Precast region
02: In-situ region
03: Bar incorporated with reinforcement in precast staircase
04: Reinforcing cast into in-situ landing, and lapped/tied with bar from precast unit

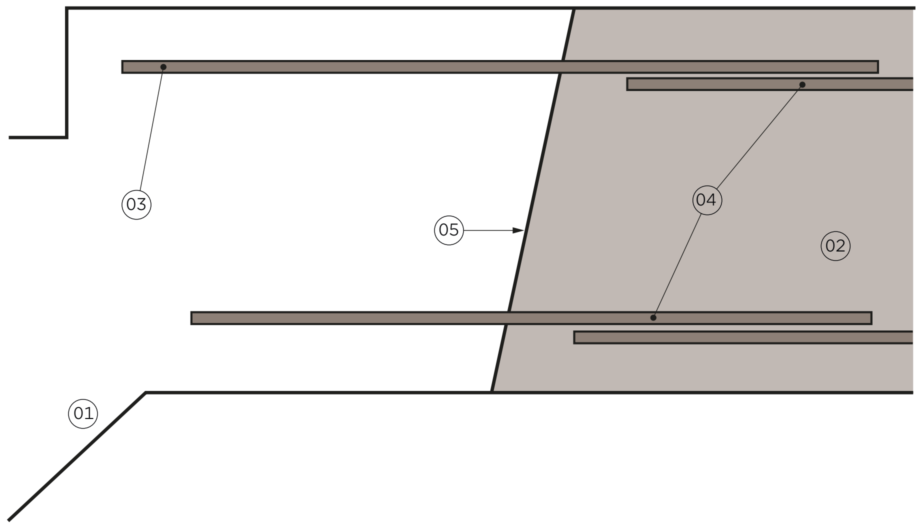
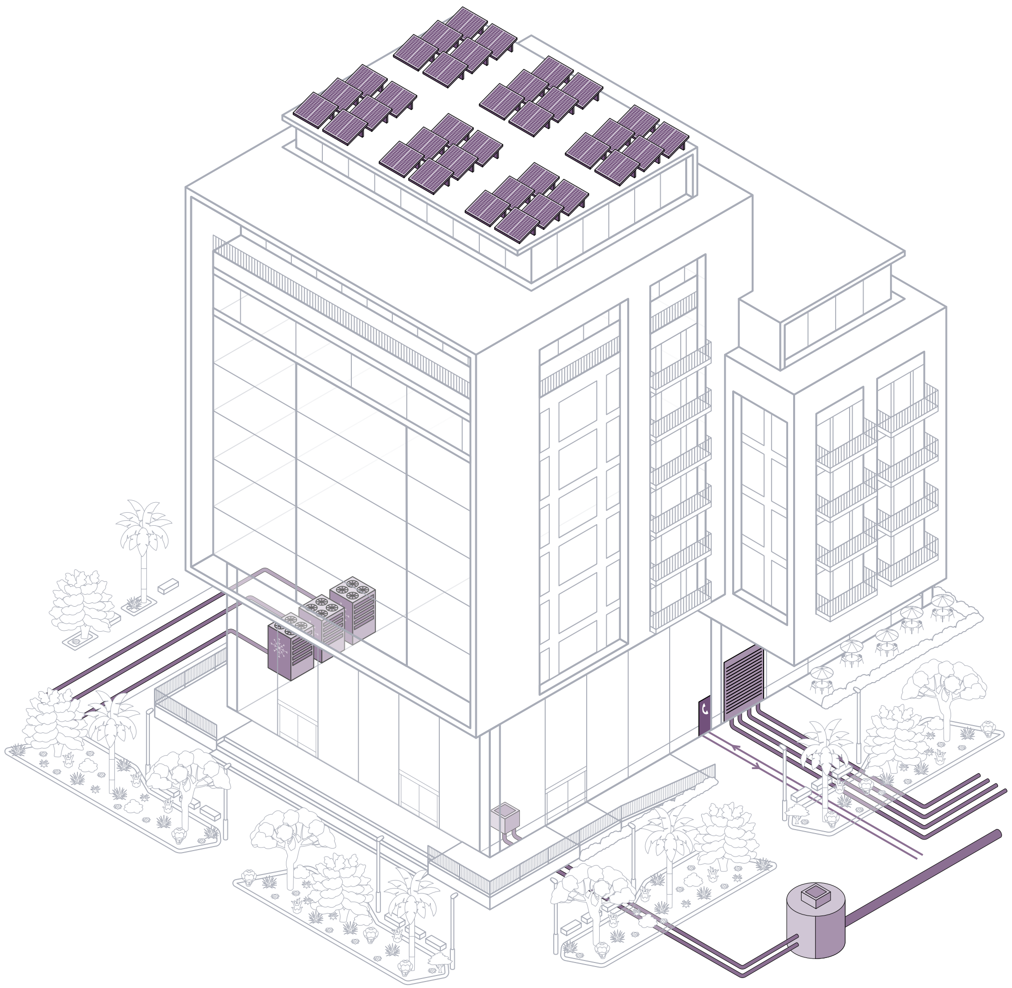


Figure F.35 Recommended connection between precast flight and in-situ landing with a pair of rebars

Key
01: Precast region
02: In-situ region
03: Bar incorporated with reinforcement in precast staircase
04: Reinforcement cast into in-situ landing, and lapped/tied with bar from precast unit
05: Prepared construction joint

Part G

Incoming utilities



G.1 Performance statements

Performance statement	The performance statement will be met by following the requirements of:
The building shall provide electrical installations that safeguard occupants against the outbreak of fire and personal injury due to electric shock.	G.4 to G.7
The building shall be provided with metered water supplies to monitor water consumption and inform water conservation.	G.9
The building shall be coordinated with the needs of the relevant incoming district cooling provisions.	G.10
The building shall enable telecommunications services that are suitably future-proof and that facilitate the use of multiple service providers.	G.11

G.2 Definitions

G.2.1 Terms

G.2.1.1 Electrical

Accessory: Device, other than current-using equipment, associated with such equipment or with the wiring of an installation.

Active power: Real component of the apparent power, expressed in watts (W), kilowatts (kW) or megawatts (MW).

Alternating current (AC): Electric current that reverses its direction many times a second at regular intervals.

Ambient temperature: Temperature of the air or other medium where the equipment is to be used.

Apparent power: Product of voltage (V) and current (A). It is usually expressed in kilovolt-ampere (kVA) or megavolt-ampere (MVA), and consists of a real component (active power) and an imaginary component (reactive power).

Appliance: Item of current-using equipment other than a luminaire or an independent motor.

Arc fault detection device (AFDD): Device that protects specifically against arc faults. AFDDs automatically trip a circuit when they detect dangerous electric arcs.

Barrier: Part providing a defined degree of protection against contact with live parts from any usual direction of access.

Bonding conductor: Protective conductor providing equipotential bonding.

Bunched cables: Two or more cables that are contained within a single conduit, duct or trunking, or, if not enclosed, are not separated from each other by a specified distance.

Busbar trunking system: Type-tested assembly, in the form of an enclosed conductor system comprising solid conductors separated by insulating material. The assembly may consist of units such as:

a) busbar trunking units, with or without tap-out facilities;
b) tap-out units where applicable; or
c) flexible, end-feeder and adaptor units.

Cable ladder: Cable support consisting of a series of transverse supporting elements rigidly fixed to main longitudinal supporting members.

Cable tray: Cable support consisting of a continuous base with raised edges and no covering. A cable tray is non-perforated, where less than 30% of the material is removed from the base.

Cable trunking: Manufactured enclosure for the protection of cables, normally of rectangular cross-section, of which one side is removable.

Circuit: Assembly of electrical equipment supplied from the same origin and protected against overcurrent by the same protective devices.

Circuit breaker: Device capable of making, carrying and breaking normal load current and making and automatically breaking, under predetermined conditions, abnormal currents such as short-circuit currents. It usually operates infrequently, although some types are suitable for frequent operation.

Cleat: Component of a support system, which consist of elements spaced at intervals along the length of the cable or conduit and which mechanically retains the cable or conduit.

Conductor: Material or device that conducts or transmits electricity.

Conduit: Part of a closed wiring system for cables in electrical installations, allowing them to be drawn in and/or replaced, but not inserted laterally.

Connected load: Total electrical power (W) consumed by all devices connected to an electrical distribution system.

Connector: Part of a cable coupler or an appliance coupler which is provided with female contacts and is intended to be attached to the end of the flexible cable remote from the supply.

Current-carrying capacity of a conductor: Maximum current which can be carried by a conductor under specified conditions without its steady state temperature exceeding a specified value.

Current-using equipment: Equipment which converts electrical energy into another form of energy, such as light, heat or motive power.

Demand factor: Ratio of maximum demand of the system to the total connected load.

Design current: Magnitude of the current [root mean square (RMS) value for AC] to be carried by the circuit in normal service.

Direct current (DC): Unidirectional flow of an electric charge.

Distribution board: Assembly containing switching or protective devices (e.g. fuses, circuit breakers, and residual current operated devices) associated with one or more outgoing circuits, fed from one or more incoming circuits, together with terminals for the neutral and protective circuit conductors. It may also include signalling and other control devices. Means of isolation may be included in the board or may be provided separately.

Diversity factor (or diversity): Ratio of sum of individual maximum demands of the different type of load during a specified period to the maximum demand of the power station during the same period.

Duct: Enclosure of metal or insulating material, other than conduit or cable trunking, intended for the protection of cables which are drawn in after erection of the ducting.

Earth: Conductive mass of the earth, of which the electric potential at any point is conventionally taken as zero.

Earth continuity conductor (ECC): Conductor used for some measures of protection against electric shock and intended for connecting together any of the following parts:

a) exposed conductive parts;
b) extraneous-conductive parts;
c) the main earthing terminal;
d) earth electrode(s); or
e) the earthed point of the source, or an artificial neutral.

Earth electrode: Conductor or group of conductors in intimate contact with and providing an electrical connection to earth.

Earth electrode resistance: Resistance of an earth electrode to earth.

Earth fault current: Fault current which flows to earth.

Earth fault loop impedance: Impedance of the earth fault current loop starting and ending at the point of earth fault.

Earth leakage: Current which flows to earth, or to extraneous-conductive parts, in a circuit which is electrically sound.

Earth leakage circuit breaker (ELCB): Safety device with high earth impedance which interrupts the circuit if a dangerous voltage (50 V AC or over) is detected.

Earthing: Connection of the exposed conductive parts of an installation to the main earthing terminal of that installation.

Earthing conductor: Protective conductor connecting the main earthing terminal of an installation to an earth electrode or to other means of earthing.

Electric shock: Dangerous physiological effect resulting from the passing of an electric current through a human body or livestock.

Electrical installation: Assembly of associated electrical equipment supplied from a common origin to fulfil a specific purpose and having certain coordinated characteristics.

Emergency switching: Operation intended to remove, as quickly as possible, danger, which might have occurred unexpectedly.

Enclosure: Part providing protection of equipment against certain external influences and in any direction protection against direct contact.

Equipment: Any item that involves the generation, conversion, transmission, distribution or utilization of electrical energy, such as machines, transformers, apparatus, measuring instruments, protective devices, wiring systems, accessories, appliances and luminaires.

Equipotential bonding: Electrical connection maintaining various exposed conductive parts and extraneous conductive parts at substantially the same potential.

Exposed conductive part: Conductive part of equipment which can be touched, and which is not a live part, but which can become live under fault conditions.

External influence: Any influence external to an electrical installation that affects the design and safe operation of that installation.

Extra-low voltage: Voltage normally not exceeding 50 V AC or 120 V ripple-free DC, whether between conductors or to earth.

Fault: Circuit condition in which current flows through an abnormal or unintended path, which can result from an insulation failure or a bridging of insulation.

Fault current: Current resulting from a fault.

Feeder pillar: Cabinet for electrical protection and distribution equipment, mounted externally and supplying several consumers.

Final circuit: Circuit connected directly to current-using equipment, or to a socket outlet or socket outlets or other outlet points for the connection of such equipment.

Fixed equipment: Equipment designed to be fastened to a support or otherwise secured in a specific location.

Flexible cable: Cable in which the structure and materials make it suitable to be flexed while in service.

Flexible cord: Cable in which the cross-sectional area of each conductor does not exceed 4 mm^2.

Fuse: Device which, by the melting of one or more of its specially designed and proportioned components, opens the circuit in which it is inserted by breaking the current when this exceeds a given value for a defined time. The fuse comprises all the parts that form the complete device.

Fuse element: Part of a fuse designed to melt when the fuse operates.

Fuse link: Part of a fuse including the fuse element(s), which requires replacement by a new or renewable fuse link after the fuse has operated and before the fuse is put back into service.

Harmonics: Amount of distortion that occurs to the voltage or current sine wave, which in electrical installations can be caused by various sources such as non-linear loads, variable speed drives, variable frequency drives, capacitor banks, UPS backup power supplies, fluorescent light ballasts, fan speed controls, halogen lights, low voltage transformers for indoor/outdoor lighting, unfiltered dimmer switches, AC/DC power supplies, etc. found in various electronic devices such as computers, printers, fax machines, televisions, etc.

Insulation: Non-conductive material enclosing, surrounding or supporting a conductor.

Inverter: Device which converts the direct current (DC) to alternating current (AC).

Isolator: Mechanical switching device which, in the open position, meets the requirements specified for the isolating function.

Live part: Conductor or conductive part intended to be energized in normal use, including a neutral conductor.

Low smoke and fume (LSF) cable: Cable rated Class C_{ca}-s1b,d2,a2 in accordance with BS EN 13501-6.

Low voltage: Voltage normally exceeding extra-low voltage but not exceeding 1,000 V AC or 1,500 V DC between conductors, or 600 V AC or 900 V DC between conductors and earth.

Luminaire: Equipment which distributes, filters or transforms the light from one or more lamps, and which includes any parts necessary for supporting, fixing and protecting the lamps, but not the lamps themselves, and, where necessary, circuit auxiliaries together with the means for connecting them to the supply.

Main earthing terminal: Terminal or bar provided for the connection of protective conductors, including equipotential bonding conductors, and conductors for functional earthing, if any, to the means of earthing.

Maximum demand: Summation of all electrical power demand that has occurred during a specified period, measured in kW or kVA.

Megger test: Measure of insulation resistance.

Neutral conductor: Conductor of a three-phase 4-wire system or the conductor of a single-phase installation which is earthed at the source of the supply.

Non-combustible: Material which is classified as Class A1 in accordance with BS EN 13501-1.

Nominal voltage: Voltage by which an installation (or part of an installation) is designated.

Overcurrent: Current exceeding the rated value. For conductors the rated value is the current- carrying capacity.

Overload: Overcurrent occurring in a circuit which is electrically sound.

Plug: Accessory having pins designed to engage with the contact of a socket outlet and incorporating means for the electrical connection and mechanical retention of a flexible cable or cord.

Point (in wiring): Termination of the fixed wiring intended for the connection of current-using equipment.

Protective device: Device which detects abnormal and intolerable conditions, which initiates appropriate corrective action to provide protection against electric shock under fault-free conditions. Backup protection is provided to operate when a system fault is not cleared or abnormal condition not detected in the required time because of failure or inability of other protection to operate or failure of appropriate circuit breaker.

Protective earthing: Earthing of a point or points in a system or in an installation or in equipment for the purpose of safety.

PV: Solar photovoltaic.

PV array: Mechanically and electrically integrated assembly of PV modules, and other necessary components, to form a DC power supply unit.

PV array cable: Output cable of a PV array.

PV array junction box: Enclosure where PV strings of any PV array are electrically connected and where devices can be located.

PV cell: Basic PV device which can generate electricity when exposed to light such as solar radiation.

PV DC main cable: Cable connecting the PV generator junction box to the DC terminal of the PV invertor.

PV generator: Assembly of PV array.

PV generator junction box: Enclosure where PV array is electrically connected and where devices can be located.

PV installation: Erected equipment of PV power supply system.

PV invertor: Device which converts DC voltage and DC current into AC voltage and AC current.

PV module: Smallest completely environmentally protected assembly of interconnected PV cells.

PV AC module: Integrated module/invertor assembly where the electrical interface terminal is AC only, with no access being provided to the DC side.

PV string: Circuit in which PV modules are connected in series for a PV array to generate the required output voltage.

PV string cable: Cable connecting PV modules to form a PV string.

PVC: Polyvinyl chloride as insulation or sheath of cable.

Rated current: Value of current used for specification purposes, established for a specified set of operating conditions of a component, device, equipment or system.

Reactive power: Imaginary component of the apparent power expressed in kVAr or MVAr.

Residual current: Vector sum of the instantaneous values of current flowing through all live conductors of a circuit at a point in the electrical installation.

Residual current device (RCD): Mechanical switching device or association of devices intended to cause the opening of the contacts when the residual current attains a given value under specified conditions.

Residual current operated circuit breaker with integral overcurrent protection (RCBO): Residual current operating device designed to perform the functions of protection against overall load and/or short-circuit.

Residual current operated circuit breaker without integral overcurrent protection (RCCB): Residual current operated switching device not designed to perform the functions of protection against overload and/or short-circuit.

Resistance area: Surface area of ground (around an earth electrode only) on which a significant voltage gradient may exist.

Ring circuit: Circuit arranged in the form of a ring and connected to a single point of supply.

Short-circuit current: Overcurrent resulting from a fault of negligible impedance between live conductors having a difference in potential under normal operating conditions.

Short-circuit current under standard test condition (Isc STC): Short-circuit current of a PV module, PV string, PV array or PV generator under standard test conditions.

Shrouded: Enclosure used to cover the cable and cable gland when the cable is entering an item of equipment, to avoid water and dust ingress.

Sikka: Public or private path separating two adjacent plots or a group of adjacent plots, that can be used by pedestrians as a primary or secondary access to any plot.

Socket outlet: Device, provided with female contacts, which is intended to be installed with the fixed wiring, and intended to receive a plug. A luminaire track system is not regarded as a socket outlet system.

Space factor: Ratio (expressed as a percentage) of the sum of the effective overall cross-sectional area of cables forming a bunch to the internal cross-sectional area of the conduit, pipe, duct, trunking or channel in which they are installed.

Stationary appliance: Electrical equipment which is either fixed, or equipment having a mass exceeding 18 kg and not provided with a carrying handle.

Surge protection device (SPD): Device designed to protect electrical systems and equipment from surge events (e.g. caused by lightening or switching of electrical loads) by limiting transient voltages and diverting surge currents.

Switch: Mechanical device capable of making, carrying and breaking current under normal circuit conditions, which can include specified operating overload conditions, and carrying for a specified abnormal circuit conditions such as those of short-circuit, and which can also be capable of making, but not breaking, short-circuit currents.

Switchboard: Assembly of switchgear with or without instruments, excluding groups of local switches in final circuits.

Switchgear: Assembly of main and auxiliary switching apparatus for operation, regulation, protection or other control of an electrical installation.

Temporary electrical systems: Electrical installation erected for a particular purpose and dismantled when no longer required for that purpose.

Wiring system: Assembly made up of cables or busbars and parts which secure and, if necessary, enclose the cable or busbar.

XLPE cable: Cross-linked polyethylene as insulation of cable.

G.2.1.2 District cooling

Customer: Building Owner, Developer or other representative (e.g. designer).

Energy transfer station (ETS): Dedicated plant room in the facility or building where a cooling energy transfer system is installed to supply chilled water to the premises.

Premises: Land and buildings, owned by the Customer, requiring chilled cooling water.

Provider: Entity that designs, supplies, installs, tests, cleans and commissions the district cooling plant that is licensed and approved by the Municipal Authorities.

Valve chamber (VC): Dedicated space in the premises, either buried or exposed, where the district cooling Provider provides isolating valves on the district cooling chilled water pipes that serve the ETS.

G.2.1.3 Telecommunications

Building Industry Consulting Service International (BICSI): Global professional/trade association supporting the advancement of the information and communications technology (ICT) community.

Building entry point (BEP): Point where external ducts physically enter a building. This can be a standalone location or incorporated into another telecoms space.

Cable pathway: Any system used to route cables, such as cable ducting, cable ladder, cable tray, conduit, duct and maintenance chamber.

Feeder cable: Cable that provides signals to a property from an ethernet or GPON-based SP network. Feeder cables can deliver signals for connection to optical splitters and distribution on the in-building telecom fibre to the x (FTTx) system, or provide a SP connection to a local optical line terminal (OLT) if the SP requires this locally within a development.

Fibre concentration point (FCP): Point where a high core count feeder cable is converted to multiple smaller core count distribution cables. The FCP can be located within the property boundary in a BEP, or outside the property in a meet-me-chamber (MMC).

Fibre to the x (FTTx): Delivery of optical fibre signals directly to a location. For SP telecom services, the x can be defined as B (building), C (cabinet), H (home) or P (premise).

Floor telecom room (FTR): Room located at each floor between the main telecom room (MTR) and multiple floor optical telecommunication outlets (TO), which allows the transition from vertical optical fibre cables to horizontal tenant cabling.

Handhole: Small maintenance chamber installed within a campus duct system specifically aiding the pulling of cables on long straight duct routes where cable pulling forces might otherwise be exceeded.

Meet-me-chamber (MMC): Maintenance chamber located in the vicinity of the property boundary and providing the first common element of the outside plant (OSP) installation, with three separate duct connections from SPs into the chamber then following a single OSP route into the development. For multi-building developments, this can also contain an FCP, enabling feeder cables to split to separate cables to individual buildings on a plot when a meet-me-room (MMR) is not utilized.

Meet-me-room (MMR): Site-specific location for SP use, as determined by the agreed masterplan. MMRs form a common location for feeder cables from SPs to terminate and split to multiple cables feeding MTRs on different plots of a development.

Main telecom room (MTR): Location where feeder cables from SPs are terminated, allowing connection to the building inside plant (ISP) common infrastructure.

Optical line terminal (OLT): Centralized piece of equipment providing service to many end users through a PON solution. OLTs can support cable distances up to 20 km from centralized equipment subject to the optical fibre cabling design.

Optical network terminal (ONT): Active component of the FTTx optical network located at a tenant premises.

Optical splitter: Passive component of the FTTx optical network taking signal from either one or two input optical cores and equally dividing the signal to the splitter outputs.

Optical telecommunication outlet (TO): Fixed connecting device where tenant indoor optical fibre cable terminates. The TO provides an optical connection for the equipment connection cord of the ONT.

Passive optical network (PON): Point-to-multipoint FTTx network architecture utilizing unpowered optical splitters. Variants of PON using the same topology and passive components include GPON, XG-PON, XGS-PON and NG-PON2.

Service Provider (SP): Provider of telecommunication services. SPs in Dubai include du and Etisalat.

G.2.2 Acronyms and abbreviations

AC	alternating current
ACB	air circuit breaker
AHU	air handling unit
APC	angle polished connector
BAPV	Building attached photovoltaics
BEP	building entry point
BICSI	Building Industry Consulting Service International
BIPV	Building integrated photovoltaics
cap	capita
Ch.	chapter
CT	current transformer
DB	distribution board
DBC	Dubai Building Code
DC	direct current
DCD	Dubai Civil Defence
DEWA	Dubai Electricity and Water Authority
DP	double-pole
DRRG	distributed renewable resource generation
du	SP in Dubai
ECC	earth continuity conductor
EID	Etisalat Identification
ELCB	earth leakage circuit breaker
EM	electromagnetic
EMI	electromagnetic interference
Etisalat	SP in Dubai

ETS	energy transfer station
EV	electric vehicle
EVSE	electric vehicle service equipment
FCP	fibre concentration point
FCU	fan coil unit
FFL	finished floor level
FGRP	fibre glass reinforced plastic
FTR	floor telecom room
FTTx	fibre to the x
G	ground floor
GAID	Global Alliance for ICT and Development
GPON	gigabit passive optical network
GS	galvanized steel
GSM	global system for mobile communication
h	height
HDPE	high density polyethylene
HDRF	heavy duty return flange
HEX	heat exchanger
HMI	human-machine interface
HV	high voltage
IBS	in-building service
ICT	information and communication technology
IEC	International Electrotechnical Commission
IET	Institution of Engineering and Technology
IP	ingress protection

ISO	International Organization for Standardization
ISP	inside plant
IT	information technology
l	length
LC	lucent connector
LDPE	low density polyethylene
LPG	liquefied petroleum gas
LSF	low smoke and fume
LSZH	low smoke zero halogen
LV	low voltage
MCB	miniature circuit breaker
MCCB	moulded case circuit breaker
MDB	main distribution board
MEP	mechanical, electrical, plumbing
MMC	meet-me-chamber
MMR	meet-me-room
MNO	mobile network operator
MSR	mobile service room
MTR	main telecom room
MV	medium voltage
NFPA	National Fire Protection Association
NG-PON2	next generation PON2
ODF	optical distribution frame
OLT	optical line terminal
ONT	optical network terminal

OSP	outside plant
PF	power factor
PLC	programme logic controller
PoE	power-over-ethernet
PON	passive optical network
PV	photovoltaic
PVC	polyvinyl chloride
RCBO	Residual current operated circuit breaker with integral overcurrent protection
RCCB	Residual current operated circuit breaker without integral overcurrent protection
RCD	residual current device
RFI	radio frequency interference
RMU	ring main unit
RoHS	restriction of hazardous substances
RTA	Road and Transportation Authority
RTMR	rooftop mobile room
RTU	remote terminal unit
SC	standard connector
SLD	single line diagram
SM	singlemode
SMDB	sub-main distribution board
SP	service provider
SPD	surge protection device
STP	shielded twisted pair
TCL	total connected load
TO	telecommunication outlet

TP	three phrase
TRA	Telecommunication Regulatory Authority
UAE FLSC	UAE Fire and Life Safety Code of Practice
UTP	unshielded twisted pair
UV	undervoltage
VC	valve chamber
VFD	variable frequency drive
VT	voltage transformer
w	width
XG-PON	10 gigabit PON
XGS-PON	symmetric XG-PON

G.3 References

G.3.1 General

Ref. G.1 UAE MINISTRY OF INTERIOR GENERAL COMMAND OF CIVIL DEFENCE, 2018. UAE Fire and Life Safety Code of Practice (UAE FLSC). United Arab Emirates: Ministry of Interior General Command of Civil Defence.

G.3.2 Electrical

BS 546, Specification – Two-pole and earthing-pin plugs, socket outlets and socket outlet adaptors

BS 559, Specification for the design and construction of signs for publicity, decorative and general purposes

BS 1363, 13 A plugs, socket-outlets, adapters and connection units

BS 4177, Specification for cooker control units

BS 4363, Specification for distribution assemblies for reduced low voltage electricity supplies for construction and building sites

BS 4444, Guide to electrical earth monitoring and protective conductor proving

BS 4573, Specification for 2-pin reversible plugs and shaver socket outlets

BS 4607, Non-metallic conduits and fittings for electrical installations. Specification for fittings and components of insulating material

BS 4662, Boxes for flush mounting of electrical accessories. Requirements, test methods and dimensions

BS 5467, Electric cables – Thermosetting insulated, armoured cables of rated voltages of 600/1,000 V and 1,900/3,300 V for fixed installations

BS 5733, General requirements for electrical accessories – Specification

BS 6004, Electric cables – PVC insulated and PVC sheathed cables for voltages up to and including 300/500 V, for electric power and lighting

BS 6121, Mechanical cable glands

BS 6231, Electric cables – Single core PVC insulated flexible cables of rated voltage 600/1,000 V for switchgear and controlgear wiring

BS 6724, Electric cables – Thermosetting insulated, armoured cables for rated voltages of 600/1,000 V and 1,900/3,300 V, having low emission of smoke and corrosive gases when affected by fire – Specification

BS 7211, Electric cables – Thermosetting insulated and thermoplastic sheathed cables for voltages up to and including 450/750 V for electric power and lighting and having low emission of smoke and corrosive gases when affected by fire

BS 7430, Code of practice for protective earthing of electrical installations

BS 7629-1, Electric cables – Specification for 300/500 V fire-resistant, screened, fixed installation cables having low emission of smoke and corrosive gases when affected by fire – Part 1: Multicore cables

BS 7671, Requirements for electrical installations – IET wiring regulations

BS 7769, Electric cables – Calculation of the current rating

BS 7846, Electric cables – Thermosetting insulated, armoured, fire-resistant cables of rated voltage 600/1,000 V for fixed installations, having low emission of smoke and corrosive gases when affected by fire – Specification

BS 7889, Electric cables – Thermosetting insulated, non-armoured cables with a voltage of 600/1,000 V, for fixed installations

BS 7909, Code of practice for temporary electrical systems for entertainment and related purposes

BS 8436, Electric cables – Specification for 300/500 V screened electrical cables having low emission of smoke and corrosive gases when affected by fire, for use in walls, partitions and building voids – Multicore cables

BS EN 13501-1, Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests

BS EN 13501-6, Fire classification of construction products and building elements – Part 6: Classification using data from reaction to fire tests on power, control and communication cables

BS EN 50085, Cable trunking and cable ducting systems for electrical installations

BS EN 50160, Voltage characteristics of electricity supply by public electricity networks

BS EN 50214, Flat polyvinyl chloride sheathed flexible cables

BS EN 50522, Earthing of power installations exceeding 1 kV

BS EN 50525, Electric cables – Low voltage energy cables of rated voltages up to and including 450/ 750 V (U0/U)

BS EN 60079, Explosive atmospheres

BS EN 60204, Safety of machinery – Electrical equipment of machines

BS EN 60269, Low voltage fuses – General requirements

BS EN 60309, Plugs, socket outlets and couplers for industrial purposes

BS EN 60335-2, Household and similar electrical appliances – Part 2: Safety

BS EN 60423, Conduit systems for cable management – Outside diameters of conduits for electrical installations and threads for conduits and fittings

BS EN 60529, Degrees of protection provided by enclosures (IP code)

BS EN 60570, Electrical supply track systems for luminaires

BS EN 60669, Switches for household and similar fixed electrical installations

BS EN 60670, Boxes and enclosures for electrical accessories for household and similar fixed electrical installations

BS EN 60898-1, Electrical accessories – Circuit breakers for overcurrent protection for household and similar installations – Part 1: Circuit-breakers for a.c. operation

BS EN 60947, Low voltage switch gear and control gear

BS EN 61008-1, Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) – Part 1: General rules

BS EN 61009-1, Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) – Part 1: General rules

BS EN 61140, Protection against electric shock – Common aspects for installation and equipment

BS EN 61386, Conduit systems for cable management

BS EN 61439, Low voltage switchgear and control gear assemblies

BS EN 61643, Low voltage surge protective devices

BS EN 61535, Installation couplers intended for permanent connection in fixed installations

BS EN 61537, Cable management

BS EN 61558, Safety of transformers, reactors, power supply units and combinations thereof

BS EN 62423, Type F and type B residual current operated circuit breakers with and without integral overcurrent protection for household and similar uses

BS EN 62606, General requirements for arc fault detection devices (AFDDs)

IEC 60038, IEC standard voltages

IEC 60255, Measuring relays and protection equipment

IEC 60364, Low voltage electrical installations

IEC 61000, Electromagnetic compatibility (EMC)

IEC 61140, Protection against electric shock – Common aspects for installation and equipment

IEC 61439, Low voltage switchgear and control gear assemblies

IEC 61851, Electric vehicle conductive charging system

IEC 61869, Instrument transformers

IEC 61921, Power capacitors – Low voltage power factor correction banks

NFPA 70, National electrical code

Ref. G.2 INSTITUTION OF ENGINEERING AND TECHNOLOGY, 2018. Electrician's guide to the building regulations. 5th edition. Stevenage: IET.

Ref. G.3 INSTITUTION OF ENGINEERING AND TECHNOLOGY, 2018. Guidance note 8: Earthing and bonding. 4th edition. Stevenage: IET.

Ref. G.4 EXECUTIVE COUNCIL OF DUBAI, 2014. Executive Council Resolution no. (46) of 2014 concerning the connections of generators of electricity from solar energy to the power distribution system in the Emirate of Dubai. Dubai: Executive Council of Dubai.

Ref. G.5 DUBAI ELECTRICITY AND WATER AUTHORITY. Publications and resources [online database]. Available from: www.dewa.gov.ae/en/consumer/solar-community/publications-resources.

Ref. G.6 DUBAI ELECTRICITY AND WATER AUTHORITY. Technical publications and resources [online database]. Available from: www.dewa.gov.ae/en/builder/useful-tools/tech-publications-resources.

Ref. G.7 DUBAI ELECTRICITY AND WATER AUTHORITY, 2016. Standards for distributed renewable resources generators connected to the distribution network. 2nd edition. Dubai: DEWA.

G.3.3 Water

Ref. G.8 Dubai Electricity and Water Authority (DEWA). Circulars and Regulations [online database]. Available from: www.dewa.gov.ae/en/builder/useful-tools/dewa-circulars.

G.3.4 District cooling

Ref. G.9 District cooling Providers' technical guidance documentation as supplied by the relevant Providers, which include:

a) Emaar District Cooling;
b) Tabreed;
c) Empower;
d) Emicool.

G.3.5 Telecommunications

G.3.5.1 Essential reading

BS EN 13501-6, Fire classification of construction products and building elements – Classification using data from reaction to fire tests on power, control and communication cables

IEC/EN 60332-1-2, Tests on electrical and optical fibre cables under fire conditions – Tests for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame

ISO/IEC 11801-1, Information technology – Generic cabling for customer premises – Part 1: General requirements

ISO/IEC 11801-2, Information technology – Generic cabling for customer premises – Part 2: Office premises

ISO/IEC 11801-3, Information technology – Generic cabling for customer premises – Part 3: Industrial premises

ISO/IEC 11801-4, Information technology – Generic cabling for customer premises – Part 4: Single-tenant homes

ISO/IEC 11801-6, Information technology – Generic cabling for customer premises – Part 6: Distributed building services

ISO/IEC 14763-1, Information technology – Implementation and operation of customer premises cabling – Part 1: Administration

ISO/IEC 14763-2, Information technology – Implementation and operation of customer premises cabling – Part 2: Planning and installation

ISO/IEC 14763-3, Information technology – Implementation and operation of customer premises cabling – Part 3: Testing of optical fibre cabling

ISO/IEC 30129, Information technology – Implementation and operation of customer premises cabling – Part 2: Planning and installation Telecommunications bonding networks for buildings and other structures

ITU-T G.657 A1/A2, Characteristics of a bending-loss insensitive single-mode optical fibre and cable

Ref. G.10 TELECOMMUNICATION REGULATORY AUTHORITY (TRA) n.d. In-Building Telecommunication Network – Specification Manual Guidelines for FTTx in new Buildings Version 2. Dubai: TRA.

G.3.5.2 Further reading

BICSI, 2020. Telecommunications Distribution Methods Manual (TDMM), 14th ed. Florida: BICSI.

BICSI, 2018. Outside Plant (OSP) Design Reference Manual (DRM), 6th ed. Florida: BICSI.

BICSI 2017. Information Technology Systems, Installation Methods Manual (ITSIMM), 7th ed. Florida: BICSI.

BICSI, 2016. Essentials of bonding and grounding, 1st ed. Florida: BICSI.

G.4 Design, erection and installation of electrical systems

G.4.1 General

Sections G.4 to G.7 outline the requirements for the design of electrical installations. They are based on the latest edition of BS 7671 and Institution of Engineering Technology (IET) documents **[Ref. G.2 and Ref. G.3]**.

11 kV medium voltage (MV) network installations shall meet the requirements of G.7. For specific requirements beyond the scope of G.7, the project shall be referred to DEWA at the concept design stage.

Sections G.4 to G.7 are not intended to:

a) take the place of a detailed specification;

b) instruct untrained persons; or

c) provide for every circumstance.

Where a situation arises that is not covered or allowed for within these sections, DEWA shall be consulted to obtain further clarity and guidance.

G.4.2 Electrical supply

The nominal electric supply voltage from DEWA (see IEC 60038) is 230/400 V ± 10%, 50 Hz, three-phase, 4-wire with separate neutral and protective conductor (generally metallic armour of the DEWA service cable). The neutral is solidly earthed at DEWA's substations and shall not be earthed elsewhere in the consumer's electrical installations. The design fault level within the substation is 40 kA (fault duration 1 s), except for fuse protected equipment/circuits.

All equipment, apparatus, materials and accessories used in electrical installations shall be designed and rated for operation on this electric supply. Overload, short-circuit and earth leakage protective devices shall be provided. Depending on the design of consumer installations, protective devices shall also be provided to protect against the following as required:

a) over voltages;

b) fluctuations;

c) transients and harmonics;

d) loss of one or more phases;

e) unforeseen interruptions.

NOTE: The earth leakage current may have a capacitive component, including that resulting from the deliberate use of capacitors.

G.4.3 Incoming supply and metering

Before commencing building design, the consumer shall obtain confirmation of the availability of a power supply from DEWA.

NOTE 1: Power supply from DEWA's network is subject to all applicable terms and conditions as issued by DEWA.

The consumer shall protect all elements of DEWA installations provided for and within the premises. Any violation, defect or damage to DEWA lines, equipment or metering shall be reported to DEWA immediately.

Where the total connected load (TCL) exceeds 400 kW, provision shall be made within the building or plot for a DEWA substation.

NOTE 2: In some circumstances a DEWA substation might be required for connected loads less than 400 kW.

Meters shall be installed to measure and record the electricity demand and consumption of the facility. All meters shall conform to DEWA specifications and be approved by DEWA.

Tariff metering shall be in accordance with G.4.5. When a building tariff meter is not present, sub meters shall be installed for each individual tenancy in the building. These submeters shall be for demand management and electricity cost allocation purposes only. Virtual meters using run-hours shall not be used as submeters.

G.4.4 Point of Supply

G.4.4.1 General

Point of supply shall be made available at one location within a plot/project, unless otherwise approved by DEWA. The point of supply defines the boundary of DEWA equipment, and shall be decided by DEWA.

The circuit breaker(s) and/or main distribution board (MDB) provided at the point of supply shall be designed and rated to suit the required application, and to conform to all applicable requirements of G.4 to G.7.

The main circuit breaker at the point of supply (see Figure G.1) shall be marked as such and shall be identifiable from other breakers for easy operation in an emergency. Where more than one incoming supply is available, in any premises, each main circuit breaker shall be marked to indicate which installation, or section of the installation, it controls.

Where a main low voltage (LV) distribution panel is connected directly to the LV side of the transformer, the main incomer circuit breaker proposed in the LV panel shall be a fully withdrawable four-pole type air circuit breaker (ACB) (see Figure G.2).

Where the consumer's main LV distribution board (DB)/panel is connected to DEWA's two or more distribution transformers, separate bus-sections with mechanically and electrically interlocked bus-section breakers/isolators (four-pole) shall be provided.

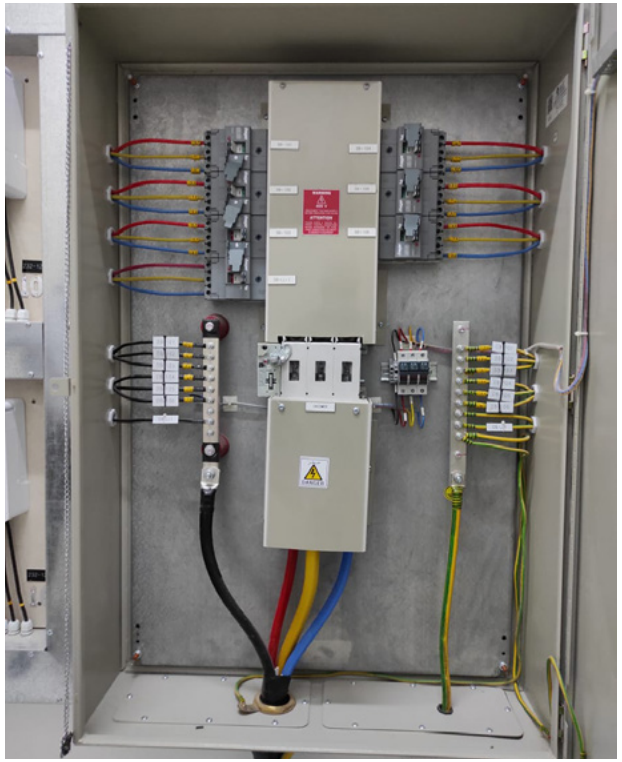


Figure G.1 Main circuit breaker

Figure G.2 Typical fully withdrawable four-pole circuit breaker

All incoming cable terminations/live connections in metering cabinets, MDBs and sub-main distribution boards (SMDBs) shall be shrouded and insulated.

All exposed live terminal connections and busbars in any LV DB shall be shrouded and/or insulated.

G.4.4.2 Switchgear locations

The main electrical switchroom shall be located near to the plot entrance, on the ground floor. Where a substation is provided within the building, the main electrical switchroom shall be provided in the ground floor area adjacent to the transformer room.

The consumer's MDBs, SMDBs and final DBs shall all be installed in locations to which access is always available. The minimum dimensions for safe access shall be in accordance with Figure G.3.

The mounting height [to the top of the board(s)] shall normally be 2 m from the ground/floor level.

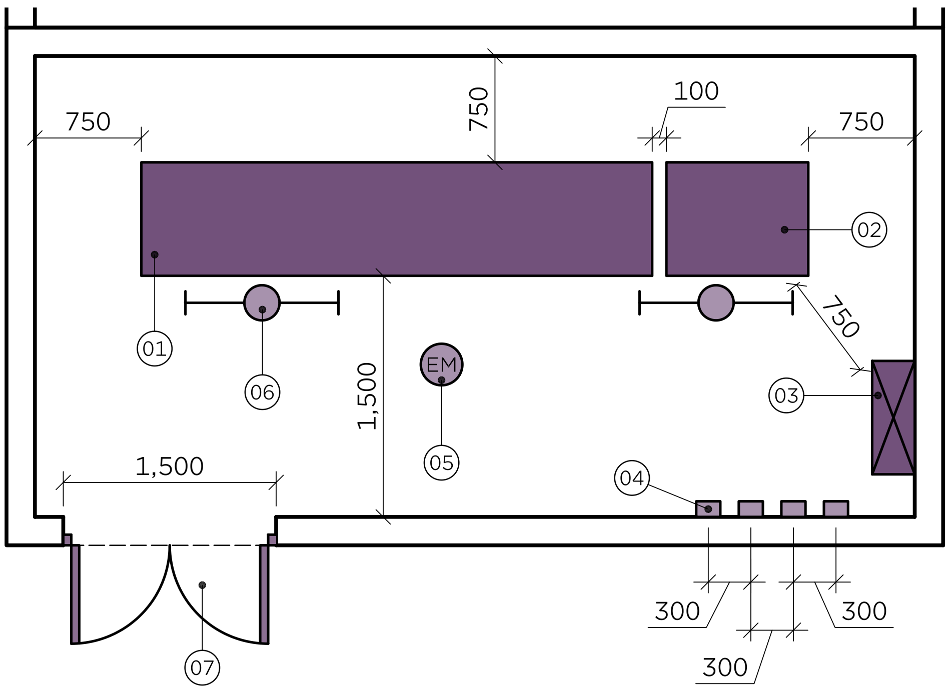
All main electrical switchrooms, and other sub-electrical switchrooms in which capacitor banks are installed, shall be air-conditioned. Non-air-conditioned electrical rooms shall be ventilated and provided with heavy duty exhaust fans and metallic louvered doors, as applicable.

As required by Table 1.9, Ch. 1 of UAE FLSC **[Ref. G.1]**, interior electrical rooms shall be separated from the rest of the building by a 2 h fire rated enclosure. If the access door to the room opens to the exterior then it can be louvered. Where the access door opens to the interior of the building it shall be 90 min fire rated without louvers.

An adequate level of illumination shall be provided to facilitate safe operation at all times. All electrical rooms shall be provided with non-maintained emergency lighting in accordance with Ch. 6 of UAE FLSC **[Ref. G.1]**.

Door openings to electrical switchrooms shall meet the following requirements.

a) The door shall open outwards in the direction of egress.
b) The opening shall be kept free from obstructions.
c) The door shall not open towards a driveway, staircases and steps, or other areas of people or traffic movement.



Key

01: LV switchboard/panel
02: Capacitor bank
03: SMDB (sample)
04: kWh meters
05: Non-maintained, minimum 3 h rated, self-contained emergency light
06: Light fitting
07: Non-combustible door in an exterior wall and 90 min fire resistance rated, non-combustible, non-louvered door in an interior wall

NOTE: The minimum clear space shown at the sides and rear of the panel is for switchboards with rear access requirements only.

Figure G.3 Layout of main electrical switchroom with one cubicle type LV switchboard/panel

A minimum illumination of 500 lux shall be provided to facilitate safe operation at all times.

Incoming supply cables to the consumer's MDB(s) shall be completely segregated and identified from the consumer's cables.

Electrical switchrooms shall not be located below or beside the following wet areas:

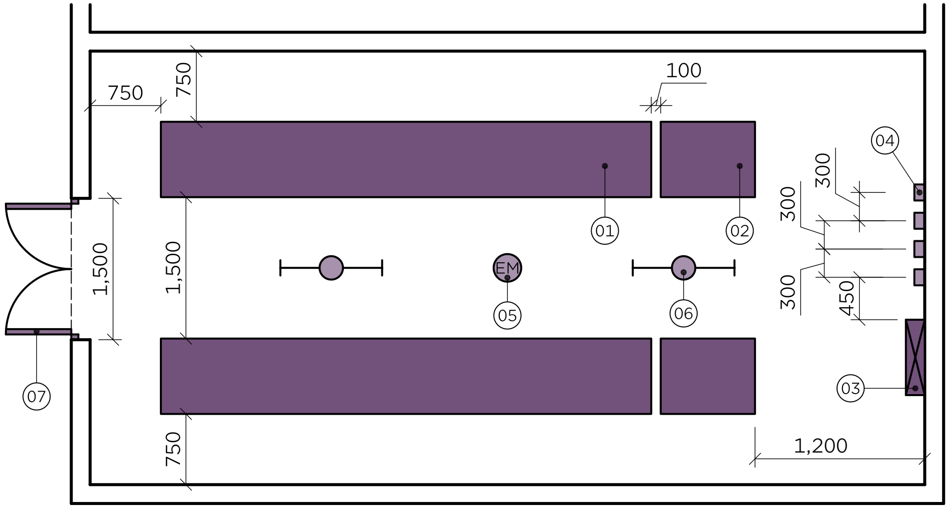
1) bathrooms;
2) toilets;
3) kitchens;
4) pantries;
5) storage tanks;
6) air conditioning chillers or other liquid/hazardous materials.

Water pipes shall not be installed within or on electrical switchroom walls.

G.4.4.3 Main electrical switchroom

The dimensional layout of electrical switchrooms shall be maintained as shown in Figure G.3 for a single LV panel, Figure G.4 for switchrooms containing two freestanding LV panels or Figure G.5 for switchrooms containing wall mounted LV panels. The electrical switchroom shall not be used for storage of any equipment, material, etc.

As required by Table 1.9, Ch. 1 of UAE FLSC [Ref. G.1], interior electrical rooms shall be separated from the rest of the building by a 2 h fire rated enclosure. If the access door to the room opens to the exterior then it can be louvered. Where the access door opens to the interior of the building it shall be 90 min fire rated without louvers.



Key
01: LV switchboard/panel
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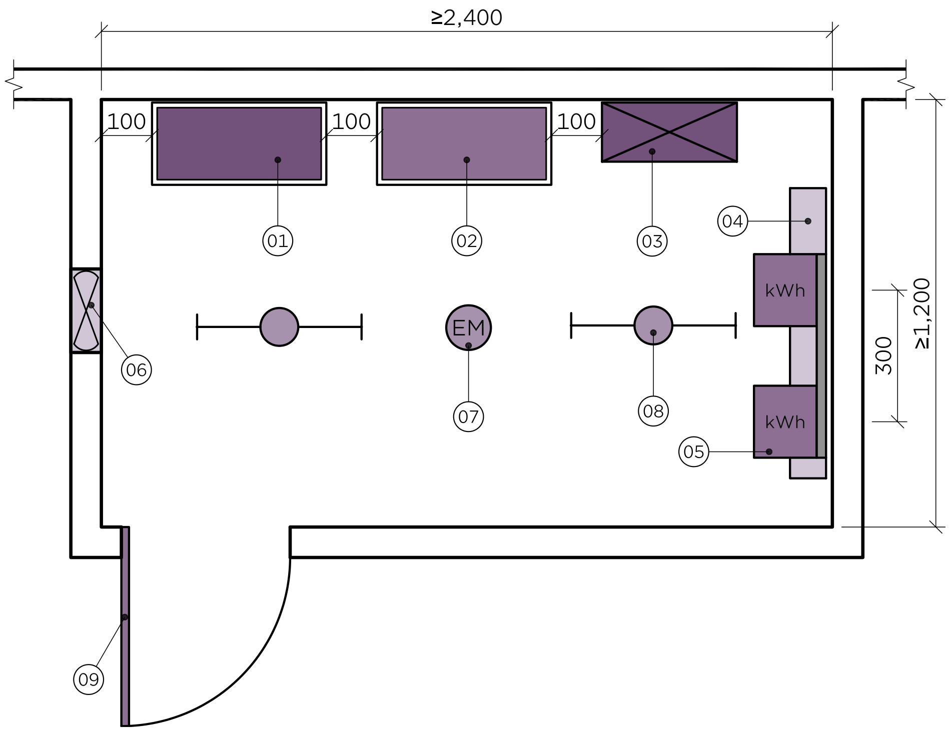
05: Non-maintained, minimum 3 h rated, self-contained emergency light
06: Light fitting
07: Non-combustible door in an exterior wall and 90 min fire resistance rated, non-combustible, non-louvered door in an interior wall

Figure G.4 Layout of main electrical switchroom with two cubicle type switchboards/panels

NOTE: The minimum clear space shown at the sides and rear of the panel is for switchboards with rear access requirements only.



Key

01: Main meter
02: MDB
03: Capacitor bank
04: PVC/GS trunking
05: kWh meters
06: Exhaust fan (for non-air conditioned room)
07: Non-maintained, minimum 3 h rated, self-contained emergency light
08: Light fitting
09: Non-combustible door in an exterior wall and 90 min fire resistance rated, non-combustible, non-louvered door in an interior wall

Figure G.5 Layout of typical electrical service room with one MDB (max. 400 A rating)

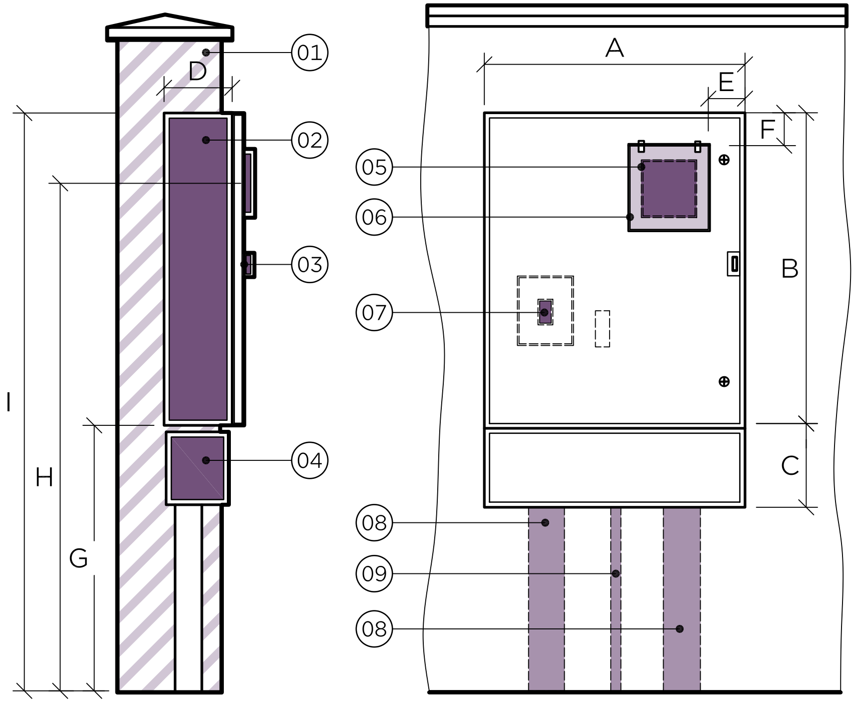
G.4.5 Tariff metering

G.4.5.1 Individual consumer premises

Individual consumer premises include villas, farms, gardens and accommodation blocks. The metering cabinet (including main incomer circuit breaker) in such premises shall be installed in the compound wall as illustrated in Figure G.6.

A minimum clearance of 2 m shall be maintained between electricity and water service cabinets/points.

For CT operated meters, VT fuses shall be sealed type, located in a sealable enclosure.



Key
01: Compound wall
02: Weatherproof (IP 55) metering cabinet
03: Hinged door with provision for wire sealing and pad locking (hole size: min. 10 mm diameter)
04: Cable (gland) box
05: Transparent meter viewing window (min. 5 mm thickness, size: 150 mm × 150 mm)
06: Protection cover with hinges on top (size: 200 mm × 200 mm)
07: Position of incomer breaker
08: 150/100 mm PVC pipe sleeve for service cable
09: Conduit/s for earthing conductors (ECC)

Type of kWh metering	Dimensions (mm)								
	A	B	C	D	E	F	G	H	I
Direct connected metering (Up to 125 A)	600	800	250	200	60	60	800 (min.)	1,600 (max.)	1,800 (max.)
CT. Operated metering (5 A meter and CT ratio up to 400/5 A)	800	1,000	300	250	80	80	800 (min.)	1,600 (max.)	1,800 (max.)

Figure G.6 Typical arrangement for tariff metering cabinet recessed within compound wall

G.4.5.2 Multiple consumer premises

Multiple consumer premises include residential/commercial buildings, industries, large utility complexes and schools. The MDBs and SMDBs, with associated metering, shall be installed in separate electrical switchrooms. Switchrooms shall be located close to the entrance boundary line. Access shall be available at all times for operation, testing, inspection, maintenance and repair.

For all buildings having a cooling load of at least 1 MW, or a gross floor area of 1,000 m^2 or greater, additional electrical submetering (of tariff class accuracy) shall be installed. The submetering shall record demand and consumption data for each energy-consuming system in the building with a load of 100 kW or greater.

All tariff metering shall be smart meters, normally provided by DEWA and restricted to one for each consumer installation, unless otherwise approved/specified by DEWA.

G.4.5.3 Metering cabinet arrangement

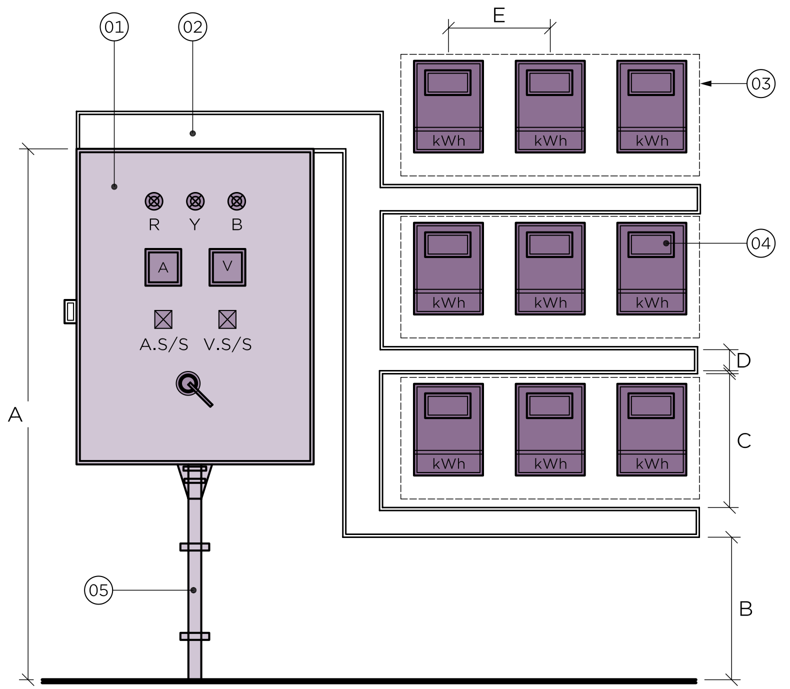
The minimum space provided for installation of a kWh meter shall be 300 mm wide and 500 mm high (see Figure G.7). A minimum space of 1,200 mm shall be provided in the front of kWh meter cabinet/meters.

The general arrangement and dimensional layout of the metering cabinets and array of meters installed in electrical switchrooms and enclosures, along with associated wiring, shall be submitted to DEWA for approval.

A minimum 2 m clearance shall be maintained between electrical and water service.

The following typical arrangements of kWh metering cabinets/kWh meters are given for guidance:

a) multi-tenant arrangements (see Figure G.7);
b) single-tenant arrangements (see Figure G.8).



Key
01: MDB/SMDB
02: PVC/GS trunking
03: Non-combustible type board/plate for fixing kWh meters
04: kWh meter
05: Supply cables

Dimensions (mm)				
A	B	C	D	E
1,800	600 (min)	500	100	300

Figure G.7 Typical multi-tenant metering arrangement

NOTE 1: Layout indicates the minimum space, maximum number of rows and arrangement of kWh meters.

NOTE 2: Earthing details, outgoing circuits and conduits terminations are not indicated.

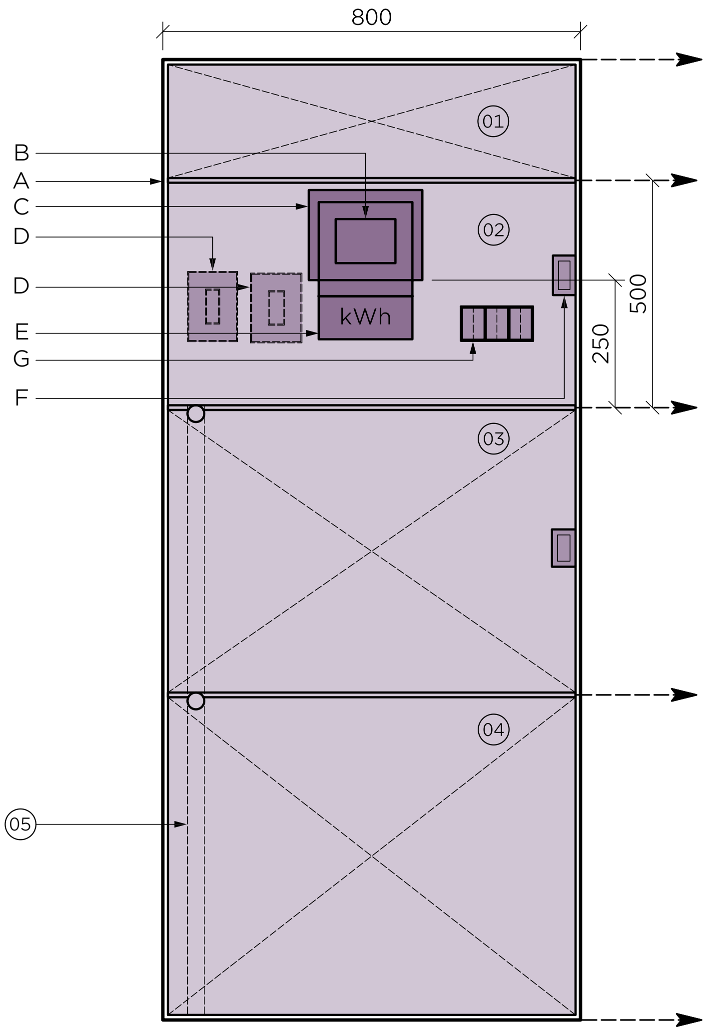


Figure G.8 Arrangement of metering in main LV panel

Key

A: CT operated, kWh metering compartment

B: Transparent viewing window for meter (size: 1.25 m × 1.25 m)

C: Protection cover with hinges on top (size: 1.5 m × 1.5 m)

D: Three sealable type VT fuse carriers in sealable enclosure for data concentrator

E: kWh meter

F: Pad locking arrangement (hole size: 10 mm diameter)

G: CT shorting terminal block in sealable enclosure (RS1 and RS2/YS1 and YS2/BS1 and BS2)

01: Load side busbars (400 mm)

02: Metering

03: Main incomer and CTs

04: Main cable terminal

05: 20 mm conduit from the kWh metering compartment to the cable trench

For CT operated meters and data concentrators, VT fuses shall be sealed type, located in a sealable enclosure.

To facilitate meter reading, a transparent viewing window shall be provided in all metering cabinets, and in doors of enclosures housing the meters with associated distribution switchgear (see Figure G.8, item B). The material used for the viewing window shall be not less than 5 mm thick. The window shall have a hinged type protection cover.

All metering cabinets and enclosures shall be constructed from non-combustible material.

When meters are installed in electrical switchrooms, fire-resistant/non-combustible base plates shall be provided. Single core PVC or XLPE insulated and PVC sheathed cables conforming to BS 6004 shall be used for connection to kWh meters.

All metering cabinets/compartments shall be provided with padlocking and wire sealing facilities on their external door/cover, which shall normally be hinged (see Figure G.9). Generally, all apparatus, circuit breakers, isolators, busbars, removable lid section of busbar - trunking, etc., installed on the supply side of any DEWA's metering shall have provision for sealing by DEWA.

Figure G.9 Typical metering cabinet padlocking and wire tag

The metering section/compartment in all MDBs and SMDBs, if and when incorporated within, shall be segregated from other sections/compartments.

For consumer premises with groups of villas, space/provision shall be made for installing DEWA feeder pillars. The location of such feeder pillars shall be finalized during estimation taking into account the cable route, cable route length, road crossing, etc.

G.4.5.4 CT metering requirements

Metering by means of current transformers (CTs) shall be installed where the circuit breaker rating at the point of supply is 160 A and above.

NOTE 1: DEWA provides the smart kWh meter(s) and associated CTs for all tariff metering. In some circumstances the consumer might be permitted to provide the kWh meter and CTs as private check meters for energy monitoring purposes.

NOTE 2: The basic data schedule for the smart metering is shown in Table G.1 and Table G.2.

The meter and CTs shown in Figure G.8 shall be tested and calibrated by DEWA prior to installation onsite.

The CTs shall be located on the busbars immediately after the circuit breaker/isolator at which the complete installation is to be metered.

Removable links of adequate length shall be provided in the busbar of each phase to enable easy maintenance and replacement of CTs.

Three CTs shall be provided for each metering.

The following CT transformation ratios shall be used:

a) 200/5;
b) 300/5;
c) 400/5;
d) 800/5;
e) 1,600/5;
f) 2,400/5.

Each CT shall have the following markings (illustrated in Figure G.10):

1) manufacturer's name and/or trademark;
2) rated primary current and secondary current;
3) rated frequency and primary maximum voltage;
4) accuracy class;
5) rated output (VA);
6) terminal (secondary winding) identification (S1, S2); and
7) power flow direction (P1, P2).

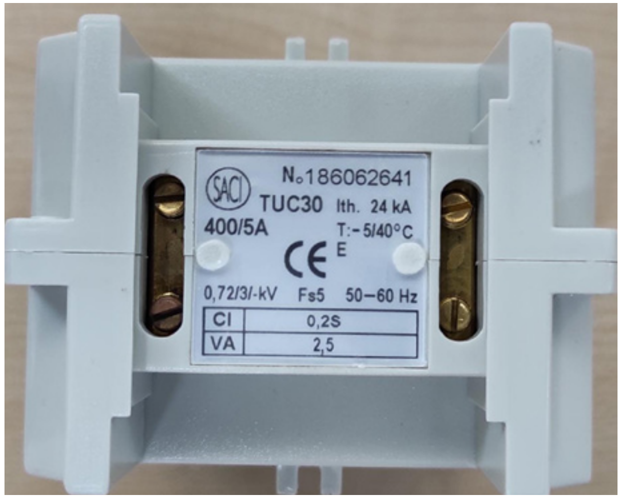


Figure G.10 Typical CT nameplate

No.	Description		Specification
1	Type of meters		Static type kWh meter
2	Reference voltages and frequency		See G.4.2
3	**Accuracy class** Meter application	System rating	
3.1	Direct metering on LV system	≤120 A	Class 1
3.2	CT metering on LV system	>125 A	0.5s
4	**Register**		
4.1	Type of register		LCD
4.2	Number of digits		8 (minimum)
4.3	Height of numerals		8 mm (minimum)
4.4	LCD screen size		80 mm × 20 mm or approved by DEWA
5	**Service conditions**		
5.1	Operating temperature range (minimum)		700 °C
5.2	Relative humidity		100%
5.3	Transport and storage temperature range (minimum)		850 °C
6	Type of communication		Modular type with detachable communication module (to choose wired or wireless communication system)
7	Meter communication ports		Optical. M-bus, RS485, etc.

Table G.1 Electricity meter specifications

No.	Description	Specification
1	Rated secondary current	5 A
2	Maximum primary voltage	600 V
3	Rated frequency	50 Hz
4	Rated primary current (only one is applicable)	200 A, 300 A, 400 A, 800 A, 1,600 A or 2,400 A
5	Rated burden	5 VA
6	Number of phases	1
7	Accuracy class CT application CT metering on LV system	
8	Medium of installation	Air
9	Size of busbars (primary) **Rated primary current** a) 200 A, 300 A b) 400 A c) 600 A, 800 A d) 1,200 A, 1,600 A e) 2,400 A	 **Busbar size** 20 mm × 10 mm 30 mm × 10 mm 50 mm × 10 mm or 2 number 30 mm × 10 mm 2 number 60 mm × 10 mm 2 number 80 mm × 10 mm

Table G.2 Current transformers (CT) specifications

G.4.6 Ambient design conditions

All equipment, apparatus, materials and accessories used in electrical installations shall be suitable for the purpose intended and capable of operating with satisfactory performance in the climatic conditions described in Table G.3.

Parameter	Condition
Altitude	Sea level (coastal)
Maximum outdoor ambient temperature (shade):	48 °C
Minimum ambient air temperature	2.8 °C
Maximum ambient air temperature	48 °C
Maximum average temperature over 24 h	37.8 °C
Maximum average over temperature one year	26.9 °C
Relative humidity	100% (max.)
Thunderstorms per year	Occasional
Earthquake loading	0.07 g
Wind speed	45 m/s at 10 m height
Ground temperature	40 °C
Soil thermal resistivity	2.0 °C/m/w at depth of 0.9 m
NOTE: Heavy condensation and sandstorms also prevail	

Table G.3 Ambient design conditions for Dubai

G.4.7 Cables and conductors

G.4.7.1 General

For general purposes and in normal situations, LSF/XLPE insulated, stranded copper conductor cables shall be used for all fixed wiring installations. The cables shall be appropriate to the building type and conform to the respective standard from the following list:

a) BS 5467;
b) BS 6004;
c) BS 6724;
d) BS 7211;
e) BS 7629-1;
f) BS 7846;
g) BS 7889;
h) BS 8436.

In certain circumstances, PVC insulated cabling may be used for general purpose installations, subject to approval by DEWA.

In flammable/explosive situations, cables shall be selected in accordance with the requirements of NFPA 70, as required by Ch. 10 of UAE FLSC [Ref. G.1].

Flexible cables and cords for use in electrical installations shall be LSF insulated and sheathed, stranded copper conductors conforming to BS 7211.

Cables for connection between ceiling rose and luminaire for pendant type light fittings and for enclosed luminaires shall be heat resistant silicone rubber insulated with stranded copper conductor conforming to BS EN 50525.

For elevators and similar applications, rubber insulated or PVC insulated flexible cables conforming to BS EN 50214 shall be used.

kWh meter tails shall normally be single core PVC insulated and sheathed cables conforming to BS 6004.

The cables used for control, relays, instrument panels, etc. shall conform to BS 6231. Single core cables armoured with steel wire or tape shall not be used for AC circuits.

G.4.7.2 Minimum size of conductors

The size of conductor used for lighting circuits shall be not less than 2.5 mm^2.

The size of conductor used for utility sockets shall be not less than 4 mm^2.

G.4.7.3 Current rating, size and voltage drop

All cables shall be sized to continuously carry the normal current of the individual circuits based on various laying conditions as applicable and the maximum ambient temperature (see BS 7769).

The cable sizes for general purpose applications should typically be not less than those given in Table G.4, Table G.5 and Table G.6.

Size of cables in concealed conduits		Max. rating of MCB/MCCB (A)	Max. load current/ demand (A)
2 × 1C, single-phase (mm^2)	3/4 × 1C, three-phase (mm^2)		
2.5	2.5	10/15	10/15
4	4	20	20
6	6	25	25
6	10	30	30
10	16	40	40
16	25	50	50
25	25	60	60
35	50	80	80
—	70	100	100
—	95	125	125
—	120	150/160	150/160

Table G.4 Typical recommended cable sizes – Single core LSF insulated, non-armoured cables, stranded copper conductors

NOTE: The following process can be used to determine which cable size to select from Table G.4, Table G.5 and Table G.6.

a) Assess initial demand with safe diversity and anticipated demand in future, if any, as applicable to individual circuits, for selection of cable size, breakers rating, etc.

b) Assess individual fault levels and select MCBs/MCCBs accordingly.

c) Refer to manufacturer's catalogues and select MCBs/MCCBs, cable sizes, etc. for specific applications, considering inductive/capacitive loads, laying conditions, voltage drop, correction factors, etc.

The voltage drop from the point of supply to any point in the wiring installation shall be not more than 4% of the nominal voltage of the electric supply, unless otherwise specified.

Size of one 3/4 C LSF/SWA/ LSF cable installed in normal situations (mm^2)	Max. rating of MCB/MCCB (A)	Max. load current/ demand (A)
2.5	10/15	10/15
4	20	20
6	30	30
10	40	40
16	50	50
25	60	60
35	80	80
50	100	100
70	125	125
65	160	160
120	180	180
150	200	200
185	250	250
240	300	300
300	350	350
400	400	400

Table G.5 Typical recommended cable sizes – Multicore armoured LSF insulated cables, copper conductors

Size of one cable installed in normal situations (mm^2)	Max. rating of MCB/MCCB (A)	Max. load current/ demand (A)
10	50	50
16	60	60
25	80	80
35	100	100
50	125	125
70	160	160
95	200	200
120	225	225
150	250	250
185	300	300
240	350	350
300	400	400

Table G.6 Typical recommended cable sizes – Multicore armoured XLPE insulated cables, copper conductors

G.4.7.4 Cable colour identification

The colour identification of insulated cable cores of unarmoured, armoured and flexible cables and of sleeve, band or disc of bare conductors shall be as indicated in Table G.7 and Table G.8.

Function	Colour identification		
Earth continuity conductor (ECC)	Green	and Yellow	
Neutral conductor in single-phase and three-phase circuits (N)	Black		
Phase conductor in single-phase circuits	Red		
	or		
	Red (R)	Yellow (Y)	Blue (B) as applicable
Phase conductor in three-phase circuits			
R-phase	Red		
Y-phase	Yellow		
B-phase	Blue		

Table G.7 Non-flexible cables and bare conductor colour identifiers

Function	Colour identification	
Live	Brown	
Neutral	Blue	
Earth	Green	and Yellow

Table G.8 Flexible cables and cores colour identifiers

G.4.8 Wiring installations exposed to high temperatures

Any part of a wiring installation (such as the individual circuit cables, final connections to equipment, appliances and light fittings) shall be rated to maintain its performance at the temperatures likely to be encountered. Heat-resistant sleeves shall be provided for individual cores and/or heat-resistant cables.

For end connections to luminaries with incandescent and halogen lamps, and fixed heating appliances, heat-resistant sleeves and cables shall be rated for a minimum operating temperature of 85 °C.

G.4.9 Wiring installations in hazardous areas

All light fittings, wiring accessories and other electrical equipment in potentially hazardous atmospheres shall be selected in accordance with BS EN 60079.

G.4.10 Load balancing

In all cases where a three-phase supply is provided to premises, the various categories of connected load (such as lighting, socket outlets, water heaters, single-phase air conditioning units, equipment, apparatus, etc.) shall be distributed and connected on red, yellow and blue phases as evenly as possible, to maintain load balance between the phases at all distribution levels.

G.4.11 Wiring accessories

G.4.11.1 Conduits and fittings

High impact rigid PVC conduits and fittings shall conform to all relevant parts of BS 4607, BS EN 60423 and BS EN 61386. They shall meet the following requirements:

a) be suitable for use at a maximum ambient temperature of 48 °C;
b) not soften or suffer structural degradation at a temperature of 70 °C;
c) be non-hygroscopic;
d) be heat-resistant.

PVC conduits shall be provided with copper/brass terminals.

Steel conduits and fittings shall conform to the relevant specifications in BS EN 60423 and BS EN 61386. They shall be hot-dip galvanized to Class 4 protection, both inside and outside.

Flexible steel conduits and fittings shall conform to BS EN 61386.

Conduit systems shall be designed and installed to exclude moisture, dust and dirt. Small drainage holes shall be provided at the lowest part of the system to avoid the accumulation of condensation.

G.4.11.2 Trunking

Where applicable, surface and underfloor (duct) trunking and their fittings shall conform to BS EN 50085. Trunking and fittings shall be constructed of steel, hot-dip galvanized both inside and outside, or non-combustible insulating material with removable covers. Installation of the trunking shall be carried out strictly in accordance with the manufacturer's guidelines.

The protective conductor shall run inside the trunking and not in parallel.

Small insulated cables shall not be installed in perforated trunking.

Additional supports shall be provided where trunking changes direction.

Earth bonding shall be provided between sections/gaps in all trunking runs and bolted connections.

G.4.11.3 Cable trays and supports

Cable trays, accessories and supports shall be either hot-dip galvanized or PVC-coated steel. Cable trays shall be either the perforated type or ladder type. They shall have sufficient strength and rigidity to support the cables installed, and be provided with upstands of dimensions sufficient to carry cables on both sides.

Cable tray systems, cable ladder systems and their fittings shall conform to BS EN 61537.

All fittings, bends, tees, elbows, couplers, etc. and supports shall be of factory-made sections and of the same quality as the trays. Cables shall be fastened securely by purpose-made clips, cleats or saddles.

Earth bonding shall be provided between sections/gaps in all cable tray runs and bolted connections.

Small insulated cables shall not be installed in perforated cable trays.

Additional supports shall be provided where cable trays change direction or cable drops out of the cable tray.

Installation shall be carried out in accordance with G.4.17.

G.4.12 Low-voltage switchgear and control gear assemblies

G.4.12.1 Main and sub main distribution boards

MDBs and SMDBs installed within the consumer installations shall be factory-built assemblies and conform to the relevant parts of BS EN 61439/ IEC 61439.

The assemblies shall be constructed of materials capable of withstanding the following when encountered in normal service:

a) mechanical stress;
b) electrical stress;
c) thermal stress;
d) the effects of humidity.

Apparatus forming part of the assembly shall have clearances, creepage distances and isolating distances conforming to BS EN 61439/IEC 61439. These distances shall be maintained during normal and relevant service conditions.

The phase busbar, neutral bar and earth bar shall be copper. They shall be colour identified as indicated in Table G.7 and Table G.8. The neutral bar shall be of the same cross-section as the phase busbar.

The circuit breakers, busbars, etc. shall be designed and rated to suit individual applications at the site conditions. Table G.9 may be used to indicate the preferred details and parameters of the equipment and components in MDBs/SMDBs for an individual application.

Parameter	Specification
I. Reference standards	BS EN 61439/IEC 61439
II. Rating of incoming supply	200 A [ ] 300 A [ ] 400 A [ ] 800 A [ ] 1600 A [ ] 2,500 A [ ]
Breaker/isolator + (+On-load)	Breaker [ ] Isolator [ ]
III. Construction	
1. Mounting	Wall [ ] Floor [ ] Pedestal [ ] ....[ ]
2. Degree of protection of the enclosure for installation	Indoor-IP41/42 [ ] Outdoor-IP54/55 [ ] ....[ ]
3. Painting/finish (internal/external)	Stove enamelled [ ] Epoxy [ ] Polyester [ ] Galvanized [ ] ....[ ]
4. Front cover (+neoprene)	Hinged [ ] Bolted [ ] Panel lock [ ] Gasketted+ [ ]

Parameter	Specification
5. kWh meter reading provision	Glass window [ ] Gasketted [ ]
6. Cable tray	Top [ ] Bottom [ ] Top and bottom [ ]
7. Ventilation	Natural via louvers [ ] Mechanical exhaust/supply [ ] ....[ ]
8. Sealing/pad locking provision	
IV. Internal layout/arrangement and fault rating	
1. Segregation of live parts: Incoming supply terminals/lugs	Barrier [ ] Shroud [ ] Firmly secured [ ] Separately mounted and removable by tool [ ]
Busbar, tap-out connections and terminals (separate and independent of each other)	Firmly secured [ ] Separately mounted and removable by tool [ ]
Neutral and earth busbars and terminals	Separately mounted with adequate working clearances/spacing from incoming supply terminals/lugs [ ]
2. Arrangement of busbars and tap-out connections to outgoing circuit breakers	Rigid, firmly secured, supported, direct and as short as possible [ ] Adequately sized [ ] Min. number of bolted joints [ ]
3. Rating/size of phase and neural busbars and terminals (at max. 50 °C ambient)	Rated for max. 70 °C internal ambient, consistent with the rated incoming supply breaker/isolator [ ] Tinned electrolytic copper [ ]

Table G.9 Specification of MDBs/SMDBs

Parameter	Specification
4. Rating of main incomer and busbars DEWA's	...................................[ ]
- Min. fault rating	40 kA [ ] ....[ ]
5. Min. and max. rating of outgoing circuit breakers	...................................[ ]
- Min. fault rating	35 kA [ ] ....[ ]
6. Provision of min. working clearance/space for incoming supply cable terminations	200 A 300 A 400 A
200 A/300 A/400 A incomers (mm) 800 A/1,600 A/2,500 A incomer (mm) Outgoing circuit cables	250 [ ] 350 [ ] 450 [ ] 750 [ ] With/without cable box [ ] Adequate [ ]
7. Provision of supports/facility for dressing/clamping outgoing circuit cables	Channels [ ] Trunking [ ] ....[ ] Max. height 2 m (From FFL) [ ]
8. Operational access/convenience for switchgear incoming supply circuit breaker/isolator outgoing circuit breaker	From outside of hinged door/bolted cover [ ] Restricted/lockable [ ]
9. Maintenance access/replacement convenience for switchgear components	Breaker [ ] CTs [ ] 4 kWh meter [ ] Gland plate [ ]
10. Provision for termination of Cu./XLPE/AWA(S.C.)	Non-ferrous glands plate [ ]

Parameter	Specification
V. Identification	
1. Rating of incoming supply and outgoing circuit breakers: (For the specified rating – refer approved single line diagram no.: ....)	Thermal [ ] Discrimination [ ] Fault [ ]
2. Type of circuit breakers: Incoming Outgoing	ACB [ ] MCCB [ ] F/S [ ] MCCB [ ] F/S [ ] C/L MCCB [ ]
3. Terminal ferrules for control/auxiliary circuits	kWh meter [ ] Indicating instruments[ ] Other...................................[ ]
VI. Earthing	Compliance with G.4.19..................... [ ]
1. Rating/size of earth busbar and terminals	Adequate, consistent with the min. fault rating specified under IV.4 and IV.5 [ ] Adequate no. and size to terminate main and circuits ECCs [ ]
2. Earthing of conductive parts	Enclosure [ ] Hinged door [ ] Cable glands [ ]
3. Termination of ECCs	Copper lugs [ ]
VII. Metering	Compliance with G.4.5.................. [ ]
1. Standard indicating instruments	Volt meter with selector switch [ ] Power factor (PF) meter [ ] Ammeter [ ] Current transformers [ ] Indicating lamps [ ]
2. kWh meters/CTs	Tested and calibrated in DEWA [ ]

Table G.9 Specification of MDBs/SMDBs (continued)

Parameter	Specification
3. Wiring/connections of CT meter	“Load” side of Incoming supply breaker [ ]
4. Protection of CT meter wiring (Allow six spare fuse cartridges in the MDB)	Current coil [ ] Voltage coil [ ] “Sealed” type fuse [ ] Heat resistant/High voltage grade [ ]
5. Mounting height from FFL	Max. 2 m. [ ] Min. 0.8 m. [ ]
6. Mounting (if door/cover mounted)	Hinged door mounted [ ]
7. CTs for tariff metering	Exclusive [ ] Accuracy class 0.2S [ ] Matching ratio [ ]
VIII. Tests/Certification	
1. Type test 2. Routine tests and checks: Visual checks; Screwed/bolted connections; Operational checks; Dielectric test.	As specified by the Consultants/Owner [ ] Certificate for review/reference [ ] Compliance with specifications [ ] Tightness [ ] Mechanical/Electrical [ ] 2,500/2,125 V (85%) [ ]

Table G.9 Specification of MDBs/SMDBs (continued)

The following shall be provided in MDBs with a rating of 200 A or more, and may be provided in SMDBs if appropriate:

a) voltmeter (with R-Y-B “OFF” selector switch);
b) ammeter (with CTs as applicable);
c) maximum demand indicator/recorder;
d) PF meter;
e) indicating lamps;
f) associated protective devices.

The switchgear, equipment and accessories shall conform to the following standards as applicable:

1) BS EN 60670;
2) BS EN 60898-1;
3) BS EN 60947;
4) BS EN 61439;
5) IEC 61439.

G.4.12.2 Final distribution boards

DBs installed for connection of the final circuits within electrical installations shall be factory-built conforming to BS EN 61439/IEC 61439. An integral isolator shall be provided for isolation of the incoming supply.

The circuit breaker accessories shall conform to the standards as specified by the project designer(s).

Rewireable type fuses shall not be used in any wiring installation. Table G.10 may be used to indicate the preferred details and parameters of the equipment and components in final DBs for an individual application.

Parameter	Specification
I. Reference standards	BS EN 61439, BS EN 60947, IEC 61439
II. Rating of incoming supply	40 A [ ] 60 A [ ] 100 A [ ] 125 A [ ] .... [ ]
(+On-load)	Breaker [ ] Isolator [ ]
III. Construction	
1. Mounting	Wall [ ] Pedestal [ ] Surface [ ] Recessed [ ]
2. Degree of protection of the enclosure for installation	Indoor-IP41/42 [ ] Outdoor-IP54/55 [ ] ....[ ]
3. Painting/Finish (internal/external)	Stove enamelled [ ] Epoxy [ ] Polyester [ ] Galvanized [ ] ....[ ]
4. Front cover (+neoprene)	Hinged [ ] Bolted [ ] Panel lock [ ] Gasketted+ [ ]
5. Cable tray/conduit entry	Top [ ] Bottom [ ] Top and bottom [ ]
6. Assembly	Factory assembled [ ] ....[ ]
IV. Internal layout/arrangement and fault training	
1. Segregation of live parts: Incoming supply terminals/lugs	Barrier [ ] Shroud [ ] Firmly secured [ ] Separately mounted and removable by tool [ ]
Busbar, tap-out connections and terminals (Separate and independent of each other)	Barrier [ ] Firmly secured [ ] Separately mounted and removable by tool [ ]
Neutral and earth busbars and terminals	Separately mounted with adequate working clearances/spacing from incoming supply terminals/lugs [ ] and outgoing terminals of MCBs/FS [ ]
2. Arrangement of busbars and tap-out connections to outgoing circuit breakers/neutral busbars	Segregated for each: Group of MCBs/TP ways [ ] ELCB Section [ ] Rigid, firmly secured, supported, direct and as short as possible [ ] Adequately sized [ ] Min. number of bolted joints [ ] Min. number of looped connections [ ]

Table G.10 Specification of DBs

Parameter	Specification
3. Rating/size of phase and neural busbars and terminals (at max. 50 °C ambient)	Rated for max. 70 °C internal ambient, consistent with the rated incoming supply breaker/isolator [ ] Tinned electrolytic copper [ ] ....[ ]
4. Min. fault rating of circuit breakers	6 kA (as per designed downstream short-circuit current) [ ]
5. Provision of supports/facility for dressing clamping outgoing circuit cables	Channels [ ] Trunking [ ] .... [ ]
6. Operational access/convenience for switchgear. Incoming supply circuit breaker/isolator Outgoing circuit breakers	Max. height 1.8 m (from FFL) [ ] From outside of hinged door/bolted cover [ ] Restricted/lockable [ ]
7. Maintenance access/replacement convenience for switchgear components	Breaker(s) [ ] Isolators [ ] ELCB/s [ ] UV relays [ ]
8. Provision for termination of PVC/SWA/PVC/XLPE/SWA/PVC cables	Gland plate [ ] Cable gland [ ]
9. ELCBs/RCCBs	Window air conditioning [ ] Split air conditioning [ ] Lighting [ ] Small power [ ] Others..................... [ ]
10. UV Relays with auto-reset timer	Window air conditioning [ ] Split air conditioning [ ] Others.................... [ ]

Parameter	Specification
V. Identification	
1. Rating of incoming supply and outgoing circuit breakers: (For details of the rating specified – refer to approved SLD/distribution schedules)	Thermal [ ] Fault [ ] Discrimination [ ]
Type of circuit breakers: Incoming Outgoing C/L- Current Limit	Isolator [ ] MCCB [ ] C/L MCCB [ ] C/L MCCB [ ] F/S [ ] C/L [ ] For general loads, Type 1/L[ ] For motor load, Type 2/G [ ]
2. Colour codes for internal, main circuits wiring: Phase Neutral Earth	 Red/yellow/blue [ ] Black [ ] Green and yellow [ ]
3. Terminal ferrules for control/auxiliary circuits	Indicating instruments [ ] Others..................... [ ]
4. Permanent labels, engraved, “Traffolite” or similar	Board designation [ ] Controls [ ] Circuit designation [ ] Indications [ ] Warning notice(s) [ ] ELCB/UV relay section [ ]

Table G.10 Specification of DBs (continued)

Parameter	Specification
VI. Earthing	Compliance with G.4.19.................... [ ]
1. Rating/size of earth busbar and terminals	Adequate, consistent with the min. fault rating specified under IV.4 [ ] Adequate no. and size to terminate main and circuits ECCs [ ]
2. Earthing of conductive parts:	Enclosure [ ] Hinged door [ ] Cable glands [ ]
3. Termination of ECCs	Copper lugs [ ]
VII. Tests/certification	
1. Type test 2. Routine tests and checks: Visual checks Screwed/bolted connections; Operational checks Dielectric test	As specified by the Consultants/Owner [ ] Certificate for review/reference [ ] Compliance with specifications [ ] Tightness [ ] Mechanical/electrical [ ] 2,500/2,125 V (85%) [ ]

Table G.10 Specification of DBs (continued)

G.4.13 Apparatus and accessories

G.4.13.1 Switches

Switches provided for local isolation of electric supply to individual apparatus and/or circuits shall conform to BS EN 60669. The rating of the switches shall be selected based on individual applications, such as for resistive or inductive loads. The current rating shall be not less than 5 A.

Switches shall be metal clad when used within industrial installations.

Switches installed for control of discharge lighting shall have a minimum current rating that is twice the steady state continuous current of the circuits.

For large groups of lighting, a gang switch shall be provided with phase barrier inside the switch boxes.

For outdoor locations, switches with weather protection classified as IP55 in accordance with BS EN 60529 shall be used.

For areas with a high risk of fire or explosion, gas sealed switches conforming to BS EN 60079 shall be used.

For appliances rated 20 A and above, and where visual indication of the presence of power is desired, a DP switch with neon indicator shall be provided.

G.4.13.2 Plugs and socket outlets

Single-phase plugs and socket outlets used in domestic and commercial installations shall conform to BS 1363. The socket outlets shall be of the type illustrated in Figure G.11.

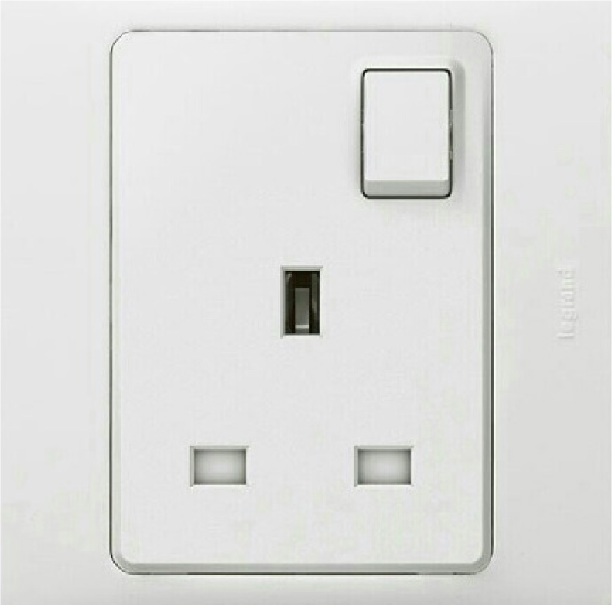


Figure G.11 Typical 3-pin flat, double-pole, shuttered, switched single socket

15 A plugs and socket outlets used in domestic and commercial installations shall conform to BS 546.

Shaver socket outlets shall conform to:

a) BS EN 61558 in bathrooms; and
b) BS 4573 in rooms other than bathrooms.

In hotel rooms, 5 A plugs and socket outlets for table lamps which are switched from a dedicated lighting circuit shall conform to BS 546.

Industrial plugs and socket outlets shall conform to BS EN 60309. They shall feature a switch that is integrally built in or attached to them. The rating and type of socket outlets with plugs shall be selected to suit individual applications and shall not be interchangeable for different current ratings.

Weather protected type (classified as IP55 in accordance with BS EN 60529) socket outlets shall be used for outdoor applications.

G.4.13.3 Arc fault detection devices (AFDDs)

Additional protection to mitigate the risk of fire due to arcing is recommended in certain applications. AFDDs protect against series and parallel arcing by detecting low-level hazardous arcing that circuit breakers, fuses and RCDs are not designed to detect.

AFDDs shall be selected in accordance with BS EN 62606. An AFDD shall be placed at the origin of the circuit to be protected.

AFDDs are available in the following types:

a) one single device, comprising an AFD unit and opening means, intended to be connected in series with a suitable short-circuit protective device declared by the manufacturer as conforming to one or more of the following standards:
   1) BS EN 60898-1;
   2) BS EN 61009-1; or
   3) BS EN 60269 series;
b) one single device, comprising an AFD unit integrated in a protective device conforming to one or more of the following standards:
   1) BS EN 60898-1;
   2) BS EN 61008-1;
   3) BS EN 61009-1; or
   4) BS EN 62423;
c) an AFD unit (add-on module) and a declared protective device, intended to be assembled onsite.

Examples of where such devices can be used include:

1) premises with sleeping accommodation;
2) locations with a risk of fire due to the nature of processed or stored materials;
3) locations with combustible construction materials;
4) structures having fire propagating features; and
5) locations with endangered or irreplaceable objects (such as museums, libraries, art galleries).

G.4.13.4 Surge protection devices (SPDs)

Surge protection devices shall be implemented on electrical distribution systems within new buildings. SPDs shall have the necessary capability to deal with the current levels and durations involved at the point of installation.

For the protection of AC power circuits, SPDs are allocated a type number. The number corresponds to a test class from the BS EN 61643 series as follows, and as illustrated in Figure G.12:

a) type 1 – only used where there is a risk of direct lightning current and typically used at the origin of an installation;

b) type 2 – used at DBs;

c) type 3 – used at or near equipment.

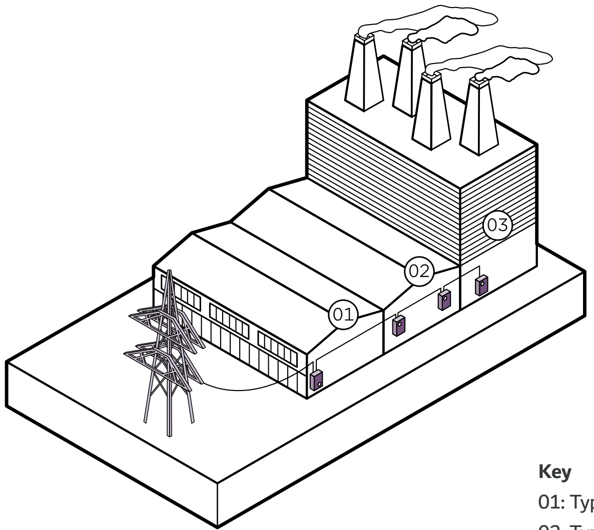


Figure G.12 SPD installation location based on type

Key
01: Type 1 Main switchboard
02: Type 2 Sub distribution
03: Type 3 Final equipment

G.4.13.5 Cooker control units

All stationary cooking appliances in domestic premises shall have a cooker control switch. The switch shall conform to BS 4177 and be located separately from the appliance (see Figure G.13). The cooking appliance shall incorporate an integral earthing terminal.

The cooker control switch shall be two-pole (for a single-phase appliance) or four-pole (for a three-phase appliance). It shall be connected to a separate final sub-circuit from the DB, through a 100 mA ELCB.

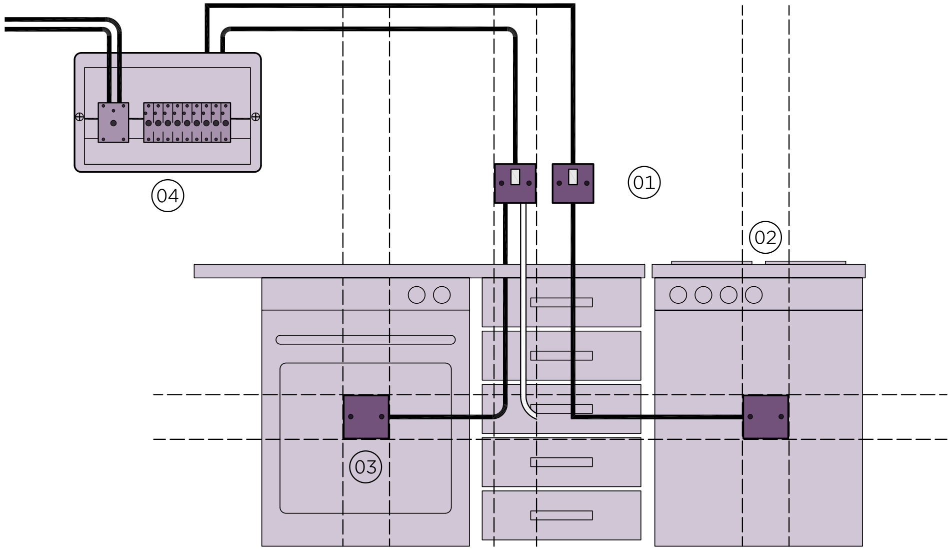


Figure G.13 Cooker control unit installed within 2 m of appliance (© Institution of Engineering and Technology. Figure based on Figure 4.4 in Institution of Engineering and Technology, 2018. Electrician's guide to the building regulations **[Ref. G.2]**)

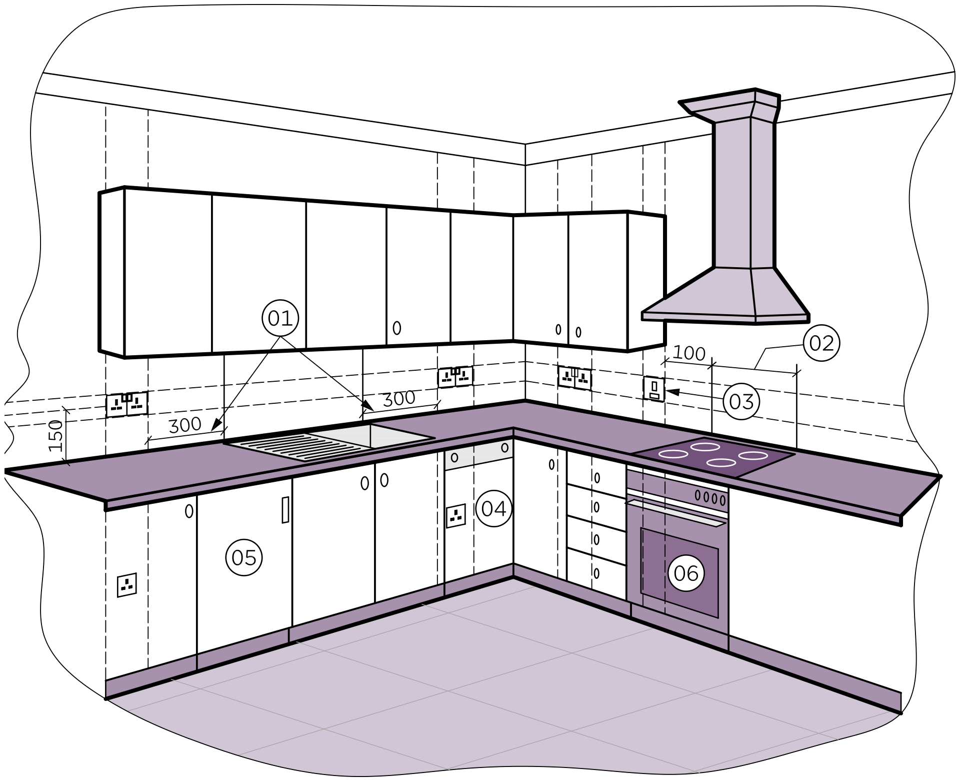
Key
01: Control switch to be located within 2 m from controlled appliance
02: Electric hob
03: Electric oven
04: Consumer unit

Cooker control units incorporating a general purpose socket outlet shall be avoided, to allow grouping of general socket outlets in a separate 30 mA RCD/ELCB section.

The breaker rating and wire size shall be selected to be compatible with the connected load of the appliance.

G.4.13.6 Kitchen appliances

Electrical appliances used in consumer installations (such as water heaters, cookers, hot plates, etc.) shall generally conform to BS EN 60335. Figure G.14 illustrates the typical setting out details of a kitchen.



Key

01: No sockets within 300 mm of edge of sink

02: No sockets or accessories above gas or electric hobs

03: Cooker switch

04: Dishwasher

05: Fridge

06: 150 vs 250 Cooker connection

Figure G.14 Cooker and kitchen typical installation setting out details (© Institution of Engineering and Technology. Figure based on Figure 5.2.2 in Institution of Engineering and Technology, 2018. Electrician's guide to the building regulations **[Ref. G.2]**)

G.4.13.7 Control of water heaters, saunas, Jacuzzis and washing machines

Double-pole switches with neon indicator shall be provided, appropriately rated for control of the equipment. The final connection to the equipment shall be made from a flex outlet plate. The plate shall be mounted adjacent to the equipment.

For water heaters installed in a bathroom or water closet, the control switch shall be installed immediately outside the room. For saunas and Jacuzzis, the control gear shall be placed outside the sauna room/cabin.

Water heaters, saunas, Jacuzzis and washing machines shall be connected to a separate final sub-circuit from the DB.

Water heaters shall incorporate an integral earthing terminal adjacent to the phase and neutral terminals. All terminals shall be housed in a suitable recess with a splash proof removable cover. Every heater circuit shall be protected by a 30 mA RCCB/ELCB.

G.4.13.8 Control of air conditioning unit/ equipment

Window-type room air conditioners with a maximum cooling capacity of 1.5 kW shall be connected by a 15 A switched socket outlet. For other room air-conditioning units, a double-pole switch of appropriate rating, with flex outlet, shall be provided and mounted adjacent to the unit.

Each room air-conditioning unit shall be connected to a separate final sub-circuit from the DB.

A maximum of two window-type air-conditioning units are permitted to connect on a single-phase supply. Where three or more window-type units are installed, they shall be balanced as evenly as possible over a three-phase supply.

The breaker rating and wire size shall be selected based on the connected load of the air conditioning unit, subject to minimum 20 A with 4 mm^2 circuit wires.

G.4.13.9 Extra LV safety apparatus

Extra LV safety apparatus includes:

a) electric buzzers and bells;
b) mirror lights and shaver socket outlets in bathrooms;
c) light fittings for underwater installations.

Extra-LV safety apparatus shall incorporate an appropriately rated double wound safety isolation transformer. The transformer shall either be integral or mounted separately. A cartridge fuse or MCB shall be incorporated in the secondary circuit. The safety isolation transformer shall conform to BS EN 61558. Segregation of LV and extra-LV circuits shall be in accordance with G.4.18.4.

G.4.13.10 HV discharge lighting equipment

HV discharge lighting equipment and installations shall conform to BS 559. They shall be rated for voltages not exceeding 5 kV, RMS to earth, measured on open circuit.

HV discharge lighting equipment, including neon signs, shall not be installed without prior approval from DEWA.

G.4.13.11 Electric motors and starters

Control of electric motors shall conform to BS EN 60204 where the equipment is within the scope of the standard.

All motors shall be protected against overload, short-circuit and earth leakage. They shall also be protected against voltage fluctuations and the loss of one or more phases, as necessary for the individual application.

Every motor having a rating exceeding 0.37 kW shall be provided with control equipment incorporating means of protection against overload of the motor.

Only the installation of single-phase motors rated up to 3.7 kW, and three-phase motors up to 110 kW, is permitted, unless otherwise approved by DEWA.

Where multiple motors above 110 kW are proposed, the advice of DEWA shall be sought on obtaining a bulk supply.

Starters shall be provided with overload relays of the thermal type. Relays shall have automatic compensation for variations in ambient temperature between 28 °C and 48 °C.

Starting equipment to limit current shall consist of any of the following:

a) adjustable speed drive;
b) intelligent controllers;
c) another type of device approved by DEWA.

All motors shall be provided with an isolator, to isolate the motor from the supply during inspection and maintenance. The isolator shall interrupt the supply on all phases. The isolator may be integral with the control gear or separate but shall be in close proximity to the motor. The control gear shall incorporate emergency stop pushbutton(s).

When motor starting gear is energized from an auxiliary circuit, the auxiliary circuit shall also be isolated during inspection and maintenance.

All starters, isolators and pushbuttons (see Figure G.15) shall be clearly marked in Arabic and English stating which machine they control and their function. To avoid confusion, the words “START” and “STOP” shall be used (and not “OPEN” and “CLOSED”).

Figure G.15 Push buttons

Motors and their control gear shall be located in well ventilated areas with adequate space for operation, inspection and maintenance.

G.4.14 Standby generators

Standby safety power provision shall be made for all projects and premises in the category of touristic, commercial and cultural, that require dedicated transformer and LV panel supplies. These include, but are not limited to:

a) shopping malls and shopping centres;
b) hotel buildings;
c) amusement and theme parks;
d) museums;
e) major exhibition halls;
f) hospitals;
g) main government buildings.

NOTE 1: For new and existing buildings, the following are considered to be essential services/loads.

a) separate main and/or sub-main LV panel;
b) in-house standby generator(s) of sufficient capacity for 100% backup, with auto-changeover functionality (ATS).

The following loads shall be served by standby generators:

1) elevators, escalators, security systems, CCTV, alarm systems, BMS systems, stairways, entrances, control rooms, data centres, electrical rooms, generator rooms, etc.;
2) minimum 20% of lighting installations in the landlord areas (corridors, public lobbies, assembly points, reception, underground parking, etc.).

NOTE 2: For new buildings, the following are considered to be non-essential services/loads:

a) additional ACB(s) as incomer with auto-changeover facility (motorized ACB operation) to connect to external mobile generator for all non-essential LV panels;
b) access for transportation and stationing of the mobile generators, intake arrangements for cabling and connections, identification labels and notices for connection of the generator during emergencies.

NOTE 3: The requirements listed above are for the standby provision of electrical power under unforeseen power interruptions only. Emergency and standby power requirements of fire and life safety systems are covered in Ch. 6 to Ch.10 of UAE FLSC **[Ref. G.1]**. Emergency generators for operational continuity can be shared with those required by UAE FLSC provided that the shared generator(s) meets the requirements of both codes.

Generator rooms shall be 2 h fire rated to conform to Table 1.9, Ch. 1 of UAE FLSC **[Ref. G.1]**. Exterior walls do not need to be fire rated unless there is a risk of exterior fire spread and the wall is fire rated in accordance with Ch. 1 of UAE FLSC **[Ref. G.1]**. Louvers in fire rated walls are not permitted without opening protection.

NOTE 4: Installing and connecting standby generators in the consumer’s installation to maintain power supply in the event of mains failure is permitted only with prior approval from DEWA.

NOTE 5: The changeover circuit breaker or isolator should have four poles for three-phase supply and two poles for single-phase supply. This ensures that the phases and neutral of the two systems remain separate and distinct.

NOTE 6: The installation should be carried out in such a way that there is no possibility of paralleling generator supply with DEWA supply.

NOTE 7: Adequate mechanical and electrical interlock should be provided between the incomer circuit breakers or isolators of both the generator and DEWA supplies. Full details of the equipment, including details of the essential loads, and circuit and wiring diagrams, should be submitted to DEWA for approval before commencement of the works.

NOTE 8: Provision for connecting a mobile generator with incomer rating 2,500 A/1,600 A, to maintain power supply in the event of mains failure, should be included in the MDB/LV panel. The circuit breaker should be a four-pole type. Adequate mechanical and electrical interlock should be provided between the incomer circuit breakers of both the mobile generator and DEWA supply.

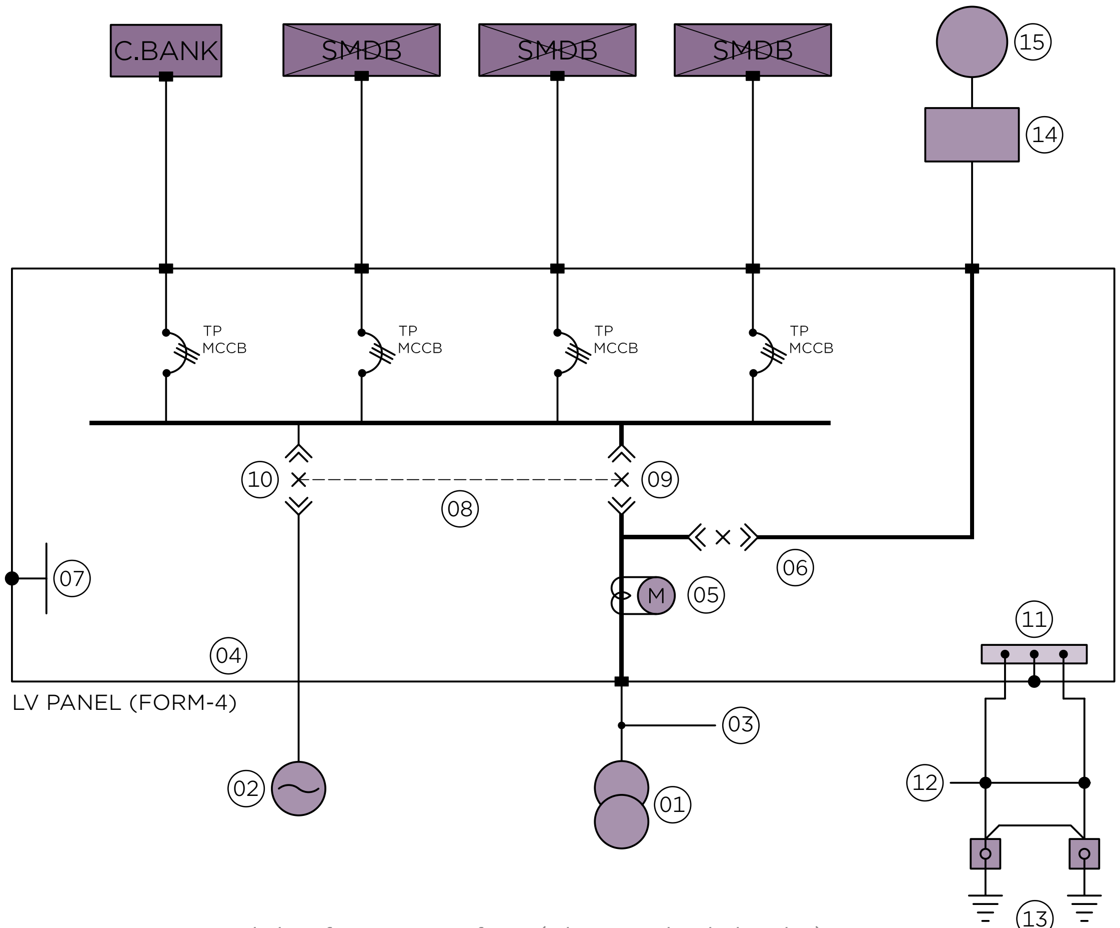
NOTE 9: The location of main electrical room should be near to the front entrance/approach road and sleeves are to be provided for intake generator cables. This provision is not mandatory for the main LV panel connected with standby generator in auto/manual changeover mode.

G.4.15 Power to fire pumps

Table 9.3, Ch. 9 of UAE FLSC **[Ref. G.1]** requires a direct power supply from the utility company to the main electric fire pump and jockey pump via a dedicated DB located inside the pump room.

NOTE: It is the responsibility of the consumer to provide this arrangement at the main LV panel.

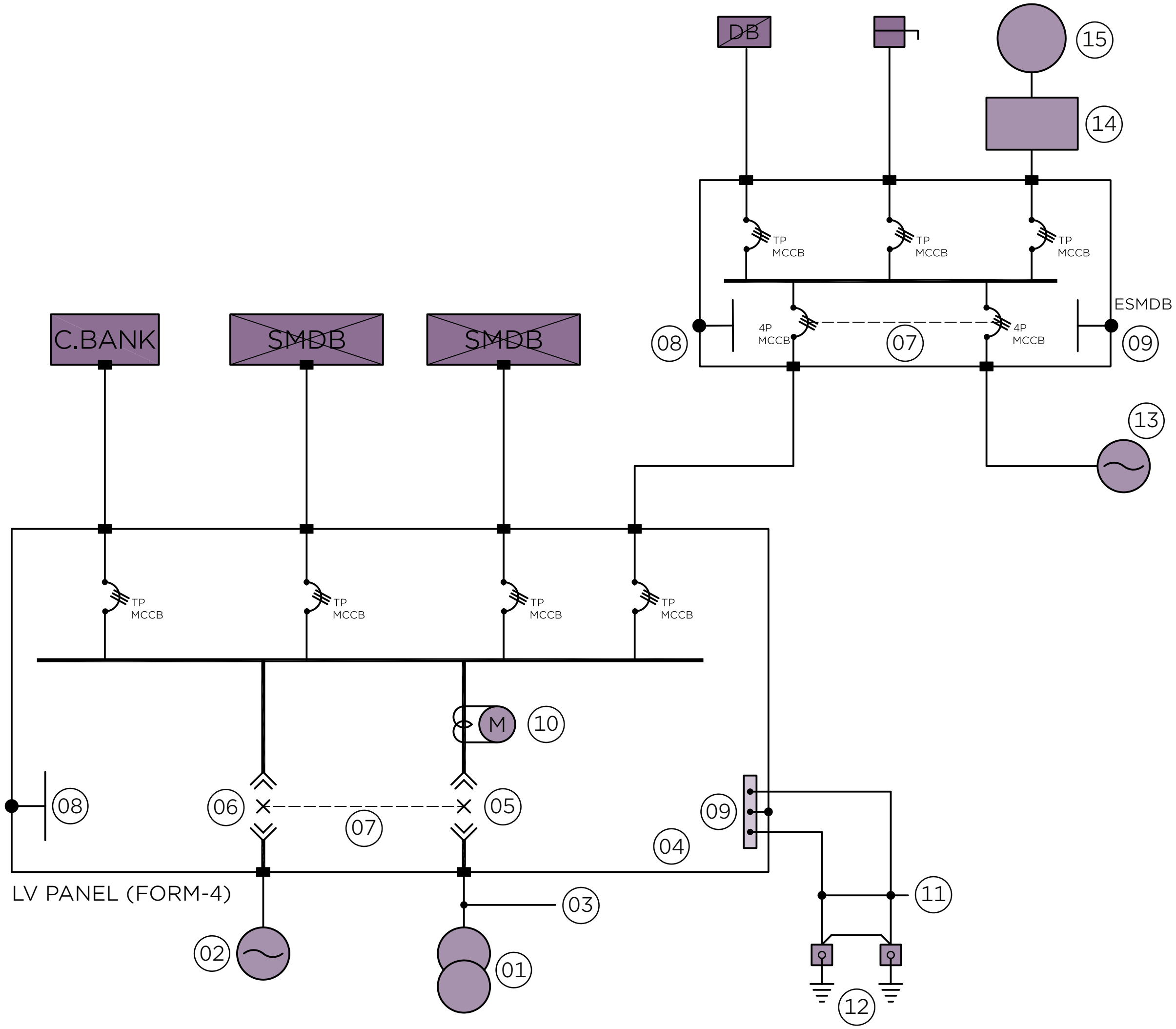
There are three possible options which are acceptable to both DCD and DEWA for providing power supplies to main electric fire pump and jockey pump. These are shown in Figure G.16, Figure G.17 and Figure G.18.



Key

01: DEWA transformer
02: Stand by generator
03: DEWA supply cable
04: LV Panel (Form – 4)
05: Check meter
06: Fire pump ACB – 4P
07: Neutral bar
08: Electro – mechanical interlock - 4P
09: DEWA incomer ACB – 4P
10: Stand by generator incomer ACB – 4P
11: Earth bar
12: Minimum 6 m apart
13: Earth pits
14: Fire pump control panel
15: Fire pump

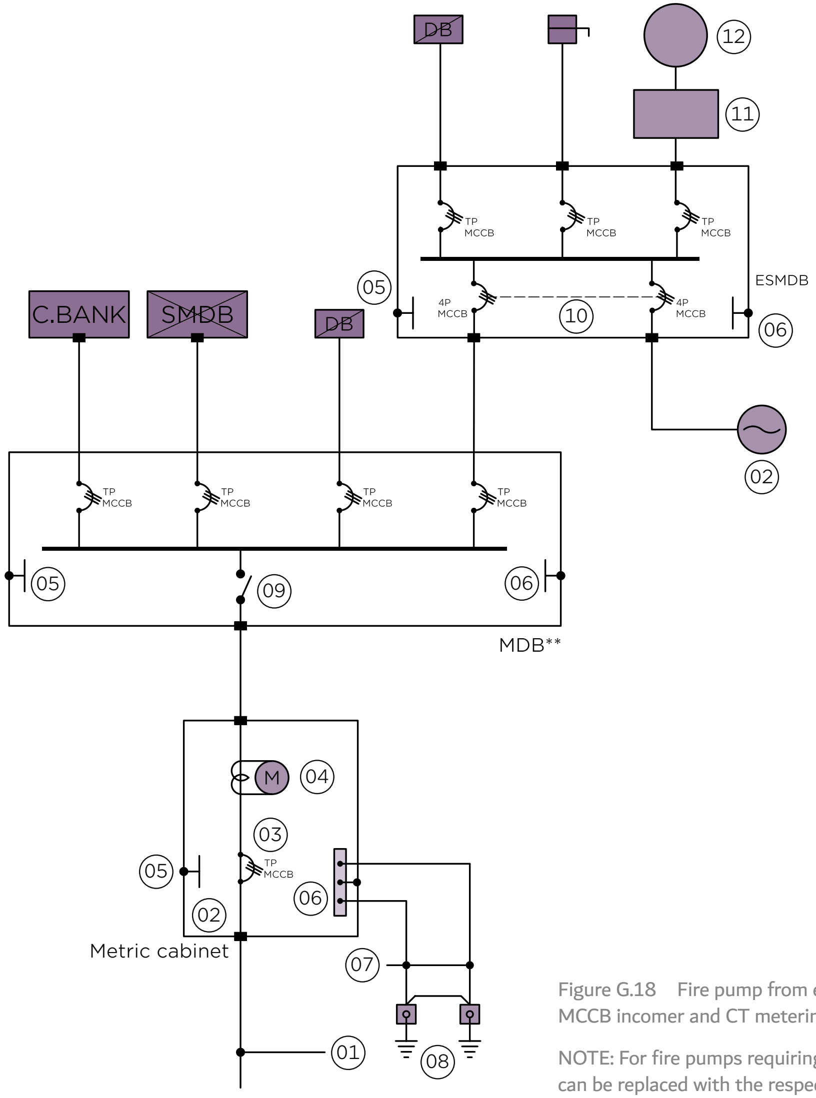
Figure G.16 Fire pump supply direct from DEWA transformer (substation within plot boundary)



Key

01: DEWA transformer
02: Mobile generator
03: DEWA supply cable
04: LV panel (Form – 4)
05: DEWA incomer ACB – 4P
06: Mobile generator incomer ACB – 4P
07: Electro – mechanical interlock – 4P
08: Neutral bar
09: Earth bar
10: Check meter
11: Minimum 6 m apart
12: Earth pits
13: Stand by generator
14: Fire pump control panel
15: Fire pump

Figure G.17 Fire pump supply from essential panel/MDB (substation within plot boundary)



Key

01: DEWA supply cable
02: Metering cabinet
03: Main incomer MCCB
04: kWh meter
05: Neutral bar
06: Earth bar
07: Minimum 6 m apart
08: Earth pits
09: Three-pole isolator
10: Electro-mechanical interlock – 4P
11: Fire pump control panel
12: Fire pump

Figure G.18 Fire pump from essential panel/MDB (external DEWA feeder with MCCB incomer and CT metering)

NOTE: For fire pumps requiring 300A or 400A direct feeder connections, the MDB can be replaced with the respective fire pump panel.

G.4.16 Assessment of connected load and maximum demand

G.4.16.1 Lighting and small power circuits

All lighting and fan circuits shall be installed as follows:

a) maximum load per circuit of 2,000 W;
b) minimum circuit wire/EEC size of 2.5 mm^2 LSF copper, with maximum circuit breaker protection of 16 A.

If light fixtures are not selected at design stage, a minimum of 100 W shall be used for each normal lighting and fan point. Fluorescent lamps shall be assessed as 1.8 times the lamp wattage.

Wherever fittings with discharge light, compact fluorescent lamps or low-volt lamps are installed, the circuit breaker rating, circuit conductor sizes and number of fittings shall be selected based on the actual load, including losses, for the specific application. Prior approval from DEWA shall be obtained for every installation.

A radial final sub-circuit shall be installed to serve a maximum of five 13 A switched socket outlets in rooms other than the kitchen. It shall be controlled by a 20 A circuit breaker in the DB. A maximum of ten socket outlets in rooms other than the kitchen shall be connected to a ring circuit, controlled by a 30 A circuit breaker.

A current demand of 13 A shall be assumed for each 13 A switched socket outlet circuit. A minimum of 200 W per point shall be used for calculation purposes for each 13 A switched socket outlet, installed for general utility purpose, other than the kitchen. All twin socket outlets shall be taken to be as two separate socket outlet points. Kitchen area might need separate circuits.

A current demand of 15 A shall be assumed for each 15 A switched socket outlet circuit. However, for general purpose utility socket outlets, an assumed load of 1,000 W per socket outlet installed in commercial and industrial premises, and 500 W per socket outlet in residential premises, is permitted.

For stationary appliances and equipment, including air conditioners, the actual load of each appliance and equipment shall be taken to be a connected load.

The current demand of specific equipment such as an electric clock, and other current-using equipment with a maximum rating of 5 VA, may be omitted from the assessment of load.

For multi-consumer installations, including commercial premises such as shops, showrooms, garages and workshops, where provision for connection of additional load might be required, the assumed connected load of additional spaces/circuits shall also be indicated in the load distribution schedules submitted for DEWA's approval (see G.4.16.2).

G.4.16.2 Maximum demand

All DBs shall be rated for the TCL before a demand factor is applied.

The demand load of each final sub-circuit is determined by adding the actual or assumed load of individual points/appliance/equipment, whichever is higher. An allowance for diversity shall be applied where appropriate.

The details of load distribution schedules shall be submitted for DEWA's approval in the format identified in Table G.11 to Table G.14.

The TCL of individual distribution levels/circuits shall be in accordance with G.4.7 to G.4.16. An appropriate demand factor worked out by a qualified electrical Engineer is permitted, to determine the maximum demand at the main or sub-main distribution level. Demand factor is equal to or less than one.

DETAILS OF CONNECTED LOAD, MAX. DEMAND & kWh METERING

PROJECT: **BUILDING/ ________** **OWNER:** **AREA:**

PLANNED COMPLETION DATE: **CONSULTANT:** **PLOT NO.:**

LVP/MDB/SMDB ______ (OF) _______________ **LOCATION OF LVP/MDB:**

CIRCUIT/ FEEDER SMDB/DB NO.	1-PH/ 3-PH	ACB/ MCCB/ ISOLATOR RATING (A)	FAULT DUTY kA	CABLE SIZE, TYPE AND NO. OF CORES			ECC SIZE 1C, mm^2	LENGTH OF CABLE (m)	CONNECTED LOAD (KW)			TOTAL CONNECTED /INSTALLED LOAD (TCL) * kW	MAX. DEMAND/ OPERATIONAL LOAD (MDL) * kW	PROPOSED TYPE & NO. OF kWh METERS			REMARKS
				NO. OF CORES 1C/2C/ 4C	TYPE XLPE/ PVC/ SWA	SIZE			R-PH kW	Y-PH kW	B-PH kW			1-PH (1)	3-PH (2)	* LV/ HV CT (3)	
Incomer:																	
Outgoing:																	
MDB CONNECTED TO: DEWA LV/DB TRANSFORMER SMDB CONNECTED TO: MDB.....						TOTAL CONNECTED LOAD PER PHASE:											TOTAL:
DEMAND FACTOR:			MAX. DEMAND: ______ kW				* OVERALL TOTAL CONNECTED/INSTALLED LOAD (TCL): __________kW							TOTAL BUILT-UP AREA:			

CONSULTANT/CONTRACTOR: TEL: FAX:

* TCL - shall include all loads proposed to be installed including standby, spare and future load provisions..
Type of meter (rating of incomer): (1) Up to 60 A (2) Up to 125 A (3) LV CT ... / ... A /HV CT ... / ... A (* 200/5 Amps CT metering)

(1)Phase	(3)Phase

Table G.11 Typical details of connected load, maximum demand and kWh metering schedule

LOAD DISTRIBUTION SCHEDULE (1-Phase)																										
PROJECT:			**BUILDING/______**										**LOCATION OF DB:__________**													
DB No.:																										
FED FROM:		**MDB/SMDB ________/ METER ENCLOSURE**																								
RATING OF INCOMER	RATING OF ELCB	SL. No.	CIR. No.	MCB RTG. IN AMPS	CCT WIRE SIZE mm^2	ECC WIRE SIZE mm^2	ROOM/AREA	CONNECTED LOADS/ POINTS														WATT/UNIT	LOAD PER CIRCUIT - WATT			REMARKS
								LTG	C. FAN	EX. FAN	SH. S/O	13 A S/O	W/H	H/D	COOKER	15 A S/O	'W' A/C	'S' A/C	WAT. PUMP				R	Y	B	
		1	C1																							
		2	C2																							
		3	C3																							
		4	C4																							
		5	C5																							
		6	C6																							
		7	C7																							
		8	C8																							
		9	C9																							
																						TOTAL				
CABLE SIZE: 1x 2/3/4C...				mm^2 Cu. PVC/XLPE/SWA/PVC +1 X 1C,....							mm^2 Cu. PVC, ECC				c. fan = ceiling fan, ex. fan = exhaust fan, sh. s/o = shaver socket - outlet											
OR																										
CABLE SIZE: 2 x 1C...				mm^2 Cu. PVC +1 X 1C,....							mm^2 Cu. PVC, ECC				w/h = water heater, h/d = Hair Dryer, 'w' = window type & 's' = split type											

Table G.12 Typical load distribution schedule

TYPICAL CONNECTED LOAD/POINTS SCHEDULE

LOCATION OF DB:

LOAD: **SCHEDULE:**

RATING OF INCOMER	RATING OF ELCB	SL. No.	CIR. No.	MCB RTG IN AMPS	CCT WIRE SIZE mm²	ECC WIRE SIZE mm²	ROOM/AREA	CONNECTED LOADS/ POINTS												WATT/UNIT	LOAD CIRCUIT			REMARKS
								LTG	C_FAN	EX_FAN	SH_S/O	13A S.S/O	W/H	H/D	COOKER	15A S/O	'W' A/C	'S' A/C	WAT_PUMP		R	Y	B	
		1	R1																					
		2	Y1																					
		3	B1																					
		4	R2																					
		5	Y2																					
		6	B2																					
		7	R3																					
		8	Y3																					
		9	B3																					
		10	R4																					
		11	Y4																					
		12	B4																					
		13	R5																					
		14	Y5																					
		15	B5																					
		16	R6																					
		17	Y6																					
		18	B6																					
																				TOTAL				

CABLE	+1X	mm² Cu, G/Y PVC, ECC	C_	Fan,	Socket
OR					
CABLE	X 1C,	mm² Cu, G/Y PVC, ECC	W/H	=	Split

Table G.13 Typical connected load/points schedule

DETAILS OF MAXIMUM CURRENT ON TRANSFORMER WITH CHILLER/MOTOR LOADS							
PROJECT:		**OWNER:**		**PLOT NUMBER:**		**AREA:**	
LV Panel No.:		**Rating:**					
Sr. No.	Type of load (chiller, motor, etc.)	kW	No. of compressors per chiller	Starting current of one compressor/ motor	Full load current with all compressors/motors running + other loads (A)	Max. current when largest compressor starts + all other compressors/ motors and other loads running (A)	Remarks (model no., make, type of starter, etc.)
Total							

Table G.14 Typical details of maximum current on transformer with chiller/motor loads

Table G.15 gives the maximum demand permitted at an MDB connected to DEWA's supply feeder/transformer for the distribution of normal residential and commercial premises without connecting large motor loads.

Item	Feeder/transformer rating (A)	Load (kW)
1	60 A – feeder	30
2	100 A – feeder	50
3	125 A – feeder	60
4	160 A – feeder	80
5	200 A – feeder	100
6	300 A – feeder	150
7	400 A – feeder	200
8	1,000 kVA transformer	800
9	1,500 kVA transformer	1,200

Table G.15 Limit of maximum demand loads

DEWA transformers supplying motors and air conditioners (maximum individual loads not exceeding 100 kW) shall be limited to the connected loads given in Table G.16.

Item	Transformer rating (kVA)	Load (kW)
1	1,500 kVA transformer	950
2	1,000 kVA transformer	650

Table G.16 Limit of maximum demand air conditioning loads

Where DEWA transformers supply motors and air conditioners whose individual loads exceed 100 kW, the maximum TCL shall be subject to approval by DEWA.

To ensure the safety of the transformers and the equipment, approval takes into account the equipment's technical specification, including:

a) the rating;
b) the type of starters;
c) the maximum starting current;
d) the number of compressors/motors; and
e) its stages of operation.

The overload protective device/incomer circuit breaker in the LV panels/MDBs shall be set at the corresponding design current.

Other methods of establishing maximum demand are permitted, where calculated by a qualified electrical Engineer with a suitable degree of knowledge and experience of the diverse applications of a particular installation. The design method and proposed diversity at each level of the distribution shall be submitted to DEWA for approval. They shall also be clearly indicated in the design drawings and schedules submitted to DEWA.

G.4.17 Design criteria for the installation of conduits, trunking, trays and accessories

G.4.17.1 Trunking and conduits

Trunking and conduits shall be selected to meet the requirements of G.4.11.

As far as possible, trunking and conduit runs from electrical switchrooms to individual consumer DBs shall be routed only within common electrical service routes and riser ducts.

Long trunking and conduit runs from electrical switchrooms located on the ground floor to consumer DBs located on upper floors shall not be installed unless unavoidable. Where armoured cables are used, they shall be installed in cable trays.

Cable trunking may be used for housing single core LSF cables where the installation of conduits is difficult due to space limitations.

Surface exposed trunking and conduit installations shall, as far as possible, have straight runs with branches at right angles only.

Draw-in boxes shall be provided in all straight conduit runs exceeding 15 m. Conduit runs having 90º bends shall be provided with draw-in boxes for every two bends.

Trunking and conduit shall be completely installed before any cable is drawn in.

Draw-wires shall be provided in all concealed conduits (and ducts) with the ends left free at the outlet boxes for pulling the wiring cables. Permitted cable routes for concealed cables are illustrated in Figure G.19.

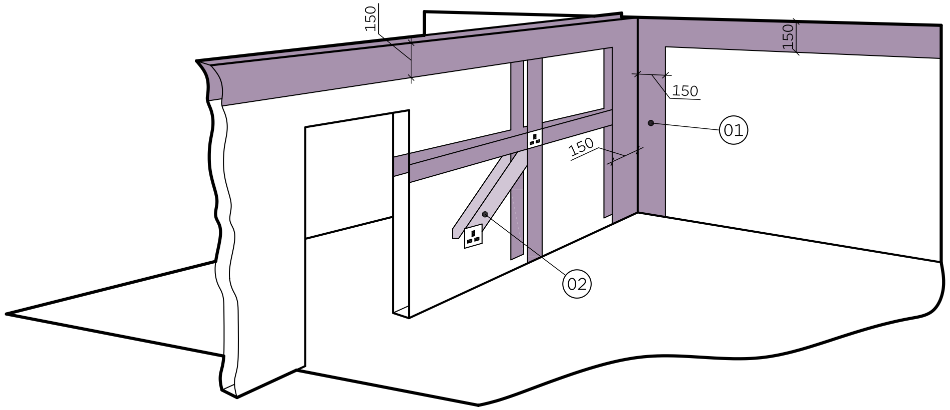


Figure G.19 Permitted cable routes for concealed cables within walls with a depth of less than 50 mm depth. (© Institution of Engineering and Technology. Figure based on Figure 2.3.3 in Institution of Engineering and Technology, 2018. Electrician's guide to the building regulations **[Ref. G.2]**)

Key

01: No protection needed

02: Protection required unless depth greater than 50 mm

All the trunking and conduit runs shall be free from sharp edges and burrs throughout their lengths. Suitable grommets and bushes shall be provided at the terminal outlets.

Trunking and conduit runs shall be supported at regular intervals (see Table G.17 to Table G.19).

Method of installation	Spacing of support (mm)	
	Steel	Rigid PVC
Horizontal	1,500	1,000
Vertical	1,800	1,200

Table G.17 Trunking – Maximum spacing of clips, cleats, saddles or supports

Method of installation	Spacing of support (mm)	
	Steel	Rigid PVC
Horizontal	1,200	1,000
Vertical	1,500	1,200

Table G.18 Conduit – Maximum spacing of clips, cleats, saddles or supports

Method of installation	Spacing of support (mm)	
	Overall diameter 20 mm to 40 mm	Overall diameter >40 mm
Horizontal	350	600
Vertical	600	800

Table G.19 Armoured cables – Maximum spacing of clips, cleats, saddles or supports

Entries to trunking shall be placed to prevent the ingress of water and all dead ends shall be closed. Only unbroken lengths of trunking shall be used for crossing partitions and walls.

Where cable trunking passes through walls, floors or other barriers, it shall be provided with a continuous cover.

Where cable trunking penetrates fire resistance rated floors, walls, partitions or ceilings, the openings remaining after passage of the trunking systems shall be sealed with an approved fire stopping system in accordance with Section 3, Ch. 1 of UAE FLSC **[Ref. G.1]**.

The trunking shall be provided with separate compartments for the different types of circuits in the following situations:

a) where a common cable trunking is used for housing both power and communication circuits; or

b) for housing circuits operating at different voltages.

All bends, tees and other accessories of cable trunking shall be of substantial sections and of the same quality as the trunking itself.

The different sections of trunking shall be bonded by copper links. Trunking shall not be used as ECC.

The minimum internal radius of any bend or elbow fitting in a conduit shall be 2.5 times the diameter of the conduit, as shown in Figure G.20.

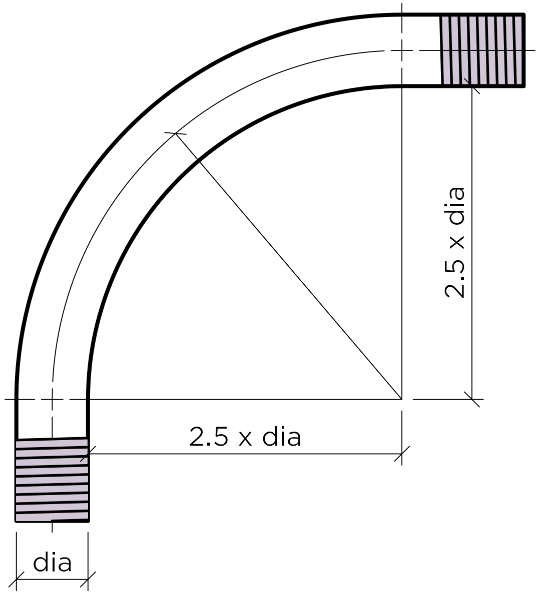


Figure G.20 Minimum internal radius of conduit elbow fitting

All terminal and intermediate ends of PVC conduits shall be firmly secured with suitable adhesives as recommended by the manufacturer.

Circuit wires shall be bunched and installed in vertical trunking runs. They shall be clamped/secured within the trunking at regular intervals not exceeding 2 m, and at the terminal ends.

Standard conduit boxes, draw-in boxes and mounting boxes of light fittings and appliances shall be fixed to the building structure independently of the wiring conduits.

All exposed threads, tool-marks or visible damage to the protective finish of the steel trunking and conduits shall be coated with zinc rich paint immediately after installation.

Suitable expansion couplers shall be provided in all trunking and conduit runs at the expansion joints in the building structure. They shall also be provided at regular intervals in all runs exceeding 7 m in length or as recommended by the manufacturer.

Suitable purpose-made boxes with adaptors, ceiling roses, etc. shall be provided at all individual outlet points of the wiring installations.

Light fittings used to house tungsten filament and halogen lamps shall be segregated protected by PVC sheathing and terminal outlet boxes such as to prevent degradation due to the associated high temperatures.

Conduit runs concealed within the building structure shall be provided with not less than 10 mm of screed cover.

When the trunking and conduit runs are installed with chases in the building structure, they shall be firmly fixed at regular intervals in accordance with the manufacturer's recommendations, using purpose-made crimpers and/or saddles.

The standard conduit boxes, draw-in boxes, floor-outlet boxes, etc. shall be installed with the cover/lid flush with the outer finish of the building structure (see BS 4662, BS 5733, BS EN 61535).

Only flush type switches, socket outlets and accessories shall be used for concealed wiring.

Where conduit and or conduit fittings are attached to equipment, smooth bore male brass brushes and flanged coupling shall be used.

Except where provision is made for fastening, conduits shall be saddled to the structure of the building in accordance with the following:

1) within 150 mm of each terminal angle box, bend or other conduit fittings;
2) at maximum intervals of 1.5 m from couplings and through fittings.

Through type draw boxes shall be counted as part of a straight run conduit.

Non-metallic conduits shall not be used in the following locations and circumstances:

i) where the conduit is exposed to outside ambient temperatures;
ii) where the conduit is at risk of being affected by chemicals which cause deterioration in its construction;
iii) plant rooms;
iv) elevator motor rooms;
v) elevator shafts.

All conduit accessories shall be factory-made sections and of the same quality as the conduit itself.

G.4.17.2 Flexible conduits

Flexible conduits shall not be used for complete fixed wiring installations. They shall only be used as and where permitted.

A flexible conduit run shall be not more than 2.5 m in length.

Metallic flexible conduits may be used for connecting electrical motors and other equipment to the fixed wiring, subject to adjustment of position and vibration.

Flexible conduits shall only be run exposed and shall be so positioned that they are not susceptible to mechanical damage. Wherever necessary, flexible conduits shall be supported in accordance with the manufacturer's recommendations.

The end of flexible conduits shall be securely anchored to the fixed conduit or equipment to which it is attached. Approved flexible conduit adaptors shall be used that maintain effective mechanical continuity without distorting the conduit.

Flexible conduit shall not be used as part of the earth conductor. A separate earth conductor shall be installed to meet the same requirements for rigid conduit installation.

G.4.17.3 Cable trays

Trays for supporting cables shall be used in warehouses, industrial plant and equipment rooms, cable trenches, shafts in buildings, etc.

The type and material of the cable trays shall be selected to suit individual site locations and shall meet the relevant requirements specified in G.4.11.

The cable trays shall be supported at regular intervals with purpose-made supports (see Table G.19).

Cable trays installed in outdoor locations and in locations where cables are exposed to the sun shall be provided with sun-shade covers. Covers shall be secured to the trays, and adequate ventilation provided, in accordance with the manufacturer's instructions.

Cables shall be fastened securely by purpose-made clips, cleats or saddles and spaced as shown in Table G.19.

Cable ties shall not be used to support multicore cables installed on cable trays that are fitted vertically.

Cable trays shall not be used in locations where they are likely to be subjected to severe physical damage.

Sufficient space shall be provided and maintained around cable trays to permit access for installing and maintaining the cables without causing unnecessary damage. Vertical clearance above the tray shall be not less than 1.5 times the height of the tray, or as given in the cable and cable tray manufacturer's recommendations.

Cable trays shall be installed as complete systems with bends and other accessories. Each run of cable trays shall be completed before the installation of cables. All sharp edges, burrs and projection shall be removed, and the tray shall be finished smooth to prevent injury to cables.

Metallic cable trays shall be bonded together using copper links, but shall not be used as an ECC.

Cable trays shall be installed in such a way as to provide ease of access to cables through the route.

Where cable trays penetrate fire rated floors, walls, partitions or ceilings, the openings remaining after passage of the wiring systems shall be sealed with an approved fire stopping system in accordance with Section 3, Ch. 1 of UAE FLSC [Ref. G.1].

G.4.18 Design criteria for the installation of cables, equipment, accessories and wiring systems

G.4.18.1 Armoured cables

Armoured cables shall be installed in one of the following ways:

a) directly buried in the ground;
b) drawn through ducts;
c) laid in concrete trenches;
d) cleated to a wall;
e) mounted on cable trays.

Cables shall be installed and used in association with other equipment in accordance with BS 7671. In environments or installations not described within the DBC, the appropriate regulations and standards shall be observed.

The current-carrying capacity of cables shall be determined after applying suitable correction factors based on the installation method of the cables.

Cables shall be selected ensuring voltage drops within the limit described in G.4.7.3.

Only armoured cables shall be used for underground installations. Precautions shall be taken to avoid mechanical damage to the cables before and during installation. Cables shall be laid as shown in Figure G.21. Where protective covers are required, they shall be centred over the cables, throughout their length.

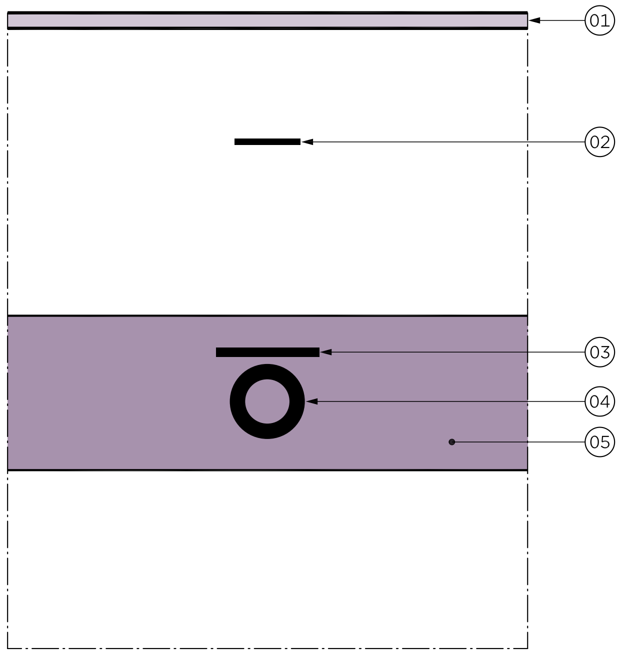


Figure G.21 Typical armoured cable installation below ground

Key
01: Ground
02: Warning tape at 300 mm below ground
03: 50 mm overlap on either side
04: Armoured cable at 900 mm below ground
05: 150 mm impervious soil layer

Where cables pass underneath driveways or roads, PVC-U ducts shall be provided with heavy duty (HD) manhole covers.

Cable routes shall be marked by cable route markers/marking tape, placed at maximum intervals of 10 m along straight runs and 2 m at deviations. Route markers shall indicate the voltage level in Arabic and English, as shown in Figure G.22.

Figure G.22 Typical cable route marker (DEWA)

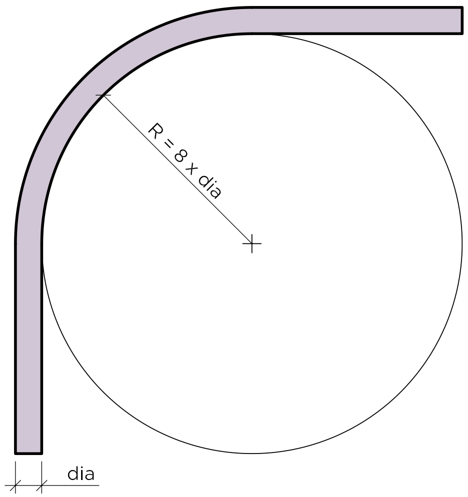


Figure G.23 Cable bending radius

Heavy duty conduit shall be provided for motor connections, external applications and locations subject to vibration, risk of mechanical damage or exposure to moisture.

Cables shall be installed on cable trays at specific locations and as stipulated in G.4.11.

In the event of crossing or proximity of underground telecommunication cables and underground power cables, a minimum vertical clearance of 100 mm shall be maintained.

For cables in fixed wiring installations, the internal radius of the bend shall be not less than eight times the cable diameter (see Figure G.23).

No joints shall be included in any cable runs in the consumer's fixed wiring installation.

Where busways penetrate fire rated floors, walls, partitions or ceilings, the openings remaining after passage of the wiring systems shall be sealed with an approved fire stopping system in accordance with Section 3, Ch. 1 of UAE FLSC **[Ref. G.1]**.

Cable glands used for armoured cables shall be of brass compression type, conforming to BS 6121, with earth tags and PVC shroud.

All terminations of cable conductors shall be mechanically and electrically sound. Terminations shall be made using a terminal or compression type socket/lug, approved by DEWA. Terminations shall not impose any mechanical strain on the terminal or socket/lug.

Separate ECCs shall be installed and terminated for each feeder/circuit, as specified in G.4.19.

Single core cable shall be arranged in trefoil formation. Non-ferrous cable gland plate shall be used for termination of single core armoured cables.
The armour shall be earthed.

No cables shall run in an elevator or hoist shaft unless the cables are part of the elevator/hoist installation.

G.4.18.2 Distribution boards

All DBs shall be installed in locations which are accessible at all times for operation, testing, inspection, maintenance and repair.

MDBs, SMDBs or final DBs shall not be installed in the following locations:

a) bathrooms and toilets;
b) damp or wet locations;
c) bedrooms;
d) kitchens;
e) above sinks;
f) store rooms;
g) rooms with an ambient temperature exceeding the ambient design conditions of the equipment;
h) dangerous or hazardous locations;
i) below any staircase.

All MDBs, SMDBs or final DBs shall be selected and designed in accordance with G.4.12.

DBs shall incorporate means for isolation of mains supply in the form of either a circuit breaker or an incomer isolator, as applicable.

Every circuit breaker or fuse within the DB shall be identified and labelled to indicate the apparatus or circuit it controls. Table G.12 and Table G.13 show typical single-phase and three-phase DB schedules.

Each final DB shall supply only the circuits in the floor area where the DB is located, as shown in Figure G.24, except for applications such as staircase and common corridor lighting in high-rise buildings.

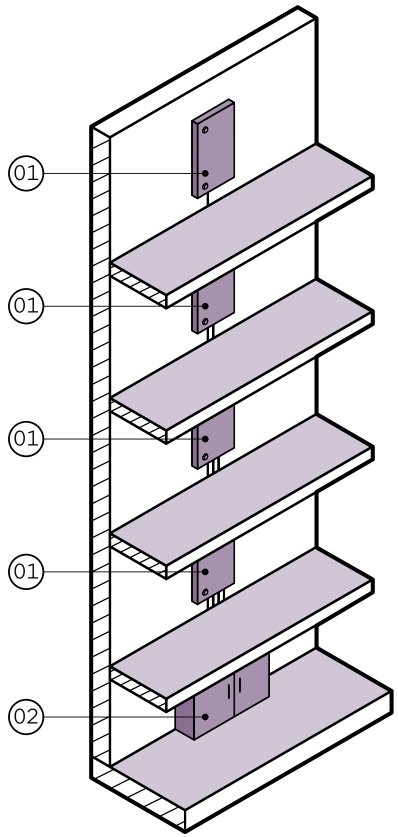


Figure G.24 Indicative electrical distribution diagram

In multi-consumer installations, each consumer's DBs shall be installed within the respective consumer's premises (e.g. retail unit, apartments, etc.) and shall be near to the entrance of the premises.

Incoming supply cable installed to any DB shall be segregated and identified from the outgoing circuit cables/wiring.

All DBs shall be installed flush or surface mounted at a maximum height of 2 m to the top of the DB as shown in Figure G.25.

All LV panels of 1,600 A and above shall be of form 4 type.

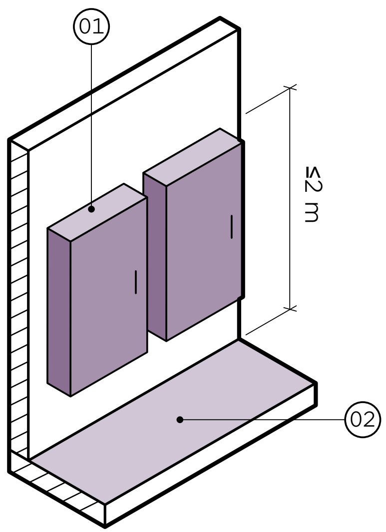


Figure G.25 Maximum DB mounting height diagram

G.4.18.3 Busbar trunking systems (busways/bus risers)

Busways shall be installed only where adequate access is available for inspection and repair throughout their entire length.

The design, manufacture, testing and performance of the busbar trunking system shall be in accordance with BS EN 61439. The IP rating shall be selected based on the location, as described in BS EN 60529.

Each piece of busbar trunking shall be subject to the following factory tests:

a) 3.5 kV dielectric test for 4 s;
b) 1,000 V Megger test in accordance with BS 7671.

Test certificates for these tests shall be produced during DEWA inspection.

The busbars shall be totally enclosed in an unventilated, low impedance sandwich design. The busbar trunking shall be sandwiched throughout its entire length and shall not be flared at tap-points.

Onsite, each piece and run of busbar trunking shall be Megger tested at 1,000 V before and after installation.

Busbar risers proposed for installation in high-rise buildings shall be designed in such a way as to ensure reliability of power supply. In the event of outage of the respective busbar riser, not more than 12 floors shall be interrupted.

Connections to switchgear shall have flanged end units of specific design and shall be manufactured by the busbar trunking manufacturer.

The busbar trunking shall be aligned and securely fixed at centres of not more than 1.5 m or as recommended by the manufacturer. The busbar trunking manufacturer shall supply galvanized fixing brackets, comprising hanger clamp, fixing channel and damping screw, as means of support to take the weight of the busbar. Additional supports shall be provided where required and as recommended by the trunking manufacturer.

The complete busbar trunking system shall be of the type, size and location indicated in the DEWA approved drawings.

The busbar shall carry its rated current without exceeding 55 ºC (or an ambient temperature of 50 ºC at 90% relative humidity) in any plane without de-rating and without affecting the DEWA power supply requirements.

Where a busbar trunking system is installed on the supply side of any DEWA kWh metering, provision for sealing by DEWA shall be made as specified in G.4.5.

The phase busbar, neutral bar and earth bar shall be of copper, identified by colour as given in Table G.8. The neutral bar shall be of the same cross-section as the phase busbar.

ECCs and equipotential bonding shall be provided as specified in G.4.19.

Where the busway passes through fire rated floors, walls, partitions or ceilings, the openings remaining after passage of the wiring systems shall be sealed with an approved fire stopping system in accordance with Section 3, Ch. 1 of UAE FLSC [Ref. G.1].

Tap-off units installed in a busbar riser at each floor level shall be at the height shown in Figure G.26. The tap-off units shall have adequate access for operation, maintenance and replacement.

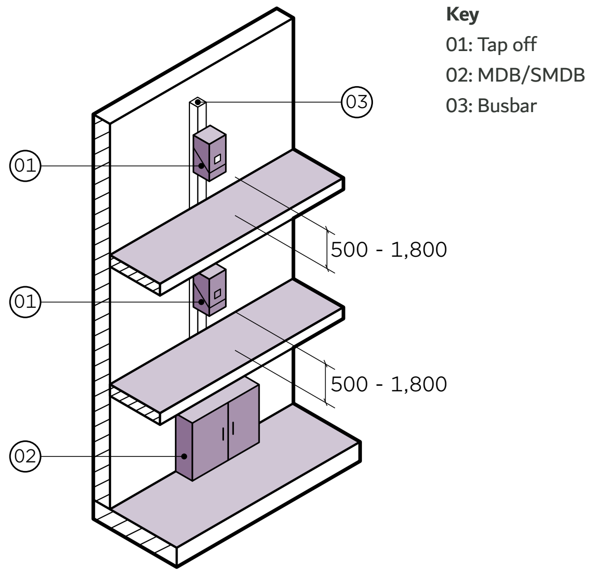


Figure G.26 Busbar tap-off mounting height requirement

G.4.18.4 Segregation of circuits, phases and wiring systems

All wiring and accessories shall be selected and installed to suit individual locations. They shall conform to G.4.11 and the following requirements.

Circuits from different DBs shall not be installed in a common conduit or trunking.

The circuit wires of individual categories and of different voltage grades shall be installed in separate conduits, or segregated with barriers where installed in the same trunking run.

The circuit wires of individual categories (such as lighting, power and emergency) shall be segregated with barriers in trunking runs or installed in separate conduits.

Where residential premised are supplied with a three-phase supply, the light fittings, socket outlets, water heaters, cookers and other single-phase apparatus in any room shall not be connected to more than one phase, unless this is unavoidable. If connection to more than one phase cannot be avoided, a minimum distance of 2 m shall be maintained between outlets, accessories or appliances connected to different phases.

Where a switch box contains more than one phase, for group switching, approved switch boxes with phase barriers shall be used and labelled to indicate that 400 V is present in the back box. All circuit wires shall be identified by colour as shown in Table G.8.

Where a wiring system is in close proximity to non-electrical services, the wiring system shall be segregated and protected against hazards that are likely to arise from the presence of the other service(s) in normal use. Provision shall be made for safe and adequate access to all parts of the wiring system which might require inspection, maintenance or replacement.

Switches controlling light fittings, water heaters, etc. shall not be installed in bathrooms. In kitchens and other areas where water is regularly used, switches shall not be mounted within 2 m of any water tap, wash basin or sink where possible. If there is insufficient space to allow for this, ceiling mounted, insulated, cord-operated switches shall be used.

Socket outlets shall not be installed in bathrooms.

Where luminaires have a track system, this shall conform to BS EN 60570.

G.4.18.5 Mounting heights of accessories

Accessories (as described in G.4.13) shall be mounted as follows (and as shown in Figure G.27).

a) All lighting switches, DP switches of air conditioning units and water heaters, ceiling fan regulators, shaver socket outlets, etc., provided as part of the electrical installation shall be mounted 1.25 m above the finished floor level.

b) 13 A switched socket outlets used for general purpose shall be installed at 450 mm above the finished floor level. 13 A switched socket outlets provided in kitchens shall be installed 150 mm above the worktop.

All switches shall be mounted in readily accessible positions.

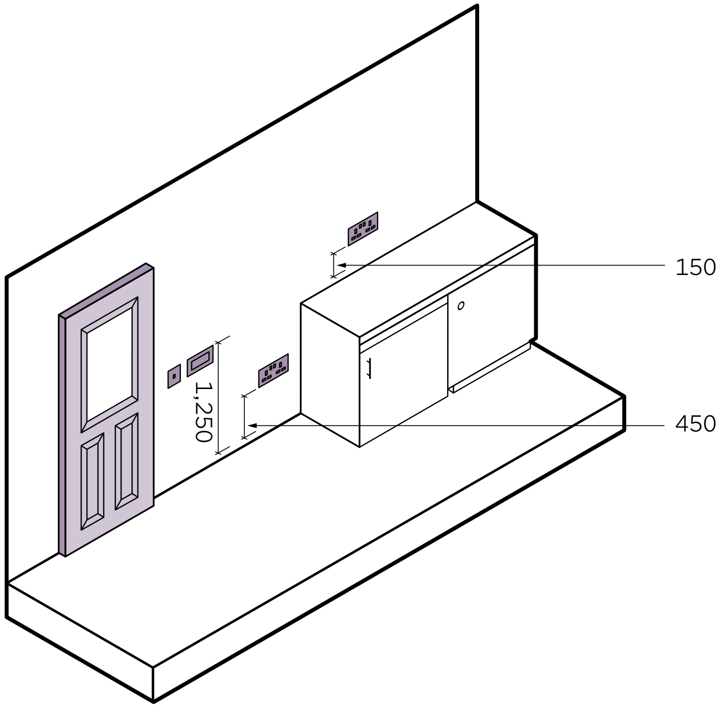


Figure G.27 Typical mounting heights of electrical accessories

G.4.18.6 Identification labels and notices

All sections of the consumer installation at the DBs shall be provided with identification labels to indicate the location and purpose of each protection device, piece of connected equipment and circuit. Instructions or caution notices for correct operation shall also be provided where necessary. All labels shall be in both English and Arabic as shown in Figure G.28. Font sizes shall be chosen to suit the individual application.

Figure G.28 Typical electrical warning label

G.4.19 Earthing and earth leakage protection

G.4.19.1 General

Earthing systems shall be designed and installed in such a way that they remain safe and do not endanger the health and safety of persons or their surroundings. Every consumer installation shall be provided with a separate earthing system within the plot limits, installed and maintained by the consumer.

An earth system shall remain effective throughout the life of the plant. It is difficult in many cases to perform of continuity checks after installation; the system shall therefore be robust and protected from mechanical damage and corrosion where necessary.

Each consumer's earthing system shall comprise the earth electrode(s) main earth lead conductor connected between the earth electrode(s) and the consumer's main earthing terminal(s) or earth busbar.

ECCs shall be provided for every outgoing circuit from the MDB, SMDB and final DBs, equipotential bonding of all metalwork and exposed conductive parts and enclosures, etc. Guidance is available in BS 7430, BS EN 50522 and IEC 60364.

Selection of the earthing conductor material shall be based on its compatibility with the material of the earth electrode. For a conductor installed in the ground, the corrosive effect of the soil shall also be taken into account.

The consumer's earthing system shall be connected to the DEWA earthing system [either the incoming supply cable armour or the earth continuity conductor (ECC), as approved by DEWA].

The following shall have separate earthing networks and shall not be connected to the main electrical earthing system:

a) MV networks;
b) LV networks;
c) Extra LV networks;
d) private generators;
e) lightning protection systems.

The earthing system shall be of low electrical resistance, good corrosion resistance and able to dissipate high fault current repeatedly.

The consumer main earthing connection shall be a TN-S system (see Figure G.29). The exposed conductive parts of all the electrical equipment of the installation shall be connected by circuit ECCs to the main earthing terminal. The earth fault loop impedance shall be sufficiently low for the protective device (fuse, circuit breaker, RCD) to operate in the required time in the event of a fault to earth.

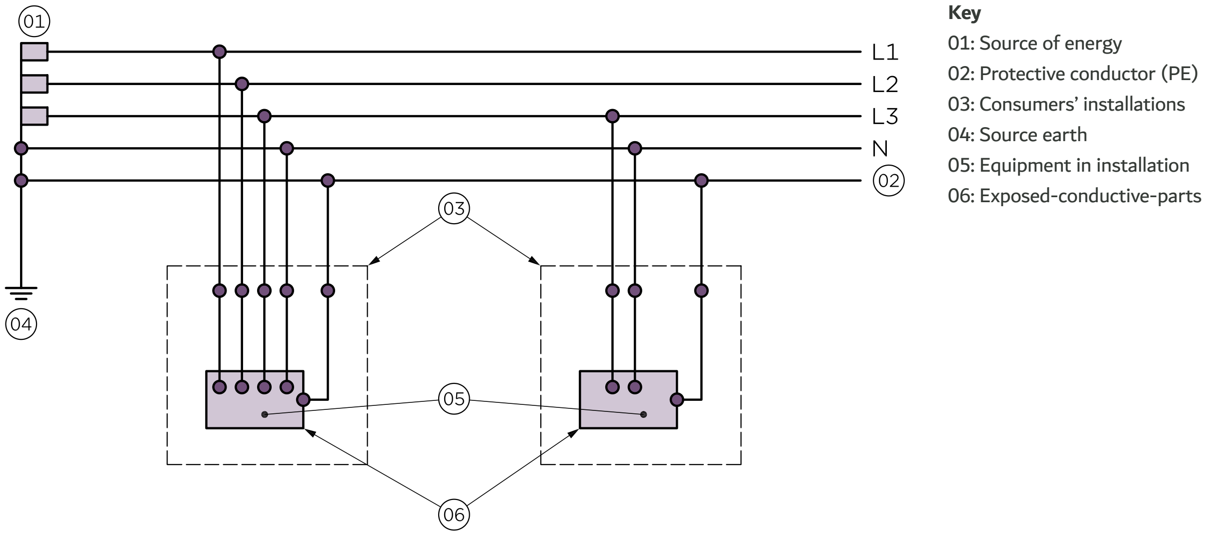


Figure G.29 Typical TN-S earthing arrangement (© British Standards Institute. Figure extracted from BS 7671:2018. Permission to reproduce extracts from British Standards is granted by BSI Standards Limited (BSI). No other use of this material is permitted).

The neutral and earth conductors shall be kept separate. They shall not be connected together at the main earth terminal or at any other point in the consumer's installation.

Where several installations have individual earthing arrangements, any common ECC shall be capable of either:

1) carrying the maximum fault current likely to flow through them; or
2) being earthed within one installation only and insulated from the earthing arrangements of any other installation.

Foundation metalwork in concrete may be used as a ready made and effective earth electrode. The total electrode area formed by the underground metalwork of a large structure can be used to provide an earth resistance lower than that obtainable by other methods. It is important that consideration is given to the possibility of corrosion of the metalwork reinforcement. The products of corrosion occupy a greater volume than the original metal, and cracking might occur.

Continuous earth leakage currents shall be mitigated by the designer of the electrical system.

NOTE: Some earth leakage currents might be incompatible with other buried metalwork, including other types of earth electrode to which foundation metalwork might be bonded, such that it might be necessary to consider the need for cathodic protection.

Damage to the concrete in the form of cracking, due to arcing or the rapid evaporation of moisture, can occur where the long-term duration earth fault currents exceed the carrying capability of the electrode. This situation is unlikely to arise if the electrode has a resistance sufficiently low to avoid dangerous voltages to earth. Where, in structures made of bolted sections, the electrical continuity of the structural joints cannot be relied upon to form permanent and reliable earth bonds, bonding loops across these joints shall be installed.

Water mains shall not be used for earthing purposes. Metal pipes (e.g. for gas, oil, compressed air or drainage) carrying other services shall only be bonded to the protective conductors and not used for the sole means of earthing.

Earth electrodes shall not be installed at a distance from a metal fence less than the buried depth of the electrode, unless they are used for earthing that fence. This is to avoid the possibility of the fence becoming live and thus dangerous at points remote from the substation, or alternatively giving rise to danger within the resistance area of the electrode by introducing a good connection with the general mass of the earth.

G.4.19.2 Consumer's main earth electrode

A minimum of one main earth electrode shall be provided for each incoming point of supply/consumer's MDB, within the consumer's premises. For installations with a main incomer of 200 A and above, a minimum of two earth pits shall be provided.

The earthing systems shall consist of copper conductors or steel rods (austenitic steel or copper clad) of appropriate dimensions, set with a driving pin and head driven to a minimum depth of 3 m. The earth electrode shall be installed inside a 300 mm × 300 mm × 300 mm earth pit with inspection cover. The connection of the earthing conductor to the earth electrode or other means of earthing shall be made using compound filled, encapsulated or substantial clamps of non-ferrous material.

NOTE: Uncoated buried copper is electro-positive to uncoated buried steel. When interconnected by a current-carrying conductor, these metals form an electrochemical cell that can cause accelerated corrosion of steel.

The consumer's main earth electrode shall be installed within 1.5 m of the MDB. Where more than one earth electrode is installed within the premises, they shall be spaced not less than 6 m apart. Load centres located laterally 50 m or more from the MDBs might require additional backup earthing.

Apart from the risk of corrosion to the earthing system, the chemical treatment of soil has environmental implications and is not a long-term solution to meet a specified level of resistance. Coke breeze shall not be used due to its highly corrosive nature.

For each incoming DEWA supply/MDB, the main earth electrode resistance shall not exceed 1 Ω.

The resistance from any point of the earth continuity conductor (ECC) to the main earth electrode shall not exceed 0.5 Ω.

The consumer's earth electrode resistance and the continuity of ECCs shall be periodically checked and maintained to ensure consumer safety as outlined in BS 4444.

Lightning protection earthing shall be separate from the earthing of the incoming DEWA supply/MDBs. A minimum distance of 7 m shall be maintained between the earthing inspection pits.

G.4.19.3 Earth continuity conductor (ECC)

Every circuit in the MDBs, SMDBs and final DBs shall be provided with a separate green and yellow (G/Y) LSF insulated copper ECC. The minimum size of ECCs shall be selected as specified in Table G.20.

Cross-sectional area of phase/neutral conductor (S) (mm^2)	Minimum cross-sectional area of ECC (G/Y LSF insulated copper conductors) (mm^2)	Minimum cross-sectional area of equipotential bonding conductors (mm^2)
$S \leq 16$	S	S/2 (not less than 6)
$16 < S < 35$	16	10
$S > 35$	S/2	S/4 (need not exceed 25)

Table G.20 Minimum size of earth continuity cables (ECC)

ECCs shall be terminated with tinned copper lugs at both ends, on purpose-made earth terminals at:

a) electrical equipment, apparatus and distribution switch gear;
b) light fittings;
c) mounting boxes of switches and socket outlets.

All busbar risers installed for electrical distribution in high-rise buildings and other consumer installations shall incorporate an appropriately sized ECC either within, or run separately along, the riser. BS 7430 gives guidance on earthing and ECCs.

Joints shall be made such that their current-carrying capacity is not less than that of the conduit itself. Joints shall also have the same insulation, mechanical strength and protection properties as those of the wiring system or conduit of which they are part.

ECCs shall be covered with green and yellow LFC insulation and terminated with purpose-made lugs or fixings.

Where associated with circuits, ECCs shall be labelled at their termination points with circuit identification numbers.

Circuit ECCs shall run alongside the associated phase and neutral conductor.

The following shall not be used as an ECC:

1) gas pipes;
2) oil pipes;
3) metallic conduit, support wires or other flexible metallic parts;
4) construction elements other than metalwork as described in G.4.19.1.

ECCs shall be protected against mechanical and chemical deterioration and electrodynamics effects in accordance with the manufacturer's requirements.

Where two ECCs are used, the ends of the ECC shall be terminated independently of each other at all connection points throughout the circuit, the DBs, junction boxes and socket outlets. To achieve this, an accessory shall be provided with two separate earth terminals.

Where the cable incorporates metallic armouring, this shall be clamped to the cable gland. The main earth conductors shall be placed such that the metallic cable sheaths can be reliable and readily connected to it by bonds made to the cable gland.

Earthing conductors shall be accessible for the connection of any detachable earthing devices used with the electrical equipment.

G.4.19.4 Earth leakage protection

Earth leakage protection shall be designed and incorporated in consumer installations in accordance with BS EN 61140 and IEC 61140.

The ELCBs/RCCBs shall generally conform to BS EN 61008-1 and BS EN 61009-1. Recommended values of operating current of ELCBs/RCCBs are specified in Table G.21, though the designer shall verify with the manufacturer's recommendations.

Sr. No.	Circuit/equipment/apparatus	Rated operating current (mA)
1	13 A switched socket outlets	30
2	Water heater/coolers/dishwashers	30
3	Refrigerator/washing machine and similar apparatus	30
4	Domestic water pumps	30
5	Jacuzzi pumps	10
6	Under water lighting	10
7	15 A switched socket outlets (general purpose)	30
8	General lighting	30/100
9	Flood lighting	100/300
10	Window/split type air conditioner	100
11	Fan coil/AHU/VAV	100
12	Package type air-conditioning unit	100/300
13	Chiller	100/500/1,000
14	Irrigation pump	100
15	Electric cooker	100
16	Industrial machine	100/300
17	Elevators/escalators/hoist	300/500
18	Neon sign	300

Table G.21 Recommended value of operating current for ELCB/RCCB in consumer installations

NOTE 1: Grouping of circuits under one ELCB/RCCB is permitted for lighting circuits, general purpose switched socket outlets, single-phase equipment/ appliances, etc. The maximum number of circuits proposed under each group should be selected taking into account the building type and the possible interruptions.

NOTE 2: Wherever an uninterruptable power supply is required to provide power to equipment and circuits as part of a fire protection system (such as fire pump, jockey pump, sump pump, sprinkler pump, pressurization pump, smoke extract fans), a suitable earth leakage detection system with indication and/or alarm should be provided.

For industrial installations that are designed with common operating systems for plant and machinery, the earth leakage protection shall be selected taking into account the safety and operational requirements.

Operation of the ELCBs/RCCBs, earth leakage detection system, etc. shall be periodically checked and tested in accordance with the manufacturer's recommendations to ensure consumer safety.

Earth leakage sensors/relays with alarm/indicators shall be provided for fire pumps, jockey pumps, submersible pumps, sump pumps, or other essential circuit/equipment with sensor settings that allow for pre-fault warning notification and fault warning notification.

G.4.19.5 Equipotential bonding

All metalwork of the consumer's installation, other than current-carrying parts, shall be provided with equipotential bonding conductors as shown in Figure G.30. This shall include, but is not limited to:

a) cable armour;

b) metal conduits;

c) metal cable tray/trunking sections;

d) metal accessory boxes;

e) exposed metalworks of consumers' appliances;

f) apparatus;

g) equipment;

h) machines;

i) building structures;

j) metallic enclosures and parts;

k) metal water pipes.

The cross-sectional area of equipotential bonding conductors shall be selected using Table G.20.

A main protective bonding conductor shall have a minimum cross-sectional area not less than half the cross-sectional area required for ECC of the installation, and not less than 6 mm^2. A maximum cross-sectional area of 25 mm^2 is sufficient if the bonding conductor is of copper or a cross sectional area affording equivalent conductance in other materials.

The equipotential bonding conductors shall be connected to the main earthing terminal within the consumer's wiring installations. The continuity shall be tested and maintained by the consumer.

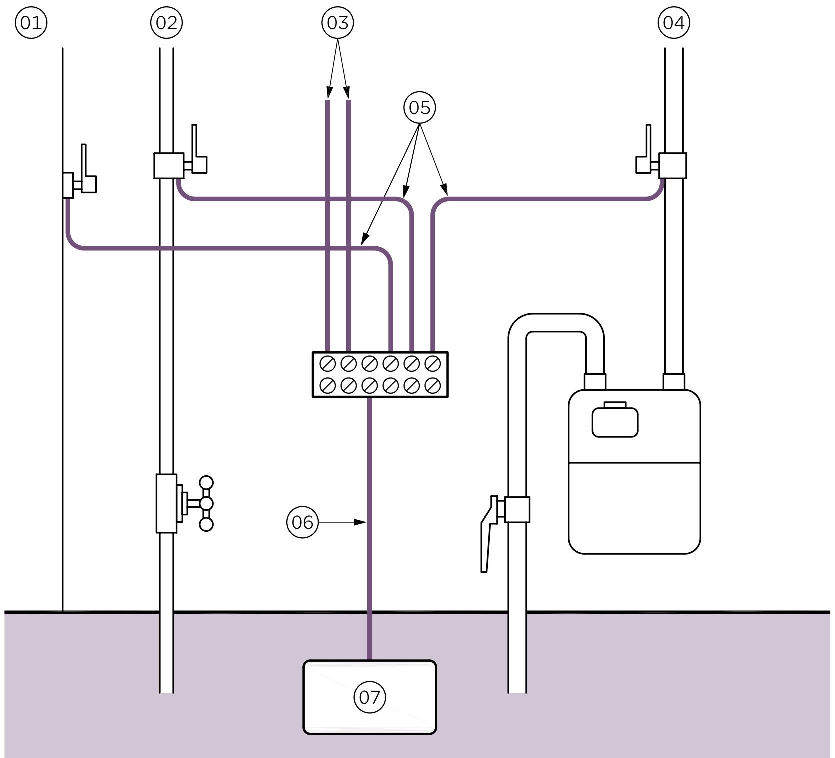


Figure G.30 Typical example of main equipotential bonding of services (© Institution of Engineering and Technology. Figure based on Figure 5.6 in Guidance Note 8: Earthing and Bonding [Ref. G.3]).

Key

01: Other extraneous conductive part
02: Water installation pipe
03: Circuit protective conductors
04: Gas installation pipe
05: Main protective bonding conductors
06: Earthing conductor
07: Means of earthing

G.4.20 Power factor correction, harmonic and undervoltage (UV) relays

G.4.20.1 PF correction

The PF of every consumer installation shall be within the range of 0.9 lagging and unity (recommended value 0.95 lagging).

All air-conditioning units/plants/equipment, machines, motors, light fittings with discharge lamps/mercury vapour/sodium vapour/fluorescent tubes, etc., shall be provided with capacitors or other approved means to achieve and maintain a PF of 0.95 lagging or above, throughout their normal working range.

For commercial premises that require DEWA service feeders of 200 A and above, where individual load compensation cannot be achieved, overall compensation at main or sub-main distribution levels shall be provided by incorporating capacitor banks with automatic regulated steps. For residential premises the limitation shall be a 400 A feeder.

The PF correction capacitor shall be a dry, encapsulated, sealed type conforming to IEC 61921.

Capacitors shall be enclosed or guarded to prevent accidental contact of conducting metal parts with exposed energized parts, terminals or buses associated with them.

Capacitors installed for PF correction shall be provided with the means for automatic, immediate discharge when the capacitor is disconnected from the source of supply.

The discharge circuit shall be either permanently connected to the terminals of the capacitor or capacitor bank, or provided with automatic means of connecting it to the terminals of the capacitor bank on removal of voltage from the line. Manual means of switching or connecting the discharge circuit shall not be provided.

The capacitors and associated components [such as PF regulator, indicating instruments, contactors (of capacitor switching duty), control switches, etc.] shall be designed and rated for operation based on:

a) the electric supply;
b) the ambient conditions specified in G.4.6;
c) the selection details recommended in G.4.13.

Capacitor units shall be designed for temperature class D in accordance with IEC 61921.

The current-carrying capacity of conductors that connect a capacitor to the terminals of a motor or to motor circuit conductors shall be:

1) a minimum of one-third of the current-carrying capacity of the motor circuit conductors; and
2) a minimum of 1.5 times the rated current of the capacitor in all cases.

An overcurrent device shall be provided in each circuit for each capacitor bank. A separate overcurrent device is not required for a capacitor connected on the load side of a motor overload protective device. The rating or setting of the overcurrent device shall be as low as practicable.

The capacitor banks installed for PF correction are major contributors to potential resonance. Such resonance conditions can magnify harmonic levels. Parallel resonance gives rise to a high impedance across the network and can cause voltage and current amplification. Network studies shall be carried out to determine the correct rating of capacitors and their operation without causing resonance. Mitigation measures shall be taken such as installing suitable harmonic filters or reactors. The capacitors shall be suitable for operation under harmonic current conditions. To minimize this risk of harmonic currents, harmonic filter reactors shall be provided in series with capacitors. Tuning of the capacitors, harmonic filter reactors shall be made below the lowest harmonic order present in the network.

The contactors used in the capacitor banks shall be able to withstand switching surge. Suitable means shall be installed to isolate each capacitor, capacitor bank, or capacitor installation from all sources of voltage and to remove the unit from service.

All non-current-carrying metal parts of capacitors shall be earthed as specified in G.4.19.

Each capacitor shall be provided with a name plate indicating the following information:

i) rated voltage;
ii) frequency;
iii) kVAr;
iv) number of phases;
v) discharge device;
vi) name of the manufacturer.

Wherever a capacitor bank/panel is installed on the supply side of DEWA kWh metering, adequate sealing provision shall be made as specified in G.4.5.

In premises where capacitor banks are not installed and individual equipment is provided with suitable means for PF correction, a PF meter shall be provided in the MDB for displaying the PF. If PF deviates from the requirement specified by the designer, consumers shall arrange for PF correction equipment to maintain the PF close to 0.95 lagging.

The capacitor bank panel shall be provided with a suitably rated main incomer isolating switch. This shall be a three-pole isolator or MCCB. The handle of the incomer isolator or MCCB shall be interlocked with the door to ensure that the capacitor bank is de-energized when the door is open.

Capacitor banks shall be provided with forced ventilation. They shall have double enclosures to limit the temperature rise for outdoor/open to sky area installations. A trip mechanism with alarm shall be provided to operate in the event of failure of the ventilation/excess temperature rise.

G.4.20.2 Harmonics and rapid voltage changes

A consumer's load shall not cause deviations of the voltage characteristics other than those permitted by BS EN 50160 and IEC 61000.

The on-site measurements to determine compliance with the harmonics limits and any excess deviations shall be carried out by the consumer. The following characteristics of a supply voltage shall be taken into account:

a) power frequency;
b) magnitude of the supply voltage;
c) supply voltage variations;
d) rapid voltage changes and flickers;
e) supply voltage dips;
f) short interruptions of the supply voltage;
g) long interruptions of the supply voltage;
h) temporary power frequency over voltages;
i) transient over voltages;
j) supply voltage unbalance;
k) harmonic voltage;
l) inter-harmonic voltage;
m) mains signalling voltage.

G.4.20.3 Undervoltage (UV) relays with auto reset timer

All air-conditioners and air-conditioning units/plants/equipment installed within the consumer's installation shall be provided with UV relays that trip the circuit breakers/contactors associated with these relays.

The tripping shall occur immediately and without any intentional time delay if the supply voltage drops to or below 75% of nominal and remains at or below 75% for a duration of 0.2 s. Tripping shall not occur if the supply voltage recovers above 75% within 0.2 s.

The UV relay's auto-reset timer shall have an adjustable time setting between 5 min and 10 min. The circuit breakers/contactors associated with the UV relay shall have an auto-closing facility to restore supply to the chillers/air conditioning units, after normalization of supply voltage, when the relay is reset automatically. The auto-closing facility shall have a motorized operation. The auto-reset timer of the UV relays shall be set at values specified in the manufacturer's schedules, approved by DEWA, to suit individual installation. Necessary provision for sealing may be incorporated in the relay to restrict access for adjustments of the setting.

UV relays with auto-reset timers shall normally be incorporated within the respective air-conditioning unit/equipment or in their control panels. For normal air-conditioners, UV relays with auto-reset timers may be provided within the consumer's DB for individual or group of air-conditioning units. Prior approval shall be obtained from DEWA for each application.

The UV relays shall only be applied to trip the respective air-conditioning units/plant or equipment sensitive to voltage variations. The UV relays shall not be applied to trip LV incomer circuit-breakers/ACB within the main LV panel. The UV relays with associated controls shall be checked and maintained regularly. The 75% voltage threshold and tripping time of the air-conditioning units/plants/equipment shall be confirmed to DEWA after installation.

G.4.21 Construction sites

G.4.21.1 General

Assemblies for the distribution of electricity on construction sites shall conform to BS 4363 and BS EN 61439.

Equipment shall be identified by a temporary label identifying the supply location, and shall be compatible with the particular supply from which it is energized. It shall only contain components connected to a single installation.

Cables shall not be installed across a site, road or walkway unless the cable is protected against mechanical damage.

All cables used on construction sites shall have a metal sheath and/or armour, both of which shall be effectively earthed and continuous.

Wiring systems shall be arranged such that no strain is placed on the terminations of conductors, unless the terminations are designed for this purpose.

Assemblies for construction sites shall incorporate suitable devices for switching and isolating the incoming supply.

A circuit breaker shall be provided for isolating the incoming supply. The circuit breaker shall either be suitable for securing in the off position by padlock, or installed inside a lockable enclosure.

Safety and standby supplies shall be connected by means of devices arranged to prevent interconnection of the different supplies.

Metering cabinets, DBs and wiring installations installed outdoors shall be weatherproof (IP 65 in accordance with BS EN 60529).

G.4.21.2 Wiring systems and distribution boards

Cables which are not installed in conduit or trunking shall be:

a) armoured;
b) protected against accidental or deliberate interference by persons; and
c) protected against the weather.

A means of emergency switching shall be provided on the supply to all equipment from which it might be necessary to disconnect all live conductors in order to remove a hazard.

Equipment shall be located, and notices displayed, in such a way as to facilitate immediate emergency disconnection of the electricity supply. Locking arrangements shall be provided that can be removed in an emergency (e.g. panic bar or keys available in a break-out box).

Where a proposal for more than one feeder means that MDBs are installed at different locations, the emergency power out facility shall be provided at a single location.

It might be necessary to use a reduced LV supply for portable tools where there is a high exposure to potential damage, or where persons are required to operate such equipment in confined spaces or other hazardous circumstances. A reduced LV shall be used where deemed necessary.

Temporary electrical systems for entertainment and similar purposes shall be provided in accordance with BS 7909.

G.4.21.3 Earth leakage protection

In addition to the overcurrent and short-circuit protection, every circuit shall be protected for earth leakage.

All of the following shall be protected with an ELCB/RCCB of rated operating current 30 mA:

a) final sub-circuits connected to 13 A switched socket outlets;
b) portable tools;
c) equipment.

A 100 mA ELCB/RCCB shall be provided for the protection of other lighting circuits,
fixed equipment, etc. unless otherwise specified.

The consumer shall check and test the earthing systems, operation of ELCBs/RCCBs, wiring installation, etc. regularly to verify that the installation is safe, and shall take remedial action if necessary.

G.5 Electric vehicle (EV) charging points

G.5.1 Charging modes

G.5.1.1 General

IEC 61851 specifies four different modes of conductive charging for electric vehicles. The four modes are summarized in G.5.1.2 to G.5.1.5.

G.5.1.2 Mode 1 charging

Mode 1 charging is illustrated in Figure G.31. Alternating current (AC) is delivered to the on-board charger of the EV, via a standard socket outlet and a charging cable without communication function. An RCD for shock protection is provided on the supply side of the fixed electrical installation. Mode 1 is not suitable for longer periods of charging at home or the work place.

Mode 1 is not permitted due to the lack of safety measures associated with this mode of charging.

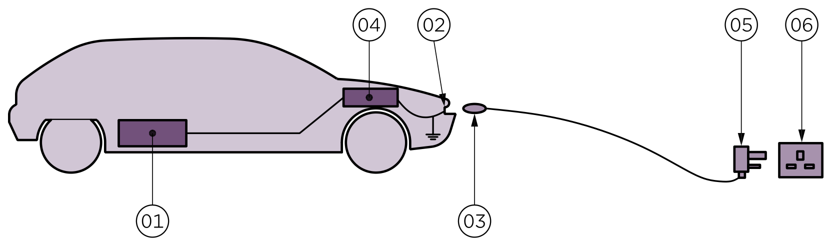


Figure G.31 Electric vehicle Mode 1 charging

Key
01: Battery
02: EV inlet
03: Connector
04: On-board charger
05: Plug
06: Socket outlet

G.5.1.3 Mode 2 charging

Mode 2 charging is illustrated in Figure G.32. The charging cable assembly incorporates an in-cable control box. The fixed electrical installation for the charging facility is similar to that of Mode 1 except that the final circuit, protective device and socket shall be of a suitable rating for the connected load, and shall not exceed 32 A, in order to cater for the higher level of charging current.

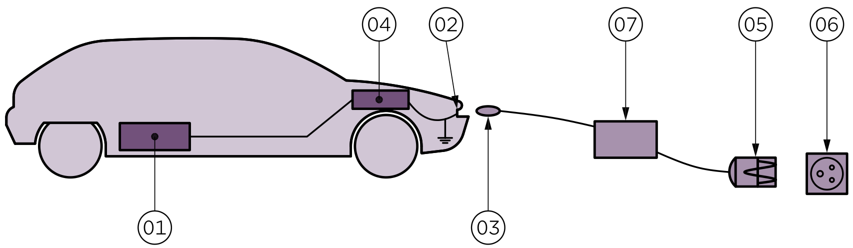


Figure G.32 Electric vehicle Mode 2 charging

Key
01: Battery
02: EV inlet
03: Connector
04: On-board charger
05: Plug
06: Socket outlet
07: In-cable control box

G.5.1.4 Mode 3 charging

Mode 3 charging is illustrated in Figure G.33. It employs dedicated EV service equipment (EVSE) and a charging cable assembly. The control pilot cable of the charging cable assembly allows communication between the EVSE and the on-board charger. Communication functions include:

a) verification of connection with the EV;

b) continuous checking of protective earth conductor integrity;

c) energization and de-energization of the supply;

d) selection of the charging rate.

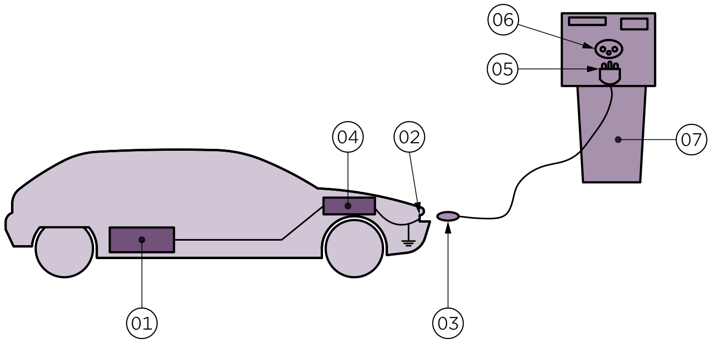


Figure G.33 Electric vehicle Mode 3 charging

Key
01: Battery
02: EV inlet
03: Connector
04: On-board charger
05: Plug
06: Socket outlet
07: AC charger facility

G.5.1.5 Mode 4 charging

Mode 4 charging is illustrated in Figure G.34. It employs an off-board charger to deliver direct current to the battery, bypassing the on-board charger. This mode can charge an EV in a relatively short time because a higher electrical power is used (ranging from 20 kW to 120 kW).

NOTE: Maximum charging capacity of a DEWA charger shall be limited to 25kW or below per charging outlet, subject to available load capacity.

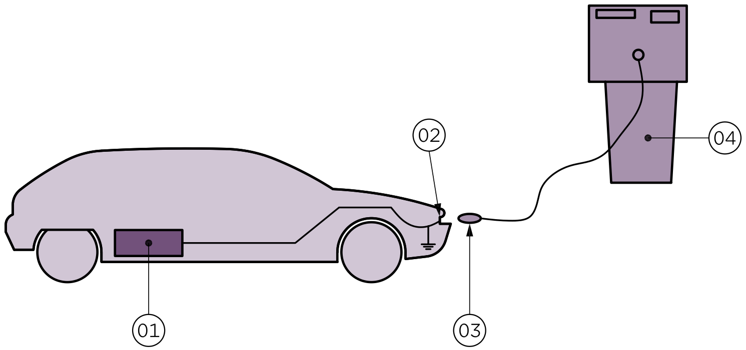


Figure G.34 Electric vehicle Mode 4 charging

Key
01: Battery
02: EV inlet
03: Connector
04: DC quick charging facility

G.5.2 EVSE design requirements

For the permitted charging modes described in G.5.1.3 to G.5.1.5, the following requirements shall be met.

a) The following general requirements shall be met.
   1) Installation of a private charging outlet shall be subject to prior DEWA approval.
   2) The design of EVSE shall enable maintenance and service work to be carried out safely.
   3) EVSE shall be installed with sufficient space around it, in accordance with the manufacturer's instructions, to allow for ventilation and cooling of the equipment.
   4) EVSE shall be installed in such a way as to minimize the distance between the EV inlet and the charging equipment.
   5) EVSE shall not be installed in locations where a potentially explosive atmosphere exists, such as petrol stations. Where such locations require EVSE, it shall be installed outside the hazardous zone.
b) The following requirements shall be met for circuits.
   1) EVSE shall be supplied by a separate and a dedicated radial circuit. The radial circuit shall supply no other loads, except for ventilation equipment required by the EVSE.

      NOTE: More than one EVSE can be fed from the same supply circuit, provided that the combined current demand of the equipment does not exceed the rating of the supply circuit.
   2) Cables supplying EVSE shall be mechanically protected by means of metal sheath/armour, or installed inside a conduit made from either:
      i) rigid steel;
      ii) plastic; or
      iii) PVC.
   3) Each final circuit shall be sized to carry the rated current of the EVSE, with limited voltage drop as required.
   4) Where the final circuit supplies more than one EVSE, there shall be no diversity. A diversity factor (usually greater than one) may be used for a dedicated distribution circuit supplying multiple EVSE charging points, provided that load control is available.
c) The following requirements shall be met for sockets and connectors.
   1) One socket outlet and/or vehicle connector shall be used to charge one EV.
   2) EVSE shall be installed such that the main operating controls and any socket outlet are between 0.75 m and 1.2 m above ground.
   3) The EV manufacturer's instructions shall be followed when determining the type of socket outlet to be installed.
d) The following requirements shall be met for isolation and switching.
   1) A means of isolating the supply to the EVSE circuit shall be provided, in accordance with G.4.13.2. The isolating device shall be:
      i) capable of being locked in the open position;
      ii) located in a position that is readily accessible for maintenance purposes; and
      iii) suitably identified by marking and/or identification.
   2) Where an emergency switch is provided, it shall:
      i) be located in a position that is readily accessible, in accordance with the manufacturer's recommendations;
      ii) be suitably identified by marking and/or labelling; and
      iii) disconnect all live conductors, including the neutral.
e) The following requirements shall be met for protection.
   1) EVSE and all associated equipment shall be selected and erected in such a way as to minimize the risk of overloads and short-circuits.
   2) Each final circuit shall be individually protected against fault current by a suitably rated overcurrent protective device.

3) Basic protection against electrical shock shall be provided by automatic disconnection of supply or electrical separation (see G.4.13.2).
4) Every charging point shall be individually protected by a 30 mA RCD. The RCD shall disconnect all live conductors, including the neutral.
5) The requirements of G.4.19 shall be met on final circuits.

f) The following requirements shall be met for labelling.
   1) The labelling and identification requirements listed in G.4.18.6 shall be met, together with the following.
   2) All labels on EVSE shall be:
      i) clear;
      ii) easily visible;
      iii) written in both Arabic and English; and
      iv) constructed and affixed to remain legible for as long as the enclosure is in use.
   3) An operation instruction for the charging facility shall be displayed at a prominent location at all parking spaces with EVSE. The instruction shall include the following information:
      i) rated voltage (V);
      ii) frequency (Hz);
      iii) current (A); and
      iv) number of phases.
   4) Directional signage inside and outside car parks is recommended to direct EV drivers to parking spaces with EVSE.

G.6 Renewable energy

G.6.1 General

As a type of renewable energy, solar energy is clean and secure. DEWA encourages the use of solar energy to reduce reliance on traditional energy sources (such as gas, oil and coal), which are diminishing.

The onsite generation of electricity from a solar PV shall be by a solar grid-connected system. The grid-connected solar generator shall be connected to the DEWA network, and operated and maintained in accordance with applicable legislation **[Ref. G.4]** and DEWA Shams Dubai regulations **[Ref. G.5]**. System documentation requirements are described in G.6.2.

NOTE 1: The connection of a solar PV system or distributed renewable resource generation (DRRG) to the DEWA grid is subject to DEWA approval.

NOTE 2: Detailed technical requirements are set out in DEWA Technical publications and resources **[Ref. G.6]**.

The designer shall comply with DEWA specifications, acceptable standards, procedures and other requirements published on DEWA website (Shams Dubai section). The requirements are updated regularly and form an integral part of the DBC.

Solar power generation systems shall conform to Section 2, Ch. 14 of the UAE FLSC **[Ref. G.1]** and this section.

Building attached photovoltaics (BAPV) systems attached to roofs, excluding curved or special roofs, are permitted to achieve a minimum fire classification of Class C when tested as per the test standards in Section 2.2.4, Ch. 14 of the UAE FLSC **[Ref. G.1]**.

The minimum fire classification permitted for building integrated photovoltaics (BIPV) and BAPV systems other than the above shall be confirmed with DEWA and DCD upon commencement of design.

G.6.2 System documentation requirements

Consultants and Contractors registered with DEWA for activities related to grid-connected solar PV systems (DRRG Solar PV Consultants and DRRG Solar PV Contractors) shall follow the DEWA guidelines published on the DEWA website for these requirements. Applications for solar connections shall be submitted online and shall include the following documents:

a) basic system information;
b) details of the system designer;
c) details of the system installer, operation and maintenance procedure.

NOTE: Detailed requirements are set out in DEWA Connection guidelines for distributed renewable resources generators connected to the distribution network **[Ref. G.7]**.

G.6.3 Wiring diagram datasheets

An annotated/table form single line wiring diagram that meets the requirements of DEWA Shams Dubai regulations **[Ref. G.5]** shall be uploaded with the DEWA application. It shall include the following information:

a) PV array general specifications:
   1) PV module type(s);
   2) total number of PV modules;
   3) number of PV strings;
   4) PV modules per string;
b) PV string information:
   1) string cable specifications – size and type;
   2) string fuse specifications (where fitted) – type and voltage/current ratings;
c) PV array electrical details:
   1) PV array main cable specifications, AC and DC – size and type;
   2) PV array junction box locations (where applicable);
   3) DC isolator type, location and rating (voltage/current);
d) earthing and overvoltage protection:
   1) details of all earth/bonding conductors – size and connection points (to include details of PV array frame equipotential bonding cable where fitted);

2) Design verification and details of any connections to an existing lightning protection system or supplementary lightning protection system that is to be provided;
3) details of any surge protection device installed (on both AC and DC lines), including location, type and rating;

e) AC electrical details, inbuilt and external protections:
   1) AC isolator location, type and rating;
   2) AC overcurrent protective device location, type and rating;
   3) residual current device location, type and rating.

G.6.4 Labelling and identification

A solar PV installation shall meet the requirements of DEWA Shams Dubai regulations [Ref. G.5], together with the following requirements.

a) All circuits, protective devices, switches and terminals shall be labelled to identify all relevant parts of the installation.
b) All DC junction boxes (PV generator and PV array boxes) shall be provided with caution labels indicating the risk due to dual source.
c) The main AC isolating switch shall be clearly labelled.
d) A single line wiring diagram shall be displayed within the respective electrical rooms/panels.
e) Inverter protection settings and installation details, as applicable, shall be displayed.
f) The procedures for emergency shutdown shall be displayed.
g) All signs and labels shall be suitably affixed.
h) Durable copies of all test and commissioning data shall be provided to the consumer.

G.6.5 Metering and metering provision

DEWA requires access to meter cabinets for the installation of smart meters (PV generation check meters and tariff meters). Contractors shall install meter cabinets in an easily accessible location, in accordance with G.4.5.

G.7 Substation and MV installations

G.7.1 MV network design requirements and guidelines (11 kV)

G.7.1.1 General

G.7 outlines the design requirements where:

a) a DEWA substation is required within the building or plot boundary; and
b) an 11kV medium voltage (MV) network provides the primary power to the building or plot.

G.7.1.2 Reliability of supply

A ring supply consisting of two feeders (a two-feed ring) is the normal feeding arrangement for power supply. A three-feed ring arrangement may be adopted for cases where all MV switchgears/RMUs are installed in one location to ensure specific supply reliability.

For reliable power supply, N-1 line criterion may be used in some installations. In case of power failure in one feeder, the other feeder should be capable of meeting the entire demand for a maximum of 6 h.

G.7.1.3 Standard cable sizes

The DEWA standard 11 kV cable sizes are:

a) 3/C 300 mm^2 copper XLPE;
b) 3/C 240 mm^2 copper XLPE;
c) 3/C 240 mm^2 aluminium XLPE.

G.7.1.4 Cable loads

The maximum sustained loads of 11 kV feeder are:

a) for 300 mm^2 copper XLPE cables (summer rating): 175 A/3 MW;
b) for 240 mm^2 copper XLPE cables (summer rating): 160 A/2.7 MW.

The single unit load demand shall not exceed the maximum sustained current of 175 A/3 MW for an 11 kV feeder cable.

All 11 kV private switchgear shall have a rated symmetrical short-circuit current not less than 31.5kA, with a short time current rating of 3 s.

For private equipment with bulk loads (e.g. furnaces or district cooling) requiring direct MV supply, space for metering units at the customer's premises/substation shall be provided. Necessary documents, drawings and SLDs shall be submitted for comments/approval at design stage.

G.7.1.5 Parallel operation

Parallel operation of DEWA's MV feeders are not allowed in any circumstances. Electrical and mechanical interlocking shall be provided where required.

Standby generators are not allowed to operate in parallel with DEWA's network. Interlocking shall be provided where required.

The customer shall maintain a PF between 0.95 (lagging) and unity at the point of connection with DEWA's MV Network.

The customer shall comply with DEWA's limits of maximum allowable motor starting currents, and corresponding electrical power ratings, as indicated in Table G.22.

Motor electrical power rating	Max. starting current*
Less than or equal to 600 kW	6 × full load current
Above 600 kW and up to 1,200 kW	4 × full load current
Above 1,200 kW and up to 1,800 kW	3 × full load current
Above 1,800 kW and up to 2,400 kW	2 × full load current
Above 2,400 kW and up to 3,000 kW	1.5 × full load current
Motor electrical power rating	Max. starting current*
* Maximum current per feeder during motor starting (including other running motors and loads) should not exceed 350 A at any circumstances.	

Table G.22 DEWA limits of maximum allowable motor starting currents

The following information shall be submitted for approval at design stage:

a) motor specification;
b) starting method characteristics and specifications;
c) number of motor starts per day and operation sequence;
d) SLDs and equipment layouts.

G.7.1.6 Harmonics

For loads that inject harmonics currents into DEWA's network, harmonic (voltage and current) study at the point of connection is required. The study shall be submitted for DEWA approval at the design stage.

The customer shall comply with DEWA's limits of harmonic emissions for voltage and current, based on IEC 61000-3-6:2.0-2008. Detailed specifications and size of equipment, including harmonics spectrum, shall be provided for DEWA approval.

After commissioning of the project, harmonics and flicker site measurements shall be conducted. A report of the measurements shall be submitted to DEWA. Where the measured values exceed DEWA's limits, the customer shall arrange for a solution to reduce the harmonic emissions to the permissible limits.

G.7.1.7 Cable trenches

The maximum allowable number of cables per trench for 11 kV cables is 20. These cables shall be arranged in a maximum of two layers within a trench with a maximum width of not more than 3 m on both sides of the road, close to 132/11 kV substation.

A minimum of 2 m clearance shall be maintained between any MV cable trench and the surrounding heat sources such as 132 kV cable trench.

The permitted horizontal spacing between MV cables is 150 mm (edge to edge for MV cables) and permitted vertical spacing between layers is 100 mm (edge to edge for 11 kV cables). Refer to Figure G.35.

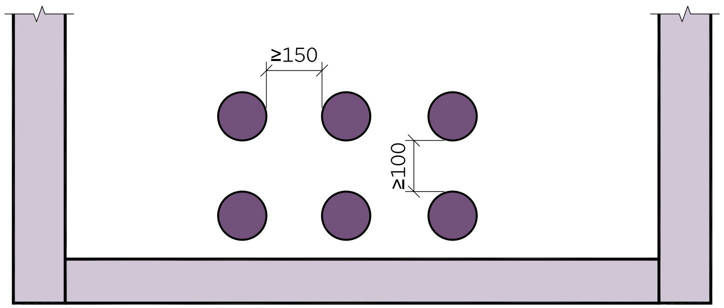


Figure G.35 Typical minimum clearance between cables installed within trench

Crossing between 132 kV cables and MV cables shall not be used unless it is unavoidable. A separate corridor shall be allocated within the premises for MV cable laying along the road.

In soil with a resistivity below 1.6 °C-m/W, the backfill around MV cables shall have a maximum moisture content of 2% and be at 90% compaction.

An SLD illustrating the protection schemes shall be submitted with a relay setting calculation at the design stage.

G.7.2 Substation construction within private plots

G.7.2.1 General

Building-type substations shall be constructed for projects such as labour accommodation, schools, nurseries and hospitals.

Pocket (self-contained) substations shall not be installed at petrol stations and inside buildings.

Expansion joints shall not be used in RMU rooms or transformer rooms, or on ceilings.

G.7.2.2 Substation location

The substation shall be positioned in a dedicated room or housing.

Substations located in basement levels shall have transformer rooms in the first basement level only.

LV electrical rooms shall be adjacent to the substation room if the main panel is private.

Wet areas shall not be installed above substations (see G.7.4).

G.7.2.3 Substation parameters

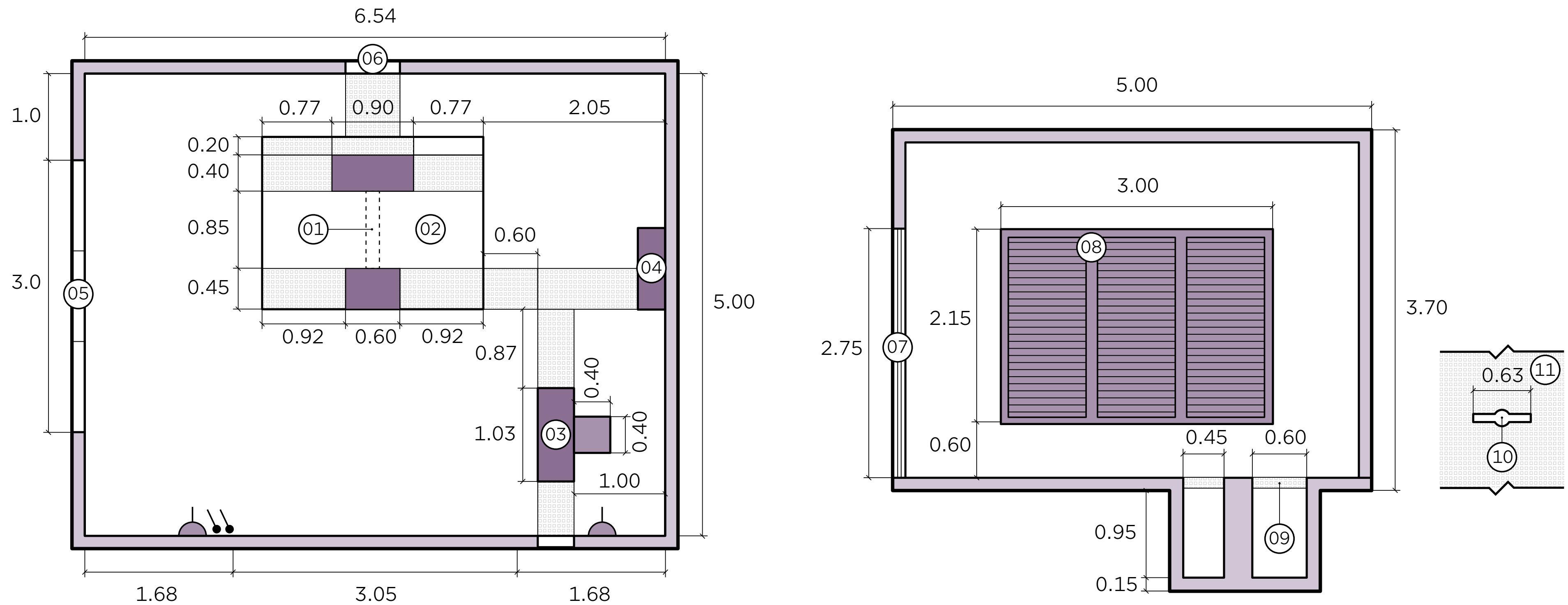
A single room substation at ground floor (see G.7.5.1) shall have a clear height of not less than 3,700 mm.

For split/basement substation arrangements (see G.7.5.2), the RMU room at ground floor shall have a clear height of not less than 3 m.

A basement transformer room shall have a clear height of not less than 3 m.

The substation finished floor level (FFL) shall be maintained between 150 mm and 300 mm above the adjacent ground level (towards the door side). Additional room parameters are shown in Figure G.36 and Figure G.37.

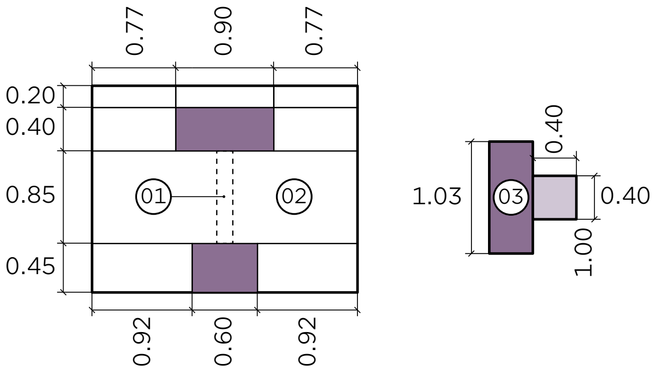
The FFL of a transformer room at basement level shall be maintained between 75 mm and 150 mm higher than the adjacent outside ground level (towards door side).



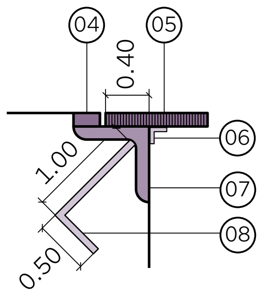
Key

01: 150 mm øPVC at trench level
02: Transformer base
03: RMU
04: RTU
05: All louver windows as door details above FFL of 0.6 m x 3 m (w) x 2.15 m (h)
06: 600 mm opening at channel base level
07: Door
08: Air intake louver
09: Chequered plate with two lifting holes
10: 25 mm diameter lifting hole
11: Chequered plate cover

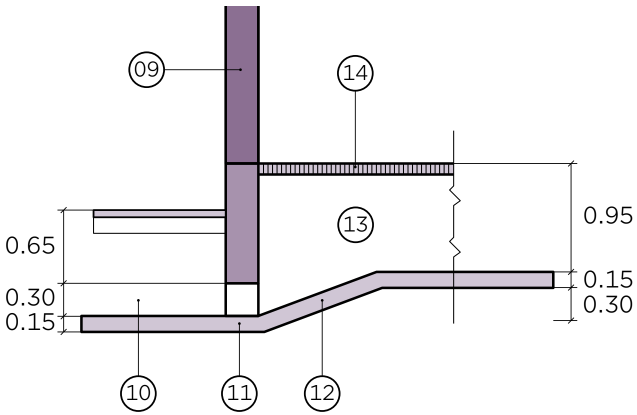
Figure G.36 General dimensional details of substations within buildings (m)



(a) Transformer and RMU details



(b) Chequered plate mounting detail



(c) Incoming trench construction details

Figure G.37 Details within Figure G.36 (m)

Key

01: 150 mm øPVC at trench level
02: Transformer base
03: RMU
04: 13 mm × 6 mm flat bar welded to angle
05: 6 mm thick hot dip galvanized chequered plate cover
06: 25 mm × 25 mm × 3 mm angle welded to chequered plate cover on two side
07: 60 mm × 60 mm × 6 mm edge angle
08: T10 anchor welded to angle at 300 mm centre-to-centre
09: Wall
10: Opening
11: Pre-cast concrete
12: Slope
13: Channel
14: Chequered plate

G.7.2.4 Earthing

Substation earthing, which forms part of the consumer's scope, shall meet DEWA requirements at design stage.

The following requirements shall be met for substation neutral earthing schemes (see Figure G.38):

a) Two or more dedicated and interconnected earth pits shall be provided for transformer earthing and shall be connected to the substation earth strips in a loop. The effective earth resistance value measured from any neutral earthing strip shall be less than 2.0 Ω.

b) Two or more dedicated and interconnected earth pits shall be provided for transformer equipment body earthing and shall be connected to the transformer equipment body earth strips in a loop. The effective earth resistance value measured from any of the equipment body earth strips shall be less than 2.0 Ω.

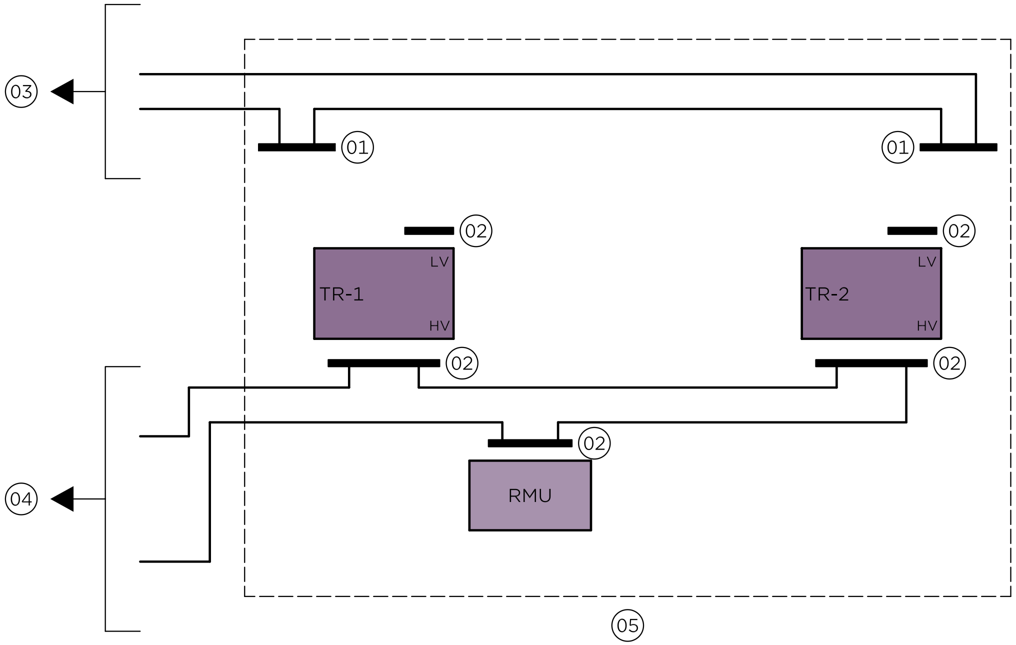
c) Interconnection of transformer neutral earthing and equipment body earthing is not permitted.

d) Earth strips shall be mounted on the cable trench wall at the nearest point to the respective equipment, with a minimum clearance of 50 mm from the wall.

e) Earth strips shall be provided with a minimum of four 12 mm diameter holes for earth looping.

f) Earth conductors shall be copper material with a minimum of 95 mm^2 diameter. If the length of conductors exceeds 50 m, 120 mm^2 diameter copper earth conductors shall be used.

g) In substations with multiple transformer and RMU arrangements, the neutral earthing scheme outlined shall be repeated for every two transformers and the same equipment body earthing scheme to be repeated for every three transformers and their corresponding RMUs.



Key
01: Substation neutral earth strips
02: Body neutral earth strips
03: To neutral earth pits
04: To body earth pits
05: Substation room

Figure G.38 Substation neutral earthing

G.7.3 Substation location and access

The substation room/RMU room shall be directly located on the RTA/public road or sikka.

Where the substation/RMU room is located on a sikka, the sikka should have a minimum clear width of 6.1 m. However, if the proposed RMU room location is less than 12 m away from the main road then the sikka can be used with a minimum clear width of 3 m.

Access shall be provided for DEWA staff and vehicles from the plot limits to the substation and RMU rooms (if setback is allocated in the affection plan by the competent authority). The access shall be directly open to sky and available 24/7.

In a split room/basement room arrangement, the transformer room may be located on an internal driveway having a clear (3 m wide x 3 m high) and direct access from the RTA road.

G.7.4 Requirements for provision of attic slabs above substations and LV electrical rooms

Wet facilities shall not normally be located above the substation/RMU room/LV electrical room. Occasionally, in exceptional unavoidable cases, this is permitted at the discretion of DEWA, and in these cases the following requirements shall be met.

a) A reinforced concrete attic slab shall be provided above the entire substation/RMU room/LV electrical room.

b) The entire attic slab and floor slab above, including the vertical sides above the attic slab, shall be waterproofed using an approved system.

c) The Consultant shall take full responsibility for supervision of the waterproofing works, during execution and testing of waterproofing.

d) All pipes, joints, trap, etc. running in wet areas shall be enclosed in an approved waterproofing membrane.

e) The void between the floor and attic slab shall have a clear height of not less than 600 mm. The void above the attic slab shall be accessed via an opening of 1,200 mm × 600 mm, fitted with an aluminium louvered door. The void shall not be used for any other purpose and shall have a permanent lighting arrangement. A drain pipe shall be provided for the attic slab to drain out any water leakage through the floor slab. Tiles are not compulsory above the attic slab.

f) The Consultant shall forward complete floor plans to DEWA. The plans shall show the location of the wet area and the substation/RMU room/ LV electrical room. The extent of the attic slab shall be clearly marked in the plans. Typical cross sections through the wet area, substation/RMU room/LV electrical room and attic slab shall be shown in the drawings, including the waterproofing arrangement/systems/materials.

The following checklist shall be followed for attic slab construction:

1) reinforced concrete attic slab above entire substation/ring main unit/LV;
2) clear depth (void) of 600 mm between attic slab and floor slab;
3) aluminium louvered access door of 1,200 mm × 600 mm to above clear depth (void) from outside substation;
4) waterproofing of attic slab, floor slab above attic slab and vertical side walls;
5) drain pipe of 40 mm diameter projecting out of the attic slab;
6) waterproofing of all pipe joints, traps, etc. running in wet areas;
7) lighting inside the void space;
8) drawings showing the above details attached;
9) guarantee letter;
10) no high pressure and vertical pipes passing in the void area;
11) PVC tray provided with a 1:100 slope towards the drain pipe.

G.7.5 Substation types and areas

G.7.5.1 Single room substation (RMU and transformer in same room on ground floor)

The dimensions for a single room substation where the RMU and transformer are in the same room on the ground floor shall conform to Table G.23 and Figure G.39 to Figure G.41.

Transformer topologies	Area required (m^2)	Minimum width of room (m)
1 × 1,000/1,500 kVA	33	4.57
2 × 1,000/1,500 kVA	55	6.1
Additional transformer	Additional 25	—
Four or more transformers (including necessary equipment)	10	—

Table G.23 Dimensions of single room substation

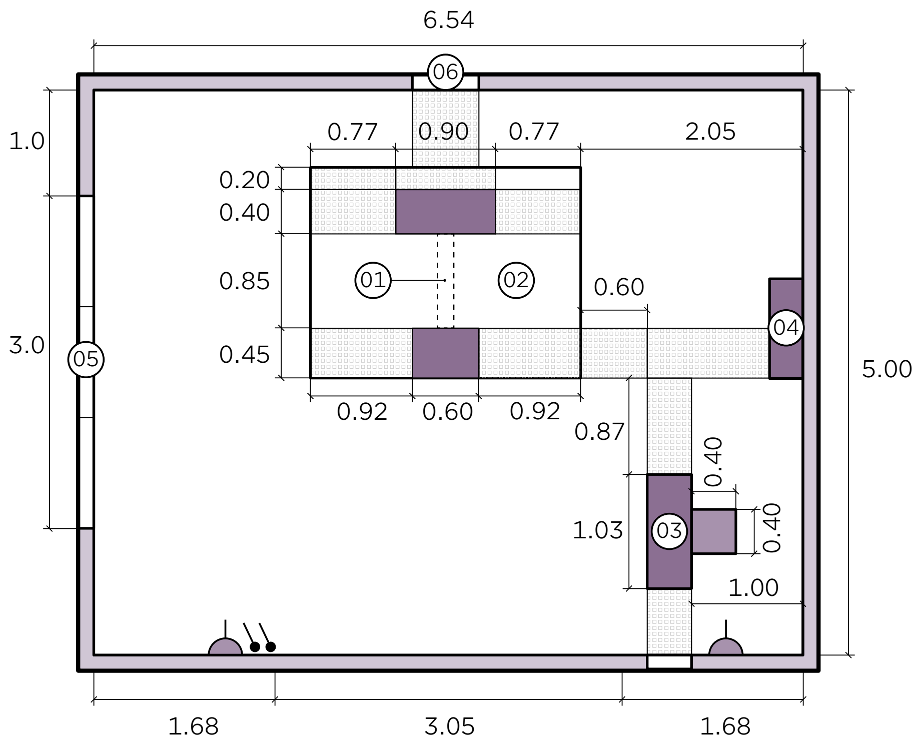


Figure G.39 Typical 1 × 1,000 kVA/1,500 kVA substation arrangement (m) (for reference only, not for construction)

Key

01: 150 mm øPVC at Trench Level

02: Transformer Base

03: RMU

04: RTU

05: Louvered windows 3.0 m (w) x 2.15 m (h), installed 0.6 m AFFL, to be constructed to same detail as louvered doors

06: 0.60 m opening at channel base level

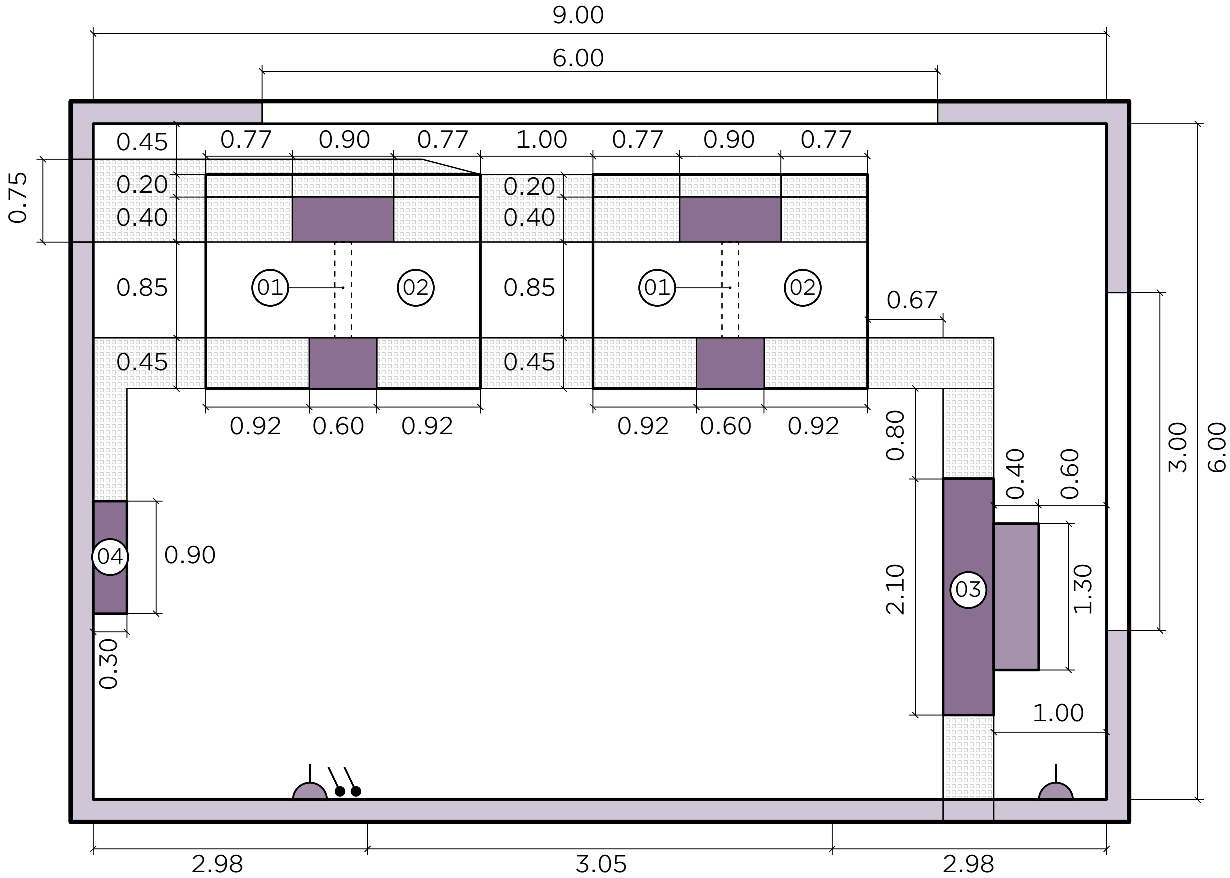


Figure G.40 Typical 2 × 1,000/1,500 kVA substation arrangement (m) (for reference only, not for construction)

Key

01: 150 mm øPVC at trench level

02: Transformer base

03: RMU

04: RTU

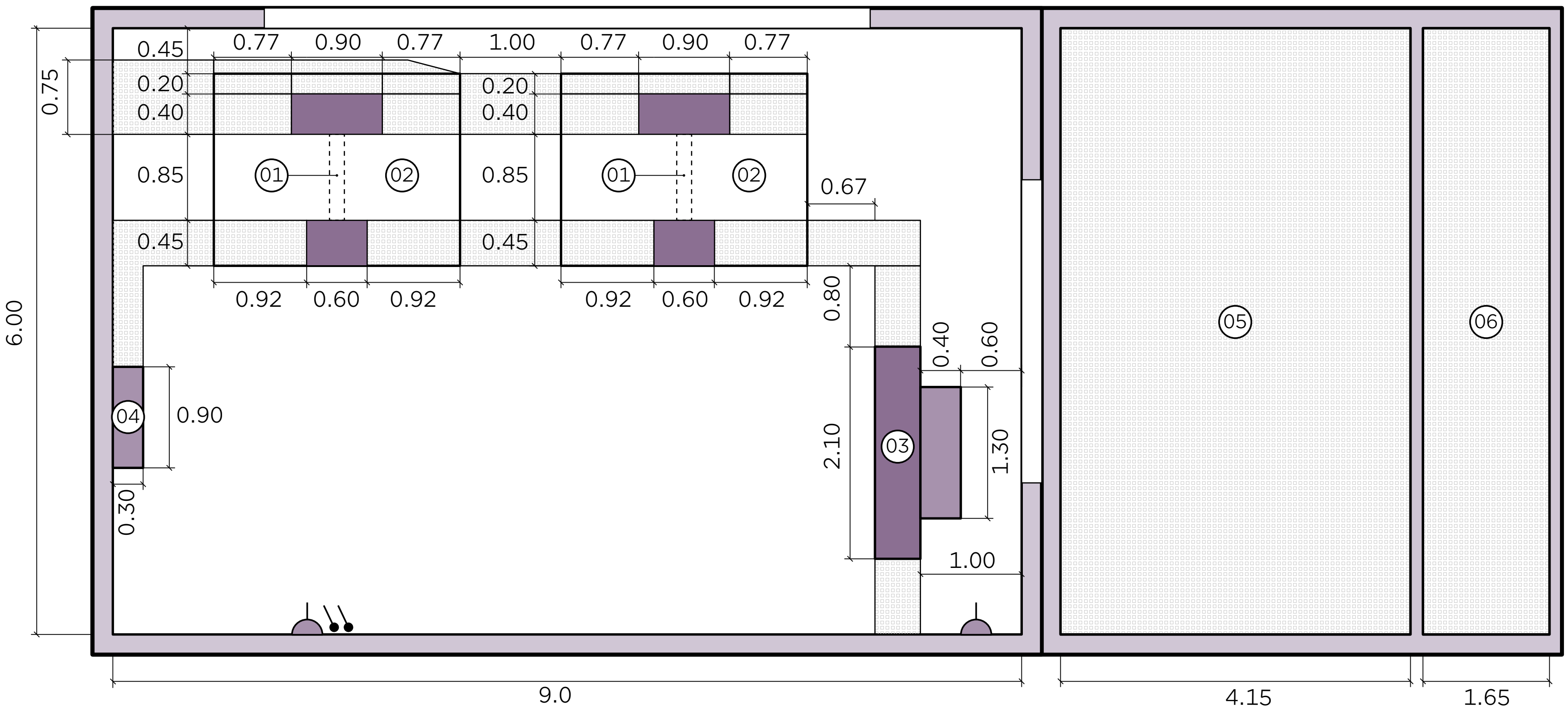


Figure G.41 Typical substation arrangement allowing for additional transformers (m) (for reference only, not for construction)

Key

01: 150mm øPVC at Trench Level

02: Transformer base

03: RMU

04: RTU

05: 25 m² for extra transformer

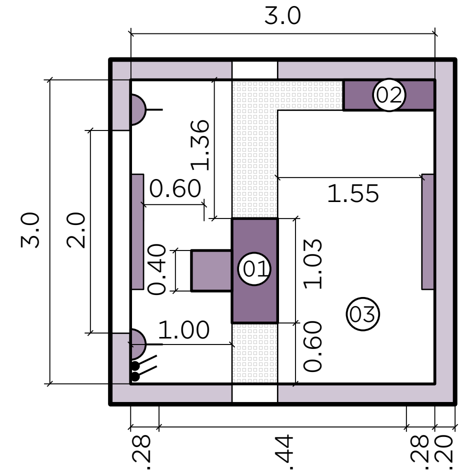
06: 10 m² for extra transformer

G.7.5.2 Split room substation (RMU and transformer in separate rooms on ground floor)

The dimensions for a split room substation where the RMU and transformer are in separate rooms on the ground floor shall conform to Table G.24, Figure G.42, Figure G.43, Table G.25 and Figure G.44.

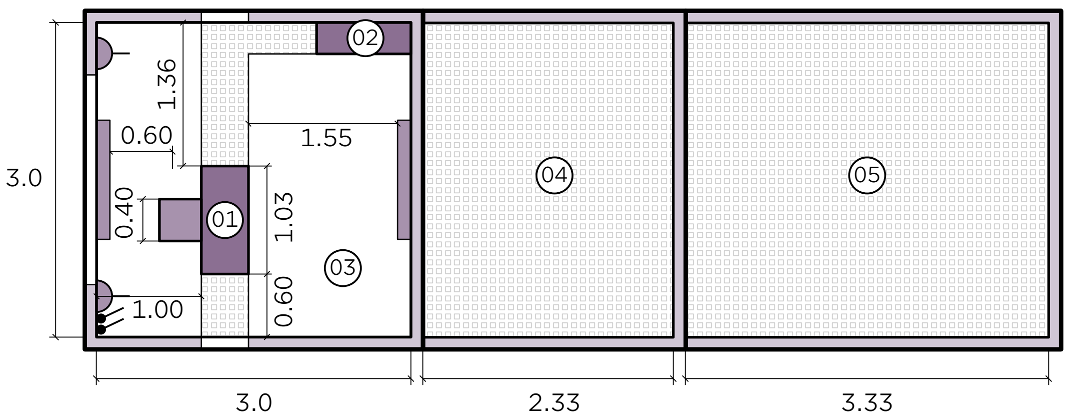
Transformer topologies	Area required (m^2)	Minimum width of room (m) towards door side
For one RMU set controlling two transformers	9	3
Additional RMU set	7	3
Four or more transformers (including necessary equipment)	10	5

Table G.24 Dimensions of RMU room, ground floor



Key
01: RMU
02: RTU
03: 9 m^2

Figure G.42 Typical ground floor RMU room spatial arrangements for one RMU (m) (for reference only, not for construction)

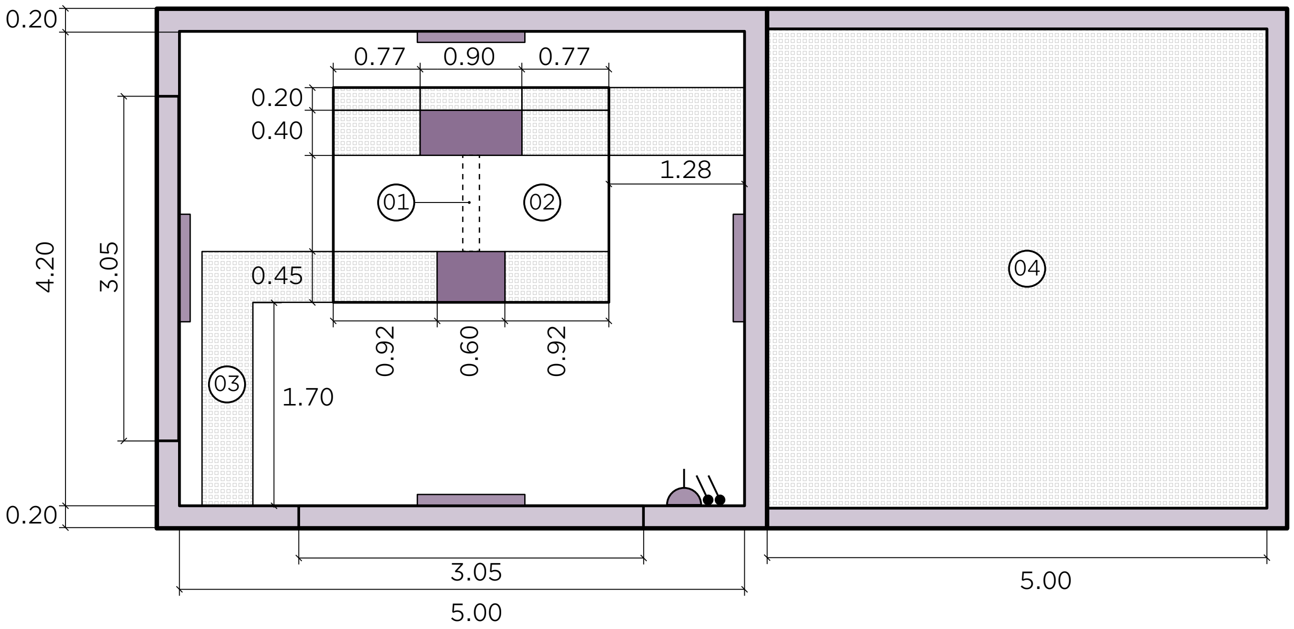


Key
01: RMU
02: RTU
03: 9 m^2
04: 7 m^2 for extra RMU
05: 10 m^2 for four and above transformers

Figure G.43 Typical ground floor RMU room spatial arrangements for multiple RMUs (m) (for reference only, not for construction)

Transformer topologies (ground floor)	Area required (m^2)	Minimum width of room (m)
1 × 1,000/1,500 kVA	21	4.57
Extra area required for an additional transformer	21	—
For 2 × 1,000/1,500 kVA transformers	42	6.1

Table G.25 Dimensions of transformer room, ground floor



Key

01: 150 mm øPVC at trench level

02: Transformer base

03: Trench

04: 21 m^2 for extra transformer

Figure G.44 Typical ground floor transformer room spatial arrangements (m) (for reference only, not for construction)

G.7.5.3 Basement substation (RMU room in ground floor and transformer room at basement level)

The dimensions for a basement substation where the RMU room is on the ground floor shall conform to Table G.26, Table G.27, Figure G.43 and Figure G.44.

RMU room, ground floor	Area required (m^2)	Minimum width of room (m) towards door side
One RMU set controlling two transformers	9	3
Additional RMU set	7	–
Four or more transformers (including necessary equipment)	10	5

Table G.26 Dimensions of RMU room, ground floor and basement substation

Transformer topologies (basement level)	Area required (m^2)	Minimum width of room (m)
1 × 1,000/1,500 kVA	21	4.57
Extra area required for an additional transformer	21	–
For 2 × 1,000/1,500 kVA transformers	42	6.1

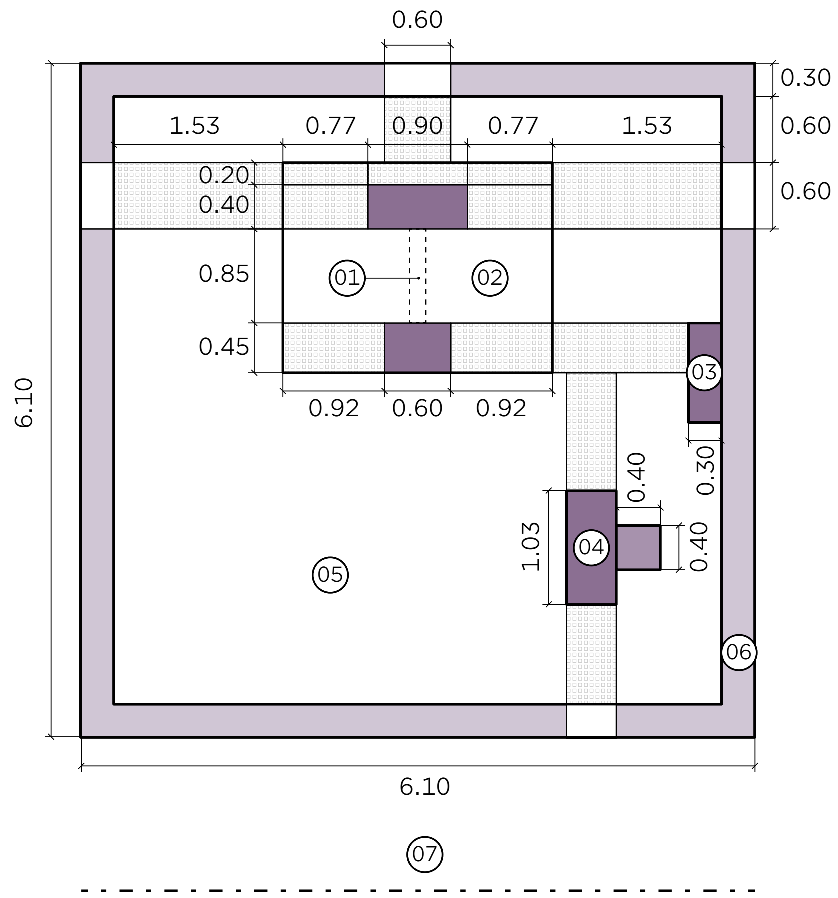
Table G.27 Dimensions of transformer room, basement substation

G.7.5.4 Open to sky dedicated substation with private panel

The dimensions of an open to sky dedicated substation with private panel shall conform to Table G.28 and Figure G.45.

Parameter	Requirement
Equipment	1 × 1,000/1,500 kVA transformer and 1 × RMU
Dimensions	6.1 m × 6.1 m
Additional requirements	Substation space shall be located along RTA/public road or sikka. LV room shall be adjacent to the substation room. Soakaway shall be 3.66 m (minimum) away from the substation.

Table G.28 Open to sky, dedicated substation parameters



Key
01: 150 mm øPVC at trench level
02: Transformer base
03: RTU
04: RMU
05: Open to sky
06: Compound wall shall not be more than 2.1 m
07: RTA road/sikka

Figure G.45 Typical open to sky dedicated substation spatial arrangement (m) (for reference only, not for construction)

G.7.5.5 Open to sky pocket substation

The dimensions of an open to sky pocket substation shall conform to Table G.29, Figure G.46 and Figure G.47.

Equipment	Dimensions (m)
1 × 1,000 kVA	4.57 × 3.66
2 × 1,000 kVA	6.1 × 6.1

Table G.29 Open to sky, dedicated substation parameters

The substation shall be directly located along the RTA/ public road or sikka. The side of the substation with the dimension 4.57 m or 6.1 m should be facing the RTA/public road/service road.

The substation shall be suitable for releasing supply through individual feeders, each of 400 A (maximum rating).

The height of the compound wall around the substation foundation (on three sides) shall be not more than 2,100 mm.

Any soakaway shall be a minimum of 3.66 m from the substation.

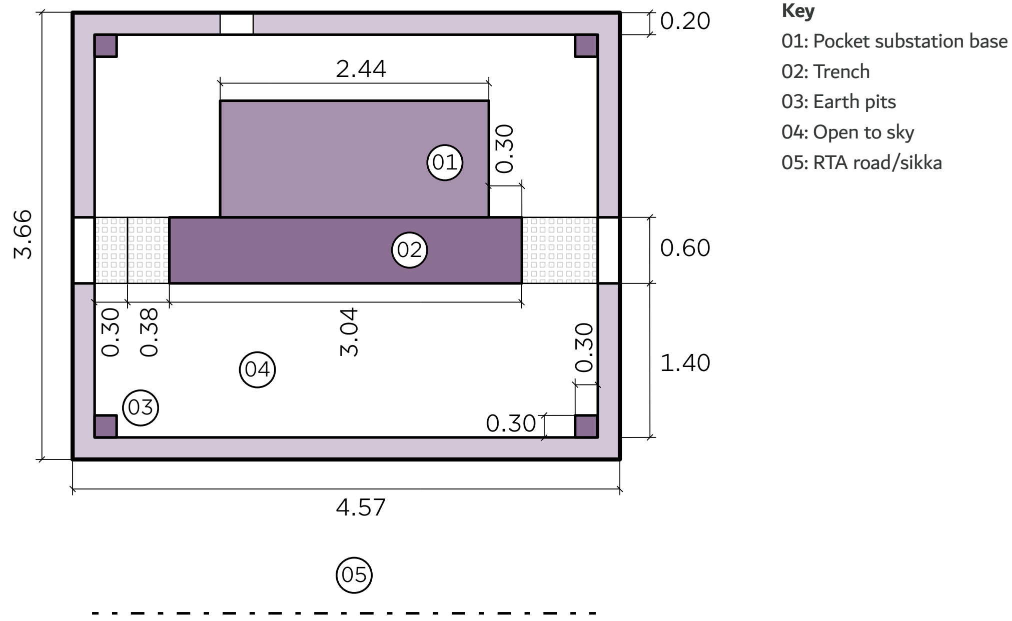
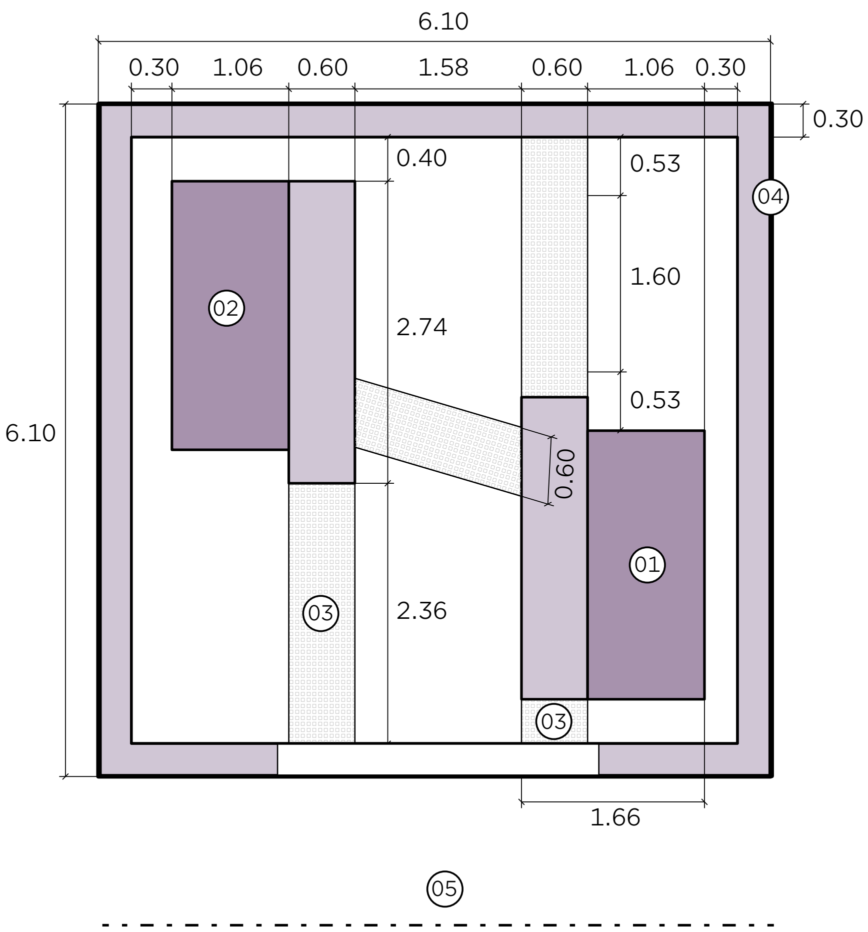


Figure G.46 Typical 1 × 1,000 kVA pocket substation spatial arrangement (m) (for reference only, not for construction)



Key
01: Pocket substation No.1
02: Pocket substation No.2
03: Trench
04: Compound wall less than 2.1m
05: RTA road/sikka

Figure G.47 Typical 2 × 1,000 kVA pocket substation spatial arrangement (m) (for reference only, not for construction)

G.7.5.6 DEWA control room requirements for direct 11 kV supply

The dimensions of a DEWA control room shall conform to Table G.30, Figure G.48 and Figure G.49.

11 kV feeder	Area (m^2)	Dimension (m)	Area for every additional feeder (m^2)	Additional requirements
Two feeders	29.16	5.4 × 5.4	8	Regular type of RMU room made of block work and RCC slab.
Two feeders	37.2	6.1 × 6.1	37.2	Open to sky with FGRP kiosk (to be supplied by DEWA). Height of the wall around the substation foundation (on three sides) not more than 2.1 m.

Table G.30 DEWA control room requirements, 11 kV supply

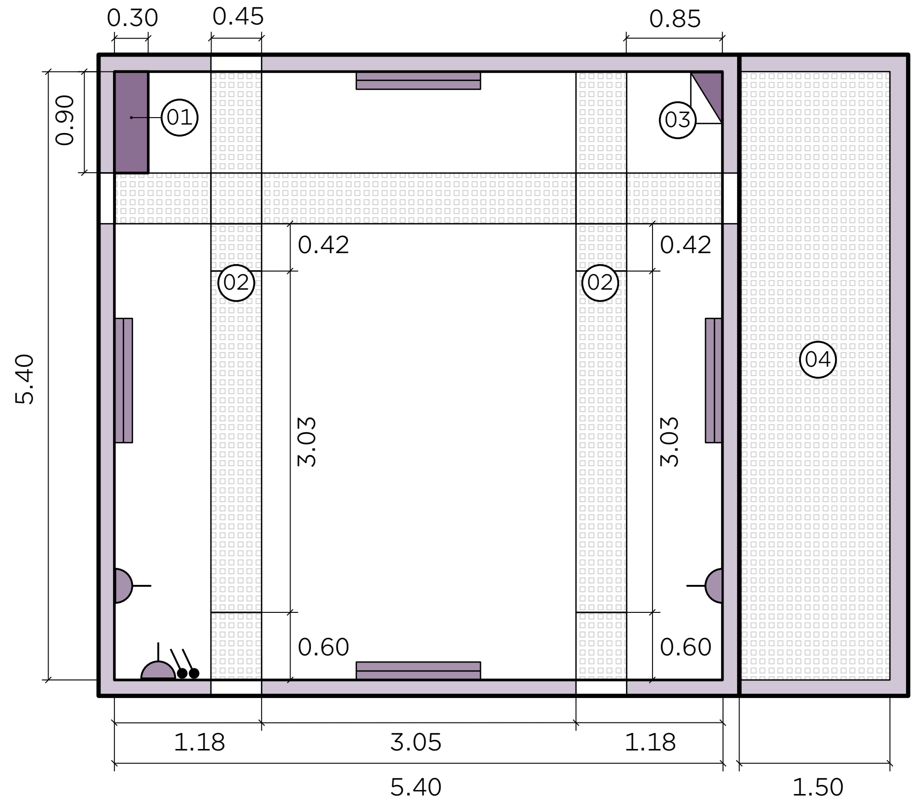


Figure G.48 Typical dedicated 11 kV/RMU room (enclosed) (m) (for reference only, not for construction)

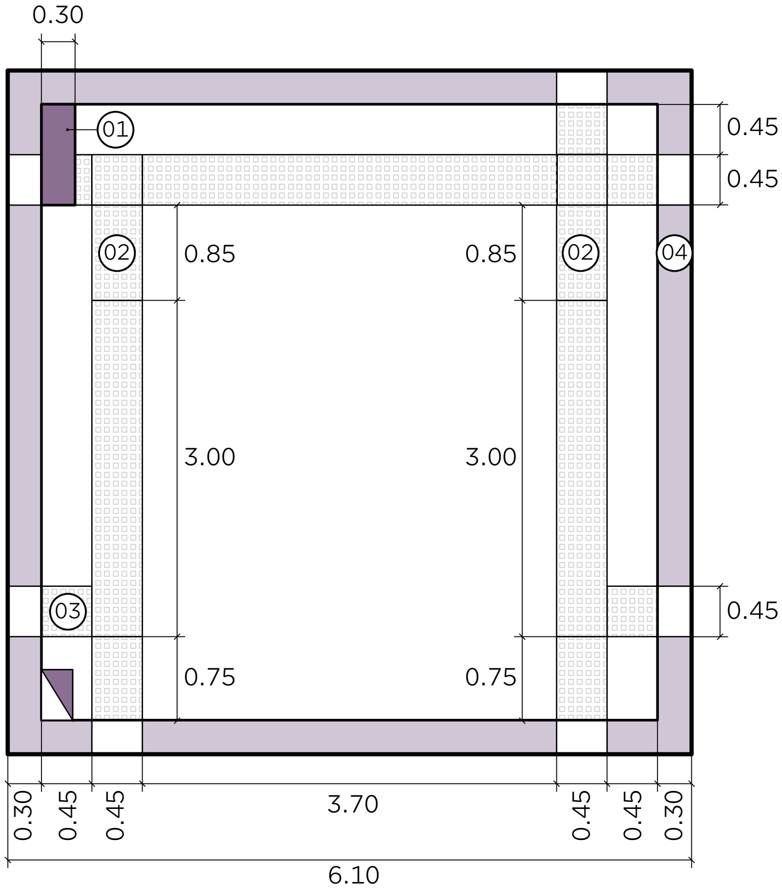
Key

01: RTU

02: Trench

03: DB

04: 8 m^2 for extra RMU



Key
01: RTU
02: Trench
03: DB
04: Compound wall less than 2.1m

Figure G.49 Typical dedicated 11 kV/RMU enclosure (open air) (m) (for reference only, not for construction)

G.7.6 Substation ventilation and fire safety provisions

G.7.6.1 General

Substations shall have adequate ventilation using natural louvers, mechanical ventilation or a combination of both, depending upon how many sides of the transformer room have direct access to an exterior wall.

Substations shall be 2 h fire rated to conform to Table 1.9, Ch. 1 of UAE FLSC **[Ref. G.1]**. Exterior walls do not need to be fire rated unless there is a risk of exterior fire spread and the wall is fire rated in accordance with Ch. 1 of UAE FLSC **[Ref. G.1]**.

G.7.6.2 Natural ventilation via two exterior walls

Substations at ground floor shall be naturally ventilated. A minimum of two sides shall be ventilated using aluminium louvered doors and fixed aluminium louvers.

Fixed aluminium louver window(s) should be at 600 mm above the outside ground level.

Aluminium louvered doors shall be of the following sizes:

a) transformer rooms: 3.05 m wide × 2.75 m high;

b) RMU rooms: 2.4 m or 3.05 m wide × 2.75 m high.

NOTE: Door details are shown in Figure G.50 and Figure G.51.

Substations shall be 2 h fire rated to conform to Table 1.9, Ch. 1 of UAE FLSC **[Ref. G.1]**. Exterior walls do not need to be fire rated unless there is a risk of exterior fire spread and the wall is fire rated in accordance with Ch. 1 of UAE FLSC **[Ref. G.1]**.

At least one exit door with door swing in the direction of egress shall be provided. If the door is in a 2 h fire rated fire rated wall, then the door shall be 90 min fire rated. Equipment access doors maybe sufficient to meet this requirement.

Walls enclosing covered parking ramps at the exit/access of the basement are interior walls. Louvers shall not be permitted in these walls unless they are protected in accordance with G.7.6.3.

G.7.6.3 Forced ventilation with no exterior walls

RMU rooms shall be at the ground floor. RMU rooms shall be 2 h fire rated to conform to Table 1.9, Ch. 1 of UAE FLSC **[Ref. G.1]**. Exterior walls do not need to be fire rated unless there is a risk of exterior fire spread and the wall is fire rated in accordance with Ch. 1 of UAE FLSC **[Ref. G.1]**.

Independent mechanical ventilation shall be provided to transformer rooms with no exterior walls (e.g. in a basement). All equipment shall be accessed from the landlord side.

The mechanical ventilation shall be sized to maintain the ambient temperature in the substation at maximum of 55 °C based on an outside air temperature of 48 °C. Supporting calculations shall be provided to justify the proposed exhaust and supply rates.

Typical details are shown in Figure G.52.

Louvers shall be provided on two sides of the room as a back-up to the mechanical ventilation system.

The total grill area shall be not less than 14.9 m^2 for 1,000 kVA transformer and not less than 18.6 m^2 for 1,500 kVA transformer.

Transformer rooms shall be 2 h fire rated to conform to Table 1.9, Ch. 1 of UAE FLSC **[Ref. G.1]**.

Louvers shall be protected by automatic 2 h fire rated shutters or 2 h fire rated curtains on the landlord side of the louvers (see Figure G.53).

Two combined fire and smoke detectors shall be provided on the landlord side of the louvers. They shall be located on the slab soffit within the vicinity of the louver in accordance with the dimensional requirements of Table 8.1 (item 25, door release service), Ch. 8 of UAE FLSC **[Ref. G.1]**.

Upon activation of both combined fire and smoke detectors, the fire rated shutters or fire rated curtains shall automatically close and the mechanical ventilation to the transformer room shall automatically stop.

The fire rated shutters or fire rated curtains shall have an automatic override switch on the landlord side.

At least one fire rated (90 min) exit door, with door swing in the direction of egress, shall be provided.

Equipment access doors may include louvers, but they shall be protected by automatic fire rated shutters or fire rated curtains on the landlord side of the louvers. The fire curtains/shutters will close in a fire and block the equipment doors therefore an alternative exit shall be provided and the equipment doors shall not be marked as an exit.

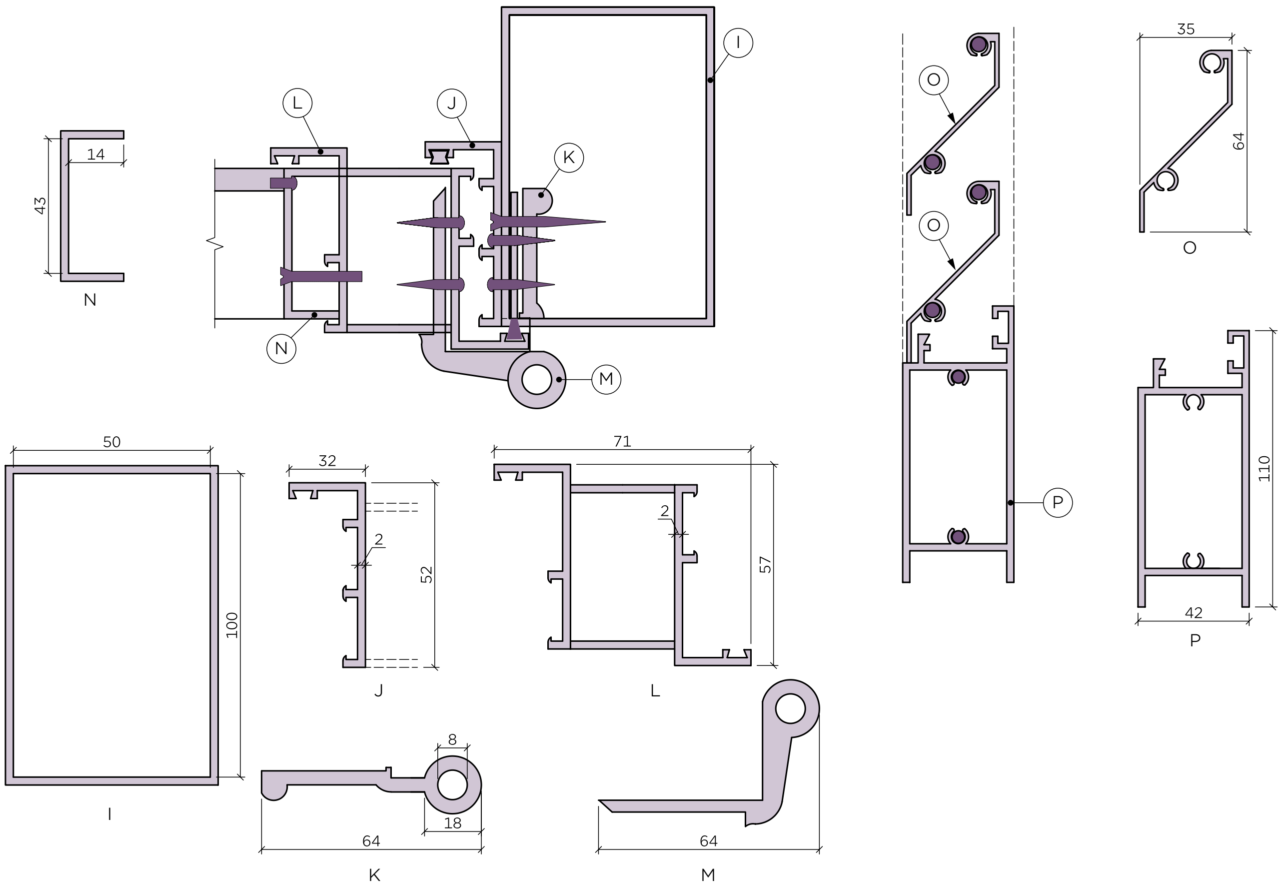
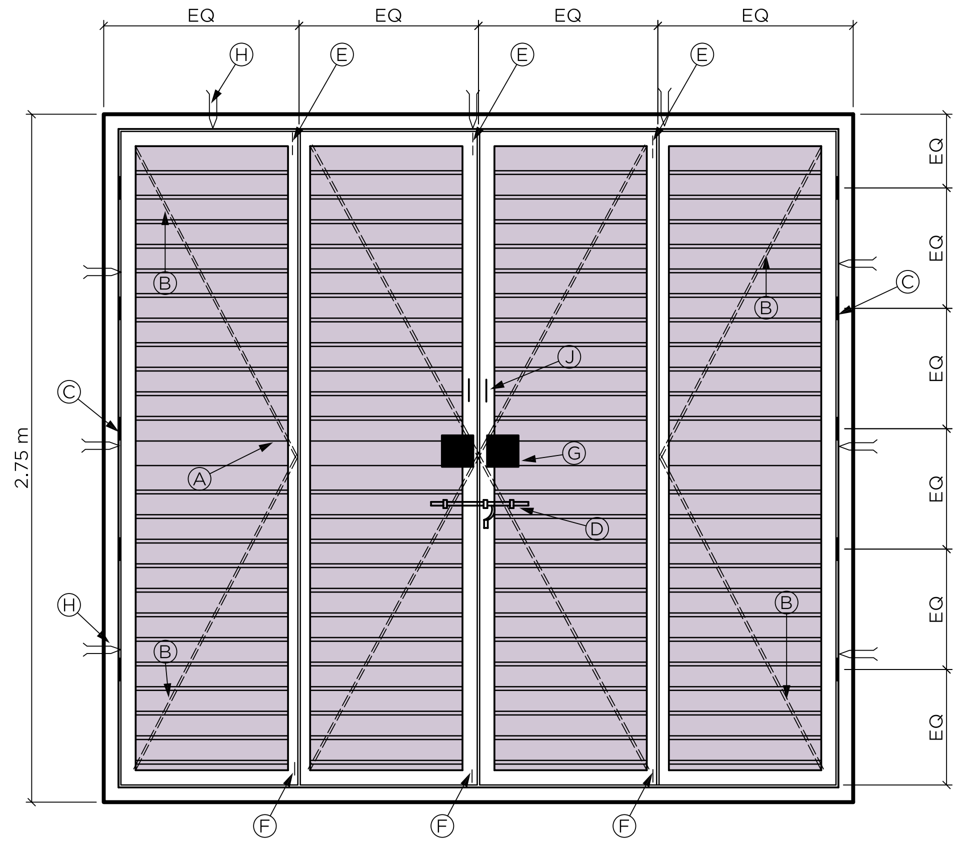
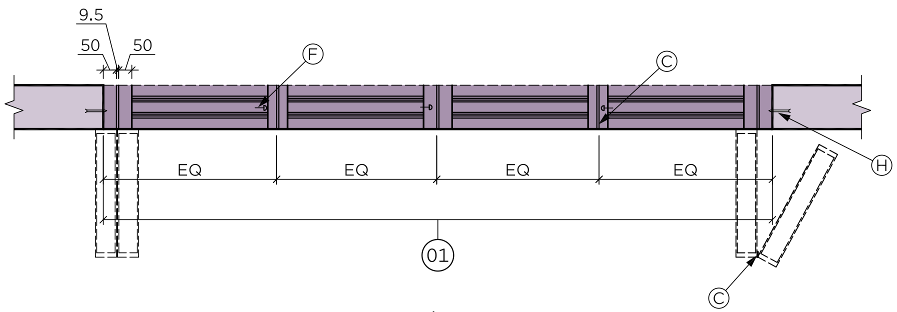


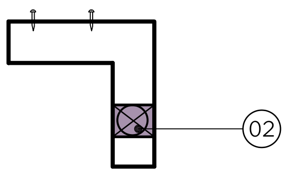
Figure G.50 Details of substation louvers



a) Elevation



b) Door plan



c) Details of additional locking arrangement

Key

01: 3.05 m, or 2.44 m if located where it opens onto a sikka/road, or as per plan

02: Slot

A: Central mullion

B: 40 mm × 20 mm bracing aluminium box

C: Heavy duty hinges

D: Heavy duty aluminium drop with locking hook

E: Heavy duty brass tower bolt (750 mm)

F: Heavy duty brass tower bolt (300 mm)

G: Handles

H: Rawl bolt

Figure G.51 Details of substation doors

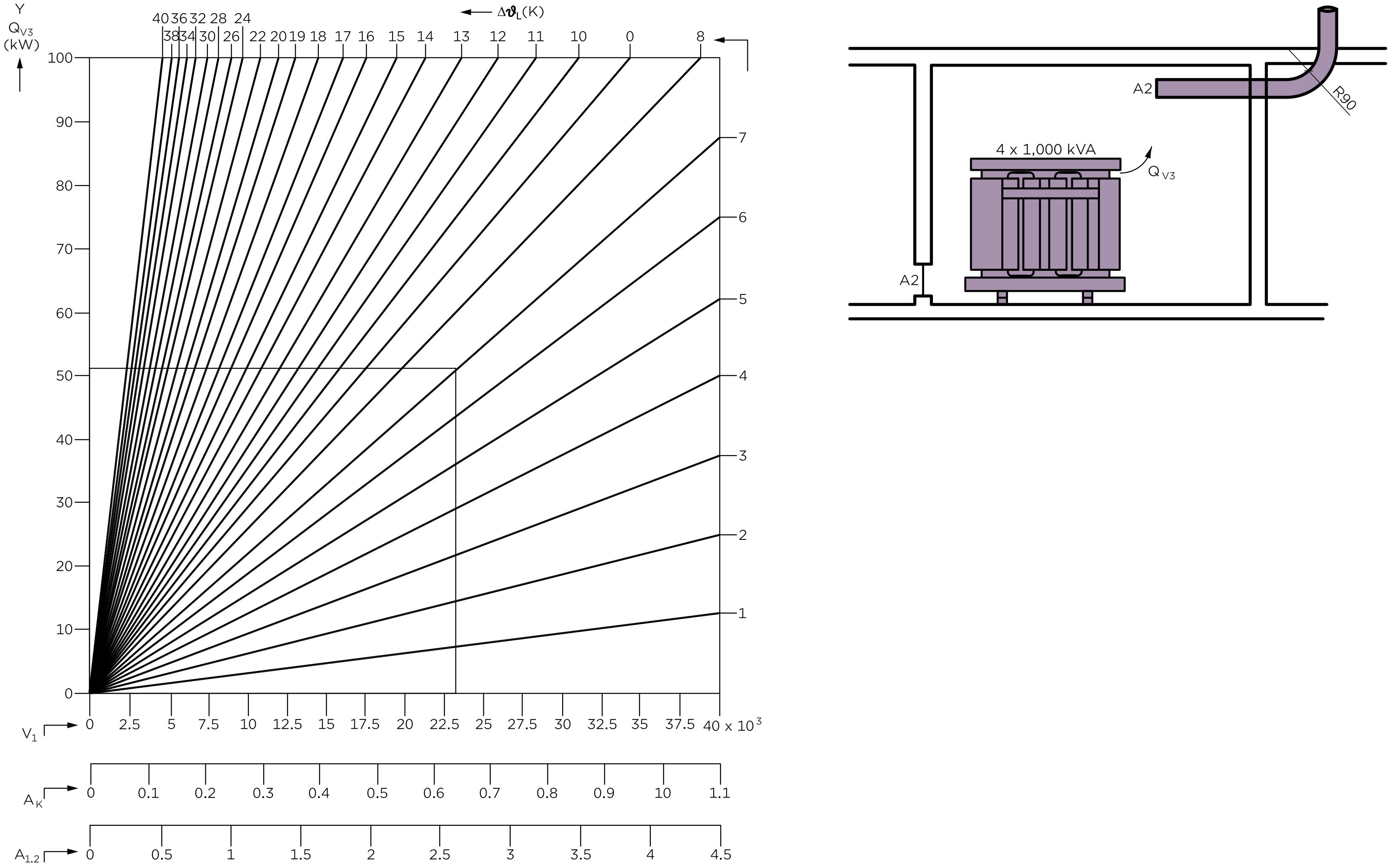


Figure G.52 Forced ventilation of transformer room in basement

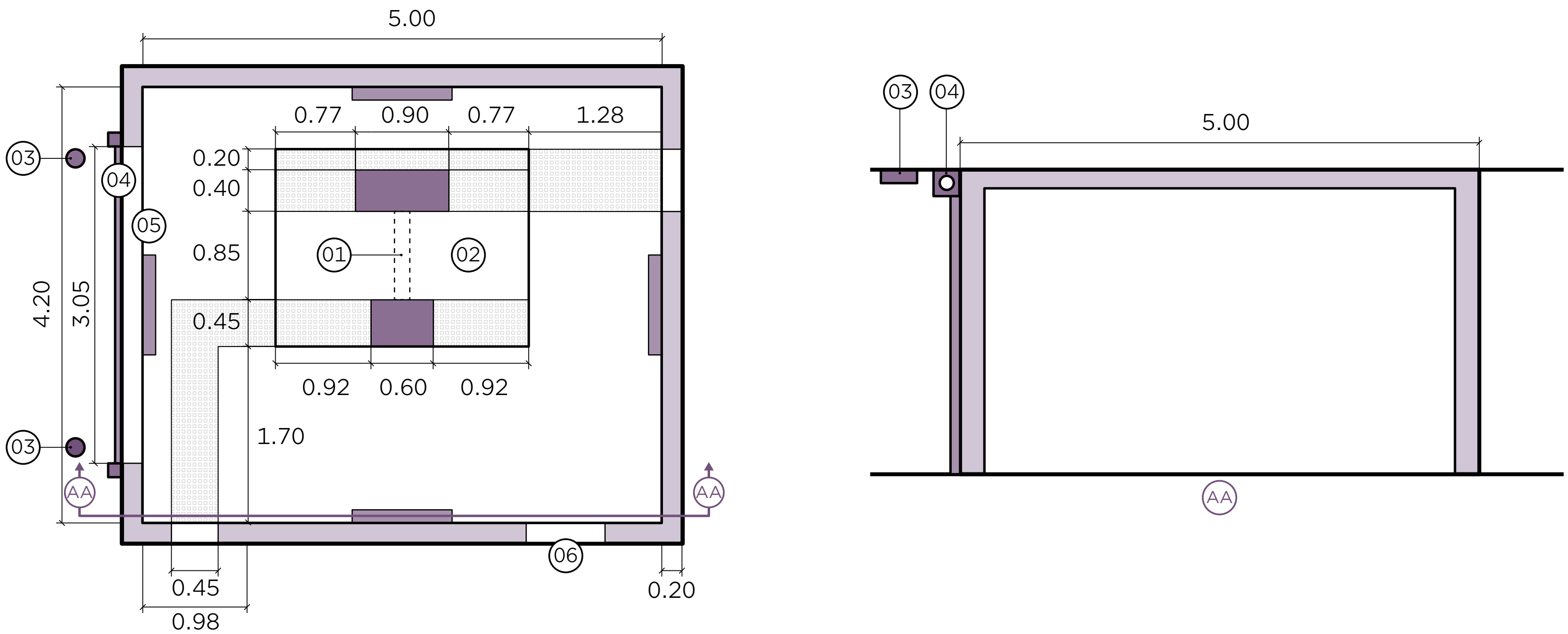


Figure G.53 Plan and section view of a basement transformer room with fire rated shutter/curtains over the louvers (m)

Key

01: 150 mm øPVC duct at trench level

02: Transformer base

03: Combined heat/smoke detector

04: 2 h fire/smoke curtain on landlords side to protect louver opening

05: Louvered door

06: 90 min fire rated door

G.7.7 Transporting equipment to basement transformer rooms

Transporting transformers between the public road and the transformer room is the customer's responsibility. The requirements set out in Table G.31 shall be followed.

Element of transport route	Requirements
Ramp	Straight, with a minimum width of 3 m. Sloped curves and speed breakers (humps) are not permitted. A minimum clear height of 3 m shall be maintained between the public road and the transformer room. The slope of the ramp shall be maintained at a maximum of 1:10 (10%).
Slab cut-out opening	The cut-out size shall be 3 m × 3 m and adjacent to the main RTA/public roadside. The area below the cut-out at basement level shall be designated as a loading/unloading bay. The area above the cut-out shall be open to sky. If there is a floor above then a minimum clear height of 7 m shall be maintained.

Table G.31 Transformer transportation requirements – main road to transformer room

G.7.8 Substation cable arrangement

Cable arrangements are subject to DEWA approval and shall conform to Table G.32.

Substation type	Cable arrangement
General substation	The cable trench inside a substation shall have a clear depth of 950 mm from the substation FFL, as indicated in Figure G.54. Cable route/arrangement from plot limit to the substation (if setback confirmed in affection plan issued by competent authority) shall be through cable trench with removable slab as shown in Figure G.55, or cable tray at high level basement. The cable route/arrangement from RMU room to transformer room for split/basement substations shall be through cable trench with removable slab as shown in Figure G.53, or cable tray at high level basement. If cables are passing through a traffic movement area, concrete encased ducts with manholes at both ends shall be provided. Spare provision for ducts shall be provided in accordance with DEWA requirements. Cable ducts shall have an internal diameter of 150 mm. NOTE: Cut-out at 950 mm depth from outside level (towards road/sikka) should be provided for HV cable entry. Typical arrangements are shown in Figure G.54 and Figure G.55.
Basement or split substation	For basement/split substation, the transformer room cable trench depth shall be 500 mm below finished floor, subject to DEWA approval. For cable tray arrangement, a clear depth of 950 mm shall be provided from the substation FFL up to the bed of the tray, with minimum clear depth of 450 mm between bottom of the slab and the bed of the tray. Cable installation/maintenance space of minimum 1.2 m shall be provided on at least one side of cable tray arrangement. The cable tray shall pass through public/open area and not through any closed area/room (there shall be no services, pipes, etc. below the cable tray). NOTE: Cable route from RMU to transformer room should be straight (without turns/bends). Where unavoidable, a minimum bending radius of R = 950 mm might be accepted.

Table G.32 Substation cable arrangement

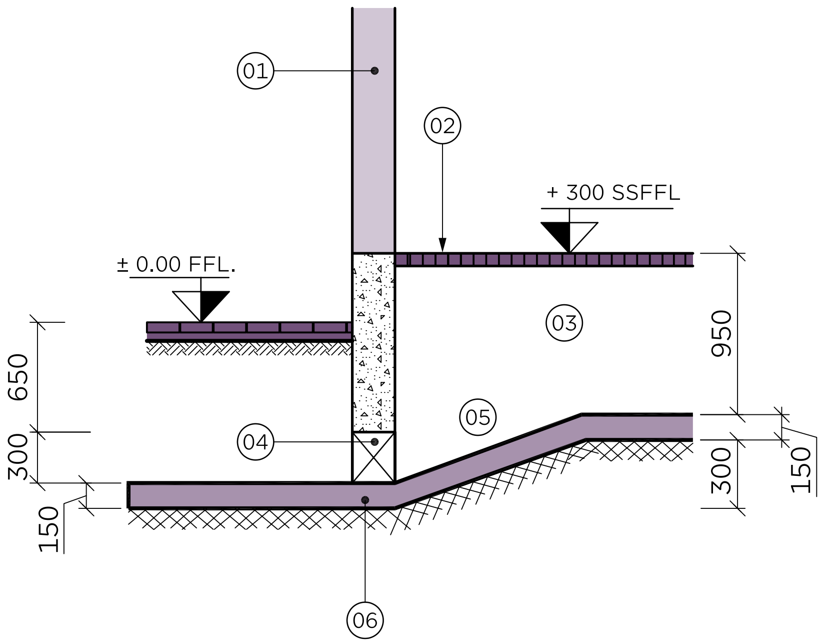


Figure G.54 Typical substation cable trench setting out details

Key
01: Wall
02: Chequered plate
03: Channel
04: Opening
05: Slope
06: Pre-cast concrete

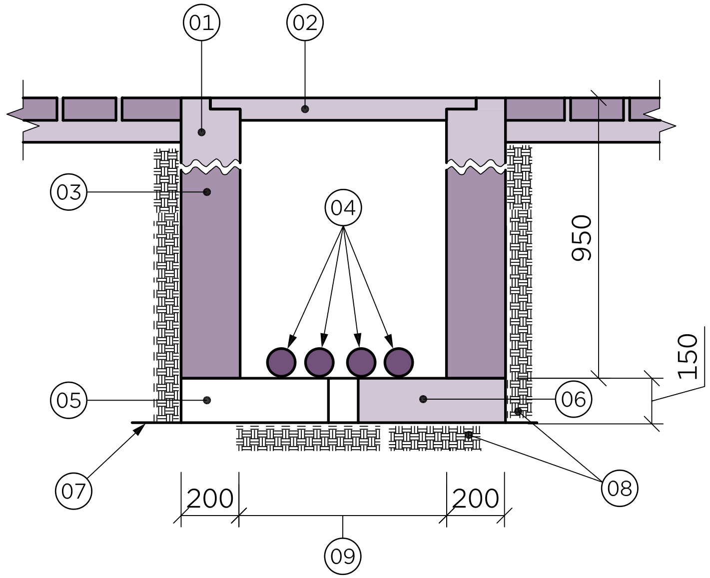


Figure G.55 Cable lying arrangement in concrete trench

Key
01: Pre-cast concrete kerb
02: Cover heavy duty
03: 200 mm thick block work
04: Cables
05: 0.08 m diameter drain in floor at 2 m c/c
06: 30 N/mm² pre-cast concrete
07: Polythene sheet
08: Compacted earth
09: Channel width – variable according to number of cables

G.7.9 Direct 11 kV supply for super high-rise towers above 200 m

G.7.9.1 Intake arrangement

The point of supply to a super high-rise tower is the supply intake of MV switchgear, which is located adjacent to the DEWA metering/control room. The switchgear shall be provided with a circuit breaker, with E/F and O/C protection.

The customer is responsible for all equipment beyond the point of supply. DEWA does not supply, operate or maintain any equipment installed above ground level.

All equipment procured by the customer shall have dual ratio (6.6/11 kV) unless it is clearly stated to be 11 kV.

All equipment shall conform to the relevant international standards (IEC standards).

Total transformer losses shall not exceed 1.5% of rated capacity.

Only cast resin transformers shall be installed in residential/commercial buildings.

Technical justification shall be submitted for availing direct 11 kV supply to the super high-rise building for locating transformers above ground level(s). This depends on the height of the building, size of load, type of load, etc. When buildings exceed 200 m then DEWA may accept direct 11 kV supply. The designer shall consult with DEWA to confirm.

MV switchgear is suitable for termination of maximum cable size of 3 × 300 mm^2 XLPE/PVC/SWA/PE aluminium/copper cable with heat shrinkable type cable terminations.

Termination at a private MV switchgear incomer shall be installed by the consumer. Terminations at a DEWA RMU shall be installed by DEWA.

G.7.9.2 Protection requirements

Suitable protection and interlocking shall be provided to ensure that a private substation does not have a negative impact on the DEWA system.

The private substation shall be configured such that its protection operates before the DEWA protection during a fault.

Mechanical and electrical interlocks shall be provided so that the incomers are not paralleled. In substations with multiple switchboards, the interlock shall extend to all of the switchboards.

Incomer protection relays shall conform to IEC 60255.

NOTE 1: Compliance is supported by type test certificates and guaranteed routine manufacturer's works test certificates. Only certificates confirming that relays have passed the type tests need to be submitted to DEWA.

The overcurrent relay shall operate correctly for fault currents up to 31.5 kA.

Instrument transformers shall conform to IEC 61869.

NOTE 2: Compliance is supported by type test certificates and guaranteed routine manufacturer's works test certificates. Only certificates confirming that current transformers (CT) have passed the type tests need to be submitted to DEWA.

The incoming current transformer shall be dimensioned such that the protection scheme operates effectively for a fault current of 31.5 kA.

Reverse power protection shall be provided to enable in-feeds to faults within the DEWA 11 kV network to be cleared within 3 s.

G.8 Liquefied petroleum gas (LPG)

G.8.1 General

LPG installations shall comply with Ch. 11 of UAE FLSC **[Ref. G.1]**. LPG main distribution pipes serving multiple floors of a building shall be contained within a dedicated 2 h fire rated shaft.

G.9 Water

G.9.1 Water metering

A DEWA main meter shall be installed to measure and record the water demand and consumption of a building.

Each individual tenancy in a building shall have a sub-meter installed which is connected to the building main meter.

Additional requirements for sub-metering are detailed in H.5.2.6.

Where a building management system or central control and monitoring system is installed, metering shall be integrated into the system to allow real time profiling and management of water demand and consumption.

G.9.2 Design and installation of water meters

The design and installation of DEWA water meters, including smart metering communications requirements, shall follow the specifications and sample drawings in the DEWA Circulars and Regulations [Ref. G.8] and as listed in Table G.33.

DEWA specification	Sample drawing number	Sample drawing title
Domestic water meter installation in meter room - guidelines	PEW-STD-AMI-003	Water meters in meter room
Bulk meter installation in chamber - guidelines	PEW-STD-AMI-004	Bulk water meters in chamber (for bulk meters 50 mm and greater diameter connection)
Bulk meter installation in chamber - guidelines	PEW-STD-AMI-005	50 mm diameter bulk water meter installation in chamber (2 in meter with LDPE connection)

Table G.33 DEWA specifications and sample drawings for design and installation of water meters

G.10 District cooling

G.10.1 General

This section identifies the coordination requirements and common technical requirements related to district cooling installations and their connection to building cooling systems.

G.10.2 Coordination with district cooling Providers

Depending on the location of the development, the Customer shall contact the relevant district cooling Provider to obtain the latest district cooling technical design guidelines [Ref. G.9].

Coordination shall start in the concept design phase and continue as necessary in later design stages. The scope of work shall be agreed as part of the service agreement between the two parties.

NOTE: district cooling Providers in Dubai include (but are not limited to) those listed in [Ref. G.9].

The building design parameters shall conform to the district cooling Provider's specific technical and interface requirements [Ref. G.9]. The following parameters shall be determined as a minimum:

a) cooling capacity requirements;
b) pipe connection size;
c) supply/return chilled water temperature on the primary and secondary sides;
d) maximum allowable system pressure; and
e) design water velocities/pressure drop.

G.10.3 Common technical requirements

The following common technical requirements shall be met for all developments featuring district cooling.

NOTE 1: The list is provided to assist Customers but does not replace requirements from the district cooling Providers.

a) The energy transfer station (ETS) shall accommodate the district cooling Provider's heat exchangers (HEXs), and all associated equipment for the primary and secondary sides of the HEXs. The chilled water system configuration shall be determined by the Customer and coordinated with the district cooling Provider.

   NOTE 2: Figure G.56 and Figure G.57 show examples of installed ETS pipework and pumps.

b) The secondary side shall include all equipment for supplying chilled water to the premises. The pipework installation shall conform to the requirements identified in H.4.13.
c) The location, configuration and space dimension for the ETS and valve chamber (VC) shall be agreed taking into account the route and availability of the main district cooling pipes. Space planning for the ETS, including accessibility of the ETS plant, shall be included in the design at the concept design phase.
d) The structural Engineer shall design the supporting structure to withstand the loading imposed by equipment in the ETS and along the equipment access route.
e) The ETS shall be provided with electric power, lighting, communication, potable water, drainage, ventilation and cooling in accordance with Part G and Part H.
f) The district cooling facility, including but not limited to the ETS, cooling towers and other mechanical and electrical plant rooms, shall conform to the fire safety requirements of Ch. 14 of the UAE FLSC [Ref. G.1].
g) In accordance with the service agreement, the district cooling Provider or Customer shall provide heat exchanger (HEXs) and primary side chilled water installation (including all piping from the underground) to the VC, and to and inside the ETS.
h) The district cooling Provider shall design the VC in coordination with relevant authorities and based on the premises load demand. VC civil construction shall be carried out by the Customer or district cooling Provider in accordance with the service agreement.
i) A smart energy metering system shall be provided in accordance with H.4.14 as part of the primary chiller water system.
j) The Customer shall provide the secondary side chilled water piping systems pumps, cooling coils, and control valves and electrical equipment.
k) The secondary chilled water circuit design shall align with the supply stated by the district cooling Provider, and shall return chilled water temperatures.

l) The chilled water distribution system and control system on the secondary side shall be designed as a variable flow chilled water system. It shall use two-way control type valves, e.g. pressure independent control valves.

m) The secondary side system shall incorporate a bypass to avoid chilled water stagnation. The minimum pump flow shall correspond to a maximum chilled water flow of 5% of the full design flow.

n) The chilled water pumping system installed in the secondary side in the ETS shall allow the chilled water flow to vary between 5% and 100% of the full design flow. The chilled water pumping design and arrangement shall account for redundancy and part load conditions (during winter/night-time operation).

o) Secondary system pipework shall be flushed, cleaned and provided with chemical dosing to provide corrosion protection, and to enable the minimum required water condition parameters of the district cooling Provider to be achieved. Flushing shall be carried out using a bypass to avoid a flow of contaminated water through the HEXs.

p) A water sample shall be analysed by a district cooling Provider-approved testing laboratory, to verify conformity to the specified water quality parameters. Analysis results shall be submitted to the district cooling Provider before any water flow is allowed through the HEXs.

q) The secondary side chilled water distribution system shall be accurately flow-balanced in order to achieve the specified temperature difference. This work shall be performed in accordance with balancing principles for variable flow systems.

r) The pumps shall be provided with variable frequency drives (VFDs). The pump VFDs shall be specified with the necessary communication protocol to allow the district cooling Provider to monitor the status of the VFDs.

s) Differential pressure transmitters shall meet the following minimum requirements.

   1) They shall be of industrial grade, and suitable for the environment in which they are installed.

   2) They shall provide a DC output of 4 mA to 20 mA with a maximum loop resistance of 1,000 Ω.

   3) They shall be linear in function, with differential pressure, and capable of isolation from the pipes that they monitor.

t) The specific products to be used for pumps, VFDs, and differential pressure and temperature transmitters utilized on the secondary circuits shall be agreed and confirmed with the district cooling Provider.

u) An industrial grade programme logic controller (PLC)/human machine interface (HMI) controller with open protocol capability shall be provided in the ETS. The ETS PLC shall be integrated with other control systems in the district cooling plant and associated building. Single mode fibre-optic connectivity shall be included with district cooling plant and ETS integration. Sleeves for fibre-optic shall be included along with a chilled water pipe and both shall be extended up to the ETS PLC control panel.

v) The chilled water pipes and fibre-optics to the VC/interface point shall be routed in accordance with the service agreement. The ETS room shall be located as close as possible to the plot VC and plot limit.

NOTE 3: The district cooling Provider might choose to review the design of the secondary side chilled water distribution and air handling equipment, to give confidence that the allowable chilled water temperature difference is likely to be achieved.

Figure G.56 Examples of ETS pipework

Figure G.57 Examples of ETS pumps

G.11 Telecommunications

G.11.1 Design and installation of telecommunications infrastructure

G.11.1.1 General requirements

This section provides the requirements for the design of all telecommunications (telecom) infrastructure installations within any development including new build, “greenfield”, redevelopment, “brownfield”, and additions, alterations, renovations or refurbishments to existing buildings, in Dubai.

These requirements are based on version two of the Telecommunication Regulatory Authority (TRA), In-Building Telecommunication Network – Specification Manual Guidelines for FTTx in new Buildings [Ref. G.10]. If the TRA is updated to give more stringent requirements, these shall be used in preference to the DBC.

This section specifies the minimum requirements to provide a baseline infrastructure. There is no restriction to extending the baseline, provided that the design meets the requirements in this section and does not prevent competition, e.g. by using proprietary standards.

All telecom infrastructure shall enable each user/tenant freedom of choice between telecommunication service providers (SPs).

The requirements cover all of the following aspects of infrastructure:

a) civil infrastructure and entry ducts;
b) fibre concentration point (FCP) space(s) per development or plot;
c) meet-me-room (MMR) space(s) per development or plot;
d) telecom rooms;
e) indoor mobile service and rooftop rooms;
f) building pathways;
g) OSP cables;
h) ISP cables.

Passive optical fibre infrastructure shall be provided to support deployment of FTTx.

Copper access networks shall not be used for SP services.

All buildings shall be equipped with physical infrastructure capable of supporting multiple high-speed SP networks which can be easily accessed by the SP. The Developer shall assume a minimum of two active SPs in the region, but may future-proof the infrastructure by incorporating provision to support a possible third SP.

New installations shall be based upon a minimum of category 6 balanced twisted pair cabling as specified in ISO 11801 1. Designers may future-proof designs by providing category 6 A cabling, which supports higher data rates and provides support for newer power-over-ethernet (PoE) standards that are typically used for video surveillance camera and wireless local area network access points. Where category 6 A is specified, unshielded twisted pair (UTP) or shielded twisted pair (STP) may be utilized.

Category 6 cabling (structured cabling system) shall as a minimum conform to the requirements specified in G.11.4.10.7.

Cabling within the tenant space (e.g. multi-tenanted commercial/retail building, home, unit, flat, apartment, single family home or similar) for onward distribution of services beyond the tenant equipment is not in the scope of these requirements.

The requirements of this section do not replace a detailed specification, act as instruction for untrained persons, or provide for every specific design circumstance. For situations beyond the scope of these requirements, the TRA shall be consulted to obtain further clarity and guidance.

Special buildings or development areas (e.g. hospitals, shopping malls, stadiums, data centres, public buildings) will need further enhanced requirements. Individual agreements shall be bespoke and beyond that of the minimum requirements established in this section.

Installations where special telecom requirements might exist shall be referred to a registered Dubai SP at the preliminary design stage to incorporate any specific requirements above that of this section.

G.11.1.2 Telecoms service

To support the deployment of SP optical broadband networks and services, the Developer shall design and install in-building elements of telecom infrastructure up to and within single and multi-tenant premises (to include single or multiple buildings, villa complex, warehouses, etc.).

Standardized telecom infrastructure shall be provided for FTTx, to enable seamless interworking of all network parts. All designed infrastructure shall support ethernet and GPON.

To optimize investments, SPs shall share essential infrastructure elements including telecom rooms, ducts, cable pathways and cabling.

G.11.1.3 Reference architecture

The general schematics in Figure G.58 and Figure G.59 shall be used as the basis for infrastructure design. Adaptations which enhance the resilience or performance of telecom infrastructure are permitted, if agreed by consultation with all stakeholders. Any such adaptations shall meet the requirements of this section.

NOTE: The reference architecture shown in Figure G.58 allows the end user to change SPs. It also allows service to be provided by multiple SPs in parallel if required.

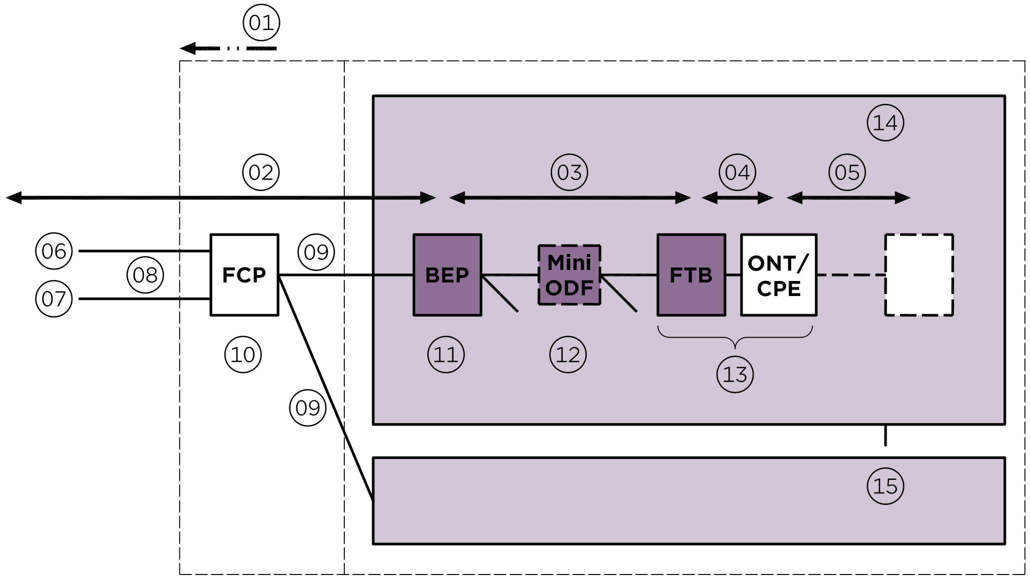
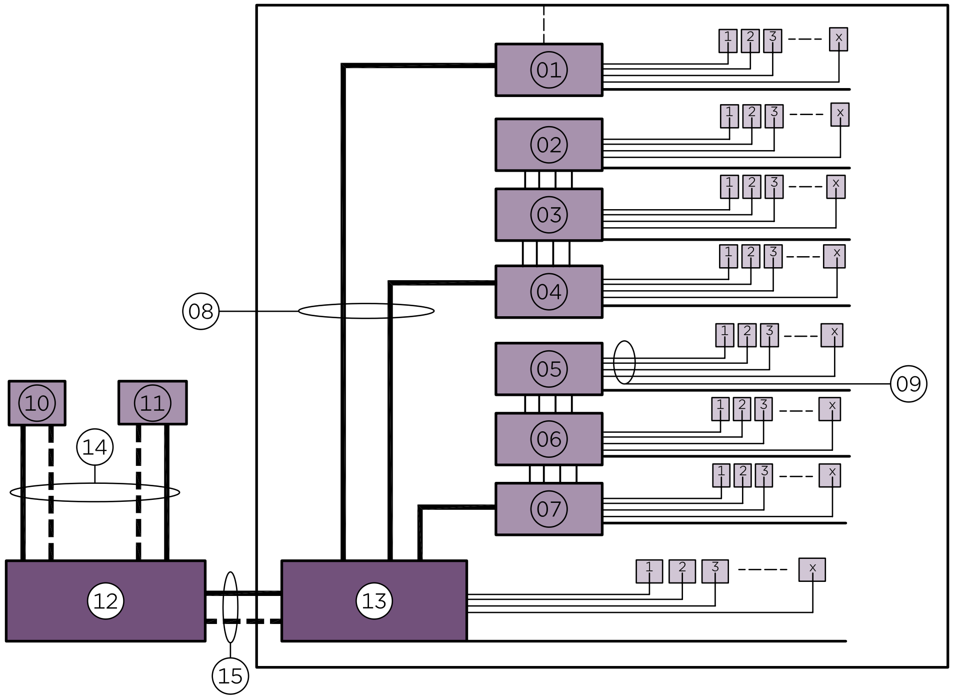


Figure G.58 Reference architecture

Key

01: Property boundary
02: External cabling (OSP)
03: In building cabling (ISP)
04: Equipment patch cord
05: Tenant/unit cabling
06: Service provider 1
07: Service provider 2
08: SP feeder cabling
09: SP distribution cabling
10: MMC/MMR
11: MTR
12: FTR
13: Consolidation cabinet
14: Building 1 boundary
15: Building n boundary



Key

01: FTR-7th floor mini ODF (splicing point)
02: FTR-6th floor
03: FTR-5th floor
04: FTR-4th floor mini ODF (splicing point)
05: FTR-3rd floor
06: FTR-2nd floor
07: FTR-1st floor mini ODF (splicing point)
08: Multicore indoor fibre cables
09: 4 core SM drop fibre cables from each unit to mini ODF (splicing point) in FTR
10: du PoP-A and B
11: Etisalat PoP-A and B
12: MMC/MMR
13: MTR with splitters
14: SP feeder cabling
15: SP distribution cabling

Figure G.59 Schematic diagram for typical building connectivity

The infrastructure design shall avoid single points of failure. The design shall enable physical diversity and redundancy in feeder and distribution cabling, and in site-wide distributor cabling. For example, a site with multiple buildings shall have more than one MMC and FCP.

The design shall include all the following elements of reference architecture:

a) duct infrastructure from SP stubs/development boundary to MMC;
b) development MMC;
c) campus duct from MMC to BEPs, including handholes, turning chambers and pulling chambers as required;
d) BEPs to accommodate SP and campus telecom cabling;
e) FCPs;
f) telecom rooms; and
g) in-building cabling.
h) Design standards shall be applied by building type:
   1) residential, designed in accordance with ISO/IEC 11801-1, ISO/IEC 11801-4 and ISO/IEC 11801-6;
   2) commercial, designed in accordance with ISO/IEC 11801-1, ISO/IEC 11801-2 and ISO/IEC 11801-6;
   3) industrial, designed in accordance with ISO/IEC 11801-1, ISO/IEC 11801-2 and ISO/IEC 11801-3 and ISO/IEC 11801-6.

The design shall include:

i) shared SP infrastructure;
ii) performance requirements which achieve system resilience;
iii) a roles and responsibilities matrix (see G.11.2);
iv) safeguards for future adjacent developments and OSP extensions to these, clearly identified as such on the design drawings;
v) provision or cessation of service to enable each tenant to adopt either SP without on-site intervention;
vi) a choice of SP;
vii) provisions for a minimum of two SPs;

   NOTE 1: The design may include an option to enhance this provision to support a future third SP.

viii) a minimum of four optical fibre cores per premise, for a two-SP design, enabling the possibility for either SP to provide an ethernet-based service;
ix) SP OLTs/fibre switches connected directly to the dedicated fibre cores allocated to them;

   NOTE 2: Large developments can have local SP OLTs where high tenant numbers are expected.

x) an MTR for a minimum of two SPs;
xi) rack space and SP cabling allowances in the MTR for two SPs;
xii) dedicated end-to-end FTTx network with full-service delivery control for each SP;
xiii) the required splitters for GPON architecture inside the MTR for each of the two SPs (SPs shall provide their own feeder fibre connecting the OLT to the splitter);
xiv) in-building cabling with multicore optical fibre cable;
xv) at least one dedicated fibre from each SP OLT to each home, commercial/retail unit or other building;
xvi) within each tenant space, a consolidation cabinet configured to house a minimum of two ONTs in parallel.

G.11.2 Responsibility matrix

Developers shall comply with the design and supply requirements of the responsibility matrix in Table G.34.

No.	Item description	Masterplan Developer (site wide)	Building Owner (individual buildings)	Service providers (SP)
1	Lead-in ducts, including connections to entry manholes outside building boundaries.	✓		
2	Installation of manholes and ducts outside the building/boundaries (including cover).	✓		
3	Entry boxes inside the building/complex of villas boundaries (including the cover).		✓	
4	Supply and installation of 4-core SM fibre terminal box with duplex LC/APC adaptors and pigtail and two SC/APC adaptors.		✓	
5	Fibre optic cable supply, pulling/blowing, termination and testing from the MTR to FTR and drop fibre cables supply, pulling, termination and testing from the FTR to consolidation cabinet (except shell and core offices, which are under the tenant scope).		✓	
6	Fibre optic cables supply, pulling, termination and testing from the MTR to FTR and drop fibre cables supply, pulling, termination and testing from the FTR to consolidation cabinet.		✓	
7	Supply and installation of mini optical distribution frame (ODF) splice cabinet at splice point location.		✓	
8	Splicing and labelling multicore fibre cables with 4-core drop cables using wall-mounted mini ODF.		✓	
9	Horizontal cabling inside the unit/apartment/office/retail (except shell and core offices, which are under the tenant scope).		✓	
10	FTTx components such as the fibre cables, 42U 800 mm × 800 mm free standing racks, ODF, high density fibre patch panel, low-density fibre patch panel, patch-free splitters, mini ODF for splice point, mini ODF for shell and core, 4-port fibre terminal box (with LC/APC and SC/APC pigtails and adaptors), GPON splitters, open rack for splitters and fibre patch cords.		✓	
11	Fibre optic splitter supply and installation (from the approved lists of suppliers/vendors of both du and Etisalat).		✓	
12	Supply of fibre patch cords and pre-patching the fibre patch cords between splitter downlink ports to building fibre patch panels (ISP) and between splitter uplink ports to OSP fibre patch panels.		✓	

Table G.34 Responsibility matrix

No.	Item description	Masterplan Developer (site wide)	Building Owner (individual buildings)	Service providers (SP)
13	Supply of pigtail cords and splicing of patch-free splitter downlink cores with the pigtail cords and terminating pigtail cords in the fibre patch panels (ISP), splicing the patch-free splitter uplink cores with feeder cable (for Etisalat).		✓	
14	Consolidation cabinet supply and installation (including accessories and related elements).		✓	
15	Supply and installation of vertical and horizontal cable trays, cable pathways, ducts and microducts.		✓	
16	Telecom rooms/spaces and related electrical, mechanical and civil requirements.		✓	
17	Plot of 10 m × 10 m for each MMR.	✓		
18	Construction of MMR.	✓		
19	Commissioning of MMR.			✓
20	Fibre optic cables supply, pulling, termination and testing from the MTR to each MSR and the rooftop room.		✓	
21	Supply and installation of fibre optic components for IBS connectivity (GSM)		✓	
22	SP identification labels (GAID and EID), supply and placement in the building unit.		✓	

Table G.34 Responsibility matrix (continued)

G.11.3 Outside plant (OSP) common infrastructure specifications

G.11.3.1 Lead-in ducts

G.11.3.1.1 General

A series of lead-in ducts shall be provided from the BEP (and MMRs where present) to MMCs within 2 m of the plot boundary. The lead-in ducts shall be reserved for the use of the SPs.

All developments shall have a minimum of two lead-in routes. These routes shall be geographically separated to support different SP routes. They shall provide physical diversity, if required by the development type.

The MMC at each position shall enable separate duct connections from three independent SPs. The SP connection to the chamber shall be a minimum of two 110 mm ducts. Alignment of each chamber shall allow the SP access face parallel to the plot boundary. Sealed stubs shall be pre-installed from the chamber to the actual boundary location.

Campus ducts from the MMC shall be installed to the BEP, installing additional turning chambers and handholes as required on each specific route. If required, at the entry to the BEP, a wide-angle long radius bend (factory-made) may be provided; alternatively, entry boxes (for main and redundant routes) may be provided.

NOTE: The BEP may be located within the MTR.

Where the masterplan includes MMRs, the duct route to the BEP shall be via the MMR plot(s). Six 110 mm ducts shall be installed to this route.

A maximum of two shallow bends up to 90° each may be included on any duct section between chambers. The distance between maintenance holes/handholes shall be not more than 200 m. Handholes shall not be used for turns, junctions or accommodating any FTTx equipment.

The work required to connect a projects infrastructure to any SP infrastructure shall be minimized. Connection points at the plot boundary shall be designed after consulting with utilities records to establish existing SP infrastructure in the site area.

All ducts designed and installed by the Developer shall:

a) be made from black PVC-U or HDPE;
b) be of smooth bore construction;
c) be buried to a depth of 600 mm below the finished ground level;
d) be sloping away from the building;
e) be protected by concrete when running under permanent paved surfaces;
f) be sealed at each end to prevent the ingress of water, sub-soil, gas, or pests;
g) have an entry/pull box installed for any right-angled or sharp bends in the lead-in duct (main and redundant) routes; and
h) include a draw rope in each duct made of twisted, mildew-resistant polypropylene (minimum outside diameter of 6 mm; minimum tensile strength of 1,000 kg).

OSP shall meet the requirements that are summarized in Table G.35. OSP requirements for mosques and other places of worship shall be in accordance with **Part K**.

No.	Item	Complex of villas	Building with less than 50 tenants or up to G+5 or building area up to 3,000 m²	Building with 51 to 100 tenants or up to G+10 or building area up to 7,000 m²	Building with 101 to 300 tenants or building area more than 7,000 m²	Building with more than 300 tenants	Shopping mall	Bulk service buildings	Group of warehouses, worker accommodation and factories
1	Entry box	JRC 12 for every 10 villas JRC 12 for plot entry per villa	JRC 12 for main route JRC 12 for redundant route	JRC 12 for main route JRC 12 for redundant route	JRC 12 for main route JRC 12 for redundant route	JRC 12 for main route JRC 12 for redundant route	JRC 12 for main route JRC 12 for redundant route	JRC 12 for main route JRC 12 for redundant route	JRC 12 for every 10 warehouses JRC 12 for plot entry per warehouse
2	Entry duct	2 × D56 (50 mm) per villa 2 × D54 (100 mm) for plot entry	2 × 100 mm primary route 2 × 100 mm secondary route	2 × 100 mm primary route 2 × 100 mm secondary route	2 × 100 mm primary route 2 × 100 mm secondary route	2 × D54 (100 mm) primary route 2 × D54 (100 mm) secondary route	2 × D54 (100 mm) primary route 2 × D54 (100 mm) secondary route	2 × D54 (100 mm) primary route 2 × D54 (100 mm) secondary route	2 × 100 mm per warehouse 2 × 100 mm primary plot entry 2 × 100 mm secondary plot entry
3	MTR (w × l × h)	Not applicable	2 m × 2 m × 3 m	3 m × 3 m × 3 m	3 m × 3 m × 3 m	3 m × 3 m × 3 m	3 m × 3 m × 3 m	3 m × 3 m × 3 m	2 m × 2 m × 3 m
4	RTMR (w × l × h)	Not applicable	3 m × 3 m × 3 m (considering G+10 floors or less)	3 m × 3 m × 3 m (considering G+10 floors or less)	3 m × 3 m × 3 m (considering G+10 floors or more)	3 m × 3 m × 3 m (considering G+10 floors or more)	To be determined during design	To be determined during design	Not applicable
5	MSR (w × l × h)	Not applicable	Not applicable	Not applicable	3 m × 3 m × 3 m every ten floors starting from the lowest basement/ ground floor (G+10 floors or more)	3 m × 3 m × 3 m every ten floors starting from the lowest basement/ ground floor (G+10 floors or more)	To be determined during design	To be determined during design	Not applicable
6	FTR (w × l × h)	Not applicable	1 m × 0.6 m × 3 m	1 m × 1 m × 3 m	1.5 m × 1.5 m × 3 m	2 m × 2 m × 3 m	To be determined during design	To be determined during design	1 m × 1 m × 3 m
7	Riser cable containment main risers	Two of 50 mm conduit	1 × 450 mm × 50 mm cable tray for fixed services 1 × 300 mm × 50 mm cable tray for IBS	1 × 450 mm × 50 mm cable tray for fixed services 1 × 300 mm × 50 mm cable tray for IBS	1 × 450 mm × 50 mm cable tray for fixed services 1 × 300 mm × 50 mm cable tray for IBS	1 × 450 mm × 50 mm cable tray for fixed services 1 × 300 mm × 50 mm cable tray for IBS	1 × 450 mm × 50 mm cable tray for fixed services IBS tray to be determined during design	To be determined during design	Two of 50 mm conduit

Table G.35 Summary of OSP requirements

G.11.3.1.2 Scenario 1 – Connection to existing SP duct infrastructure

The Developer shall connect the development OSP to the existing SP duct systems or spur provided for the development plot (see Figure G.60). This shall include providing handholes, ducts and turning chambers as required to connect the SP duct to the MMC.

MMC positions shall be coordinated with the existing SP infrastructure, as the SPs might have different infrastructure connection points for the specific development.

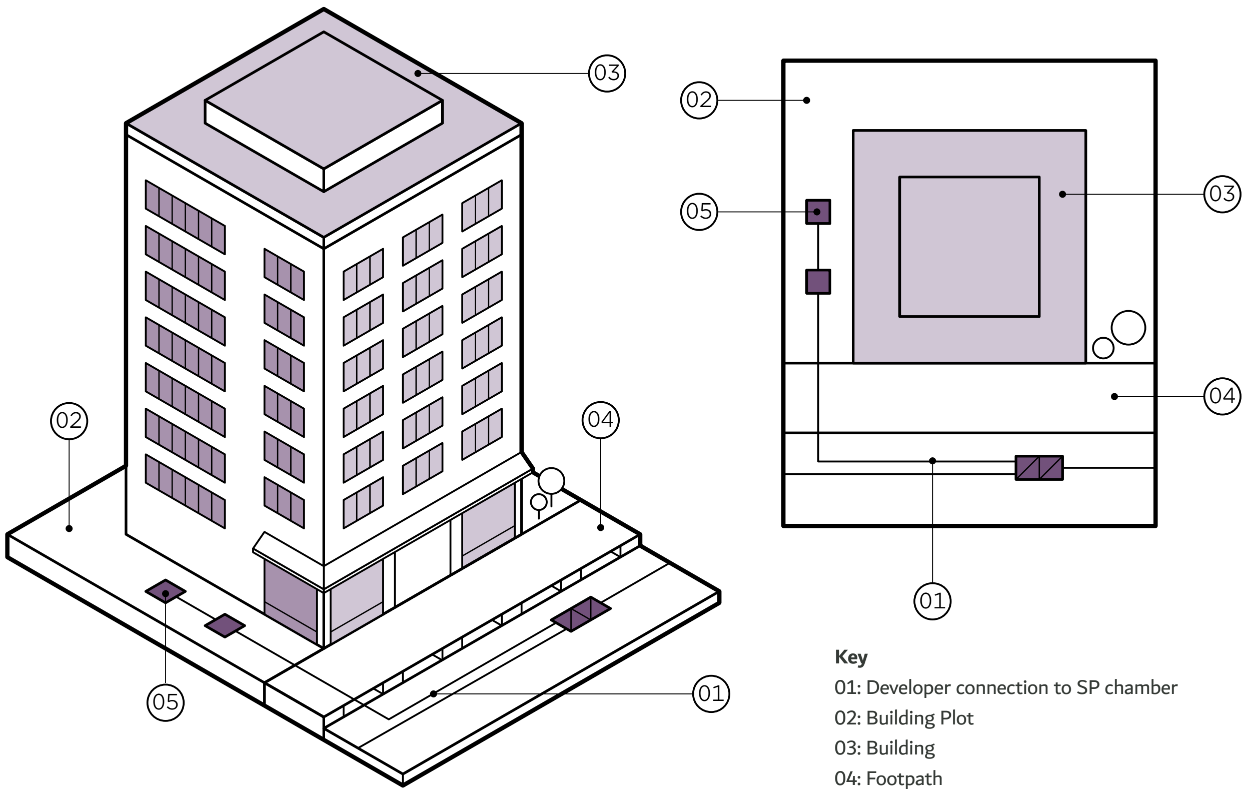


Figure G.60 Lead-in duct connection to existing infrastructure

Key
01: Developer connection to SP chamber
02: Building Plot
03: Building
04: Footpath
05: BEP/MTR

G.11.3.1.3 Scenario 2 – SP duct network is still to be built

The Developer is responsible for extending MMC stub ducts to 1 m outside the plot boundary (see Figure G.61). The building developer is responsible for locating and clearly identifying lead-in ducts.

G.11.3.1.4 Entry boxes

Entry boxes and MMC shall be provided for SPs to install their cables through the main and redundant lead-in ducts inside the plot. The type and size of entry/pull boxes shall be selected to suit the characteristics of the building development.

All lead-in ducts shall be designed in coordination with the design of other buried services.

G.11.3.1.5 BEP

The BEP may be the FCP interface between the feeder cabling and the in-building network if not completed within the MMC.

The transition from outdoor to indoor cable shall be performed in the BEP within 2 m of the cable exiting the duct where either:

a) sheath material of OSP cables is not suitable for installation within buildings; or
b) metallic armouring forms part of the cable construction.

Where main and redundant lead-in ducts cannot be routed directly into the MTR, steel cable trays shall be provided from the BEP. The trays shall be located in common areas, and shall be easily accessible to allow cables to be added in future. The trays shall be covered if they are in an area accessible to the public and are less than 4.8 m above the floor.

A cable tray of minimum dimensions 300 mm × 100 mm (w × h) with heavy duty return flange (HDRF) shall be provided for each plot BEP (main and redundant).

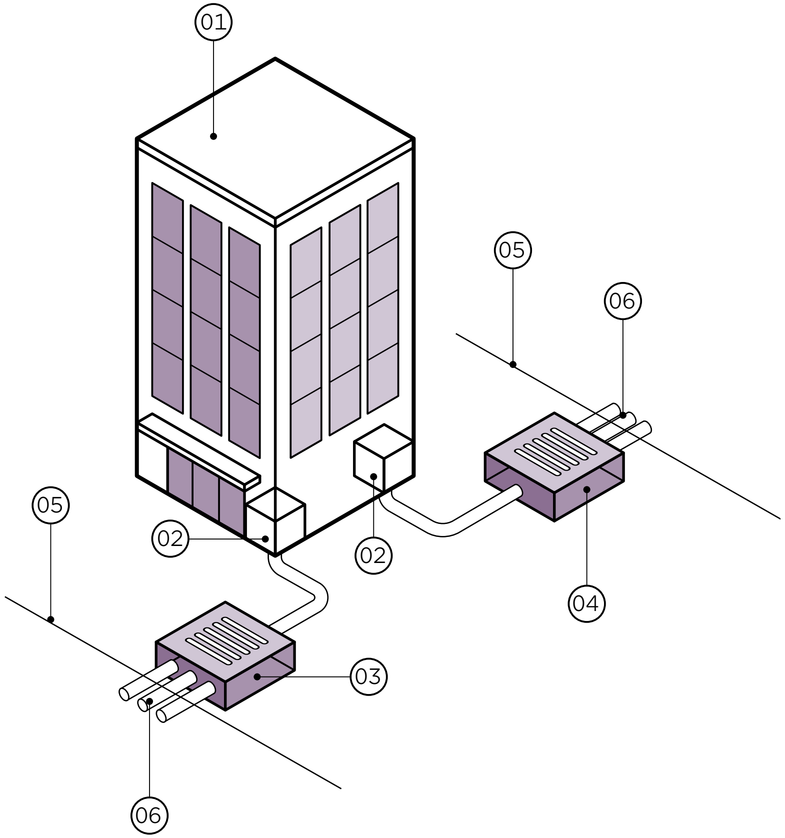


Figure G.61 Lead-in duct connections prepared for new SP infrastructure

Key

01: Building with dual entry points
02: BEP
03: Development MMC A
04: Development MMC B
05: Development boundary
06: Developer ducts capped 1 m outside plot boundary for future SP connection

G.11.3.2 Meet-me-room (MMR)

Where a need for one or more MMRs has been determined by the masterplan, the MMRs shall be positioned in accordance with the agreed site layout (see Figure G.62 and Figure G.63).

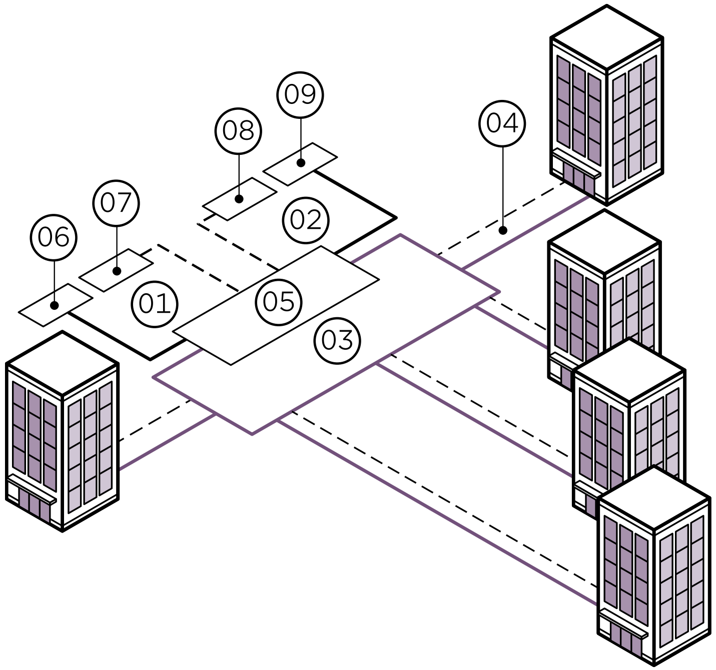


Figure G.62 Incorporation of single MMR in a commercial multi-building development

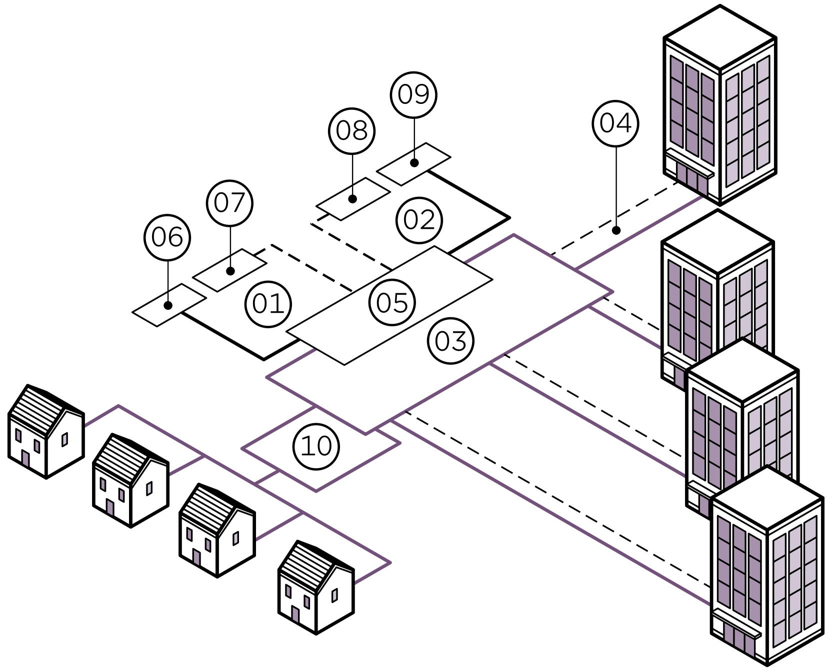


Figure G.63 Incorporation of single MMR in a mixed use multi-building environment

Key

Main route cables
Redundant route cables
01: du feeder cables
02: Etisalat feeder cables
03: Distribution cables for buildings
04: Distribution cables for buildings by lead operator
05: MMR
06: du POP-A
07: du POP-B
08: Etisalat POP-B
09: Etisalat POP-A
10: Distribution cables for villas

G.11.4 Inside plant common infrastructure specifications (ISP)

G.11.4.1 Telecom rooms

G.11.4.1.1 General

The following types of telecom rooms shall be provided based on the needs of the project.

a) main telecom room (MTR);

b) floor telecom room (FTR);

c) mobile service room (MSR); and

d) rooftop mobile room (RTMR).

In multi-storey buildings, telecom rooms shall be vertically aligned and linked by a shared cable pathway. This cable pathway shall not reduce the minimum required room space.

All telecom rooms shall be for the sole use of SPs. The rooms shall be accessible to SP personnel 24 hours a day and be secured from unauthorized entry.

NOTE: It is common for a key to be kept with the facilities manager.

All telecom rooms shall conform to the fire safety requirements of UAE FLSC [Ref. G.1]. If the building Developer has any concerns about access or the required fire safety provisions, these shall be highlighted at the design stage.

G.11.4.1.2 Location

Telecom rooms shall be located away from any sources of:

a) heat;

b) moisture;

c) corrosive atmospheric or environmental conditions;

d) high voltages;

e) radio frequency interference (RFI); and

f) electromagnetic interference (EMI).

Telecom rooms shall not be located directly beneath or next to wet areas such as showers, washrooms, swimming pools and waste areas.

G.11.4.1.3 Maintenance

Telecom rooms shall be designed to be free of the following items unless otherwise indicated in this section:

a) equipment not associated with the room;

b) utility pipes;

c) cables;

d) sprinkler systems;

e) windows.

Signage shall be added to the room to state “no storage permitted”.

Rodents often gnaw cables, resulting in damage and service disruption. Best practice pest control methods shall be used to prevent pests from entering telecom spaces and cable pathways.

Additional measures to protect against pests may involve the installation of covers to cable trays. If used, covers shall be removable to allow for the installation of additional cables.

G.11.4.2 Main telecom rooms (MTRs)

The layout and service provision for MTRs shall be in accordance with Table G.36.

A typical MTR layout is shown in Figure G.64.

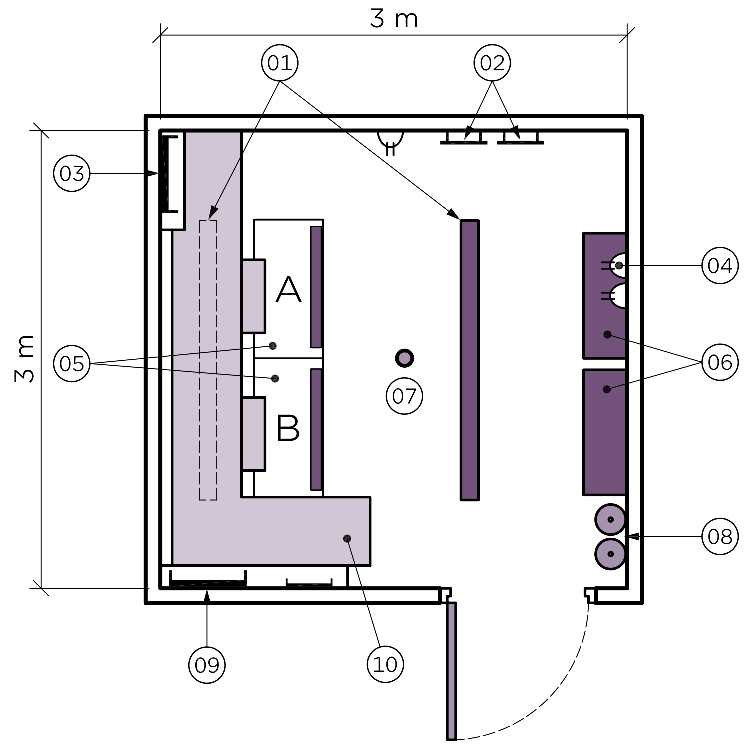
MTR frame layouts shall be as detailed in Figure G.65 and Figure G.66.

<table>
<tr><th rowspan="2">Parameter</th><th colspan="3">Details and requirements</th></tr>
<tr><th>MTR (residential buildings)</th><th>MTR (commercial and mixed use buildings)</th><th>FTR</th></tr>
<tr><td>Purpose</td><td colspan="2">Termination of telecom cables and housing telecom equipment.</td><td>The routing, splicing or termination of telecom cables.</td></tr>
<tr><td>Location</td><td colspan="2">Ground or basement floor level.
NOTE: Where single-tenant buildings have tenant IT server rooms, the MTR should be located adjacent to this position.</td><td>One per floor of multi-tenant buildings (e.g. commercial or residential buildings).</td></tr>
<tr><td>Minimum size and layout requirements</td><td colspan="2">See Table G.35.
This shall be reviewed based on the building use and number of tenants and the size increased accordingly.
Room design shall enable safe and free access within the MTR. All equipment cabinets shall be provided with 1 m free space to the front and rear of every cabinet position.
Wall-mounted equipment shall be positioned to provide safe and adequate working areas for the installation and maintenance of equipment.</td><td>See Table G.35.</td></tr>
<tr><td>Floor loading</td><td colspan="2">10 kN/m^2 (distributed load).</td><td>10 kN/m^2 (distributed load).</td></tr>
<tr><td>Doors</td><td colspan="2">Doors shall swing in the direction of egress with an automatic door closer system fitted on the hinged edge.
Minimum opening of 1 m × 2.1 m (w × h).
All doors shall be solid wood core or steel construction with a minimum fire resistance rating of 90 min.</td><td>Two doors shall swing in the direction of egress with an automatic door closer fitted on the hinged edges. At least one door shall be 810 mm wide in accordance with Ch. 3 of UAE FLSC [Ref. G.1]. Total minimum opening of 1.5 m × 2.1 m (w × h).
All doors shall be solid wood core or steel construction with a minimum fire resistance rating of 90 min.</td></tr>
<tr><td>Labelling</td><td colspan="2">Doors with du and Etisalat telecom room labels.</td><td>Doors with du and Etisalat telecom room labels.</td></tr>
<tr><td>Penetrations</td><td colspan="2">All penetrations and openings to telecom rooms shall be protected or fire-stopped in accordance with Section 2 and Section 3, Ch. 1 of UAE FLSC [Ref. G.1].
All ducts directly entering a telecom room shall be water-sealed and gas-sealed.</td><td>All penetrations and openings to telecom rooms shall be protected or fire-stopped in accordance with Section 2 and Section 3, Ch. 1 of UAE FLSC [Ref. G.1].
All ducts directly entering a telecom room shall be water-sealed and gas-sealed.</td></tr>
<tr><td>Access requirement</td><td colspan="2">In order to move equipment into and out of telecom rooms, access routes and doorways from outside the building to these rooms shall be greater than 1 m × 2.1 m (w × h).</td><td>Not applicable.</td></tr>
<tr><td>Wall and floor finish</td><td colspan="2">Rooms shall be free of contaminants and pollutants.
All walls, floors and ceilings shall be finished in such a way as to minimize dust and static electricity.
Surfaces shall be painted with primer and a light-coloured finish coat.</td><td>Rooms shall be free of contaminants and pollutants.
All walls, floors and ceilings shall be finished in such a way as to minimize dust and static electricity.
Surfaces shall be painted with primer and a light-coloured finish coat.</td></tr>
<tr><td>Compartmentation and egress</td><td colspan="2">Rooms shall conform to the fire and life safety requirements of Table 1.9, Ch. 1 and the applicable sections of Ch. 3 to Ch. 10 of UAE FLSC [Ref. G.1].</td><td>Rooms shall conform to the fire and life safety requirements of Table 1.9, Ch. 1 and the applicable sections of Ch. 3 to Ch. 10 of UAE FLSC [Ref. G.1].</td></tr>
<tr><td>Fire suppression</td><td colspan="2">Water sprinklers shall not be used.
Rooms ≥ 10 m^2 in gross area shall be protected with clean agent as required by Table 9.30, Ch. 9 of UAE FLSC [Ref. G.1].</td><td>Water sprinklers shall not be used.
Clean agent suppression systems are not required in typical FTRs (see Ch. 9 of UAE FLSC [Ref. G.1])</td></tr>
</table>

Table G.36 Layout and service requirements for MTRs and FTRs

Parameter	Details and requirements		
	MTR (residential buildings)	MTR (commercial and mixed use buildings)	FTR
Fire extinguishers	One handheld CO_2 cylinder extinguisher and one handheld multi-purpose powder extinguisher to be provided inside the room.		One handheld CO_2 cylinder extinguisher and one handheld multi-purpose powder extinguisher to be provided inside the room.
Task lighting	Task lighting shall be provided to the front and rear face of equipment cabinets, with a minimum of 500 lux maintained at 1,000 mm above finished floor level (FFL).		Task lighting shall be provided to the front and rear face of equipment cabinets with a minimum of 500 lux maintained at 1,000 mm above FFL.
Emergency lighting	To be provided in accordance with Ch. 6 of UAE FLSC [Ref. G.1].		To be provided in accordance with Ch. 8 of UAE FLSC [Ref. G.1].
Smoke detectors	To be provided in accordance with Ch. 6 of UAE FLSC [Ref. G.1].		To be provided in accordance with Ch. 8 of UAE FLSC [Ref. G.1].
General power	Four 13 A twin sockets fed from the essential power supply with a dedicated 20 A circuit breaker.		One 13 A twin socket.
Telecoms power	Two ×32 A TP isolator fed with dedicated feeder from essential power supply (EDB).	Two × 40 A TP isolator fed with dedicated feeder from essential power supply (EDB).	Not applicable.
Earthing arrangements	One room earth bar.	Two room earth bars connected to dedicated earth pits with resistance less than 1 Ω.	One room earth bar.
Cooling design	All cooling shall be designed such that cold air is delivered to the front working face of the telecom equipment cabinets. This may be directly from the air handling unit (AHU) or by ducted supply. Return air shall be allowed to circulate to the AHUs naturally. AHUs shall be positioned such as to maintain efficiency of the system by avoiding mixing of the return air and cold air paths.		All cooling shall be designed such that cold air is delivered to the front working face of the telecom equipment cabinets. This may be directly from the AHU or by ducted supply. Return air shall be allowed to circulate to the AHUs naturally. AHUs shall be positioned such as to maintain efficiency of the system by avoiding mixing of the return air and cold air paths.
Cooling	Air conditioning unit to maintain the temperature at 24 °C.	Dedicated air conditioning system to maintain the temperature at 21 °C ± 1 °C and the relative humidity at 50% ± 10%. A/C system (ducted split FCU), duty and standby units with interlocking. A/C power from essential power supply (EDB). Heat dissipation 300 W m²/3 kW per rack.	Not applicable.

Table G.36 Layout and service requirements for MTRs and FTRs (continued)



Key

01: Lighting (including emergency lighting per Ch. 6 of UAE FLSC **[Ref. G.1]**
02: AC clean earth bar
03: OSP fibre cable entry
04: General power 4 × 13 A twin sockets fed from essential power supply
05: Telecom power 2 x 40 A TP above racks from essential power supply
06: AHU (duty and standby)
07: Fire detector(s)
08: 2 × handheld fire extinguishers
09: Building riser
10: 450 mm x 50 mm cable tray at high level
A: SP open rack
B: Building ODF

Figure G.64 Typical layout for a main telecom room (MTR)

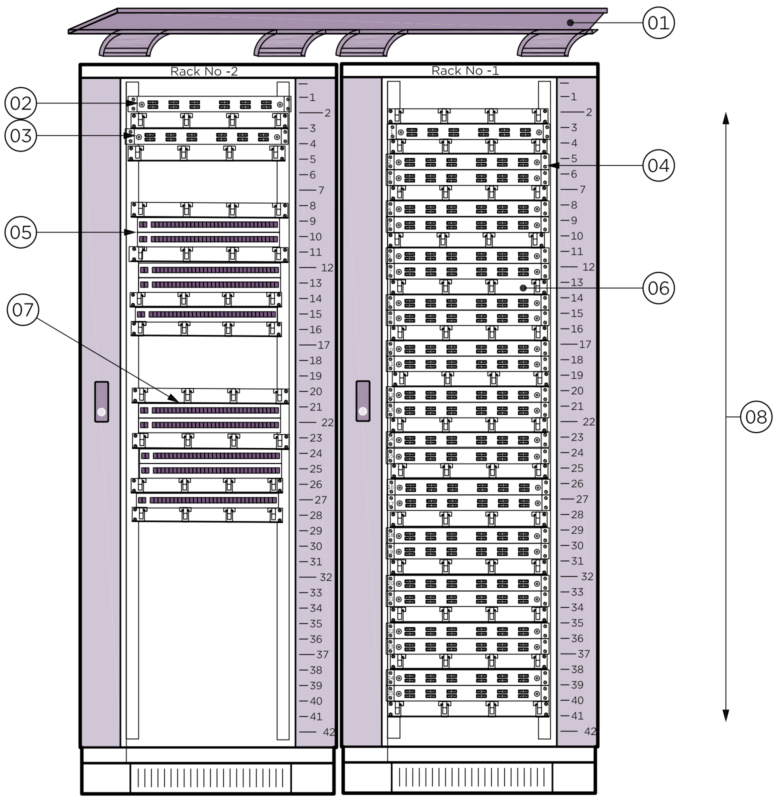


Figure G.65 MTR building fibre terminations using SC/APC optical patch panel

Key

01: High level overhead fibre pathways

02: Uplink fibre patch panels SC/APC (for main cable)

03: Uplink fibre patch panels SC/APC (for redundant cable)

04: 24 port SC/APC optical patch panel – 1U

05: 2 × 32 SC/APC splitters for Etisalat

06: Cable manager – 1U

07: 2 × 32 LC/APC splitters for du

08: Building fibre cable termination

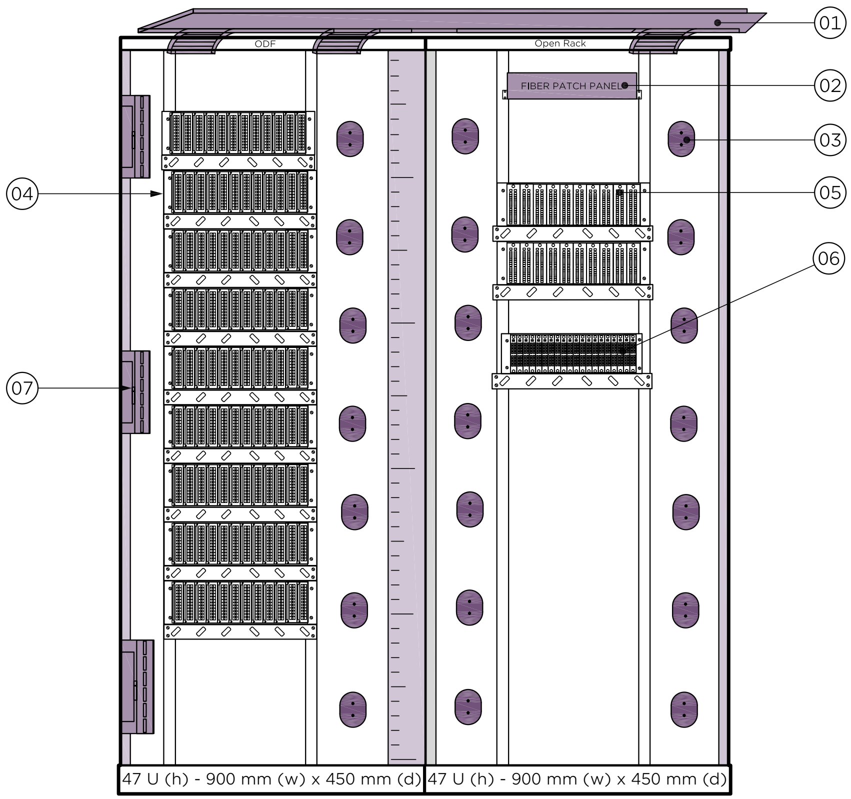


Figure G.66 MTR open rack elevation using SC/APC ODF

Key

01: High level overhead fibre pathways

02: Uplink fibre patch panels SC/APC

03: Cable guide

04: 144-port high density SC/APC optical patch panel

05: 10 high density connectorized 2 × 32 SC/APC splitters for Etisalat

06: 10 high density connectorized 2 × 32 LC/APC splitters for du

07: Cable holder/lacing bar

G.11.4.3 Floor telecom rooms (FTRs)

The layout and service provision for FTRs shall be in accordance with Table G.36.

A typical FTR layout is shown in Figure G.67.

The mini ODF layout shall be as shown in Figure G.68.

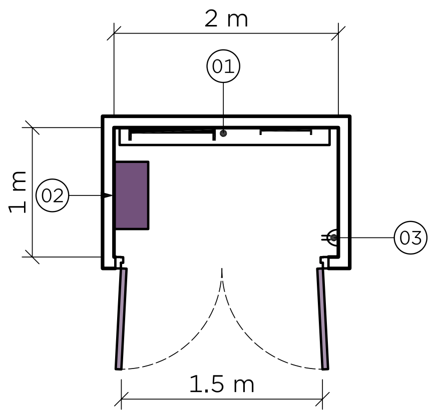


Figure G.67 Typical FTR room layout

Key
01: Building riser and containment
02: Mini ODF (splice cabinet)
03: 13A twin socket

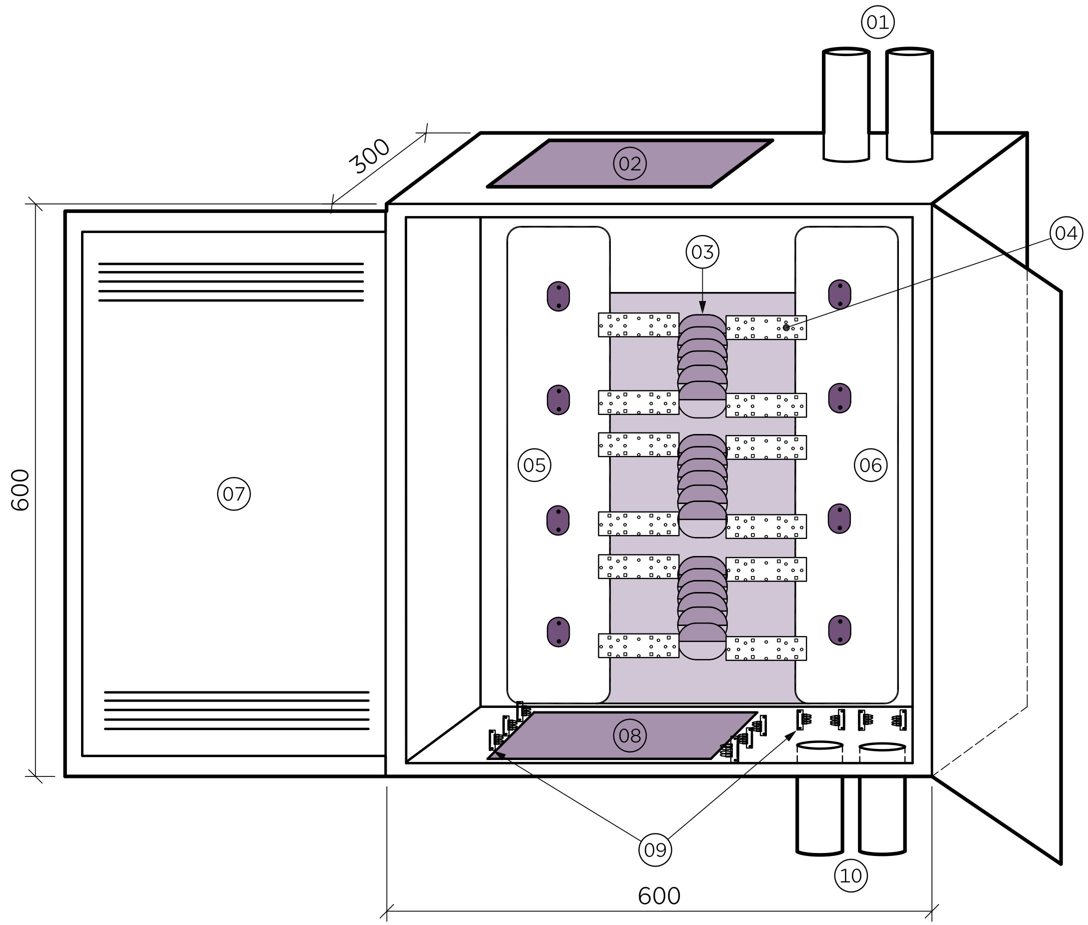


Figure G.68 Mini ODF (splice cabinet)

Key
01: Cable entry for multicore indoor fibre cables
02: Opening for drop fibre cables from building risers
03: Flip type splice tray with storage capacity of 12-core fibres
04: Cable/tube holder
05: Storage space for drop fibre cables
06: Storage space for fibre tubes
07: Door
08: Opening for drop fibre cables from building risers
09: Cable holder
10: Cable entry for multicore indoor fibre cables

G.11.4.4 Mobile network services

G.11.4.4.1 General

NOTE 1: The technologies associated with mobile/cellular network services are evolving and new requirements will arise over time. In Dubai, the FTTx SPs, du and Etisalat, are also the mobile network operators (MNOs).

The Developer shall consult the MNOs at an early stage of design development to determine their specific requirements and any impacts on the design of the building(s). Guidance is provided in Table G.37.

Number of floors	MSR Size (w x l x h)	RTMR Size (w x l x h)
Up to G+10	Not applicable.	3 m × 3 m × 3 m
G+11 to G+100	3 m × 3 m × 3 m (every 10 floors starting from the basement level/ground floor).	3 m × 3 m × 3 m
Shopping mall/bulk service buildings	To be determined in consultation with MNOs.	
Cluster of buildings with each having more than G+5 floors	To be determined in consultation with MNOs.	

Table G.37 Sizes of MSR and RTMR rooms

The Developer shall follow the requirements of the MNOs associated with mobile network services within buildings and surrounding outdoor areas.

NOTE 2: This includes, but is not limited to, provision of rooms and associated MEP services (e.g. cable pathways, electrical and mechanical) required by the MNOs to deploy any in-building and external infrastructure.

G.11.4.4.2 Rooftop mobile rooms (RTMRs)

An RTMR shall be provided by Developers on all multi-tenant buildings.

Space shall be reserved on the rooftop for the installation of mobile service antennas.

NOTE 1: Antenna arrangements vary between buildings. They are typically positioned at the corners of buildings or on any raised structure on the rooftop.

The need for RTMR, coordination of position on the rooftop and detailed antenna arrangement shall be determined by the Developer during consultation with the MNOs at the early design stage.

On sites with multiple buildings, the MNO consultation shall determine which buildings require an RMTR.

The layout and service provision for RTMRs shall be in accordance with Table G.38.

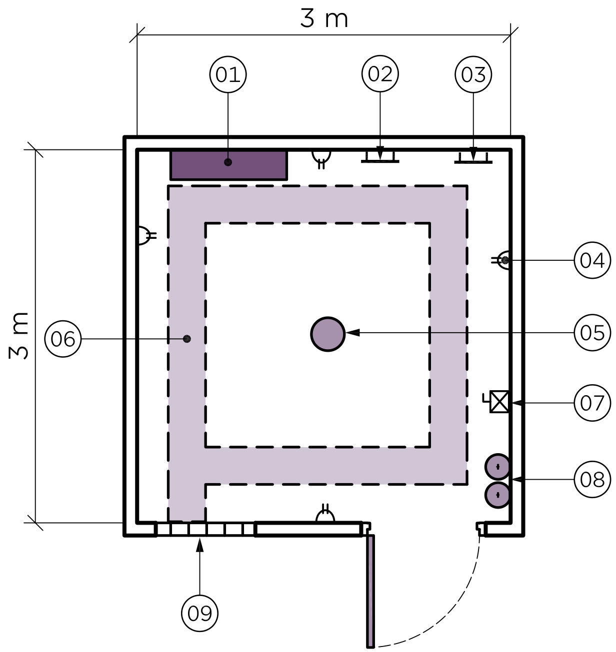
A typical RTMR layout is shown in Figure G.69.

Parameter	Details and requirements	
	RTMRs	MSRs
Purpose	Supports the deployment of installations for area mobile coverage.	Supports the deployment of installations for area mobile coverage.
Location	Rooftop	In all multi-tenant buildings which are above G+10 floors, provided on every 10th floor starting from the basement/ground floors. Where possible, located adjacent to the FTR position
Minimum size and layout requirements (w × l × h)	3 m × 3 m × 3 m	3 m × 3 m × 3 m
Floor loading	10 kN/m² (distributed load).	10 kN/m² (distributed load).
Doors	Door shall swing in the direction of egress with an automatic door closer system fitted on the hinged edge. Minimum opening of 1 m × 2.1 m (w × h). All doors shall be solid wood core or steel construction with a minimum fire resistance rating of 90 min.	Door shall swing in the direction of egress with an automatic door closer system fitted on the hinged edge. Minimum opening of 1 m × 2.1 m (w × h). All doors shall be solid wood core or steel construction with a minimum fire resistance rating of 90 min.
Labelling	Doors labelled as "Mobile Service Room".	Doors labelled as "Mobile Service Room".
Penetrations	All penetrations and openings to telecom rooms shall be protected or fire-stopped in accordance with Section 2 and Section 3, Ch. 1 of UAE FLSC **[Ref. G.1]**. All ducts directly entering a telecom room shall be water-sealed and gas-sealed.	All penetrations and openings to telecom rooms shall be protected or fire-stopped in accordance with Section 2 and Section 3, Ch. 1 of UAE FLSC **[Ref. G.1]**. All ducts directly entering a telecom room shall be water-sealed and gas-sealed.
Cable pathways	External antenna cable routes. Openings shall be 600 mm × 400 mm (w × h), 500 mm below the room ceiling in walls facing the building's rooftop area. Connected to building riser through 300 mm × 50 mm vertical cable tray.	Connected to building riser through 300 mm × 50 mm vertical cable tray.
Wall and floor finish	Rooms shall be free of contaminants and pollutants. All walls, floors and ceilings shall be finished in such a way as to minimize dust and static electricity. Surfaces shall be painted with primer and a light-coloured finish coat.	Rooms shall be free of contaminants and pollutants. All walls, floors and ceilings shall be finished in such a way as to minimize dust and static electricity. Surfaces shall be painted with primer and a light-coloured finish coat.
Compartmentation and egress	Rooms shall conform to the fire and life safety requirements of Table 1.9, Ch. 1 and the applicable sections of Ch. 3 to Ch. 10 of UAE FLSC **[Ref. G.1]**.	Rooms shall conform to the fire and life safety requirements of Table 1.9, Ch. 1 and the applicable sections of Ch. 3 to Ch. 10 of UAE FLSC **[Ref. G.1]**.
Fire suppression	Water sprinklers shall not be used. Rooms ≥ 10 m² in gross area shall be protected with clean agent as required by Table 9.30, Ch. 9 of UAE FLSC **[Ref. G.1]**.	Water sprinklers shall not be used. Rooms ≥ 10 m² in gross area shall be protected with clean agent as required by Table 9.30, Ch. 9 of UAE FLSC **[Ref. G.1]**.
Fire extinguishers	One handheld CO_2 cylinder extinguisher and one handheld multi-purpose powder extinguisher to be provided inside the room.	One handheld CO_2 cylinder extinguisher and one handheld multi-purpose powder extinguisher to be provided inside the room.

Table G.38 Layout and service requirements for RTMRs and MSRs

Parameter	Details and requirements	
	RTMRs	MSRs
Task lighting	Task lighting shall be provided to the front and rear face of equipment cabinets with a minimum of 500 lux maintained at 1,000 mm above FFL.	Task lighting shall be provided to the front and rear face of equipment cabinets with a minimum of 500 lux maintained at 1,000 mm above FFL.
Emergency lighting	To be provided in accordance with Ch. 6 of UAE FLSC [Ref. G.1].	To be provided in accordance with Ch. 6 of UAE FLSC [Ref. G.1].
Smoke detectors	To be provided in accordance with Ch. 8 of UAE FLSC [Ref. G.1].	To be provided in accordance with Ch. 8 of UAE FLSC [Ref. G.1].
General power	Four 13 A twin sockets fed from the essential power supply with a dedicated 20 A circuit breaker.	Four 13 A twin sockets fed from the essential power supply with dedicated 20 A circuit breaker.
Telecoms power	Two 63 A TP isolators fed with dedicated feeder from essential power supply.	Two 63 A TP isolators fed with dedicated feeder from essential power supply.
Earthing arrangements	Two room earth bars connected to dedicated earth pits with resistance less than 1 Ω.	Two room earth bars connected to dedicated earth pits with resistance less than 1 Ω.
Cooling design	All cooling shall be designed such that cold air is delivered to the front working face of the telecom equipment cabinets. This may be directly from the air handling unit (AHU) or by ducted supply. Return air shall be allowed to circulate to the AHUs naturally. AHUs shall be positioned such as to maintain efficiency of the system by avoiding mixing of the return air and cold air paths.	All cooling shall be designed such that cold air is delivered to the front working face of the telecom equipment cabinets. This may be directly from the AHU or by ducted supply. Return air shall be allowed to circulate to the AHUs naturally. AHUs shall be positioned such as to maintain efficiency of the system by avoiding mixing of the return air and cold air paths.
Cooling	Dedicated air conditioning system to maintain the temperature at 21 °C ± 1 °C and the relative humidity at 50% ± 10%. A/C system (ducted split FCU), duty and standby units with interlocking. A/C power from essential power supply. Heat dissipation 36 kW.	Dedicated air conditioning system to maintain the temperature at 21 °C ± 1 °C and the relative humidity at 50% ± 10%. A/C system (ducted split FCU), duty and standby units with interlocking. A/C power from essential power supply. Heat dissipation 12 kW.

Table G.38 Layout and service requirements for RTMRs and MSRs (continued)



Key
01: Cross connect cabinet
02: AC clean earth bar
03: DC clean earth bar
04: 32 A twin socket fed from utility power with dedicated circuit breaker
05: Smoke detector connected to BMS
06: 300 mm width cable ladder at high level
07: 2 × 63 A three-phase isolator fed from essential building power
08: 2 × handheld extinguishers
09: Opening for containments

Figure G.69 Typical layout for RTMR and MSRs

G.11.4.4.3 Mobile service rooms (MSRs)

The layout and service provision for MSRs shall be in accordance with Table G.38.

NOTE: A typical MSR layout is shown in Figure G.69.

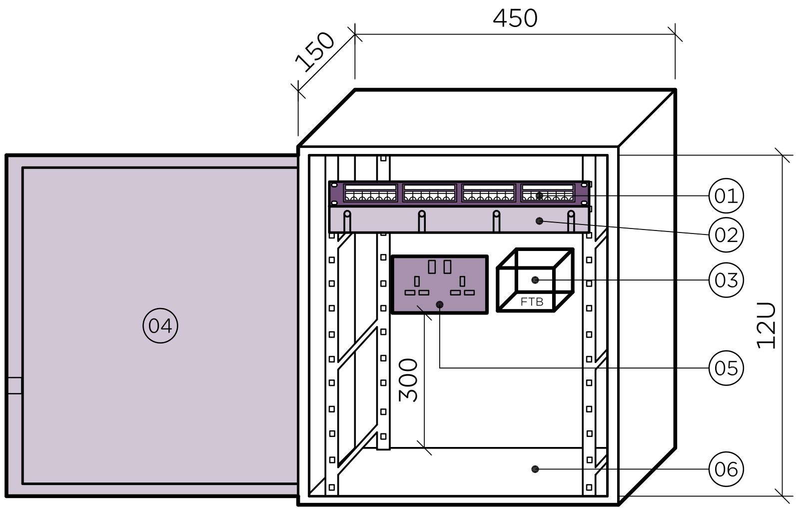
For major developments including malls, airports, stadiums and other large buildings all mobile service room provisions are subject to specific requirements to be agreed by the Developer with the MNOs with consideration of the specific mobile capacity requirements of the development.

G.11.4.5 Apartment/office/retail consolidation cabinets

Each tenant space shall be provided with a consolidation cabinet (see Figure G.70 or Figure G.71) Each cabinet shall be capable of accommodating two telecom operators' requirements at the same time (see Figure G.72).

Optical fibre cabling from the FTR to each consolidation cabinet shall comprise one 4-core fibre cable.

Consolidation cabinets shall be provided in accordance with Table G.39.



Key

01: RJ45 patch panel – 1U

02: Cable management panel – 1U

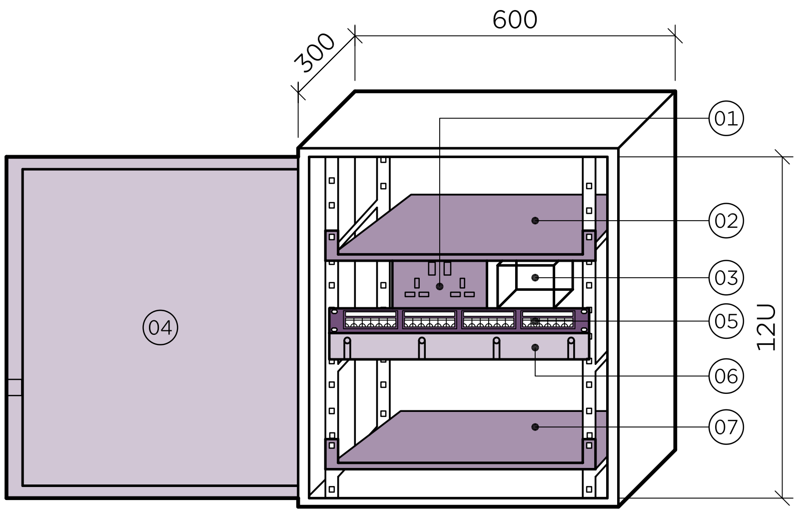
03: 4 port fibre termination box (2-ports SC/APC and 2 ports LC/APC)

04: Perforated door

05: 13 A twin socket (from dedicated circuit breaker)

06: Bottom area left with free space for operator's use

Figure G.70 Consolidation cabinet 450 mm × 150 mm – to serve premises up to 8-port



Key

01: 13 A twin socket (from dedicated circuit breaker)

02: Metallic shelf for Etisalat – 1U

03: 4 port fibre termination box (2-ports SC/APC and 2 ports LC/APC)

04: Perforated door

05: RJ45 patch panel – 1U

06: Cable management panel – 1U

07: Metallic shelf for du – 1U

Figure G.71 Consolidation cabinet 600 mm × 300 mm – to serve premises more than 8-port

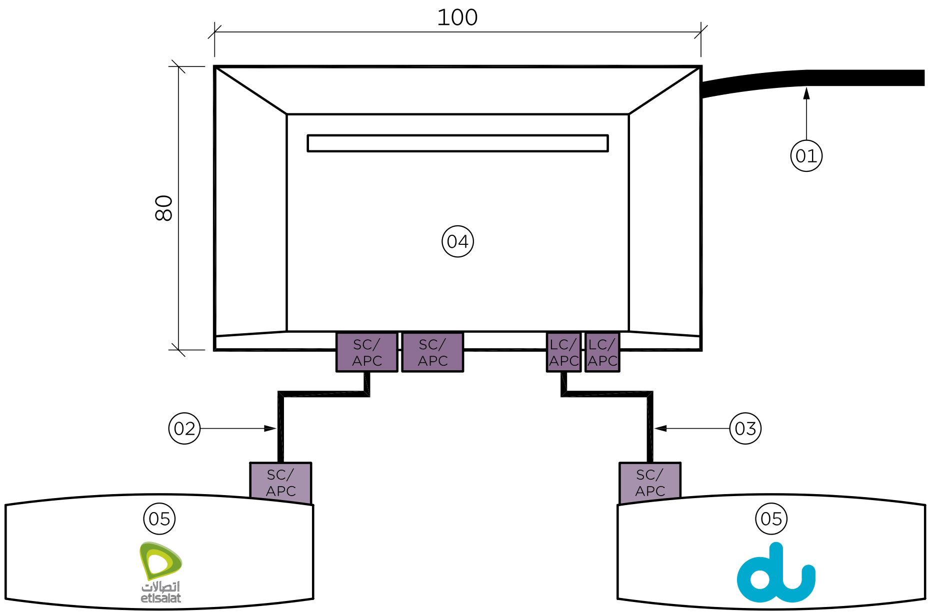


Figure G.72 Fibre termination box fitted within consolidation cabinet

Key

01: 4 core SM indoor drop fibre cable – flat cross-section
02: SC/APC to SC/APC simplex patch cord
03: LC/APC to SC/APC simplex patch cord
04: Fibre termination box with 2-port SC/APC and 2-port LC/APC
05: Optical network terminal

Parameter	Details and requirements	
	Apartment/office/retail up to eight loaded copper port	Apartment/office/retail eight to twenty four loaded copper ports
Minimum internal dimension (h × w × d)	12U, 450 mm × 150 mm	12U, 600 mm × 300 mm or 150 mm
Mounting location	Concealed in the wall with the front of the cabinet flush with the wall.	
Mounting restrictions	Located in an accessible area inside the tenant premises, close to the entrance and not inside the kitchen, pantry, washroom, laundry room or bedroom. Not close to sources of water or heat. Not close to any electrical distribution or busbars.	
Mounting height	Installed with the bottom of the cabinet at a height of 600 mm to 1,200 mm above FFL, according to site conditions.	
Equipment clearance	1 m free space to the front of the cabinet.	
Area lighting	Minimum of 500 lux maintained at 1,000 mm above FFL.	
Ventilation	Minimum of one air change per hour.	
Copper cabling patch panel	24-port 450 mm copper patch panel.	24-port 600 mm copper patch panel.
Twisted pair copper cabling	24 copper cables or less per tenant.	More than 24 copper cables per tenant.
Cable management	Cable entries to accommodate incoming fibre optic and copper cables. Horizontal cable management for copper patch cables.	
Optical fibre termination	Fibre terminal box with adapters and pigtails for two LC/APC ports and two SC/APC ports for a 4-core SM fibre drop cable termination.	
Security	Lockable front door.	
Power	13 A dual socket outlet inside the consolidation cabinet, with dedicated circuit breaker on the domestic supply and not looped with other general power socket outlets.	
Labelling	Floor/flat number.	

Table G.39 Minimum specifications for consolidation cabinet

G.11.4.6 Labour accommodation consolidation cabinet

G.11.4.6.1 General

The SP general internet service to labour accommodation buildings shall be provided as a dedicated service in each accommodation unit. Designs may allow for the future deployment of WiFi-based access.

A single MTR/MMR can serve multiple accommodation buildings on the same site. Where cable is run between buildings, the cable shall be internal/external grade. Cables shall be installed within a flexible sub-duct for all external routes, owing to their small diameter.

Consolidation cabinets shall be provided in accordance with Table G.40.

Each cabinet shall be capable of accommodating two-SP ONTs at the same time.

Copper cabling to final TO positions shall be a minimum specification of category 6. Developers may future-proof the installation through use of category 6 A cabling, especially if future use of a WiFi overlay is anticipated.

Parameter	Details and requirements	
	Accommodation building consolidation cabinet	Accommodation unit consolidation cabinet
Minimum internal dimension (h × w × d)	12U, 600 mm × 300 mm	12U, 450 mm × 150 mm
Mounting location	Concealed in the wall with the front of the cabinet flush with the wall.	
Mounting restrictions	Located in an accessible area inside the tenant premises close to the entrance and not inside the kitchen, pantry, washroom, laundry room or bedroom. Not close to sources of water or heat. Not close to any electrical distribution or busbars.	
Mounting height	Installed with the bottom of the cabinet at a height of 600 mm to 1,200 mm above FFL, according to site conditions.	
Equipment clearance	An adequate safe working space around the location.	
Area lighting	Minimum of 500 lux maintained at 1,000 mm above FFL.	
Ventilation	Adequate ventilation shall be provided; minimum of one air change per hour.	
Copper cabling patch panel	One or more 24-port 600 mm copper patch panel as required.	24-port 450 mm copper patch panel.
Twisted pair copper cabling (maximum 90m cable length)	Cables as required per block area.	Up to 24 cables per unit.
Cable management	Cable entries to accommodate the incoming fibre optic and copper cables. Horizontal cable management for twisted pair patch cables.	
Optical fibre termination	Fibre terminal box with adapters and pigtails for two LC/APC ports and two SC/APC ports for a 4-core SM fibre drop cable termination.	
Security	Lockable front door.	
Power	13 A dual socket inside the consolidation cabinet with dedicated circuit breaker on the domestic supply and not looped with other general power sockets.	
Labelling	Accommodation building number.	Accommodation unit number.

Table G.40 Minimum specifications for consolidation cabinet

G.11.4.6.2 Scenario 1: Low-density occupation/single occupier tenant organizations

In this scenario, the design shall allow individual buildings to be wired with copper cabling to the fixed TO positions for each accommodation unit's communal area televisions and telephones (see Figure G.73).

Designers shall provide the minimum number of cabinets required. Cabinets shall be located in a central position. Cabling can serve multiple building levels, maximizing the area covered by each unit, provided that cable lengths are within the 90 m permanent link limitation. One or two cabinets might be able to serve single or double storey accommodation blocks of up to 150 m building length.

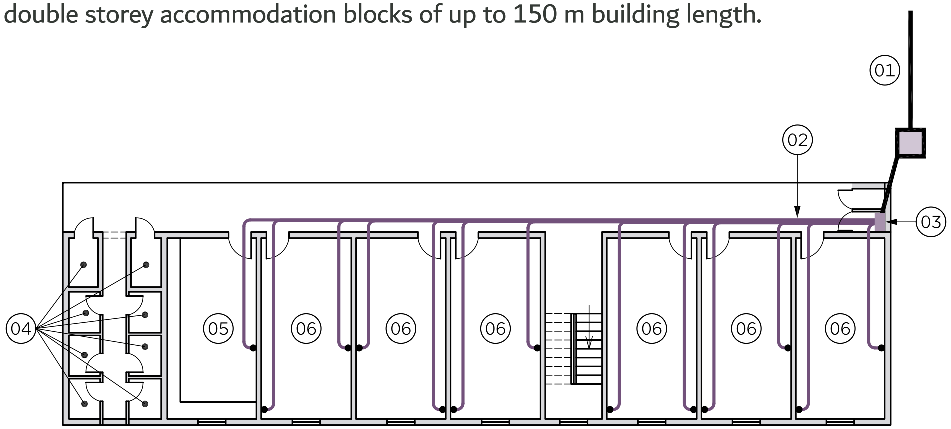


Figure G.73 Ground floor plan of copper cabling to each accommodation unit

Key

01: Manhole (600 × 600 × 900) mm with grade (A) cover positioned close to the building wall

02: Category 6 cable from each TO (RJ45) to consolidation cabinet

03: Consolidation cabinet

04: Bathrooms

05: Kitchen/communal area

06: Bedroom

G.11.4.6.3 Scenario 2: High density occupation/multiple occupier tenant organizations

Where a more flexible service provision is required, the design shall feature optical fibre drop cabling directly from an FTR, MTR or MMR to a consolidation cabinet in each accommodation unit (see Figure G.74). Local copper cabling shall provide connections for services from the consolidation cabinet.

Each unit connection shall comprise one 4-core SM drop cable per cabinet.

The designer may future-proof the accommodation by providing copper cabling to allow future deployment of a WiFi overlay service.

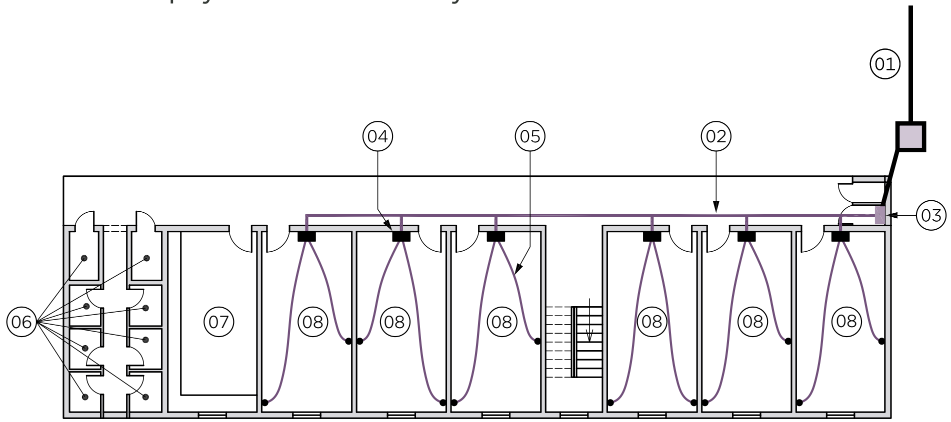


Figure G.74 Ground floor plan of fibre drop cable to each accommodation unit

Key

01: Manhole (600 × 600 × 900) mm with grade (A) cover positioned close to the building wall

02: Mini ODF Splice cabinet

03: Consolidation cabinet

04: Category 6 cable from each TO (RJ45) to consolidation cabinet

05: 4 core drop fibre from mini ODF splice cabinet to consolidation cabinet in each room

06: Bathrooms

07: Kitchen/communal area

08: Bedroom

G.11.4.7 Business consolidation cabinet – Commercial shell and core

The Developer shall provide one mini ODF in each FTR (see Table G.41 and Figure G.75).

Each FTR ODF shall have SM fibre cable connection to the MTR. This shall comprise multicore fibre cables with a minimum core count, to allow through-connection of four cores of fibre per 200 m^2 of leasable space to support a two-SP design.

Multicore fibre cables shall be spliced on the dedicated splice trays in the ODF.

4-core SM drop cables shall be pulled for every 200 m^2 of leasable floor space or to each tenant consolidation cabinet.

Drop cables shall be routed to the FTR mini ODF on the same building level.

Drop cables shall be spliced on the dedicated splice trays in the ODF. All fibre cores shall be clearly labelled.

Tenant area distribution cables shall be coordinated directly between the building Owner and the tenant.

Parameter	Details and requirements
Minimum internal dimension	600 mm × 600 mm × 300 mm (h × w × d)
Mounting location	Side wall of FTR.
Mounting height	1,500 mm above FFL.
Fittings	Fully loaded with pre-terminated SC/APC pigtail and SC/APC adaptors for SPs. Dedicated splice tray for multicore fibre cables. Dedicated splice trays for drop cables.
Fibre connectivity	Multicore SM fibre cable capacity from MTR to each FTR ODF. Minimum cable core count calculated for each floor, based on four fibre cores for every 200 m^2 of leasable space +25% to support a two-SP design. Multicore cables spliced on dedicated multicore splice trays in the FTR ODF. 4-core SM drop cable from the FTR ODF for every tenant consolidation cabinet per 200 m^2 of leasable floor space on the same level. Drop cables spliced on dedicated drop cable splice trays in the FTR ODF.
Security	Lockable panels all round. Lockable front door.
Cable entries	To accommodate the multicore SM fibre cables and drop fibre cables. To accommodate the incoming fibre optic cables.
Labelling	Floor number.

Table G.41 Minimum specifications for consolidation cabinet

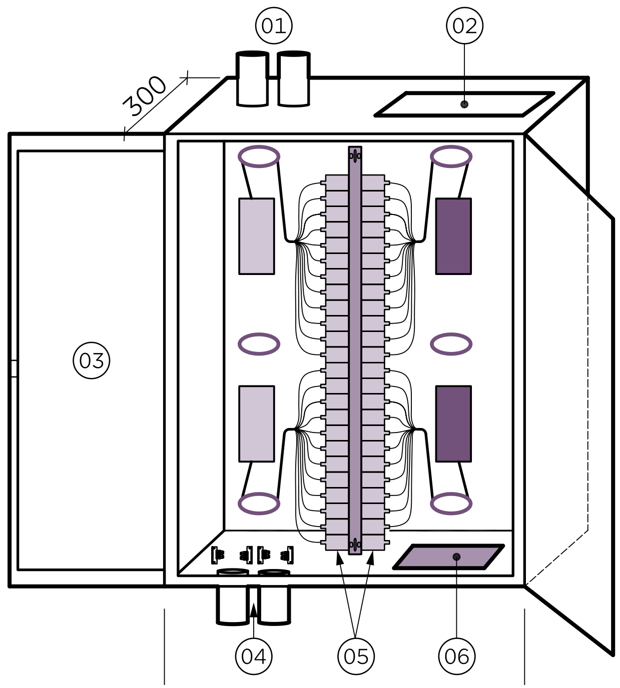


Figure G.75 Business consolidation cabinet, mini ODF provided in each FTR

Key

01: Cable entry for multicore fibre cables from MTR

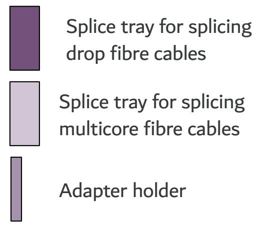
02: Opening for drop fibre cables from tenants

03: Door

04: Cable entry for multicore fibre cables from MTR

05: AC/APC pigtails

06: Opening for drop fibre cables from tenants



G.11.4.8 Cable pathways

G.11.4.8.1 General

Cable pathway specifications shall conform to Table G.42.

The following requirements shall be met for risers and all cable trays, conduits, ducts and microduct pathway systems.

a) Pathways shall be designed such that installed cables do not exceed the minimum specified bend radius during or after installation.

b) Day one installation shall not exceed 50% of the cable tray capacity.

c) All cable trays shall be made from hot dip galvanized slotted steel and shall be of HDRF construction.

d) All metal parts shall be free from sharp edges and shall be earth bonded in accordance with ISO/IEC 30129.

e) Riser openings, slab penetrations and wall penetrations for pathways passing through fire-rated construction shall be sealed with approved fire-stopping material in accordance with Section 3, Ch.1 of UAE FLSC [Ref. G.1]. Fire-stopping shall be reinstated whenever cables are installed after completion of initial fire-stopping works.

f) Vertical pathways shall be continuous between all levels. There shall be no reduction of capacity through penetrations.

g) Pathways shall not run through areas exposed to:
   1) excessive heat (i.e. areas in direct sun or rooms with heat generating equipment);
   2) moisture;
   3) corrosive atmospheric or environmental conditions;
   4) high voltages;
   5) radio frequency interference (RFI); or
   6) electromagnetic interference (EMI).

h) The separation of telecom and electrical pathways shall conform to ISO 14763-2.

i) Cable trays shall be easily accessible in common areas to facilitate any future provision of additional cables.

j) Cable trays in publicly accessible areas and less than 4.8 m above the floor level shall have removable protective covers.

k) All conduit junctions/pull boxes shall have minimum internal dimensions of 300 mm × 300 mm × 150 mm (w × h × d).

l) The Developer shall select telecom riser locations to provide a continuous route through the building, and taking into account the location and distribution of other services. On some developments, multiple risers might be required to provide service resilience.

m) Risers and cable pathways allocated for SP use shall not be shared with landlord or tenant cabling systems. In specific developments where space optimization might be advantageous, the Developer shall agree riser sharing principles for FTTx cabling and bespoke landlord/tenant cabling.

n) Minimum in-building service (IBS) pathways shall be adapted to accommodate specific design requirements of MNOs per development.

Parameter	Multi-tenant building	Warehouse and labour accommodation	Groups of towers
Risers	Two dedicated telecom risers. Riser one shall be in or adjacent to the FTR.	One dedicated telecom riser.	Two dedicated telecom risers. Riser one shall be in or adjacent to the FTR.
Slab opening	To allow vertical routing of IBS and telecom trays.	To allow vertical routing of telecom conduits.	To allow vertical routing of IBS and telecom trays.
Vertical pathway – riser	One 450 mm × 50 mm cable tray (telecom) One 300 mm × 50 mm cable tray (IBS)	Two 50 mm conduits (copper), junction/ pull box per floor per conduit.	One 450 mm × 50 mm cable tray (telecom) One 300 mm × 50 mm cable tray (IBS)
Horizontal pathway – riser 2 to FTR	One 100 mm × 50 mm cable tray (telecom) One 100 mm × 50 mm cable tray (IBS)	Not applicable.	One 100 mm × 50 mm cable tray (telecom). One 100 mm × 50 mm cable tray (IBS)
Horizontal pathway – FTR to: a) common corridors b) elevator lobbies c) podium levels d) basement levels	150 mm × 50 mm cable tray (IBS)	Not applicable.	150 mm × 50 mm cable tray (IBS)
Horizontal pathway –FTR to consolidation cabinet	200 mm × 50 mm corridor cable tray from FTR, small tray or conduit from corridor tray to consolidation cabinet.		
Horizontal pathway – FTR to consolidation cabinet (low-density buildings or permanent consolidation cabinet position)	200 mm × 50 mm corridor cable tray from FTR, small tray or conduit from corridor tray to consolidation cabinet. or Dedicated 50 mm conduit, one per route.		
Horizontal pathway –consolidation cabinet to telecom outlets	Not applicable.	One 25 mm conduit per dual copper outlet from cabinet. Increase conduit size if multiple dual outlets fed on the same route. Junction/pull boxes at sharp/90° bends or routes over 30 m.	Not applicable.
Horizontal pathway – MTR links (development with podium link level)	Not applicable.	Not applicable.	300 mm × 100 mm tray linking MTRs of each tower
Horizontal pathway – MTR links (development without podium link level)	Not applicable.	Not applicable.	OSP duct system, 2 × D54 (100 mm) ring of ducts between buildings, two entry points per building to OSP.

Table G.42 Cable pathway specifications

G.11.4.8.2 Microduct

Horizontal microduct shall only be used when:

a) the consolidation cabinet locations are permanent;
b) the cable density is low;
c) the flexibility to modify routing is not required; and
d) the ducts in Table G.43 can be installed from the FTR to each tenant.

Parameter	Multi-tenant building	Warehouse
MTR to each FTR	One-way 12/8 mm microduct per required multicore cable + 30% spare empty microduct tubes	Not applicable.
MTR to each MSR	One-way 12/8 mm microduct per required multicore cable + 30% spare empty microduct tubes	Not applicable.
MTR to RTMR	One-way 12/8 mm microduct per required multicore cable + 30% spare empty microduct tubes	Not applicable.
FTR ODF to consolidation cabinet	Two-way 8/5 mm microduct (one tube for drop cable, one tube spare)	Two-way 8/5 mm microduct (one tube for drop cable, one tube spare)

Table G.43 Microduct specifications

G.11.4.9 Fibre termination components and GPON splitters

G.11.4.9.1 Approved optical fibre components

All optical fibre components shall be selected from the approved product list held by SPs.

G.11.4.9.2 GPON splitter calculation per building

The number of GPON splitters required for each SP per building shall be calculated using Eq. G.1.

Eq. G.1

GPON splitters required for each SP per building = number of tenants ÷ 30

where:

30 is the downlink ports of (2 in × 32 out) splitters.

Two downlink ports of (2 in × 32 out) splitters shall be provided as spare ports for operational maintenance.

The number of GPON business splitters required for each SP per building shall be calculated using Eq. G.2.

Eq. G.2

GPON business splitters required for each SP per building =
(Number of business tenants x 1.1) ÷ 8

G.11.4.9.3 GPON optical splitter requirements

Optical splitters shall:

a) be planar light wave circuit type;
b) have RoHS-compliant metal plating and plastic;
c) have the operating wavelength range 1,260 nm to 1,635 nm;
d) have the operating temperature range –24 °C to +85 °C; and
e) have dust covers on the uplink and downlink connectors.

In addition, optical splitters shall meet the following requirements.

1) (2 in × 32 out) optical splitters shall have the maximum insertion loss + connector loss (at operating wavelength from 1,260 nm to 1,635 nm) to ≤18 dB (for residential tenants).
2) (2 in × 8 out) optical splitters shall have the maximum insertion loss + connector loss (at operating wavelength from 1,260 nm to 1,635 nm) to ≤11 dB (for business tenants).

G.11.4.9.4 High density connectorized modular splitter specification

High density (2 in × 32 out and 2 in × 8 out) connectorized modular splitters shall be used for buildings of more than 100 units. They shall meet the following requirements.

a) The modular splitters shall be fitted inside the splitter chassis (sub-rack).
b) Each splitter chassis (sub-rack) shall be 483 mm (19 in) with in-built cable management facility to route the uplink and downlink fibre patch cords.
c) Each splitter chassis (sub-rack) shall have eight (2 in × 32 out) modular splitters with LC/APC connector type.
d) Each splitter chassis (sub-rack) shall have four (2 in × 32 out) modular splitters with SC/APC connector type.
e) Each splitter chassis (sub-rack) shall have 12 (2 in × 8 out) modular splitters with operator specific connector type.
f) Each splitter chassis (sub-rack) shall be 3U to 4U in height.
g) Each modular splitter shall have visible label holder for unique identification.
h) The modular splitters shall have an easy snap-in design which requires no tools.
i) For du, uplink and downlink ports of (2 in × 32 out and 2 in × 8 out) modular splitters shall have LC/APC connectors.
j) For Etisalat:
    1) for buildings up to 256 units, (2 in × 32 out) and (2 in × 8 out) patch-free splitters with splicing trays shall be provided;
    2) for buildings of 256 or more units, uplink and downlink ports of (2 in × 32 out and 2 in × 8 out) modular splitters shall have SC/APC connectors.

G.11.4.9.5 Low-density connectorized splitter specification

Low-density (2 in × 32 out and 2 in × 8 out) connectorized splitters shall be used for a building with less than 100 units. They shall meet the following requirements.

a) Low-density splitters shall be 483 mm (19 in), 1U, rack mountable.
b) Low-density splitters shall have an in-built cable management facility to route the uplink and downlink fibre patch cords.
c) Uplink and downlink ports of (2 in × 32 out) and (2 in × 8 out) splitters shall have LC/APC connectors for du.
d) For buildings with less than 256 units, (2 in × 32 out) and (2 in × 8 out) optical patch-free splitters with splicing trays shall be provided for Etisalat.
e) Each splitter shall have two uplink ports (two inputs). The uplink ports of splitters with uplink patch panels shall be connected in the following order:
    1) the first uplink port of the splitter shall be connected to the main uplink patch panel;
    2) the second uplink port of the splitter shall be connected to the redundant uplink patch panel.

G.11.4.9.6 Multicore fibre cable termination

Fibre termination components shall be provided to splice multicore SM fibre cables with 4-core SM drop cables. Termination components shall meet the following requirements.

a) 4-port fibre terminal box (with LC/APC and SC/APC pigtails and adaptors) inside the 12U cabinet of tenant premises (office/retail/warehouse).
b) fully loaded high- or low-density fibre patch panels with adaptors and pigtails inside the MTR for SPs.
c) FTR mini ODFs with splice trays to splice multicore fibre cables with respective 4-core drop cables.

G.11.4.10 Fibre and copper cables

G.11.4.10.1 General

All cables (and connecting accessories) shall be selected from the approved product list held by SPs.

All fixed and permanently installed telecom cables within a building shall be halogen-free, achieve a minimum rating of Euroclass C_{ca}-s1b,d2,a2 when tested in accordance with BS EN 13501-6 and be CE marked.

NOTE: CE marking represents a manufacturer's declaration that products conform to the applicable manufacturing and testing standard.

All other cables, microduct and conduit including patch cords shall meet the minimum requirements of IEC/EN 60332-1-2.

Unless for a specific development type, fibre optic cables shall be supplied, spliced, labelled and tested inside the MTR, FTR, and consolidation cabinets by the Developer. This shall include the supply and installation of fibre optic cables and their related accessories.

The fibre optic design shall be based on building type, number of tenant units and structure.

All fibre cables shall be continuous lengths free from joints and splices.

A minimum of 25% spare fibre cores shall be included in the design while calculating multicore fibre core capacity, to allow for maintenance and additional service demands.

All optical fibre testing shall be completed in accordance with ISO/IEC-14763-3.

The optical fibre cable required shall have the following common general specifications of:

a) SM;
b) indoor grade;
c) cable jacket and microducts to be halogen-free and flame-retardant material (LSZH type);
d) air blown micro-cable in accordance with ITU-T G.657 A1/A2;
e) fibre optic colour coding in accordance with ISO 11801-1;
f) microducts for air blown micro-cables installation; and
g) bend-insensitive.

Drop fibre cable shall be:

1) flexible drop fibre; and
2) 4-core cable, flat cross-section.

Multicore fibre cable shall:

i) be flexi-tube (gel free) micro-cable/micro-bundle cable of 24 fibre cores and above; and
ii) have a tight buffer structure up to 12 fibre cores.

G.11.4.10.2 Villa complexes and warehouses

For villa complexes and warehouse developments, the SP shall provide the fibre optic cables.

The Developer shall supply the consolidation cabinet and a 4-core fibre termination box installed inside the consolidation cabinet.

G.11.4.10.3 MTR to consolidation cabinet (direct fibre)

Direct fibre installation may be applied in mixed use developments of low-rise buildings, accommodation blocks and/or villa complexes having a common MTR.

The fibre optic cables shall be provided from the MTR to each consolidation cabinet. The fibres shall pass through the FTR and shall be continuous lengths, free from joints, branches or patching.

G.11.4.10.4 MTR to FTR mini ODF (multicore fibre)

Multicore fibre installation may be installed in high-rise buildings, malls or other large buildings, based on building type, quantity of tenant units and structure.

The number of fibre cores required per floor FTR is calculated as shown in Table G.44. The multicore fibre cable shall be provided from the MTR to the mini ODF inside the FTR.

Number of tenants per building	Number of fibre cores per building (two core fibre each for two SPs)	MTR optical patch panels	Rack/ODF size
0 to 150		Total fibre cores per building/24 = No. of 24-port patch panels	Free standing rack 42U 800 mm × 800 mm (w × d)
151 to 300	(Total number of tenants × 4-core) +25%	Total fibre cores per building/144 = No. of 144-port patch panels	Floor-mounted ODF 47U 900 mm × 450 mm (w × d)
301 to 600			Floor-mounted ODF 47U 900 mm × 450 mm (w × d)

Table G.44 Fibre provision relative to tenant numbers

Locations of mini ODFs in a high-rise buildings shall start from the first floor and then cover a maximum of three floors. For example, a mini ODF installed at the first floor shall cover the first, second and third floors, the next mini ODF location shall be on the fourth floor serving the fourth, fifth and sixth floors, the next mini ODF shall be on the seventh floor, etc.

Multicore fibre cables shall be directly spliced to 4-core fibre cables using the mini ODF cabinet inside the FTRs.

Multicore fibres shall be terminated directly into optical patch panels in the MTR. These patch panels shall be used to patch to each SP's splitter.

All fibre optic cables shall be supplied, spliced, labelled and tested inside the MTR and FTRs. Detailed fibre cores shall be allocated in accordance with Table G.45.

For buildings with less than 256 units, patch-free splitters shall be used for Etisalat.

Feeder cables shall be directly spliced with the splitter inputs and fixed in the splicing trays.

Splitter outputs shall be spliced with the fibre pigtail cords and terminated in the optical distribution patch panels.

Apartment/office/retail		Horizontal distribution	Vertical distribution		Building MTR		
Tenant No.	4-port fibre terminal box with 2 LC/APC and 2 SC/APC	4-core indoor SM Drop fibre cables	Wall mount splice cabinet with 24 fibre splice tray capacity	24-core indoor SM multicore fibre cable - micro module/ flexi- tube	24port SC/APC optical patch panel	Etisalat – 2 × 32 SC/APC GPON splitter	du – 2 × 32 LC/APC GPON splitter
Tenant 1	Port-1 - SC/APC - Etisalat	Blue - core - 1	Splice tray - 1	Blue - core - 1	SC/APC-Port-1	ETC, splitter downlink port-1	
	Port-2 - SC/APC - Etisalat	Orange - core - 2	Splice tray - 1	Orange - core - 2	SC/APC-Port-2		
	Port-3 - LC/APC - du	Green - core - 3	Splice tray - 1	Green - core - 3	SC/APC-Port-3		du, splitter downlink port-1
	Port-4 - LC/APC - du	Brown - core - 4	Splice tray - 1	Brown - core - 4	SC/APC-Port-4		
Tenant 2	Port-1 - SC/APC - Etisalat	Blue - core - 1	Splice tray - 1	Slate - core - 5	SC/APC-Port-5	ETC, splitter downlink port-2	
	Port-2 - SC/APC - Etisalat	Orange - core - 2	Splice tray - 1	White - core - 6	SC/APC-Port-6		
	Port-3 - LC/APC - du	Green - core - 3	Splice tray - 1	Red - core - 7	SC/APC-Port-7		du, splitter downlink port-2
	Port-4 - LC/APC - du	Brown - core - 4	Splice tray - 1	Black - core - 8	SC/APC-Port-8		
Tenant 3	Port-1 - SC/APC - Etisalat	Blue - core - 1	Splice tray - 1	Yellow - core - 9	SC/APC-Port-9	ETC, splitter downlink port-3	
	Port-2 - SC/APC - Etisalat	Orange - core - 2	Splice tray - 1	Purple - core - 10	SC/APC-Port-10		
	Port-3 - LC/APC - du	Green - core - 3	Splice tray - 1	Pink - core - 11	SC/APC-Port-11		du, splitter downlink port-3
	Port-4 - LC/APC - du	Brown - core - 4	Splice tray - 1	Aqua - core - 12	SC/APC-Port-12		
Tenant 4	Port-1 - SC/APC - Etisalat	Blue - core - 1	Splice tray - 1	Blue/black stripe - core - 13	SC/APC-Port-13	ETC, splitter downlink port-4	
	Port-2 - SC/APC - Etisalat	Orange - core - 2	Splice tray - 1	Orange/black stripe - core - 14	SC/APC-Port-14		
	Port-3 - LC/APC - du	Green - core - 3	Splice tray - 1	Green/black stripe - core - 15	SC/APC-Port-15		du, splitter downlink port-4
	Port-4 - LC/APC - du	Brown - core - 4	Splice tray - 1	Brown/black stripe - core - 16	SC/APC-Port-16		
Tenant 5	Port-1 - SC/APC - Etisalat	Blue - core - 1	Splice tray - 1	Slate/black stripe - core - 17	SC/APC-Port-17	ETC, splitter downlink port-5	
	Port-2 - SC/APC - Etisalat	Orange - core - 2	Splice tray - 1	White/black stripe - core - 18	SC/APC-Port-18		
	Port-3 - LC/APC - du	Green - core - 3	Splice tray - 1	Red/black stripe - core - 19	SC/APC-Port-19		du, splitter downlink port-5
	Port-4 - LC/APC - du	Brown - core - 4	Splice tray - 1	Black - core 20	SC/APC-Port-20		
Tenant 6	Port-1 - SC/APC - Etisalat	Blue - core - 1	Splice tray - 1	Yellow/black stripe - core - 21	SC/APC-Port-21	ETC, splitter downlink port-6	
	Port-2 - SC/APC - Etisalat	Orange - core - 2	Splice tray - 1	Purple/black stripe - core - 22	SC/APC-Port-22		
	Port-3 - LC/APC - du	Green - core - 3	Splice tray - 1	Pink/black stripe - core - 23	SC/APC-Port-23		du, splitter downlink port-6
	Port-4 - LC/APC - du	Brown - core - 4	Splice tray - 1	Aqua/black stripe - core - 24	SC/APC-Port-24		

Table G.45 Building fibre termination core assignments by using 483 mm (19 in) 1U – 24-port SC/APC optical patch panel

G.11.4.10.5 FTR mini ODF to consolidation cabinet

4-core fibre cables shall be provided from each consolidation cabinet to its respective mini ODF inside the FTR (see Table G.46).

Each fibre cable shall be directly spliced to multicore fibre cables within the FTR mini ODF.

Fibre core	Port number	Assign to
1 - Blue	1-SC/APC	SP1 GPON
2 – Orange	2-SC/APC	SP1 spare
3 - Green	3-LC/APC	SP2 GPON
4 - Brown	4-LC/APC	SP2 spare

Table G.46 4-core fibre cables core assignments, two connected SPs

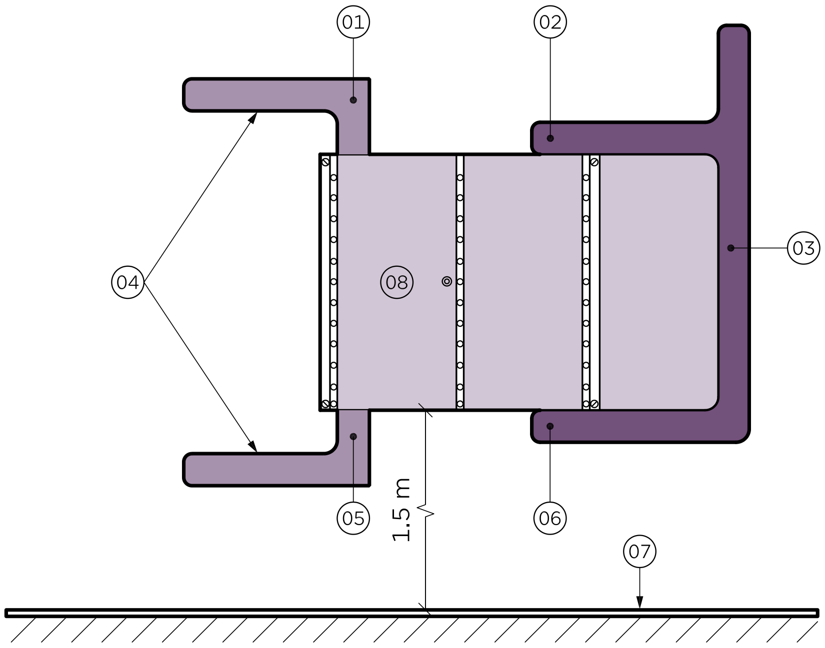
G.11.4.10.6 MTR to each MSR and the RTMR

To enable IBS connectivity within each building, the Developer shall provide a pre-terminated cross-connect cabinet installed at each MSR and in the rooftop room. The cross connect cabinet position, mounting arrangement and cabinet elevation shall conform to Figure G.76 and Figure G.77. The cabinet shall:

a) have a minimum size of 600 mm (w) × 150 mm (d); and
b) accommodate 24 SC/APC pigtails and adaptors.

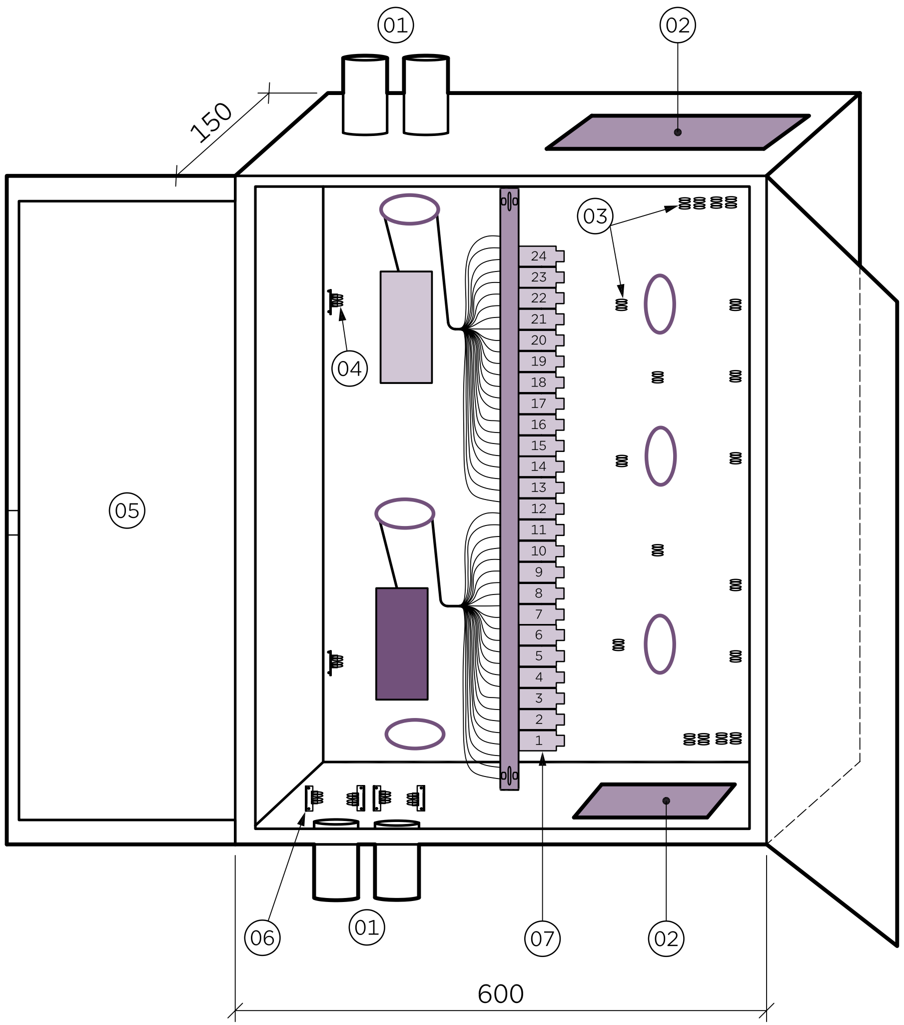
In addition, the following requirements shall be met.

1) 24-core fibre cables shall be installed from the MTR to each MSR and to the RTMR.
2) 24-core fibre cables shall be terminated inside the MTR rack using 483 mm (19 in), 24-port SC/APC fibre patch panel.
3) 24-core fibre cables shall be terminated inside the cross-connect cabinets in the MSR and rooftop rooms:
   i) cores 1 to 12 shall be allocated to connect Etisalat IBS equipment;
   ii) cores 13 to 24 shall be allocated to connect du IBS equipment.



Key
01: Top cable entry for fibre cables
02: Top entry for fibre patch cords
03: PVC trunking to route fibre patch cords
04: Cable tray
05: Bottom cable entry for fibre cables
06: Bottom entry for fibre patch cords
07: Finish floor level (FFL)
08: Cross connect cabinet

Figure G.76 Cross-connect cabinet mounting detail (inside RTMR)



Key

01: Cable entry for 24-core fibre cables from MTR

02: Opening for fibre patch cords

03: Velcro

04: Tube holder

05: Door

06: Cable holder

07: SC/APC pigtails and adapters

12 slot splice tray –for Etisalat (cores 1 to 12 of MTR cable)

12 slot splice tray –for du (cores 13 to 24 of MTR cable)

Adaptors and pigtails

Ring to manage fibre patch cords, fibre pigtails and buffer tubes

Figure G.77 Cross-connect cabinet – elevation layout

G.11.4.10.7 Category 6 copper cabling

To deliver services from the consolidation cabinets to building outlets, twisted pair copper cables shall be provided. The full design is the responsibility of the Developer; however, the following minimum requirements shall be met for the efficient and effective provision of services.

a) The cables shall conform as a minimum to the requirements for category 6 cabling as specified in ISO 11801-1.

b) The wiring shall be a star topology from the consolidation cabinet.

c) Dual RJ45 TOs with spring loaded sliding shutters shall be provided wherever service is required.

d) Design shall include additional spare TOs to provide service flexibility for tenants.

e) Each socket in the dual RJ45 outlet shall be wired back to the consolidation cabinet with an individual cable.

f) TOs shall not be cascaded or looped.

g) Cable pairs shall not be split between outlets.

h) The permanent link cable length from consolidation cabinet to TO shall not exceed 90 m.

i) Cable lengths shall be de-rated where required due to local temperature conditions and cable specifications to enable end-to-end error-free channel performance up to 1 Gbps for category 6 and 10 Gbps for category 6 A.

j) At the consolidation cabinet, copper cables shall be terminated on an RJ45 patch panel and labelled with the socket and outlet served. Terminations shall be to the TIA 568B pair scheme.

k) In each TO, each cable shall be terminated such as to maintain the twists in each pair up to the termination. The termination shall be in accordance with the selected manufacturer's installation instructions.

l) Strain relief shall be provided at the terminated ends of each cable.

m) The components of the system shall all be of the same category (6 or 6 A) and type (UTP or STP), and from a single manufacturer, to ensure optimum performance and compatibility.

n) The results from copper cable tests shall be recorded and retained for future reference.

G.11.4.11 Bulk service

The Developer is responsible for designing and implementing bulk service infrastructure to support landlord building facility management and security applications, and in specific circumstances tenant business requirements.

NOTE: This kind of service solution is usually applied to projects/buildings having their own IT network (single-tenant) such as hotels, hospitals, schools, universities, banks, airports and other similar establishments.

The client shall have an IT server room and a minimum of one dedicated MTR (Figure G.78) for SP telecom/network equipment installation.

The tenant/client shall provide written requirements during the design stage, confirming the bulk service and explaining the service required to be provided up to the client IT room.

The exact requirements related to telecom cabling and EM requirements shall be determined during the design stage based on the client's service requirements.

For bulk services setup the tenant/client shall:

a) install 483 mm (19 in) 42U free standing rack within the MTR;

b) install and test 12 core fibre cable between MTR and client IT server room, terminating the fibre cables at both ends using 12-port fibre patch panels:

    1) cores one to six shall be allocated to connect Etisalat equipment;

    2) cores seven to 12 shall be allocated to connect du equipment;

c) install and test 24 category 6 A copper cables between the MTR and client IT server room:

    1) ports one to 12 shall be allocated to connect Etisalat equipment;

    2) ports 13 to 24 shall be allocated to connect du equipment;

d) install main and spare optical splitter(s) and patch panels;

e) install two 12-port SC/APC pre-terminated fibre patch panels to each SP uplink fibre;

f) provide SC/APC adaptors and pigtail for fibre interfaces;

g) extend 300 mm × 50 mm HDRF cable tray from MTR to client IT server room.

The distance between the MTR and client IT server room shall be within 70 m (to remain within the 90 m permanent link distance limitation, while provisioning fixed services over copper cables).

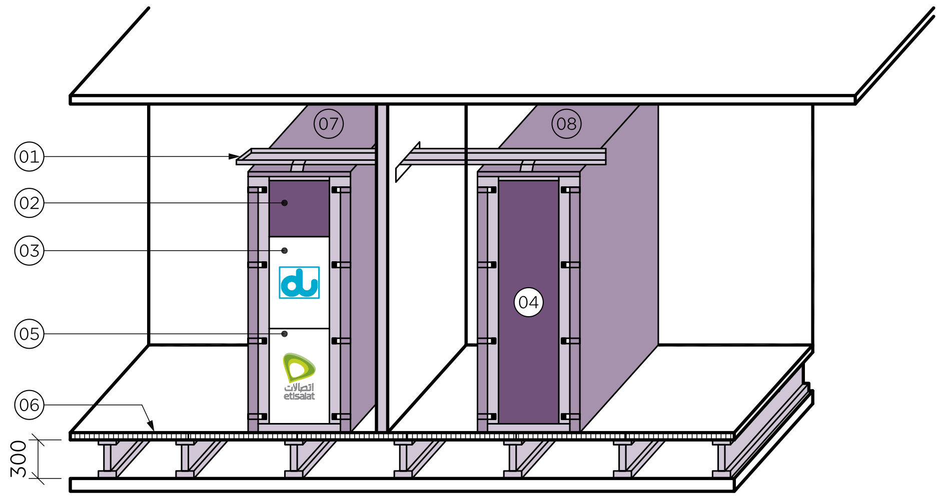


Figure G.78 Bulk service MTR arrangement

Key

01: 300 mm × 50 mm cable tray
02: 10 U space reserved for OSP link (MMR to building MTR) and ISP link (building MTR to client server room)
03: 16 U space reserved for active equipment – du
04: Clients server rack
05: 16 U space reserved for active equipment – ETC
06: Raised floor tiles (optional)
07: MTR room
08: Client server room

G.11.4.12 Labelling scheme

G.11.4.12.1 General

The installed system shall be administered in accordance with ISO/IEC 14763-1.

All sections of the installation shall be provided with suitable identification labels to clearly indicate the location and purpose of each item or cable.

Instructions and "Optical Fibre Caution" notices shall also be provided. All labels shall be in both English and Arabic. The letter sizes shall be selected to suit individual applications.

G.11.4.12.2 SP GAID and EID identification plate for each unit/tenant

The SP identification plate (see Figure G.79) shall be installed at the door entrance of the residential/commercial units. The identification plate shall be made of plastic or light metal with the alphanumeric characters (GAID or EID) engraved on it.

The GAID and EID reference number details shall be made available to the Developer during the inspection stage.

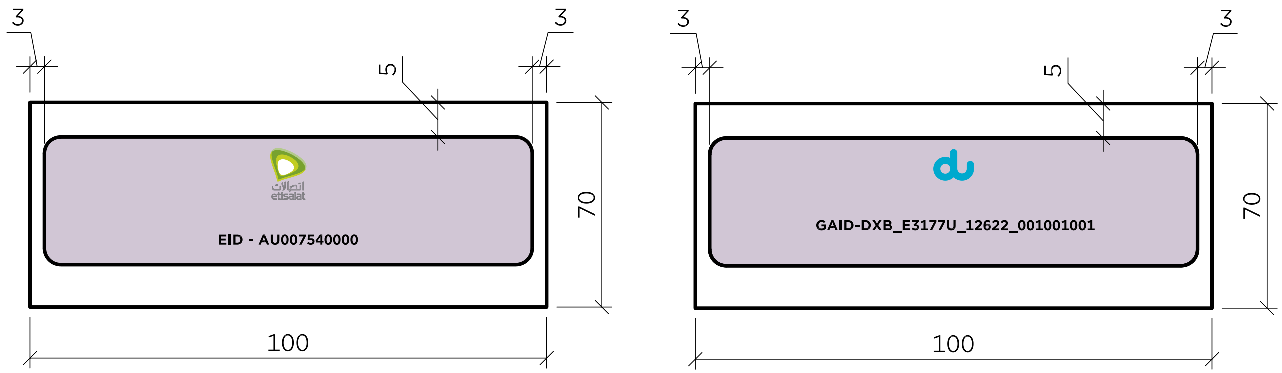


Figure G.79 Example EID and GAID identification plate with labelling details

G.11.4.12.3 Component and location labelling

When labelling telecom cabling and equipment, common suffixes and designations shall be used in label text as detailed in Table G.47 to Table G.49.

Location	Labelling designation
Apartment	ACP
BMS Room	BMS
Equipment rack	RCK
Floor	FL
Floor telecom room	FTR
Main telecom room	MTR
Offices	OCP
Reception	REP
Retail shop	RCP

Table G.47 Labelling designations

<table>
<tr><th>MTR/FTR side
Floor (Fxx) – Location + number – core number (Cxx)</th><th>Tenant side
MTR/FTR number – core number</th></tr>
<tr><td>Example for floor 01 apartment 04
FL01-ACP04-C01
FL01-ACP04-C02
FL01-ACP04-C03
FL01-ACP04-C04</td><td rowspan="4">MTR01-C01
MTR01-C02
MTR01-C03
MTR01-C04
or
FTR01-C01
FTR01-C02
FTR01-C03
FTR01-C04</td></tr>
<tr><td>Example for floor 01 office 10
FL01-OCP10-C01
FL01-OCP10-C02
FL01-OCP10-C03
FL01-OCP10-C04</td></tr>
<tr><td>Example for ground floor reception
FL00-REP-C01
FL00-REP-C02
FL00-REP-C03
FL00-REP-C04</td></tr>
<tr><td>Example for ground floor retail unit 25
FL00-RCP25-C01
FL00-RCP25-C02
FL00-RCP25-C03
FL00-RCP25-C04</td></tr>
</table>

Table G.48 Labelling scheme for SM fibre cables MTR/FTR to tenant unit

Label type	Format	Example
Labelling of cabinet inside apartment, office, reception or retail shop	Floor number/ name – Location + Number	FL01-ACP12
Labelling of fibre cable after terminating inside fibre ODF or patch panel	Floor number/ name – Location + Number – ODF core number	FL01-ACP12-ODF C1, C2, C3, C4
Labelling for 4-core fibre terminal box (always terminate pigtail one to core one of the SM fibre cable)	Rack number-ODF number-ODF row/ slot number-core numbers	RK2-ODF1-S1-C1, C2, C3, C4

Table G.49 Labelling scheme for equipment

The labelling scheme for 2-core adapters inside the fibre terminal box shall follow Figure G.80 depending upon the orientation of the adaptor.

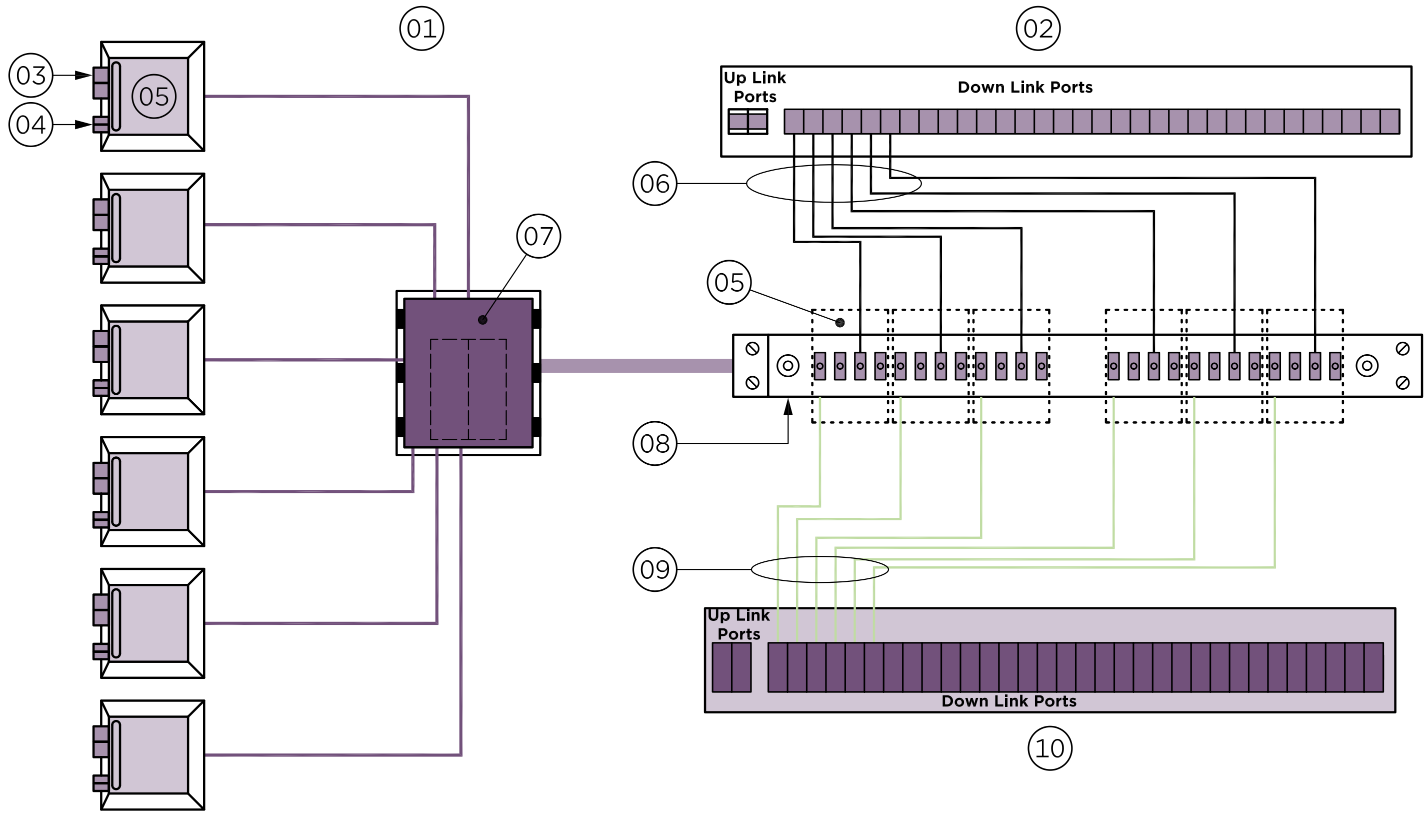
(a) Vertical orientation (b) Horizontal orientation

Figure G.80 Labelling scheme for 2-core adapter inside the fibre terminal box

G.11.4.12.4 SLD and connectivity/wiring detail

The single line diagram (SLD) detail and full as-built documentation for the installation shall be posted inside the MTR to trace end-to-end SP connectivity.

Example SLDs are shown in Figure G.81 and Figure G.82.



Key

01: Core assignment SLD – with SC/APC fibre patch panel

02: 2 × 32 LC/APC splitter for du

03: SC/APC port 1, 2

04: LC/APC port 3, 4

05: Tenant connections (1 to 6)

06: Simplex fibre patch cords (LC/APC to SC/APC)

07: Mini ODF Splice Cabinet

08: 24 port SC/APC fibre patch panel

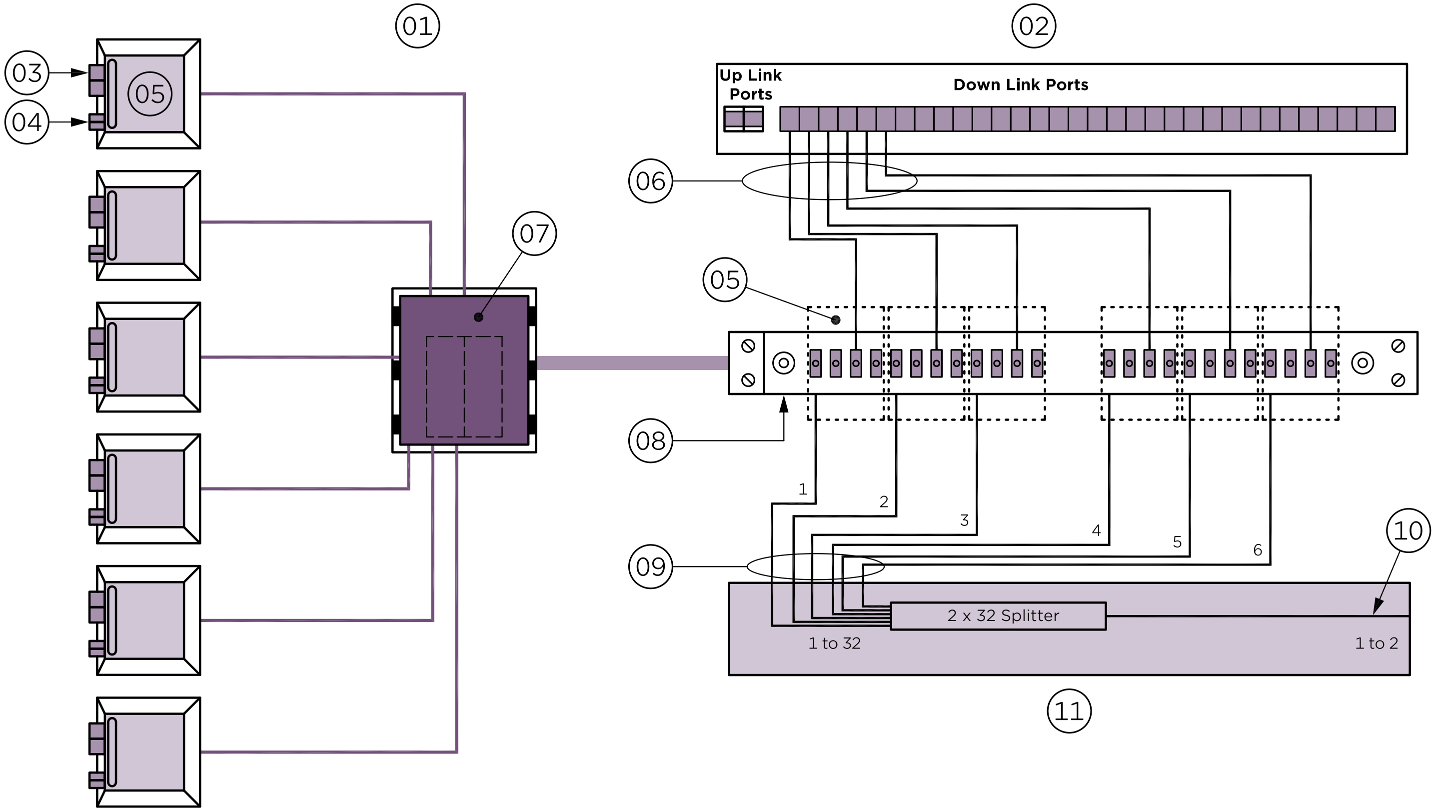
09: Simplex fibre patch cords (SC/APC to SC/APC)

10: 2 x 32 port SC/APC splitter for Etisalat (for buildings with more than 256 units)

Tight buffer or micro modules LSZH indoor multicore fibre cable

4-core flat profile LSZH indoor drop fibre cable

Figure G.81 Example SLD for a building with more than 256 units



Key

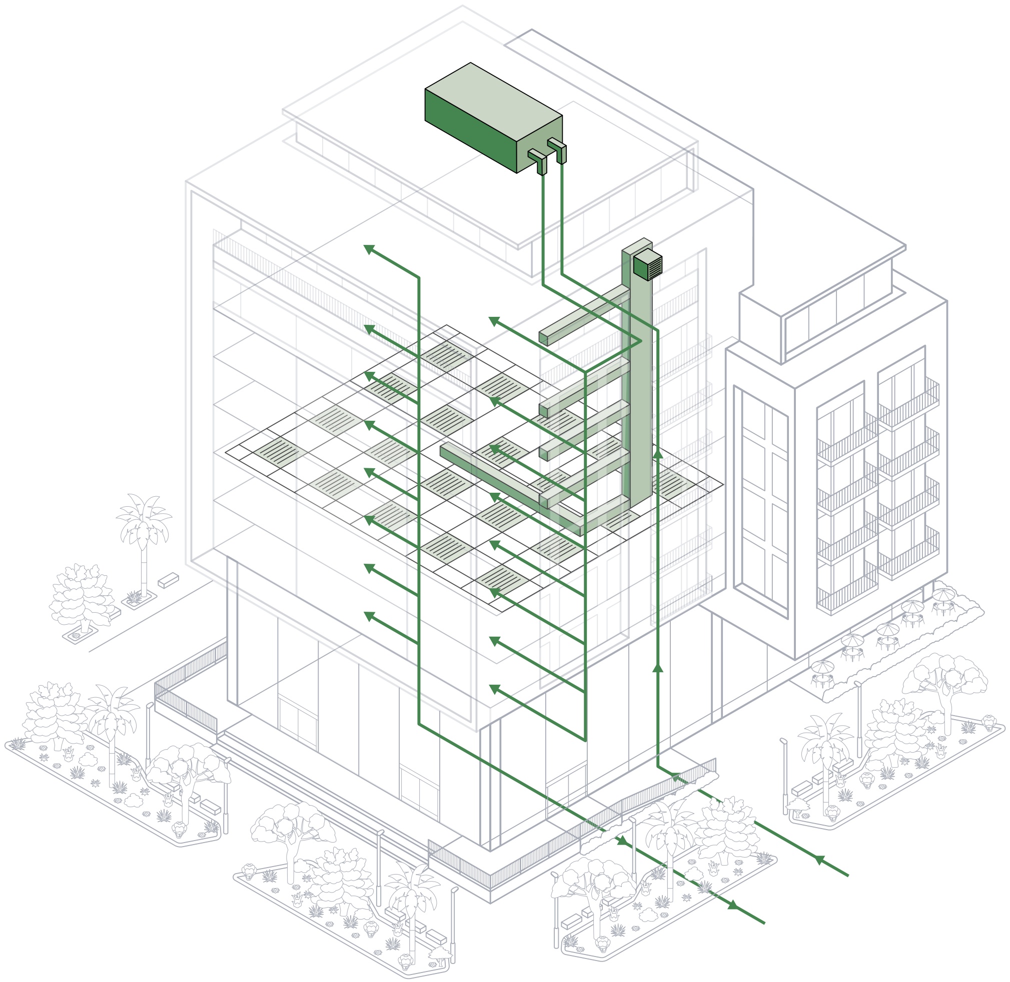
01: Core assignment SLD – with SC/APC fibre patch panel
02: 2 × 32 LC/APC splitter for du
03: SC/APC port 1, 2
04: LC/APC port 3, 4
05: Tenant connections (1 to 6)
06: Simplex fibre patch cords (LC/APC to SC/APC)
07: Mini ODF Splice Cabinet
08: 24 port SC/APC fibre patch panel
09: Fibre pigtail SC/APC
10: Uplink cable
11: Splice tray with 2 x 32 patch free splitters for Etisalat

Tight buffer or micro modules LSZH indoor multicore fibre cable

4-core flat profile LSZH indoor drop fibre cable

Figure G.82 Example SLD for a building with less than 256 units

Part H
Indoor environment



H.1 Performance statements

Performance statement	The performance statement will be met by following the requirements of:
The building shall provide fixed building services that: a) are energy-efficient; b) have effective controls; c) ensure optimal operational efficiency; d) facilitate the health and comfort of the occupants.	H.4, H.8
The building shall provide a reliable supply of safe water with sanitary fittings selected to reduce water consumption.	H.5, H.8
The building shall provide drainage systems to collect and convey drainage flows in a safe and efficient manner.	H.6, H.8
The building shall safeguard people from undue noise being transmitted from adjacent spaces, occupancies and the exterior.	H.10
The building shall provide artificial lighting to enable safe movement when there is insufficient natural light.	H.7, H.8
The building shall provide appropriate digital services enablement, ensuring interoperability and future-proofing of communications.	H.11

H.2 Definitions

H.2.1 Terms

H.2.1.1 HVAC and occupant comfort

Air contaminants: Unwanted airborne constituents that might reduce acceptability or adequacy of the air quality.

Air leakage: Air that escapes from or to a building through a joint, coupling, junction, or the surfaces which enclose the building. The flow of uncontrolled air within a building through cracks or openings.

Air ventilation: Share of supply air that is outdoor air, plus any recirculated air that has been filtered or otherwise treated to maintain acceptable indoor air quality.

Air volume: Amount (volume) of air delivered to a space through ventilation, typically specified in litres per second or cubic metres per minute.

Building envelope: Physical barrier between the exterior and the conditioned environment of a building to resist air, water, moisture, heat, cold, light, and noise transfer. For an air-conditioned building, the building envelope comprises the elements of a building that separate conditioned spaces from the exterior. Crown extensions to the façade to cover plant screen cladding are part of the building envelope. The building envelope does not include the physical barrier below ground.

Building management system (BMS): Computer-based control system which controls and monitors the mechanical and electrical equipment in a building, such as ventilation, lighting, power systems, fire systems, and security systems, or controls and monitors a number of buildings.

Building services: All necessary services required to operate the building such as plumbing, mechanical, electrical and others.

Commissioning: Quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meets defined objectives and criteria.

Condensation: Process through which a gas or vapour changes to liquid form. Also defined as the water which is produced in this process.

Control systems: Localized controls that allow users to change/adjust the level of lighting and air-conditioning in a space.

Cooling coil: Coiled arrangement of tubing or pipe for the transfer of heat between a cold fluid and air.

Cooling load: Amount of cooling that a building will require to meet the conditions specified by the Authority. The cooling load is determined by the output of the heat load calculation required by the Authority.

Cooling tower approach: Difference between the leaving water temperature and the entering air wet-bulb temperature in a cooling tower.

Demand controlled ventilation (DCV): Ventilation system that provides for the automatic reduction of outdoor air intake below design rates, when the actual occupancy of spaces served by the system is less than design occupancy. Demand is often assessed by using the measure of the amount of carbon dioxide (CO_2) in a space to reflect occupancy levels.

Diversity factor: Relates to the thermal characteristics of the building envelope, temperature swings and occupancy load.

Ductwork: Airtight devices that carry conditioned air throughout the building. This includes terminal fixtures to distribute air.

Ductwork leakage: Escape of air through cracks and gaps when air-conditioning ductwork is not airtight. Ductwork leakage results in an increase in energy consumption of supply and return air fans.

Exhaust air: Air removed from a building space and discharged to the outside of the building through a mechanical or natural ventilation system.

Global warming potential (GWP): Contribution of greenhouse gases released to the atmosphere in the global warming phenomenon.

Heat load calculation: Process of calculating the total heat generated inside the building by various sources.

Heating, ventilation and air-conditioning system (HVAC): Equipment, distribution systems, and terminals that provide either individually or collectively, the processes of heating, ventilating, or air-conditioning to a building or a portion of a building.

Make-up air (dedicated replacement air): Air deliberately brought into the building from the outdoors and supplied to the vicinity of an exhaust hood to replace the air and cooking effluent being exhausted. Make-up air is generally filtered and fan-forced, and it can be heated or cooled depending on the requirements of the application.

Mechanical system: Those systems within a building which include components of mechanical plant or machinery. These systems include, but are not limited to, the HVAC system of a building.

Mechanical ventilation: Ventilation provided by mechanically powered equipment, such as fans.

Minimum efficiency reporting value (MERV): Filtering efficiency of an air filter that has been evaluated using the ASHRAE 52.2 test procedure. An air filter's performance is determined by comparing airborne particle counts upstream and downstream of the air filter (or other air cleaning device) under test conditions. A higher MERV rating equates to higher air filtration efficiency.

Mixed mode ventilation: Combination of mechanical and natural ventilation.

Monitoring equipment: Equipment used to measure, and record status or conditions related to a building or to verify pre-set conditions and provide control or alarm functions if conditions vary.

Natural ventilation (passive ventilation): Ventilation provided by thermal, wind or diffusion effects through windows, doors, or other openings in the building.

Negative pressure: Pressure less than that in adjoining spaces.

Occupancy sensor: Device that detects the presence or absence of people within an area and causes lighting, equipment, or appliances to be regulated accordingly.

Outdoor air: Outside air supplied to a building space through mechanical or natural ventilation to replace air in the building that has been exhausted.

Refrigerants: Working fluids of refrigeration cycles, which absorb heat at low temperatures and reject heat at higher temperatures.

Replacement air: Outdoor air that is used to replace air removed from a building through an exhaust system. Replacement air can be derived from one or more of the following: make-up air, supply air, transfer air, and infiltration. However, the ultimate source of all replacement air is outdoor.

Relative humidity: Ratio of partial density of water vapour in the air to the saturation density of water vapour at the same temperature and the same total pressure.

Space pressurization: Static pressure difference between the adjacent spaces of a building, with the air tending to move from higher-pressure spaces to lower-pressure spaces.

Supply air: Air entering a space from an air-conditioning, heating, or ventilating system for the purpose of comfort conditioning. Supply air is generally filtered, fan-forced, and heated, cooled, humidified, or dehumidified as necessary to maintain specified temperature and humidity conditions. Only the quantity of outdoor air within the supply air flow is used as replacement air.

Thermal comfort: Condition of mind which expresses satisfaction with the thermal environment. The thermal comfort measurement is subjective in nature as it depends on environmental and personal factors.

Thermal insulation: Materials/products or the methods and processes used to reduce heat transfer. Heat energy can be transferred by conduction, convection or radiation. The flow of heat can be delayed by addressing one or more of these mechanisms and is dependent on the physical properties of the material employed to do this.

Thermal transmittance: Rate of transfer of heat through a material(s) or assembly, expressed as a U-value.

Transfer air: Air transferred from one room to another through openings in the room envelope, whether it is transferred intentionally or not. The driving force for transfer air is generally a small pressure differential between the rooms.

Zoning: Virtual separation of the floors in the buildings based on the elevator groups, such that the elevators serving one zone do not serve the other zone.

H.2.1.2 Water supplies

Backflow: Flow upstream, that is in a direction contrary to the intended normal direction of flow, within or from a water fitting.

Deadleg: Length of water system pipework leading to a fitting through which water only passes infrequently when there is draw off from the fitting, providing the potential for stagnation.

Electrical trace heating tape: Electrical multicored wire installed with thermal insulation around a pipe to maintain hot water return temperatures when a pumped hot water secondary system is not installed.

Legionella bacteria: Causative agent of Legionnaires' disease and its lesser form, Pontiac fever. Legionella generally infects the lungs through inhalation of contaminated aerosol. Legionella bacteria grow in water between 20 °C and 45 °C and can be spread by water droplets.

Microbiological bacteria: Microorganism capable of causing disease that can be transmitted via the water supply.

Non-potable water: Water that is not suitable for drinking but can be used for other purposes depending on its quality.

Potable water: Drinking water that is suitable for human consumption.

Pumped hot water return: Domestic hot water return system that uses a pump to generate circulation in the pipework system.

Raw water tank: Tank that stores non-potable water and has not received any form of water treatment.

Thermal balancing valve: Automatic valve that balances hot water return subcircuits.

Thermostatic mixing valve: Valve with one outlet, which mixes hot and cold water and automatically controls the mixed water to a user-selected or pre-set temperature.

Water outlet: Opening for the discharge of water via a plumbing fixture such as a tap or showerhead.

H.2.1.3 Drainage

Cesspit: Holding tank installed below ground that is used for the temporary collection of faecal matter.

Discharge stack: Main (generally vertical) pipe conveying discharges from sanitary fittings.

Drainage system: System composed of drainage equipment, and other components collecting waste water and discharging by means of gravity, or effluent pumping plant which can be part of a gravity drainage system.

Floor gully: Discharge fitting intended to receive water from floors through apertures in a grating or from waste pipes that connect to the floor gully body or trap.

Grease trap: Appliance used to intercept fats, oils and grease from kitchen appliances.

Greywater: Waste water not containing faecal matter or urine.

Inspection chamber: Chamber construction that provides access into the drainage system. The chamber dimensions only permit access to the sewer or drain line from ground level.

Manhole: Chamber construction that provides access into the drainage system. The chamber dimensions permit a person entry at the sewer drain level (if required).

Oil separator: Below-ground vessel used to intercept contaminated drainage flows that incorporate oil or petrol.

Rainwater: Water resulting from natural precipitation that has not been deliberately contaminated.

Rainwater pipe: Pipe used to collect and transport rainwater from building roof areas to another drainage system.

Rodding eye: Removable fitting that provides access into the drainage system for cleaning and maintenance.

Rodding point: Small diameter connection into the drainage systems that permits entry into the system for cleaning or inspection of the downstream connection.

Sanitary fittings: Fixed appliances supplied with water that are used for cleaning and washing (i.e. baths, showers, wash basins, bidets, water closets, urinals, dishwashers and washing machines).

Sanitation pipework: Arrangement of discharge pipework, with or without ventilated pipes, connected to a drainage system.

Septic tank: Tank installed below ground in which sewage is collected and allowed to decompose through bacterial activity before draining to a soakaway.

Soakaway: Buried drainage feature used to manage surface water on-site and infiltrate into the surrounding ground.

Upper floor: Any floor above the lowest level, which could be a basement level.

Ventilation pipework: Main vertical ventilating pipe, connected to a discharge stack, to limit pressure fluctuations within the discharge stack.

Wastewater: Water which is contaminated by use and all water discharging into the drainage system.

Water trap: Device that the prevents foul air by means of a water seal.

H.2.1.4 Acoustics

Noise: Unwanted sound.

Reverberation time: Time, measured in seconds (s), taken for the sound to decay by 60 dB after a sound source has been stopped.

Reverberation: Persistence of sound in a space after a sound source has been stopped.

Sound pressure level: Physical intensity of sound, measured in decibels (dB).

H.2.1.5 Fire safety

Exit: Portion of a means of egress that is separated from all other spaces of the building or structure by construction, location or equipment as required to provide a protected way of travel from exit access to the exit discharge.

Exit access: Portion of a means of egress that leads to an exit.

Exit discharge: Portion of a means of egress between the termination of an exit and a public way.

High-rise building: Building height greater than or equal to 23 m and up to 90 m, measured in accordance with the UAE FLSC [Ref. H.1]. A more detailed definition is given in UAE FLSC.

Super high-rise building: Building height greater than 90 m, measured in accordance with the UAE FLSC [Ref. H.1]. A more detailed definition is given in UAE FLSC.

H.2.1.6 Lighting

Electronic ballast: A piece of equipment required to control the starting and operating voltages of fluorescent lights. Electronic lighting ballasts use solid state circuitry and can greatly reduce or eliminate any flicker in the lamps.

Lighting power density: Electrical power consumed by the lighting installation per unit floor area (W/m^2) or unit length, linear metre (W/lm) of an illuminated space.

Lux: Unit of illuminance, measuring luminous flux per unit area.

H.2.1.7 Digital services enablement and ICT

Application programming interface (API): Computing interface provided by an application, system, or service; which provides other applications with a method to connect and interact with it.

BACnet: Communication protocol for building automation and control networks. BACnet interfaces are widely implemented in HVAC and BMS systems worldwide and likely to be supported long-term.

Cable pathway: Any system used to route cables, such as cable ducting, cable ladder, cable tray, conduit, duct and maintenance chamber.

Data governance: Set of processes to manage the availability, usability, integrity and security of data in enterprise systems.

Digital services enablement: Process of future-proofing a building's smart application potential, by providing the fundamental connectivity requirements in terms of infrastructure, systems and technology throughout the design, construction and building operation stages of a project. This approach allows for future implementation of smart functionalities, use cases and downstream initiatives that might not initially be defined, thereby providing flexibility in terms of timescale and adaptability in terms of meeting operator or occupier functional requirements. Such initiatives might include, but are not limited to, analytics, alerts, calculations, dashboards and prediction models.

Fieldbus: Family of process control protocols that are widely used for real-time distributed control.

Internet of Things (IoT): System of devices embedded with sensors, software and network connectivity, that are provided with unique identifiers. The devices have the ability of being responsive, as they collect and exchange data over a network without requiring human-to-human or human-to-computer interaction.

Interoperability: Ability of different suppliers' products to share data and intelligence in a more open way which provides opportunities to create new use cases by combining and integrating various functions across different operational systems and their smart devices. Interoperability is a key principle for smart buildings, IoT and ICT infrastructure design.

JavaScript Object Notation (JSON): Open standard data interchange format using a text format.

Konnex (KNX): Field protocol which overlaps with BACnet use cases and which supports communication scenarios between products common in building control. Device capabilities are sufficiently standardized such that it is possible to combine devices from different manufacturers into a common system or network.

LonWorks: Internationally standardized proprietary protocol that overlaps with BACnet use cases. It offers several physical communications solutions for field devices..

Main equipment room (MER): Equipment room accommodating the centralized network switching and communications equipment supporting building systems and the information technology (IT) application servers belonging to the landlord, anchor tenant or owner-occupier.

M-Bus: Communication protocol developed to provide a communications interface specifically for consumption meters.

Message queueing telemetry transport (MQTT): Open IoT protocol which supports the publish/subscribe method for messaging between devices.

Modbus: General-purpose digital communications bus which suits devices with very constrained capabilities. Modbus is commonly offered in devices such as electrical meters and some HVAC applications.

Open platform communications (OPC): Communications standard used for system integration. Object payloads are typically binary in construction with the origin and consumer applications both typically MS Windows applications. Recent standardization efforts extend OPC to allow implementation on C and Java platforms as well as Windows API, and add methods of expressing the communications as XML or web services.

Operational technology: Hardware, software, gateways and devices that support the monitoring and control of various processes within a facility. The term is typically used to cover facility and process systems such as BMS and SCADA, as opposed to traditional corporate IT systems.

Secondary equipment room (SER): Equipment room accommodating distributed network switching and communications equipment supporting building systems and the IT application servers belonging to the landlord, anchor tenant or owner-occupier. Equivalent alternative name is the secondary communications room.

Sensor networks: Network of interconnected sensor nodes that collect data about the surrounding environment.

Smart gateway: Gateway device which provides a smart interface to allow a subsystem operating on a closed protocol to communicate over an encrypted TCP/IP connection using an open IoT protocol.

Smart interface/IoT interface: Interface which allows internet scalable addressability and security; communication is over an encrypted TCP/IP connection, using open IoT protocols.

Smart meter: Smart meters provide near-real-time information on energy consumption. It helps to control and manage energy use, save money, switch energy supplier more quickly, and reduce carbon emissions.

Supervisory control and data acquisition (SCADA): System used to monitor and control process-based plant or equipment. SCADA systems are typically deployed in main utility controls (e.g. power, water, gas, sewage) and/or where a control system is required to integrate other individual control systems.

Use case: Interaction between a user and smart functionality within a smart or digital building. The use case describes how the user is expected to use a technology for the completion of a task.

H.2.2 Acronyms and abbreviations

AAV	air admittance valve
AHU	air handling unit
AMCA	Air Movement and Control Association International, Inc.
ANSI	American National Standards Institute
API	application programming interface
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	ASTM International
AV	audio visual
BACnet	building automation and control network
BDNS	building device naming standard
BICSI	Building Industry Consulting Service International
BIM	building information modelling
BMS	building management system
BS EN	British Standard European Norm
CAFM	computer aided facilities management
cap.	capita
CIBSE	Chartered Institution of Building Services Engineers
CNS	common network system
CO	carbon monoxide
CO_2	carbon dioxide
DCD	Dubai Civil Defence
DCV	demand controlled ventilation
DEWA	Dubai Electricity and Water Authority
DHA	Dubai Healthcare Authority
DHCP	dynamic host configuration protocol
DIES	Dubai's Integrated Energy Strategy
ESMA	Emirates Authority for Standardization and Metrology
FCU	fan coil unit
FGI	Facility Guidelines Institute
FIC	final inspection chamber
GRP	glass-reinforced plastic
HSE	Health and Safety Executive
HTM	health technical memoranda
HVAC	heating ventilation and conditioning
ICNIRP	International Commission on Non-Ionizing Radiation Protection
ICT	information and communications technology
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
IETF	Internet Engineering Task Force
IFC	industry foundation classes
IoT	Internet of Things
IP	internet protocol
ISO	International Organization for Standardization
IT	Information technology
JSON	JavaScript object notation
KNX	konnex
LAN	local area network
LoRaWAN	long range wide area network
LPWAN	low power wide area network
MER	main equipment room
MERV	minimum efficiency reporting value
MQTT	message queueing telemetry transport
NFPA	National Fire Protection Association
OPC	open platform communications
OT	operational technology
PAPA	passive air pressure attenuators
PoE	power over ethernet
PVC-U	unplasticized poly(vinyl chloride)
QR	quick response code
SCADA	supervisory control and data acquisition system
SCS	structured cabling system
SDN	software-defined networking
SER	secondary equipment rooms
SI	International system of units
SMACNA	Sheet Metal and Air-Conditioning Contractors National Association
TCP/IP	transmission control protocol/internet protocol
TO	telecommunications outlet
TRA	Telecommunications Regulatory Authority
TSE	treated sewage effluent
TVOC	total volatile organic compound

TWA	time weighted average
UAE FLSC	UAE Fire and Life Safety Code of Practice
UL	Underwriters Laboratories
VOC	volatile organic compound
VPN	virtual private network
XML	extensible mark-up language

H.3 References

H.3.1 Essential references

H.3.1.1 General

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H.3.1.2 HVAC and occupant comfort

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ASTM A254, Standard specification for copper-brazed steel tubing

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ASTM B42, Standard specification for seamless copper pipe, standard sizes

ASTM B43, Standard specification for seamless red brass pipe, standard sizes

ASTM B75, Standard specification for seamless copper tube

ASTM B88, Standard specification for seamless copper water tube

ASTM B135, Standard specification for seamless brass tube

ASTM B280, Standard specification for seamless copper tube for air-conditioning and refrigeration field service

ASTM B302, Standard specification for threadless copper pipe, standard sizes

ASTM D2996, Standard specification for filament-wound "fiberglass" (glass-fiber-reinforced thermosetting-resin) pipe

ASTM E84, Standard test method for surface burning characteristics of building materials

ASTM E2231, Standard practice for specimen preparation and mounting of pipe and duct insulation materials to assess surface burning characteristics

ASHRAE 15, Safety standard for refrigeration systems

ASHRAE 34, Designation and safety classification of refrigerant

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NFPA 37, Standard for the installation and use of stationary combustion engines and gas turbines

NFPA 54, National fuel gas code

NFPA 61, Standard for the prevention of fires and dust explosions in agricultural and food processing facilities

NFPA 69, Standard on explosion prevention systems

NFPA 70, National electrical code

NFPA 85, Boiler and combustion systems hazards code

NFPA 88A, Standard for parking structures

NFPA 91, Standard for exhaust systems for air conveying of vapors, gases, mists, and particulate solids

NFPA 211, Standard for chimneys, fireplaces, vents, and solid fuel-burning appliances

NFPA 499, Recommended practice for the classification of combustible dusts and of hazardous (classified) locations for electrical installations in chemical process areas

NFPA 654, Standard for the prevention of fire and dust explosions from the manufacturing, processing, and handling of combustible particulate solids

NFPA 853, Standard for the installation of stationary fuel cell power systems

SMACNA, HVAC Duct construction standards, depending on the specific application

UL 103, Standard for factory-built chimneys for residential type and building heating appliances

UL 507, Standard for electric fans

UL 586, Standard for safety for high-efficiency, particulate, air filter units

UL 641, Standard for type L low-temperature venting systems

UL 723, Standard for test for surface burning characteristics of building materials

UL 726, Standard for type L low-temperature venting systems

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H.3.1.3 Water supplies

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H.4 HVAC systems and occupant comfort

H.4.1 General

This section sets out the minimum requirements and basis of design for heating, ventilation and air-conditioning (HVAC) systems and thermal comfort within buildings. Relevant sustainability criteria and cross-references to UAE FLSC [Ref. H.1] are included.

HVAC systems shall be designed to minimize energy usage and ensure the comfort of building occupants. Systems shall be selected to ensure long life, easy maintenance, and simple and effective controls.

For systems or applications not covered by this section, design solutions and guidance shall be obtained from the current edition of the ASHRAE handbooks, guides and standards.

The requirements for healthcare buildings, and all relevant codes and standards, are identified within the Dubai Health Authority (DHA) Regulations [Ref. H.2 to Ref. H.11] and DHA Health facility guidelines [Ref. H.12 to Ref. H.16].

H.4.2 Protection of structure

The building or structure shall not be weakened by the installation of mechanical systems.

Mechanical equipment to be supported by the structure and any associated seismic bracing shall be coordinated with the Structural Engineer. Installation of mechanical systems over structural joints should be avoided. If that is not possible, flexible ducts/pipes may be used.

Where any portion of the building or structure needs to be altered or replaced in the process of installing or repairing any mechanical system, the building or structure shall be left in a safe structural condition in accordance with Part F.

Penetrations of floor/ceiling assemblies, and any assemblies that are required to have a fire-resistance rating, shall be protected in accordance with Section 3, Ch. 1 of UAE FLSC [Ref. H.1].

H.4.3 Equipment and appliance location

HVAC equipment and appliances shall not be installed in a hazardous location unless listed and approved for the specific installation.

Fuel-fired appliances shall not be in, or obtain combustion air from, any of the following rooms or spaces:

a) sleeping rooms;
b) bathrooms;
c) toilet rooms;
d) storage closets;
e) surgical rooms.

This subsection does not apply to direct-vent appliances that obtain all combustion air directly from the outdoors.

Appliances shall not be installed where they might be subject to mechanical damage unless protected by approved barriers.

Appliances installed in outdoor locations shall be approved by the Authority for outdoor installation.

Mechanical equipment and systems shall not be installed in an elevator shaft.

Individual heat rejection equipment having a power rating greater than 4.0 kW, and which exhausts externally, shall be installed not less than 3 m above the external ground level of the building.

To reduce damage to property from leaks, fan coil units shall be installed in wet areas in residential apartment buildings.

H.4.4 Access and service space

HVAC equipment and appliances shall be accessible for inspection, service, repair and replacement. Access shall not necessitate disabling the function of a fire-resistance-rated assembly, or removing any of the following:

a) permanent construction;
b) other appliances; and
c) venting systems or other piping or ducts not connected to the appliance being inspected, serviced, repaired or replaced.

The requirements given in ASHRAE 180 shall be met for HVAC systems.

A level working space at least 762 mm × 762 mm shall be provided in front of the control side to service an appliance. Rooms containing appliances shall be provided with a door and an unobstructed access path measuring not less than 915 mm wide × 2.3 m high. Where equipment and appliances requiring access are installed on roofs or elevated structures at a height exceeding 4,800 mm, such access shall be provided by a permanent approved means of access.

H.4.5 Acoustic requirements and noise criteria

Ch. 49, Table 1 of the ASHRAE HVAC applications handbook **[Ref. H.17]** identifies design guidelines for acceptable noise levels for HVAC-related background noise for a range of typical building and room types. These design guidelines shall be used as the basis for determining acceptable noise levels for the specific occupancy. If a higher or lower value is considered desirable, an analysis of economics, space use and user needs shall be obtained from an Acoustic Consultant to determine an appropriate value.

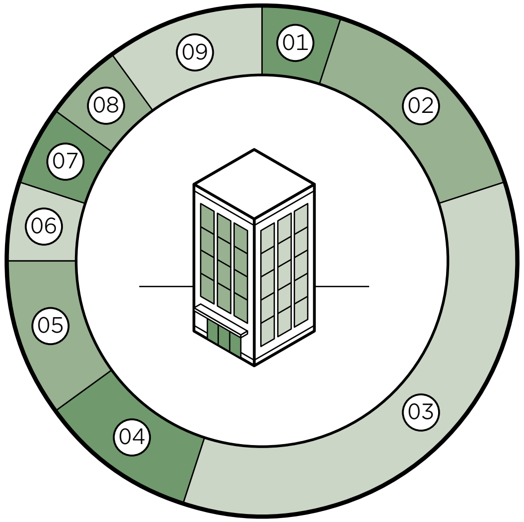
An experienced Acoustic Consultant shall be engaged to provide guidance on acoustically critical spaces such as (but not limited to) audio control rooms, broadcasting studios, places of worship, lecture theatres, cinemas, shopping malls, gymnasium located over habitable spaces, school auditoria and for all performing arts spaces.

NOTE: Further details are given in H.10.

H.4.6 Building HVAC energy load

H.4.6.1 General

Building HVAC loads typically dominate a building's energy consumption (see Figure H.1). To minimize the building HVAC energy load, the envelope design and fabric selections shall meet the minimum performance requirements for the building envelope (see **Part E**) and, where necessary, the building energy load targets identified in ASHRAE 90.1.



Key
01: AHU – 5%
02: Auxillary equipment and loads – 15%
03: Chiller – 35%
04: FCU – 10%
05: Lights – 10%
06: Package AC units – 5%
07: Primary pump – 5%
08: Secondary pump – 5%
09: Split AC – 10%

Figure H.1 Typical building energy load profile

The energy load of air-conditioned buildings shall be calculated in accordance with H.4.6.2 to H.4.6.7.

H.4.6.2 Outdoor design conditions

The design criteria values shown in Table H.1 shall be used for outdoor design conditions in Dubai.

Design criteria	Value to be used
Dry bulb temperature	46 °C
Wet-bulb temperature	29 °C
Dubai city latitude (North)	25 °N
Extent of variation in the temperature on the day of design (outdoor daily range)	13.8 °C
Climate zone	0B (as given in Table a-6 of ASHRAE 169:2013)

Table H.1 Outdoor design conditions for Dubai

H.4.6.3 Indoor design conditions

The design criteria values shown in Table H.2 shall be used for indoor design conditions in Dubai.

Design criteria	Value to be used
Dry bulb temperature	24 °C ±1.5 °C
Relative humidity	50% ±5%

Table H.2 Indoor design conditions for Dubai

Indoor design conditions might vary depending on the occupancy or use of the building. The ASHRAE HVAC applications handbook [Ref. H.17] shall be used as the reference for all indoor design conditions for specific occupancies or usage.

When diversity factors to be used in heat load calculations are not known, the coefficients indicated in ASHRAE Fundamentals handbook [Ref. H.18], Ch. 18 shall be used.

The following safety factors shall be applied:

a) sensible heat: ≤10%;

b) latent heat: ≤5%.

H.4.6.4 Outdoor air design conditions

All buildings that are fully air-conditioned shall be provided with an outdoor air system. The system shall ensure that the building is provided with treated outdoor air for at least 95% of the year. The following maximum design temperatures shall be used:

a) dry bulb temperature: 34 °C;

b) wet bulb temperature: 32 °C.

H.4.6.5 Heat gain and loss calculations

Heat load calculations shall be carried out for each air-conditioned space, including peak load incidence in that space. The calculations shall be carried out using software registered with the Authority.

H.4.6.6 External load criteria

The building envelope shall meet the requirements in Part E to determine thermal transmittance and shading coefficients.

The following parameters shall be taken into account in the building load calculations:

a) building envelope orientation;

b) building envelope design and construction details;

c) building floor plans;

d) building elevations and sections;

e) impact of external shading factors (see E.5.3); and

f) any special requirements for the building use or operation.

H.4.6.7 Internal load criteria

H.4.6.7.1 Occupancy

The total number of occupants within the building shall be determined based on room occupancy data provided by the client or Architect. Occupant loads shall be determined in accordance with B.5.1.

Where occupancy density for each space is not identified, the default occupancy density values stated in ASHRAE 62.1, ASHRAE 62.2 and ASHRAE 170 shall be used.

H.4.6.7.2 Lighting

Project-specific lighting loads shall be used. Where lighting loads are not available, they shall be determined based on the recommendations in ASHRAE 90.1.

H.4.6.7.3 Electrical equipment loads

Project specific electrical equipment loads shall be used. Where equipment loads are not available, they shall be as recommended in ASHRAE 90.1 for each application type.

H.4.7 Thermal comfort criteria

HVAC systems shall be capable of providing the range of internal conditions in Table H.3, for 95% of the year.

Variable	Lower limit	Upper limit
Dry bulb temperature	22.5 °C	25.5 °C
Relative humidity	30% (min)	60% (max)

Table H.3 Thermal comfort requirements

For occupant comfort, normal occupied spaces shall have an average air velocity between 0.2 m/s and 0.3 m/s.

H.4.8 Energy conservation and efficiency: building systems

H.4.8.1 Minimum efficiency of HVAC systems

HVAC equipment and systems shall meet the minimum energy efficiency requirements and test procedures, approved by Emirates Authority for Standardization and Metrology (ESMA), as specified in the following tables of UAE.S 5010-5:

a) Table 1: Split and packaged unit including cassette type unit;

b) Table 2: Water source heat pumps;

c) Table 4: Multiple split unit.

Chillers shall meet the minimum efficiency requirements and test procedures given in Table 6.8.1 to Table 6.8.3 of ASHRAE 90.1:2019.

The chiller equipment requirements shall be met for all chillers, including those where the leaving fluid design temperature is <4.5 °C.

H.4.8.2 Exhaust air energy recovery

For buildings with a requirement for treated outdoor air of over 1,000 l/s, energy recovery systems shall be provided to handle at least 50% of the total exhausted air. The energy recovery systems shall have at least 70% sensible load recovery efficiency.

Figure H.2 shows a typical energy recovery wheel.

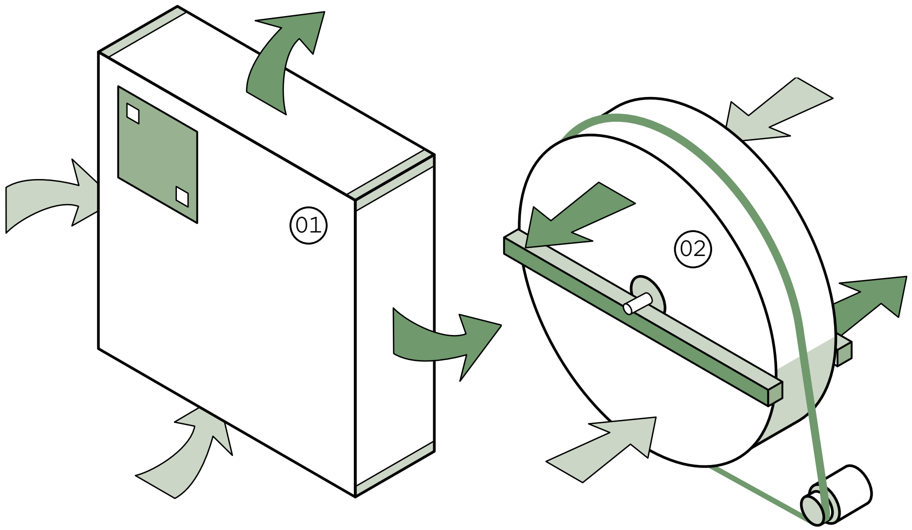


Figure H.2 Ventilation energy recovery thermal wheel

Key

01: Plate heat exchanger

02: Rotary heat exchanger

H.4.8.3 Demand controlled ventilation

Demand controlled ventilation (DCV) using carbon dioxide (CO_2) sensing shall be used in spaces larger than 100 m² and having a maximum design occupancy density greater than or equal to 25 people per 100 m². Default occupancy density values from ASHRAE 62.1 and ASHRAE 62.2, shall be used when the actual occupancy is not known.

CO_2 concentration set-point shall be kept below 800 ppm.

An alarm shall be triggered if CO_2 concentration rises above 1,000 ppm. This alarm can either be automatically monitored by a central control system, if available, or give a local audible or visual indication when activated.

For all buildings with DCV, the CO_2 sensors and systems shall be checked and recalibrated in accordance with the manufacturer's recommendations. Recalibration shall be carried out at intervals not exceeding 12 months, and shall be carried out by specialized companies.

H.4.8.4 Pipe and duct insulation

The following shall be insulated to minimize heat loss and prevent condensation:

a) all pipes carrying refrigerant, hot water or chilled water; and
b) ducts supplying conditioned air (including prefabricated ducts).

This shall include pipes and ducts passing through conditioned and unconditioned spaces.

Pipes and ducts shall be encased in thermal insulation in accordance with BS 5422 or ASHRAE 90.1.

H.4.9 Infiltration/air leakage

H.4.9.1 Performance

Air-conditioned buildings with a cooling load of 1 MW or greater shall achieve an air leakage that does not exceed 5 m³/h/m² into or out of the building, at an applied pressure difference of 50 Pa.

Air tightness testing shall be carried out to verify compliance, in accordance with BS EN 13829 or ASTM E779 or as approved by the Authority.

Positive pressure, with respect to atmosphere, shall always be maintained in the building.

H.4.9.2 Air loss from entrances/exits

Loss of conditioned air from a main entrance to an air-conditioned building shall be mitigated by a lobby or door barrier system.

H.4.10 Ventilation and air quality

H.4.10.1 General

An adequate supply of outdoor air shall be provided to facilitate the health and comfort of the occupants of buildings and to limit condensation.

Adequate space pressurization shall be provided to reduce moisture and contaminant transfer between adjacent spaces, thereby reducing contamination of occupied spaces and unwanted condensation and mould growth. Space pressurization (via return, transfer or exhaust air) in space or location shall be designed at an expected air quality classification in accordance with the Authority requirements (if any) or refer to tables 5.16.1, 6.2.2.1, 6.5 of ASHRAE 62.1:2019.

H.4.10.2 Minimum ventilation requirements for adequate indoor air quality

All air-conditioned buildings shall be ventilated either mechanically or by mixed mode. They shall meet the minimum requirements of ASHRAE 62.1, ASHRAE 62.2 and ASHRAE 170.

Occupancy density shall be determined in accordance with B.5.1 where possible. If the occupancy is not listed in B.5.1, the outdoor air flow rate shall be based on the default occupancy density values stated in ASHRAE 62.1, ASHRAE 62.2 and ASHRAE 170.

H.4.10.3 Indoor air quality

Air filters for general ventilation shall meet the efficiency classification given in ISO 16890-1 based upon particulate matter.

The maximum limit for the indoor air contaminants stated in Table H.4 shall not be exceeded.

Indoor air quality testing shall be carried out prior to occupancy. A test report showing compliance with these requirements shall be submitted to the Authority.

Contaminant	Maximum limit	Sampling duration
Formaldehyde	<0.08 (ppm)	
Total volatile organic compound (TVOC)	<300 µg/m³	8 h continuous monitoring (8 h time-weighted average [TWA])
Suspended Particulates (<10 µm)	<150 µg/m³	

Table H.4 Schedule, duration of sampling and maximum limit for contaminants

Air quality testing shall be carried out by specialized companies or laboratories accredited by the Authority.

Air quality testing equipment shall have an initial and periodical calibration certificate as specified in ISO/IEC 17025. Calibration certification shall be carried out either annually or as specified by the manufacturer, whichever is the more frequent, and shall be carried out by an external calibration facility, accredited by the Authority. The initial and periodical calibration certificates shall be saved in a dedicated register. The calibration certificate shall be checked by the Authority to validate the accuracy of the readings. Calibration certificates shall also be provided when renewing the indoor air quality certificate of the building.

Paints, coatings, adhesives and sealants used in the building shall not exceed the allowed limits for volatile organic compound (VOC) specified by the Dubai Central Laboratory [Ref. H.19]. These materials shall be accredited/certified from Dubai Central Laboratory, or any other laboratory approved by the Authority.

Carpet systems (carpets or new permanently installed carpet padding) shall be certified/accredited by the Dubai Central Laboratory, or any other laboratory approved by the Authority. Carpets shall not be installed in labour accommodation, educational facilities or any other places as determined by the Authority.

NOTE: Alternative filtration techniques, such as electronic filters and air cleaners using photocatalytic oxidation, should be approved by the Authority prior to installation/use due to negative health effects that can arise from exposure to ozone and its volatile reaction products. Substantial technical evidence is required on the use of these techniques and should be validated by international agencies and test standards. They are not considered to be a replacement for mechanical filtration, but can be used as aids to achieve better indoor air quality.

H.4.10.4 Air inlets and exhausts

Outdoor air inlets for all ventilation systems, including doors, operable windows and mixed mode ventilation systems, shall be located at a suitable distance from potential sources of contamination as specified in ASHRAE 62.1, ASHRAE 62.2 and the ASHRAE HVAC applications handbook [Ref. H.17].

NOTE: This is to reduce the possibility of odour, smoke or other air contaminants entering the ventilation system.

Exhaust air shall be discharged in such a way that it does not get drawn back into the building or the building ventilation system. It also shall not become a nuisance to the building occupants or occupants of nearby buildings or to pedestrians.

Air inlets and exhaust louvers/vents shall be positioned such as to prevent recirculation of air, and separated by a distance not less than the minimum given in Table 5-1 of ASHRAE 62.1:2019. Air inlets and exhausts shall be located relative to prevailing wind directions, using wind rose diagrams for the building. Air inlets shall be positioned at upwind or windward direction. Exhausts (such as from kitchens, toilets and smoke extract) shall discharge at downwind or leeward direction.

Intake air shall be drawn into the system through sand trap louvers sized for at least 1 m/s across the face area of the louver, to provide an 80% or higher filtration efficiency at coarse sand grain size (355 μm to 425 μm).

H.4.10.5 Isolation of pollutant sources

All buildings with activities producing hazardous fumes or chemicals (such as print rooms and laboratories) shall be provided with dedicated air extraction systems for those spaces. The system shall create negative pressure and exhaust the fumes or chemicals, to prevent them from entering adjacent rooms.

H.4.10.6 Pandemic air quality measures

The recent pandemic has meant that many Owners and tenants are looking to enhance ventilation solutions to improve air quality and to control airborne diseases and pollutants. The research and technologies in this field are evolving and later editions of the DBC might include specific design requirements. In the interim, Owners wishing to add filtration and purification systems to control airborne infectious diseases in epidemic/pandemic situations, or to control bacterial pollutants in the air, shall consult the Authorized Department in DM for advice and approval of the proposed technology.

H.4.11 Natural ventilation

Natural ventilation of occupied spaces via windows, doors or other openings is permitted but shall not be relied upon to provide ventilation and thermal comfort. Operating mechanisms for such openings shall be accessible so that the openings are readily operable by the building occupants.

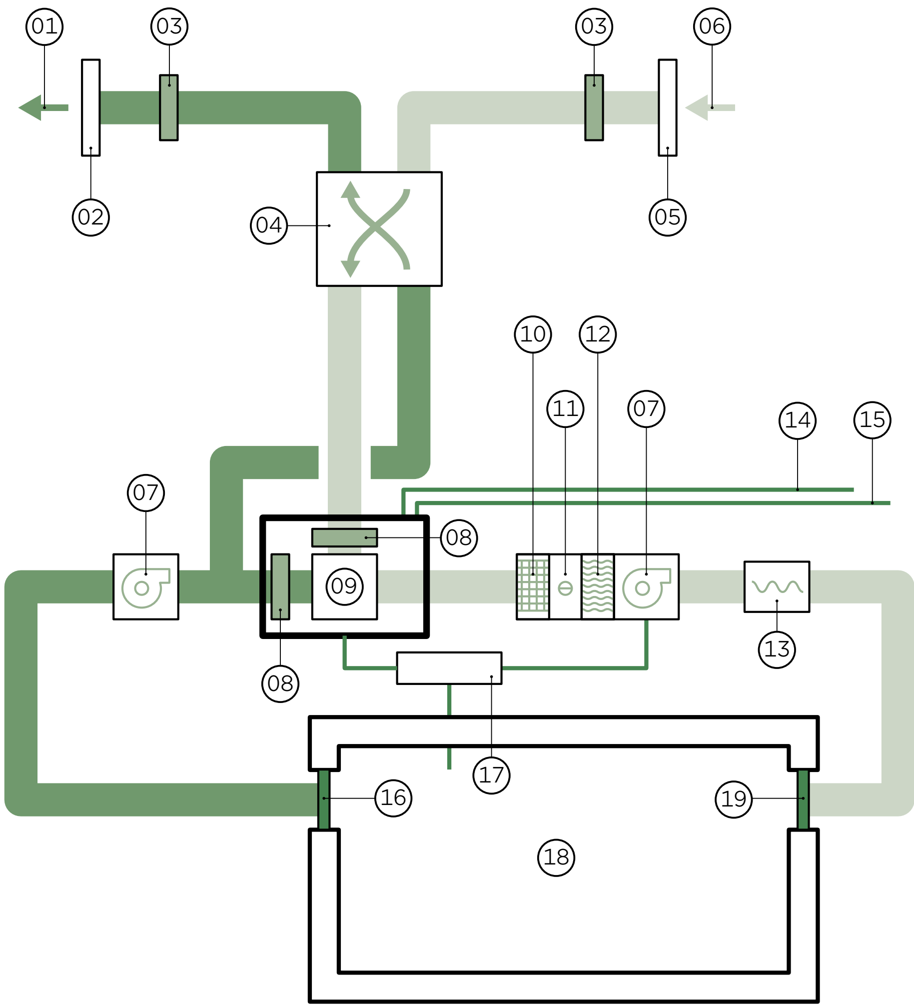
H.4.12 Mechanical ventilation

H.4.12.1 General

The ventilation system design and selection shall be determined by the mechanical design Engineer for the given application, taking into account all relevant issues associated with the building design, usage, configuration and commissioning, operation and maintenance of the system.

Mechanical ventilation shall be provided by a method of supply air and return or exhaust air (see Figure H.3). The amount of supply air shall be approximately equal to the amount of return and exhaust air. The system shall not be prohibited from producing negative or positive pressure. Air handling units shall deliver filtered and conditioned air within the building. Air handling units shall be American Heating and Refrigeration Institute or Eurovent certified.

Mechanical ventilation installations shall meet the requirements given in Ch. 16 of the ASHRAE Fundamentals handbook [Ref. H.18].



Key

01: Exhaust air outlet
02: Exhaust air louver
03: Shut-off damper
04: Heat recovery (alternative to recirculation, if required)
05: Fresh air intake – Sandtrap louver
06: Outdoor air intake
07: Supply/extract fan
08: Recirculating damper (if required)
09: Mixing box (if required)
10: Filter
11: Cooling coil
12: Dehumidifier (if required)
13: Attenuator
14: Recirculation system (if required)
15: Draw-through arrangement (refer to SMACNA)
16: Extract grille
17: Control
18: Occupied zone
19: Air terminal units coupled with, but not limited to;
a) Constant air volume system;
b) Variable air volume system;
c) Fan coil units.

Figure H.3 Example of a mechanical balanced ventilation for non-residential buildings (© Crown Copyright, 1998. Modified figure based on Figure 1, Good practice guide 257, The Department of the Environment, Transport and the Regions (DETR). Contains public sector information licensed under the Open Government Licence v3.0)

H.4.12.2 Ducts and duct connectors

Duct sizing shall be based on the recommended velocity and pressure drop ranges given in Ch. 21 of the ASHRAE Fundamentals handbook [Ref. H.18].

All metallic duct systems shall be constructed in accordance with SMACNA HVAC duct construction standards – Metal and flexible [Ref. H.20].

Ch. 10 of UAE FLSC [Ref. H.1] requires flexible air ducts to be tested and classified in accordance with ANSI/UL 181, and only used when the air temperature in the ducts does not exceed 250 °C or as vertical ducts serving not more than two adjacent stories in height.

In accordance with Ch. 10 of UAE FLSC [Ref. H.1], pipe and duct insulation and coverings, duct linings, vapour retarder facings, adhesives, fasteners, tapes and supplementary materials added to air ducts, plenums, panels, and duct silencers used in duct systems, shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with ASTM E84 or UL 723. When fire testing pipe and duct insulation and coverings, duct linings (and their adhesives and tapes), the specimen preparation and mounting procedures of ASTM E2231 shall be followed.

Fibrous duct construction shall conform to the latest SMACNA fibrous glass duct construction standards [Ref. H.21].

Flexible duct connectors shall not pass through any wall, partition, or enclosure of a vertical shaft that is required to have a fire resistance rating of 1 h or more. Flexible duct connectors shall not pass through floors.

In accordance with Ch. 10 of UAE FLSC [Ref. H.1], ventilation ducts shall not pass through smokeproof enclosures, exit stairs, exit passageways or (unless unavoidable) the firefighting lobby. Where having the ventilation duct within the firefighting lobby cannot be avoided, that part of the duct that is within the lobby shall be enclosed in fire-resisting construction at least equal to that of the elements of structure.

H.4.12.3 Shafts as air ducts

In accordance with Ch. 10 of UAE FLSC [Ref. H.1], shafts used for air ducts shall not accommodate:

a) exhaust ducts used for the removal of smoke- and grease-laden vapours from cooking equipment;
b) ducts used for the removal of flammable vapours;
c) ducts used for moving, conveying, or transporting stock, vapour, or dust;
d) ducts used for the removal of non-flammable corrosive fumes and vapours;
e) refuse and linen chutes;
f) piping, except for non-combustible piping conveying water or other non-hazardous or nontoxic materials; and
g) combustible storage.

H.4.12.4 Plenums

Plenum design shall meet the requirements given in the ASHRAE Fundamentals handbook [Ref. H.18] and in Table 10.1, Ch. 10 of UAE FLSC [Ref. H.1].

Supply, return, exhaust, relief and ventilation air plenums shall be limited to uninhabited crawl spaces, areas above a ceiling or below the floor, attic spaces and mechanical equipment rooms. Plenums shall be limited to one fire compartment. Fuel-fired appliances shall not be installed within a plenum.

Plenum enclosures shall be constructed of non-combustible materials permitted for the type of construction classification of the building.

All materials within plenums shall be non-combustible or as permitted by Table 10.1, Ch. 10 of UAE FLSC [Ref. H.1].

Plenums shall not be used as part of a smoke management system.

H.4.12.5 Air filters

HVAC systems shall be provided with approved air filters to the minimum recommended efficiency reporting value in accordance with the ASHRAE HVAC systems and equipment handbook [Ref. H.22] and in Table E-1 of ASHRAE 52.2:2017. Filters shall also be installed in the return air system, upstream from any heat exchanger or cooling coil.

Media type air filters shall conform to UL 900.

High efficiency particulate air filters shall conform to UL 586.

Electrostatic-type air filters shall conform to UL 867.

Air filters utilized within dwelling units shall be designed for the intended application and are not required to be approved.

Ducts shall be constructed to allow an even distribution of air over the entire filter.

Ductwork shall be effectively sealed to limit air leakage in the system. The application of duct sealing and air leakage shall meet the requirements of ASHRAE 111 and SMACNA HVAC duct construction standards, depending on the specific application.

H.4.12.6 Ductwork air leakage

Air ductwork shall be designed, built and installed in such a way as to minimize air leakage.

The following shall be pressure tested prior to occupancy:

a) ductwork attached to equipment and having an external static pressure of more than 250 Pa;
b) ductwork exposed to external ambient conditions or within unconditioned spaces.

Pressure testing shall be carried out in accordance with the Authority's approved methodology to verify that air leakage does not exceed the permitted maximum.

Ductwork leakage testing shall be carried out by a company that is specialized in commissioning of buildings and is approved by the Authority.

H.4.12.7 Exhaust ventilation systems

Mechanical exhaust ventilation systems (see Figure H.4) shall meet the requirements of the ASHRAE Fundamentals handbook [Ref. H.18] and ASHRAE 62.1.

The air removed by every mechanical exhaust system shall be discharged outdoors at a point where it will not cause a nuisance and at distances no less than those specified in Table 5-1 of ASHRAE 62.1:2019. The air shall be discharged to a location from which it cannot again be readily drawn in by a ventilating system. Air shall not be exhausted into an attic or crawl space.

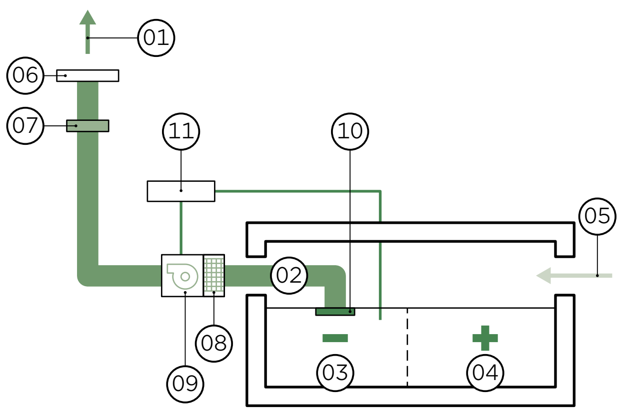


Figure H.4 Example mechanical exhaust ventilation system (© Crown Copyright, 1998. Modified figure based on Figure 1, Good practice guide 257, The Department of the Environment, Transport and the Regions (DETR). Contains public sector information licensed under the Open Government Licence v3.0)

Key

01: Exhaust air outlet
02: Positively pressurized extract ductwork shall not run within the occupied spaces
03: Wet or contaminated zone
04: Occupied zone
05: Supply air through air inlet
06: Exhaust air louver
07: Relief air damper
08: Filter
09: Extract fan
10: Extract grille
11: Control

H.4.12.8 Mechanical ventilation in fire mode

HVAC systems in a building shall be designed to shut down automatically in a fire, unless they are an integral part of a smoke management system.

Air duct smoke detectors shall be provided in accordance with Ch. 10 of UAE FLSC [Ref. H.1].

Each air distribution system shall be provided with at least one manually operable means for stopping the operation of the supply, return, and exhaust fan(s) in an emergency.

The means of manual operation shall be located in the emergency command centre or in a dedicated protected room.

H.4.12.9 Fire and smoke dampers

Fire dampers, smoke dampers and/or combined fire and smoke dampers shall be provided as required by Ch. 10 of UAE FLSC [Ref. H.1].

H.4.12.10 Smoke control and pressurization systems

Smoke control and pressurization systems shall be provided when required by Section 3, Ch. 10 of UAE FLSC [Ref. H.1]. The design of the systems shall be in accordance with Ch. 10 of UAE FLSC [Ref. H.1].

NOTE: Roof ventilation systems as required by Table 10.26, Ch. 10 of UAE FLSC [Ref. H.1] are no longer mandated by Dubai Civil Defence (DCD) for warehouses <900 m² in built-up ground floor areas.

The installation of electrical wiring and equipment associated with smoke control systems shall be in accordance with NFPA 70.

H.4.12.11 Ventilation for vehicle parking areas

Mechanical ventilation shall be provided to ensure the carbon monoxide (CO) concentration within enclosed parking areas (see B.7.2.3.2) is maintained below 50 ppm. The concentration shall be maintained by providing at least six outside air changes per hour, or by installing a variable air volume ventilation system that is controlled by an input response from the CO monitoring equipment.

CO monitoring equipment shall be installed, with at least one CO sensor per 400 m^2 floor area of parking. An audible alarm shall be triggered when the CO concentration reaches or exceeds 75 ppm in at least 5% of the monitored locations.

Outdoor air shall be provided for each parking level.

Occupied areas, such as offices, shopping centres, hotels, elevator lobbies, waiting rooms and ticket booths connected to an enclosed parking space, shall be supplied with conditioned air under positive pressure when compared with the adjoining parking area.

For smoke clearance purposes, ventilation systems shall be capable of providing ten air changes per hour and shall meet the requirements of Section 3.5, Ch. 10 of UAE FLSC [Ref. H.1].

Where a building management system (BMS) is installed, CO concentration shall be monitored to allow real time profiling and management of air quality.

CO monitoring equipment shall be checked and recalibrated every 6 months or according to manufacturer specification by a specialized calibration company, certified by the Authority.

Natural ventilation of vehicle parking areas shall conform to B.7.2.3.2 and NFPA 88A.

NOTE: The definition of open parking in NFPA 88A exceeds the current requirements of UAE FLSC [Ref. H.1], but DCD refers to NFPA 88A as it supersedes the edition referenced in UAE FLSC [Ref. H.1].

H.4.12.12 Motors and fans

Motors and fans shall be sized to provide the required air movement and shall conform to Ch. 21 and Ch. 45 of the ASHRAE HVAC systems and equipment handbook [Ref. H.22].

Motors in areas that contain flammable vapours or dusts shall be of a type approved for such environments.

A manually operated remote control, installed at an approved location, shall be provided to shut off fans or blowers in flammable vapour or dust systems.

Electrical equipment and appliances used in operations that generate explosive or flammable vapours, fumes or dusts shall be interlocked with the ventilation system so that the equipment and appliances cannot be operated unless the ventilation fans are in operation.

Motors for fans used to convey flammable vapours or dusts shall be located outside the duct or shall be protected with approved shields and dustproofing. Motors and fans shall be provided with a means of access for servicing and maintenance.

Parts of fans in contact with explosive or flammable vapours, fumes or dusts shall be of non-ferrous or non-sparking materials, or their casing shall be lined or constructed of such material. When the size and hardness of materials passing through a fan can produce a spark, both the fan and the casing shall be of non-sparking materials. When fans are required to be spark resistant, their bearings shall not be within the airstream, and all parts of the fan shall be grounded.

Fans in systems handling materials that can clog the blades, and fans in buffing or woodworking exhaust systems, shall be of the radial-blade or tube-axial type.

Fans located in systems conveying corrosives shall be of materials that are resistant to the corrosive or shall be coated with corrosion resistant materials.

H.4.12.13 Clothes dryer exhausts

Dryer exhaust systems shall be independent of all other systems and shall convey the moisture, and any products of combustion, to the outside of the building.

Clothes dryer exhaust ducts shall be fire rated, and the fire-resistance rating shall be maintained in accordance with Table 1.9, Ch. 1 of UAE FLSC [Ref. H.1]. Fire dampers, combination fire/smoke dampers and any similar devices that will obstruct the exhaust flow shall not be used in clothes dryer exhaust ducts.

Each vertical riser shall be provided with a means for cleanout.

Screens shall not be installed at the exhaust termination.

H.4.12.14 Domestic kitchen exhaust equipment

Where domestic range hoods and domestic appliances equipped with downdraft exhaust are located within dwelling units, such hoods and appliances shall discharge to exterior through sheet metal ducts constructed of galvanized steel, stainless steel, aluminium or copper. Such ducts shall have smooth inner walls and shall be airtight and equipped with a backdraft damper.

Where installed in accordance with the manufacturer's installation instructions and where mechanical ventilation is otherwise provided, ductless range hoods are not required to discharge to the outdoors.

H.4.12.15 Commercial kitchens

H.4.12.15.1 Kitchen hood ventilation systems

Commercial kitchen hood ventilation systems shall be designed for the type of cooking appliance and hood served. The design shall follow the requirements of the ASHRAE HVAC applications and Fundamentals handbooks [Ref. H.17, Ref. H.18]; Section 2.18, Ch. 10 of UAE FLSC [Ref. H.1]; and DW/172.

Fire dampers, combination fire/smoke dampers and any similar devices that will obstruct the exhaust flow shall not be incorporated in kitchen hood ventilation systems.

Exhaust duct systems shall not have openings other than as required for correct operation and maintenance of the system. Any section of duct system that cannot be accessed from the duct entry or discharge shall be provided with cleanout openings. Cleanout openings shall be equipped with tight-fitting doors constructed of steel having a thickness not less than that required for the duct.

Exhaust equipment, including fans shall be of an approved design for the application. Exhaust fan motors shall be located outside of the exhaust airstream.

Exhaust fans shall be positioned so that the discharge will not have an impact on the roof, other equipment or appliances or parts of the structure.

H.4.12.15.2 Commercial kitchen hoods

Commercial kitchen exhaust hoods shall be installed and maintained in accordance with the ASHRAE HVAC applications, Fundamentals and HVAC systems and equipment handbooks [Ref. H.17, Ref. H.18 and Ref. H.22]; Section 2.18, Ch. 10 of UAE FLSC [Ref. H.1]; and DW/172. Exhaust hoods shall be Type I or II and shall be designed to capture and confine cooking vapours and residues.

Type I hoods shall be installed where cooking appliances produce grease or smoke. Type II hoods shall be installed above dishwashers and light-duty appliances that produce heat or moisture and do not produce grease or smoke.

Type I hoods shall be equipped with listed grease filters designed for the specific purpose.

H.4.12.15.3 Commercial kitchen make-up air

The total replacement air flow rate for the commercial kitchen ventilation system shall be equal to the total kitchen exhaust air flow rate plus the net exfiltration. It is permissible to supply replacement air to the kitchen space by using transfer air from areas other than the kitchen.

Every kitchen shall be slightly negatively pressurized (e.g. –0.25 Pa) to adjacent rooms or immediately surrounding areas, to help contain odours in the kitchen and to prevent odour migration out of the kitchen. The dedicated mechanical make-up air system shall provide not less than 75% and not more than 95% of the total extracted air volume, with the remaining infiltrating naturally into the kitchen from surrounding areas.

The building housing the kitchen shall be slightly positively pressurized (+1.25 Pa to +5.0 Pa maximum) compared to the atmosphere, to prevent infiltration of outdoor air.

NOTE: An example of restaurant and kitchen air balancing is shown in Figure H.5.

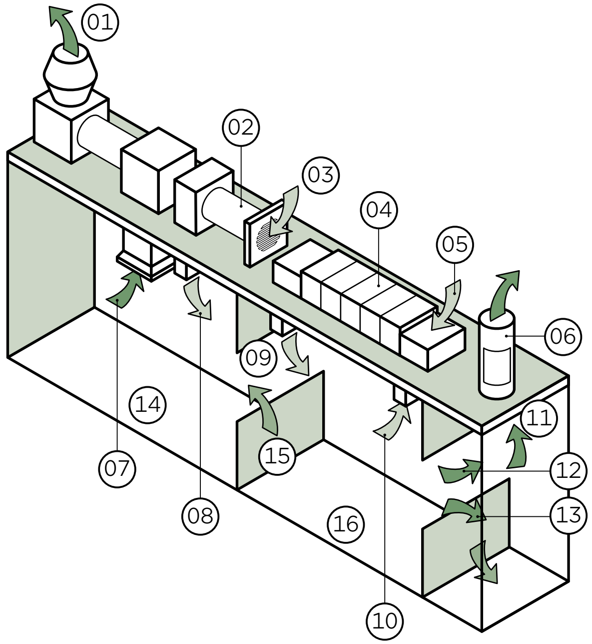


Figure H.5 Example of restaurant and kitchen air balancing

Key

01: Kitchen exhaust (3,000 l/s)
02: Dedicated outdoor air
03: Outdoor air (2,400 l/s)
04: Roof terminal unit
05: Outdoor air (1,000 l/s)
06: Toilet exhaust
07: Kitchen exhaust (3,000 l/s)
08: Supply air (2,400 l/s)
09: Supply air (3,300 l/s)
10: Return air (2,300 l/s)
11: Toilet exhaust (250 l/s)
12: Transfer air (250 l/s)
13: Exfiltration (150 l/s)
14: Kitchen (negatively pressurised)
15: Transfer air (600 l/s)
16: Dining area (positively pressurised)

Commercial kitchen replacement air design shall conform to Sections 6.2, 6.3 and 7 of ASHRAE 154:2016, and to DW/172.

The make-up air shall not reduce the effectiveness of the exhaust system. Make-up air shall be provided by gravity or mechanical means or both. Mechanical make-up air systems shall be automatically controlled to start and operate simultaneously with the exhaust system.

The temperature differential between make-up air and the air in the conditioned space shall not exceed 6 °C.

H.4.12.16 Dust, stock and refuse conveying systems

Collectors and separators involving such systems as centrifugal separators, bag filter systems and similar devices, and associated supports shall be constructed of non-combustible materials and shall be located on the exterior of the building or structure. A collector or separator shall not be located within 3 m of combustible construction or an unprotected wall or floor opening, unless the collector is provided with a metal vent pipe that extends 9.1 m above the highest part of any roof.

Collectors such as “Point of Use” collectors, close extraction weld fume collectors, spray finishing booths, stationary grinding tables, sanding booths, and integrated or machine-mounted collectors may be installed indoors provided that the installation is in accordance with the applicable NFPA standards. These standards include, but are not limited to, NFPA 33, NFPA 61, NFPA 69, NFPA 70, NFPA 91, NFPA 499, and NFPA 654.

Collectors in independent exhaust systems handling combustible dusts may be installed indoors provided that such collectors are installed in compliance with the applicable NFPA standards mentioned above.

A delivery pipe from a cyclone collector shall not convey refuse directly into the firebox of a boiler, furnace, dutch oven, refuse burner, incinerator or other appliance.

An exhaust system shall discharge to the outside of the building either directly by flue or indirectly through the bin or vault into which the system discharges except where the contaminants have been removed. Exhaust system discharge may be recirculated provided that all of the following criteria are met:

a) the solid particulate has been removed at an efficiency of not less than 99.9% at 10 μm (0.01 mm);
b) vapour concentrations are less than 25% of the lower flammable limit; and
c) approved equipment is used to monitor the vapour concentration.

The outlet of an open-air exhaust terminal shall be protected with an approved metal or other non-combustible screen to prevent the entry of sparks.

A safety or explosion relief vent shall be provided on all systems that convey combustible refuse or stock of an explosive nature.

H.4.12.17 Combustion air

Solid fuel-burning appliances shall be provided with combustion air in accordance with the appliance manufacturer’s installation instructions. Oil-fired appliances shall be provided with combustion air in accordance with NFPA 31.

Combustion and dilution air for gas-fired appliances (other than fireplace stoves and direct-vent appliances) shall be in accordance with the requirements given in Ch. 7 of the ASHRAE HVAC systems and equipment handbook [Ref. H.22] and in NFPA 54.

H.4.12.18 Chimneys and vents

H.4.12.18.1 General

Every fuel burning appliance shall discharge the products of combustion to a vent, factory-built chimney or masonry chimney. The chimney or vent shall be designed for the type of appliance being vented.

Oil-fired appliances shall be vented in accordance with NFPA 31. Gas-fired appliances shall be vented in accordance with NFPA 54.

Venting systems shall be designed and constructed to develop a positive flow adequate to convey all combustion products to the outside atmosphere.

H.4.12.18.2 Vents

All vent systems shall be approved by the Authority. Vents shall be tested in accordance with UL 641.

Vent systems shall be sized, installed and terminated in accordance with the vent and appliance manufacturer's installation instructions. Vents shall terminate with an approved cap in accordance with the vent manufacturer's installation instructions.

Double wall vents shall terminate not less than 610 mm above the highest point of the roof penetration and not less than 610 mm higher than any portion of a building within 3,050 mm.

Venting systems of direct-vent appliances shall be installed in accordance with the appliance and the vent manufacturer's instructions.

The support of all portions of vents shall be sufficient for the design and weight of the materials employed.

Where vents pass through insulated assemblies, an insulation shield shall be installed to provide clearance between the vent and the insulation material.

H.4.12.18.3 Connectors

Connectors shall be used to connect appliances to the vertical chimney or vent, except where the chimney or vent is attached directly to the appliance.

Connectors shall be located entirely within the room in which the connecting appliance is located.

The connector shall not be smaller than the size of the flue collar supplied by the manufacturer of the appliance. Where the appliance has more than one flue outlet, and in the absence of specific instructions from the manufacturer, the connector area shall be not less than the combined area of the flue outlets for which it acts as a common connector.

H.4.12.18.4 Factory-built chimneys

Factory-built chimneys shall be approved by the Authority and shall be installed and terminated in accordance with the manufacturer's installation instructions.

Chimneys for use with open combustion chamber appliances installed in buildings other than dwelling units shall meet the requirements of UL 103 and shall be marked "Building Heating Appliance Chimney".

H.4.12.18.5 Metal chimneys

Metal chimneys shall be constructed and installed in accordance with NFPA 211.

H.4.12.19 Explosion control

Buildings with potential explosion hazards shall be provided with ventilation for explosion control as required by Ch. 10 of UAE FLSC [Ref. H.1]. Explosion control systems shall be designed and installed in accordance with Ch. 10 of UAE FLSC [Ref. H.1].

H.4.13 Hydronic systems

H.4.13.1 General

This section applies to hydronic piping systems that are part of HVAC systems. They include steam, hot water, chilled water, steam condensate and ground source heat pump loop systems.

The design and installation of hydronic systems shall meet the requirements of the ASHRAE Fundamentals handbook **[Ref. H.18]**.

H.4.13.2 Materials

The pipe material and associated pipeline equipment and fittings shall have the appropriate temperature and pressure rating for the system in which it is operating. They shall be suitable for the fluid or gas conveyed.

Hydronic pipe material shall conform to the relevant ASTM standards (see Ch. 22 of the ASHRAE Fundamentals handbook **[Ref. H.18]**).

H.4.13.3 Pipe joints and connections

Pipe joints and connections shall be suitable for the pressure of the hydronic system.

H.4.13.4 Valves

Shut-off valves shall be installed in hydronic piping systems in order to enable the isolation of all piping equipment.

NOTE: Further details are given in Ch.22 of the ASHRAE Fundamentals handbook **[Ref. H.18]**.

H.4.13.5 Pipe installation

Pipes, valves, fittings and connections shall be installed in accordance with the conditions of approval.

Hydronic piping systems shall be designed and installed to permit the system to be drained.

Openings for pipe penetrations in walls, floors or ceilings shall be larger than the penetrating pipe. Openings through concrete or masonry building elements shall be sleeved. The annular space surrounding pipe penetrations within fire rated walls or floors shall be protected in accordance with Section 3, Ch. 1 of UAE FLSC **[Ref. H.1]**.

A hydronic piping system shall not be in direct contact with building materials that cause the piping material to degrade or corrode, or that interfere with the operation of the system.

Piping shall be installed to prevent detrimental strains and stresses in the pipe. Provisions shall be made to protect piping from damage resulting from expansion, contraction and structural settlement. Piping shall be installed to avoid structural stresses or strains within building components.

Pipe shall be supported in accordance with Ch. 22 of the ASHRAE Fundamentals handbook **[Ref. H.18]**.

The flash point of transfer fluid in a hydronic piping system shall be not less than 28 °C above the maximum system operating temperature. The transfer fluid shall be compatible with the make-up water supplied to the system.

NOTE: Further guidance is given in the ASHRAE Fundamentals handbook **[Ref. H.18]**.

H.4.13.6 Pipe design

Hydronic piping design and sizing shall follow the guidelines within the ASHRAE Fundamentals handbook [Ref. H.18].

For heating and chilled water services the following design criteria shall be applied.

a) Pressure drop shall not exceed 250 Pa/m for all pipe sizes.
b) Maximum pipe velocity shall not exceed 1.2 m/s for pipe sizes of 50 mm and smaller, and 2.5 m/s for pipe sizes of 65 mm and larger.
c) Minimum pipe velocity shall be not less than 0.45 m/s.

The above criteria shall be reviewed against the ASHRAE Fundamentals handbook [Ref. H.18] based on the particular installation and anticipated operating hours.

Piping to be embedded in concrete shall be pressure tested prior to pouring concrete.

During pouring, the pipe shall be maintained at the proposed operating pressure. Joints of pipe or tubing that are embedded in a portion of the building, such as concrete or plaster, shall meet the following requirements.

1) Steel pipe shall be welded by electrical arc or oxygen/acetylene method.
2) Copper tubing shall be joined by brazing with filler metals having a melting point of not less than 538 °C.
3) Polybutylene pipe and tubing shall be installed in continuous lengths or shall be joined by heat fusion.

H.4.13.7 Pumped hydronic systems

Hydronic cooling or heating systems shall include pressure independent two-way control valves.

Expansion tanks and air separators shall be sized correctly.

Pump motors and pump seal cooling shall be designed for a variable speed operation range of 15 to 50 Hz (300 rpm to 1,450 rpm). Pumps shall be selected to handle 105% of design flow to allow for possible flow increases in the presence of low Delta-T condition.

The mechanical efficiency of the pump shall be not less than 85%. The electric efficiency of the pump motor shall be not less than 95%.

The variable speed drive efficiency shall be not less than:

a) 97% at 50 Hz (1,450 rpm);
b) 95% at 35 Hz (1,000 rpm);
c) 90% at 25 Hz (725 rpm); and
d) 85% at 15 Hz (300 rpm).

H.4.13.8 Pressure vessels

All pressure vessels shall be in accordance with the ASME Boiler and pressure vessel code [Ref. H.23]. They shall bear the label of an approved agency and shall be installed in accordance with the manufacturer's installation instructions.

H.4.13.9 Boilers

H.4.13.9.1 General

Oil-fired boilers and their control systems shall be in accordance with UL 726. Electric boilers and their control systems shall be listed and labelled in accordance with UL 834.

Boilers shall be designed and constructed and installed in accordance with the requirements of ASME CSD-1 and, as applicable, Sections I or IV of the ASME Boiler and pressure vessel code [Ref. H.23], or NFPA 85.

Boilers shall be installed in accordance with the manufacturer's instructions. Operating instructions shall be permanently attached to the boiler, to avoid misplacement. Boilers shall have all controls set, adjusted and tested by the installer. The manufacturer's rating data and the nameplate shall be attached to the boiler.

Boilers shall be mounted on floors of non-combustible construction.

Hot water and steam boilers shall have all operating and safety controls set and operationally tested by the installing Contractor. A complete control diagram and boiler operating instructions shall be provided by the installer for each installation.

H.4.13.9.2 Boiler connections

Every boiler or modular boiler shall have a shut-off valve in the supply and return piping. For multiple boiler or multiple modular boiler installations, each boiler or modular boiler shall have individual shut-off valves in the supply and return piping.

H.4.13.9.3 Safety and pressure relief valves and controls

All steam boilers shall be protected with a safety valve. Hot water boilers shall be protected with a safety relief valve.

All pressure vessels shall be protected with a pressure relief valve or pressure-limiting device as required by the manufacturer's installation instructions for the pressure vessel.

Safety and safety relief valves shall be approved by the Authority and shall have a minimum rated capacity for the equipment or appliances served. Safety and safety relief valves shall be set at a maximum of the nameplate pressure rating of the boiler or pressure vessel.

H.4.13.9.4 Boiler low-water cut-off

All steam and hot water boilers shall be protected with a low-water cut-off control.

The low-water cut-off shall automatically stop the combustion operation of the appliance when the water drops below the lowest safe water level as established by the manufacturer.

H.4.13.9.5 Steam boiler blow-off

Every steam boiler shall be equipped with a quick-opening blow-off valve. The valve shall be installed in the opening provided on the boiler.

The size of the valve shall be either as specified by the boiler manufacturer or determined by the size of the valve opening.

H.4.13.9.6 Hot water boiler expansion tank

An expansion tank shall be installed in every hot water system. For multiple boiler installations, at least one expansion tank shall be provided. Expansion tanks shall be of the closed or open type. Tanks shall be rated for the pressure of the hot water system.

H.4.13.9.7 Gauges

Every hot water boiler shall have a pressure gauge and a temperature gauge, or a combination pressure and temperature gauge. The gauges shall indicate the temperature and pressure within the normal range of the system's operation.

H.4.13.9.8 Testing

Hydronic piping systems, other than ground source heat pump loop systems, shall be tested hydrostatically at one and half times the maximum system design pressure, but not less than 689 kPa (100 psi). The duration of each test shall be not less than 15 min.

Ground source heat pump loop systems shall be tested before connection (header) trenches are backfilled. The assembled loop system shall be pressure tested with water at 689 kPa (100 psi) for 30 min with no observed leaks. Flow and pressure loss testing shall be performed, and the actual flow rates and pressure drops shall be compared to the calculated design values. If actual flowrate or pressure drop values differ from calculated design values by more than 10%, the problem shall be identified and corrected.

Upon completion of the assembly and installation of boilers and pressure vessels, acceptance tests shall be conducted in accordance with the ASME Boiler and pressure vessel code [Ref. H.23].

H.4.13.9.9 Flushing, cleaning and water treatment

Before the system is operated, all water piping shall be flushed, chemically cleaned and treated following the guidelines in the ASHRAE HVAC applications handbook [Ref. H.17].

H.4.13.10 Refrigeration

H.4.13.10.1 General

The design, construction and installation of refrigeration systems shall meet the requirements of the ASHRAE Refrigeration handbook [Ref. H.24] and ASHRAE 15, including:

a) system requirements;
b) refrigerant types and classifications;
c) system application requirements;
d) machinery room requirements;
e) refrigerant piping installation and materials; and
f) testing.

H.4.13.10.2 Refrigerant and ozone depletion management

Refrigerants with zero ozone depletion potential or with global warming potential less than 100 shall be used, unless the equipment contains less than 0.23 kg of refrigerant.

H.4.14 HVAC systems controls and metering

H.4.14.1 Controls for HVAC systems

HVAC systems shall be equipped with efficient controls to reduce energy consumption, in accordance with ASHRAE 90.1.

Control systems shall meet the following requirements.

a) Control systems shall be divided into sub-zones with independent controls for each building zones. Controls for each sub-zone may vary based on the zone's exposure to sun or cooling load levels or by nature of usage.
b) All independent control areas shall be able to:
   1) control temperature; and
   2) turn off the systems when the building or the controlled part of the building is not occupied.
c) Central systems shall operate only when required by zonal control systems.

H.4.14.2 Building management system (BMS)

Buildings having a cooling load of 1,000 kW, or a gross area of 5,000 m^2 or greater, shall have a BMS capable of ensuring that the building's systems operate as designed and as required during all operating conditions. The system shall provide full control and monitoring of system operations, apart from diagnostic reporting.

The system shall control the chiller plant and HVAC equipment as a minimum, and record energy and water consumption. It shall also monitor and record the performance of these items.

BMS systems shall be configured to optimize energy usage.

H.4.14.3 H.4.14.3 Control systems for hotel rooms

Hotel guest rooms shall incorporate automatic control systems that can turn off the lighting, air-conditioning and power when the room is not occupied.

Each guest room should also incorporate an automatic control system that can turn off the air-conditioning when a balcony door or window is kept open.

Outdoor air ventilation shall be provided so that rooms can be kept well-ventilated and under positive pressure during unoccupied periods. The ventilation shall be demand-controlled and capable of being activated by occupancy sensor or light switch. It shall be electrically interlocked.

H.4.14.4 Air-conditioning metering

In buildings supplied by a central air-conditioning source (such as a chiller plant or district cooling), or where cooling energy is delivered individually to several consumers, smart meters approved by the Authority shall be installed to measure and record chilled water supply to air-conditioning units. The meters shall provide accurate records of consumption, which shall be determined as follows.

a) Smart energy meters designed to measure the supply of chilled water shall be installed for each dwelling unit, office or tenant. The measuring device shall measure the water flow and supply and return temperatures to determine the temperature differential for calculating the amount of cooling energy consumed.
b) Where a BMS is installed, the smart metering shall be connected to allow real time profiling and management of energy consumption.
c) Smart meters used shall be specifically designed for the measurement of chilled water and not for hot water.
d) All smart meters shall be capable of remote data access and shall have data logging capability.
e) Virtual meters using run-hours are not acceptable as sub-meters.

The meter readings and actual consumption details shall only be for energy measurement, demand management and cost allocation purposes.

H.4.15 Fuel oil piping and storage

H.4.15.1 General

The design and installation of fuel oil piping systems, and the storage of fuel oil, shall be in accordance with Ch. 13 of UAE FLSC [Ref. H.1], Ch. 22 of the ASHRAE Fundamentals handbook [Ref. H.18], and NFPA 31.

H.4.15.2 Materials

Piping materials shall conform to the following standards:

a) brass pipe: ASTM B43;
b) brass tubing: ASTM B135;
c) copper or copper-alloy pipe: ASTM B42, ASTM B302;
d) copper or copper-alloy tubing: (type K, L or M) ASTM B75, ASTM B88, ASTM B280;
e) non-metallic pipe: ASTM D2996;
f) steel pipe: ASTM A53, ASTM A106; and
g) steel tubing: ASTM A254, ASTM A539.

Piping materials shall be rated for the operating temperatures and pressures of the system. They shall be compatible with the type of liquid to be conveyed in the pipes.

H.4.15.3 Joints and connections

Joints and connections shall be of a type approved for fuel oil piping systems.

Allowance shall be made for expansion, contraction, jarring and vibration. Piping other than tubing, connected to underground tanks, except straight fill lines and test wells, shall be provided with flexible connectors, or otherwise arranged to permit the tanks to settle without impairing the tightness of the piping connections.

H.4.15.4 Piping support

Pipe hangers and supports shall have sufficient strength to withstand all anticipated static and specified dynamic loading conditions associated with the intended use. Pipe hangers and supports that are in direct contact with piping shall be of approved materials that are compatible with the piping and that will not promote galvanic action.

Hangers and anchors shall be attached to the building construction in an approved manner. The spacing between piping supports shall be not less than the minimum specified in ANSI MSS SP-69.

H.4.16 Specific appliances and equipment

H.4.16.1 Gas-fired appliances

Gas-fired appliances shall be approved, designed, installed and constructed in accordance with NFPA 54 and Ch.11 in UAE FLSC [Ref. H.1].

H.4.16.2 Fireplace stoves and room heaters

Stoves and solid fuel-type room heaters shall be approved by the Authority. They shall be installed in accordance with the manufacturer's installation instructions.

Fireplace stoves shall be tested in accordance with UL 737. Solid fuel-type room heaters shall be tested in accordance with UL 1482.

Fireplace inserts shall be approved by the Authority in accordance with UL 1482. They shall be installed in accordance with the manufacturer's installation instructions.

H.4.16.3 Cooling towers, evaporative condensers and fluid coolers

A cooling tower used in conjunction with an air-conditioning appliance shall be installed in accordance with the manufacturer's installation instructions and the requirements given in Ch. 40 of the ASHRAE HVAC systems and equipment handbook [Ref. H.22].

Cooling towers, evaporative condensers and fluid coolers shall be located such as to prevent the discharge vapour plumes from entering occupied spaces. They shall be readily accessible for maintenance and repair. Plume discharges shall be not less than 1.5 m above or 6.1 m away from any ventilation inlet to a building.

The separation distance between cooling tower exhaust and external ventilation air intakes or other building openings shall be in accordance with ASHRAE 62.1:2019. The minimum separation distance shall be calculated based on the wind direction and the location of outdoor air intake as described in Clause 5.5.1(b) and Appendix B: B1.2, B1.3 and B2.2 of ASHRAE 62.1:2019.

Cooling towers shall be selected to achieve the minimum energy performance requirements given in ASHRAE 90.1. All cooling towers shall be Cooling Technology Institute certified and shall be selected at 32.0 °C wet-bulb temperature and cooling tower approach between 2 °C to 3 °C.

H.4.16.4 Infrared radiant heaters

Infrared radiant heaters shall be fixed in a position that is free of fuel and electric supply lines. Heaters shall be installed with clearances from combustible material in accordance with the manufacturer's installation instructions and the ASHRAE Fundamentals handbook [Ref. H.18].

H.4.16.5 Sauna heaters

Sauna heaters shall be installed in accordance with UL 875 and the manufacturer's installation instructions.

H.4.16.6 Engine and gas turbine-powered equipment and appliances

The installation of liquid-fuelled stationary internal combustion engines and gas turbines, including exhaust, fuel storage and piping, shall meet the requirements of NFPA 37. Stationary engine generator assemblies shall meet the requirements of UL 2200.

Permanently installed equipment and appliances powered by internal combustion engines and turbines shall be installed in accordance with the manufacturer's installation instructions and NFPA 37.

H.4.16.7 Pool and spa heaters

Pool and spa heaters shall be installed in accordance with the manufacturer's installation instructions.

Oil-fired pool and spa heaters shall be tested in accordance with UL 726. Electric pool and spa heaters shall be tested in accordance with UL 1261.

H.4.16.8 Cooking appliances

Cooking appliances that are designed for permanent installation (including ranges, ovens, stoves, broilers, grills, fryers, griddles and barbecues) shall be approved by the Authority and relevant UL Code, and installed in accordance with the manufacturer's installation instructions.

NOTE: Further guidance is given in the ASHRAE Fundamentals handbook [Ref. H.18].

H.4.16.9 Conversion burners

The installation of conversion burners shall conform to ANSI Z21.8.

H.4.16.10 Unit heaters

Unit heaters shall be installed in accordance with the listing and the manufacturer's installation instructions. Oil-fired unit heaters shall be tested in accordance with UL 731.

Suspended-type unit heaters shall be supported by elements that are designed and constructed to accommodate the weight and dynamic loads. Hangers and brackets shall be of non-combustible material. Suspended-type oil-fired unit heaters shall be installed in accordance with NFPA 31.

H.4.16.11 Stationary fuel cell power systems

Stationary fuel cell power systems having a power output not exceeding 10 MW shall be tested in accordance with ANSI/CSA FC 1 and installed in accordance with the manufacturer's installation instructions and NFPA 853.

Central battery systems for emergency lighting shall also conform to Ch. 6 of the UAE FLSC [Ref. H.1].

H.4.16.12 Gaseous hydrogen systems

The installation of gaseous hydrogen systems shall be in accordance with the applicable requirements of NFPA 2.

H.4.16.13 Radiant heating systems

Electric radiant heating systems selection shall be approved by the Authority and shall be installed in accordance with the manufacturer's instructions and the ASHRAE Fundamentals handbook [Ref. H.18].

Clearances for radiant heating panels to any wiring, outlet boxes and junction boxes used for installing electrical devices or mounting luminaires shall be in accordance with NFPA 70.

H.4.16.14 Evaporative cooling equipment

Evaporative cooling equipment shall be installed in accordance with the manufacturer's instructions and the ASHRAE Fundamentals handbook [Ref. H.18].

H.4.16.15 High volume large diameter fans

High volume large diameter fan selection shall meet the requirements of the ASHRAE Fundamentals handbook [Ref. H.18]. The fans shall be tested in accordance with ANSI/AMCA 230, labelled in accordance with UL 507 and installed in accordance with the manufacturer's instructions.

H.5 Water supplies

H.5.1 General

This section covers all occupancies except healthcare and low-rise residential dwellings (see Part K).

The requirements for healthcare buildings, and all relevant codes and standards, are identified in the DHA Regulations [Ref. H.2 to Ref. H.11] and DHA Health facility guidelines [Ref. H.12 to Ref. H.16].

This section sets out the minimum requirements and basis of design for the water services systems within a building. It also includes minimum sustainability criteria.

For systems or applications not covered by this section, the requirements and recommendations in the following documents shall be met:

a) BS EN 806;
b) BS EN 8558;
c) HSE Approved Code of Practice L8 [Ref. H.25] and associated technical guidance documents [Ref. H.26 to Ref. H.28];
d) HSG272 [Ref. H.29] and HSG220 [Ref. H.30]; and
e) Water Supply (Water Fittings) Regulations [Ref. H.31].

H.5.2 Water conservation and reuse

H.5.2.1 Compliance methods

There are two compliance routes for water use.

a) Elemental method: All buildings shall conform to H.5.2.2.
b) Performance method: A calculation method may be employed for a building which might not meet the elemental requirements for water-efficient fixtures detailed in H.5.2.2.

The performance method shall use supporting calculations to compare the annual water consumption of the proposed building with that of a reference building which meets the elemental requirements of H.5.2.2. The reference building shall be equal in shape, size and operational patterns to the proposed building.

Compliance will be demonstrated if the calculated annual water consumption of the proposed building is equal to or lower than the annual water consumption of the reference building.

H.5.2.2 Water-efficient fittings

The following water-efficient fittings shall be used:

a) fixtures with a flow rate less than or equal to the flow rates shown in Table H.5;
b) dual flush toilets;
c) automatic (proximity detection) or push-button faucets in all public facilities;
d) cisterns serving single or multiple urinals in public, commercial and industrial buildings with manual or automatic flush controls that operate based on usage patterns. Only sanitary flushing shall be possible in the event of building closure or shutdown (including overnight).

Faucets installed for specialized application may be exempted from meeting the flow rates, subject to Authority approval.

Fixture type	Maximum flow rate
Showerheads	8 l/min
Hand washbasins	6 l/min
Kitchen sinks	7 l/min
Dual flush toilets	6 l full flush
	3 l part flush
Urinal	2.4 l in non-public facilities 1 l per flush or waterless in public facilities

Table H.5 Maximum flow rate

H.5.2.3 Condensate drainage

Condensate water produced by air-conditioning equipment shall be collected and disposed of appropriately. Condensate collection pans and drainage pipes shall be installed to provide proper drainage and to prevent any stagnant water. An air break of not less than 25 mm shall be provided between the condensate piping and the wastewater pipe. If the condensate water is not reused, it shall be discharged into the wastewater system through a properly sized water trap.

H.5.2.4 Condensate reuse

Where the cooling load is greater than 350 kW, condensate water shall be recovered and reused from all of the following:

a) air-conditioning equipment;

b) air handling units; and

c) equipment handling a mixture of return air and outside air, where the outside air is not preconditioned.

NOTE: The condensate water can be reused for irrigation, toilet flushing, or other on-site purposes where it will not come into direct contact with the human body. The condensate water can also be reused for heat recovery (see H.4.8.2).

H.5.2.5 Water-efficient irrigation

Exterior landscaping (including green roofs) shall be irrigated using non-potable water (see H.5.4.6 for irrigation system examples), or by drip or subsoil water delivery systems.

All irrigation systems shall incorporate backflow prevention devices if they are connected to a potable water source in any location. The backflow prevention devices shall be installed in line with the manufacturer's requirements.

H.5.2.6 Water metering

H.5.2.6.1 Main meters

Dubai Electricity and Water Authority (DEWA) main meters shall be installed to measure and record the water demand and consumption of a building in accordance with G.9.

H.5.2.6.2 Sub-meters

Each individual tenancy in a building shall have a DEWA sub-meter installed which is connected to a building main meter.

Sub-meters shall also be installed to record consumption data for internal and external (e.g. irrigation) water uses, for buildings having:

a) a cooling load of 1 MW or greater; and/or

b) a gross area of 5,000 m^2 or greater.

Where a BMS is installed, metering shall be integrated into the system to allow real-time profiling and management of water demand and consumption.

Virtual meters using run-hours shall not be used as sub-meters.

The sub-meters should be used for demand management and cost allocation purposes.

H.5.2.7 Wastewater reuse

If a system is installed for the collection and reuse of greywater produced within the building, or for the use of treated sewage effluent (TSE) from an external source, the following requirements shall be met.

a) The building shall be dual-plumbed for the collection and recycled use of greywater. Any pipes which transport greywater shall be colour-coded differently from pipes that are used for potable water and be labelled "Not suitable for drinking".
b) There shall be an air break of not less than 25 mm between any potable water sources and greywater collection systems.
c) Greywater shall not be used for purposes where it will come into direct contact with the human body. It shall be treated to the standard required by the Authority.

Commercial car washing facilities shall recover and reuse at least 50% of their wastewater.

All wastewater reuse systems shall incorporate sampling points to enable water quality testing to be undertaken.

H.5.2.8 Cooling tower water supply

Potable water supplied by DEWA shall not be used for heat rejection purposes.

Where cooling towers are used, treated sewage effluent (TSE), seawater or recycled water shall be used to meet the water demand for all heat rejection purposes. Secondary water sources shall be approved by DEWA.

A separate totalising meter shall be fitted on the water supply line to the individual cooling towers. A daily log of water use shall also be kept.

Water treatment plant will be required to remove impurities from the cooling tower feed water and the circulatory water. Leaving cooling tower water untreated can lead to organic growth, fouling, and corrosion of the system. This reduces the efficiency and service life of the cooling tower plant.

The type of water treatment system required depends on a number of factors including:

a) type of cooling tower;
b) quality of water feed required;
c) cooling tower manufacturer's requirements;
d) chemistry of make-up and circulation water;
e) whether or not blowdown will be treated for reuse in the cooling tower; and
f) type of heat exchanger.

Typically, water treatment systems shall include filtration and ultrafiltration, ion exchange/softening, chemical addition of inhibitors and biocides and an automated monitoring system. The water treatment system shall regulate and control the levels of alkalinity, chlorides, hardness, iron levels, organic matter, silica, sulphates, total dissolved solids and total suspended solids in the system.

The cooling water system shall not contain dead legs or sections where debris and biofilms might accumulate.

The cooling tower shall be fitted with drift eliminators to minimize the release of water droplets.

The cooling water system should be easily and safely accessible for cleaning, maintenance and disinfecting.

The operation and maintenance of water systems serving a cooling tower shall be designed in accordance with HSE Approved Code of Practice L8 **[Ref. H.25]**.

H.5.3 Sustainable water heating system

Central or decentralized hot water systems shall be configured utilizing a sustainable hot water heating technology, such as solar hot water, except in buildings where:

a) such a hot water system would be impractical due to tenancy, metering, and pipework distribution constraints; or
b) hot water generation utilizing local point-of-use electric water heaters would provide a more energy-efficient design solution.

The percentage heating contribution from the solar hot water heating system depends on the occupancy and estimated hot water usage profile. The system designer shall target 75% of the total hot water daily demand being produced by the solar hot water system. To reduce system standing losses, all hot water storage vessels and distribution pipework shall be insulated.

H.5.4 Cold water services

H.5.4.1 Cold water distribution

Cold water shall be supplied to the following sanitary fittings:

a) Water closet flushing;
b) washbasins;
c) sinks;
d) showers;
e) maintenance areas, workshops and back of house areas;
f) cleaners' sinks; and
g) bib tap points.

Where municipal water system pressures are inadequate to serve the building, a pumped water supply system shall be provided to deliver water to sanitary fittings at all building levels.

The booster pump set shall be connected to a water storage tank. The booster set shall provide a pressurized supply of cold water to all cold water outlets and hot water plants.

The booster pumps should be multistage, variable speed pumps rather than a duty/standby single pump system. This approach provides a longer system life with higher energy efficiencies, as well as providing a wider range of system flow rates for the facility.

NOTE: Depending on the occupancy type and resiliency strategy required, the booster pumps might need to be connected to the building emergency power supply.

The pumped cold water distribution strategy shall be determined by the height of the building. For high-rise buildings, intermediate water plant rooms might be required at certain floor levels to provide a system pressure break.

Cold water systems should be maintained, where possible, at a temperature below 20 °C. The water should reach a temperature of no more than 20 °C within 2 min at the outlets.

All booster pumps shall have an accumulator vessel and incorporate automatic controls to ensure even pump wear and prevent system stagnation.

For all buildings, water meter rooms, water meter and isolation valve locations shall conform to DEWA Regulations [Ref. H.32].

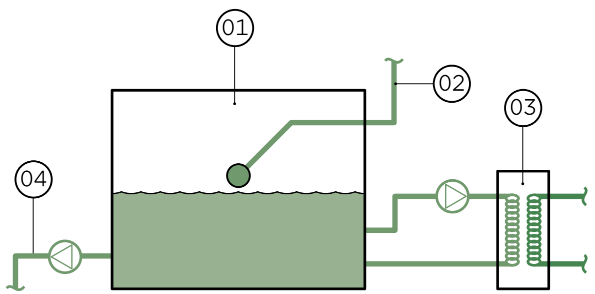
Water check meters shall be installed on all water services connections to mechanical plant to monitor water consumption.

All parts of the cold-water system, including storage tanks and pipework, shall be designed to avoid water stagnation and ensuring flow through all parts of the system. Dead legs in the cold-water systems shall be avoided.

The cold water distribution system shall be designed in accordance with the relevant parts of the Water Supply (Water Fittings) Regulations [Ref. H.31], BS EN 806 and BS EN 8558.

H.5.4.2 Cooled water systems

In buildings where there is a requirement for a cooled water supply (15 °C to 20 °C), this can be achieved via the installation of a heat exchanger connected to the building chilled water system. The heat exchanger is connected to the final cooled water storage tank that serves this system. Cooled water can be utilized to serve wash hand basins, sinks, baths, showers and shatafs. Cooled water systems (see Figure H.6) are often required in healthcare buildings, hotels and sports facilities. In buildings where a chilled water system is not available, a cooled water system could be achieved by connection to heat pump.



Key
01: Cold water storage tank
02: Cold water supply
03: Plate heat exchanger
04: To domestic cold water services

Figure H.6 Cooled water system schematic arrangement

Cooled water systems shall be served from a separate dedicated system including water tanks, pumps, water treatment and pipework distribution system. All system components shall be clearly labelled to prevent the risk of cross connection to other building water distribution systems.

NOTE: Water that does not require cooling needs greater maintenance for the purposes of water quality and Legionella protection.

H.5.4.3 Water recycling systems

Water recycling systems installed for the flushing of water closets or landscape irrigation (see Figure H.7) shall be served from separate dedicated plant that includes water tanks, pumps, water treatment and associated pipework distribution system. All system components shall be clearly labelled to prevent the risk of cross connection to other building water distribution systems.

Key

01: Aerated shower head
02: Spray taps
03: Waterless/air flush urinal
04: Greywater controls
05: Low volume cistern
06: Dual flush toilet
07: Low water appliances
08: Rainwater treatment
09: Rainwater storage
10: Rainwater harvesting controls
11: Water meter
12: Greywater treatment
13: Greywater storage tank

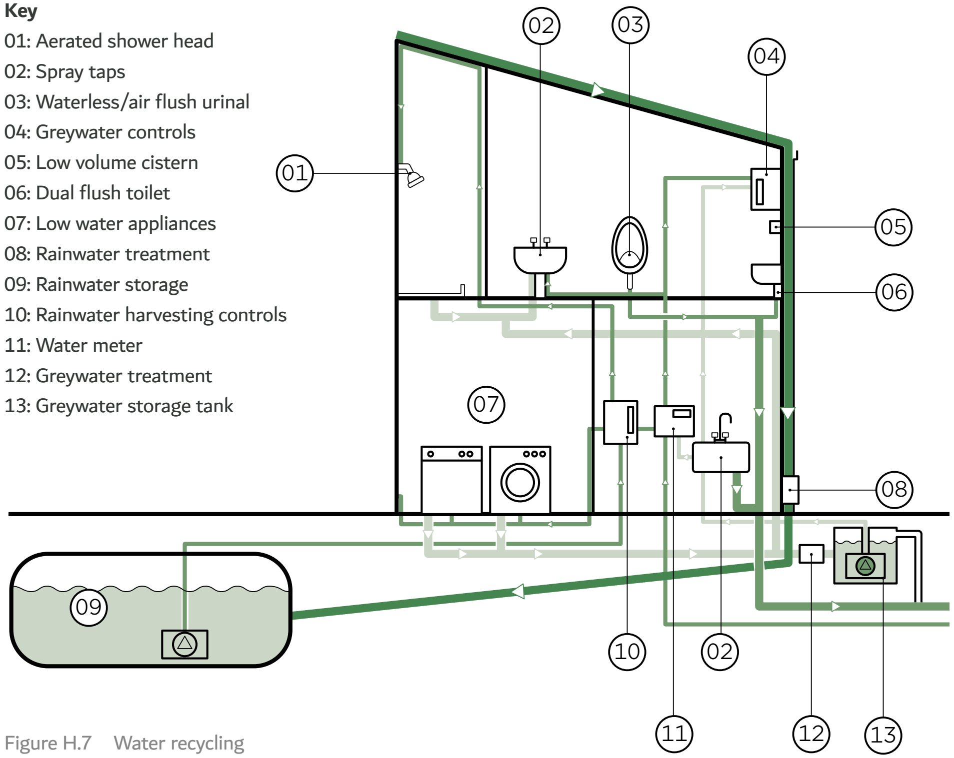


Figure H.7 Water recycling

H.5.4.4 Laboratory buildings

The cold water supply to laboratory appliances and laboratory hot water plant shall be served from separate dedicated plant that includes water tanks, pumps, water treatment and associated pipework distribution system. All system components shall be clearly labelled to prevent the risk of cross-connection to other building water distribution systems.

H.5.4.5 Swimming pool cold water supply

A cold water supply shall be provided to serve the pool filtration and chemical water treatment plant of a swimming pool.

The cold water supply that serves the pool water treatment system shall be fed from a dedicated cold water break tank to isolate the chemical treatment plant completely from the building's cold water supply. A booster pump set shall be connected to the break tank to provide a pressurized supply of cold water to the water treatment equipment.

The cold water break tank and booster pump set shall be located in the pool filtration plant room. The pool filtration shall be designed by the pool filtration specialist.

NOTE: The objective of the pool water treatment system is to provide a hygienic, safe, comfortable and pleasant environment both for the bathers and spectators in the pool hall. This is to be achieved under anticipated bathing load levels.

H.5.4.6 Irrigation water supply

When a supply of water for the irrigation of lawned, planted areas and green roofs is required, the system shall be supplied from a recycled water system. Suitable recycled water systems include:

a) greywater recycling systems; and

b) condensate reuse systems.

Water disinfection shall be provided for above-ground sprinkler irrigation systems that create an aerosol of water droplets.

NOTE 1: Disinfection of the water supply is not required for subsurface landscape irrigation systems.

NOTE 2: Dispersal disinfection filtration systems provide an effective means of treatment for water irrigation systems.

The irrigation system shall be served from the water recycling plant or via a separate dedicated plant that includes a storage tank, pumps, filtration and water treatment plant. A backflow protection device shall be provided at point of connection to each irrigation supply.

The irrigation water supply shall be fed from a dedicated pipework distribution system. Isolation and drain valves shall be provided to enable the system to be easily maintained.

All system irrigation system components shall be clearly labelled to prevent the risk of cross-connection to other building water distribution systems.

H.5.5 Potable water storage tanks

H.5.5.1 General

Potable water storage shall be provided in the building, to protect the building against interruptions to the incoming mains supplies and to enable water supply pressures to be safely maintained.

H.5.5.2 Water tank locations

NOTE: It is common in Dubai for buildings to incorporate two potable water storage tanks (not including fire suppression water storage), with one tank located at the incoming main (basement or ground floor) and one tank at roof level. This strategy is permitted, but the popularity of pressure boosting systems has enabled cold water storage at roof level to be omitted (see Figure H.8). The location of cold-water storage tanks is also influenced by the height of the building. For high-rise buildings, intermediate water plant rooms might be required to provide a system pressure break.

A risk assessment shall be carried out to determine the best location for the potable water tanks. The assessment shall take into account building spatial constraints, and access and maintenance. If there is a risk of flooding, the potable water tanks shall not be placed in areas of flooding risk such as the basement or at ground floor level.

Water tanks shall be positioned as far as possible from drainage network lines, manholes, septic tanks and cesspits. In all cases, drainage pipelines shall not run above or next to above- or below-ground water tanks.

DEWA shall have access to any part of the building to conduct an inspection of the water supply tanks, to verify compliance with public health conditions and associated technical specifications.

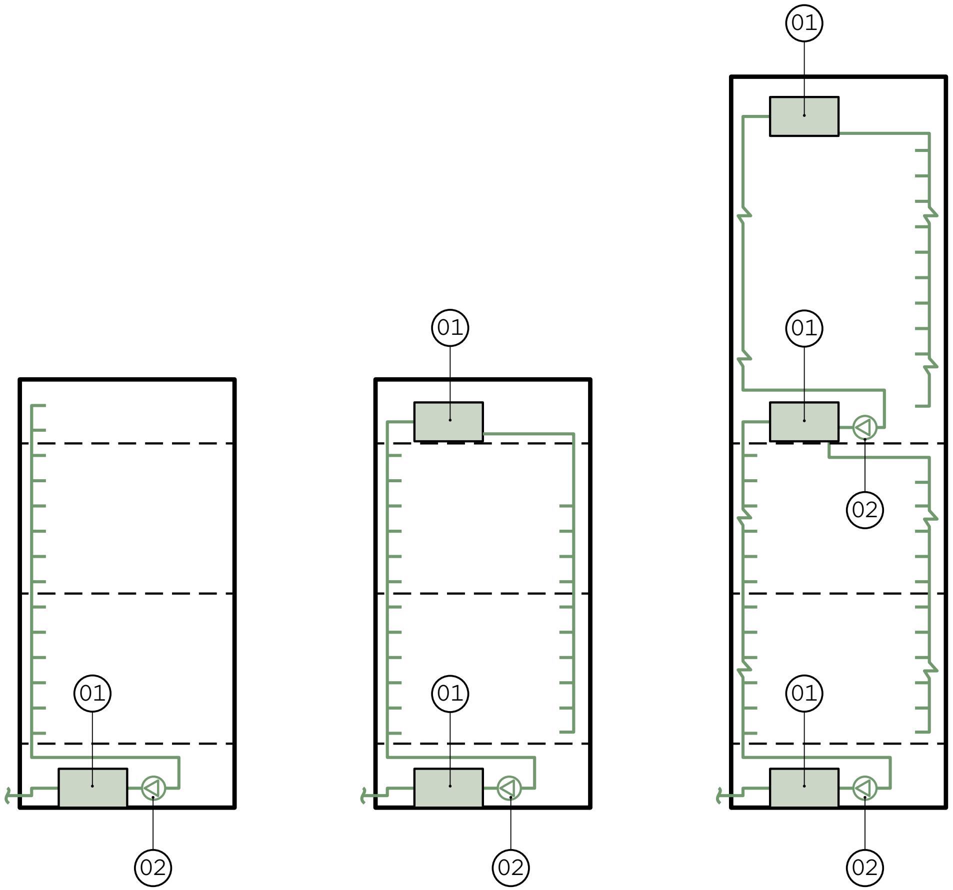


Figure H.8 Alternative cold water supply system arrangements

Key

01: Cold water storage tank

02: Cold water booster pump set

H.5.5.3 Water storage tank sizing

The capacity of domestic water supply tanks shall be calculated based on the actual demand of the building occupants. As a minimum, water tanks shall be sized based on 24 h demand from all water connections except firefighting, and shall be not less than 1 m^3. Water tanks for labour accommodation shall be sized for 48 h demand.

Table H.6 gives water consumption rates in accordance with DEWA transmission planning guidelines [Ref. H.36]. The maximum water consumption rates in each range should not be used unless justified based on project requirements.

User category	Consumption rates (l/cap./day)
Day clinic (per medical practitioner) including visitors	300 - 450
Club house/recreation	100
Commercial buildings	60-100
Entertainment & leisure/theater	10-60
Events	10-50
Guardhouse	60-75
Headquarters	60-80
Hotels (per employee)	60-80
Hotels (per guest)	200-300
Laboratory	60-80
Labour accommodation	80-150
Local plaza/retail/town center	60-82
Logistic, academic & business center	60-75
Manufacturing/mineral	60-80
Medical (per bed)	350-450

User category	Consumption rates (l/cap./day)
Mixed used commercial	60-80
Mixed used residential	250-350
Mosques	10 - 60
Nursery/child care centre	50-70
Offices	45-60
Public amenities	10 - 50
Residential buildings (flat)	200-300
Restaurant (per meal)	10-15 l/d per meal
Schools/university	40-60
Shops	45-60
Theatre	10-50
Villas	250-350
Visitors	14-40
Industrial (workshops/machinery/warehouse, etc.)	60-80

Table H.6 DEWA reference per capita consumption rates

H.5.5.4 Water tank construction

Domestic water tanks shall be manufactured from a material that does not rust or corrode. The tank material shall not:

a) adversely affect the nature (e.g. colour, taste or odour) or chemical properties of the water;
b) be affected by either temperature or humidity;
c) be impervious to light; or
d) cause any harmful effect to human health.

The tank shall be free from sharp corners that could accumulate dirt, microbes or prevent effective periodic cleaning.

The maximum height of reinforced concrete tanks shall be calculated by a Structural Engineer.

The height of pre-insulated glass-reinforced plastic (GRP) tanks shall not exceed more than 3 m, with water levels not exceeding 2.5 m and free board not less than 0.5 m.

Cold water storage tanks shall be arranged in one of the following two ways:

1) divided into two equal compartments (50/50 configuration as shown in Figure H.9). This type of arrangement allows for one part of the tank to be cleaned, disinfected, serviced, repaired, inspected, etc. while the other is in operation. This means that a water supply pipe needs to be supplied to each part of the tank, as set out in local requirements. To ensure that the water flow is provided when required, and that each tank section is provided with an equal volume of flow, a water meter shall be installed on the supply to each ball float or chain valve; or
2) provided as two separate tanks that are installed in a parallel configuration.

For both arrangements, the connecting pipework and valves shall achieve a balanced throughput of water through each tank or tank section, avoiding deadlegs that can lead to water stagnation.

Domestic water supply tanks shall be provided with lockable manholes. The dimensions of the manhole openings shall be sufficient to allow a person to access the tank safely for cleaning. Openings shall be located away from public circulation areas and sources of contamination.

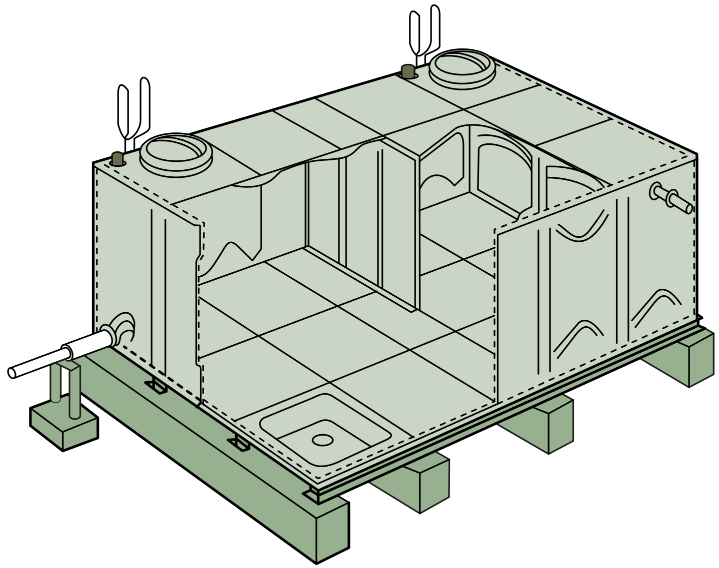


Figure H.9 Sectional cold water storage tank arrangement

In each water tank (or water tank section when divided tanks are used), the following components shall be provided:

i) an isolation valve at the inlet and outlet of the tank division;
ii) a valve strainer at the outlet of each tank division;
iii) drain connection at the bottom of each tank. The invert of the drain shall be located to fully drain that division of the tank;
iv) overflow pipe from each division of the tank;
v) overflow warning pipe with insect protection screen of 0.65 mm mesh. The screen area shall be capable of passing the same amount of water as the overflow or warning pipe;
vi) an external and internal access ladder; and
vii) a vent pipe with a corrosion resistant air inlet mesh.

In circumstances where it might be difficult to install an overflow or a warning pipe to a drain line, an audible warning alarm shall be installed to inform the building maintenance team of a tank overflow occurrence.

Water tanks that are installed above ground shall be constructed from pre-insulated GRP. Tanks shall be installed in a conditioned space that is free from contamination and shall not be exposed to the external Dubai climate.

Sectional GRP tanks shall be specified with externally flanged connections (base and sides) to simplify tank cleaning and sterilization.

There shall be a 1 m free space around all sides and above the top of the GRP tank for equipment maintenance.

Raw water tanks can be constructed out of concrete and can be buried below ground, or they can be located within a conditioned room. All concrete tanks shall be lined with a suitable GRP coating or liner.

Tanks shall be cleaned and sterilized after completion of work and prior to the actual use of the tank. All cold water storage tanks shall incorporate a laboratory testing certificate stating its suitability for storing drinking water in accordance with DEWA requirements [Ref. H.32].

H.5.5.5 Tank pump room

The pump room shall be of sufficient size to enable operation, maintenance and repair of the various pumps that connect to the tank. Each pump set shall be installed on a reinforced concrete base.

H.5.5.6 Firefighting water tanks

The firefighting water tank and pump connection arrangements shall conform to Ch. 9 of UAE FLSC [Ref. H.1].

Firefighting water tanks shall be located next to or below the fire pump room, depending upon the pump type selected. They shall conform to Table 1.9, Ch. 1 of UAE FLSC [Ref. H.1].

The firefighting water tank area shall have adequate drainage, and an arrangement such that an overfilling tank does not flood the area and the pump room, in accordance with Table 9.3, Ch. 9. of UAE FLSC [Ref. H.1]. The pump room and floor corridors shall be provided with a drainage facility to drain the dripped and leaked water or water flooded during firefighting operations.

A centralized firefighting water tank to serve multiple buildings in a development is permitted provided that the buildings are owned by one entity and the maintenance of the system is managed and controlled as part of the common area. The size of the tank shall be designed for more than one fire event simultaneously, to be agreed with DCD.

A mechanical floor shall be provided every 90 m in super high-rise buildings to accommodate the firefighting pumps and tanks required by Section 4.2, Ch. 9 of UAE FLSC [Ref. H.1].

H.5.5.7 Combined firefighting and water storage

Where water tanks are also used for firefighting purposes, the water storage capacity shall be increased to include firefighting water storage capacity and the system shall be designed to facilitate regular turnover of the cold water storage volume in the tank.

The tank and pump connection arrangements shall conform to Ch. 9 of UAE FLSC [Ref. H.1].

The fire pump test line shall not discharge back into the tank.

H.5.6 Water treatment

H.5.6.1 Treatment against microbiological bacteria growth

A proper and effective method shall be implemented to control microbiological bacteria growth in building water systems, cooling towers, and internal and external water features.

One of the following control methods shall be used:

a) pasteurization;
b) chemical treatment (biocides, chlorine, etc);
c) silver copper ionization;
d) filtration systems.

The choice depends on the building, the water systems it serves, the source of the incoming water supply, and the capital and on-going maintenance costs.

The designer shall formulate a strategy to maintain water quality and minimize the risk of Legionella bacteria for each manufactured water system from the point of supply to point of use. The suitability of the materials used in the construction of the manufactured water system shall not adversely affect water quality.

Water systems shall not use materials that aid microbial growth.

Any cooling water system, including its make-up water tanks, shall be provided with a suitable automatically controlled water treatment system (e.g. an automatic biocide-dosing device) for management of corrosion, scaling, fouling and microbial growth. All such treatment systems should work effectively at all times when the water cooling system is in operation.

All water features that have a water storage volume of over 1,000 l and that create a water spray or aerosol shall be designed, installed, operated, treated and maintained to minimize the risk of Legionella bacteria or microbiological bacteria growth in accordance with:

1) latest DM guidelines, if any;
2) Guidelines for the control of Legionella in water systems [Ref. H.33];
3) Private swimming pools safety guidelines [Ref. H.34];
4) Public swimming pools safety guidelines [Ref. H.35]; and
5) HSE Approved Code of Practice L8 [Ref. H.25] and associated technical guidance documents [Ref. H.26 to Ref. H.30].

This includes, but is not limited to cooling towers, evaporative condensers, hot and cold water systems, warm water systems, evaporative air coolers, spas, water features, fountains, misters, etc.

H.5.6.2 Water softening

Water softening shall be provided in areas where the quality of the incoming water supply is not suitable for its intended use.

NOTE 1: The high levels of calcium and magnesium salts in hard water areas result in scale deposits in the system's equipment and pipework, which in turn reduce the flow and efficiency of the system and increase the surface area of biofilm.

NOTE 2: Water softening might be required to serve the following equipment within some buildings:

a) water treatment plant;
b) steam boilers;
c) laundry areas;
d) kitchen areas; and
e) hot water systems.

Softening of the cold-water supply to the hot water distribution system should be provided where necessary to reduce the risk of scale being deposited at the base of the calorifier and heating coils

The chemical composition of the incoming water shall be investigated at the early stages of design. A decision shall be made on the basis of this investigation as to whether water softening is required.

H.5.7 Servicing and isolation valves

The water servicing distribution pipework shall incorporate service valves on all items of plant and sources of supply to allow for isolation to facilitate maintenance. As a minimum, branch isolation valves shall be provided on branches and risers at the connection to the main distribution system.

Isolation valves, non-return valves, flushing and injection points shall be positioned in suitable locations to allow for the sterilization of the whole system or individual zones during maintenance works.

Quarter turn isolation valves shall be provided on the water supply to all sanitary fittings to aid repair and maintenance.

All water servicing valves shall be positioned in an accessible location that permits maintenance and replacement of the valves without damage to wall, ceiling or floor finishes.

H.5.8 Backflow protection

The water systems shall be designed and installed in such a way as to reduce the risk of contaminating the cold water supplies. In particular, the requirements of the Water Supply (Water Fittings) Regulations [Ref. H.31] shall be met, and the appropriate classification of fluid category backflow protection shall be provided.

Where required to prevent cross-contamination, the water services system shall be protected by the use of break tanks or air gaps, meeting the correct fluid category classification, as an integral part of the plant and equipment served from the water services system. This protection shall be provided in all areas of the building.

H.5.9 Controls and monitoring

To provide early warning of problems within the system, the system shall include a means of monitoring:

a) incoming mains temperature;

b) water tank storage temperatures; and

c) water temperatures at the furthest hot and cold water outlets (sentinel).

All temperature monitoring points in the water service systems shall be linked to the BMS.

H.5.10 Hot water services

Hot water shall be supplied to:

a) washbasins;

b) sinks;

c) showers;

d) maintenance areas, workshops and back of house services areas; and

e) cleaners' sinks.

The hot water system may be configured as:

1) a centralized system – a hot water system that serves the building from central plant;

2) decentralized systems – where several hot water systems are served from their own plant; and

3) a point-of-use hot water system – where hot water is generated local to the sanitary fitting or appliance.

NOTE 1: The chosen type of hot water system depends on several factors including occupancy type, building usage, building opening hours, building energy, hot water generation strategy and system installation and maintenance costs. A typical hot water system with return configuration is shown in Figure H.10.

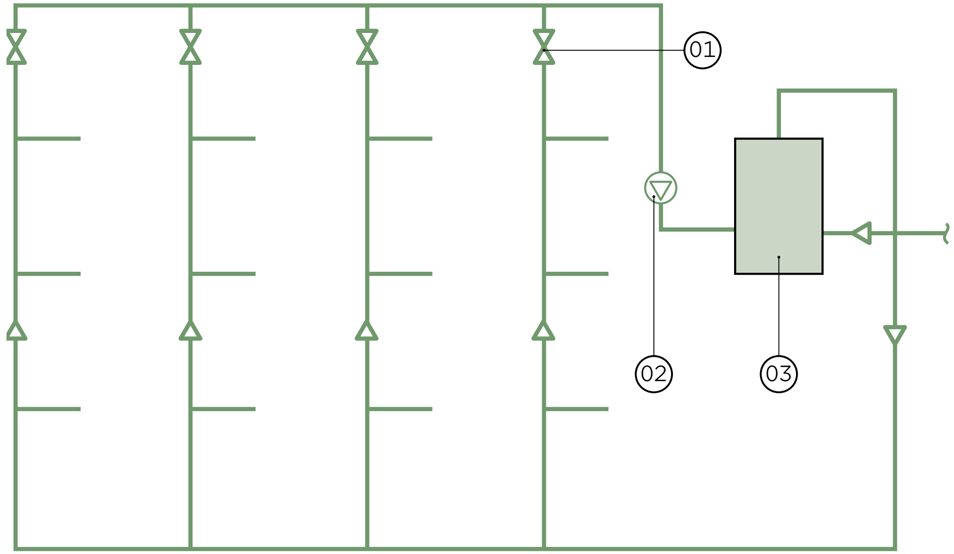


Figure H.10 Typical domestic hot water return configuration

Key

01: Thermal balancing valve

02: Secondary circulation pump

03: Water heater

Hot water may be generated using direct or indirect heating methods including:

i) electrical hot water generation (direct);

ii) fuel-burning hot water generation (indirect, including boiler/steam);

iii) solar hot water generation (utilizing a secondary source of direct or indirect heat generation); and

iv) heat pump system.

Where hot water is stored, the water storage temperature shall be kept at not less than 60 °C to prevent bacterial growth within the stagnant water. The water shall reach a temperature of 50 °C within 1 min at the outlets.

NOTE 2: Duplicate hot water plant might be required to ensure that hot water can be supplied during periods of plant maintenance. This requirement is dependent upon several factors, including the occupancy type and building opening hours.

A pumped hot water return shall be provided, unless electrical trace heating tape is used. The hot water return shall be designed to maintain distribution temperatures between 50 °C to 55 °C. The hot water return system shall include thermal balancing valves for all hot water sub-circuits.

Warm water systems are typically found in care facilities such as early childhood centres, primary schools and secondary schools. Heated water stored in warm water systems shall be maintained at a temperature of not less than 60 °C. In order to safeguard against scalding, thermostatic mixing valves shall be provided to prevent hot water that is delivered to the outlets of sanitary fixtures, used primarily for personal hygiene purposes, from exceeding 45 °C.

All parts of the hot-water system, including storage tanks, water heaters and pipework, shall be designed to avoid water stagnation and ensuring flow through all parts of the system. Dead legs in the hot-water systems shall be avoided.

Temperature stratification shall be avoided in heaters and storage containers by the installation of a stirring or mixing device. The hot water distribution system shall be designed to the relevant parts of the Water Supply (Water Fittings) Regulations **[Ref. H.31]**, BS EN 806 and BS EN 8558.

Thermostatic mixing valves shall be installed on all hot water outlets that are used for handwashing or bathing, including those in Table H.7. Thermostatic mixing valves shall conform to HSE Approved Code of Practice L8 **[Ref. H.25]**.

Sanitary fitting	Maximum recommended temperature (°C)
Shower and hair washing	41
Washbasin	38 to 41
Baths	44

Table H.7 Sanitary fitting hot water outlet temperatures

H.5.11 Water services system installation requirements

Water services distribution pipework shall be sized to meet the system demands based on the number of fittings and the equipment connected to it.

Pipe velocities shall be restricted to approximately 1.5 m/s to maintain system longevity, minimize noise generation and limit pressure waves.

Interior hot and cold-water pipework shall be insulated in accordance with BS 5422.

Pressure reducing valves shall be installed to enable safe water discharge pressures at all sanitary fittings and kitchen appliances.

Surge protection valves shall be installed at the top of all water services risers. The system shall also incorporate water hammer arrestors.

The cold-water supply to all water closet ablution hoses shall incorporate a vacuum breaker.

Drain valves shall be provided at all system low points. Air vents shall be installed at all system high points.

Water supply pressures at sanitary fitting terminal outlets shall be limited to 1.5 bar to ensure the safe operation of these fittings.

Automatic water supply shut-off valves shall be provided on water distribution pipework serving areas of the building that might be partially or intermittently occupied. Automatic shut-off provisions may be utilized, in conjunction with proximity sensors or leak detection systems, to help reduce water consumption and mitigate the risk of leaks that otherwise might go unnoticed and cause damage to the building. The precise measures that are provided shall be determined according to the occupancy type. Water heaters shall be certified and approved by the responsible authority.

All water supply pipework and fittings shall be approved by either the Water Regulations Advisory Scheme (www.wrasapprovals.co.uk/) or the Water Research council (www.wrcplc.co.uk/wrc-approved™).

H.5.12 Provisions for future connection

Capped off water services connections shall be provided to all building areas that require future fit-out.

NOTE: These connections might require sub-metering to enable the building Owner to charge the tenant for the volume water they consume.

Wherever practicable, water services connections shall be configured such that they do not create a deadleg. Where pipework routing makes this configuration impracticable, water service connections shall be terminated with an automatic flushing valve to enable water turnover through each connection.

H.5.13 Interfaces for BMS and automatic controls

The water services design shall provide volt-free contacts on all plant and equipment for monitoring/control purposes via BMS.

H.6 Drainage

H.6.1 General

This section covers all occupancies except healthcare and low-rise residential dwellings (see Part K).

The requirements for healthcare buildings, and all relevant codes and standards, are identified within the DHA Regulations [Ref. H.2 to Ref. H.11] and DHA Health facility guidelines [Ref. H.12 to Ref. H.16].

This section sets out the minimum requirements and basis of design for the above- and below-ground drainage systems within a building and up to 1.5 m beyond the site boundary.

For systems or applications not covered within this section, the requirements in BS EN 12056 and BS EN 752 shall be met.

H.6.2 Sanitary plumbing system

H.6.2.1 General

A sanitary plumbing system shall be provided to all domestic sanitary fittings and kitchen appliances. The sanitary plumbing system shall:

a) convey and collect drainage flows to sewer infrastructure, cesspools, septic tanks or holding tanks;
b) minimize the risk of blockage or leakage;
c) prevent foul air from the drainage system entering the building during normal system usage; and
d) provide access provisions to clean and maintain the system.

The surface of sanitary fittings (such as toilets, urinals and wash basins) shall be of a material that is easy to clean and maintain.

All sanitary fittings shall be provided with a water trap. If the water trap forms part of the sanitary appliance, the fitting shall be removable. All other water traps shall be fitted directly after the sanitary appliance and shall be removable or fitted with a rodding eye.

All sanitary fitting tap flow rates, and water closet and urinal cistern flush volumes, shall conform to Table H.8.

Sanitary fitting type	Maximum flow rate/flush volume
Shower heads	8 l/m
Hand wash basins	6 l/m
Kitchen sinks	7 l/m
Dual flush water closets	6 l full flush 3 l part flush
Urinals	2.4 l in non-public facilities 1 l per flush or waterless in public buildings

Table H.8 Maximum sanitary fitting flow rates/flush volumes

H.6.2.2 Sanitation system disposal

The sanitation system shall be designed to collect and convey soil and waste flows by gravity to the public drainage network. The sanitation systems shall be designed in accordance with BS EN 12056.

Sanitation pipework and ventilation pipework shall be configured to control pressure fluctuations that might occur in the system. Sanitary fitting water traps shall be maintained during normal system working conditions. Primary ventilated and secondary ventilated discharge stack arrangements may be utilized for this purpose. The discharge stack arrangement shall be determined according to the building height, the grouping of sanitary fittings within the building, and any other relevant factors.

All building discharge stacks shall terminate externally to vent to atmosphere (see Figure H.11).

For tall buildings, branch pipework connections located directly above the base of a discharge stack shall be configured such that soil and waste flows from the upper floor levels do not adversely affect the connecting sanitary appliance water traps. To achieve this, one of the following requirements shall be met, depending on the building height (see Figure H.11).

a) For buildings of less than 20 storeys in height, sanitary fittings located one storey level above the base of a discharge stack shall not be connected to any vertical stack that drains the upper floor levels of the building.
b) For buildings greater than 20 storeys in height, sanitary fittings located two storey levels above the base of a discharge stack shall not be connected to any vertical stack that drains the upper floor levels of the building.

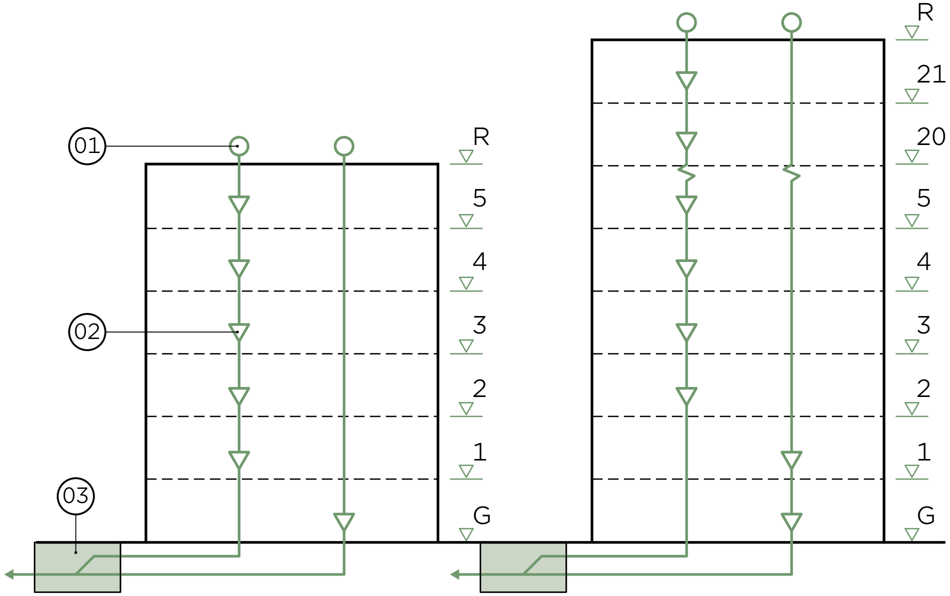


Figure H.11 Base of discharge stack branch connection arrangements (© Chartered Institute of Plumbing & Heating Engineering (CIPHE). The CIPHE cannot be held responsible for any errors or omissions related to the information included)

Key
01: Vent cowl
02: Discharge stack
03: Manhole

Where greywater recycling is proposed within a building, separate discharge stacks shall be provided to drain greywater appliances such as showers, hand wash basins and baths (see Figure H.12). For most occupancies, wastewater flows from kitchen appliances should not be recycled.

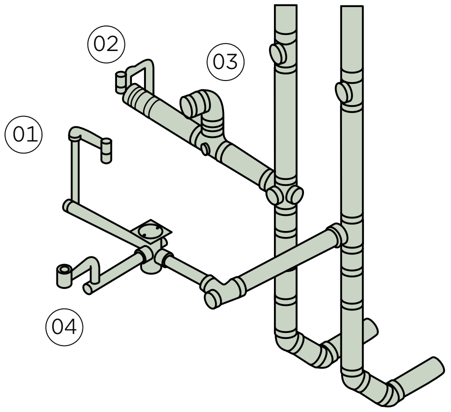


Figure H.12 Greywater sanitary plumbing connection detail

Key
01: Washbasin
02: Bidet
03: Water closet
04: Bath/shower

Where condensate recycling is proposed from mechanical plant, separate discharge stacks shall be provided to collect condensate flows.

For laboratory buildings, separate discharge stacks shall be provided to drain laboratory appliances such as lab sinks and fume cupboards.

H.6.2.3 Drainage from mechanical plant

Gravity drainage connections shall be provided from water services pressure relief and valve test lines. The connection shall be made indirectly into the sanitation system, either via a deep sealed trapped tundish, or to, or over, a floor gully.

All air-conditioning units and balcony drains shall be connected to the sanitation system. The connection shall be made indirectly into a waste stack, either via a deep sealed trapped tundish, or to, or over, a floor gully. Flexible polyethylene pipes shall not be used for air-conditioning unit condensate drain pipework.

H.6.2.4 Floor drains

Floor drains (see Figure H.13) shall be installed in all building areas containing wet sanitary fittings or appliances (including kitchens, toilets, showers, cleaners' rooms and ablution areas).

Floor drains shall also be provided in mechanical plant rooms, waste rooms and garages, for plant drainage and for cleaning and washdown.

All floor drain body and grating materials shall be specified to suit the floor finishes within which they are installed and the imposed traffic loads to which they are expected to be subject. A waterproof seal shall be achieved between the floor finish and the edge of floor grating to prevent the migration of water at this junction.

Floor drains shall be constructed of a material that will not be degraded by the discharge they have been installed to receive.

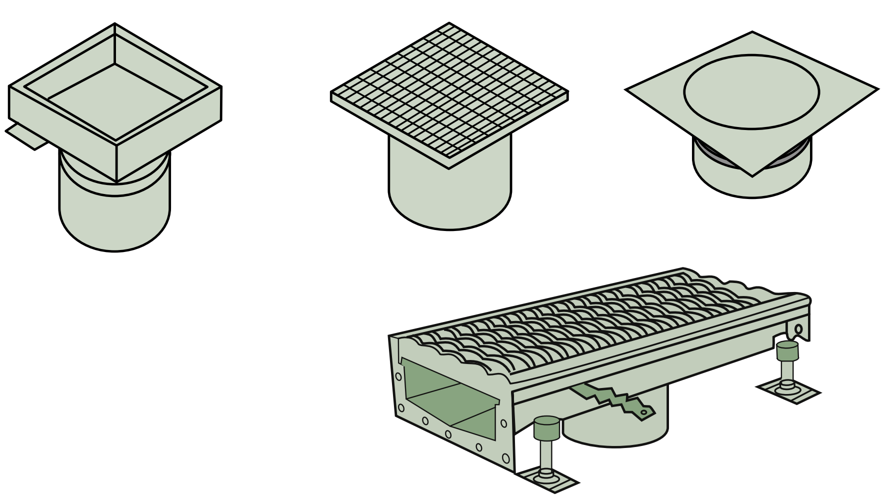


Figure H.13 Typical floor gully body and grating details

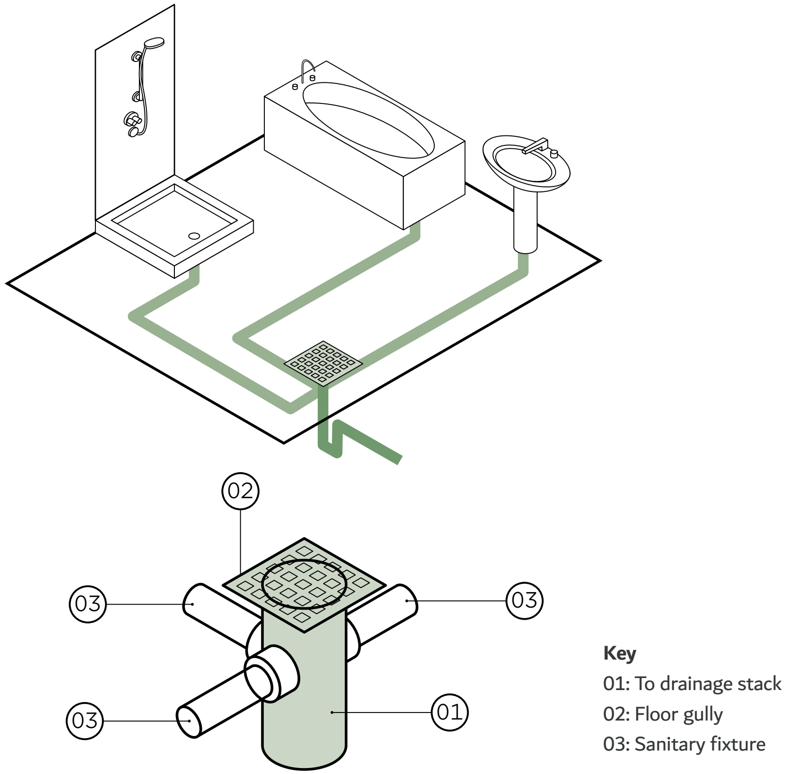


Figure H.14 Floor drain with back inlet connection detail

In order to prevent trap seal evaporation, all floor drains shall be configured to receive wastewater flows from a sanitary fitting or condensate connection from an air-conditioning unit. Where this is not practicable, automatic drain trap primer shall be installed. A floor gully with a back inlet connection shall be utilized to receive the waste pipe connections from these fittings.

All floor drains shall have a water seal at least 75 mm deep. Waste pipe connections from bidets or urinals shall connect directly to a discharge stack, not a floor drain (see Figure H.14).

The waste system from one floor drain to another floor drain shall not be directly connected.

H.6.2.5 Ventilation pipework

Vent pipes from manholes, vertical discharge stacks and vent pipes shall be positioned at least 3 m horizontally from any opening into the building and any mechanical plant air inlet. Such vent pipes shall extend at least 2 m above the roof level (see Figure H.15). All discharge stacks and vent pipes shall be fitted with a vent cowl.

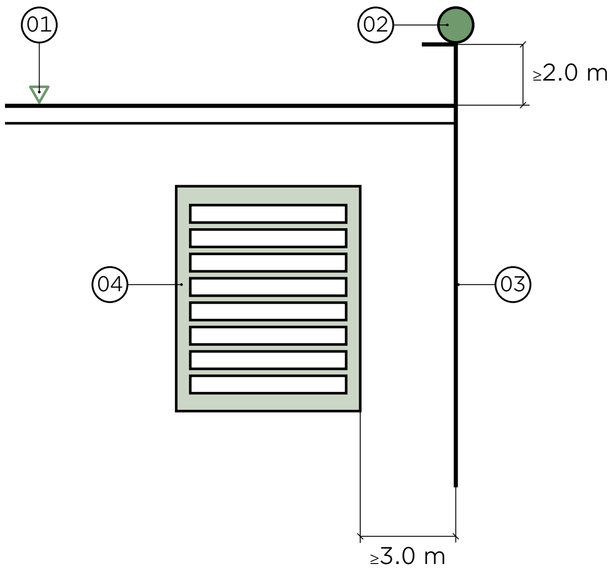


Figure H.15 Vent pipe location constraints

Key

01: Roof level
02: Vent cowl
03: Stack vent
04: Opening into the building (e.g. windows, doors and air intakes)

Ventilation pipework from drainage sumps, grease traps, oil interceptors and sand interceptors shall vent to atmosphere separately, to lower the risk of cross-contamination between each system.

To help control pressure fluctuations (see Figure H.16) that naturally occur within drainage systems, air admittance valves (AAVs) and passive air pressure attenuators (PAPAs) may be used as an alternative to installing secondary ventilation pipework. Where this approach is adopted, design calculations shall be submitted to the Authority for approval.

All AAV and PAPA fittings shall be sized and installed in accordance with the specified valve manufacturer's requirements, and shall conform to BS EN 12056 and BS EN 12380. All valve termination locations shall permit ease of access for maintenance and replacement.

Wherever practicable, all drainage stacks that utilize AAV or PAPA fittings shall terminate externally. Where drainage stacks are proposed to terminate internally, the designer shall provide technical justification for this approach for approval by the Authority.

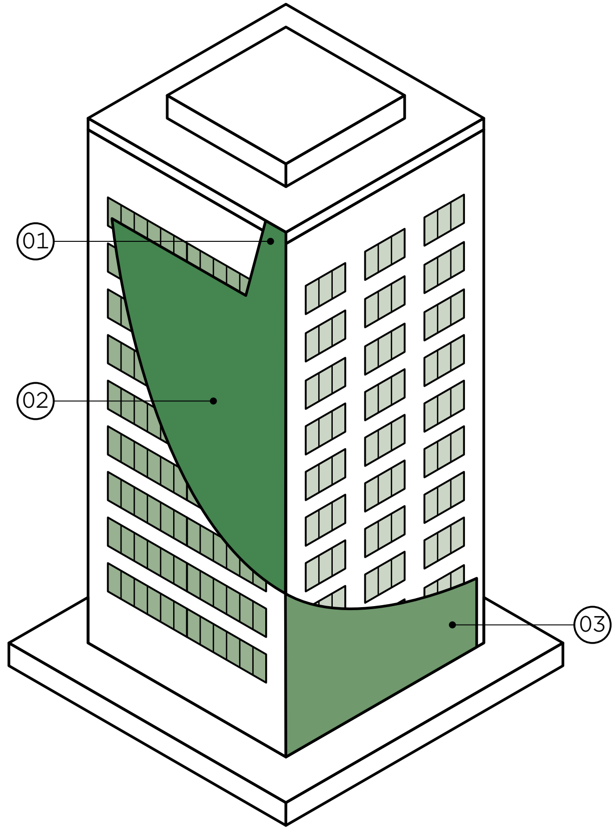


Figure H.16 Drainage pressure fluctuations

Key

01: Prior to stack termination, pressure falls below atmosphere

02: Throughout the length of the stack, negative pressures continue to increase due to friction and the introduction of connecting branch flows, which can also create local positive pressure fluctuations

03: Internal stack pressures gradually increase towards the base of the stack; at the base of the stack, pressure exceeds atmospheric

H.6.2.6 Sanitary plumbing acoustic requirements

The sanitation system shall be designed and routed through the building with attention to the acoustic requirements of the space that it passes through. Acoustic insulation shall be provided where required.

H.6.2.7 Rodding eyes

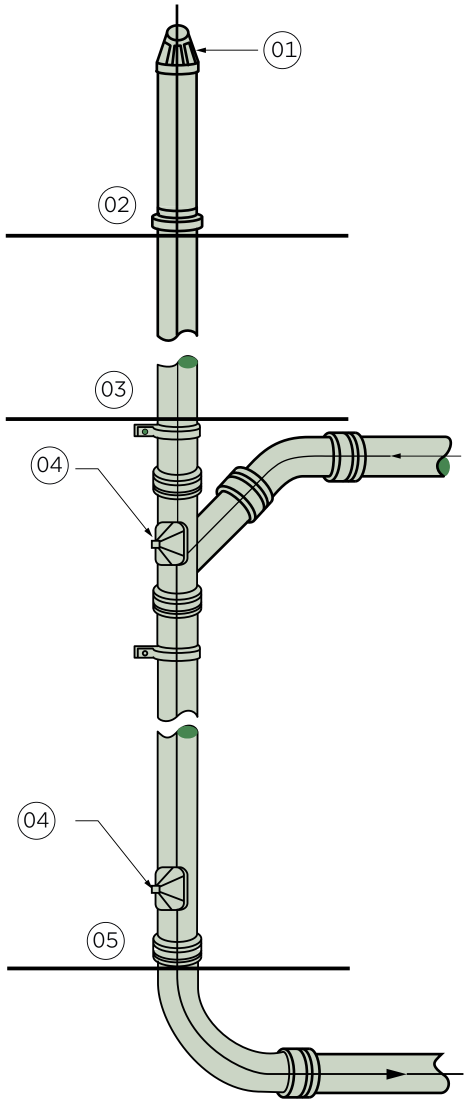
To provide effective access for maintenance and cleaning, rodding eyes shall be installed:

a) at the start of all horizontal runs in sanitation pipework; and

b) at changes of direction in any sanitation pipework.

Access junctions (see Figure H.17) shall be installed in discharge stacks at every storey level to provide access to clear blockages.

All rodding eyes shall terminate above the spill-over level of the appliance.



Key
01: Vent cowl
02: Roof level
03: Typ. floor levels
04: Access covers
05: Ground floor level

Figure H.17 Drainage discharge stack detail illustrating rodding eye and vertical access junction locations

H.6.2.8 Sanitation pipework

All internal pipework shall be manufactured from PVC-U in accordance with BS EN 1329-1. Waste pipework shall conform to BS 5255 and BS EN 1329-1.

The size of the sanitary fitting outlet connections installed within the sanitation system shall be not less than the minimum shown in Table H.9.

Sanitary fitting	Minimum outlet size (mm)
Water closet	100
Wash basin	32
Kitchen sink	40
Floor drain	75
Bath tub/shower	40
Washing machine	40
Balcony drain	50

Table H.9 Minimum sanitary fitting outlet sizes

The size of the pipework shall be not less than the minimum shown in Table H.10 for buildings up to seven storeys in height, and in Table H.11 for buildings of more than seven storeys.

Pipework system	Minimum pipe size (mm)
Soil vent pipe	100
Waste vent pipe	100
Rainwater pipe	100
Vent pipe	75
Balcony drain	50
AC drain pipe	32

Table H.10 Minimum drainage pipework sizes for buildings up to seven storeys

Pipework system	Minimum pipe size (mm)
Soil vent pipe	150
Waste vent pipe	150
Rainwater pipe	100
Vent pipe	100
Balcony drain	50
AC drain pipe	32

Table H.11 Minimum drainage pipework sizes for buildings above seven storeys

Only long radius fittings shall be used in the wet portion of any discharge stack.

Thermoplastic drainage pipework shall not run through electrical rooms, electric sub-stations, prayer rooms, kitchens, kitchen food stores and bedrooms.

Drainpipes shall not be cast into a building structural element without prior approval from the Structural Engineer at the Authority.

Where drainage pipework is required to pass through a structural element in a building, a cast iron sleeve shall first be fitted within the structural element to allow the drain to pass through. The sleeve shall offer a tolerance of at least 50 mm to simplify the installation of the pipe. The gap between the pipe and the sleeve shall then be filled with suitable sealant.

The routing of drainage pipework through sensitive areas of a building should be avoided. Sensitive areas might include, but are not limited to, the following:

a) areas of architectural significance;
b) pipework routes through areas of different ownership or tenancy; and
c) areas where access to drainage pipework might be restricted.

Where routing drainage pipework through these areas cannot be avoided, the pipework installation shall be configured to mitigate the risk of pipework leaks. This shall be achieved by using pipework materials that have limited pipework joints, or “pipe in pipe” installation techniques.

H.6.2.9 Leak detection systems

Leak detection systems shall be installed in areas of a building where an undetected water or drainage leak could affect sensitive equipment or cause significant damage to the building and its interior (e.g. electrical communication rooms, base of mechanical services risers, floor voids and some plant room areas). The requirement for and extent of leak detection systems will depend on the building occupancy or use.

To enable an automatic warning signal to be sent to the BMS, all leak detection systems shall be wired to a dedicated control panel which incorporates volt-free contacts.

H.6.3 Below-ground drainage

H.6.3.1 Drainage systems

Below-ground drainage systems shall be designed in accordance with BS EN 752 to receive soil and waste flows from the above-ground sanitation system.

Foul water flows shall be collected and conveyed to the external drainage network by gravity flow.

Buried drainage pipework, fittings and ring seal joints shall be specified to suit the ground conditions in which they are installed and the nature of the discharge they receive.

Drainpipe sizes and gradients shall be selected based on the calculated flows through the drainage system. In all instances, self-cleansing velocity shall be achieved through each drain section. The drainage design and associated calculations shall be issued to the Authority for approval.

Drainage pipe connections shall be airtight and free from any internal obstructions. Pipe bedding and surround materials shall be selected to suit the prevailing geotechnical ground conditions. All drainpipe bedding and backfilling materials shall be installed in accordance with the specified pipework manufacturer’s requirements.

Drainpipes shall not be routed through ducts, bridges or their associated foundations. Where drains are required to pass through a building structural element, they shall be encased within a cast iron sleeve. The sleeve shall be sized to allow the drain to safely pass through. The gap between the pipe and the sleeve shall be filled with a suitable sealant.

If an underground drainpipe line is installed less than 600 mm below finished floor level, it shall be provided with 150 mm thick concrete encasement.

Underground drainage pipework and fittings shall conform to BS EN 13476.

Refer to the Authority drainage details for confirmation of approved manhole, inspection chamber, pipe bedding, gully and pipe connection arrangements.

Commercial and industrial waste shall not be drained into the public drainage network unless approved by the Authority. Approval will only be granted if the appropriate equipment is available for the initial treatment of the waste.

H.6.3.2 Access to drainage systems

Means of access (see Figure H.18) for cleaning and maintaining the below-ground drainage system include:

a) manholes;
b) inspection chambers;
c) rodding points;
d) access fittings.

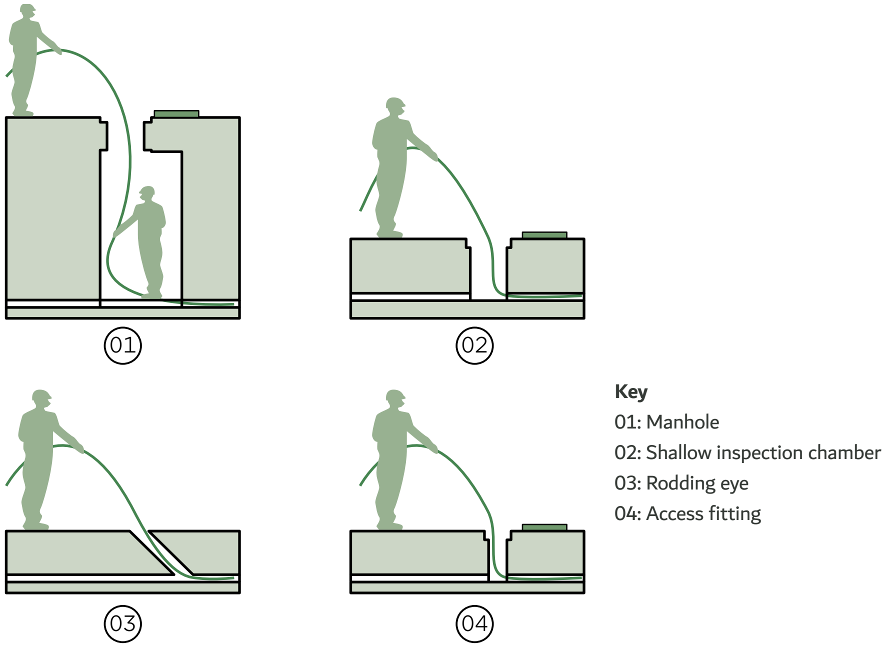


Figure H.18 Different types of below-ground drainage access (© British Standards Institute. Figure extracted from BS EN 752:2017. Permission to reproduce extracts from British Standards is granted by BSI Standards Limited (BSI). No other use of this material is permitted).

Access shall be provided at the following points in the drainage system:

1) at or near the end of a drainage run;
2) at a bend or change in the system direction or drain gradient;
3) at a junction (unless each drain run can be cleared from an adjacent access point); and
4) at all changes in system pipe size.

The maximum distances between types of access are given in Table H.12.

Drainage pipes underneath flooring and inside walls shall be protected from any external works, and against the potential settlement of floors. Distances between means of access shall not exceed the values in Table H.12.

Drainage system location	To junction/ branch (m)	To access fitting (m)	To inspection chamber (m)	To manhole (m)
From start of external drain	-	12	18	20
From rodding point	12	12	18	20
From access fitting (small 150 mm × 100 mm, large 225 mm × 100 mm)	12	12	18	20
From inspection chamber	12	18	18	20
From manhole	-	-	18	20

Table H.12 Maximum spacing of drainage access provisions

H.6.3.3 Sump pits

All basement levels shall be provided with appropriate means and equipment to drain and filter water (such as sand separation rooms and mechanical plant rooms).

Sump pump pits (see Figure H.19) shall have a depth of not less than 1 m from the level of the lowest inlet pipe.

All sump pump pits shall be positioned in an accessible location for ease of cleaning and maintenance.

All sump pits shall incorporate two submersible pumps operating in a duty/standby configuration. Where the sump pump operation is important to the operation of the building, the electrical supply to the submersible pump installation shall have generator back-up.

Each submersible pump shall be wired to a dedicated control panel which incorporates volt-free contacts.

NOTE: The volt-free contacts and control panel enables an automatic warning signal to be sent to the BMS in the event of pump failure.

Open grated sump pits do not require a vent pipe.

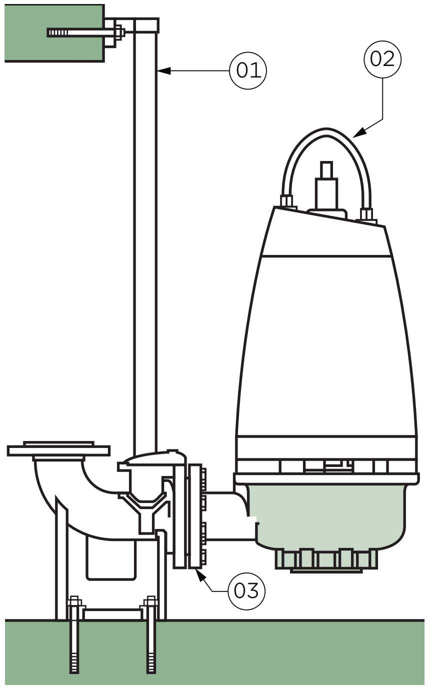


Figure H.19 Typical sump pump detail (© CIBSE. Figure based on Figure 6.13 from CIBSE, 2014. Guide G – Public health and plumbing engineering guide. London: CIBSE).

Key
01: Guide rail
02: Pump
03: Auto coupling

H.6.3.4 Foul pumping stations

Where the external public drainage network is of insufficient depth, or where there is a risk of internal flooding due to sewer surcharge, foul flows from sanitary fittings shall discharge into a foul pumping station.

The pumping station (see Figure H.20) shall be evacuated by submersible pumps that transport foul flows via a pumping main to the external public drainage network.

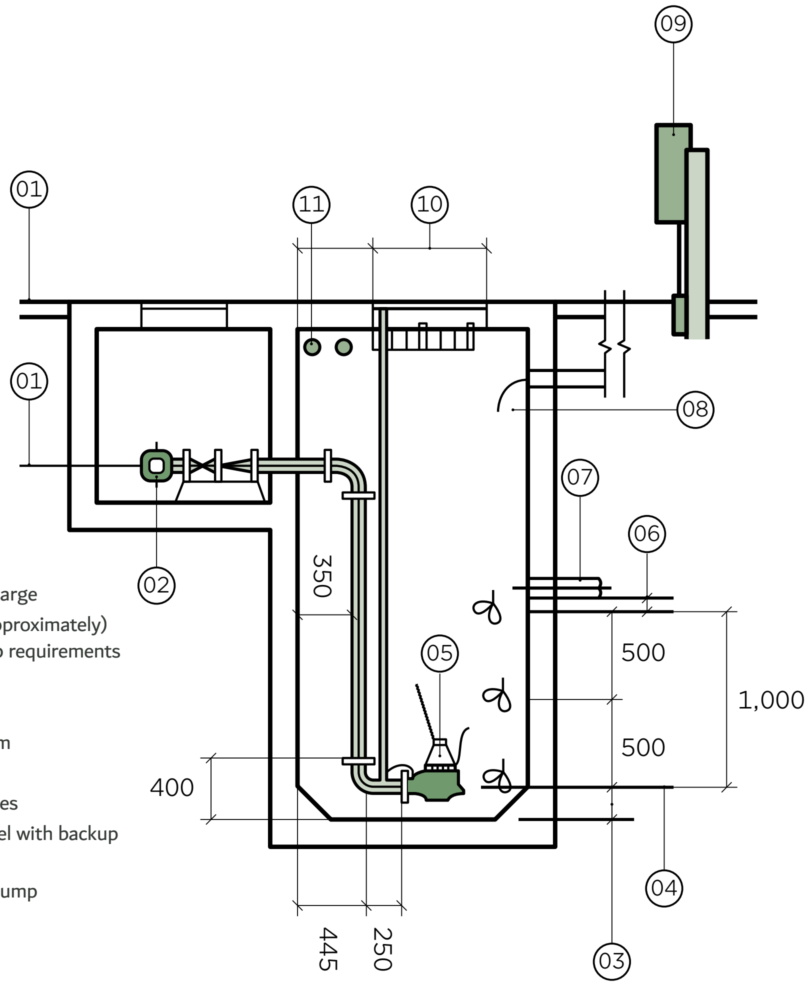
The pumping station shall house pumps that incorporate an auto-changeover facility to ensure even pump wear. All pumping stations shall incorporate, as a minimum, N+1 resilience with pumps operating in a duty/standby configuration, where “N” indicates the duty equipment.

The wet well capacity of the foul pumping station should be sized to provide approximately 24 h foul water storage in the event of pump failure. The foul water storage volume shall be provided below the lowest incoming chamber connection. Where pumping station system resilience is important to the operation of the building, the electrical supply to the pumping station shall have generator back-up.

Where possible, the pumping station shall be located externally. Where this cannot be achieved, the pumping station shall be located inside the building within a dedicated plant room that permits easy access for cleaning and maintenance. The pumping station shall have a dedicated vent pipe that terminates externally to vent to atmosphere.

The pumping station shall be wired to a dedicated control panel which incorporates volt-free contacts.

NOTE: The volt-free contacts and control panel enables an automatic warning signal to be sent to the BMS in the event of pump failure.



Key
01: Invert level
02: 110 Ø discharge
03: 150 mm (approximately) subject to pump requirements
04: Min. level
05: Pump
06: Min. 100 mm
07: Inlet pipe
08: Control cables
09: Control panel with backup power supply
10: Subject to pump requirements
11: Ventilation

Figure H.20 Typical foul water pumping station detail

H.6.3.5 Manholes

All manholes shall be installed within the boundaries of the building plot. During the design, care shall be taken to select the appropriate location of the last manhole (i.e. the one before the public network) in terms of ease of connection to the public drainage network and to fulfil the conditions of the Authority.

The manhole schedule shall be arranged as shown in Figure H.21. The manhole invert level, cover level depth and distance between manholes shall be determined by the Authority public drainage connection level and the final inspection chamber (FIC). All datum units shall be produced in the International System of Units (SI units).

Manhole No.	Cover Level	Invert Level	Distance to next chamber (m)	Depth (m)	Cover Type	Remark
Authority						
FIC						
Manhole No.						

Figure H.21 Sample manhole schedule

The invert level of the external drainage system shall be determined by the Consultant. The drainage connection level shall match that of the FIC. The depth of the last manhole shall be obtained from or approved by the Authority.

Acute angle branch connections shall not be made within manholes.

Pipework connections into a manhole shall be installed where the tops of each incoming drain connect at the same level.

NOTE 1: This connection arrangement means that smaller diameter connecting pipes are not flooded when there is flow through the bigger pipes.

Backdrops shall be provided when the level difference between incoming drain and main sewer is considerable.

All inspection chambers, manholes and gully traps constructed in covered building areas shall be a dry type (not open channel) and provided with recessed double seal type cover.

Manhole access covers shall be suitable for the wheel loads to which they are subjected and for their surrounding floor or road finishes, in accordance with BS EN 124-1.

NOTE 2: Manholes located in garages, driveways or other areas of vehicle movement are likely to require heavy-duty covers.

If inspection chambers or manholes are installed in agricultural land, the manhole cover shall be raised at least 75 mm above the natural ground level.

Manhole venting shall be provided by a vent pipe serving the first and last manholes of any drainage line. Vent pipes shall be located at least 100 mm below cover level.

Manholes shall be sited away from underground water tanks, at a distance not less than the depth of the water tank.

Manholes shall not be installed inside buildings, except in chutes, corridors, service rooms, car sheds and ventilated corridors. Such manholes shall be dry type (not open channel).

H.6.3.6 Manhole construction

Where a manhole or inspection chamber is constructed below the groundwater table level, the entire manhole construction shall be either waterproofed reinforced concrete or GRP.

All main line channels shall be in the centre of the manhole. The sides of manhole channels shall be extended vertically to the same level of the soffit of the pipe.

Benching of incoming branch drains shall be inclined towards the main direction of flow.

The diameter of the semi-circular channel in the bottom of manhole shall be equal to that of the outgoing drain diameter.

The benching of inspection chambers/manholes shall have a smooth curved surface using granolithic concrete that does not restrict drainage flows.

The manhole chamber and access cover sizes shall be not less than the minimum values given in Table H.13.

Manhole depth (mm)	Minimum manhole size (mm)	Manhole cover size (mm) for sewerage and storm water
Up to 1,300	600 × 600	600 × 600
From 1,301 to 1,700	800 × 800	600 × 600
From 1,701 to 2,500	1,000 dia. (with GRP lining)	600 dia.
From 2,501 to 4,000	1,500 dia. (with GRP lining)	600 dia.

Table H.13 Minimum manhole chamber and access cover sizes

H.6.3.7 Final inspection chamber and provision for future connection

The final inspection chamber (FIC) shall be constructed near the building compound wall and opposite the public drainage connecting chamber/manhole. The FIC cover shall be ductile iron with a GRP push-fit sealing plate. The FIC manhole shall have one incoming connection and shall operate by gravity flow.

Where there is no public drainage system, the FIC for the building shall still be provided for connection to a future public drainage network/manhole. The FIC shall be located towards the narrowest adjacent road.

H.6.4 Rainwater disposal

H.6.4.1 General

A rainwater disposal system shall be provided to remove rainwater from all building roof areas. The system shall be designed in accordance with BS EN 12056, and configured to reduce the impact of sand and dust ingress.

The system shall be designed to enable regular ongoing maintenance to remove sand and dust from roof gutters, outlets and rainwater pipework.

Rainfall intensity design criteria shall be taken from intensity duration-frequency curves developed for Dubai urban areas as shown in Table H.14.

For each building development, the rainfall intensity criteria used for design purposes shall be agreed with the Authority.

Unless a more stringent design rainfall intensity is requested by the Authority or another party, a rainfall intensity of 75 mm/h shall be utilized for building roof disposal systems.

Rainwater disposal gutters, channels and rainwater pipes shall be:

a) installed with a gradient not greater than 1/50 and not less than 1/70;
b) made of robust material, complete with waterproof joints; and
c) installed in a safe and reliable manner that is equipped with suitable means of gutter and pipe protection (where required).

Rainwater shall be drained directly onto the surface of a road or passage. It shall not be drained into the drainage pipes of septic tanks or cesspits, or into an adjacent neighbour's premises.

Where possible, rainwater should be drained within the land boundaries at least 2 m away from the building.

Return period	Intensity (mm/h) by duration (h)						
	0.50 (h)	1.00 (h)	1.50 (h)	2.00 (h)	2.50 (h)	6.00 (h)	24.00 (h)
1,000 year	103.44	70.99	52.40	43.63	34.90	20.51	7.62
200 year	83.78	57.81	42.73	35.50	28.40	16.43	6.12
150 year	80.26	55.45	41.00	34.05	27.24	15.70	5.86
100 year	75.30	52.12	38.56	31.99	25.59	14.66	5.48
75 year	71.77	49.75	36.82	30.53	24.43	13.93	5.21
50 year	66.78	46.40	34.37	28.47	22.78	12.89	4.83
40 year	64.03	44.56	33.01	27.33	21.87	12.32	4.62
30 year	60.46	42.17	31.26	25.86	20.69	11.58	4.35
25 year	58.20	40.65	30.15	24.92	19.94	11.11	4.18
20 year	55.41	38.78	28.78	23.77	19.02	10.53	3.97
15 year	51.80	36.35	27.00	22.27	17.82	9.78	3.70
10 year	46.63	32.89	24.46	20.14	16.11	8.71	3.30
5 year	37.48	26.75	19.96	16.35	13.08	6.81	2.61
4 year	34.38	24.67	18.44	15.07	12.06	6.17	2.37
3 year	30.19	21.86	16.38	13.34	10.67	5.30	2.06
2 year	23.65	17.48	13.16	10.64	8.51	3.94	1.56

Table H.14 Dubai rainfall intensity frequency data

The routing of rainwater pipework through sensitive areas of a building should be avoided. Sensitive areas might include, but are not limited to:

1) areas of architectural significance;
2) pipework routes through areas of different ownership or tenancy; and
3) areas where access to drainage pipework might be restricted.

Where routing pipework through these areas cannot be avoided, the pipework installation shall be configured to mitigate the risk of pipework leaks. This shall be achieved by using pipework materials that have limited pipework joints, or “pipe in pipe” installation techniques.

H.6.4.2 Siphonic rainwater disposal systems

Siphonic rainwater systems shall be designed and installed in accordance with BS EN 12056.

Only specialist Consultants shall be employed to design and install these systems. Where siphonic rainwater systems are proposed, the Consultant shall design the system using analytical software to demonstrate the hydraulic performance of the system. The Consultant shall provide design drawings, schematics and specifications for submission to the Authority.

H.6.4.3 Rainwater disposal system acoustic requirements

The rainwater disposal system shall be designed and routed through the building with attention to the acoustic requirements of the space that it passes through. Acoustic insulation shall be provided where required.

H.6.4.4 Drainage of hardstanding paved areas

Hardstanding paved areas shall be designed in accordance with BS EN 752. They shall be drained using floor gully’s and linear drainage channels.

The design rainfall intensity shall be 65 mm/h, unless a more stringent value is requested by the Authority or another party.

Hardstanding paved areas shall be constructed to slope away from the building. Where external levels would otherwise cause water to pond along a wall, a reverse gradient shall be constructed at least 500 mm from the wall to divert water away.

If a public storm water drainage network is not available in the area, a rainwater storm drain or holding tank should be provided within the land boundaries. Where such a facility is provided, it shall be sufficient to hold rainwater for at least one day.

H.6.4.5 Miscellaneous rainwater drainage

Rainwater pipes shall not be connected to sewer lines. They shall be terminated above ground, to allow free discharge onto the external ground surface.

Exposed roof areas or canopies shall be configured with a gradient of not greater than 1/50 and not less than 1/70 in order to direct rainwater to suitable channels, gutters or outlets.

All building parapet roof areas shall incorporate emergency overflow provisions.

All internal roof or paved areas that are open to the sky (that have a catchment area of 16 m^2 or less) shall be provided with floor drains to enable rainwater pipework to connect to the nearest gully or waste discharge stack. All other areas that are open to the sky shall be provided with a rainwater drain that provides free discharge to an external area.

For all air ventilation shafts, access doors shall be provided at the lower level of the well to facilitate cleaning and maintenance of the rainwater drainage system.

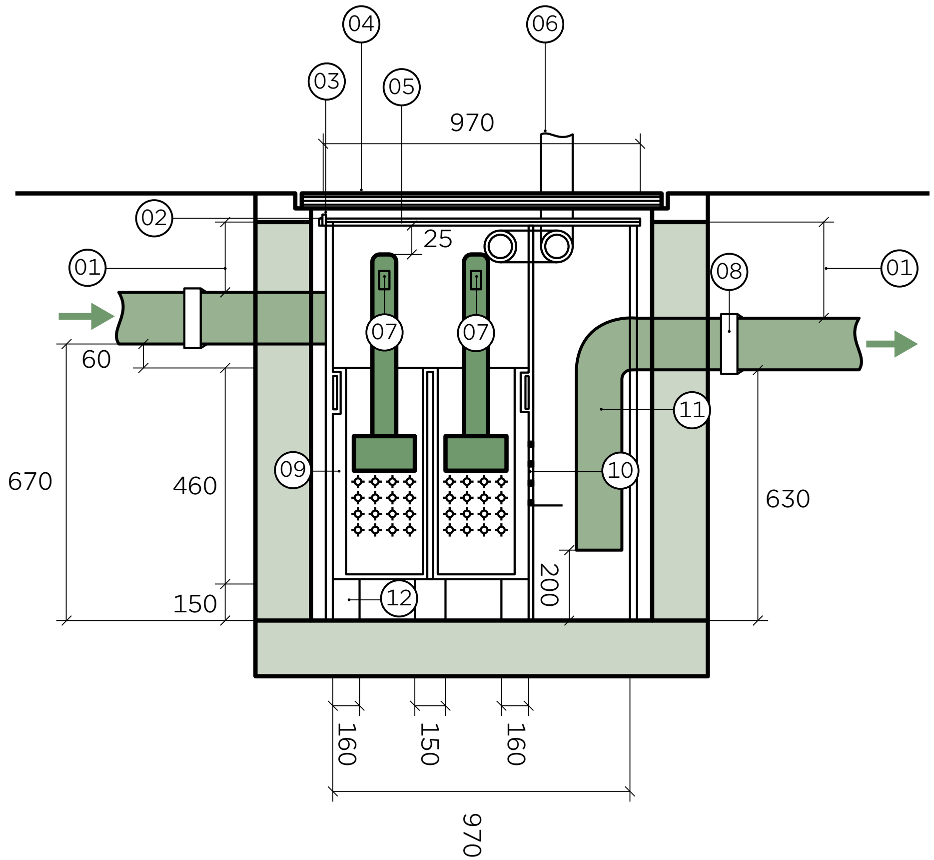
H.6.5 Grease traps

A dedicated above-ground gravity drainage system shall be provided to drain wastewater flows from food production kitchen areas within a building. The system shall connect to a grease trap (see Figure H.22).

Grease traps shall conform to BS EN 1825-1 or equivalent. Except for residential buildings, design proposals for grease traps shall be submitted to the Authority
for approval.

All discharge stacks that serve food production kitchen areas shall terminate externally to enable each stack to safely vent to atmosphere.

Grease traps shall be positioned external to the building in locations that facilitate vacuum tanker access.



Key

01: Dimension varies to suit requirement
02: 5 mm THK. neoprene gasket
03: 10 × 40 brass nut/bolt
04: Ductile heavy duty manhole cover
05: 1,070 mm × 815 mm × 15 mm THK. GRP sealed cover
06: 55ø (50 mm) air vent
07: Lifting handle
08: 110ø outlet pipe
09: Two bucket 460 mm deep removeable PVC perforated bucket with 25ø holes in four rows each side
10: 55ø holes in three rows 8 nos. in each row
11: 100ø PVC pipe
12: Support for bucket seating

Figure H.22 Typical kitchen grease trap connection detail

H.6.6 Oil interceptors

Oil interceptors shall be provided for vehicle washing and service stations (see Figure H.23).

Oil separators shall be designed in accordance with BS EN 752 and BS EN 8588. They shall be installed in a location that allows easy access for a vacuum tanker, to aid regular emptying.

Oil separators shall have:

a) a dedicated vent pipe and cable duct connection; and
b) a control panel with an audible alarm that indicates when the separator requires emptying.

Oil separator access covers shall be suitable for the wheel loads to which they are subjected and for their surrounding floor or road finishes.

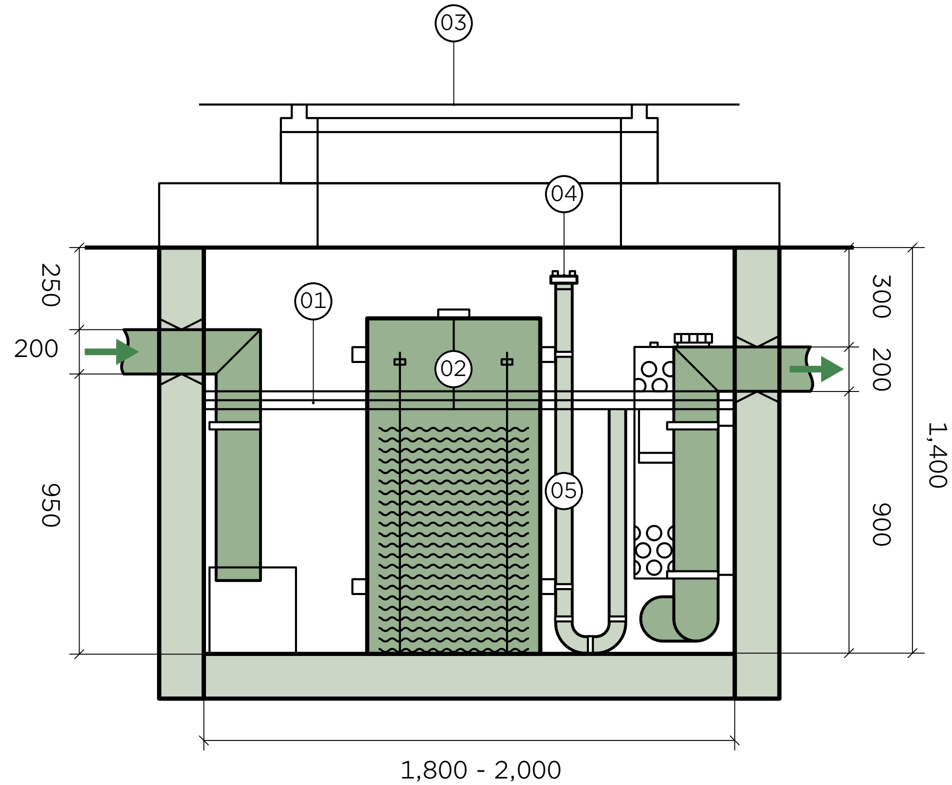


Figure H.23 Typical oil separator detail

Key
01: Oil
02: Small dam
03: 2 × 600 × 600 cast iron heavy duty cover
04: Fire hose coupling (type C)
05: Oil drainage unit

H.6.7 Swimming pools

Drainage for swimming pools and backwash pumps shall be shown on separate drainage layout plans.

For swimming pools on the roof or upper floors, a separate 100 mm diameter drain (after the backwash regulating valve) shall be installed to the ground floor manhole connection. This drain shall not connect to a basement sump pump.

Backwash drainage flows from the pool filtration system shall discharge unattenuated into the public drainage system where this is approved by the Authority. If approval for an unattenuated discharge cannot be obtained, backwash water shall discharge into an attenuation tank to enable a reduced drainage flow rate to the public drainage system.

Architectural safety features for pools are discussed in B.8.3.2.2.

H.6.8 Provisions for future connection

Within all buildings, waste and vent pipe connections shall be provided to all areas of possible future fit-out, including, but not limited to, retail units, office or administrative areas, food production and sport and leisure facilities.

H.6.9 Above- and below-ground drainage testing

All drainage systems shall be tested with air or water to verify that the systems do not have any defects. All drainage test certification shall be submitted to the Authority for review and approval.

All drainage systems shall be tested as soon as practicable after installation. Interim and final test certificates shall be of an agreed format, which shall give full details of the site, system, location, type of test and witnesses, together with signatures and test dates.

Unless more stringent testing is requested by the Authority or another party, the following procedures shall be used for above-ground drainage systems.

a) Pipes shall be interim tested using an air pressure of 100 mm water gauge held constant for 5 min.
b) If the system fails the test, any faults shall be rectified, and the test repeated until a satisfactory test result has been achieved.
c) On completion of installation and connection of sanitary appliances, a final air test shall be made, using an air pressure of 50 mm water gauge held constant for 5 min.

For below-ground drainage systems, unless more stringent testing is requested by the Authority or another party, testing shall be undertaken using air or water in accordance with BS EN 1610.

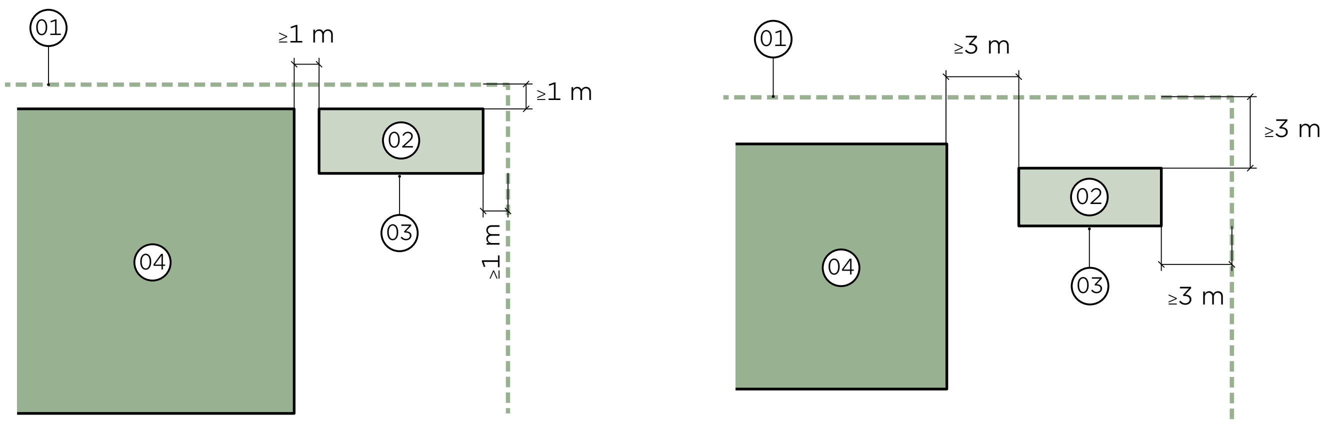
H.6.10 Septic tank and sewage holding tanks

Where there is no public drainage network available, the building shall be provided with a sewage holding tank. Septic tanks shall be utilized only for remote building locations that are expected to generate low foul water flow rates.

Septic tanks and sewage holding tanks shall meet the following requirements.

a) Tanks shall be situated within the plot boundaries and be easily accessible for cleaning, emptying and maintenance. They shall be included in the sanitation, architectural and construction drawings, and tank locations shall be subject to approval by the Authority.
b) Tanks shall be capable of being connected in future to the public drainage network.
c) Swimming pool water shall not be drained into a septic tank.
d) Tanks shall be constructed of reinforced concrete, glass reinforced plastic or brickwork. All tanks shall be installed in accordance with the tank manufacturer's requirements, and to withstand any potential vehicle loading.
e) Where a tank is to be founded at a lower level than that of an adjacent footing, the tank shall be constructed before the footing.
f) Tanks shall have openings of adequate size, with a heavy-duty lockable access cover of suitable dimensions to enable cleaning and maintenance.
g) The roof level of a tank shall not terminate above the adjacent ground level in which it is situated.
h) Tanks shall have adequate capacity, calculated on the basis of daily personal consumptions given in standard tables produced by the Authority. Tanks shall be emptied without impeding the operation of the building.
i) Where insulation is provided to prevent leakage through walls, non-penetrating reinforced concrete tanks shall be situated at a distance not less than 1 m from nearby buildings and boundary walls, and brick tanks at a distance not less than 3 m. The reinforced concrete tanks shall be at a minimum depth of 1.5 m from the invert of the pipe connected to the tank inlet, and shall have a spacing of at least 3 m from the nearest water tank.

   NOTE: Location constraints are illustrated in Figure H.24.
j) Tanks shall not be located within a 5.5 m set back of a vehicular access area unless this is unavoidable. If a tank has to be located within this area, the road and tank construction shall be sufficiently robust for road use by fire tenders and heavy goods vehicles.
k) Tanks shall be provided with a ventilation pipe.
l) All tank openings shall be covered in such a way as to prevent insects from entering.
m) Holding tanks shall have a high-level alarm facility connected to a dedicated control panel, which will generate an alarm in the event of wastewater overflowing. For buildings with a BMS, the control panel shall be linked to the BMS to generate an automatic alarm. For buildings that do not have a BMS, the control panel shall have a visual and audible alarm.
n) Tanks shall be provided with a breaching pipe for pumping out operations.



(a) Reinforced concrete and concrete encased GRP holding tanks

(b) Brickwork holding tank

Figure H.24 Septic tank and sewage holding tank location constraints diagram

Key

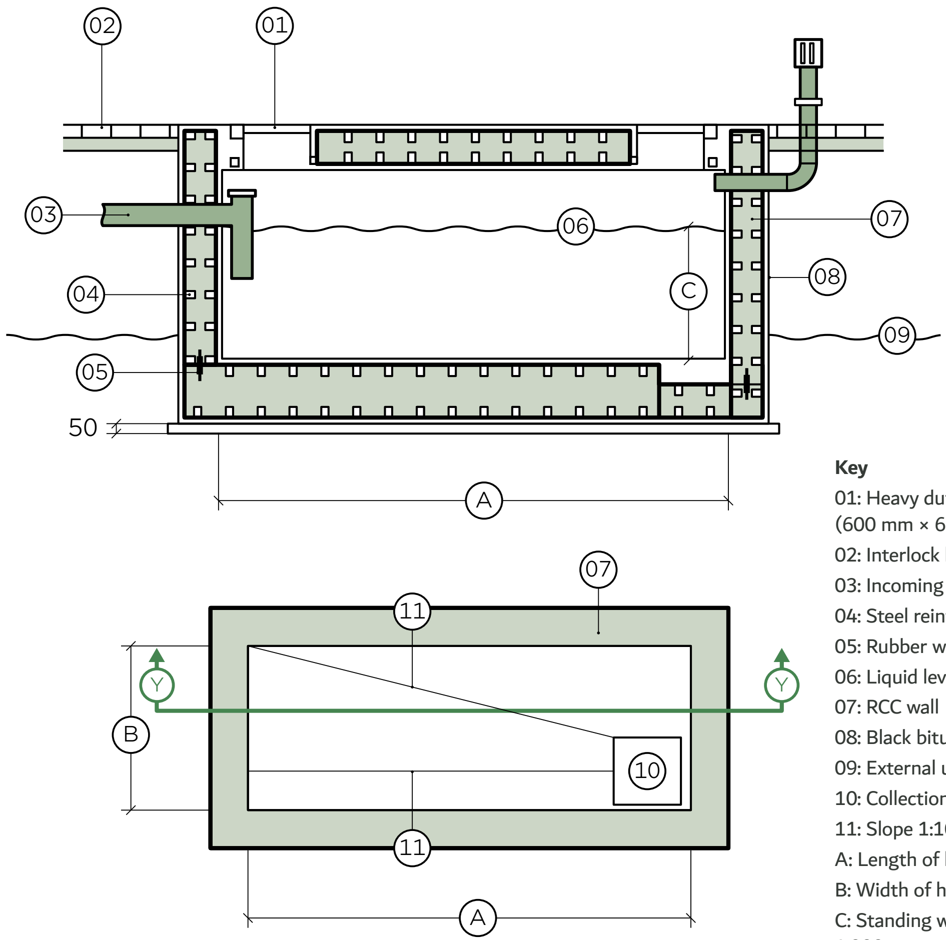
01: Site boundary/boundary wall
02: Septic/holding tank
03: No underground water tank shall be located within 1m of the tank location
04: Building

Key

01: Site boundary/boundary wall
02: Septic/holding tank
03: No underground water tank shall be located within 3m of the tank location
04: Building

A GRP sealing plate shall be installed on the last manhole before the tank and on the manhole utilized for future connection before the sewer line.

Tanks shall be designed in accordance with BS 6297. A typical sewage holding tank arrangement is shown in Figure H.25.



Key

01: Heavy duty MH cover (600 mm × 600 mm)
02: Interlock level
03: Incoming PVC-U pipe
04: Steel reinforcement rebar
05: Rubber water stopper
06: Liquid level
07: RCC wall
08: Black bitumen paint all round
09: External underground water table
10: Collection pit
11: Slope 1:10
A: Length of holding tank is variable
B: Width of holding tank
C: Standing water in the holding tank minimum 1,000 mm

NOTE: Minimum size for holding tank = A x B x C = 25 m^3

Figure H.25 Typical sewage holding tank arrangement

H.6.11 Soakaways

Where a soakaway (see Figure H.26) is part of the building drainage strategy, it shall be constructed in accordance with the following requirements.

a) Only the surface water drainage flows shall discharge into a soakaway.
b) The foundation level of the base of the soakaway shall be kept at least 1 m above the winter water table.
c) The soakaway shall be located at least 3 m away from a building footing or boundary wall.

Soakaways shall be filled with boulders that are 75 mm to 100 mm in size.

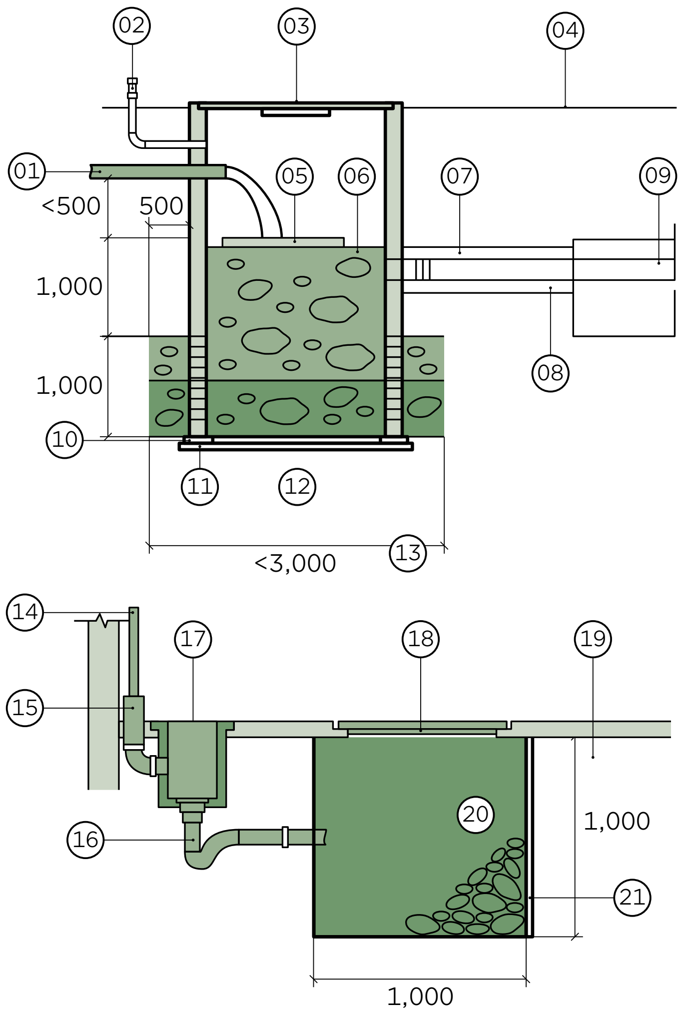
If the soakaway is to be founded at a lower level than that of an adjacent footing, the soakaway shall be constructed before the footing.

The floor area of the soakaway shall be determined according to the percolation rate in accordance with appropriate test in BS 6297.

The soakaway shall be not less than 1 m away from a septic or holding tank.

The soakaway shall be constructed at a level that does not undermine the adjacent footing of a building or a boundary wall.

There shall be no side leakage from the soakaway.



Key
01: Inlet 150ø min.
02: Vent pipe 50 mm min.
03 Cover (600 mm x 600 mm)
04: Ground level
05: Concrete slab
06: GRP filter
07: Solid pipe – 1,000mm long
08: 150 mm gravel surround
09: 200 mm diameter perforated pipe
10: RCC
11: Plain cement concrete
12: Permeable floor area
13: Min 3,000 mm
14: Condensate drain pipe
15: Copper to PVC pipe joint
16: P-trap
17: Sealed gully trap
18: 600 mm diameter clear access cover
19: Loose soil
20: 1,000 mm diameter perforate PVC chamber filler with pea gravel
21: Sand trap membrane to prevent ingress into chamber

Figure H.26 Illustration of a typical soakaway

H.7 Lighting

H.7.1 Lighting in the workplace

All indoor and outdoor spaces (including transition areas) in the workplace shall meet the illuminance requirements in BS EN 12464-1 and ISO 8995-1. Additional information can be found in the IES Lighting handbook [Ref. H.37].

The requirements for healthcare buildings and all relevant codes and standards are identified in the DHA Regulations [Ref. H.2 to Ref. H.11] and DHA Health facility guidelines [Ref. H.12 to Ref. H.16].

H.7.2 Lighting power densities – interior

The lighting power density shall be calculated using either the building area method or the "space-by-space" method as set out in Sections 9.5 and 9.6 of ASHRAE 90.1:2019.

When using the building area method, the maximum average lighting power density for the interior connected lighting load shall not exceed the values given in Table H.15.

Occupancy	Maximum average lighting power density across total building area (W/m²)
Business, assembly, hotel establishments: Offices, hotels, resorts, restaurants, etc	7.5
Educational facilities	7.8
Industrial	8.9
Retail, malls, workshops	9.8
Warehouses	4.9
Residential (common interior areas)	6.9

Table H.15 Interior lighting power density

Lighting power density values for occupancies not listed in Table H.15 shall not exceed the values given in ASHRAE 90.1 or equivalent as approved by the Authority.

H.7.3 Lighting power densities – exterior

As far as practicable, the average lighting power density for the exterior connected lighting load shall not exceed the values given in Table H.16.

Building area	Maximum average lighting power density (W/m² or W/lm)
Uncovered parking lots and drives	0.86 W/m²
Walkways less than 3 m wide	2.3 W/lm
Walkways 3 m wide or greater	1.5 W/m²
Outdoor stairways	7.5 W/m²
Main entries	69 W/lm of door width
Other doors	46 W/lm of door width
Open sales areas (including vehicle sales lots)	2.1 W/m²
Building façades	2.2 W/m² for each illuminated wall or surface or 16.4 W/lm for each illuminated wall or surface length
Entrances and gatehouse inspection stations at guarded facilities	5.4 W/m²
Drive-up windows at fast food restaurants	200 W/drive-through

Table H.16 Exterior lighting power density

Average exterior lighting power density values for areas not listed in Table H.16 shall not exceed the values indicated in ASHRAE 90.1 or equivalent as approved by the Authority.

If the average exterior lighting power density values exceed the values specified in Table H.16, the additional lighting load should be powered entirely through renewable energy sources (such as photovoltaic systems or similar). Any lighting power reduction generated by the renewable energy source shall be deducted from the annual energy consumption in the performance-based method.

H.7.4 Lighting controls

Lighting controls for interior lighting shall be provided in accordance with the following requirements.

a) Occupants shall be able to control or switch off lighting when daylight levels are adequate or when spaces are unoccupied.
b) In common areas that are not regularly occupied (such as corridors and lobbies), lighting levels shall be automatically reduced when the space is unoccupied, to a maximum of 25% of the normal level.
c) In offices and education facilities, all lighting zones shall be fitted with occupant sensor controls capable of switching normal lighting on and off based on occupancy level, with the following exceptions.
    1) Lighting required for safety purposes is excluded.
    2) If the average design lighting power density value is less than 6 W/m^2 of gross area, these controls do not need to be provided.
d) In offices, artificial lighting within 6 m of exterior windows should be fitted with lighting controls. Where lighting controls are fitted, they shall incorporate photocell sensors that are capable of adjusting electric lighting levels to supplement the levels of daylight when required. The combination of artificial light and daylight shall provide an illumination level at the working plane between 400 lux and 500 lux. When 100% of daylight is available, illumination might exceed 500 lux.

H.7.5 Electronic ballasts

High frequency electronic ballasts shall be used with:

a) fluorescent lights of 150 W and less; and
b) metal halide lights of 150 W and less.

High frequency electronic ballasts shall conform to an international standard approved by the Authority, and shall be labelled as such.

H.7.6 Light levels on means of egress

The floors and other walking surfaces within an exit, the exit access and exit discharge, shall be illuminated as follows:

a) The illumination for stairs, when in use, shall be not less than 108 lux, measured at the walking surfaces.
b) The illumination for floors and walking surfaces, other than stairs, shall be not less than 10.8 lux, measured at the floor.
c) In assembly occupancies, the illumination of walking surfaces of exit access shall be not less than 2.2 lux during periods of performances or projections involving directed light (e.g. onto a cinema screen).
d) The minimum illumination requirements do not apply where operations or processes require low lighting levels.

The illumination shall be arranged such that the failure of any single lighting unit does not result in an illumination level of less than 2.2 lux in any designated area. Light levels on means of egress in emergency mode shall conform to Ch. 3 and Ch. 6 of UAE FLSC **[Ref. H.1]**. Emergency lighting shall be provided in all areas listed in Table 6.6, Ch. 6 of UAE FLSC **[Ref. H.1]**. The exterior routes from the point of exit discharge to the public way shall be provided with emergency lighting in accordance with Table 6.6, Ch. 6 of UAE FLSC **[Ref. H.1]**. Assembly points and mall parking lots shall have emergency lighting or a source of illumination (e.g. public street lights) that has a separate power supply to the building.

H.8 Commissioning

Commissioning of air distribution systems, water distribution systems, lighting, central control and building management systems, refrigeration systems and boilers shall be carried out in accordance with the CIBSE commissioning codes [Ref. H.38, Ref. H.39, Ref. H.40, Ref. H.41, Ref. H.42, Ref. H.43] or other commissioning code/standard approved by the Authority.

A systems manual shall be developed, and shall be provided to the building operator upon completion of commissioning works. The systems manual shall document the information required to allow future operations staff to understand and optimally operate the commissioned services.

A non-technical user guide shall be developed for building occupiers.

H.9 Fire safety systems

H.9.1 General

Emergency voice evacuation systems, two-way communication systems, fire detection and alarm systems and fire protection systems shall be provided as required by, and designed to conform to, Ch. 7 to Ch. 9 of UAE FLSC [Ref. H.1].

H.9.2 Emergency voice evacuation systems

Emergency voice evacuation systems shall be provided as required by, and designed to conform to, Ch. 7 of UAE FLSC [Ref. H.1].

An emergency voice evacuation system shall be provided at all high-rise and super high-rise buildings and the following:

a) malls;
b) assembly buildings;
c) amusement and theme parks;
d) educational buildings;
e) hotel buildings;
f) detention and correctional facilities; and
g) hospitals.

DCD does not enforce item 9, Table 7.3, Ch. 7 of UAE FLSC [Ref. H.1]. Emergency voice evacuation systems are therefore not required in storage and industrial buildings in Dubai.

As specified in Table 8.1, Ch. 8 of UAE FLSC [Ref. H.1]:

1) emergency voice evacuation speakers shall be provided inside exit staircases;
2) audible sounders shall not be installed in buildings with emergency voice evacuation systems.

In addition, DCD does not permit emergency voice evacuation speakers inside the emergency command centre.

H.9.3 Two-way communications systems

A two-way communication system for fire fighters shall be provided as required by, and designed to conform to, Ch. 7 of UAE FLSC [Ref. H.1].

A two-way communication system for fire fighters shall be provided at all super high-rise buildings and the following:

a) malls;
b) assembly buildings;
c) amusement and theme parks;
d) hotel buildings; and
e) detention and correctional facilities.

When required by C.5.9.3.2, a two-way communication system shall be provided for use by people of determination, and shall be designed to conform to Ch. 7 of UAE FLSC [Ref. H.1].

H.9.4 Fire detection and alarm systems

Fire detection and alarm systems shall be provided as required by, and designed to conform to, Ch. 8 of UAE FLSC [Ref. H.1].

Automatic heat detection shall be provided in non-sprinklered, enclosed parking areas, in accordance with Table 8.1, Ch. 8 of UAE FLSC [Ref. H.1].

Audible sounders shall not be installed inside exit staircases, in accordance with Table 8.1, Ch. 8 of UAE FLSC [Ref. H.1].

In addition, DCD does not permit audible sounders inside the emergency command centre.

H.9.5 Fire protections systems

Fire protection systems shall be provided as required by, and designed to conform to, Ch. 9 of UAE FLSC [Ref. H.1].

NOTE: The design of firefighting water tanks or combined potable and firefighting water tanks is covered in H.5.5.6 and H.5.5.7.

DCD requires at least one dry/wet riser landing valve to be provided at roof level. Additional landing valves shall be provided if the roof area cannot be covered by a single 61 m hose.

Motorized zone control valves, as required by Table 9.7, Ch. 9 of UAE FLSC [Ref. H.1] for high-rise buildings, are not required by DCD.

Basements and all corridors on every floor shall be provided with drainage facilities to clear water from fire fighting activities (see Ch.9 of UAE FLSC [Ref. H.1]).

H.10 Acoustics

H.10.1 Site planning requirements

All sites shall be planned and landscaped to contribute to the relief and masking of noise in external spaces. This shall include determining the appropriate placement of water features, planting and other decorative features.

A pleasant outdoor soundscape shall be achieved to the extent possible.

H.10.2 Health and safety

Plant rooms, workshops and industrial area shall be designed such that the hearing of those who need to enter when equipment is operating will not be damaged. Where this cannot be achieved by controlling noise levels, warning signs shall be clearly displayed, and effective hearing protection shall be provided.

H.10.3 Acoustic comfort

H.10.3.1 General

As a general rule, the following areas of acoustic performance shall meet the minimum provisions of the reference standards listed in Table H.17:

a) internal noise from building services;

b) external noise sources (such as road traffic and aviation);

c) internal airborne sound insulation; and

d) internal impact sound pressure levels and reverberation times.

Higher or lower values might be appropriate in some circumstances, and should be based on careful analysis of economics, space use, and user needs and guidance from an Acoustic Consultant.

Occupancy	Standard
Residential	Approved Document E [Ref. H.44] BS 8233
Healthcare	Dubai Health Authority Regulations [Ref. H.2 to Ref. H.11] and DHA Health facility guidelines [Ref. H.12 to Ref. H.16]. Health Technical Memorandum 08-01 [Ref. H.45] or FGI Guidelines for design and construction of hospitals and outpatient facilities [Ref. H.46].
Educational, including nurseries, schools, colleges and universities.	Building Bulletin 93: Acoustic design of schools – Performance standards [Ref. H.47]
Business	BS 8233 British Council for Offices' Guide to specification [Ref. H.48]
Industrial	BS 8233
Assembly (e.g. libraries, museums)	BS 8233

Table H.17 Design standards for acoustics per occupancy

H.10.3.2 Building services noise

Guidance on building services noise in spaces not listed in Table H.17 is given in Ch. 48 of the ASHRAE HVAC applications handbook [Ref. H.17]. Ch. 48, Table 1 of the handbook identifies design guidelines for acceptable HVAC related background noise for a range of building and room types.

The total services noise level within each space shall include the effects of:

a) structure borne noise from plant;

b) airborne noise break-out from plant rooms; and

c) external plant noise break-in through the building envelope.

Building services noise shall be free from attention-catching effects, tonality and impulsiveness.

Noise from a building's services and plant shall be controlled to prevent disturbance to any nearby noise sensitive receptors such as dwellings, places of worship, outdoor amenities or circulation areas. Control of noise from a building shall include limiting noise breaking back into the building that the plant is serving. This contribution to the total internal noise level shall be included when designing the building envelope, or when specifying plant noise limits and mitigation requirements such as screening or plant enclosures.

H.10.3.3 Sound insulation

The sound insulation of the building envelope, internal floors and partitions shall be designed in accordance with the standards listed in Table H.17 or better, and the additional requirements described in H.10.4. Figure H.27 illustrates examples of sources of noise to be included in the design of sound insulation of building facades and internal elements of the structure.

NOTE: The sound insulation performance of building elements specified in the listed documents is presented in terms of their performance on-site. The on-site performance will be numerically lower than the performance measured in a laboratory, which is specified by suppliers and manufacturers of building materials. The difference can be due to the quality of workmanship on-site and because the performance can be compromised by flanking transmission, which allows sound to be transmitted via other elements of the building, as illustrated in Figure H.27.

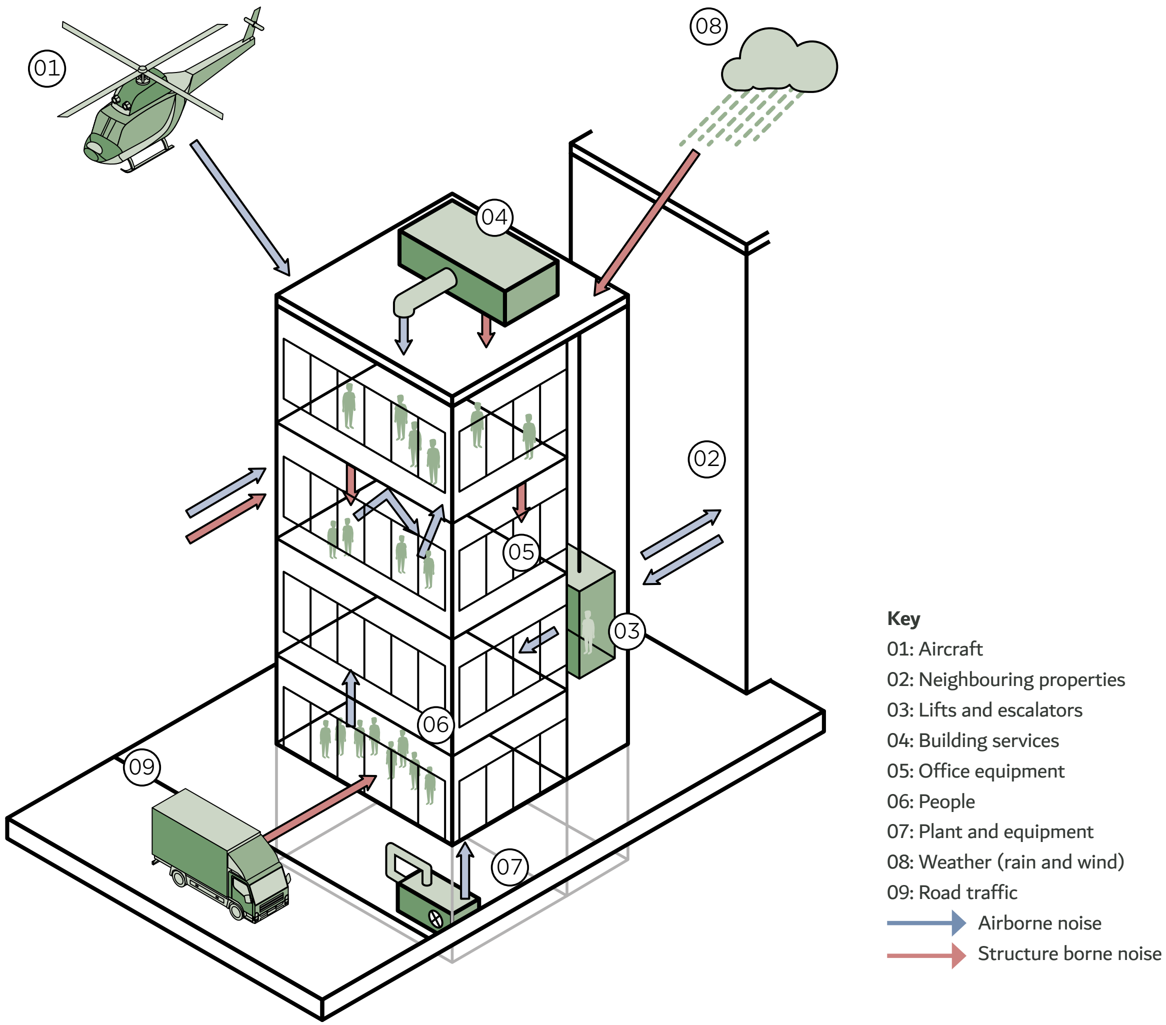
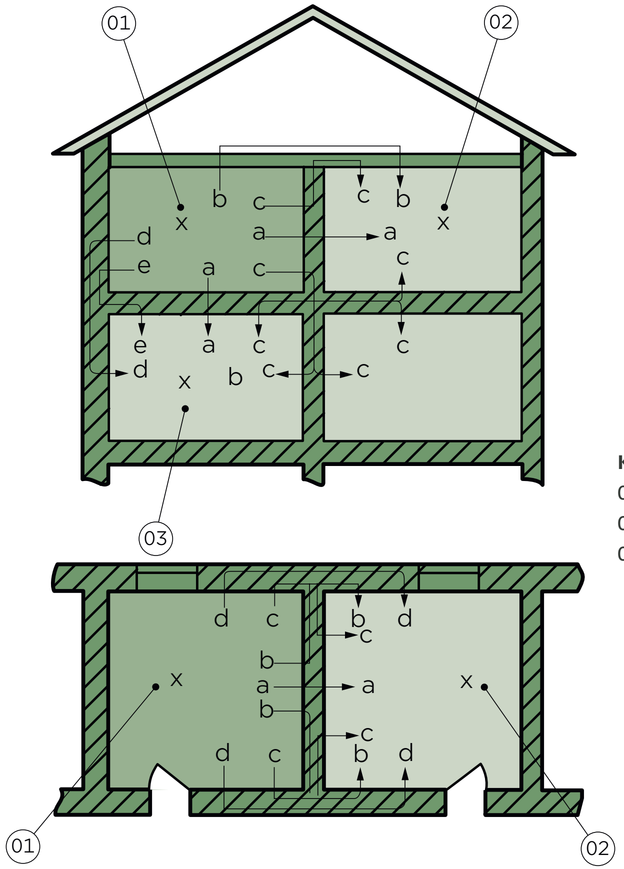


Figure H.27 Examples of noise sources that affect acoustic design (© BCO Guide to specification 2019. For both relevant text and images [Ref. H.48])



Key

01: Room 1: Source room

02: Room 2: Horizontal receiver

03: Room 3: Vertical receiver

Figure H.28 Transmission paths (via the structure) of noise originating in Room 1 (© British Standards Institute. Figure extracted from BS 8233:2014. Permission to reproduce extracts from British Standards is granted by BSI Standards Limited (BSI). No other use of this material is permitted).

NOTE: The arrows indicate the direction of transmission of sound from letter X in the source room to the same letter X in the receiving room.

H.10.3.4 Control of reverberation

Where control of reverberation is required to reduce the build-up of sound (see Figure H.29), support speech intelligibility, or support the performance of public address and voice alarm sound systems, the room design shall include sound-absorbing surfaces. Sufficient sound-absorbing material shall be included to achieve the reverberation times given in the documents listed in Table H.17. For occupancy types not listed, the advice of an Acoustic Consultant should be sought.

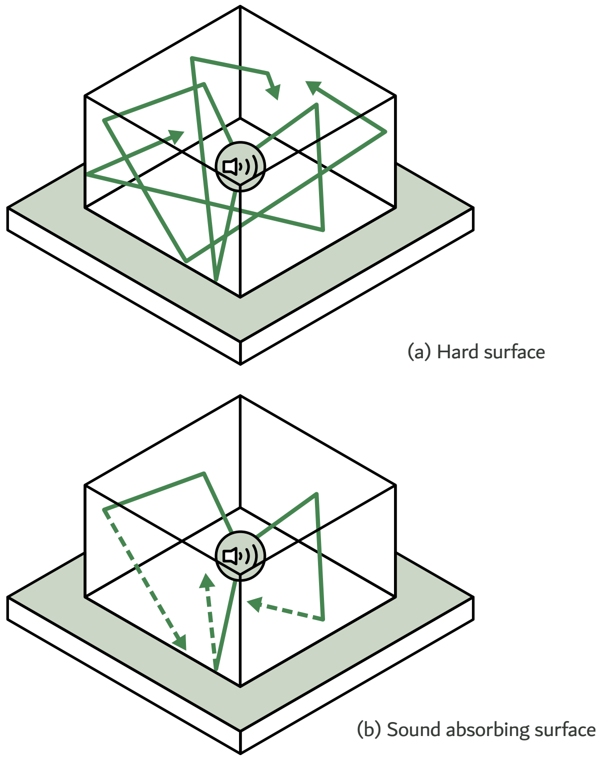


Figure H.29 Use of sound-absorbing materials to control reverberation

H.10.4 Additional requirements for different occupancies

H.10.4.1 Mosques

An integrated approach to the acoustic design of mosques is essential. Achieving good sound system speech intelligibility in the prayer hall, that is compatible with the architecture, requires careful location and specification of sound-absorbing and diffusing finishes.

Sound insulation of the prayer hall is also important. The walls, roof and door openings shall be designed to control the ingress of noise from adjacent spaces within the building and from outside.

An Acoustic Consultant should be appointed to carry out the acoustic design of the building and the sound systems.

H.10.4.2 Healthcare

Patient rooms should be located as far as possible from roads, car parking areas and service yards.

Hospitals shall be designed to give appropriate levels of patient acoustic and visual privacy and dignity throughout the care process.

In multiple-bed rooms, visual privacy from casual observation by other patients and visitors shall be provided for each patient but speech privacy is unlikely to be practicable.

Acoustic design of healthcare occupancies shall conform to HTM 08-01 [Ref. H.45] or FGI guidelines [Ref. H.46].

H.10.4.3 Educational

School operators might stipulate requirements for their brand.

The advice of an Acoustic Consultant should be sought for the design of specialist facilities such as performing arts rooms.

H.10.4.4 Hotels

Hotel operators will stipulate requirements for their brand of hotel and serviced apartments.

In the absence of any specific operator guidance, the requirements of Approved Document E [Ref. H.44] for "rooms for residential purposes" shall be adopted.

H.10.4.5 Performing arts venues

Buildings for performing arts uses shall be designed individually for the specific intended uses of the building. A specialist Acoustic Consultant should be involved from the early stages of the design.

The acoustic design of ancillary spaces within the building shall follow the relevant parts of the standards listed in Table H.17.

H.10.5 Vibration and ground-borne noise

Railways above or below ground can cause perceptible vibration and generate audible rumbling in nearby buildings.

Guidance on vibration levels for human comfort, and criteria for sensitive equipment, are provided in Ch. 48, Table 45 of the ASHRAE HVAC applications handbook [Ref. H.17].

Guidance on acceptable levels of ground borne noise is given in the Federal Transit Administration's Transit noise and vibration impact assessment manual [Ref. H.49] and Association of Noise Consultants' Measurement and assessment of ground borne noise and vibration [Ref. H.50].

H.11 Digital services enablement and ICT

H.11.1 Scope

Dubai has an aspiration to enable digital services as described in H.11.7.

The following sections of the DBC define the requirements for digital services entablement. These sections only apply when there is a client brief for a digitally connected building.

H.11.2 Minimum requirements for digital services enablement

H.11.2.1 Digital building technology model

Digital services and operational technology (OT) in buildings relies on layers of key capabilities. These key capabilities cover smart devices, inter-connectivity across networks, applications and processes residing in centralized platforms (including data sets and user facing applications), data analytics and reporting systems. Building users benefit from access to a richer range of data sets that can be analysed and presented in management dashboards and performance reports.

A layered approach shall be adopted when defining an overall smart buildings system architecture (see Figure H.30).

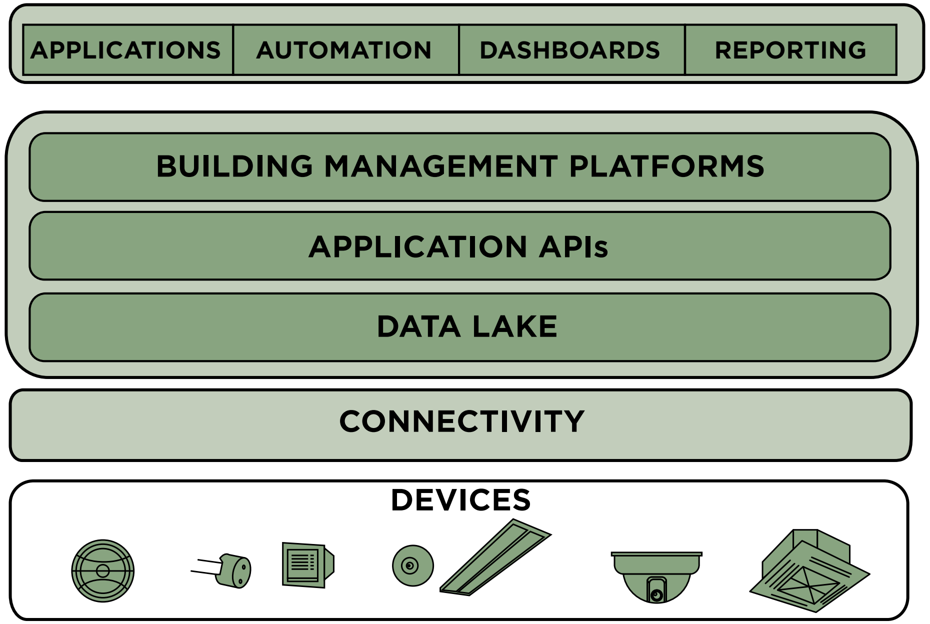


Figure H.30 An example of a layered approach to digital buildings system architecture

H.11.2.2 Implementation requirements

All building OT shall be digital-enabled by being configured to consume information, and communicate the information that it produces, via open IoT protocols.

Building OT, includes, but is not limited to:

a) HVAC equipment and ancillaries;

b) vertical transportation systems;

c) lighting systems;

d) BMS;

e) energy metering;

f) renewable energy systems; and

g) occupancy monitoring systems.

Figure H.31 shows one example of a digital-enabled building, with the building systems connected to a digital building infrastructure, to which future digital systems might be connected.

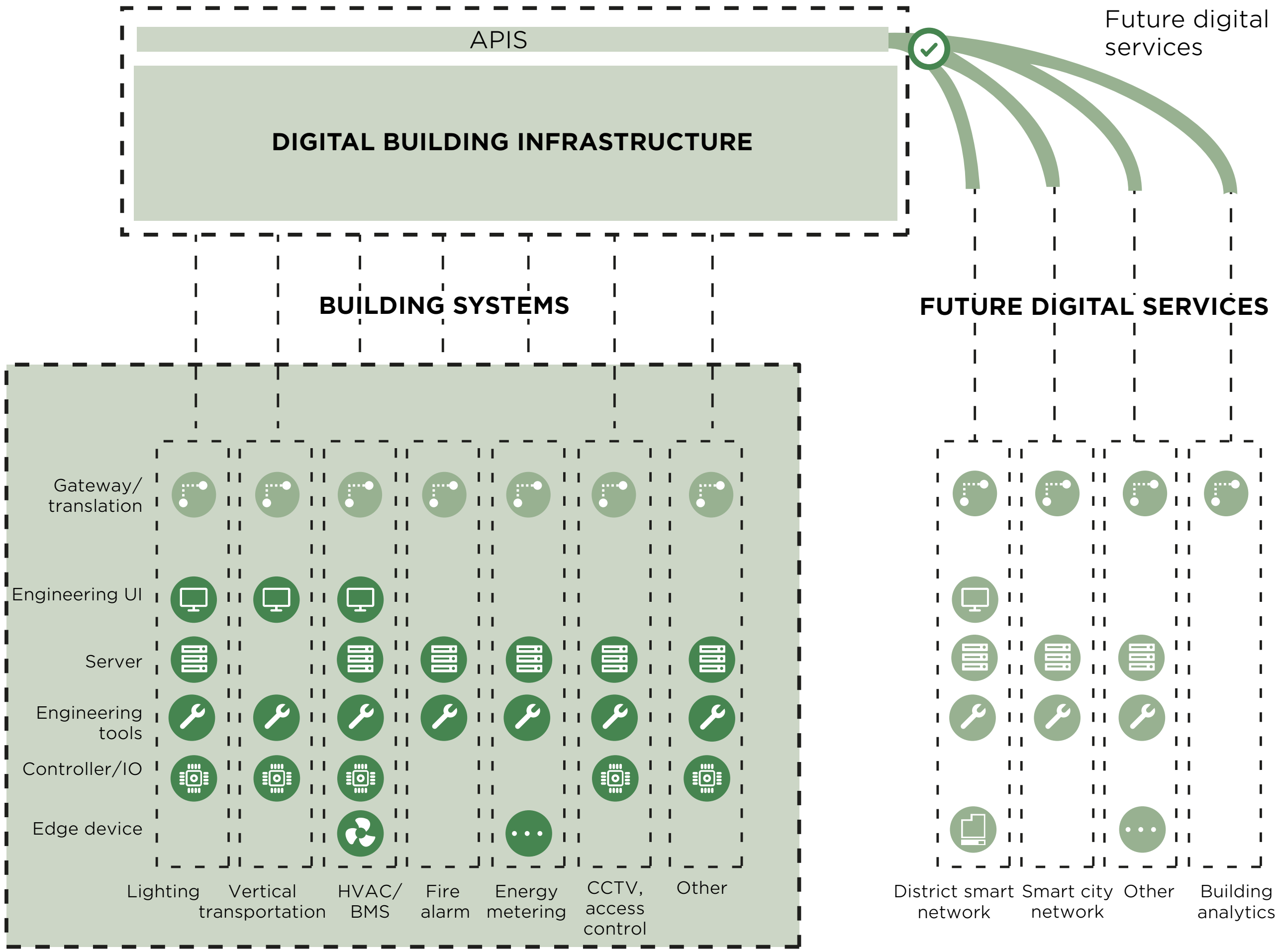


Figure H.31 One example of a digital-enabled building showing building operation systems connected

H.11.2.3 IoT protocols for digital services enablement

The current standard for communication with digital-enabled devices is the transmission of plain text JavaScript Object Notation (JSON) payload using message queueing telemetry transport (MQTT) as the transmission protocol.

MQTT/JSON should be used as the IoT protocol. The IoT protocol used shall be consistent across a building.

It is not a requirement for the open IoT protocol to replace the extensive control and communication protocols which are traditionally used within buildings. The designer shall determine the most suitable system topology for the building. The open IoT protocol connections do not replace other external data connections which might be required (e.g. connections between the building fire alarm system and DCD; between the building cooling systems and distinct cooling providers; and between smart utility meters and utility providers) and which shall continue to meet the relevant requirements.

ISO/IEC 30141 provides a standardized IoT reference architecture using a common vocabulary, reusable designs and industry best practices.

H.11.2.4 Building control and operation communication protocols

Digital/IoT integration gateways and interfaces should be provided at the lowest level where a secure IP network interface is provided.

NOTE: This is to minimize middleware and additional commissioning steps that can lead to reduced robustness through failure of the middleware layers as the building and edge hardware is adapted or updated over time.

It might not be possible to incorporate IoT protocols at the device level in all instances, such as where sensors or actuators work on analogue signals. Such devices are traditionally connected to a remote input/output gateway. The gateways should be configured to communicate using an open IoT protocol over an encrypted transmission control protocol/internet protocol (TCP/IP) connection, or they may be configured to connect to a smart integration gateway.

For devices which communicate via legacy protocols such as BACnet or LonWorks, protocol conversion should be provided at the controller to publish and optionally consume data using an open IoT protocol over an encrypted TCP/IP connection.

For systems such as konnex (KNX), a gateway should be provided with protocol conversion to publish and optionally consume data using an open IoT protocol over an encrypted TCP/IP connection. KNX systems can be connected to a smart gateway via a legacy protocol converter, but this option is less preferred.

For devices communicating over serial protocols such as Modbus, a protocol converter should be provided that publishes and optionally consumes data using an open IoT protocol over an encrypted TCP/IP connection. Technical information about the individual Modbus including address and payload should be recorded during procurement of all Modbus equipment to facilitate this.

M-Bus installations should be provided with a gateway that exposes a protocol conversion interface to publish and optionally consume data using an open IoT protocol over an encrypted TCP/IP connection.

Where open platform communication (OPC) is offered in building automation, protocol conversion to XML or JSON text payloads shall be provided. A protocol converter or an IoT gateway should be provided, to publish and optionally consume data using an open IoT protocol over an encrypted TCP/IP connection.

Where SCADA is used in building automation, the system should be configured to incorporate a protocol converter to publish and optionally consume data using an open IoT protocol over an encrypted TCP/IP connection.

Wireless sensor networks or IoT networks installed in buildings, such as Bluetooth, Zigbee or LoRaWAN, should expose a smart interface at the gateways, or be connected to a smart gateway, to publish and optionally consume data using an open IoT protocol over an encrypted TCP/IP connection.

Some devices may form part of a managed service and connect directly to a proprietary internet-based system via the building network or cellular services. For these, the service provider shall provide an authenticated application programming interface (API) to allow access to the data or support open IoT protocols. Any managed service specifications shall take into account the requirements of TRA IoT Regulatory Policy [Ref. H.51] and TRA IoT Regulatory Procedure [Ref. H.52].

Any technology communicating using other control and operation communication protocols, and all other systems, should be configured to expose a smart interface to publish and optionally consume data as required using an open IoT protocol over an encrypted TCP/IP connection.

Figure H.32 depicts the connectivity of the common connectivity protocols which may be used within a smart-enabled building.

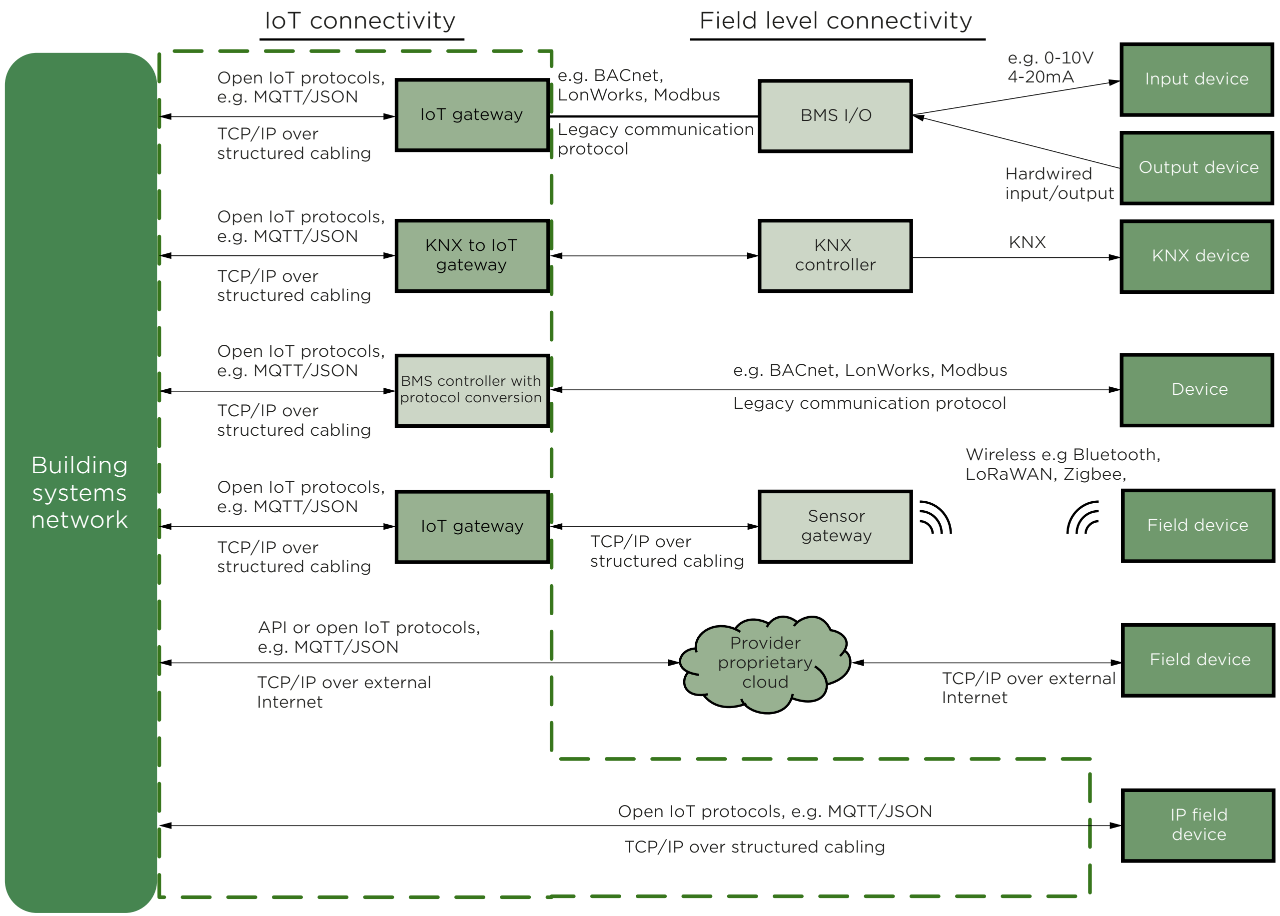


Figure H.32 Configuration of some typical building control/communication protocols to support open IoT protocols

H.11.2.5 Device and data naming

A consistent device and data naming schema shall be adopted. The device naming schema shall be used to assign names for all devices or equipment within the building. The data naming schema shall be used to assign consistent names to datasets and data points, including inputs and outputs. Figure H.33 shows an excerpt from an example device naming standard.

Device type	Device abbreviation
Actuator	ATR
Air dryer	ADR
Air handling unit	AHU
Air control damper	ACD
Automatic transfer switch	ATS
Balancing valve	BCV
BMS pane	BMS

$$\underbrace{\text{AE\_DB\_BLD1}}_{\text{Building Identifier}}\text{\_}\underbrace{\text{AHU}}_{\text{Device Type}}\text{-}\underbrace{\text{43}}_{\text{Unique Identifier}}$$

Figure H.33 Excerpt from an example device naming standard

Schemas shall:

a) be applicable to all building control devices;

b) be applicable to any equipment that can change state and that is monitored within a building, including equipment provided by third parties such as building tenants or service providers;

c) incorporate all data inputs and outputs; and

d) be agreed during the design stage with the developer or building operator.

Data governance shall be adhered to throughout the building lifecycle of the building assets, allowing an asset to be identified through design, construction and operation, including commissioning and decommissioning of assets. The schema shall be documented and included within the building documentation at handover.

The schema shall be consistent across media, including equipment data sheets, building information modelling (BIM) model, control systems, record drawings, operations and maintenance, physical labels/QR codes, and computer aided facilities management (CAFM) records.

Devices shall therefore have the same name within the record information and within the digital representation.

The device and data naming schemas shall be non-proprietary. Where a Developer or building operator has an already applicable device and data naming schema from a building within their portfolio, then this can be adopted.

Where a Developer or building operator does not have device and data naming schemas from a building within their portfolio, the BDNS [Ref. H.53] open naming convention should be used.

A translation/mapping solution can be applied, if required, where linking datasets between different systems (e.g. BIM and CAFM). This is to maximize consistency and the interoperability between buildings.

H.11.2.6 Data governance and privacy

Sufficient controls shall be provided to facilitate data governance and restrict access to information.

Examples of controls include:

a) internal access, e.g. building operational data to enable facilities management and optimum building operation;
b) named access, e.g. personal data (such as people finding applications) or data from dwellings;
c) group-based, e.g. tenant information accessible by employees;
d) public/open, e.g. whole building metrics;
e) presence detection for energy saving, safety and/or security; and
f) sensing of home appliances.

Personal data shall be controlled in line with all applicable data protection requirements.

H.11.2.7 Home automation in residential buildings

Control systems installed within individual residences or within residential blocks shall utilize standardized open bus protocol or standardized radio frequency/mesh protocol for device-to-device digital communication. For integration between products of different suppliers, open interfaces should be used.

Smart systems installed within residential settings shall be able to communicate with common home automation systems. Home automation systems include, but are not limited to:

a) lighting systems;
b) smart assistant (speaker);
c) sensor systems for comfort;
d) sensor systems for air quality; and
e) presence detection for energy saving, safety and/or security.

H.11.2.8 Device requirements and security

Building operational devices that are connected to the building IP network shall conform to Part J. Where Part J applies, devices that are part of a building's physical security and access control functions (e.g. surveillance cameras) shall be connected over an independent dedicated security network.

Where critical systems are required to operate without reference to dynamic host configuration protocol (DHCP) servers or name servers, then the relevant devices on that system shall have static IP addresses.

Other IP-based smart-enabled building operation devices should support IETF standards, e.g. DHCP address assignment, encryption, authentication, remote administration and firmware/software updates.

All data transmitted to and from any device shall be encrypted in transit using standard protocols (e.g. TLS RFC-5246) suitable for transmission over the internet.

All devices shall have the manufacturer's default access credentials changed. Certificate-based authentication should be used where available. Each device should have its own unique certificate.

Suitable security on all devices connected to the building network shall be provided to avoid devices being compromised maliciously or non-compliant devices being connected to the network.

Security controls shall be implemented to restrict the access of devices only to the resources required.

H.11.2.9 Data validation

Upon completion, smart-enabled technologies shall be validated to demonstrate that they are providing data using the client protocols and in the correct data format.

H.11.3 ICT

H.11.3.1 Overview

Physical infrastructure (including cabling, cable pathways and equipment rooms) is required to enable a smart building. The infrastructure typically falls into the following distinct categories:

a) incoming service provider: enables one or more telecommunications service providers to deliver fixed and mobile cellular services into a building.
Refer to G.11 and Part K for buildings and single dwelling units respectively;

b) landlord: landlord cabling and data network infrastructure to support smart applications;

c) tenant or occupier: tenant's or occupier's own cabling and network infrastructure to support smart applications within their own occupied spaces.

These three infrastructures shall be segregated to enable different parties to separately manage and operate their networks.

This section specifies the minimum requirements for landlord and/or occupier cabling, equipment rooms and cable pathways.

H.11.3.2 Equipment rooms and cabling pathways

The designer shall plan and design the landlord and/or occupier infrastructure in accordance with ISO/IEC 11801, ISO/IEC 14763 and ISO/IEC 30129. The following aspects of ICT infrastructure shall be established as a minimum:

a) landlord and/or occupier information and communications technology (ICT) equipment room(s), the main equipment room(s) (MERs) or Building Distributor;

b) landlord and/or occupier ICT riser, with optional secondary equipment rooms (SERs) or floor distributors to remain within cable length constraints where the building size necessitates;

c) landlord and/or occupier structured cabling system (SCS), comprising backbone and horizontal cabling systems;

d) space for satellite reception dishes on a roof or other location having a clear line of sight of the southern sky. Satellite dishes shall not be placed towards the edge of the roof or close to a roof parapet wall. The satellite dishes shall be securely fixed against the anticipated wind loading. For multi-tenant buildings, appropriate space and infrastructure shall be provided for an integrated reception system served by a common head end and common satellite dish(es), to avoid individual tenants placing their own dish and infrastructure on the building or at their own windows/balconies.

Where business continuity is important, the planning for ICT infrastructure shall mitigate the impact of single points of failure.

To facilitate a high availability backbone infrastructure, the design shall provide:

1) at least two MERs, located geographically apart with a separation distance of not less than 30 m and in separate fire evacuation zones;

2) at least two risers, located geographically apart with a separation distance of not less than 10 m and in separate fire compartments; and

3) backbone cabling system from one or more MERs, with multiple cables utilizing physically separate cable pathways.

H.11.3.3 Landlord and tenant cabling infrastructure

The landlord and tenant ICT cabling infrastructure shall be based on ISO/IEC 11801 and ISO/IEC 14763.

All fixed and permanently installed telecom cables within a building shall be halogen-free, achieve a minimum rating of Euroclass Cca-s1b, d2, a2 when tested in accordance with BS EN 13501-6 and be CE marked.

NOTE 1: CE marking represents a manufacturer's declaration that products conform to the applicable manufacturing and testing standard.

All other cables, microduct and conduit including patch cords shall meet the minimum requirements of IEC 60332-1-2.

The designer shall specify the fire performance of cables according to IEC 60332-1-2 for single wire installations and IEC 60332-3 for vertically mounted bunched cables.

The landlord cabling infrastructure topology shall align with the need to enable the landlord ICT systems within the building. The landlord ICT systems are deemed essential, irrespective of the need to enable a smart building.

The landlord cabling system shall include:

a) a backbone cabling system, typically comprising optical fibre cables, and optionally copper cables by exception (see Note 2); and
b) a horizontal cabling system, typically comprising copper category 6 A (or higher performance), and optionally optical fibre cables by exception (see Note 2).

NOTE 2: Where the designer considers that category 6 copper data cabling is suitable for all foreseen applications during a 10 year life of the cabling infrastructure, and that use of power over ethernet (PoE++, IEEE 802.3bt – part of the IEEE 802.3 standards suite) is not foreseen, then it may be used in the design.

A tenant or occupier cabling system shall also follow the standards ISO/IEC 11801 and ISO/IEC 14763. The extent of the tenant or occupier cabling system shall be determined according to the extent of their occupancy in a building (i.e. whether part floor, whole floor, multiple floors or whole building).

Depending on the level of ownership and occupancy, a tenant cabling system shall include:

1) a backbone cabling system, comprising optical fibre cables, and optionally copper cables by exception (see NOTE 2); and
2) a horizontal cabling system, comprising copper category 6 A, and optionally optical fibre cables by exception (see NOTE 2).

As a minimum, the landlord SCS (see Figure H.34) shall enable spatial safeguarding and connectivity for:

i) wireless networks operating in the unlicensed spectrum to cover all landlord areas, and by exception to cover tenant areas where a need arises;
ii) wired sensors and instrumentation;
iii) devices within landlord command and control rooms;
iv) ICT devices for front of house services to tenants, staff and visitors to the building, e.g. reception and visitor management services;
v) ICT devices for back of house operations, security and facilities management services; and
vi) devices associated with enabling smart building applications, e.g. interactive displays, information kiosks, digital signage and advertising displays in public areas.

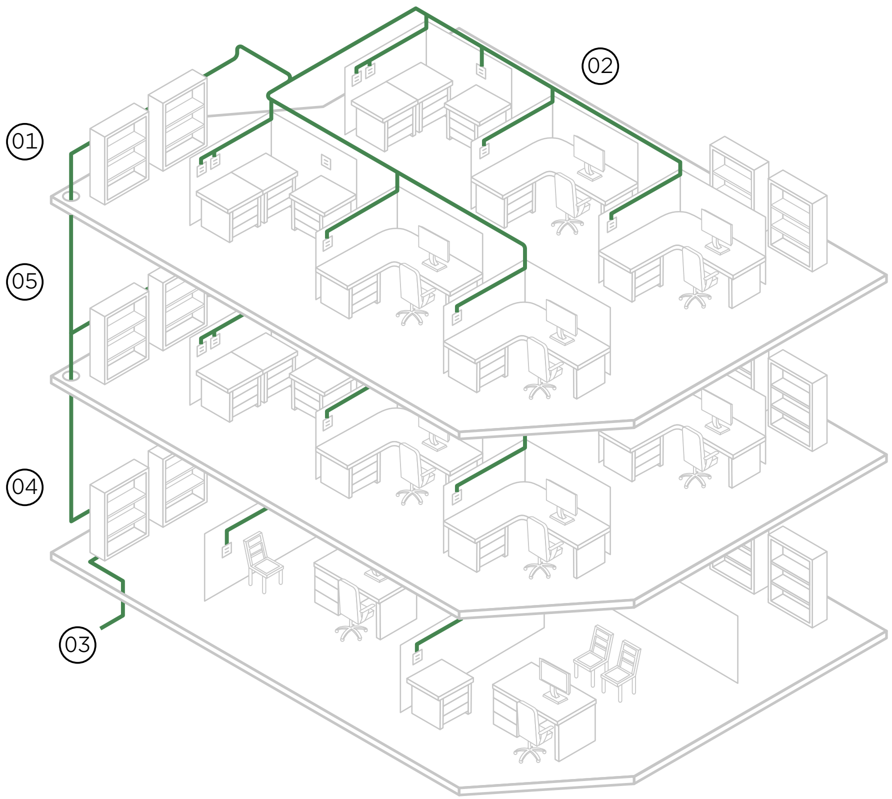


Figure H.34 A typical approach to SCS distribution (example of tenant occupying multiple floors)

Key

01: Floor distributor or SER
02: Horizontal cabling
03: Building entry point
04: Building distributor or MER
05: Backbone cabling

H.11.3.4 Distribution techniques

This subsection describes the concept of zone distribution (see Figure H.35), which applies equally to warehouses, factories, schools, hotels, residential apartments and multi-dwelling units.

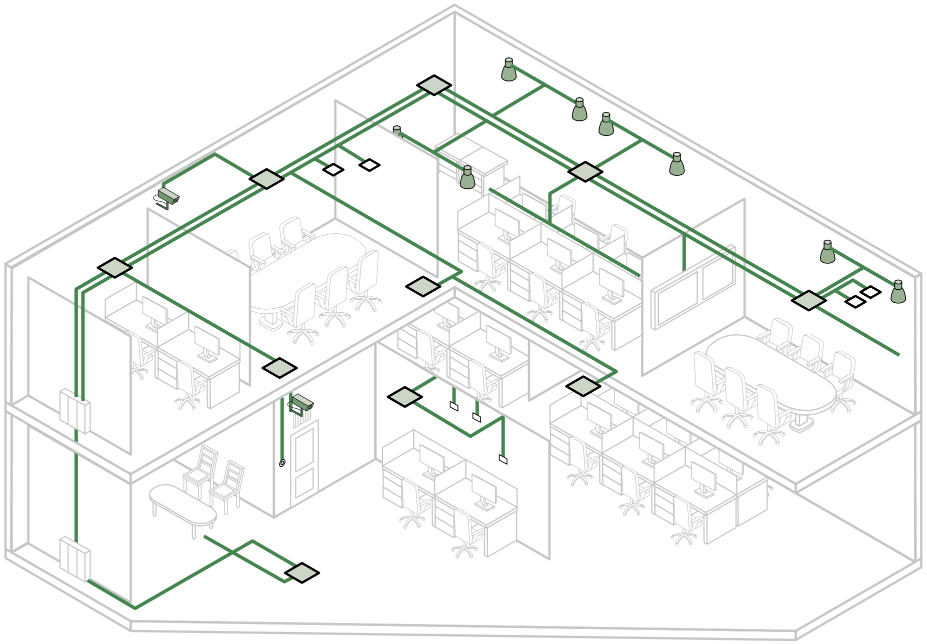


Figure H.35 The concept of zone distribution

As the density of IoT connected devices is expected to grow substantially in a smart building, the landlord cabling system (see Figure H.36) shall be organized using one or a combination of the following options:

a) zone distribution topology with consolidation points or active zone enclosures that can be deployed in a distributed manner closer to device and associated final telecommunications outlet (TO) locations;

b) zone distribution topology for field IoT networking (see Figure H.36). This comprises a grid of consolidation points spaced in a regular grid pattern, typically in the ceiling, or a series of distributed zone enclosures with active equipment (e.g. ruggedized switches) in a compact form factor.

The following requirements shall be met as appropriate.

1) Floor-based distribution outlets shall be spaced in a regular grid. Outlets shall function as a traditional TO or consolidation point but respecting the rules around permanent link limits prescribed by ISO/IEC 11801.

2) Wall or column TOs shall be spaced at regular intervals. TOs shall function as a traditional TO or consolidation point but respecting the rules around permanent link limits prescribed by ISO/IEC 11801.

3) Multimedia type wall outlets points shall be provided to present a range of ICT and audio visual (AV) interfaces at a meeting desk where AV services are required.

4) Private wireless technology shall be taken into account in the planning of density of outlets. For instance, extending wireless coverage into multiple rooms within a residential unit would require outlets in the ceiling to be provided for wireless access points to enable ubiquitous wireless connectivity within a residential environment.

5) PoE, PoE+ and PoE++ shall be taken into account in the design and planning of SCS copper cabling. The power density and infrastructure resilience in the network equipment rooms (MERs, SERs) shall also be taken into account.

6) Where distributed zone enclosures with active equipment are deployed, the designer shall rationalize the space, power and equipment density needs for SER or floor distributor rooms, or, in the case of villas and townhouses, a consolidation cabinet (see Part K).

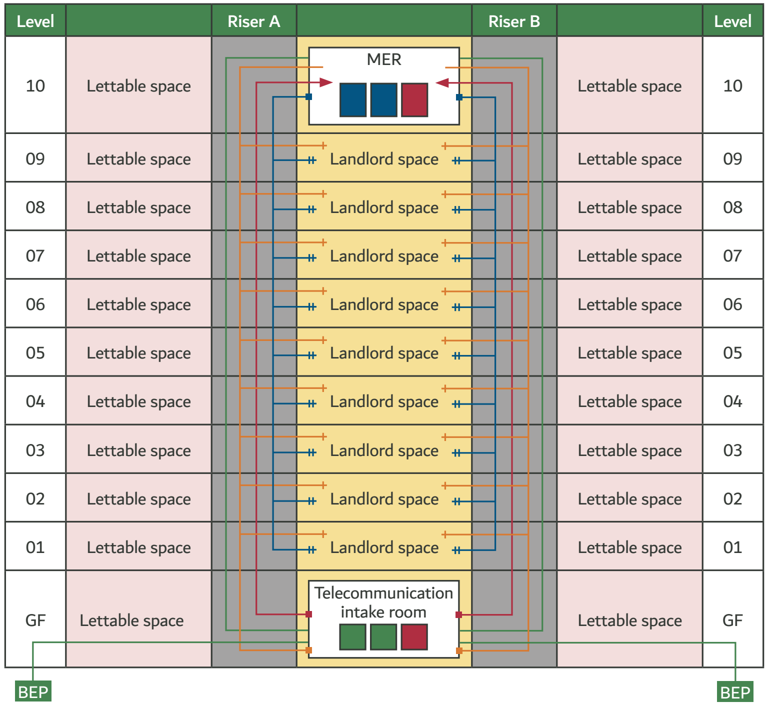


Figure H.36 Illustration of a typical structured cabling topology

Key

- Building entry point
- Communications room
- Riser
- Lettable space
- Landlord network
- Horizontal category 6a
- Optical fibre links
- CW1308/copper backbone
- Incoming WAN links

The grid arrangement, TO density and spacing, or adoption of zone distribution shall be determined by the designer to align with the requirements of corporate IT and smart building applications.

The designer shall include the following:

i) device performance requirements on bandwidth and PoE (all types);

ii) future flexibility over the lifetime of the building; and

iii) concealed or secure cable pathways.

H.11.3.5 Connection topologies for digital services in buildings

There are different types of connection topologies. The most commonly adopted connection topologies shall be used. Various topologies are defined in H.11.8.

H.11.3.6 Landlord data network infrastructure

The building shall be equipped with a data network infrastructure. This infrastructure shall provide the means of data communications for a variety of landlord ICT end point devices, including standards-based connectivity for wired or wireless sensors and instrumentation devices that are intended for enabling smart building applications.

The landlord network infrastructure shall as a minimum conform to the IEEE 802 series of data network standards. Data network standards are continually updated, and new standards are introduced in response to continual technology advancements. The most current and published standards shall be used at the time of the design of the building technologies. Where there is a time lapse between design and subsequent construction, the technical design authority and the Contractor shall agree upon a suitable procurement pathway to achieve the state-of-the art for the intended requirements for smart building enablement.

Figure H.37 shows a possible data network infrastructure in a smart-enabled commercial building.

There are multiple network topology options for the enablement of the landlord data network infrastructure supporting the sensor and instrumentation devices.

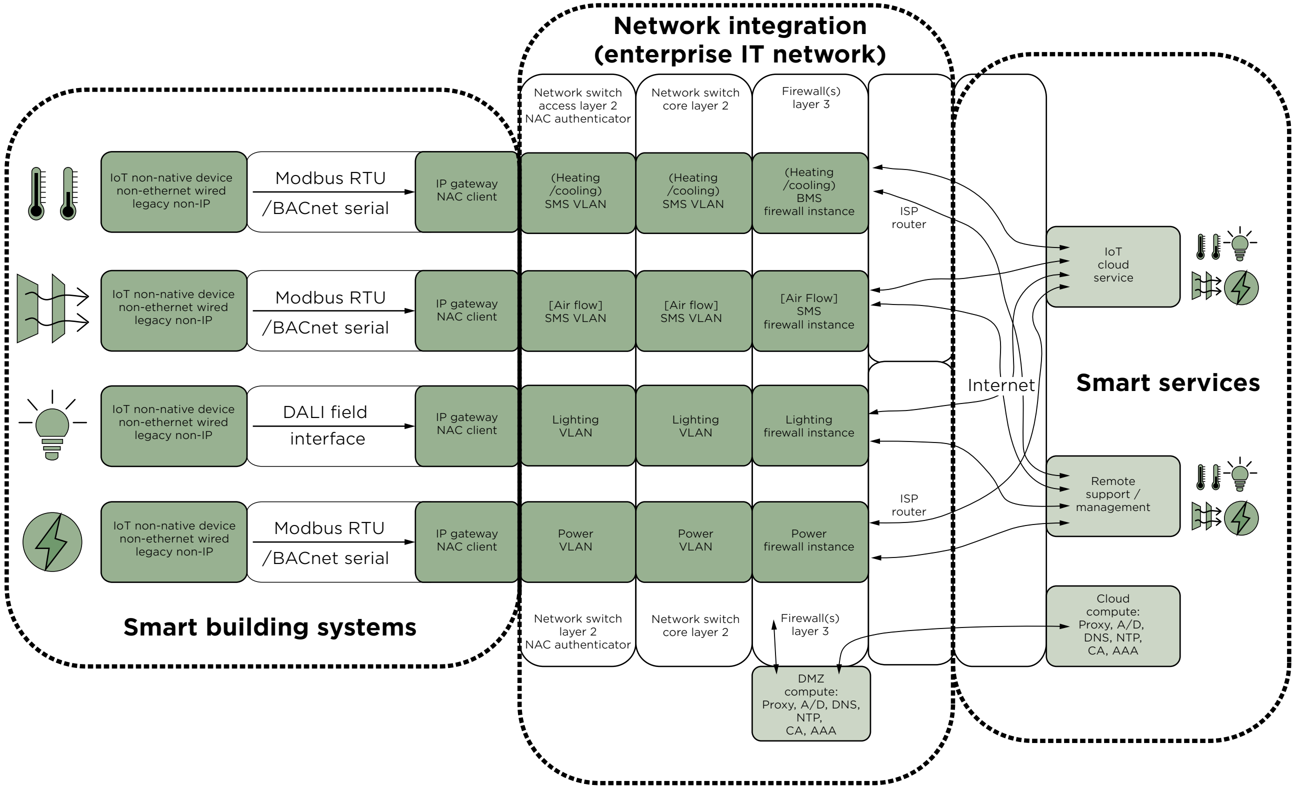


Figure H.37 Converged data network in a typical building

As a minimum the following topologies shall be included:

a) a standalone OT network that operates independently of the landlord common network system (CNS) for IT applications which facilitate landlord ICT services within the building; and
b) a converged network topology that enables the landlord CNS to support the data communications needs of the smart building sensor and instrumentation devices.

The OT network shall be provided with wide area network communications capability in accordance with the information assurance, network and cyber security requirements and implementation guidelines adopted by the landlord or owner-occupier. As a minimum the following topologies should be included during the design of the network infrastructure:

1) a dedicated wide area communications network, which shall operate independently of other wide area communications network supporting landlord ICT applications;
2) a common use wide area communications network, utilizing virtual private network (VPN) technologies to secure and segregate data within OT and IT applications, which shall be designed and configured to be compatible with the required smart building applications;
3) a hybrid option where:
   i) specific smart building applications have dedicated wide area network communications, e.g. for direct access to external cloud computing resources via wireless networks, such as cellular 4G/LTE, LTE-M and future 5G services, and low power wide area network (LPWAN) communications; and,
   ii) some of the smart building applications utilize the wide area bandwidth provided for the landlord ICT applications with or without VPN segregation, e.g. access to the common incoming service provider internet access service.

Fixed network telecommunications equipment shall be TRA type approved.

H.11.3.7 Special safety monitoring requirements

Fire alarm control panels serving buildings or separate tenants shall be connected to DCD through smart and direct alarm systems in accordance with Ch. 16 of UAE FLSC [Ref. H.1].

The interface units use cellular transmission to transmit critical building safety alarms to the remote DCD monitoring system. The smart alarm interface unit and its antenna (local to the unit) require excellent cellular signal strength for effective transmission.

A cellular signal strength shall be achieved of at least –70 dBm for 2G/3G signals and –90 dBm for 4G signals at the position of the interface units deployed at various locations in the building.

Requirements for providing in-building public cellular service are specified in G.11.

H.11.3.8 Wireless technology

H.11.3.8.1 Wireless technology bands

Wireless technology falls under licensed bands and unlicensed bands.

Licensed bands cover technology such as public cellular (all forms including 4G, LTE, 5G) services and certain emerging cellular IoT solutions.

The unlicensed bands cover technology such as Wireless LAN, Bluetooth, LPWAN with its different variants in the market (e.g. LoRaWAN, Sigfox).

Wireless technology equipment shall be TRA type approved.

H.11.3.8.2 Public cellular (licensed)

The designer shall consult the public licensed service providers (Etisalat and/or du) to provide cellular-based solutions within their building. The backbone infrastructure to provide cellular services in the building shall meet the requirements in G.11.

H.11.3.8.3 Private wireless (unlicensed)

The designer shall comply with TRA regulations [Ref. H.54, Ref. H.55, Ref. H.56] in respect of the design, specification of unlicensed technology.

Solutions deployed shall be approved for use in UAE and supported locally.

H.11.3.8.4 Health and safety

The designer shall comply with TRA regulations [Ref. H.56] in respect of health and safety requirements for radio and telecommunications equipment.

The designer shall follow International Commission on Non-Ionising Radiation Protection (ICNIRP) guidelines [Ref. H.57] for the specification and deployment of wireless transmission equipment, with respect to its impact on human health and exposure of humans to such equipment.

The planning of facilities and the installation of the equipment shall meet the limits for exposure to electromagnetic fields, including exclusion zones.

H.11.4 Information management and asset data management

When producing information, the project team shall follow industry recognized standards such as the ISO 19650 series and ISO 29481-1 to facilitate interoperability between software applications used during all stages of the asset's lifecycle.

The project team shall define at the start of the project what geometric and non-geometric properties are to be captured and recorded. The defined properties shall facilitate the Contractor's and the client's intended use of this information.

This definition shall include the capture of ICT infrastructure TO information against their respective devices, to keep track of the correct provision and association of ICT infrastructure points provided to IP and non-IP devices.

The project team shall establish the information model with the defined properties, regardless as to whether the information to populate these properties is available.

To enable interoperability of information across the lifecycle of an asset, the project team shall deliver project information within industry foundation classes (IFC) datasets conforming to ISO 16739-1.

H.11.5 Recommended data collection for assets

This subsection provides a non-exhaustive list of some datasets which should be collected by asset operators, and which should be made available to Dubai through an API. This information may be by room, level, unit, or tenant within an asset.

Captured information should be stored in a persistent and secure data store. Requirements for data governance are given in H.11.2.6.

Datasets that should be collected include, but are not limited to:

a) weather (e.g. temperature, humidity, precipitation, wind);
b) total building occupancy/footfall;
c) granular occupancy/footfall;
d) vertical transportation (e.g. elevator status);
e) water consumption;
f) total water consumption e.g. (metering data);
g) storm drainage systems (e.g. flowrate at outfall);
h) irrigation systems;
i) granular cooling demand;
j) total cooling demand;
k) electrical systems;
l) total electrical consumption (e.g. metering data);

m) renewable energy generation;

n) fire alarm;

o) lighting (e.g. status, light levels);

p) Sprinkler system;

q) car parking (e.g. available places);

r) electric vehicle charging (e.g. status, energy consumption).;

s) waste (e.g. chutes, bin fill); and

t) façade systems (e.g. motorized blinds position).

NOTE 1: It is not recommended that residential assets capture information related to granular occupancy/footfall or façade systems.

NOTE 2: It is not recommended that information related to granular occupancy/footfall, water consumption, electrical systems, lighting or façade systems is made available to the city.

H.11.6 Digital services and smart technology in operation

The designer should analyse use cases to inform the design, and determine whether smart applications might be appropriate, taking into account the requirements of the individual Developer. Table H.18 gives examples of common technologies.

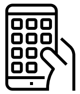
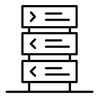
Smart application/use case	Icon	Description
Digital twin		Creating a digital representation of a building, with potential to increase operational efficiency (thereby optimizing resource), improve asset management, deliver cost savings and improve productivity.
Dashboard applications		Visualizing whole building data through a single system, generate insights and identify trends or anomalies. Can be used to visualize energy and water consumption, and also used to set up rules and alerts to optimize running systems within buildings.
Asset information		Asset management applications which can utilize live data and trends for more informed decisions and proactive maintenance.
Digital signage		Digital signage to display building information, such as news, wayfinding or dashboards such as energy consumption.
Locating people		Indoor location services to support building occupants finding colleagues within commercial buildings.
Room calendar integration		Rooms such as meeting rooms are integrated into calendar systems and are capable of preconditioning resulting in potential energy savings.
Mobile apps		Building occupants can use their mobile phones for control, e.g. local environmental control, lighting, calling elevators.
Wayfinding		Wayfinding applications help building occupants navigate in a building.
Robotic and integrated car parking		Robotic car parking solutions and car park information readily integrated with building information allowing use cases such as interaction by users via mobiles and correlation with occupancy.

Table H.18 Common smart building applications and use cases

H.11.7 Annex – Digital services and smart buildings background

H.11.7.1 Context

The following are some key drivers for digital building technology in Dubai.

a) Dubai's Integrated Energy Strategy (DIES) 2030 has an ambitious target of reducing energy and water demand by 30% by 2030. Reducing cooling requirements within buildings is a key focus area for DEWA and the Authority (www.taqati.ae/dies-2030/).
b) Dubai is focused on achieving sustainable growth through effective waste management, green mobility and investment in clean energy and smart technologies. These pillars support an environment that fosters innovation and discovery, promotes research and development of new technologies and builds supportive policy and regulatory frameworks.
c) Optimization of energy and water demand for buildings to enable demand side management (a strategic part of the DIES 2030 programme).
d) Dubai clean energy strategy 2050 targets an increase in renewable electricity produced to 75% by 2050.

H.11.7.2 Conventional approach to digital services and smart functionality in buildings

Digital services and smart functionality have conventionally been implemented through the BMS or using proprietary vendor hardware. However, this approach has posed several challenges:

a) limited interoperability between systems, typically due to the absence of communication channels;
b) complexity and limited flexibility;
c) vendor lock-in, typically limited to a single provider with difficulty to change;
d) convoluted naming of equipment and data, possibly requiring significant processing before any ingestion or analysis;
e) might not be up to date with latest technological advancements – digital service applications typically rely on latest software and hardware, unlike BMS solutions which might not be regularly updated;
f) diverged networks and inadequate network provisions, which could prevent data to be economically communicated between proprietary systems;
g) limitations to data sharing between building tenants and landlords.

H.11.7.3 Digital services enabled approach

Digital services enablement resolves some of the challenges and mitigates some of the disadvantages of the conventional approach. Providing the fundamental connectivity requirements in terms of infrastructure, systems and technology allows for future implementation of smart functionalities, use cases and downstream initiatives. These might include, but are not limited to:

a) analytics;
b) alerts;
c) calculations;
d) dashboards; and
e) prediction models.

The digital services enabled approach provides:

1) building OT installed that can communicate via open IoT protocols;
2) a consistent and standardized device naming and data structuring;
3) a building IP network which can support suitable IP Connectivity to devices; and
4) an open systems architecture.

Digital services and smart buildings can bring many benefits, including increased energy efficiency, enhanced marketability, predictive maintenance and enhanced user experience. Efficiently collecting, analysing and leveraging data insights acts as a catalyst for optimizing building performance, improving the use of resources and moving towards buildings that can respond to the climate emergency. This is illustrated at a building level in Figure H.38.

Collecting data across Dubai provides insightful statistics about how buildings are performing at a macro level. This can support decision-making and provides the opportunity to contribute to a wider smart city initiative.

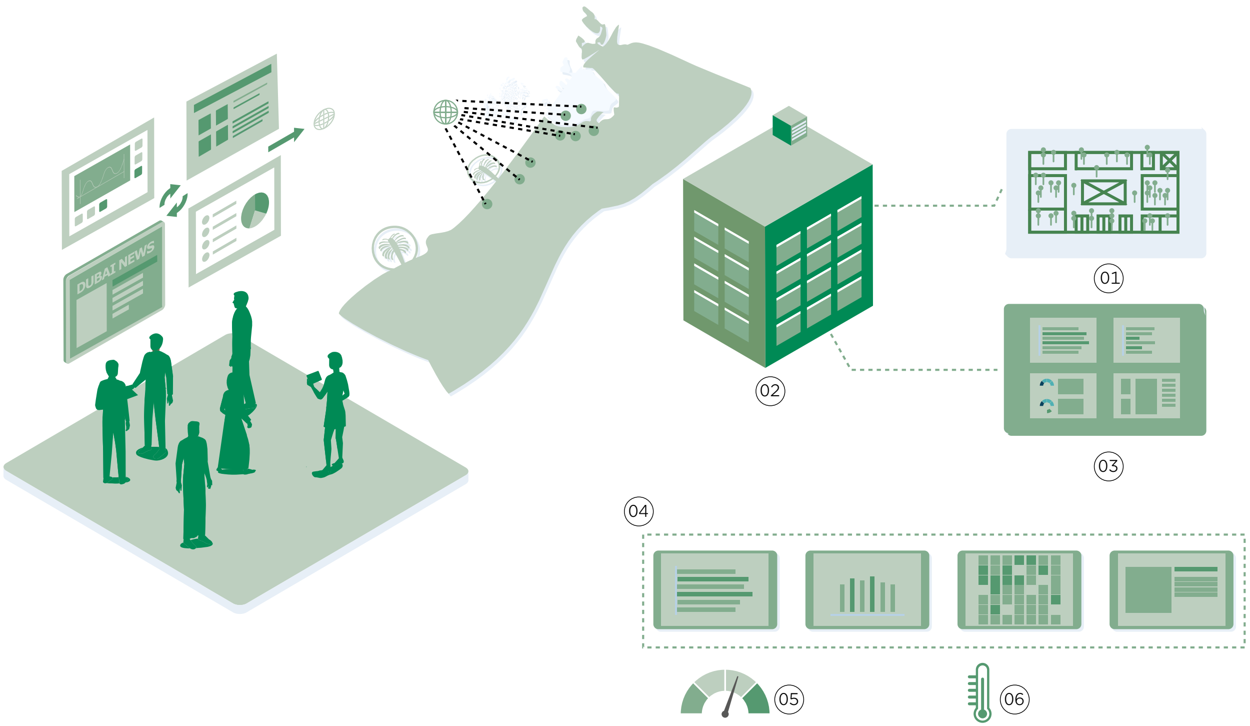


Figure H.38 Graphical illustration of smart buildings and functionality

Key

01: Occupancy

02: Computer-aided facilities management (CAFM)

03: BMS analytics

04: Dashboards

05: Energy/water meter

06: Environment conditions

For building occupiers, the fine level of control and data availability within smart buildings can help to improve internal environmental quality. Research has shown that within office buildings, this can improve productivity and creativity. Smart technology systems such as desk booking systems and heatmaps can allow employees to find suitable areas to work considering their personal preferences such as temperature or noise levels. Collectively, such technologies improve the occupier's experience of their space. Functionality such as visualizations of energy consumption and water usage can help building occupants to understand their usage and encourage them to reduce these.

There are also benefits to building operators. Visualizations and dashboards, such as that shown in Figure H.39, can be assembled to show entire systems within the building collectively, allowing a level of insight into the operation and usage of a building. Machine learning algorithms can be employed to optimize building running, reducing energy consumption and increasing efficiency. It allows for proactive maintenance where issues are rectified earlier.

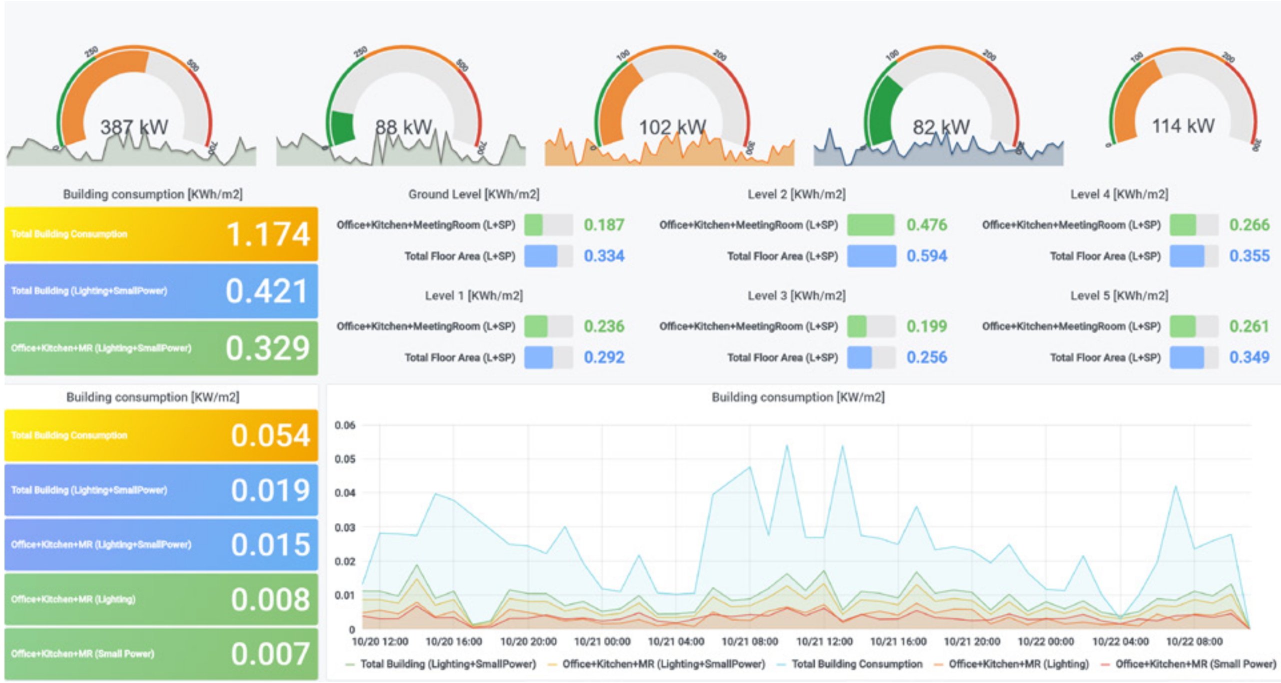


Figure H.39 Web dashboard visualizing whole building information

The use of consistent data naming and device naming schemas through design, construction and operation, including commissioning and decommissioning, provides a link between devices and data. It is supported by:

i) using open standards for 3D model representations of devices and data interchange such as industry foundation classes (IFC) datasets conforming to ISO 16739-1;

ii) transferring parameters from design model to physical labels and metadata;

iii) keeping the device identity and naming consistent across project phases.

There are a growing number of technologies which support IoT. Examples include software-defined networking (SDN) and IoT specific firewall systems. There is wide adoption of IP connectivity in devices and sensors, and an increasing number of these supporting open IoT protocols. Leading software development companies are offering solutions for IoT and smart buildings as a service, which includes dedicated infrastructure in addition to applications.

There is a growing market expectation for smart building functionality, especially within residences owing to the rise of home assistants and home automation devices.

H.11.8 Annex – Connection topologies for digital services in buildings

H.11.8.1 General

There are different types of connection topologies. The most commonly adopted connection topologies shall be used. Various topologies are defined in H.11.8.2 to H.11.8.5.

H.11.8.2 Star topology

The star topology (Figure H.40) can be deployed for most building ICT distribution networks in a combination of wired and wireless networks.

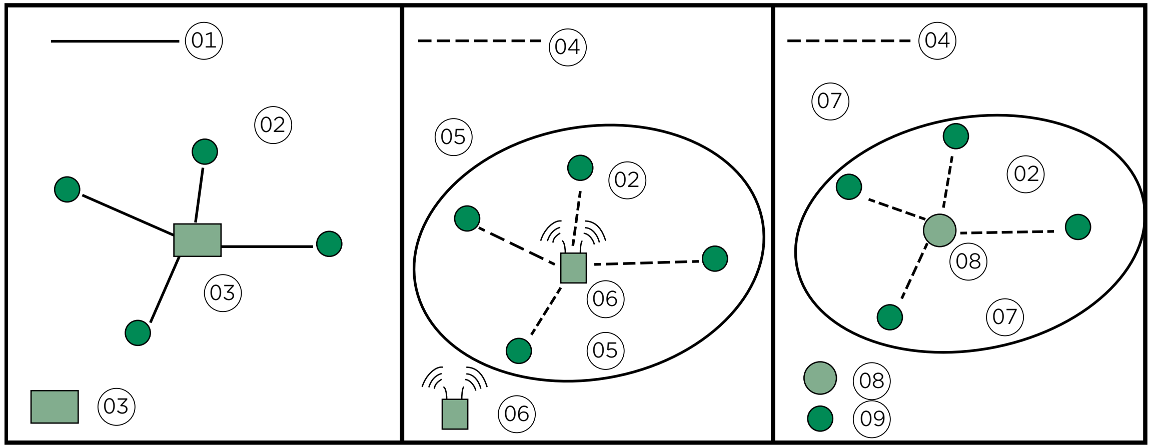


Figure H.40 Star network topology in sensor networks

Key

01: Wired
02: Sensor node
03: Data collection unit
04: Wireless
05: Basic service set
06: Access point
07: Personal area network
08: ZigiBee coordinator
09: ZigiBee end device

H.11.8.3 Ring topology

The ring topology (Figure H.41) can deliver efficiencies in network distribution in large buildings and can offer additional resilience especially at controller and gateway level in digital buildings.

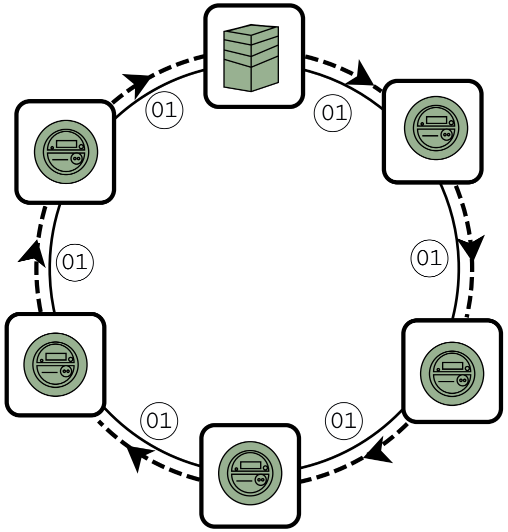


Figure H.41 Conceptual diagram of ring topology

Key
01: Data flow

H.11.8.4 Bus topology

Bus topology (Figure H.42) is simple and commonly used at device and field control level (e.g. fieldbus; see ISO/IEC 61158).

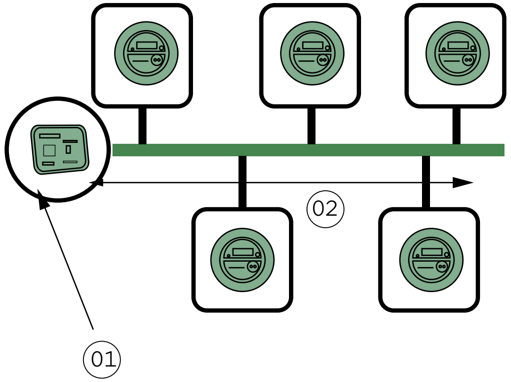


Figure H.42 Bus network in a control system

Key
01: Terminator
02: Data flow

H.11.8.5 Mesh topology

Mesh topology (Figure H.43) is where every control or gateway node communicating on a network needs to connect to every other node. Mesh topology is particularly useful in resilient building backbone networks as well as with wireless mesh where wireless access points can communicate with other wireless access points.

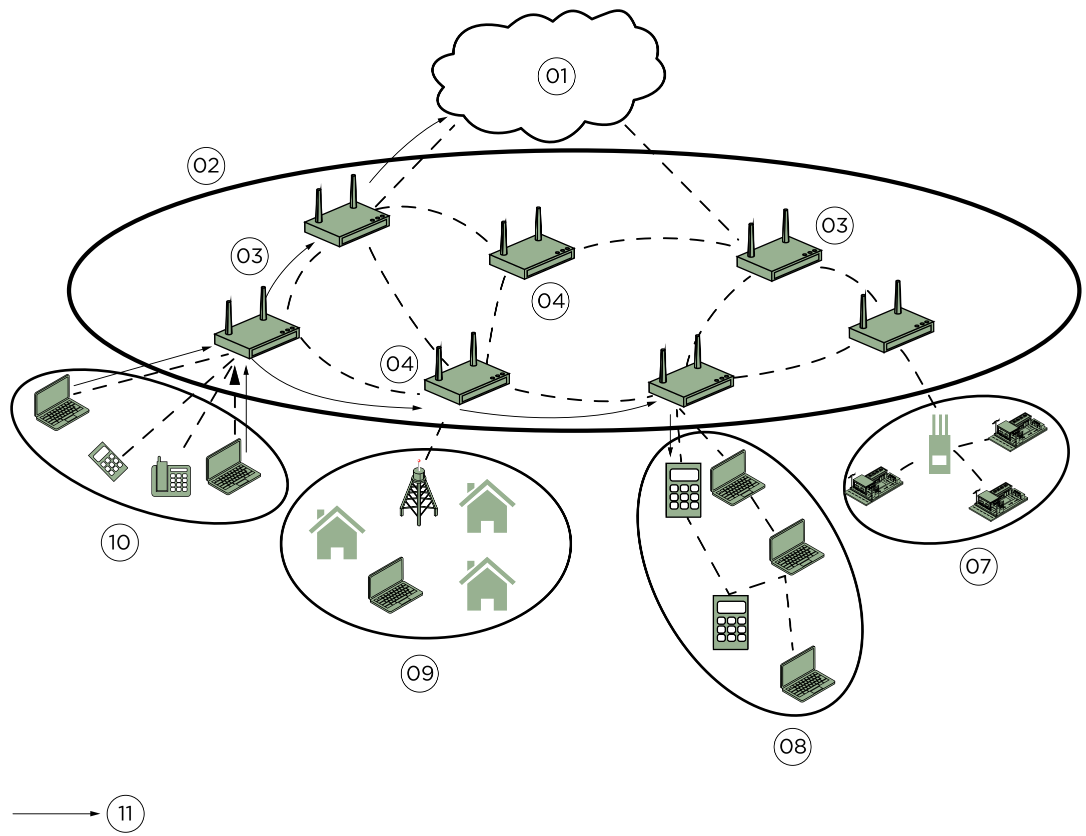
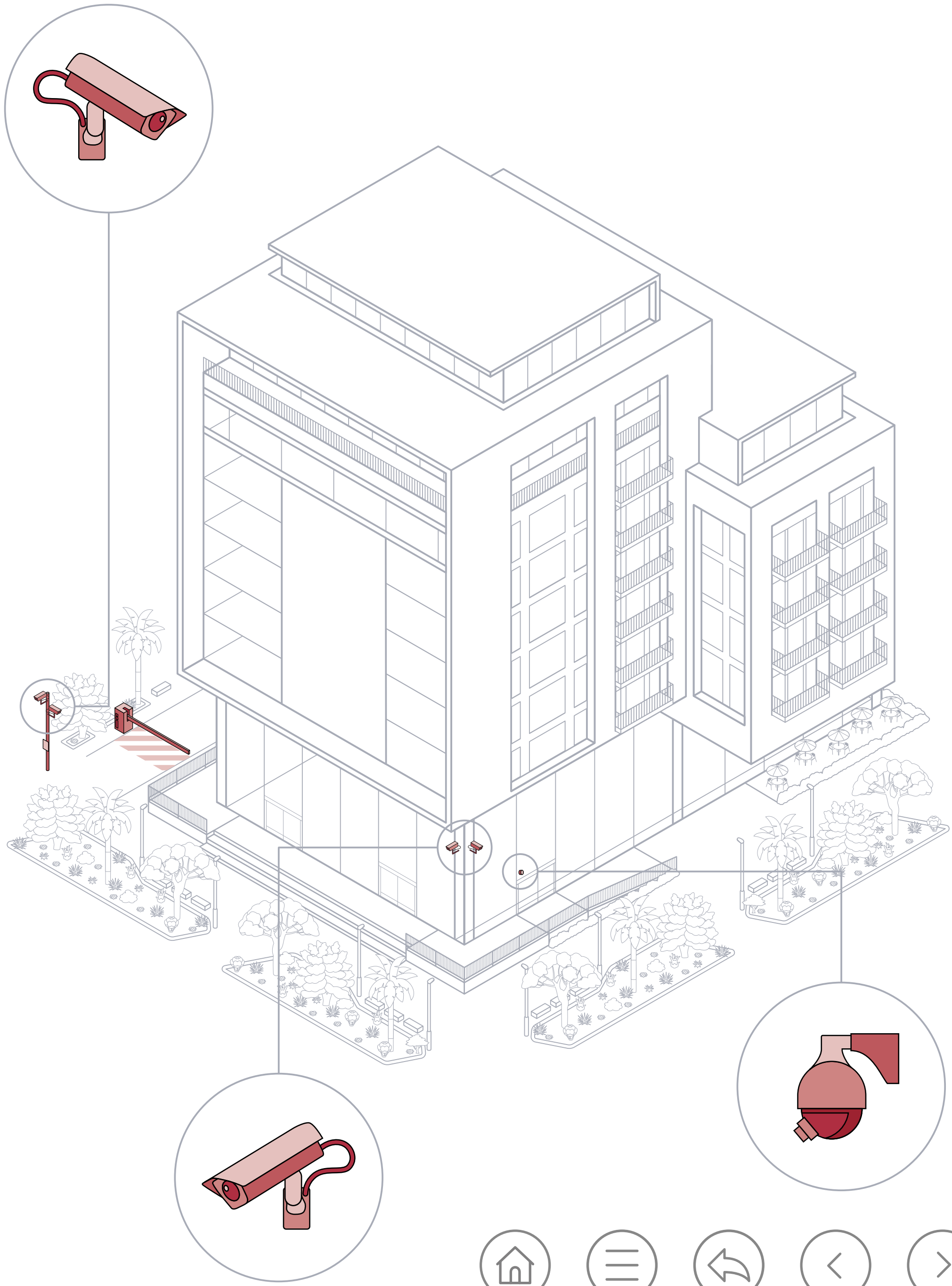


Figure H.43 Example of wireless mesh networking across several wireless mesh routers

Key

01: Internet
02: Wireless mesh backbone
03: Mesh router with gateway
04: Mesh router
05: Sensor network
06: Mobile ad hoc network
07: Wimax network
08: WiFi network
09: Multihop flows
10: WiFi network
11: Multihop flows

Part J
Security



J.1 Performance statements

Performance statement	The performance statement will be met by following the requirements of:
The building shall be in accordance with the security requirements of Security Industry Regulatory Agency (SIRA) to keep Dubai as one of the safest and most secure cities.	J.4 to J.7

J.2 Definitions

J.2.1 Terms

Automatic number plate recognition (ANPR): Technology that uses optical character recognition on images to read vehicle registration plates to create vehicle location data. ANPR is monitored by City Ring.

City Ring: System that allows SIRA to monitor ANPR systems in Dubai to verify that they are configured and working correctly.

Detection (D): Images used to detect key events such as the nature of movement, direction and overall appearance of people. The person's whole body and the surrounding area at an average distance are the most important part of the image. The size of the target image is not less than 10% of the display size.

Electronic access control systems (EACS): type of security that manages and controls who or what is allowed entrance to a system, environment or facility. It identifies entities that have access to a controlled system, environment or facility based on the validity of their credentials.

Hostile vehicle mitigation (HVM): Measures provided to prevent vehicles passing a control point.

Identification (I): Images used to identify persons (targets) that are not previously identified as they enter an establishment. A target's face is the most important part of the image. The size of the target image is not less than 120% of the display size.

Intrusion detection system (IDS): Security system that detects unauthorized entry (intruders) into a building or other area.

Pan tilt zoom (PTZ): Camera equipped with motors that allows it to pan, tilt and zoom using telemetry remote control.

Recognition (R): Images used to recognize and follow previously identified persons (targets). The whole body and the surrounding area are the most important part of the image. The size of the target image is not less than 50% of the display size.

VideoGuard: System that allows SIRA to monitor video surveillance systems (VSS) in Dubai to verify that they are configured and working correctly.

Video surveillance systems (VSS): Surveillance cameras used for the purpose of observing an area.

NOTE: VSS is sometimes referred to as CCTV, which is an outdated term.

J.2.2 Acronyms and abbreviations

ANPR	automatic number plate recognition
Ch.	chapter
D	detection
EACS	electronic access control systems
HVM	hostile vehicle mitigation
I	identification
IDS	intrusion detection system
IR	infrared
PTZ	pan tilt zoom
R	recognition
SIRA	Security Industry Regulatory Agency
UAE FLSC	United Arab Emirates Fire and Life Safety Code of Practice
VSS	video surveillance systems

J.3 References

Ref. J.1 SECURITY INDUSTRY REGULATORY AGENCY (January 2020). Preventative Systems Manual, Law 12 of year 2016 and by-law regulation 1-2018. Version 3.1. Dubai: SIRA. Available from: www.sira.gov.ae/en/laws-and-regulations.aspx#page=1.

Ref. J.2 UAE MINISTRY OF INTERIOR GENERAL COMMAND OF CIVIL DEFENCE, 2018. UAE Fire and Life Safety Code of Practice (UAE FLSC). United Arab Emirates: Ministry of Interior General Command of Civil Defence.

J.4 Legal context and mandatory requirements

Preventative Systems Manual, Law 12 of year 2016 and By-law regulation 1-2018 [Ref. J.1] is the legal framework for security systems within Dubai. It is issued and maintained by SIRA, which oversees and monitors the implementation of physical and electronic security systems.

Part J is based on version 3.1 of the Preventative Systems Manual [Ref. J.1] and provides a summary of security and VSS requirements by building type. Part J shall be used in conjunction with the latest online version of the manual.

It is mandatory under the Preventative Systems Manual [Ref. J.1] that security system Consultants, installers and maintenance staff working on projects in Dubai are SIRA-registered security Engineers. Anybody appointing a SIRA-registered security Engineer shall verify that the security Engineer’s accreditation is valid at the time of design, installation and maintenance of the system, and is not under pending suspension, expectation of suspension, or withdrawal by SIRA.

J.5 Security requirements by building type

yes	no

Table J.1 summarizes when VSS, control rooms, EACS, alarm and IDS, and HVM are required within each building type.

#	Building type	VSS required?	Control room required?	EACS required?	Alarm and IDS required?	HVM required?
1	Cinemas and theatres					
2	Recreation parks			a		b
3	Art galleries				c	
4	Shooting ranges	d				
5	Places of worship					
6	Financial and monetary institutions			e		
7	Internet services shops					
8	SIM card shops	f				
9	Staff and labour accommodation					
10	Important complexes (e.g. groups of towers, a villa compound etc)					
11	Hotels	g		h		
12	Department stores and supermarkets					
13	Shops selling precious goods			i	j	
14	Military and hunting equipment stores	d				
15	Vehicle rental facilities					
16	Warehouses					
17	Warehouses of hazardous and precious substances					
18	Self-storage					
19	Manufacture and sale of precious metals/stones					
20	Hazardous substances factories					
21	Robotic storage					
22	Shopping centres and malls	j				k
23	Motor fuel dispensing facilities					

Table J.1 Security requirements by building type

NOTES:

a	**Recreation parks**	EACS
	Access control systems are required in waterparks at the following locations: chemicals storage rooms and water treatment rooms.	
b	**Recreation parks**	HVM
	In front of the main gates and the areas where guests and visitors gather.	
c	**Art galleries**	Alarm and IDS
	Applies to art galleries with a piece of art that is worth more than 1 M AED.	
d	**Shooting ranges and military and hunting equipment stores**	VSS
	Range scheduling, membership management and registration software shall be used.	
e	**Financial and monetary institutions**	EACS
	In the cashier areas and its affiliated rooms.	
f	**SIM card shops**	VSS
	Dedicated tables shall be provided to sell/display SIM cards and mobile phones.	
g	**Hotels**	VSS
	Three, four and five-star hotels and luxury and tourist hotel apartments only shall use a digital VSS.	

h	**Hotels**	EACS
	For entering rooms in three, four, five-star hotels, luxury and tourist hotel apartments. This shall include the following features: log in and out on the lock with at least 3,000 actions; links all locks to a central system and keeps records of actions for at least six months.	
i	**Shops selling precious goods**	EACS
	In the cashier areas and its affiliated rooms.	
j	**Shops selling precious goods**	Alarm and IDS
	If the establishment displays items worth more than 100,000 AED.	
k	**Malls**	HVM
	In front of the main gates and the areas where guests and visitors gather.	

J.6 VSS requirements by building type

Table J.2 provides a summary of the VSS operational requirements for fixed coloured cameras in each building type.

	Cinemas and theatres	Recreation parks	Art galleries	Shooting ranges	Places of worship	Financial and monetary institutions	Internet services shops	SIM card shops	Staff and labour accommodation	Important complexes (e.g. groups of towers, a villa compound etc)	Hotels	Department stores and supermarkets	Shops selling precious goods	Military and hunting equipment stores	Vehicle rental facilities	Warehouses	Warehouses of hazardous and precious substances	Self-storage	Manufacture and sale of precious metals/stones	Hazardous substances factories	Robotic storage	Shopping centres and malls	Motor fuel dispensing facilities
On sales and cashier desks	R		R	R		R	R					R	R	R	R				R				R
On all reception and assistance desks	R	R	D	R					R	R	R			R	R	R	R	R		R	R	R	
Inside elevators towards the elevator panel containing floor numbers (wide angle)	R	R							R	R	R											R	
In elevator lobbies	R	R			R				R	R	R											R	
In stairways					R				R	R	R												
On the landing area of the stairs and escalators	R	R																				R	
On main entrance lobby	D	D	D			D					D							D	D		D	D	
On lobbies associated with other entrances to the building									D	D													
On all emergency exits among/between floors	R	R							R	R	R											R	
On all emergency exit discharge doors	I	I	I	I	I	I			I	I	I	I	I	I	I	I	I	I	I	I	I	I	

Table J.2 VSS operational requirements for fixed coloured cameras by building type

I: Identification, **R:** Recognition, **R1:** Recognition and inside ATM, **R2:** Recognition on entrance, **D:** Detection, **D1:** Detection leading to residential units, **D2:** Detection and IR for night vision, **D3:** Detection and PTZ to support, **D4:** Detection on water tanks, **D5:** Detection on units, **ANPR:** Automatic number plate recognition, **IR:** Infrared, **PTZ:** Pan, tilt, zoom

	Cinemas and theatres	Recreation parks	Art galleries	Shooting ranges	Places of worship	Financial and monetary institutions	Internet services shops	SIM card shops	Staff and labour accommodation	Important complexes (e.g. groups of towers, a villa compound etc)	Hotels	Department stores and supermarkets	Shops selling precious goods	Military and hunting equipment stores	Vehicle rental facilities	Warehouses	Warehouses of hazardous and precious substances	Self-storage	Manufacture and sale of precious metals/stones	Hazardous substances factories	Robotic storage	Shopping centres and malls	Motor fuel dispensing facilities
On all entrances	I	I	I	I	I	I	I		I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
On entrances to bars, discos, nightclubs and ballrooms											I												
On all entrances to business centres											R												
Inside business centres											D												
On gym entrances									R	R	R												
On swimming pool and pool deck									D	D	D												
On seating area and projector room	D																						
On seating and waiting areas		D					D								D							D	
On indoor area															D		D			D			
On safe (money) and bag deposit rooms	R					R					R							D	R			R	
On safe maintenance entrances and routes leading to those entrances																					I		
On viewing area																		D			D		
On secure area																		R					

Table J.2 VSS operational requirements for fixed coloured cameras by building type (continued)

I: Identification, **R:** Recognition, **R1:** Recognition and inside ATM, **R2:** Recognition on entrance, **D:** Detection, **D1:** Detection leading to residential units, **D2:** Detection and IR for night vision, **D3:** Detection and PTZ to support, **D4:** Detection on water tanks, **D5:** Detection on units, **ANPR:** Automatic number plate recognition, **IR:** Infrared, **PTZ:** Pan, tilt, zoom

	Cinemas and theatres	Recreation parks	Art galleries	Shooting ranges	Places of worship	Financial and monetary institutions	Internet services shops	SIM card shops	Staff and labour accommodation	Important complexes (e.g. groups of towers, a villa compound etc)	Hotels	Department stores and supermarkets	Shops selling precious goods	Military and hunting equipment stores	Vehicle rental facilities	Warehouses	Warehouses of hazardous and precious substances	Self-storage	Manufacture and sale of precious metals/stones	Hazardous substances factories	Robotic storage	Shopping centres and malls	Motor fuel dispensing facilities
On ATMs, public phones and public phone charging stations	R	R				R1					R											R	R
All back and front of house corridors	D	D		D					D	D1	D									D		D	
On corridors to toilets				D																			
On corridors to prayer rooms	D	D																				D	
Inside men's prayer rooms	D	D																				D	
Corridors with restaurants/shops											D												
Outdoor corridors											D2												
On the back entrances of hotel units that overlook public areas (including gardens and terraces)											D												
On the external entrances of restaurants, cafes and shops											I												
External area (cameras view not less than 110°)						D													D				
On outdoor areas around building					D				D	D						D	D			D			
On outdoor yards and surrounding areas of the building									D														

Table J.2 VSS operational requirements for fixed coloured cameras by building type (continued)

I: Identification, **R:** Recognition, **R1:** Recognition and inside ATM, **R2:** Recognition on entrance, **D:** Detection, **D1:** Detection leading to residential units, **D2:** Detection and IR for night vision, **D3:** Detection and PTZ to support, **D4:** Detection on water tanks, **D5:** Detection on units, **ANPR:** Automatic number plate recognition, **IR:** Infrared, **PTZ:** Pan, tilt, zoom

	Cinemas and theatres	Recreation parks	Art galleries	Shooting ranges	Places of worship	Financial and monetary institutions	Internet services shops	SIM card shops	Staff and labour accommodation	Important complexes (e.g. groups of towers, a villa compound etc)	Hotels	Department stores and supermarkets	Shops selling precious goods	Military and hunting equipment stores	Vehicle rental facilities	Warehouses	Warehouses of hazardous and precious substances	Self-storage	Manufacture and sale of precious metals/stones	Hazardous substances factories	Robotic storage	Shopping centres and malls	Motor fuel dispensing facilities
On outdoor spaces, performance and crowd gathering areas		D3																				D3	
On all outdoor toilets entrances																							R
On car park pathways and driveways	D	D		D	D				D	D	D											D	D
On gas tanks storage area, liquefied gas storage and filling areas	R	R									R											R	
On electrical room entrances		R									R											R	
In water tank rooms		R									R											R2, D4	
On fresh air treatment unit (HVAC) entrances		R									R											R2, D5	
On fuel tanks backup generators		D									D											D	
On doors of hazardous substances containers																	R			R			
Vehicle fuel supply lines																							D
Fuel refilling lines to main fuel tank																							D
On SIM card and mobile phone tables								I, R															
In display shelf aisles												D				D	D						

Table J.2 VSS operational requirements for fixed coloured cameras by building type (continued)

I: Identification, **R:** Recognition, **R1:** Recognition and inside ATM, **R2:** Recognition on entrance, **D:** Detection, **D1:** Detection leading to residential units, **D2:** Detection and IR for night vision, **D3:** Detection and PTZ to support, **D4:** Detection on water tanks, **D5:** Detection on units, **ANPR:** Automatic number plate recognition, **IR:** Infrared, **PTZ:** Pan, tilt, zoom

	Cinemas and theatres	Recreation parks	Art galleries	Shooting ranges	Places of worship	Financial and monetary institutions	Internet services shops	SIM card shops	Staff and labour accommodation	Important complexes (e.g. groups of towers, a villa compound etc)	Hotels	Department stores and supermarkets	Shops selling precious goods	Military and hunting equipment stores	Vehicle rental facilities	Warehouses	Warehouses of hazardous and precious substances	Self-storage	Manufacture and sale of precious metals/stones	Hazardous substances factories	Robotic storage	Shopping centres and malls	Motor fuel dispensing facilities
On all display tables and showrooms			D									D	D						R				
On all display tables and boxes outside the establishment or displayed elsewhere																			R				
On the games and computer tables							D																
On all shooting ranges				D																			
Inside gun store				R																			
On the arms and ammunition handover tables				R																			
On shelving aisles												D	D	D									
On storage area														D									
All places of worship					D																		
On both the area and vehicle entrance and exit of loading and unloading areas	D	D, ANPR									D					D	D			D		D, ANPR	
On both the area and vehicle entrance and exits of passenger drop off areas	D, ANPR	D, ANPR									D, ANPR											D, ANPR	

Table J.2 VSS operational requirements for fixed coloured cameras by building type (continued)

I: Identification, **R:** Recognition, **R1:** Recognition and inside ATM, **R2:** Recognition on entrance, **D:** Detection, **D1:** Detection leading to residential units, **D2:** Detection and IR for night vision, **D3:** Detection and PTZ to support, **D4:** Detection on water tanks, **D5:** Detection on units, **ANPR:** Automatic number plate recognition, **IR:** Infrared, **PTZ:** Pan, tilt, zoom

	Cinemas and theatres	Recreation parks	Art galleries	Shooting ranges	Places of worship	Financial and monetary institutions	Internet services shops	SIM card shops	Staff and labour accommodation	Important complexes (e.g. groups of towers, a villa compound etc)	Hotels	Department stores and supermarkets	Shops selling precious goods	Military and hunting equipment stores	Vehicle rental facilities	Warehouses	Warehouses of hazardous and precious substances	Self-storage	Manufacture and sale of precious metals/stones	Hazardous substances factories	Robotic storage	Shopping centres and malls	Motor fuel dispensing facilities
On vehicle entrances and exits	R, ANPR	R, ANPR	ANPR								ANPR					ANPR	ANPR			ANPR		R, ANPR	ANPR
On vehicle entrances and exits of car parks	ANPR	ANPR		ANPR	ANPR				ANPR	ANPR	ANPR											ANPR	ANPR
Digital recording (days) for all cameras	31	31	31	31	31	31*	31	31	31	31	31	31	31	31	31	31	31	90	31	31	90	31	31
Central monitoring system (VideoGuard) must be installed	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes+	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recording speed of outdoor cameras (fps)																							25

* 75 days for ATM machines + more than 50 residential units

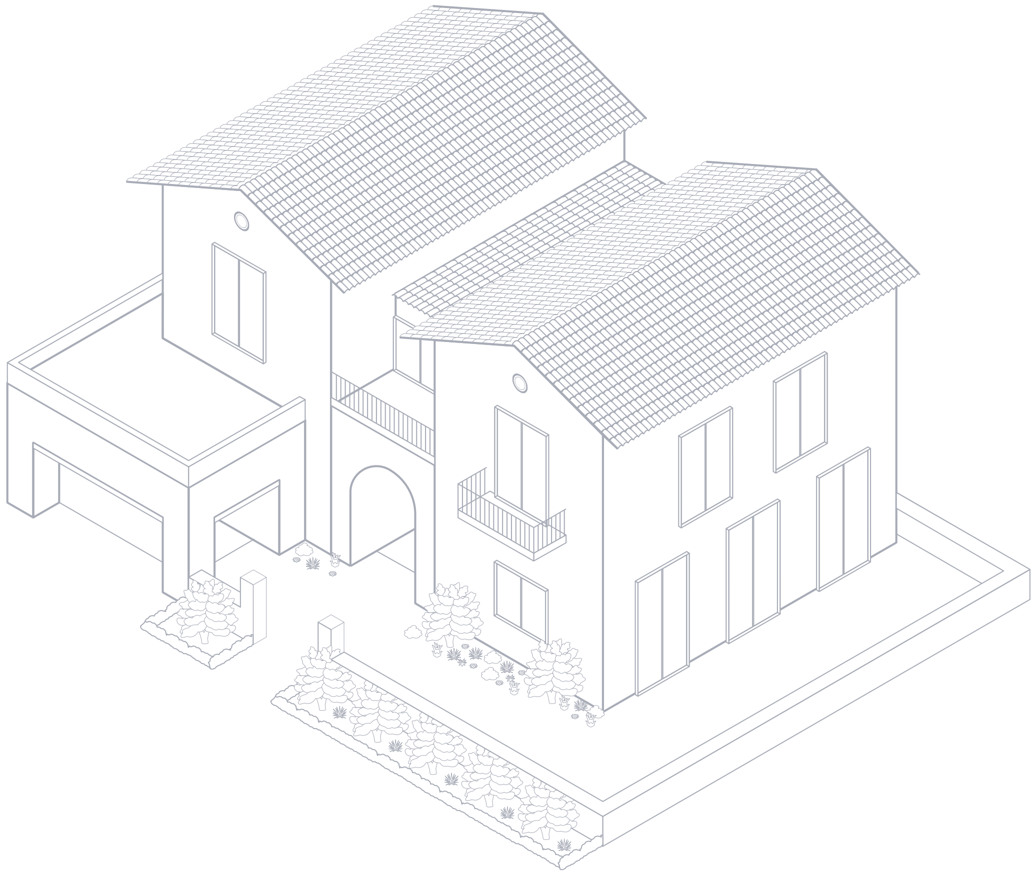
Table J.2 VSS operational requirements for fixed coloured cameras by building type (continued)

I: Identification, **R:** Recognition, **R1:** Recognition and inside ATM, **R2:** Recognition on entrance, **D:** Detection, **D1:** Detection leading to residential units, **D2:** Detection and IR for night vision, **D3:** Detection and PTZ to support, **D4:** Detection on water tanks, **D5:** Detection on units, **ANPR:** Automatic number plate recognition, **IR:** Infrared, **PTZ:** Pan, tilt, zoom

J.7 Fire and life safety

Electronic access control systems and any other locking system on exit doors shall be in accordance with Table 3.2, Ch. 3 of the UAE FLSC [Ref. J.2].

Part K
Villas



K.1 Performance statements

Section	Performance statement	The performance statement will be met by following the requirements of:
Architecture	The building shall be appropriately integrated with the surrounding natural and built environment.	K.5.1 and K.5.2
	The building shall facilitate the safety, convenience and welfare of building occupants as they move in and around the building, including access and egress.	K.5.3 and K.5.5
	The building shall provide minimum communal provisions and facilities for the health and welfare of building occupants.	K.5.4, K.5.7 and K.5.8
	The site shall provide appropriate access and safe circulation for vehicles.	K.5.6

Section	Performance statement	The performance statement will be met by following the requirements of:
Building envelope	The building envelope shall safely resist the loads imposed upon it.	K.7.1
	The building envelope shall reduce the energy required to cool the building.	K.7.2
	The building envelope shall control moisture to protect the building, its users, its mechanical systems and its contents from physical or chemical damage.	K.7.4
	The building envelope shall protect occupants from falling from balconies, roofs or through lightwells.	K.7.6
	The building envelope shall provide glazing that safely resists impact, whilst incorporating measures to prevent occupants colliding with the glazing.	K.7.6

Section	Performance statement	The performance statement will be met by following the requirements of:
Structure	The building structure shall safely sustain and transmit to the ground the combined dead, imposed, thermal, wind and seismic load conditions for its intended life.	K.8.1 to K.8.6
	The building structure shall provide a structure that protects other property from physical damage.	K.8.5 to K.8.6
	The building structure shall provide a structure that does not sustain damage or collapse to an extent that is disproportionate to the cause.	K.8.1.4
Incoming Utilities	The building shall provide electrical installations that safeguard occupants against the outbreak of fire and personal injury due to electric shock.	K.9.1 to K.9.3
	The building shall be provided with metered water supplies to monitor water consumption and inform water conservation.	K.9.5
	The building shall enable telecommunications services that are suitably future-proof.	K.9.7

Section	Performance statement	The performance statement will be met by following the requirements of:
Indoor environment	The building shall provide fixed building services that: a) are energy-efficient; b) have effective controls; c) ensure optimal operational efficiency; and d) facilitate the health and comfort of the occupants.	K.10.1
	The building shall provide a reliable supply of safe water with sanitary fittings selected to reduce water consumption.	K.10.2
	The building shall provide drainage systems to collect and convey drainage flows in a safe and efficient manner.	K.10.4
	The building shall safeguard people from undue noise being transmitted from adjacent spaces, occupancies and the exterior.	K.10.5

K.2 Definitions

K.2.1 General

The definitions in Part A apply.

K.2.2 Architecture

Affection plan: Plan of the plot or site issued by the Authority, showing information that includes (but not limited to) the plot boundaries, plot dimensions, plot areas, plot setbacks and surroundings as well as the land uses. Also called site plan.

Amenity area or space: Public or private area within the boundaries of a plot or a development site for the building occupant's recreation or convenience (such as landscaped areas, patios, swimming pools, play areas, prayer rooms, exercise areas and similar uses).

Annex: Building or installation, attached to or independent from the main building, the use of which is secondary or complementary to the function of the main building.

Balcony: Covered or uncovered occupied projection or partial projection outside the external walls, attached to the building and accessed from the building interior spaces (see Figure K.1).

Basement floor: Storey of a building wholly or partly below the gate level that is not the first storey above gate level. A basement slab soffit level is not higher than 1,500 mm above the building gate level.

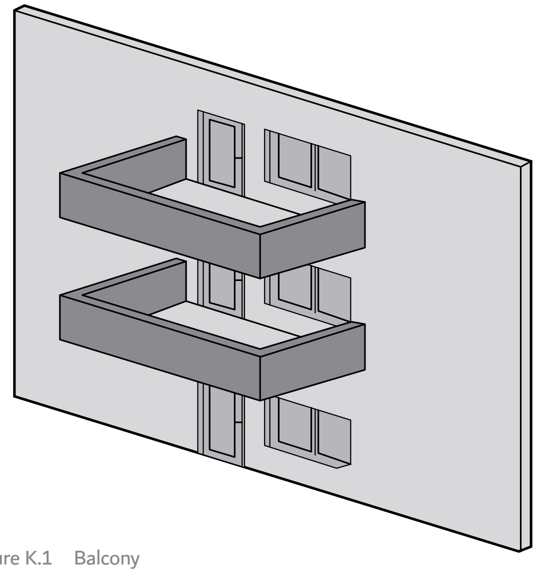


Figure K.1 Balcony

Boundary wall or fence: Free-standing structure constructed from approved materials surrounding a plot, resting on the ground and rising above ground level and used for confinement and/or screening for safety or security or division purposes.

Building height, total: Vertical distance measured from the approved road edge level at the plot main access to the highest roof surface or element.

Building height: Vertical distance measured from the approved road edge level at the plot main access to the mean finished level of the building roof.

Building projection: Projection or protrusion that extends outside the vertical external wall of the floor below, such as balconies.

Building setback: Horizontal distance between the nearest part of any building or structure on the plot above ground and the plot boundary, measured perpendicular to the plot boundary.

Clear width: Free unobstructed space for access.

Community: Single family dwelling units built in a group by developer and sold, leased or rented to individual families.

Corridor: Enclosed component that defines and provides a path of travel.

Courtyard: Open, uncovered space, unobstructed to the sky, bounded on three or more sides by exterior building walls or other enclosing devices as shown in Figure K.2.

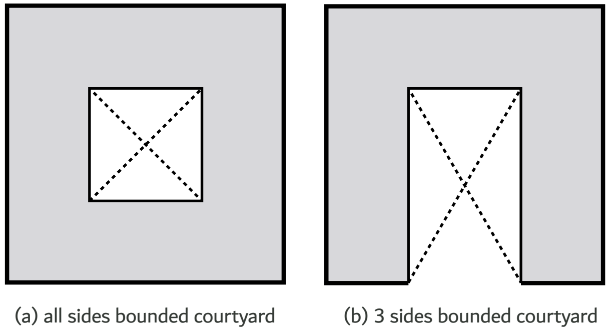


Figure K.2 Courtyard

Flight: Continuous run of stair treads from one landing to another.

Floor finish: Exposed floor surfaces of buildings including coverings applied over a floor or stair, including risers.

Floor height: Vertical distance from top to top of two successive finished floor surfaces. For the topmost storey, from the top of the floor finish to the top of the ceiling joists or, where there is no ceiling, to the top of the roof surface.

Floor or storey: Portion of a building located between the upper surface of a floor and the upper surface of the floor or roof next above.

Garage: Building or structure, or any part thereof, used or intended for parking or storage of vehicles, which may or may not include a roof.

Gate level: Defined height on the plot's boundary at the vehicular or pedestrian access point to the plot. It is an elevation difference between the road level (existing or future) and the level of the plot's access point.

The gate level of a plot is a minimum height of +300 mm from the edge of the road level or a slope of between 2-5% from the edge of the road to the plot's access point.

Gross area (GA): Floor area within the inside perimeter of the exterior walls of a building. The measurement excludes shafts and courtyards, but includes corridors, stairways, ramps, closets, base of atria (or similar voids) and the thickness of interior walls, columns or other features.

Ground floor: First floor in the building above the gate level.

Guardrail: Vertical protective barrier erected along elevated walking surfaces, exposed edges of stairways, balconies and similar areas that minimizes the possibility of fall from elevated surfaces to lower level.

Guard room: Room, unit, or residential space on the same plot of land as the main building, or located within the main building, designated for the occupancy of the guard.

Habitable space: Space in a building for living, sleeping or eating involving occupancy for continuous period of time. Bathrooms, toilet rooms, closets, halls, storage or utility spaces and similar areas are not habitable spaces.

Handrail: Horizontal or sloping rail intended for handhold and grasping by hand for guidance or support (see Figure K.3).

Hardscape: Area of a project site, excluding buildings, made with hard materials, including roads, car parks, patios, courtyards and walkways.

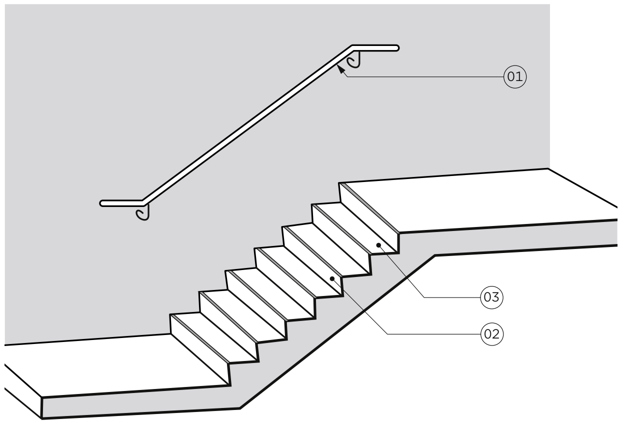


Figure K.3 Stair components

Key
01: Handrail
02: Riser
03: Tread

Housekeeper's room: Attached or separate room or unit on the same plot of land as the main building, designated for the residence of housekeepers or other maintenance staff such as gardeners, guards and drivers.

Landing: Floor area at the top of a flight of stairs or between two flights of stairs, or a platform or part of a floor structure at the end of a ramp or at the entrance to an elevator car.

Level: Ground or floor surface, or part of a surface, having a slope of not more than 2% at any point and in any direction.

Low-rise building: Building height less than or up to 15 m, measured in accordance with the UAE FLSC [Ref. K.1]. A more detailed definition is given in UAE FLSC.

Massing: Overall mass or size of a building or project, its physical volume or magnitude.

Masterplan: Comprehensive plan to guide the long-term physical development of a specific area based on identified objectives, strategies, and timelines for implementation. Includes plans for land use, community facilities and utilities, transportation of goods and people, and energy use and conservation. Zoning ordinances and policies are developed for different areas or zoning districts based on the masterplan.

Means of egress: Continuous and unobstructed route from any point in a building or structure to a public way.

Neighbour: Any adjacent plot excluding roads and sikkas.

Net area (NA): Actual occupied area, not including unoccupied accessory areas such as corridors, stairways, ramps, toilet rooms, mechanical rooms and closets.

Net floor height: Net distance between the finished floor level (FFL) of a floor and the exposed surface of the floor celling.

Parapet wall: Part of any wall entirely above the roof line.

Plot: Area of land that is:

a) clearly defined (by landmarks, coordinates, distinct number, and the lengths of its sides and location);
b) intended for construction under any approved plan or division project, or by any other method; and
c) legally authorized to be used for construction or building as one unit.

Plot area: Total area of a plot between its boundary lines as measured on a horizontal plane.

Plot boundary: Boundary dividing one plot from another, or from a street or any public place.

Plot coverage: Horizontal area occupied by all main and annex buildings on the same plot, calculated from the external surfaces of external walls or useful roofed balconies in the ground or upper floors, whichever have more floor projections.

Public way: Street, alley, or other plot of land open to the outside air, leading to a street, that has been deeded, dedicated or otherwise permanently appropriated for public use, and has a clear width and height of not less than 3 m.

Ramp: Inclined solid flat plane that is steeper than 5% from the horizontal.

Reflectance: Measure of light reflected in a given direction by a surface and which is expressed in a unit term from 0 to 100 scale, respectively, that represents a grey scale progression from the notional extremes of total light absorption (black) to total light reflection (white).

Riser: Near-vertical element in a set of stairs, forming the space between one step and the next (see Figure K.3).

Road or street: Public or private road allocated for vehicles or pedestrian use or both, except for sikka as defined in land use classification and regulations in Dubai.

Shading device: Projecting fixture that extends outside the external wall of any building, or a cover (such as a louver), to protect any door or window from rain or solar effect.

Shaft: Enclosed unoccupied space extending through one or more stories of a building, connecting vertical openings in successive floors, or floors and roof.

Sidewalk: Hard-surfaced walk or raised path along and parallel to the side of the street for pedestrians.

Sikka: Public or private path separating two adjacent plots or a group of adjacent plots, that can be used by pedestrians as a primary or secondary access to any plot.

Space: Identifiable area including room, toilet, hall, assembly area, entrance, storage room, alcove, courtyard or lobby.

Stair: Change in elevation, consisting of one or more risers.

Staircase: Space inside the building within which the stairs are erected.

Stairway: One or more flights of stairs, either exterior or interior, with necessary landings and platforms connecting them to form a continuous and uninterrupted passage from one level to another.

Structure: Constructed, erected material or combination of materials which requires being located on the ground or attached to something located on the ground.

Swimming pool: Constructed pool for swimming, bathing or wading whether above or below the ground surface regardless of depth or water surface area.

Terraces: Covered or uncovered platform or roof, protected by a guardrail or parapet wall and supported by the structure of the floor below.

Townhouses: Multiple villas connected by one or more walls to a series of similar villas.

Tread: Stepping space in a stair flight to set the foot (see Figure K.3).

Vehicle access: Roadway, usually paved, intended to provide ingress and egress of vehicular traffic from a public right-of-way to a building entrance or parking area.

Vehicular gate: Barrier intended for use at a vehicular entrance or exit to a facility, building or portion thereof.

Villa: Separate building located on a separate plot allocated with all its floors for the dwelling of one single family with an independent car parking space in addition to independent external open space.

Water closet: Toilet bowl and its attached accessories.

K.2.3 Accessibility

Accessibility: Ease of independent approach, entry, evacuation and/or use of a building and its services and facilities by all of the building's potential users, regardless of disability, age or gender, and with an assurance of individual health, safety and welfare.

People of determination: People with specific needs or disabilities, who are suffering from a temporary or permanent, full or partial deficiency or infirmity in their physical, sensory, mental, communication, educational or psychological abilities.

K.2.4 Building envelope

Building elevation: View showing the image of one side of the building. A flat representation of one façade.

Building envelope: Physical barrier between the exterior and the conditioned environment of a building to resist air, water, moisture, heat, cold, light, and noise transfer. For an air-conditioned building, the building envelope comprises the elements of a building that separate conditioned spaces from the exterior. Crown extensions to the façade to cover plant screen cladding are part of the building envelope. The building envelope does not include the physical barrier below ground.

Containment: Glass barrier resisting penetration and preventing people from falling even after failure or breakage.

Damp-proof course: Layer of waterproof material or construction in the wall of a building near the ground, to prevent rising damp.

Damp-proof membrane: Material applied to prevent moisture transmission.

Drained air space: Air layer within a wall that allows any entering water or moisture to be drained out.

Glazed element: Individual element within a building envelope that lets in light, including windows, plastic panels, clerestories, skylights, doors that are more than one half glass, and glass block walls.

Glazing: Glass that is installed as one of the components of a wall, floor, ceiling or roofing system.

Groundwater pressure: Pressure of groundwater held within a soil or rock, in gaps between particles.

Guardrail: Vertical protective barrier erected along elevated walking surfaces, exposed edges of stairways, balconies and similar areas that minimizes the possibility of fall from elevated surfaces to lower level.

Interstitial condensation: Condensation which occurs within or between layers of a construction.

Light transmittance: Percentage of incident light that passes through the glazed elements. When this percentage increases, the amount of daylight that passes into the building will increase.

Moisture: Water or other liquid diffused in a small quantity as vapour, within a solid, or condensed on a surface.

Mould: Type of fungus that grows on damp or decaying material surfaces.

Operational forces: Forces sustained by the building envelope during operation of the building, e.g. impact from equipment or occupants.

Shading coefficient (SC): Ratio of solar heat gain at normal incidence through glazing to that occurring through an approximately 3 mm thick clear float glass.

Shading device: Projecting fixture that extends outside the external wall of any building, or a cover (such as a louver), to protect any door or window from rain or solar effect.

Skylight or overhead glazing: Glass or other transparent or translucent glazing material installed at a slope of 15° or more from vertical.

Solar reflectance index (SRI): Index that combines reflectivity and emissivity, measuring a material's ability to reject solar heat. SRI is defined such that a standard black (reflectance 0.05 and emittance 0.90) is 0 and a standard white (reflectance 0.80 and emittance 0.90) is 100. Materials with higher SRI absorb less heat and can reduce heat island effect.

Solid metal panels: Factory manufactured panel consisting of solid metal skin or skins without a core. Solid metal panels could be aluminium, steel, copper, zinc, stainless steel, titanium, etc.

Surface condensation: Condensation which occurs on a visible surface within a building.

Thermal bridge: Component or assembly of components penetrating through an otherwise continuous thermal line through which heat is transferred at a substantially higher rate than through the surrounding envelope areas. Examples could be a metal fastener, concrete beam, balcony slab or column.

Thermal insulation: Materials/products or the methods and processes used to reduce heat transfer. Heat energy can be transferred by conduction, convection or radiation. The flow of heat can be delayed by addressing one or more of these mechanisms and is dependent on the physical properties of the material employed to do this.

Thermal transmittance: Rate of transfer of heat through a material(s) or assembly, expressed as a U-value.

Vapour resistance layer: Material layer within a wall or roof build-up with a high resistance to moisture vapour.

Window-to-wall ratio (WWR): Percentage determined by dividing the glazed area by the total external wall area of the building envelope. WWR can be calculation per orientation or per entire building.

K.2.5 Structure

Geotechnical laboratory: Physical or legal entity in charge of carrying out geotechnical soil investigations and licensed to practice investigation activities in Dubai in accordance with the applicable legislation.

Geotechnical Specialist Contractor: Physical or legal person in charge of carrying out specialist geotechnical works and design. It is licensed to practice geotechnical construction and design activities in Dubai in accordance with the applicable legislation.

Serviceability: Condition beyond which a structure or member becomes unfit for service and is judged to be no longer useful for its intended use.

K.2.6 Incoming utilities

K.2.6.1 Electrical

Accessory: Device, other than current-using equipment, associated with such equipment or with the wiring of an installation.

Active power: Real component of the apparent power, expressed in watts (W)/kilowatts (kW)/megawatts (MW).

Alternating current (AC): Electric current that reverses its direction many times a second at regular intervals.

Ambient temperature: Temperature of the air or other medium where the equipment is to be used.

Apparent power: Product of voltage (in volt) and current (in amps). It is usually expressed in kilovolt-ampere (kVA) or megavolt-ampere (MVA) and consist of a real component (active power) and an imaginary component (reactive power).

Appliance: Item of current-using equipment other than a luminaire or an independent motor.

Arc fault detection device (AFDD): Devices that protect specifically against arc faults. They automatically trip a circuit when they detect dangerous electric arcs.

Barrier: Part providing a defined degree of protection against contact with live parts from any usual direction of access.

Bonding conductor: Protective conductor providing equipotential bonding.

Bunched cables: Two or more cables that are contained within a single conduit, duct, or trunking, or if not enclosed, are not separated from each other by a specified distance.

Cable tray: Cable support consisting of a continuous base with raised edges and no covering. A cable tray is non-perforated, where less than 30% of the material is removed from the base.

Cable trunking: Manufactured enclosure for the protection of cables, normally of rectangular cross-section, of which one side is removable.

Circuit: Assembly of electrical equipment supplied from the same origin and protected against overcurrent by the same protective devices.

Circuit breaker: Device capable of making, carrying and breaking normal load current and making and automatically breaking, under predetermined conditions, abnormal currents such as short-circuit currents. It usually operates infrequently, although some types are suitable for frequent operation.

Cleat: Component of a support system, which consist of elements spaced at intervals along the length of the cable or conduit and which mechanically retains the cable or conduit.

Conductor: Material or device that conducts or transmits electricity.

Conduit: Part of closed wiring system for cables in electrical installations, allowing them to be drawn in and/or replaced, but not inserted laterally.

Connector: Part of a cable coupler or of appliance coupler which is provided with female contacts and is intended to be attached to the end of the flexible cable remote from the supply.

Current-carrying capacity of a conductor: Maximum current which can be carried by a conductor under specified conditions without its steady state temperature exceeding a specified value.

Current-using equipment: Equipment which converts electrical energy into another form of energy, such as light, heat or motive power.

Demand factor: Ratio of maximum demand of the system to the total connected load.

Direct current (DC): Unidirectional flow of an electric charge.

Distribution board: Assembly containing switching or protective devices (e.g. fuses, circuit breakers, and residual current operated devices) associated with one or more outgoing circuits, fed from one or more incoming circuits, together with terminals for the neutral and protective circuit conductors. It may also include signalling and other control devices. Means of isolation may be included in the board or may be provided separately.

Diversity factor (or diversity): Ratio of sum of individual maximum demands of the different type of load during a specified period to the maximum demand of the power station during the same period.

Duct: Enclosure of metal or insulating material, other than conduit or cable trunking, intended for the protection of cables which are drawn in after erection of the ducting.

Earth: Conductive mass of the earth, whose electric potential at any point is conventionally taken as zero.

Earth continuity conductor (ECC): A conductor used for some measures of protection against electric shock and intended for connecting together any of the following parts:

a) exposed conductive parts;
b) extraneous-conductive-parts;
c) the main earthing terminal;
d) earth electrode(s); or
e) the earthed point of the source, or an artificial neutral.

Earth electrode: Conductor or group of conductors in intimate contact with and providing an electrical connection to earth.

Earth electrode resistance: Resistance of an earth electrode to earth.

Earth fault current: Fault current which flows to earth.

Earth fault loop impedance: Impedance of the earth fault current loop starting and ending at the point of earth fault.

Earth leakage: Current which flows to earth, or to extraneous-conductive parts, in a circuit which is electrically sound.

Earth leakage circuit breaker (ELCB): Safety device with high earth impedance which interrupts the circuit if a dangerous voltage (50 V AC or over) is detected.

Earthing: Connection of the exposed conductive parts of an installation to the main earthing terminal of that installation.

Earthing conductor: Protective conductor connecting the main earthing terminal of an installation to an earth electrode or to other means of earthing.

Electric shock: Dangerous physiological effect resulting from the passing of an electric current through a human body or livestock.

Electrical installation: Assembly of associated electrical equipment supplied from a common origin to fulfil a specific purpose and having certain coordinated characteristics.

Enclosure: Part providing protection of equipment against certain external influences and in any direction protection against direct contact.

Equipment: Any item for purposes such as generation, conversion, transmission, distribution or utilization of electrical energy, such as machines, transformers, apparatus, measuring instruments, protective devices, wiring systems, accessories, appliances and luminaires.

Equipotential bonding: Electrical connection maintaining various exposed conductive parts and extraneous conductive-parts at substantially the same potential.

Exposed conductive part: Conductive part of equipment which can be touched, and which is not a live part, but which may become live under fault.

External influence: Any influence external to an electrical installation which affects the design and safe operation of that installation.

Extra-low voltage: Normally not exceeding 50 V AC or 120 V ripple free DC, whether between conductors or to Earth.

Fault: Circuit condition in which current flows through an abnormal or unintended path, which can result from an insulation failure or a bridging of insulation.

Fault current: Current resulting from a fault.

Final circuit: Circuit connected directly to current-using equipment, or to a socket outlet or socket outlets or other outlet points for the connection of such equipment.

Fixed equipment: Equipment designed to be fastened to a support or otherwise secured in a specific location.

Flexible cable: Cable in which the structure and materials make it suitable to be flexed while in service.

Fuse: Device which, by the melting of one or more of its specially designed and proportioned components, opens the circuit in which it is inserted by breaking the current when this exceeds a given value for a defined time. The fuse comprises all the parts that form the complete device.

Fuse element: Part of a fuse designed to melt when the fuse operates.

Fuse link: Part of a fuse including the fuse element(s), which requires replacement by a new or renewable fuse link after the fuse has operated and before the fuse is put back into service.

Insulation: Non-conductive material enclosing, surrounding or supporting a conductor.

Inverter: Device which converts the direct current (DC) to alternating current (AC).

Isolator: Mechanical switching device which, in the open position, meets the requirements specified for the isolating function.

Live part: Conductor or conductive part intended to be energised in normal use, including a neutral conductor.

Low smoke and fume (LSF) cable: Cable rated Class Cca-s1b, d2, a2 in accordance with BS EN 13501-6.

Low voltage: Normally exceeding extra-low voltage but not exceeding 1,000 V AC or 1,500 V DC between conductors, or 600 V AC or 900 V DC between conductors and earth. The actual voltage of the installation may differ from the nominal value by a quantity within normal tolerances.

Luminaire: Equipment which distributes, filters or transforms the light from one or more lamps, and which includes any parts necessary for supporting, fixing and protecting the lamps, but not the lamps themselves, and, where necessary, circuit auxiliaries together with the means for connecting them to the supply.

Main earthing terminal: Terminal or bar provided for the connection of protective conductors, including equipotential bonding conductors, and conductors for functional earthing, if any, to the means of earthing.

Maximum demand: Summation of all electrical power demand that has occurred during a specified period, measured in kW or kVA.

Neutral conductor: Conductor of a three-phase 4-wire system or the conductor of a single-phase installation which is earthed at the source of the supply.

Non-combustible: Material which is classified as Class A1 in accordance with BS EN 13501-1.

Nominal voltage: Voltage by which an installation (or part of an installation) is designated.

Overcurrent: Current exceeding the rated value. For conductors the rated value is the current- carrying capacity.

Overload: Overcurrent occurring in a circuit which is electrically sound.

Plug: Accessory having pins designed to engage with the contact of a socket outlet and incorporating means for the electrical connection and mechanical retention of a flexible cable or cord.

Point (in wiring): Termination of the fixed wiring intended for the connection of current-using equipment.

Protective device: Device which detects abnormal and intolerable conditions, which initiates appropriate corrective action to provide protection against electric shock under fault-free conditions. Backup protection is provided to operate when a system fault is not cleared or abnormal condition not detected in the required time because of failure or inability of other protection to operate or failure of appropriate circuit breaker.

PVC: Polyvinyl chloride as insulation or sheath of cable.

PV: Solar photovoltaic.

PV array: Mechanically and electrically integrated assembly of PV modules, and other necessary components, to form a DC power supply unit.

PV generator: Assembly of PV array.

PV installation: Erected equipment of PV power supply system.

PV module: Smallest completely environmentally protected assembly of interconnected PV cells.

PV string: Circuit in which PV modules are connected in series, for a PV array to generate the required output voltage.

Reactive power: Imaginary component of the apparent power expressed in kVAr or MVAr.

Residual current: Vector sum of the instantaneous values of current flowing through all live conductors of a circuit at a point in the electrical installation.

Residual current device (RCD): Mechanical switching device or association of devices intended to cause the opening of the contacts when the residual current attains a given value under specified conditions.

Residual current operated circuit breaker with integral overcurrent protection (RCBO): Residual current operating device designed to perform the functions of protection against overall load and/or short circuit.

Residual current operated circuit breaker without integral overcurrent protection (RCCB): Residual current operated switching device not designed to perform the functions of protection against overload and/or short circuit.

Resistance area: Surface area of ground (around an earth electrode only) on which a significant voltage gradient may exist.

Ring circuit: Circuit arranged in the form of a ring and connected to a single point of supply.

Short-circuit current: Overcurrent resulting from a fault of negligible impedance between live conductors having a difference in potential under normal operating conditions.

Shrouded: Enclosure used to cover the cable and cable gland when the cable is entering an item of equipment, to avoid water and dust ingress.

Socket outlet: Device, provided with female contacts, which is intended to be installed with the fixed wiring, and intended to receive a plug. A luminaire track system is not regarded as a socket outlet system.

Stationary appliance: Electrical equipment which is either fixed, or equipment having a mass exceeding 18 kg and not provided with a carrying handle.

Switch: Mechanical device capable of making, carrying and breaking current under normal circuit conditions, which can include specified operating overload conditions, and carrying for a specified abnormal circuit conditions such as those of short-circuit, and which can also be capable of making, but not breaking, short-circuit currents.

Wiring system: Assembly made up of cables or busbars and parts which secure and, if necessary, enclosed the cable or busbar.

XLPE cable: Cross linked polyethylene as insulation of cable.

K.2.6.2 Telecommunications

Building entry point (BEP): Point where external ducts physically enter a building. This can be a standalone location or incorporated into another telecoms space.

Cable pathway: Any system used to route cables, such as cable ducting, cable ladder, cable tray, conduit, duct and maintenance chamber.

Fibre to the x (FTTx): Delivery of optical fibre signals directly to a location. For SP telecom services the x may be defined as B (building), C (cabinet), H (home), P (premise).

Optical network terminal (ONT): Active component of the FTTx optical network located at a tenant premises.

Optical splitter: Passive component of the FTTx optical network taking signal from either one or two input optical cores and equally dividing the signal to the splitter outputs.

Passive optical network (PON): Point to multipoint FTTx network architecture utilizing unpowered optical splitters. Variants of PON using the same topology and passive components include GPON, XG-PON, XGS-PON and NG-PON2.

Service Provider (SP): Provider of telecommunication services. SPs in Dubai include du and Etisalat.

K.2.7 Indoor environment

K.2.7.1 HVAC systems and occupant comfort

Air contaminants: Unwanted airborne constituents that might reduce acceptability or adequacy of the air quality.

Air leakage: Air that escapes from or to a building through a joint, coupling, junction, or the surfaces which enclose the building. The flow of uncontrolled air within a building through cracks or openings.

Air ventilation: The share of supply air that is outdoor air, plus any recirculated air that has been filtered or otherwise treated to maintain acceptable indoor air quality.

Commissioning: Quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meets defined objectives and criteria.

Condensation: Process through which a gas or vapour changes to liquid form. Also defined as the water which is produced in this process.

Cooling coil: Coiled arrangement of tubing or pipe for the transfer of heat between a cold fluid and air.

Cooling load: Amount of cooling that a building will require to meet the conditions specified by the Authority. The cooling load is determined by the output of the heat load calculation required by the Authority.

Diversity factor: Relates to the thermal characteristics of the building envelope, temperature swings and occupancy load.

Ductwork: Airtight devices that carry conditioned air throughout the building. This includes terminal fixtures to distribute air.

Ductwork leakage: Escape of air through cracks and gaps when air-conditioning ductwork is not airtight. Ductwork leakage will result in an increase in energy consumption of supply and return air fans.

Exhaust air: Air removed from a building space and discharged to the outside of the building through a mechanical or natural ventilation system.

Global warming potential (GWP): Contribution of greenhouse gases released to the atmosphere in the global warming phenomenon.

Heat load calculation: Process of calculating the total heat generated inside the building by various sources.

Heating, ventilation and air-conditioning system (HVAC): Equipment, distribution systems, and terminals that provide either individually or collectively, the processes of heating, ventilating, or air-conditioning to a building or a portion of a building.

Make-up air (dedicated replacement air): Air deliberately brought into the building from the outdoors and supplied to the vicinity of an exhaust hood to replace the air and cooking effluent being exhausted. Make-up air is generally filtered and fan-forced, and it may be heated or cooled depending on the requirements of the application.

Mechanical system: Those systems within a building which include components of mechanical plant or machinery. These systems include, but are not limited to, the HVAC system of a building.

Mechanical ventilation: Ventilation provided by mechanically powered equipment, such as fans.

Mixed mode ventilation: Combination of mechanical and natural ventilation.

Natural ventilation (passive ventilation): Ventilation provided by thermal, wind or diffusion effects through windows, doors, or other openings in the building.

Occupancy sensor: Device that detects the presence or absence of people within an area and causes lighting, equipment, or appliances to be regulated accordingly.

Outdoor air: Outside air supplied to a building space through mechanical or natural ventilation to replace air in the building that has been exhausted.

Refrigerants: Working fluids of refrigeration cycles, which absorb heat at low temperatures and reject heat at higher temperatures.

Replacement air: Outdoor air that is used to replace air removed from a building through an exhaust system. Replacement air can be derived from one or more of the following: make-up air, supply air, transfer air, and infiltration. However, the ultimate source of all replacement air is outdoor.

Relative humidity: Ratio of partial density of water vapour in the air to the saturation density of water vapour at the same temperature and the same total pressure.

Space pressurization: Static pressure difference between the adjacent spaces of a building, with the air tending to move from higher pressure spaces to lower-pressure spaces.

Supply air: Air entering a space from an air-conditioning, heating, or ventilating system for the purpose of comfort conditioning. Supply air is generally filtered, fan-forced, and heated, cooled, humidified, or dehumidified as necessary to maintain specified temperature and humidity conditions. Only the quantity of outdoor air within the supply airflow is used as replacement air.

Thermal comfort: Condition of mind which expresses satisfaction with the thermal environment. The thermal comfort measurement is subjective in nature as it depends on environmental and personal factors.

Thermal insulation: Materials/products or the methods and processes used to reduce heat transfer. Heat energy can be transferred by conduction, convection or radiation. The flow of heat can be delayed by addressing one or more of these mechanisms and is dependent on the physical properties of the material employed to do this.

K.2.7.2 Water

Backflow: Flow upstream, that is in a direction contrary to the intended normal direction of flow, within or from a water fitting.

Deadleg: A length of water system pipework leading to a fitting through which water only passes infrequently when there is draw off from the fitting, providing the potential for stagnation.

Electrical trace heating tape: Electrical multicored wire installed with thermal insulation around a pipe to maintain hot water return temperatures when a pumped hot water secondary system is not installed.

Legionella bacteria: Causative agent of Legionnaires' disease and its lesser form, Pontiac fever. Legionella generally infects the lungs through inhalation of contaminated aerosol. Legionella bacteria grow in water between 20 °C and 45 °C and can be spread by water droplets.

Microbiological bacteria: Microorganism capable of causing disease that may be transmitted via the water supply.

Non-potable water: Water that is not suitable for drinking but can be used for other purposes depending on its quality.

Potable water: Drinking water that is suitable for human consumption.

Pumped hot water return: Domestic hot water return system that uses a to pump generate circulation in the pipework system.

Thermal balancing valve: Automatic valve that balances hot water return subcircuits.

Thermostatic mixing valve: Valve with one outlet, which mixes hot and cold water and automatically controls the mixed water to a user-selected or pre-set temperature.

Water outlet: Opening for the discharge of water via a plumbing fixture such as a tap or showerhead.

K.2.7.3 Drainage

Cesspit: Holding tank installed below ground that is used for the temporary collection of faecal matter.

Discharge stack: Main (generally vertical) pipe conveying discharges from sanitary fittings.

Drainage system: System composed of drainage equipment, and other components collecting waste water and discharging by means of gravity, or effluent pumping plant which can be part of a gravity drainage system.

Floor gully: Discharge fitting intended to receive water from floors through apertures in a grating or from waste pipes that connect to the floor gully body or trap.

Greywater: Waste water not containing faecal matter or urine.

Inspection chamber: Chamber construction that provides access into the drainage system. The chamber dimensions only permit access to the sewer or drain line from ground level.

Manhole: Chamber construction that provides access into the drainage. The chamber dimensions permit man entry at the sewer drain level (if required).

Rainwater: Water resulting from natural precipitation that has not been deliberately contaminated.

Rainwater pipe: Pipe used to collect and transport rainwater from building roof areas to another drainage system.

Rodding eye: Removable fitting that provides access into the drainage system for cleaning and maintenance.

Rodding point: Small diameter connection into the drainage systems that permits entry into the system for cleaning or inspection of the downstream connection.

Sanitary fittings: Fittings supplied with water that are used for cleaning and washing (i.e. baths, showers, wash basins, bidets and water closets).

Sanitation pipework: Arrangement of discharge pipework, with or without ventilated pipes, connected to a drainage system.

Septic tank: Tank installed below ground in which sewage is collected and allowed to decompose through bacterial activity before draining to a soakaway.

Soakaway: Buried drainage feature that used to manage surface water on site and infiltrate into the surrounding ground

Upper floor: Any floor above the lowest level, which could be a basement level.

Ventilation pipework: Main vertical ventilating pipe, connected to a discharge stack, to limit pressure fluctuations within the discharge stack.

Wastewater: Water which is contaminated by use and all water discharging into the drainage system.

Water trap: Device that prevents foul air by means of a water seal.

K.2.8 Acronyms and abbreviations

AC	alternating current
ACI	American Concrete Institute
AHU	air handling unit
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers.
ASTM	ASTM International
ATC	Applied Technology Council
BAPV	Building attached photovoltaics
BEP	building entry point
BIPV	Building integrated photovoltaics
BRE	Building Research Establishment
BS	British Standard
BS EN	British Standard European Norm
cap.	capita
CFC	Chlorofluorocarbon
CFR	Code of Federal Regulations
Ch.	chapter
CIRIA	Construction Industry Research and Information Association
CO_2	carbon dioxide
CPSC	Consumer Product Safety Commission
CPT	cone penetration test
CRR	cyclic resistance ratio
CSR	cyclic stress ratio
CWCT	Centre for Window and Cladding Technology
d	depth
du	SP in Dubai
DB	distribution board
DCD	Dubai Civil Defence
DC	direct current
DCR	developmental control regulations
DEWA	Dubai Electricity and Water Authority
DMD	Dubai Municipality datum
DP	double pole
DRRG	distributed renewable resource generation
ECC	earth continuity conductor
EIAC	Emirates International Accreditation Centre
EID	Etisalat Identification
ELCB	earth leakage circuit breaker
EMI	electro-magnetic interference
ESMA	Emirates Authority for Standardisation and Metrology
Etisalat	SP in Dubai
FFL	finished floor level
FIC	final inspection chamber
FM	Factory Mutual
FS	factor of safety
FTTx	fibre to the x
G	ground level floor
GA	gross area
GAID	Global Alliance for ICT and development
GIFR	geotechnical investigation factual report
GIR	geotechnical interpretative report
GRP	glass reinforced plastic
h	height
HDPE	high density polyethylene
HDRF	heavy duty return flange
HSE	Health and Safety Executive
HVAC	heating ventilation and air- conditioning
IBC	International Building Code
ICE	Institution of Civil Engineering
ICT	information and communications technology
IEC	International Electrotechnical Commission
IET	Institution of Engineering and Technology
ISO	International Organization for Standardization
ISP	inside plant
IT	Information technology
l	length
LPG	liquefied petroleum gas
MCB	miniature circuit breaker
MCCB	moulded case circuit breaker
MEP	mechanical, electrical and public health
MMR	meet-me-room
MRI	mean recurrence interval
NA	net area
NFPA	National Fire Protection Association
NOC	no objection certificate

ODF	optical distribution frame
ODP	ozone depletion potential
OLT	optical line terminal
ONT	optical network terminal
OSP	outside plant
PV	photovoltaic
PCI	Precast/prestressed Concrete Institute
PoE	power-over-ethernet
PON	passive optical network
psi	pound per square inch
PV	photovoltaic
PVC-U	unplasticized poly (vinyl chloride)
RFI	radio frequency interference
RCBO	Residual current operated circuit breaker with integral overcurrent protection
RCCB	Residual current operated circuit breaker without integral overcurrent protection
RTA	Roads and Transport Authority
SCI	Steel Construction Institute
SIRA	Security Industry Regulatory Agency
SLD	single line diagram
SM	singlemode
SMACNA	Sheet Metal and Air-Conditioning Contractors National Association
SPT	standard penetration test
SP	service provider
STP	shielded twisted pair
SI	International system of units
SRI	solar reflectance index
TMS	The Masonry Society
TN	technical note
TO	telecommunications outlet
TRA	Telecommunications Regulatory Authority
UAE FLSC	UAE Fire and Life Safety Code of Practice
UK NA	United Kingdom National Annex
UL	Underwriters Laboratories
UTP	unshielded twisted pair
UV	under voltage
VOC	volatile organic compound
w	width
WWR	window to wall ratio

K.2.9 Notation

Notation	Definitions
EI	stiffness
F_a	short period site coefficient at 0.2 s period
F_{PGA}	site coefficient for peak ground acceleration
h_D	hydrostatic pressure
H	building height
h_w	thickness of concrete wall
MCE_R	risk-targeted maximum considered earthquake
MCE_G	maximum considered earthquake geometric mean
PGA_M	MCE_G peak ground acceleration adjusted for site effects (F_{PGA})
S_1	MCE_R, 5% damped spectral responses acceleration parameter at a period of 1s
S_S	MCE_R, 5% damped spectral responses acceleration parameter at short period
$S_{S\ LS}$	life safety, 5% damped spectral responses acceleration parameter at short period
$S_{1\ LS}$	life safety, 5% damped spectral responses acceleration parameter at a period of 1 s
T_L	long-period transition period (s)
V_{ref}	reference wind speed (m/s) in accordance with ASCE/SEI 7-16 (i.e. 3 s gust speed at 10 m above the ground in exposure category C)
w_k	crack width limit

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K.4 Scope

This standalone Part details the requirements for the design of detached villas and townhouses of not more than three stories in height.

Cross-references to other Parts relate to the design of systems or spaces such as elevators, prayer rooms, assembly areas, electrical or IT rooms and underground parking which may be added to a villa/townhouse but it is not common practice.

Villas and townhouses converted to retail, restaurant, clinics or other non-residential use shall conform to **Parts A** to **J**.

K.5 Architecture

K.5.1 General architectural requirements

Villas and townhouses shall be designed according to the planning limitations and provisions required by the Authorities, as stipulated in development control regulations (DCR) and/or affection plans. Limitations on development include, but are not limited to:

a) setbacks;

b) access locations;

c) the Datum Level;

d) service lines;

e) any other planning restriction.

Villas and townhouses located in heritage areas should respect the identity of these areas and shall adhere to any conservation requirements imposed by the Authorities.

The villa/townhouse or development should take the following into account:

1) Arabic and Islamic cultural identity;
2) local architectural character;
3) relationship with the surrounding environment;
4) compatibility with the planning limitations and urban planning themes of surrounding developments.

The massing of the proposed structure should take into account the visual privacy of adjacent residential buildings in the surrounding properties and neighbourhoods.

Space for utility provision and other services as required by the concerned service providing Authorities shall be provided within the plot limits.

K.5.2 Development limitations

K.5.2.1 Gate level

The gate level is a defined height on the plot's boundary at the vehicular or pedestrian access point to the plot. It is an elevation difference between the road level (existing or future) and the level of the plot's access point.

The gate level of a plot shall be a minimum height of +300 mm from the edge of the road level or a slope of between 2-5% from the edge of the road to the plot's access point.

K.5.2.2 Building height

Villa and townhouse heights shall follow the provisions noted within plot DCRs and affection plans as provided by permitting Authorities.

Villa and townhouse height shall be calculated from the approved road edge level at the plot main access to the average roof finish floor level as shown in Figure K.4. Ground level should be elevated from adjacent roads for protection from flooding.

The maximum total building height shall be limited to 16 m.

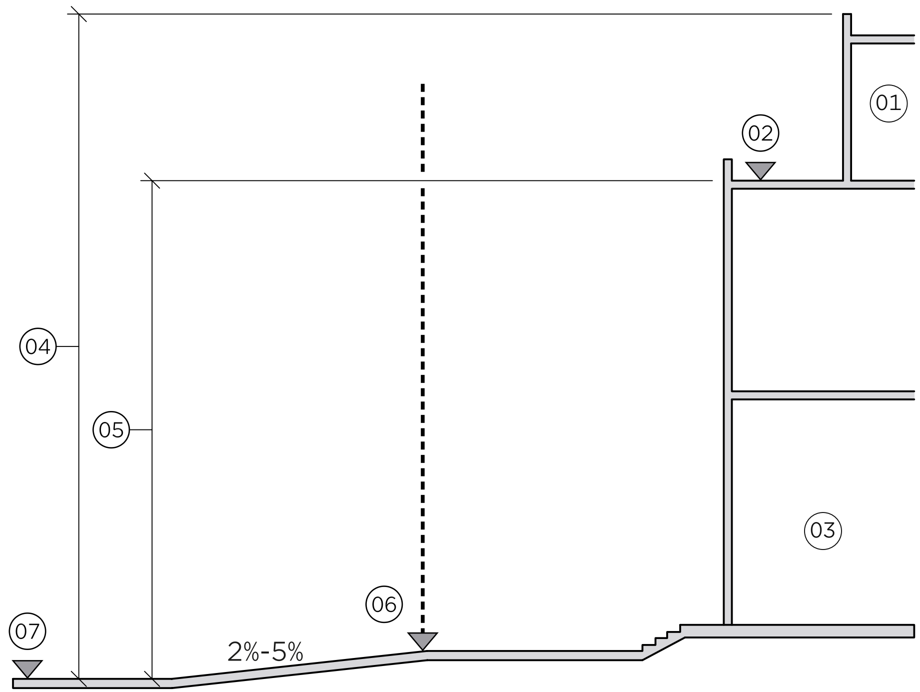


Figure K.4 Villa/townhouse height

Key

01: Roof structure
02: Roof level
03: Ground floor
04: Total building height
05: Building height
06: Gate level
07: Road edge level
- - - - Plot limit

K.5.2.3 Annexes

It is permitted to build annexes to residential villas/townhouses without any setback from the plot boundary.

Annexes can be used as private garages, housekeeper's rooms, external kitchens, amenities such as a gym or enclosed swimming pool, or as a majlis.

Annexes shall conform to the following requirements.

a) Setback shall be not less than 1.5 m between the annex and the main villa building. In townhouses the annex can be attached to the main townhouse building. See Figure K.5 and Figure K.6.
b) Annexes shall either be attached to plot boundary or follow building setback requirements in accordance with K.5.2.4.
c) The area of the annex shall not exceed 60% of the main building gross area (GA).
d) The maximum height of the annex shall be limited to 5.5 m.

K.5.2.4 Building setbacks

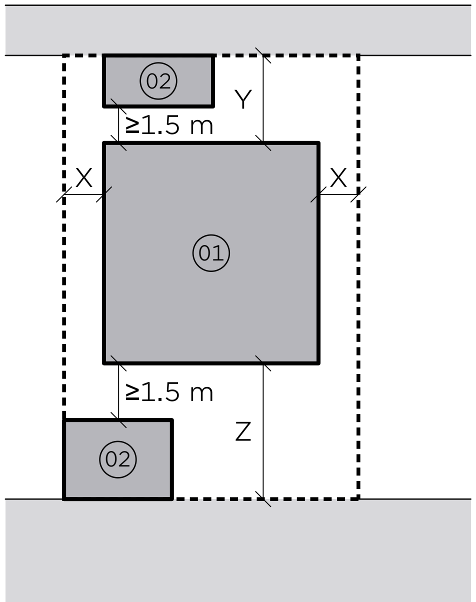
Building setbacks shall follow the permitting Authorities' requirements as noted in the DCR or affection plan. DCR and affection plan limitations shall take precedence over the requirements of this section.

Villas shall be separated or exterior walls shall be fire resistance rated to prevent external fire spread as required by Ch. 1 of UAE FLSC [Ref. K.1].

When setback limitations are not defined, setbacks shall be in accordance with Table K.1 and Figure K.5 to Figure K.9. For standalone villas, the distance between multiple buildings within the same plot shall be not less than 1.5 m measured from the least horizontal distance between buildings. Setbacks for annexes shall conform to K.5.2.3.

Villa type	Setback from road (Z) (m)	Setback from neighbour (X) (m)	Setback from sikka (Y) (m)
Villa	3	3	3
Townhouse/attached villa	3	0	3

Table K.1 Setback requirement



Key
01: Villa
02: Annex
X: Setback from neighbours
Y: Setback from sikka
Z: Setback from road

Figure K.5 Setback plan - Villas

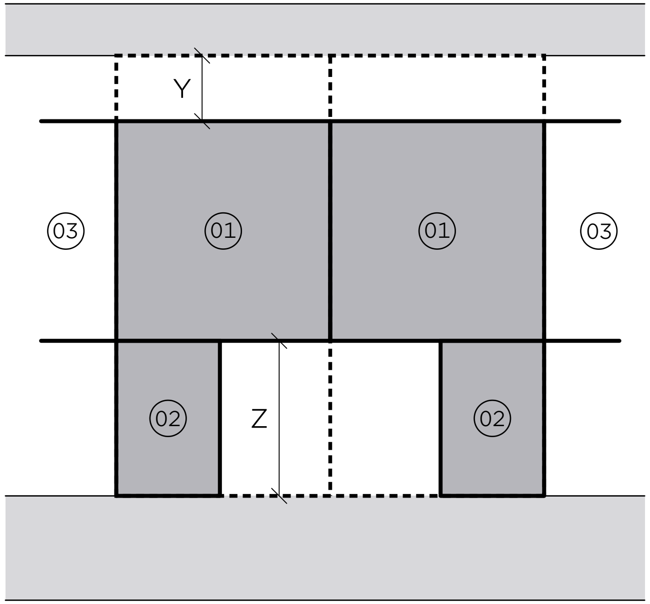


Figure K.6 Setback plan – Townhouses

Key
01: Villa
02: Annex
03: Neighbour
Y: Setback from sikka
Z: Setback from road

Key
X: Setback from neighbour
Z: Setback from road

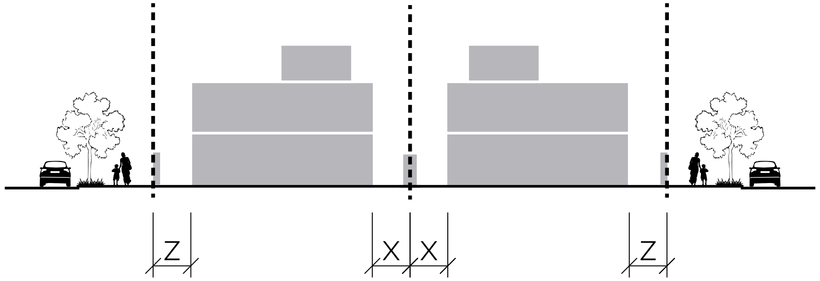


Figure K.7 Setback from neighbours (X) and road (Z) for standalone villas

Key
Y: Setback from sikka
Z: Setback from road

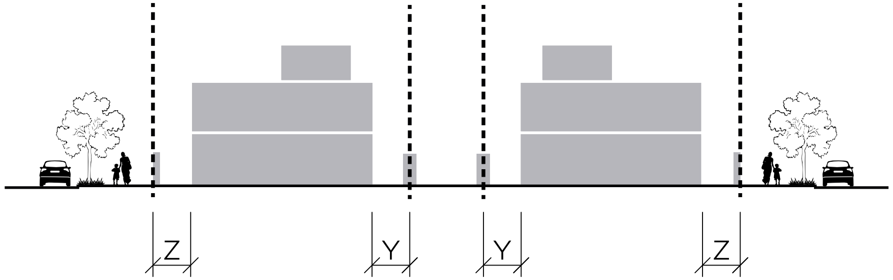


Figure K.8 Setback from road (Z) and sikka (Y) for standalone villas

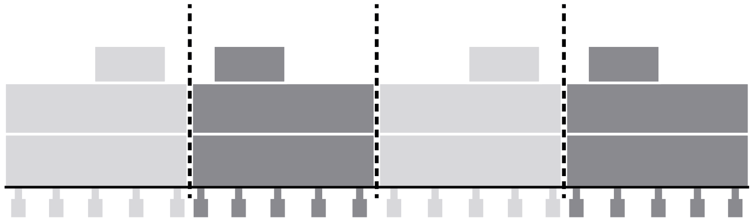


Figure K.9 Adjacent townhouses with separated structural foundations

Key

- - - - Plot limit

The following structures shall be allowed within setbacks up to the plot limit:

a) plot fencing;

b) site enhancement landscape and hardscape;

c) basement and villa substructure;

d) pergolas and lightweight parking shading structures;

e) internal roads

f) parking areas; and

g) villa annexes.

K.5.2.5 Balconies, building projections and terraces

K.5.2.5.1 Limitations

Balconies and building projections shall conform to the DCR or affection plan. DCR and affection plan limitations shall take precedence over the requirements of this section.

Balconies and building projections shall meet the following requirements.

a) They are situated at an elevated level from ground floor, not less than 2.7 m from finished floor level (see Figure K.10).

b) Balconies and projections shall follow setback requirements and shall not project beyond the plot limit.

c) Decorative projections up to 300 mm in depth are allowed within villa setback not less than 2.7 m above FFL. At roof, decorative projections are allowed up to 900 mm in depth.

d) The minimum horizontal distance of projections from adjacent villas/townhouses or neighbouring plot limits shall be not less than 3 m.

e) Balconies shall be provided with life safety features, such as fall protection and guardrails in accordance with K.5.2.5.2.

f) Privacy of neighbouring plots should be taken into account when setting the location and orientations of balconies.

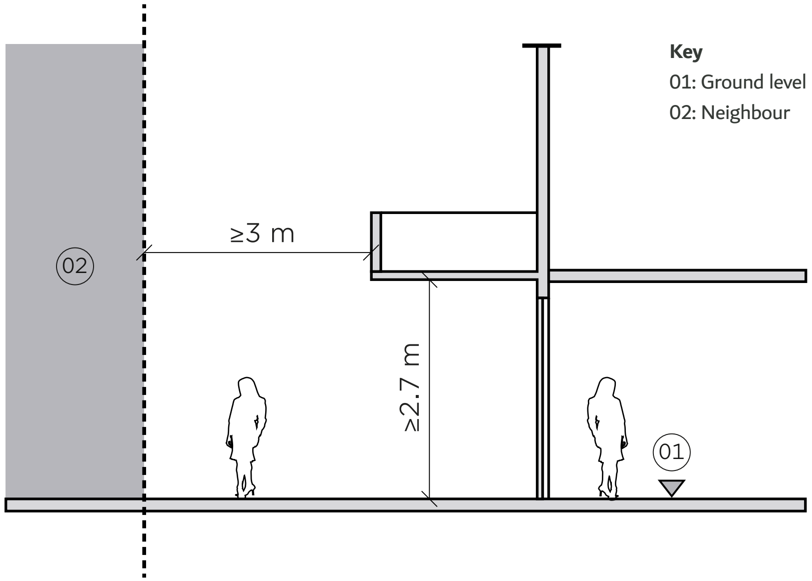


Figure K.10 Projection

K.5.2.5.2 Guardrails for fall protection

Guardrails are required for any space, walking or standing which is elevated 760 mm above the FFL.

The guard height from FFL (or lowest stepping feature), shall be not less than 1,200 mm.

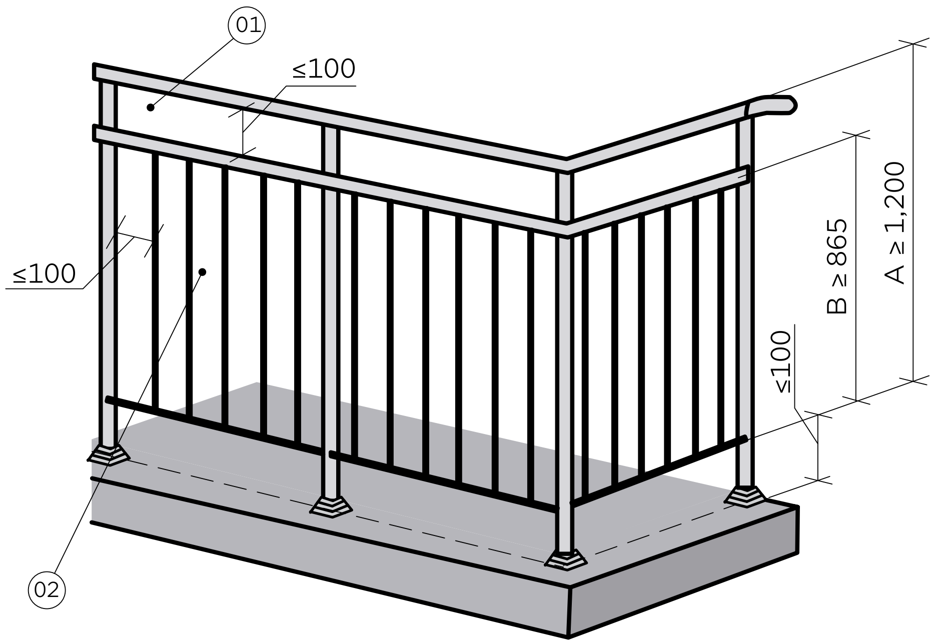


Figure K.11 Guard specifications

Key

01: Gaps more than 100 mm not acceptable

02: Stepping feature within 865 mm from base of guardrail not acceptable

The separation distance between vertical posts or members, curved frames or design features, of balcony, guardrail or handrail shall not allow the passage of a 100 mm diameter sphere.

Horizontal climbable elements are not permitted within 865 mm height of the bottom of the guardrail, i.e. (B) in Figure K.11.

If the design demands any gap between finished floor surface and the bottom most horizontal component of the railing, such gap shall be not more than 100 mm.

The balcony, handrail and guard assembly shall be able to withstand the loads specified in ASCE/SEI 7-16.

If the design demands usage of glass panels in the balcony construction, such glass shall be laminated glass which holds in place if shattered and withstand the loads specified in ASCE/SEI 7-16. See E.9.2.

K.5.2.6 Gross area (GA)

GA shall be calculated from within the inside perimeter of the exterior walls of the building excluding vents, shafts and courtyards.

GA includes corridors, stairways, the thickness of interior walls, columns or other features. A sample plan is provided in Figure K.12.

GA for townhouses shall be calculated from the centreline of the shared wall between the two villas. See Figure K.13.

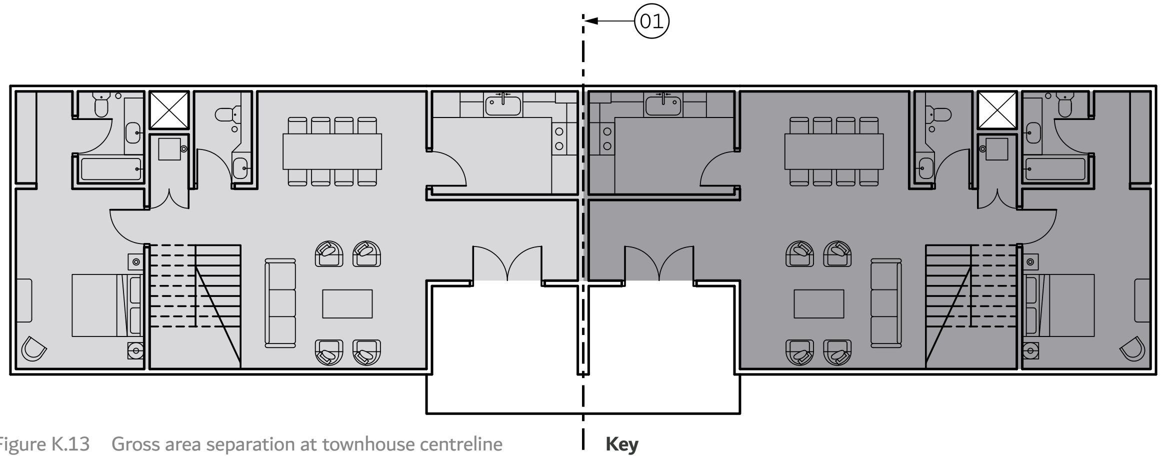


Figure K.13 Gross area separation at townhouse centreline

Key

01: GA boundary at plot boundary/townhouse separation line

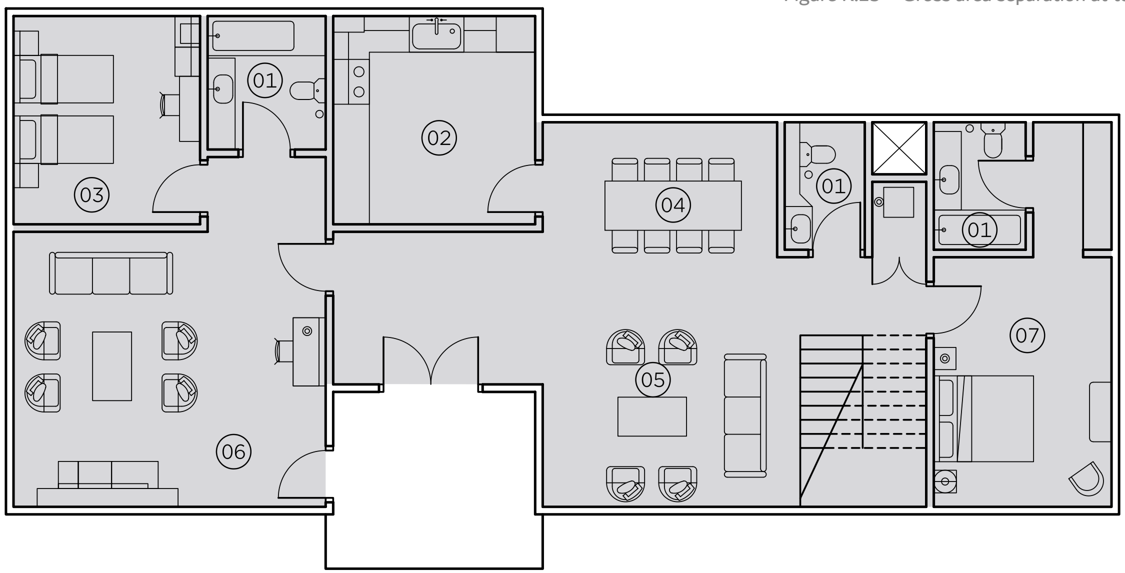


Figure K.12 Gross area (highlighted areas are included in area definition)

Key

01: Toilet

02: Kitchen

03: Guest bedroom

04: Dining

05: Living

06: Majlis

07: Ensuite bedroom

K.5.2.7 Plot coverage

Plot coverage shall be calculated as the horizontal area occupied by all main and annex buildings on the same plot, calculated from the external surfaces of external walls or useful roofed balconies in the ground or upper floors, whichever have more floor projections.

The following shall be excluded (see Figure K.14):

a) lightweight structures such as canopies, parking shades and pergolas; and

b) ornamental and non-accessible building projections such as roof eaves and window shades.

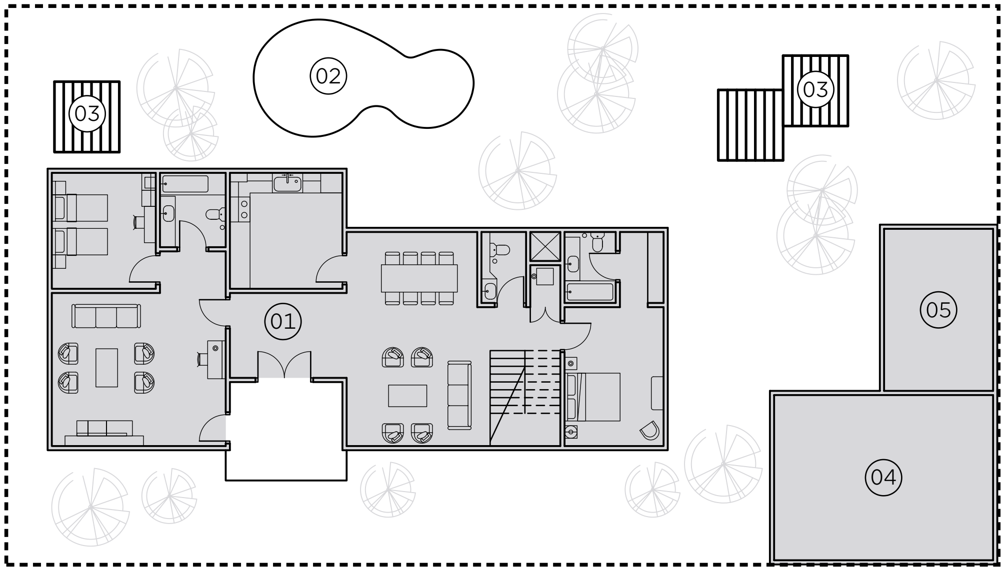


Figure K.14 Plot coverage (highlighted areas are included)

Key
01: Villa
02: Swimming pool
03: Pergolas
04: Garage
05: Annex
---- Plot limit

K.5.2.8 Floors general requirements

K.5.2.8.1 Ground floor

A villa or townhouse may have more than one ground floor where a split-level entrance has been provided and where the plot has a significant level difference.

K.5.2.8.2 Basements

The basement shall not extend beyond the plot limits.

The clear unobstructed height of the basement and semi-basement shall be not less than the values given in K.5.3.2.

Habitable spaces located in basement floors shall be provided with daylighting as required in K.5.4.2.

The basement slab soffit level shall not exceed 1.5 m above the building gate level as shown in Figure K.15.

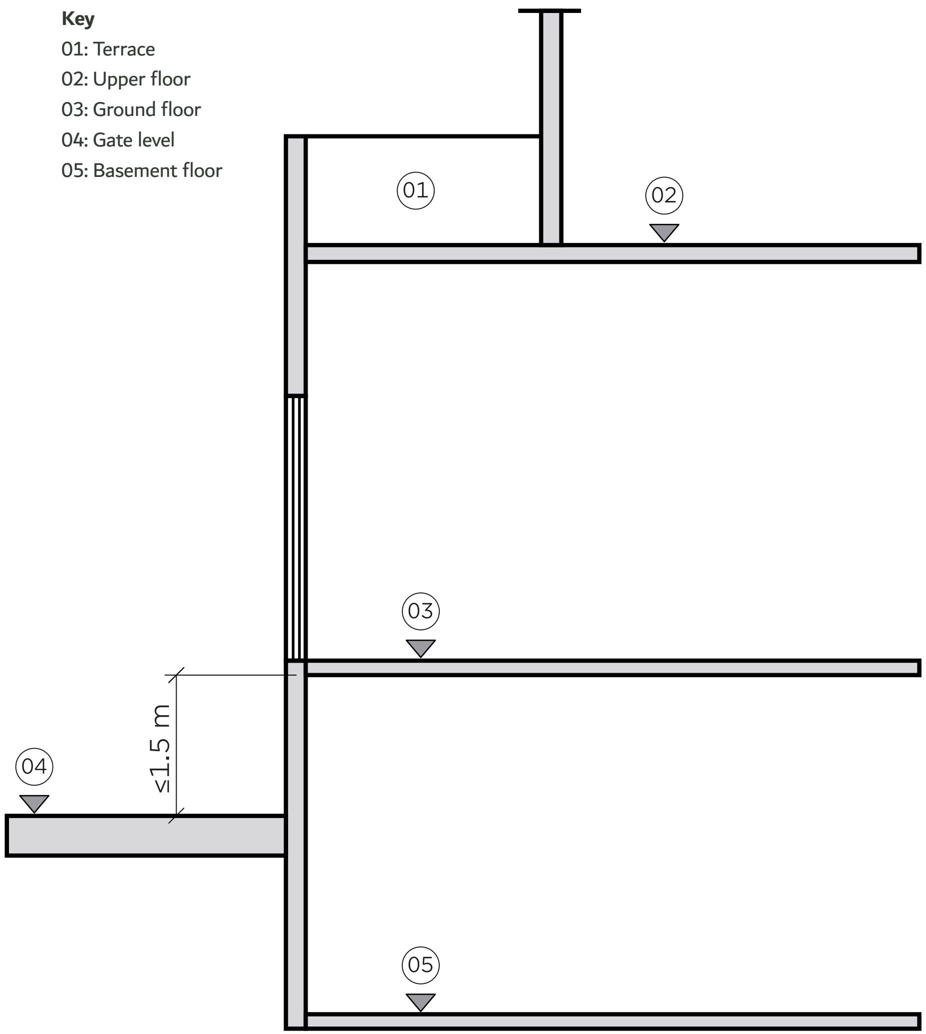


Figure K.15 Villa basement limit

K.5.2.8.3 Roof

Accessible roofs shall be provided with life safety features such as fall protection and guardrails in accordance with K.5.2.5.2.

Waterproofing and thermal insulation material shall be fitted on the rooftop in order to protect it from water leaks and solar gain effects.

Structures on roof level shall not exceed 50% of the roof floor area.

Roof structures shall be set back a minimum of 1.5 m from the building façade. The staircases or elevator room are excluded from the 1.5 m setback requirement, but they shall be calculated as part of the 50% construction area as shown in Figure K.16.

Roofs occupying more than 50% of the roof floor area or not provided with a setback shall be treated as a regular floor.

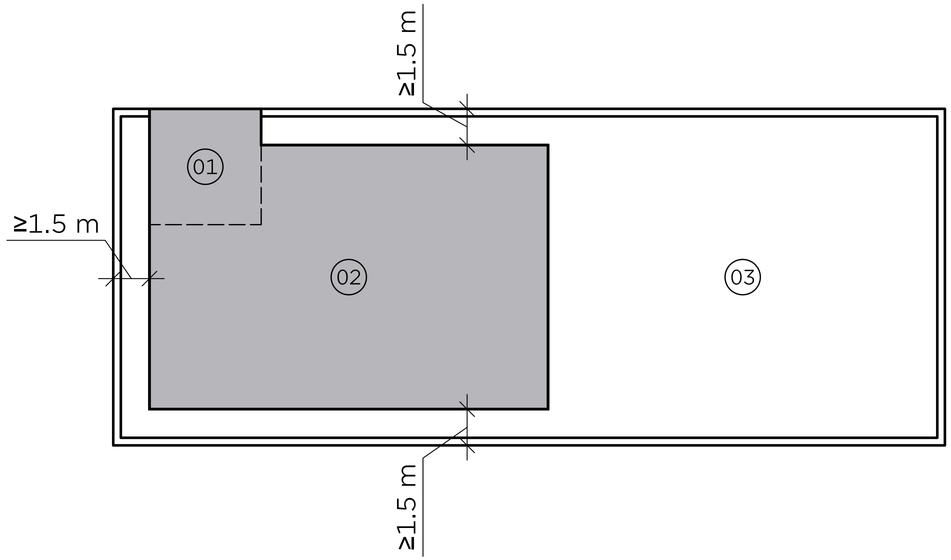


Figure K.16 Roof coverage and setback

Key
01: Staircase or elevator room
02: Roof structure, not more than 50% of roof area
03: Roof

K.5.3 Minimum space requirements

K.5.3.1 Minimum room sizes

The net area and clear dimension of a room/space shall be not less than the values given in Table K.2 and Figure K.17.

Space use	Minimum area (m^2)	Minimum dimension – length and width of a room (m)
Living space (bedroom, living room, etc.)	10.5	3
Housekeeper's rooms/guard rooms – single occupancy (without toilet)	5.5	2.1
Enclosed kitchen	5.4	1.8
Bathroom and toilets	In accordance with fixture clearances noted in K.5.7	

Table K.2 Minimum room sizes

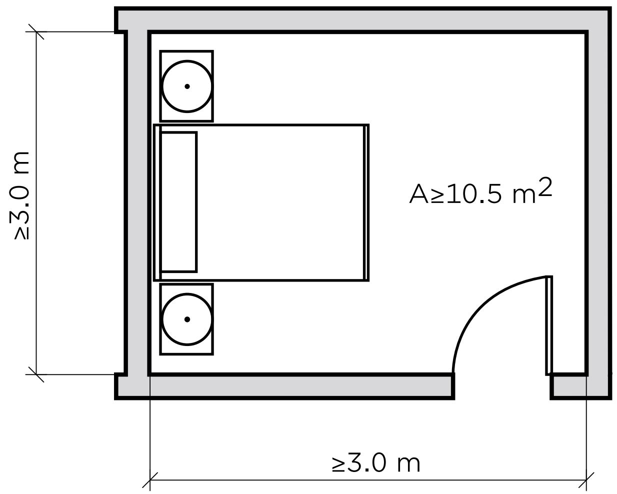


Figure K.17 Minimum bedroom sizes

Manoeuvring space between kitchen counters or in adjacency to single-sided kitchen counter shall be not less than 1.2 m (see Figure K.18).

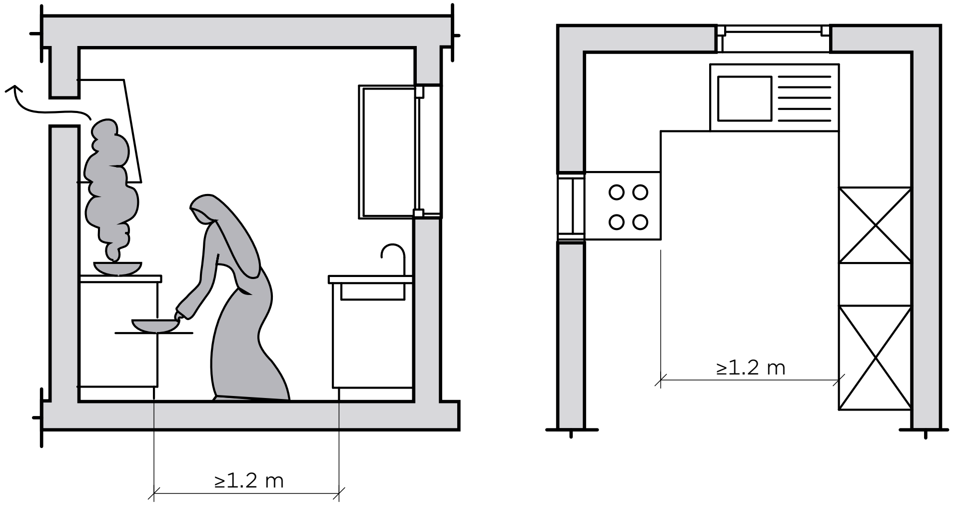


Figure K.18 Manoeuvring space within kitchen

K.5.3.2 Minimum clear heights

Clear heights shall be not less than the minimum values given in Table K.3. Clear heights shall be calculated from FFL to any structural suspended element or ceiling soffits, as shown in Figure K.19.

Space use	Minimum clear heights (m)
Living and bedroom spaces	2.7
Any other spaces	2.3
Staircases	2.3
Rooms under staircases (non-habitable only) NOTE: Non-habitable rooms under staircases may include utility rooms, powder rooms and storage	2.03

Table K.3 Minimum clear heights

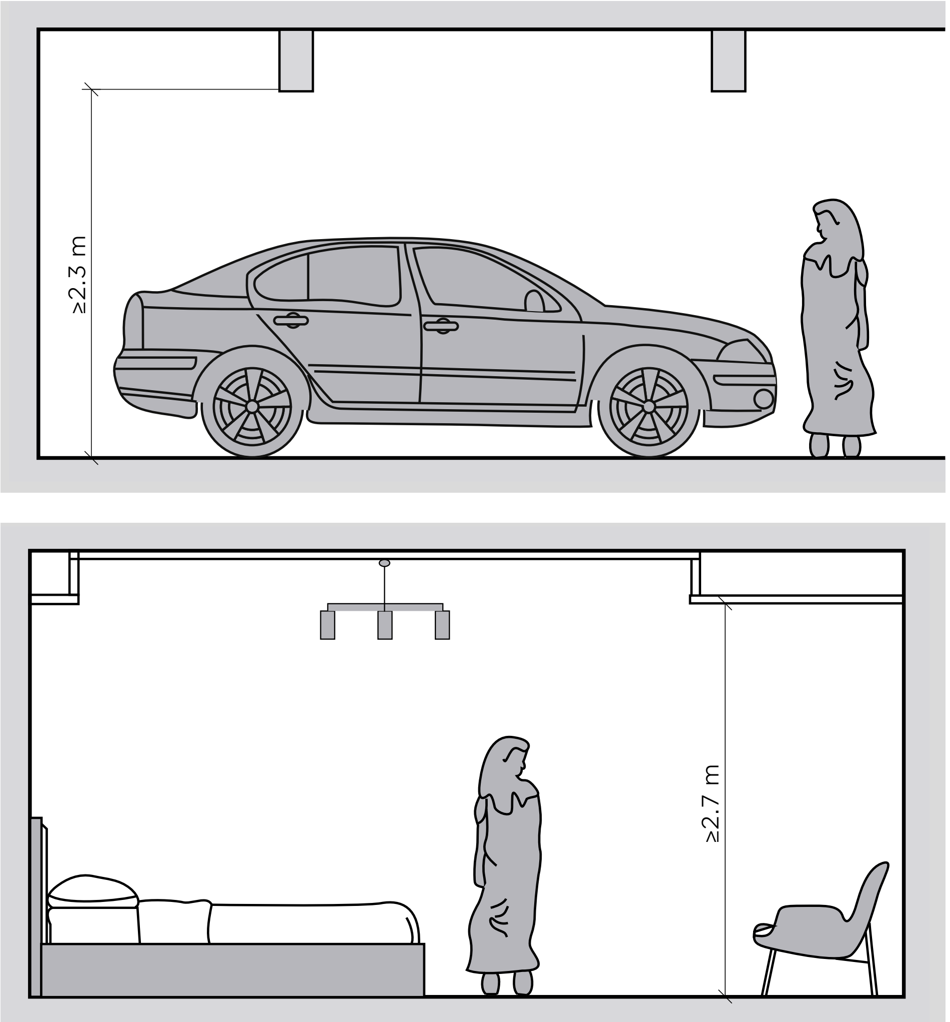


Figure K.19 Measurement of minimum clear heights

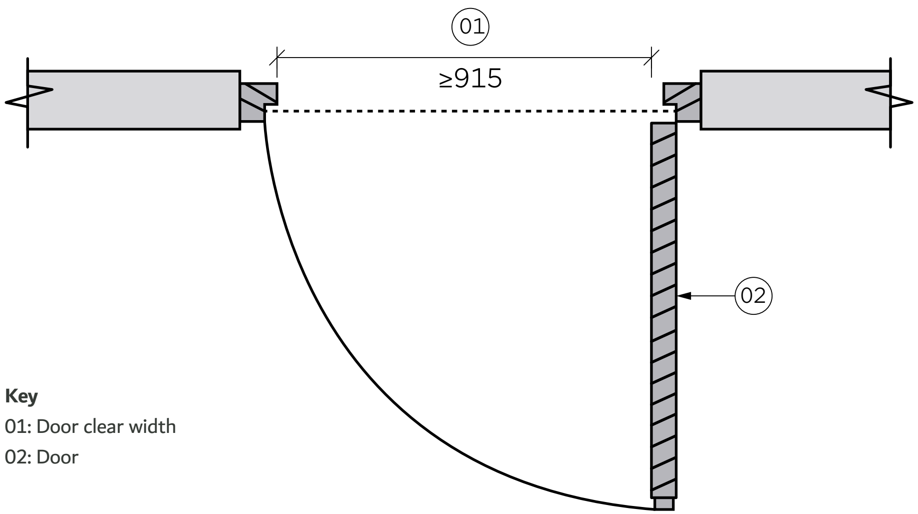
K.5.4 Openings

K.5.4.1 Doors

Door clear widths shall be not less than the values given in Table K.4 and Figure K.20.

Door location	Minimum door clear width (mm)
Entry doors, general	915
Bathrooms and toilets	710

Table K.4 Minimum door clear width



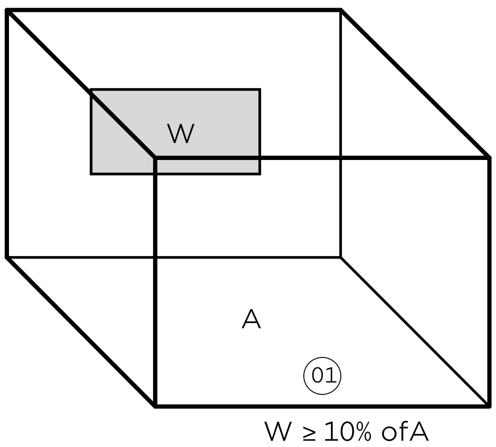
Key
01: Door clear width
02: Door

Figure K.20 Door minimum clear width

K.5.4.2 Windows and daylighting

K.5.4.2.1 Minimum area of windows

Villa/townhouse bedrooms, living rooms and kitchens shall be equipped with windows with net glazing area not less than 10% of the habitable space floor area (see Figure K.21). Daylight modelling to justify lighting levels can be used to reduce minimum opening percentage requirements. Lux levels from daylight shall achieve a minimum of 150 lux in bedrooms and living rooms.



Key
01: Habitable space
A: Room area
W: Window net glazing area

Figure K.21 Window glazing area to room area ratio

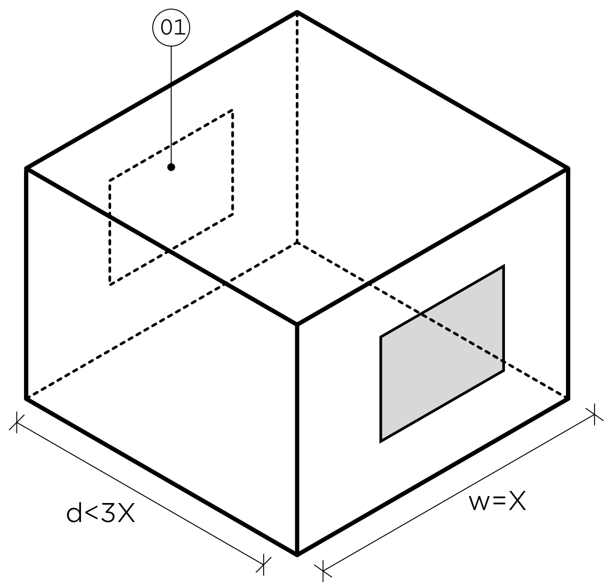
The following requirements and recommendations apply to windows.

a) When windows are equipped with mechanical opening means, they shall be positioned at a height between 900 mm to 1,500 mm from the room FFL.
b) The operable portion of the window shall be positioned at a safe height. The window sill shall be positioned at a height of not less than 900 mm from the interior FFL.
c) The required amount of daylighting can be provided through skylights or windows or combination of both for all building spaces. The skylight glazing should be positioned at a slope of 15° or more from vertical and directly connected to the space it serves.
d) Windows may only face neighbouring plots when the required setback is achieved and when the requirements for external fire spread are achieved as per Sections 2.7 and 2.8, Ch. 1 of UAE FLSC [Ref. K.1].
e) Housekeeper's rooms shall be provided with adequate natural lighting and equipped with windows with net glazing area not less than 8% of the room floor area.

K.5.4.2.2 Habitable room conditions for natural lighting

For rooms to be adequately naturally lit through windows, the room depth should not exceed three times its width (see Figure K.22).

When the room depth exceeds three times the width in which the window of the room is located, additional natural lighting should be provided through an additional window adhering to the criteria set in Figure K.22. The additional window can be along any of the room's other sides with direct access to daylighting.



Key
01: Additional opening

Figure K.22 Windows in rooms

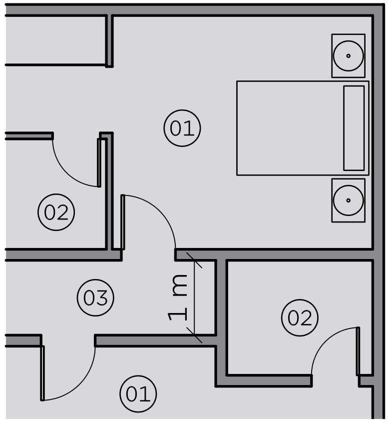
K.5.4.2.3 Access to views

Direct line of sight (views) shall be provided to the outdoor environment from habitable spaces.

K.5.5 Circulation and egress

K.5.5.1 Hallways and corridors

Hallways and corridors shall have a minimum clear width of 1.0 m and a clear headroom of 2.3 m without obstructions (see Figure K.23).



Key
01: Bedroom
02: Ensuite toilet
03: Internal corridor

Figure K.23 Corridor example

K.5.5.2 Stairs

K.5.5.2.1 General

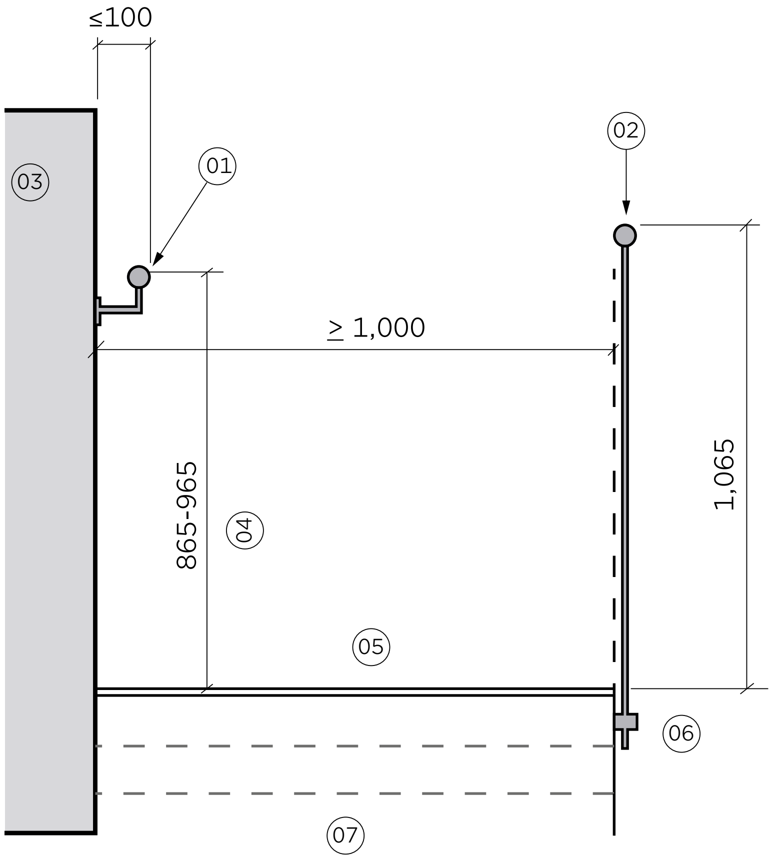
Spiral stairs, winders and open stairs are permitted for all uses other than access and exit from basements.

Basements shall have standard enclosed exit stair of 1,000 mm clear width leading to discharge level.

K.5.5.2.2 Stairway width

All stairways shall have at least 1,000 mm clear width.

The required width of a stairway shall be measured from wall to the clear available width of the step (see Figure K.24). The maximum projections of handrails allowed in the required width is 100 mm on each side, at a height of 865 mm to 965 mm (see Figure K.24).



Key
01: Handrail
02: Dual guardrail
03: Wall
04: Handrail
05: Tread
06: Open side
07: Stair

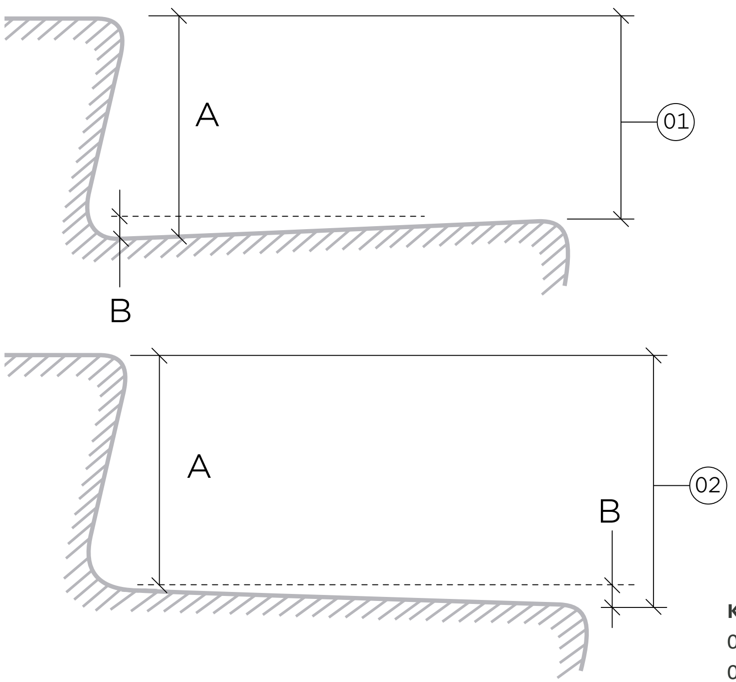
Figure K.24 Handrail encroachment

K.5.5.2.3 Stair risers and treads

Stair riser height as measured in Figure K.25 shall be in the range 100 mm to 180 mm.

Riser heights shall be as uniform as possible throughout each stair flight between landings.

Where riser heights are adjusted to meet acceptable stair treads, flights and arrangements, there shall be no more than 10 mm difference in riser height within a single flight.



Key
01: Riser height = A - B
02: Riser height = A + B

Figure K.25 Stair risers

Minimum stair tread depth shall be not less than 280 mm (see Figure K.26).

The tread slope shall not exceed 21 mm/m (2% slope).

Tread depth shall be as uniform as possible throughout the stair. There shall be no more than 10 mm difference in tread depth within a single flight.

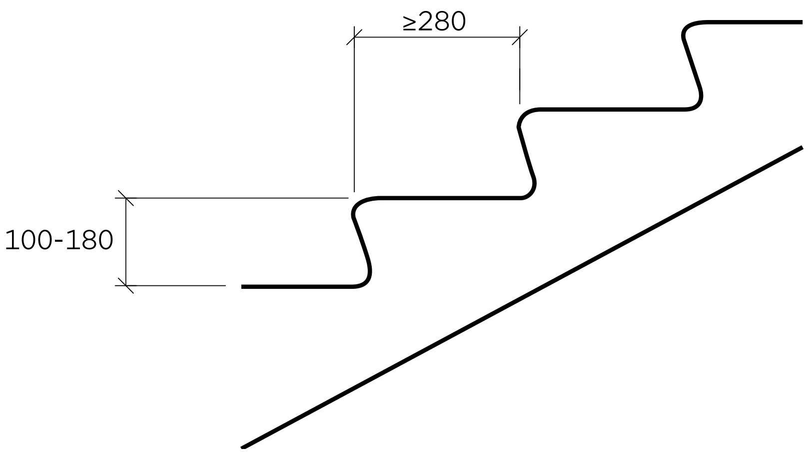


Figure K.26 Step dimensions

K.5.5.2.4 Landings

An intermediate landing is not required on stairways in villas regardless of the floor to floor height. Intermediate landings are recommended if the floor to floor height exceeds typical practice (e.g. > 4m).

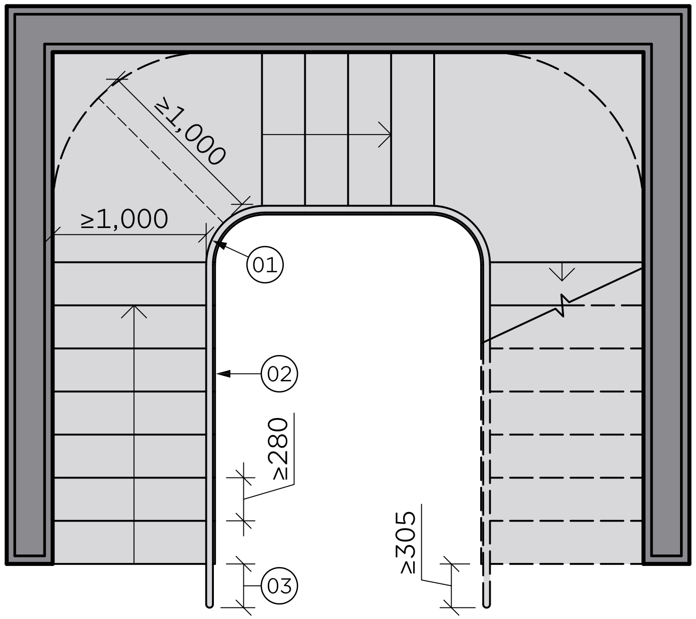
For enclosed staircases, the stair shall have a landing at the door opening and the landing width shall be not less than the required stairway width.

The maximum landing area that a door can encroach in its swing is one half of the required landing width.

Landing width shall not decrease in width along the direction of egress travel, as shown in Figure K.27.

The landing width shall be not less than 1,000 mm. The landing width is not required to exceed 1,000 mm in the direction of travel, provided that the stairway has a straight run.

The landing slope shall not exceed 21 mm/m (2% slope).



Key
01: Continuous
02: Dual guardrail
03: Equal to tread depth

Figure K.27 Example of a villa stair

K.5.5.2.5 Handrails

Stairs shall have handrails on the open side of the stair as shown in Figure K.28.

Handrails on stairs shall be located between 865 mm and 965 mm above the surface of the tread, measured vertically to the top of the rail from the leading edge of the tread.

The height of required handrails that form part of a guardrail (see Figure K.24) can exceed 965 mm, but shall not exceed 1,065 mm, measured vertically to the top of the rail from the leading edge of the tread.

Handrails shall be installed to provide a clearance of not less than 57 mm between the handrail and the wall to which it is fastened.

Handrails shall continue for the full length of each flight of stair.

Inside handrails shall be continuous and graspable between flights at landings.

Handrails shall have circular cross-section with an outside diameter of not less than 32 mm and not more than 51 mm.

Handrail shape that is other than circular (see Figure K.29) shall be with a perimeter dimension of not less than 100 mm, but not more than 160 mm, and with the largest cross-sectional dimension not more than 57 mm, provided that graspable edges are rounded so as to provide a radius of not less than 3.2 mm.

Handrail brackets shall not project horizontally beyond the sides of the handrail within 38 mm of the bottom of the handrail. For each additional 13 mm of handrail perimeter dimension above 100 mm, the vertical clearance dimension of 38 mm may be reduced by 3.2 mm.

Handrail brackets shall have edges with radius not less than 0.25 mm.

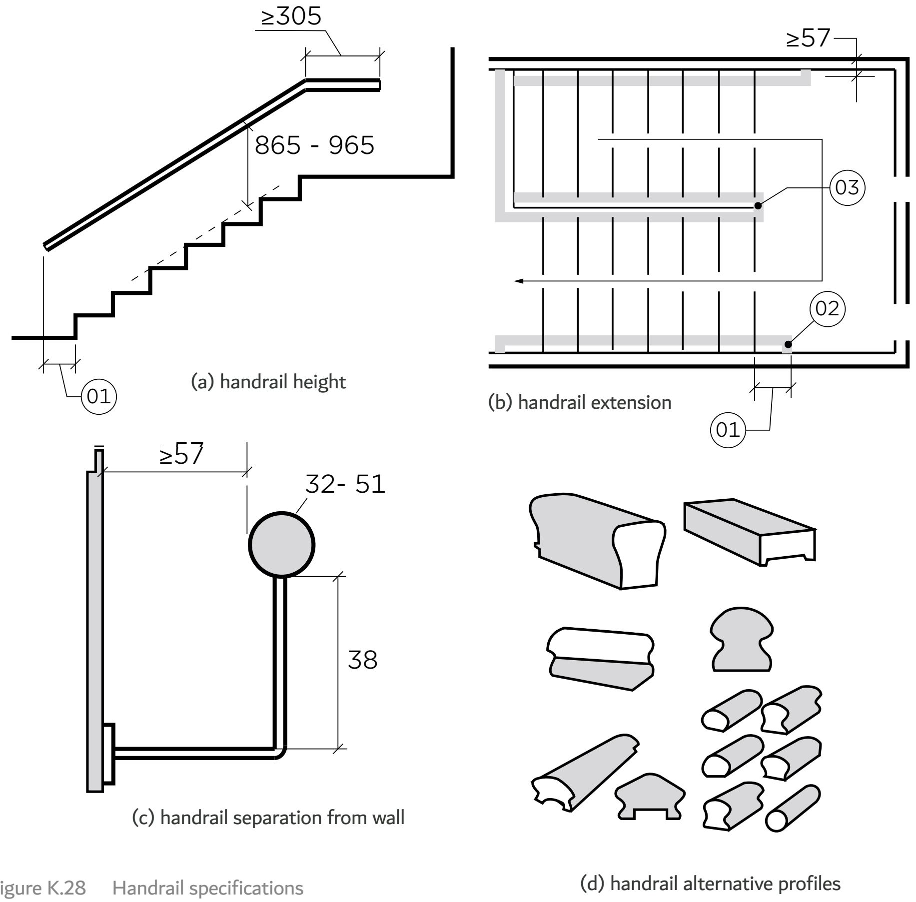


Figure K.28 Handrail specifications

Key
01: One tread depth handrail extension
02: Return of handrail to wall required
03: Handrail turn required

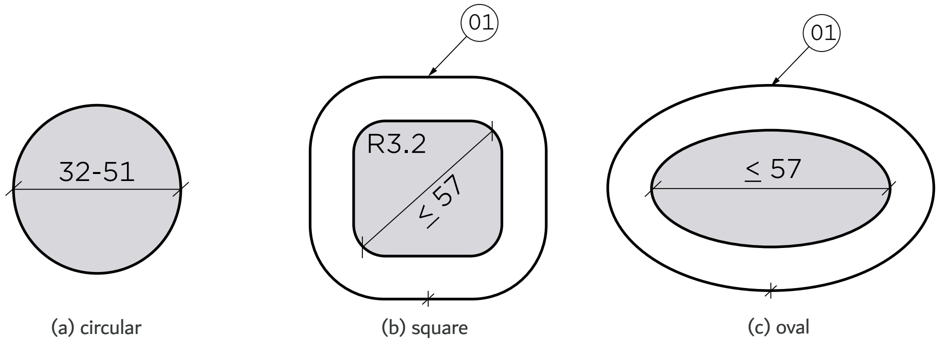


Figure K.29 Cross-sections of handrails

Key
01: 100 mm to 160 mm perimeter

K.5.5.2.6 Guardrails

Guardrails as shown in Figure K.30 shall be provided for every stairway where the elevated surface is more than 760 mm from finished ground level.

Such guardrails shall not encroach on the required clear width of the stairway.

The height of guardrails shall be measured vertically to the top of the guardrail from the surface adjacent thereto.

Guardrails shall be a minimum of 1,200 mm high. In case of stairway or ramp handrails that form part of a guardrail, the height of the guardrail can be reduced to 1,065 mm.

Open guardrails, shall have intermediate rails or an ornamental pattern up to a height of 865 mm, such that a sphere 100 mm in diameter is not able to pass through any opening.

The triangular openings formed by the riser, tread, and bottom element of a guardrail at the open side of a stair shall be of such size that a sphere 150 mm in diameter is not able to pass through the triangular opening.

Guardrails at landings or balconies over stairways shall also conform to K.5.2.5.2.

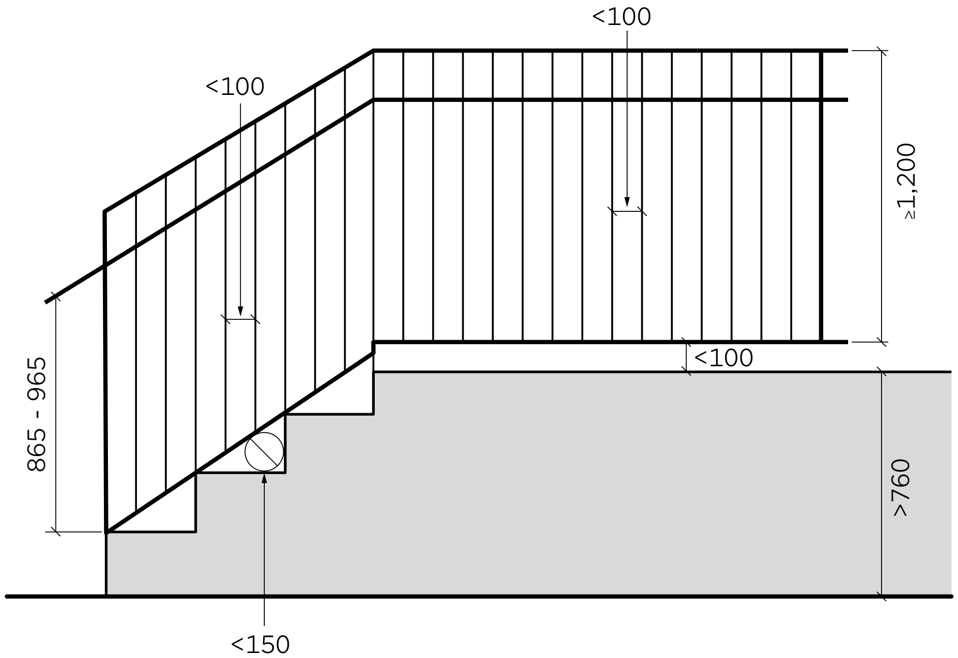


Figure K.30 Guardrail example

K.5.5.2.7 Exterior stairways

Outside stairs more than 11 m above the finished ground level, shall be provided with an opaque visual obstruction not less than 1,200 mm in height.

K.5.5.2.8 Spiral or curved stairs and winders

Spiral or curved stairs (see Figure K.31) shall meet the following requirements.

a) The clear width of the stairs shall be not less than 1,000 mm.
b) Curved stair headroom shall be not less than 2,300 mm and spiral stair headroom shall be not less than 2,030 mm.
c) Spiral stairs shall have a tread depth not less than 190 mm at a point 305 mm from the narrower edge (see Figure K.32).
d) Curved stairs shall have tread depth of not less than 255 mm at a point 305 mm from the narrowest edge (see Figure K.33).
e) The height of risers shall not exceed 240 mm.
f) All treads shall be identical.
g) Handrails shall be provided in accordance with K.5.5.2.5.
h) The turn of the stairway shall be such that the outer handrail is at the right side of descending users.
i) Winders (see Figure K.31) shall have a tread depth of not less than 150 mm at their narrowest, and a tread depth of not less than 280 mm when measured at a point 305 mm from narrowest edge.

Spiral stairs have limited capacity for circulation and movement and are not recommended to be utilized as the main stairway of the villa.

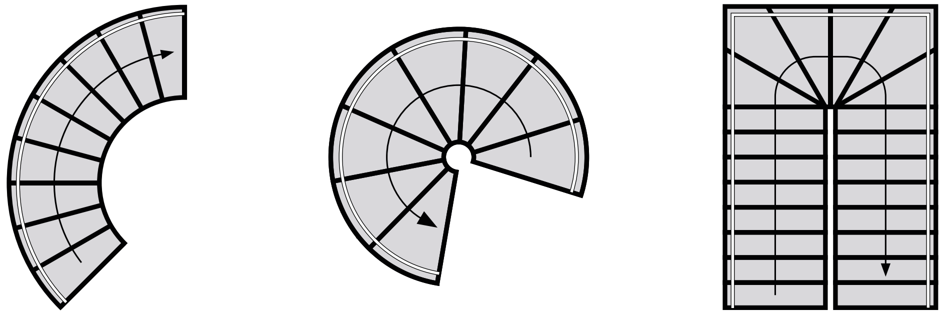


Figure K.31 Examples of curved stairs, spiral stairs and winders

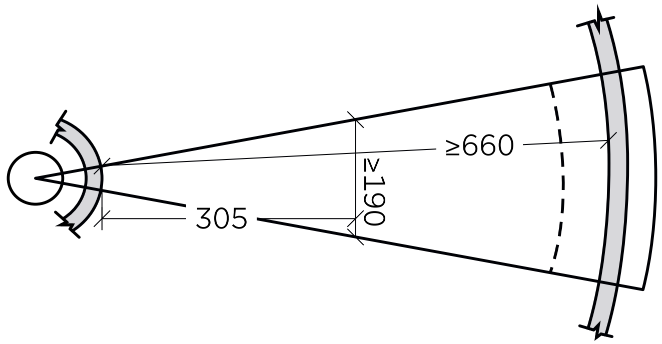


Figure K.32 Spiral stairs

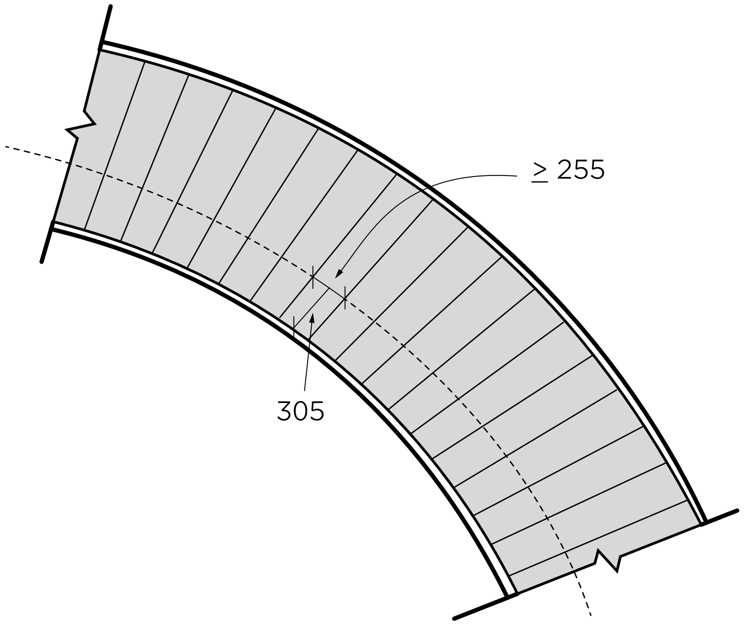


Figure K.33 Curved stairs

K.5.5.2.9 Surfaces

Stair treads and landings shall be free of projections or lips that could trip stair users.

Stair treads and landings within the same stairway shall have consistent surface traction.

K.5.5.2.10 Minimum headroom

Head room in stairways shall be not less than 2.3 m, measured vertically above a plane, parallel to the most forward projection of the stair tread (see Figure K.34).

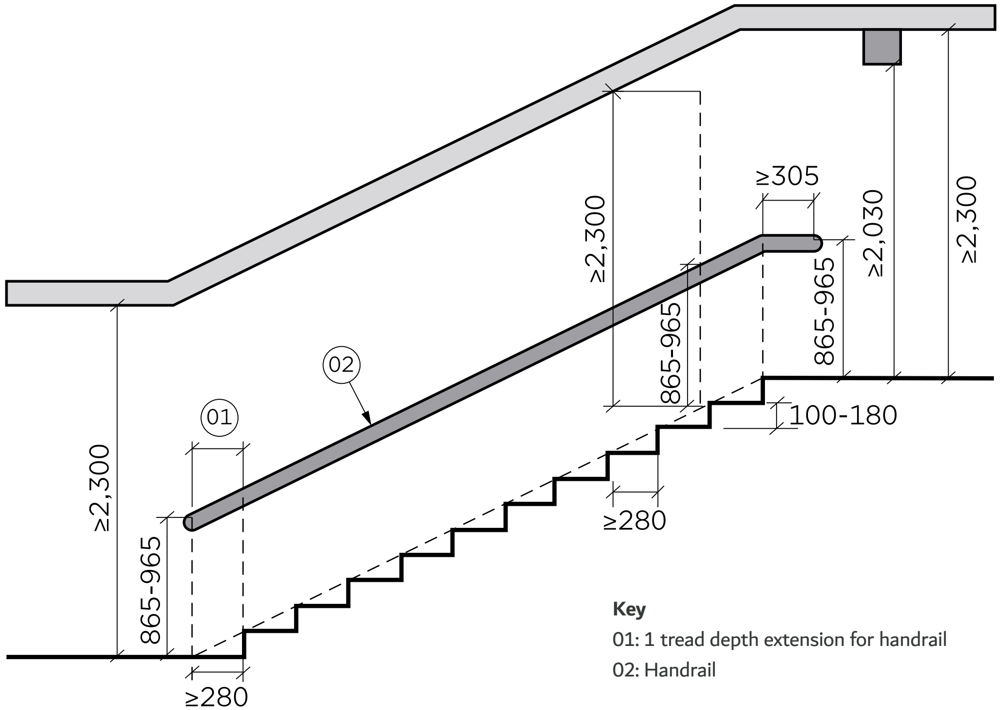


Figure K.34 Staircase arrangement

K.5.5.3 Ramps

If ramps are provided for access, they shall conform to C.5.9.1.

K.5.5.4 Elevators

If elevators are provided, their design shall conform to D.5 and D.6.

K.5.5.5 Means of egress

Means of egress shall conform to Ch. 3 of UAE FLSC [Ref. K.1].

K.5.6 Access and vehicular requirements

K.5.6.1 Building access

The following provisions shall be included when setting the villa/townhouse access strategy during the design process.

a) The design shall allow for pedestrian access.

b) Access routes for firefighting shall be provided in accordance with Ch.2 of UAE FLSC [Ref. K.1].

c) All parts of the site to which vehicles may have access shall be hard-surfaced and drained.

K.5.6.2 Firefighting vehicle access

For cluster housing developments (with shared communal facilities), a fire truck accessway with a width not less than 6 m shall be provided to within a travel distance of 60 m from every point on the projected plan area of any building in the housing developments, as shown in Figure 2.10, Ch. 2 of UAE FLSC [Ref. K.1].

K.5.6.3 Vehicle access and movement

K.5.6.3.1 General requirements

Vehicle access shall be located away from any traffic intersections depending on road type, vehicle type and other factors as approved by the Authority.

Vehicle access shall conform to RTA ROW requirements and shall be designed in accordance with the RTA Dubai access management manual [Ref. K.3] and RTA Geometric design manual for Dubai roads [Ref. K.4].

Vehicular entries and exits shall be separated from any local road intersection by at least 6 m from the chamfered edge of the plot (see Figure K.35).

Access shall be as defined in the affection plan or DCR and subject to the agreement and approval from RTA.

Vehicle access shall not be located opposite a T junction, as shown in Figure K.36.

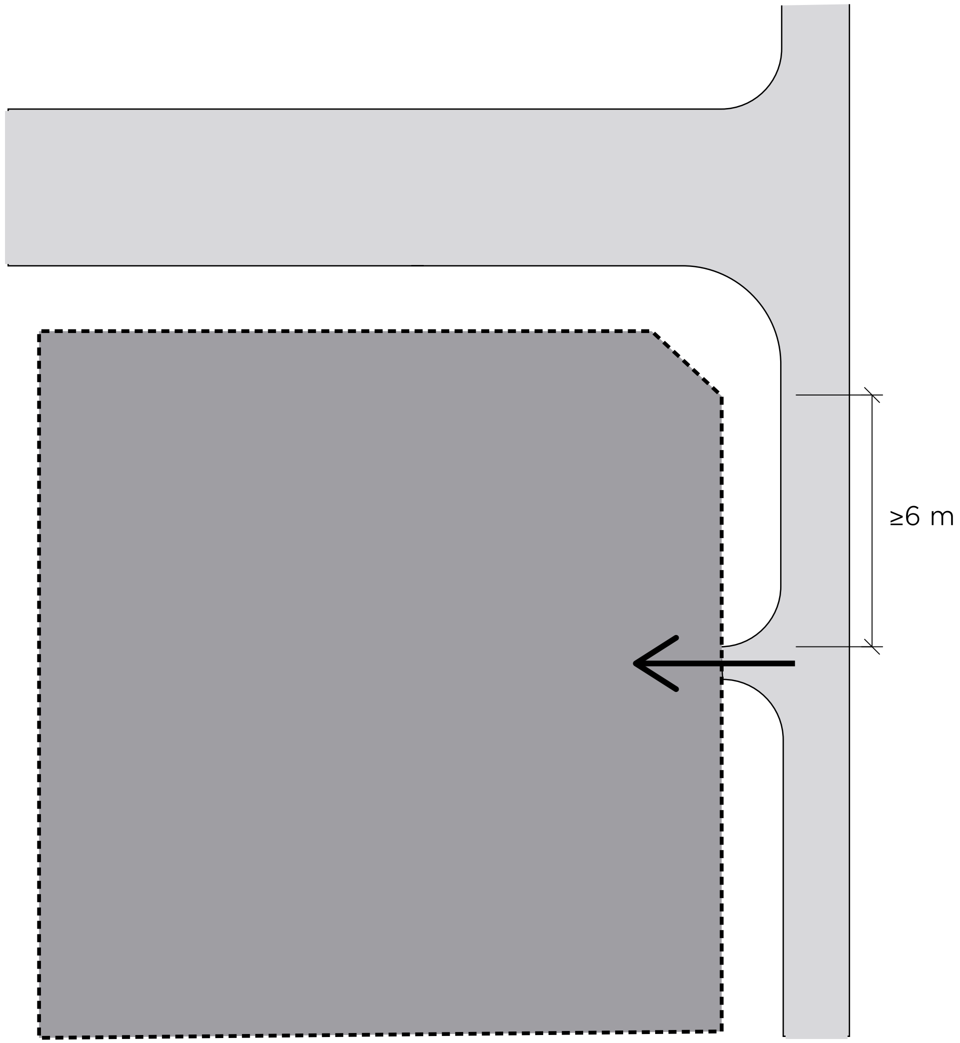


Figure K.35 Building vehicle access

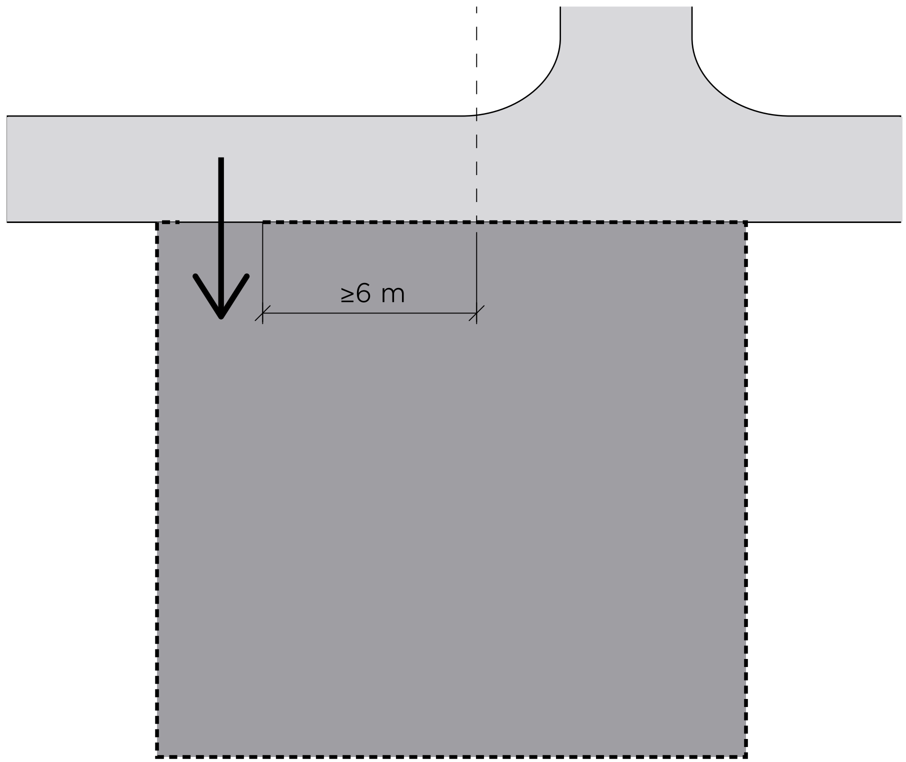


Figure K.36 T junction vehicle access

Key

- - - - Plot limit

The minimum width of internal roads shall be 3 m wide clear unobstructed.

The vehicular roadway and parking area should be provided with exterior lighting to illuminate the surface area. Lighting shall be designed, arranged and installed to confine direct rays within plot limits and to direct light away from adjacent structures, premises or streets. Lighting fixtures should be shielded to avoid light pollution.

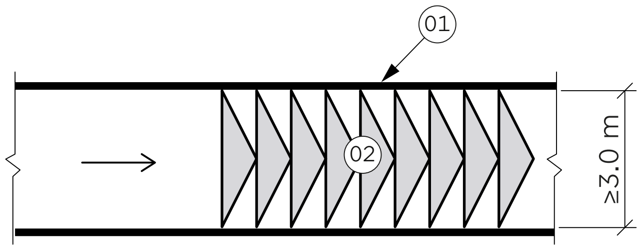
K.5.6.3.2 Vehicular ramps

Ramps allocated for vehicular access shall conform to Table K.5.

Ramp type	Maximum slope percentage	Minimum single lane width (m)	Minimum inner circle radius (m)	Minimum vertical clear height above any point (m)
Straight See Figure K.37	12%	3	-	2.4
Curved	12%	3.5	4	2.4
Helical	8%	5	6	2.4

Table K.5 Ramp slope and width

Villas/townhouses can have a single lane ramp to be used for access and exit as shown in Figure K.37.



Key
01: Curb or structure
02: Ramp

Figure K.37 Ramp for villas, single lane

Vehicular ramps shall be equipped with the following:

a) Floor surfaces shall be of broom finish texture or provided with anti-slip treatment.
b) Ramps shall be free from any projections or obstacles that can obstruct safe movement or use.
c) Corners of structural elements adjacent to ramps shall be covered with protective materials.
d) Ramps shall be provided with adequately sized reflective mirrors to enhance visibility at directional changes, turns and in areas where visibility is difficult.
e) Ramps shall be equipped with all necessary connections for rainwater drainage.
f) Floor surfaces shall be non-combustible, graded and equipped with drainage in accordance with Table 3.37, Ch. 3 of UAE FLSC [Ref. K.1].

K.5.6.4 Parking areas and garage

Parking areas (covered or uncovered) shall be provided for vehicles within the plot limits in accordance with Table K.6, unless the requirement of the DCR or affection plan differs. DCR and affection plan requirements shall take precedence over Table K.6.

All parking lots shall be provided with durable and well-drained surfaces.

Parking spaces under buildings or basement parking shall account for the presence of columns and adjacent walls.

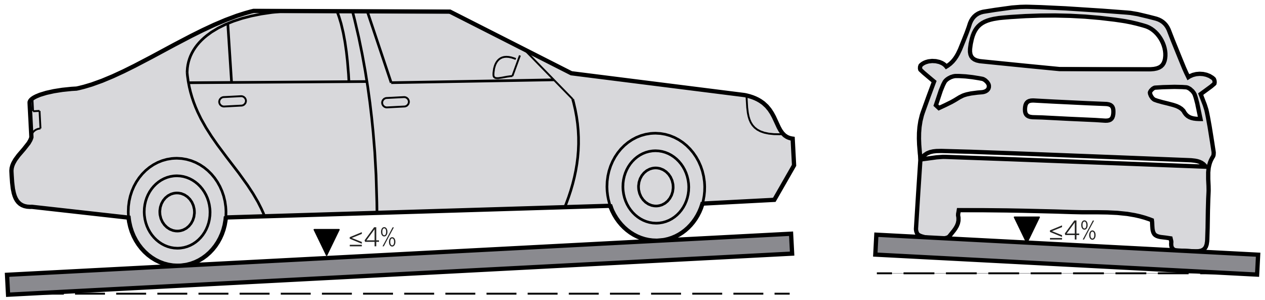


Figure K.38 Parking slope

Tandem parking shall be allowed within the plot limit.

The maximum slope in which parking is allowed shall be 4% as shown in Figure K.38.

Villa type	Minimum parking requirement
Villa	1 bay per villa
Townhouse	1 bay per townhouse

Table K.6 Parking requirement

Garages shall conform to Table K.7 and Figure K.39.

Garage type	Minimum width (m)	Minimum length (m)
Single garage – open	3	5.5
Single garage – enclosed	3.6	6.0
Double garage – enclosed	6.0	6.0

Table K.7 Garage minimum dimensions

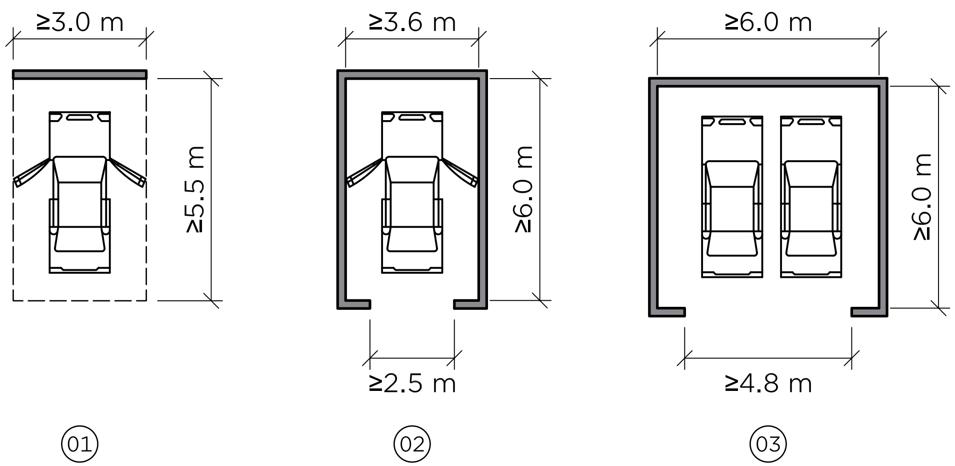


Figure K.39 Garage minimum dimensions (single and double)

Key
01: Single garage – open
02: Single garage
03: Double garage

If the villa or townhouse provides more than two parking bays, they shall meet the requirements for parking sizes and manoeuvring given in B.7.2.4.

K.5.6.5 Maintenance ladders

Maintenance ladders shall conform to B.7.3.3.

K.5.7 Sanitary requirements

K.5.7.1 General requirements

Every villa/townhouse shall include sanitary facilities, including a water closet, sink and a bathtub or shower.

Water closet, wash basins, showers and baths shall have a smooth and readily cleanable non-absorbent surface.

All sanitary fixture finishing materials and fixed fittings shall be moisture-proof and the floors of these fixtures shall be made of non-slip materials.

Lighting shall be provided in all sanitary facilities.

Appropriate ventilation should be provided in all sanitary facilities in accordance with K.10.1.6.

In toilets, bathrooms and shower rooms, the floor finish material shall have a smooth, hard, non-absorbent surface.

Intersections of such floors with walls shall have a smooth, hard, non-absorbent vertical base that extends upward to the walls to a height of not less than 100 mm.

Walls and partitions within 600 mm of sanitary fixtures shall have a smooth, hard, non-absorbent surface, up to a height of not less than 1,200 mm above FFL. The finished material should be moisture-proof.

Shower compartments and walls above bathtubs shall be finished with a smooth, non-absorbent surface to a height of not less than 1,800 mm above the drain outlet.

K.5.7.2 Fixture clearances

Fixed fittings in sanitary facilities shall conform to the fixture clearances in Figure K.40 and as follows:

a) The centres of water closet, wash basins and faucets shall be not less than:
   1) 400 mm from any side wall, partition, vanity or other obstruction; and
   2) 750 mm from the centre of an adjacent fixture.

b) There shall be a 750 mm clearance in front of the water closet or wash basin to any wall or door leaf, and 600 mm clearance to any opposite fixture.

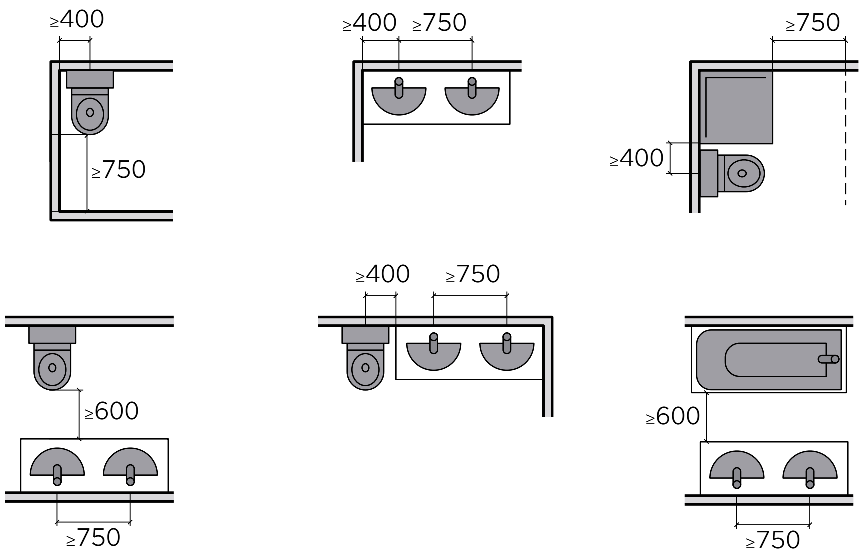


Figure K.40 Fixture clearances

K.5.8 Amenities

K.5.8.1 Gymnasiums, exercise rooms

If exercise rooms are provided, the location of these spaces shall be studied to avoid creating noise impact and privacy concerns for neighbours and adjacent structures. Acoustic treatment of these spaces is recommended.

K.5.8.2 Swimming pools

K.5.8.2.1 General requirements

This section applies to private pools within individual villa plots. Community swimming pools shall comply with B.8.3.2.

Swimming pools and decks shall be constructed of non-toxic, inert, impervious and durable materials.

Swimming pools shall be provided with adequate lighting, both above and under the water surface in order to provide an adequate illumination for the overall area of the pool.

Operable windows adjacent to the pool shall have a minimum sill height of 1,200 mm above the indoor FFL.

Swimming pools shall conform to the safety requirements of DM-PH & SD-GU80-PRSPS2 [Ref. K.5].

K.5.8.2.2 Swimming pool floors

The slope in the floor in the shallow area of the pool shall not exceed 12%.

The slope in the floor in the deep end of the pool shall not exceed 33%.

The designed water depth as measured at the shallowest point in the shallow area shall be not less than 850 mm and not higher than 1,200 mm.

K.5.8.2.3 Swimming pool fences

Outdoor swimming pools shall be surrounded by a fence that meets the following requirements.

a) The top of the fence shall be not less than 1,200 mm above FFL.
b) The vertical clearance between FFL and bottom of the fence shall not exceed 50 mm.
c) Any openings in the fence shall not allow the passage of a 100 mm diameter sphere.
d) The fence enclosure shall be equipped with self-closing and self-latching gates.
e) Gates in fences shall be equipped with a locking device. Gates shall open away from the pool.

Swimming pool fences are not required in the following conditions.

1) A swimming pool fence is not required where the walls of adjacent structures can perform as a fence or a protective barrier to the swimming pool. Doors with direct access to the pool through the wall shall be equipped with an audio alarm that provides an audio warning when the door is opened, or the door shall be self-closing with self-latching devices.
2) A swimming pool that has a power safety cover conforming to ASTM F1346 is not required to have a swimming pool fence.
3) Where the pool is adjacent to the edge of a natural body of water and public access is not allowed along the shoreline, a barrier is not required between the water body and the pool.
4) Where the pool wall structure is used as a barrier, the wall shall have a minimum height of 1,200 mm above FFL for the entire perimeter of the pool. The pool access ladder or steps shall be capable of being secured, locked or removed to prevent access.

K.5.8.2.4 Decks and walkways

Swimming pools shall be surrounded by a continuous unobstructed deck or walkway, which shall be not less than 1.2 m wide, excluding the width of the coping or the interior portion of a gutter. The deck or walkway shall be immediately adjacent to the pool as shown in Figure K.41.

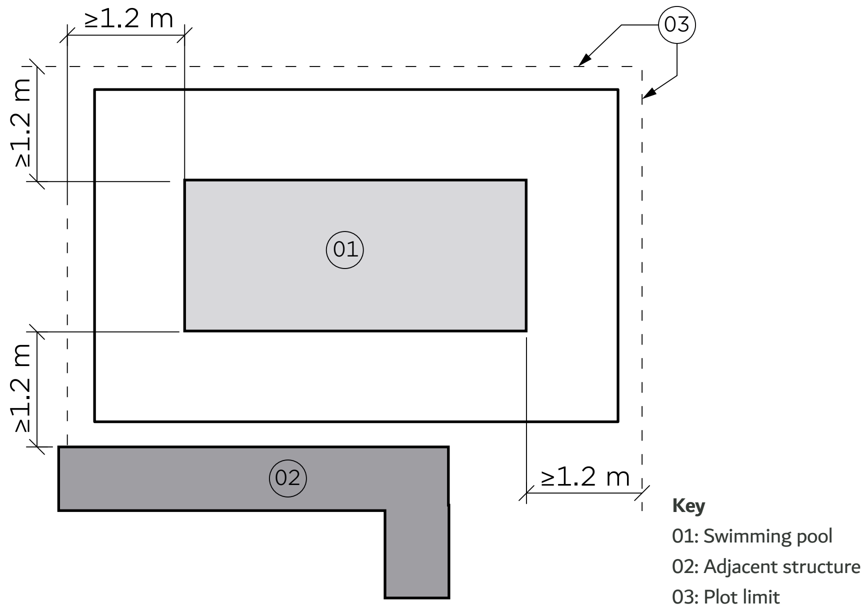


Figure K.41 Swimming pool setback and walkway requirements

The deck or walkway shall be constructed in impervious material with a smooth, non-slip and easily cleanable surface.

All decks and walkways shall have a 2% slope, in order to drain water effectively to deck drains.

K.5.9 Waste storage

K.5.9.1 General

All villas and townhouses shall be provided with a suitable area for the storage of general waste and recycling. This shall be either:

a) a dedicated waste storage area within the boundary of the property with a minimum of one 240 l bin for general waste, and one 240 l bin for recycling, with a maximum allowable container size of 360 l; or

b) a communal waste storage area for the consolidated storage of waste and recycling from multiple properties. This shall be adequately roofed and enclosed and located in a convenient and accessible location. Communal waste storage areas shall be provided with larger bulk containers for waste and recycling of up to 2,500 l as appropriate.

K.5.9.2 Specification of waste storage areas

All waste storage areas shall meet the following requirements.

a) Waste storage areas shall be convenient and easily accessible for residents and waste contractors alike. Where access by a waste management contractor is required, suitable and unimpeded access shall be provided for waste collection vehicles to allow the easy removal of waste and recycling from the property.

b) Access to waste storage areas shall be sufficient to facilitate the easy entry, exit and manoeuvring of waste and recycling containers. Where a change in floor level exists, any longitudinal gradient falling away from the storage location shall not exceed 8.33% (1:12). Access paths should be free of kerbs and steps, and avoid difficult turns and bends. Drop kerbs shall be provided where access paths meet roadways.

c) The distance that residents have to travel in order to access waste storage areas, whether separated or as part of the building, should be no more than 50 m, excluding any vertical distance.

d) The distance that waste contractors have to travel in order to access waste storage areas, from the location where the waste collection vehicle can safely stop, should be no more than 30 m for bins of up to 240 l, or 15 m for containers greater than 240 l. Manual manoeuvring of waste containers greater than 1,500 l in capacity should be avoided as far as is possible.

e) To limit the effect of odour, waste storage areas shall not be placed in close proximity to the property and any ventilation openings shall be located away from the windows.

f) The waste storage area shall meet the requirements for fire safety as detailed in B.8.5.

Where a waste storage room or enclosed waste storage area is provided, including those provided for communal waste storage, the following additional requirements shall be met.

1) Waste storage areas shall have a concrete pad designed to handle the load of the bins and any other equipment.

2) Floor and wall surfacing shall be finished with non-slip concrete, ceramic tiles, or similar impervious and waterproof material to facilitate cleaning. Textured finishes should be avoided, as they attract dirt and detritus. Walls, floors and ceilings shall be finished with a light colour.

3) A water supply and adequate drainage shall be provided to facilitate cleaning of the waste storage area and waste containers. This may be provided direct from the water supply network or from a high-level tank. All drains and gullies should be connected to the drainage pipes of the development and have cleanable filters and/or grates to prevent blockages to the drainage system caused by waste residue.

4) Lighting shall be provided with sealed (ingress protection rated) bulkhead fittings to protect against water from cleaning and washdown.

5) All windows shall be airtight and protected by a metal mesh wire screen in order to prevent insects and rodents from accessing the waste storage area.
6) All doors shall be provided with ventilation louvers or mechanical ventilation. Doors shall open to the outside and be fitted with automatic door closers. They shall be of a sufficient width to allow waste containers to pass into and out of the waste storage area.

K.5.9.3 Dimensions of waste storage areas

Suitable storage space for waste and recycling shall be calculated and determined based on the type and number of containers required and the collection frequency. The storage space provision shall be sized for two days of waste and recycling generation as a minimum.

In order to determine the area required for waste storage, the following requirements shall be met:

a) The required number of containers shall be calculated based on estimates of the potential waste and recycling quantity to be generated by the development, using suitable metrics for estimating the waste and recycling produced, such as the expected occupancy of the development, and number of bedrooms. A suggested waste generation rate of 2.5 kg/bedroom is provided by the Authority.
b) Waste storage areas shall accommodate all required containers according to their standard size. The type of container required shall be determined based on the quantity of waste and recycling generated by the development, and the practicalities of access to the development and removal of waste and recycling by the waste management contractor.
c) Guideline dimensions and examples of typical container sizes are shown in Table K.8 and Table K.9. Container sizes vary by manufacturer. Typical standards for waste containers are provided in BS EN 840-1 to BS EN 840-4 and these shall be taken into account when determining the waste storage requirements.
d) The dimensions of the waste storage area shall allow for manoeuvring of the required containers so as to provide suitable access to the containers as well as easy removal and return to the waste storage area. This shall include a minimum clearance of 150 mm between individual containers and between containers and any surrounding walls. Any doors or openings through which waste containers must pass through shall be wide enough to accommodate the relevant waste container sizes.

Capacity (litres)	Capacity (m^3)	Width (mm)	Length (mm)	Height (mm)
240	0.24	580	715	1,060
360	0.36	660	880	1,100

Table K.8 Wheeled bins

Capacity (litres)	Capacity (m^3)	Width (mm)	Length (mm)	Height (mm)
660	0.66	720	1,250	1,320
1,100	1.1	980	1,250	1,355
2,500	2.5	1,370	2,040	1,540

Table K.9 Eurobins and bulk storage containers

K.5.10 Materials of construction

K.5.10.1 Asbestos-containing materials

Asbestos-containing materials shall not be used.

K.5.10.2 Lead or heavy metals containing material

Paints or other materials that contain a percentage of lead or other heavy metals that is more than the prescribed limits set by Dubai Municipality shall not be used, unless the metal is encapsulated in systems such as a photovoltaic cell. All paints and materials containing lead or other heavy metals shall be accredited/certified from Dubai Central Laboratory or any source approved by the Authority.

K.5.10.3 Interior finishes

Interior finishes shall conform to Section 2.14 and Table 1.12, Ch. 1 of UAE FLSC [Ref. K.1].

K.5.11 Fire separation

Townhouses shall be separated from adjacent townhouses with a 2 h fire-rated wall as required by Table 1.2, Ch. 1 of UAE FLSC [Ref. K.1]. The wall shall extend from the foundation to the roof. The fire resistance rating can be reduced to 1 h for sprinkler protected townhouses as permitted by Table 1.11b, Ch. 1 of UAE FLSC [Ref. K.1].

The percentage of unprotected openings in exterior walls shall conform to Table 1.4 in Ch. 1 of UAE FLSC [Ref. K.1].

K.5.12 Exterior environment

K.5.12.1 Surfaces shading

At least 50% of the hardscape of the development shall achieve at least one of the following:

a) demonstrate an SRI of at least 29;

b) use an open grid pavement system (see Figure K.42);

c) be shaded by vegetation;

d) be shaded by materials with an SRI equal to or greater than those specified in K.7.2.7; or

e) be shaded by solar panels.

K.5.12.2 Exterior light pollution and controls

Exterior landscape lighting shall be aimed or shielded to prevent the lighting of the night sky or neighbouring plots.

K.5.13 Screening of building equipment

All outdoor mechanical equipment should be concealed from public view by solid walls, screens, fences, parapet walls, enclosing structures or landscape.

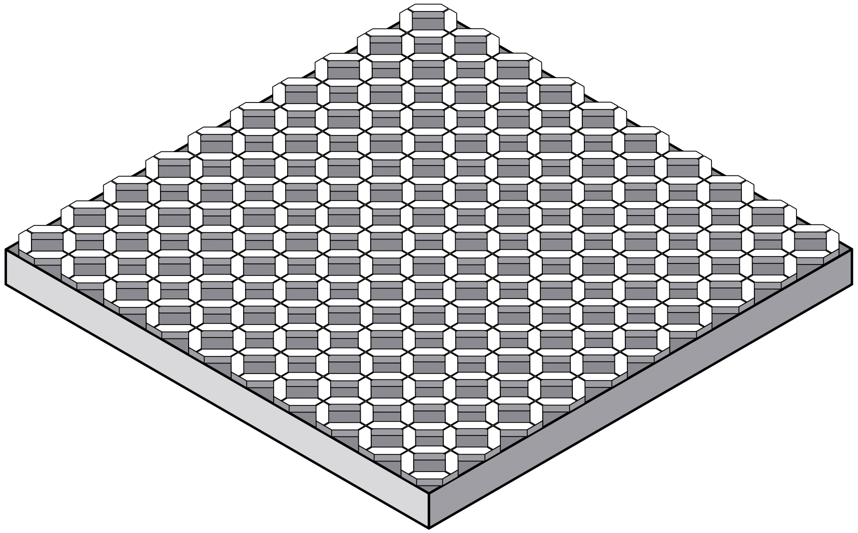


Figure K.42 Open grid pavement system

K.6 Accessibility

Accessibility provisions for people of determination in villas and townhouses are optional. Where accessibility provisions are to be made, they shall conform to Part C and to Volume 1 of Approved Document M [Ref. K.6].

K.7 Building envelope

K.7.1 Structural

K.7.1.1 Strength and stability

K.7.1.1.1 General

Any part of the building envelope presents a hazard if it becomes detached from the building. The building envelope and associated openings shall be designed and constructed to safely resist the loads required by K.8 and those mentioned in this section.

The building envelope shall:

a) be capable of safely sustaining, and transmitting to the supporting structure of the building, all static and dynamic design loads (i.e. dead, imposed, thermal, seismic, wind, etc.) without fracture or permanent deterioration of its performance;
b) be securely fixed to and supported by the structure of the building. This shall comprise both vertical support and horizontal restraints;
c) be made, where necessary, to accommodate differential movement of the cladding and the supporting structure of the building, such as differential settlement, inter-storey drifts, etc.;
d) be of durable materials/products. The service life of the fixings shall be not less than the building envelope. Fixings shall be corrosion-resistant and of a material type appropriate for the local environment and exposure conditions;
e) not fully or partially detach from the building (although it may break under the life safety structural performance level as described in K.8); and
f) not be a source of noise or be at risk of resonant excitation caused by wind.

K.7.1.1.2 Wind loads

Wind loads shall be calculated in accordance with K.8.4.11.

NOTE: Pressure coefficients might vary across the building envelope. Higher pressure is expected at corners.

K.7.1.1.3 Load resistance and transmission

The building envelope shall be capable of resisting and transmitting to its points of support all static and dynamic design loads without fracture or permanent deterioration of its performance.

There shall be no significant irreversible deformation of surfaces resulting from such design loads.

K.7.1.1.4 Permanent fixture loading

Building envelopes which are intended to support permanent fixtures and/or maintenance equipment attached to either internal or external faces shall be capable of withstanding, without excessive deflection or permanent deterioration of its performance, the forces arising from these fixtures, including during use.

K.7.1.1.5 Operational forces

Without any reduction in its performance, the building envelope shall be capable of sustaining and transferring a single concentrated load of 0.89 kN (200 lb) in accordance with Section 4.5.1 of ASCE/SEI 7-16, or be provided with a guardrail.

Balustrades and guardrails at balconies, terraces, roofs and changes in level greater than 760 mm shall conform to K.5.2.5.2.

K.7.1.1.6 Thermal movements

The building envelope shall be capable of accommodating changes in dimension and shape of its components resulting from changes in service temperatures, and from differential service temperatures between the inside and outside of the building, without any reduction in its performance.

K.7.1.1.7 Deflection

Under the action of the most onerous combination of loads, the deflections of building envelope components shall be limited such that no defect occurs, and deflections are fully recovered after removal of loads.

The allowable limit deflection shall be determined by material properties, the distance between points of attachment and the method of attachment.

NOTE: The deflections given in Table K.10 are generally acceptable in line with Part 3 of the CWCT Standard for systemised building envelopes **[Ref. K.7]**.

Component	Measurement	Maximum deflection
Storey-height assemblies, other than masonry	Between points of attachment to structure	1/200 for span ≤ 3,000 mm 5 mm + 1/300 for 3,000 mm < span < 7,500 mm 1/250 for span ≥ 7,500 mm
Opaque infill panels in secondary framing, excluding glass	Between points of support	1/360 for brittle material such as stone 1/90 for non-brittle materials such as aluminium or steel Manufacturer recommendation shall also be sought.
Framing containing glass: Single glass Insulating glass units	Between ends of frame Between ends of unit	1/125 span of member 1/175 span of double-glazed unit Manufacturer recommendation shall also be sought.

Table K.10 Maximum recoverable deflection under design load

For deflection limits of main structural elements refer to K.8.

K.7.1.1.8 Fixings

Fixings to secure the building envelope shall be selected based on the proven performance of the fixing. Manufacturer test data is generally determined using a European technical assessment (ETA), a British Standard (BS), a European Norm (EN) or an ASTM International (ASTM) standard.

The strength of fixings shall be selected based on tests using materials representative of the material into which the fixing is to be anchored, taking account of any inherent weaknesses that might affect the strength of the fixing (e.g. cracks in concrete due to shrinkage and flexure, or voids in masonry construction).

The design of any component shall address the consequences of failure of any individual fixing.

Fixings shall not be welded.

K.7.1.2 Structural use of glass

Glass used structurally, or glass that is not supported by load-bearing framing or that is providing in-plane restraints to components, shall be designed with redundancy in the system. The redundancy shall be such that if failure or breakage of the glass occurs, the loading is shared by adjacent components.

NOTE: The Institution of Structural Engineer's report on structural use of glass in buildings **[Ref. K.8]** gives further guidance.

K.7.1.3 Structural use of silicone

The structural use of silicone in the building envelope shall be in accordance with ETAG 002 **[Ref. K.9]**.

K.7.1.4 Materials

Building envelope materials and components shall meet the requirements given in K.8.3 and IBC [Ref. K.2], Section 1404, Section 1405 and Ch. 23 to Ch. 26.

The properties of glass used in the structural design shall be in accordance with ASTM E1300.

K.7.1.5 Impact resistance

The building envelope shall be capable of withstanding applied or transferred impacts that might occur during normal use (whether accidental, e.g. an object being kicked, or deliberate, e.g. during maintenance) without sustaining damage that is not repairable and without deterioration of its performance.

The test energy impacts for opaque areas should be not less than those given in Table K.11, in accordance with CWCT TN 75 [Ref. K.10].

Soft and hard body testing shall follow the procedures in CWCT TN 76 [Ref. K.11].

Areas of exposure	Description	Soft body		Hard body	
		Safety	Serviceability	Safety	Serviceability
Areas within 1.5 m of ground or adjacent finished floor level (FFL)	Area accessible to the public and building users with little incentive to exercise care. Chance of accident occurring and of misuse.	500J	120J	10J	10J
	Area accessible primarily to those with some incentive to exercise care. Some chance of accident occurring or of misuse.	500J	120J	10J	6J
Areas between 1.5 m to 6 m above ground or above adjacent FFL	Area liable to impacts from thrown or kicked objects. Might also be subject to impact during maintenance which might impose a higher impact energy.	350J	120J	10J	6J
Areas more than 6 m above ground or above adjacent FFL	Area mainly subject to impact during maintenance which might impose a higher impact energy.	350J	120J	3J	3J

Table K.11 Exposure categories and impact test energy for opaque or opaque areas

When subjected to the serviceability impact in Table K.11, materials and products used in the building envelope shall achieve the following performance.

a) Brittle materials shall present no failure or damage.

b) Other materials shall present no harm to surface finish, no indentation or damage.

Serviceability impacts shall not adversely affect the structural safety of the building, or damage any part of the building such that it could fall or cause serious injury to people inside or outside the building.

The impact strength for glazing and plastic glazing sheet materials shall be obtained from the safety and security recommendations in BS 6262-4.

K.7.1.6 Load combination

Loads shall be factored and combined in accordance with ASCE/SEI 7-16.

K.7.2 Energy conservation

K.7.2.1 Energy compliance method

There are two compliance routes for energy performance, as shown in Figure K.43.

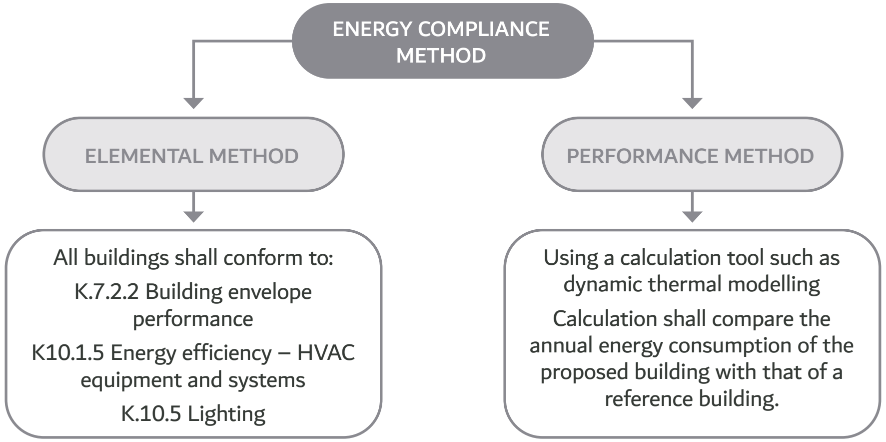


Figure K.43 Flow chart for energy compliance method

Where the performance method in Figure K.43 is to be used, the reference building shall be equal in shape, size and orientation to the proposed building. Calculation shall be determined in accordance with ASHRAE 90.1:2019, Appendix G, except for the minimum requirements for building envelope, equipment efficiencies and other parameters and conditions that are listed in the elemental method in Figure K.43.

Compliance will be demonstrated if the annual energy consumption of the proposed building is equal to or lower than the annual energy consumption of the reference building.

K.7.2.2 Building envelope performance

K.7.2.2.1 Non-glazed elements

With the exception of non-conditioned enclosed parking areas, the average thermal transmittance for external walls, roofs, and exposed floors (the underside of the floor is exposed to ambient conditions) shall not exceed the values in Table K.12 and Figure K.44.

Element	Average thermal transmittance (W/m²K)
Roof	≤0.3
External wall and exposed floor	≤0.57

Table K.12 Thermal transmittance for non-glazed elements of roof, external wall and exposed floor

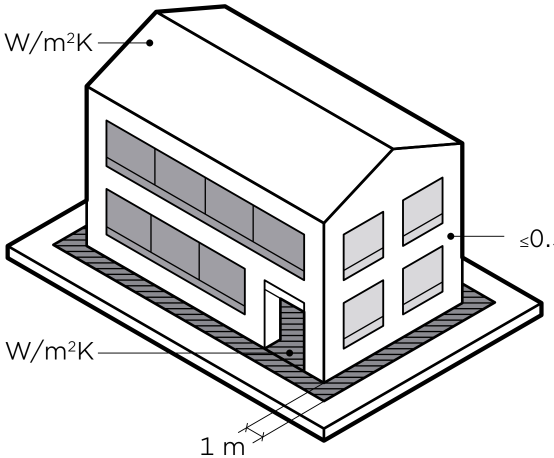


Figure K.44 Thermal transmittance for non-glazed elements of roof, external wall and exposed

While the U-value for external walls can be achieved using aerated concrete blocks, the use of insulation for the entire building envelope is recommended. Insulation materials shall conform to Sections 4 to 7, Ch. 1 of UAE FLSC [Ref. K.1].

If columns and beams within the building envelope are not insulated, the glazing thermal transmittance requirement (see K.7.2.2.2) shall be improved by 10%. As an example, if glazing thermal transmittance is 2.1 W/m^2K in K.7.2.2.2, the improved value should be 1.9 W/m^2K.

For the floor area that is in contact with the ground, the thermal transmittance requirement shall be achieved by installing 1 m of perimeter insulation as shown in Figure K.44.

K.7.2.2.2 Glazed elements – Fenestration

The glazing vertical surfaces shall meet the performance criteria in Table K.13 based on window-to-wall ratio (WWR).

Glazed vertical surfaces	Window to external wall ratio		
	<40%	40% to 60%	>60%
Thermal transmittance (U-value) (W/m^2K)	≤2.1	≤1.9	≤1.7
Shading coefficient	≤0.4	≤0.32	≤0.25
Light transmittance	≥40%	≥32%	≥25%

Table K.13 Performance criteria for glazed vertical surfaces based on WWR

For skylights, the performance criteria in Table K.14 shall be met depending on the glazing area over the total roof area.

Skylights	Percentage of glazed roof based on total roof area	
	≤10%	>10%
Thermal transmittance (U-value) (W/m²K)	≤1.9	≤1.9
Shading coefficient	≤0.32	≤0.25
Light transmittance	≥32%	≥25%

Table K.14 Performance criteria for glazed roof based on total roof area

Thermal transmittance values are overall U-values for the glazed elements. Overall U-values are calculated as the area-weighted averages of the centre of pane U-value (glazing and panel) and frame U-value including all edge effects (spacer and frame) and thermal bridges. Glazed elements having back-insulated panels shall also meet the thermal transmittance requirement including framing, edges effects and thermal bridges.

NOTE: The thermal transmittance of an insulating glass unit is higher when the glazing is installed horizontally instead of vertically.

K.7.2.3 Shade effect calculation

The use of external shading is recommended. The impact of external shading (where used) and adjacent buildings can be taken into account when calculating external load criteria. Examples of shading devices are shown in Figure K.45.

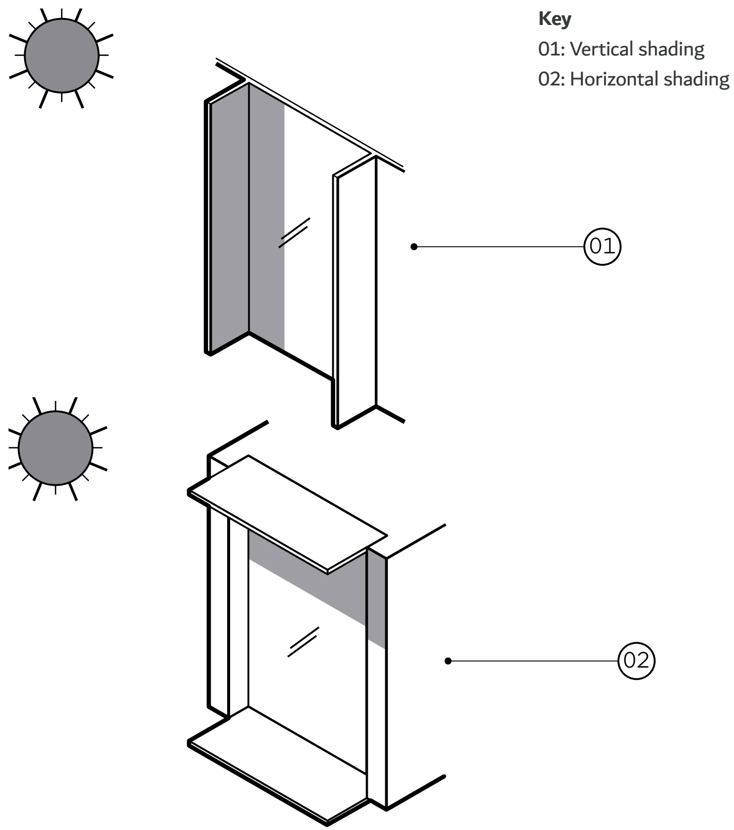


Figure K.45 Examples of shading arrangements

The impact of external shade factors on the building's thermal load shall be calculated when the performance method (see K.7.2.1) is used to verify energy compliance.

K.7.2.4 Thermal bridges

For all air-conditioned buildings, thermal bridges shall be either eliminated or insulated to reduce the amount of heat transfer. Thermal bridging can occur at connection points between concrete or steel beams, external walls and columns and around doors and windows (see Figure K.46).

NOTE: The BRE publication [Ref. K.12] on assessing the effects of thermal bridging at junctions and around openings gives further details.

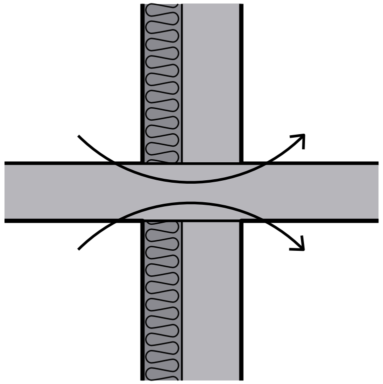


Figure K.46 Example of thermal bridge in buildings

K.7.2.5 Durability

The building envelope shall be designed and specified to limit degradation due to environmental factors throughout the design life of the building.

K.7.2.6 Sealing of windows and doors

Doors and window frames on the building exterior shall be sealed.

Sealing materials shall conform to Sections 4 to 7, Ch. 1 of UAE FLSC [Ref. K.1]. They shall also prevent the transmission of air and sound that might occur as a result of pressure differences across the exterior of the building.

K.7.2.7 Heat island effect reduction

Opaque building envelope surfaces shall have an SRI value not less than that shown in Table K.15 and Figure K.47, for a minimum of 75% of the roof area.

Element	SRI value
Steep sloped roofs (slopes steeper than 1:6)	≥29
Flat and low sloped roofs (slopes lower than or equal to 1:6)	≥78
External walls	≥29

Table K.15 Building envelope SRI value requirements

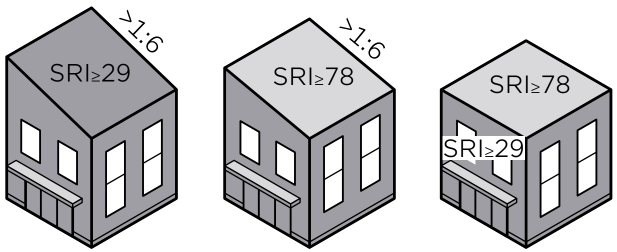


Figure K.47 Illustration of SRI requirements based on slope of element

K.7.3 Exterior lighting pollution

Permanently installed exterior lighting shall meet the following requirements.

a) All exterior light fixtures on the building site, other than architectural accent lighting, shall be shielded, so that the full light emitted by the fixture, either directly or indirectly by reflection or by refraction from any part of the fixture, is projected below the horizontal plane passing through the lowest part of the fixture (see Figure K.48).

b) Architectural accent lighting shall be aimed or shielded to prevent the lighting of the night sky. Wall washing lights shall spill no more than 10% of the lighting past the building façade.

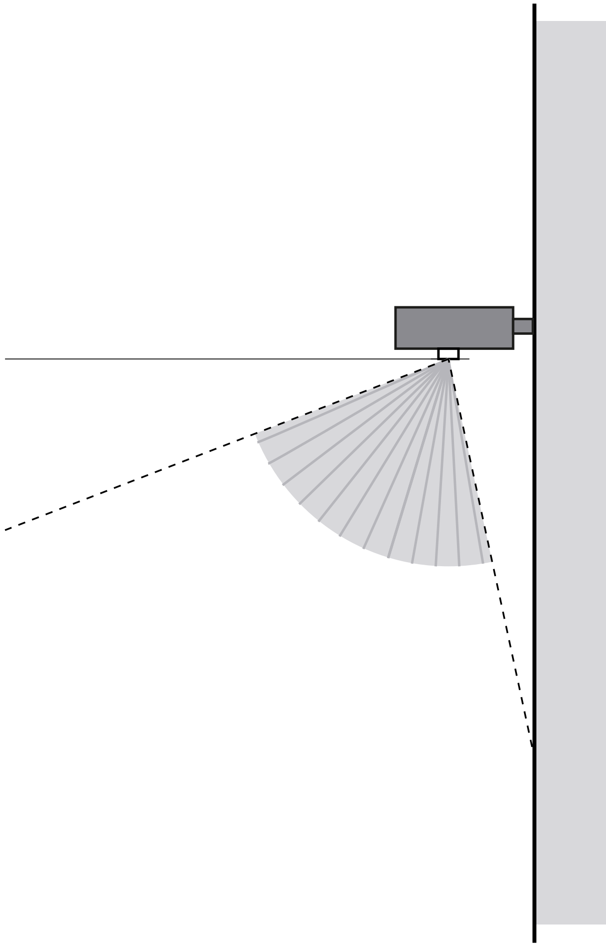


Figure K.48 Example of downward directed lighting projected below the horizontal plane of the lowest part of the fixture

K.7.4 Moisture

K.7.4.1 General

Moisture control is fundamental to the functioning of any building. Controlling moisture is important to protect occupants from adverse health effects and to protect the building, its mechanical systems and its contents from physical or chemical damage.

The building envelope shall protect the building and occupants from:

a) harmful effects caused by ground moisture;

b) precipitation (including windblown spray); and

c) the risk of interstitial or surface condensation.

K.7.4.2 Ground moisture

The building envelope shall:

a) resist the passage of moisture from the ground to the inside of the building;

b) not be damaged by moisture from the ground; and

c) not carry moisture from the ground to any part which could be damaged.

For building envelope walls that are not subject to groundwater pressure, a damp-proof course shall be provided at least 150 mm above the level of the adjoining ground, as shown in Figure K.49, unless there is a part of the building design that protects the wall. The damp-proof course shall be continuous with any damp-proof membrane in the floor.

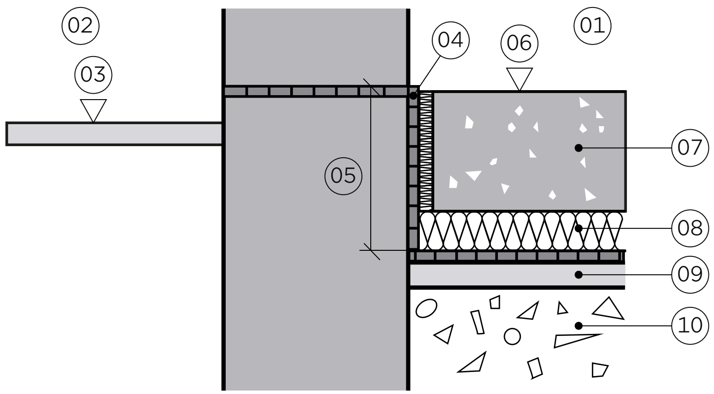


Figure K.49 Minimum height for damp-proof course at ground level (© Crown Copyright, 2013. Figure based on Diagram 8 of the Building Regulations (2010), Approved Document Part C, 2004 Edition with 2010 and 2013 amendments. Contains public sector information licensed under the Open Government Licence v3.0)

Key

01: Out
02: In
03: Internal ground level
04: Continuous damp-proof course between wall and floor membrane
05: At least 150 mm if wall is an external wall
06: External ground floor
07: External pavement
08: Insulation
09: Compacted soil
10: Soil

Guidance on protection for building envelope walls that are subject to groundwater pressure can be found in BS 8102.

K.7.4.3 Precipitation including windblown spray

K.7.4.3.1 General

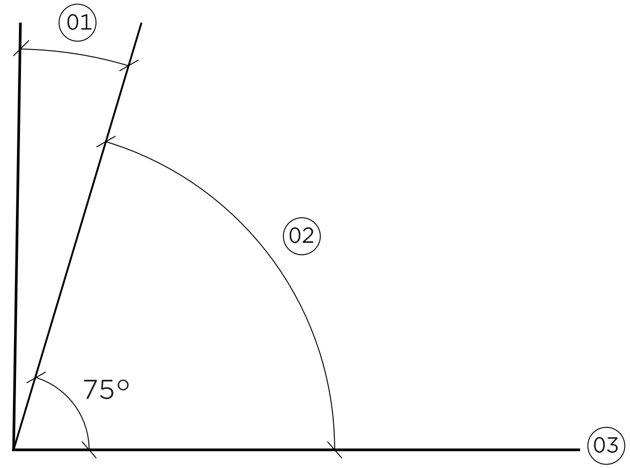
The building envelope shall resist the penetration of precipitation:

a) to the inside of the building; and
b) to any part of the building envelope that might be damaged by moisture.

K.7.4.3.2 Horizontal and inclined surfaces

Horizontal surfaces or inclined surfaces in the building envelope (see Figure K.50) shall:

a) be jointless and impermeable to moisture;
b) have sealed joints and be impermeable to moisture; or,
c) have overlapping joints and be impermeable or be backed by a material which directs precipitation towards the outer face.



Key

01: Vertical surfaces
02: Inclined surfaces
03:Horizontal surfaces

Figure K.50 Horizontal, inclined or vertical surfaces

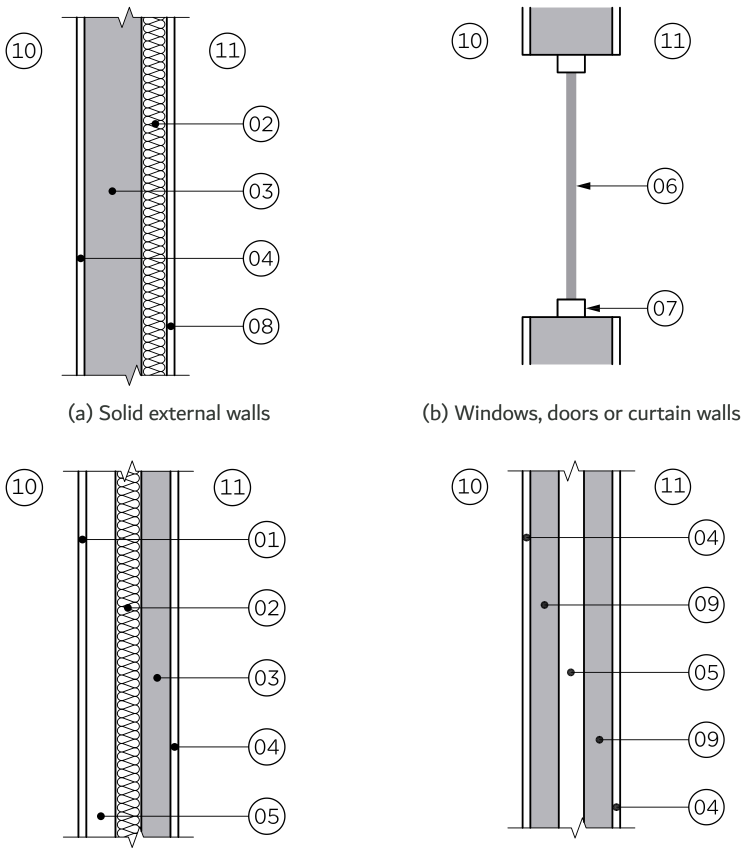
K.7.4.3.3 Vertical surfaces

Vertical surfaces in the building envelope (see Figure K.50) shall meet the following requirements as appropriate to the external wall build-up type. Examples of external wall build-up type are given in Figure K.51.

a) Solid external walls: The wall shall hold moisture arising from rainwater until the moisture can be released in a dry period, without penetrating to the inside of the building or causing damage to the building. If the wall is insulated, the insulation shall provide resistance to the ingress of moisture to keep the wall dry.

b) Solid external walls with air cavities or with rainscreens: The outer leaf of an external cavity wall shall either be separated from the inner leaf by a drained air space or prevent the precipitation from being carried to the inner leaf.

c) Curtain walling, doors and windows: Joints between curtain walling, doors, windows and interfaces with other walls shall resist the penetration of precipitation to the inside of the building and not permit moisture to reach any part of the building which could be damaged.



(a) Solid external walls

(b) Windows, doors or curtain walls

(c) Solid external walls with rainscreens

(d) Solid external walls with cavities

Key

01: Cladding
02: Thermal insulation layer (vapour resistance layer on the outer face)
03: Block wall
04: Plaster
05: Cavity
06: Glass
07: Framing
08: Plaster or gypsum board
09: Aerated blockwork
10: Out
11: In

Figure K.51 Examples of external wall build-up types

K.7.4.3.4 Flashing

Flashing shall be installed to prevent moisture from entering the building envelope or redirect moisture to the exterior. Flashing shall be installed at:

a) perimeters of exterior door and window assemblies;
b) penetrations and terminations of exterior wall assemblies;
c) exterior wall intersections with roofs, balconies and similar projections; and
d) built-in gutters from which moisture could enter the wall.

K.7.4.4 Risk of interstitial or surface condensation

The building envelope shall:

a) be designed and constructed such that its structural and thermal performance is not adversely affected by interstitial condensation; and
b) not promote surface condensation or mould growth.

The following technical solutions may be used to minimize condensation risk, depending on the wall type.

1) Curtain walling, skylight, doors and windows can incorporate thermal breaks in the glazed framed systems.
2) Roofs and solid external walls can include a vapour resistance layer.
3) Interfaces and junctions between different elements of the building envelope (such as windows) can ensure continuity of the vapour barrier by extending and overlapping the vapour resistance layer between elements.

NOTE: BS 5250 gives further guidance on control of condensation in buildings. While the guidance provides principles to control condensation, some commentary and forms of construction given in the annexes might not be applicable to delete Dubai climate.

K.7.5 Acoustics

The building envelope shall meet the acoustic requirements of K.10.4.

K.7.6 Protection from falling, collision and impact

K.7.6.1 Protection against impact with glazing

Safety glazing shall be installed in critical locations in doors, side panels and low-level glazing as shown in Figure K.52 and Figure K.53.

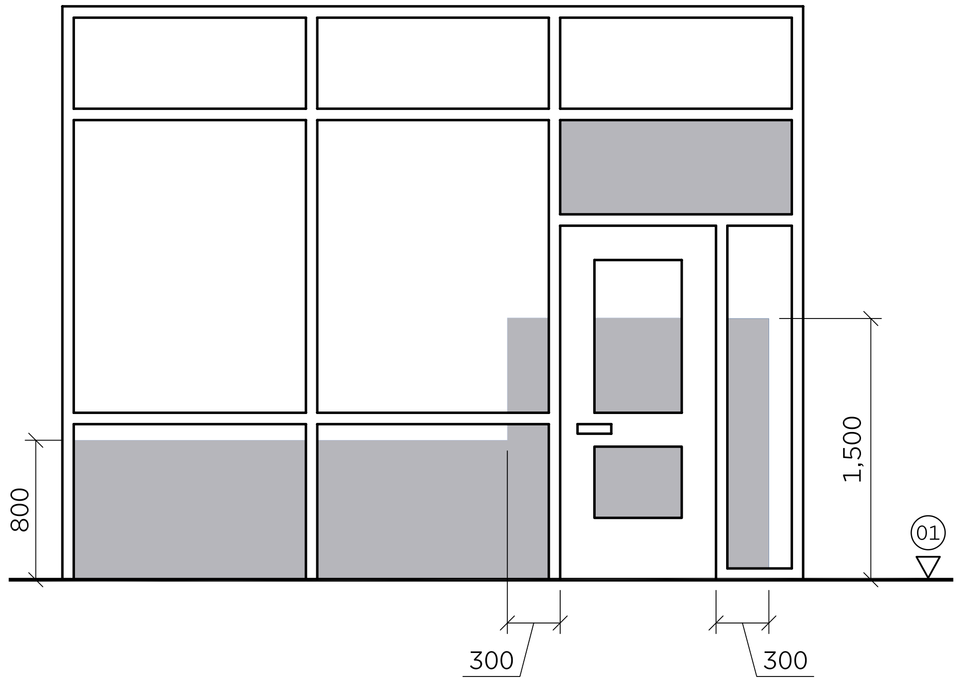


Figure K.52 Safety glazing at door and adjacent areas (© Crown Copyright, 2013. Figure based on Diagram 5.1 of the Building Regulations (2010), Approved Document Part K, 2013 Edition. Contains public sector information licensed under the Open Government Licence v3.0)

Key
01: Floor level

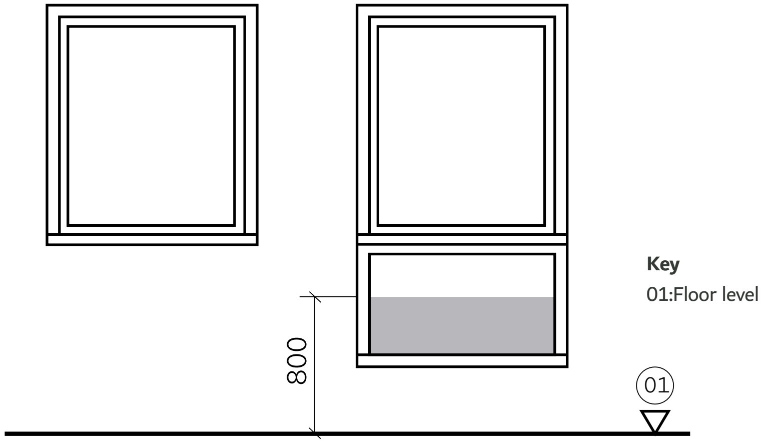


Figure K.53 Safety glazing at windows (© Crown Copyright, 2013. Figure based on Diagram 5.1 of the Building Regulations (2010), Approved Document Part K, 2013 Edition. Contains public sector information licensed under the Open Government Licence v3.0)

In accordance with Section 5, Ch. 1 of UAE FLSC [Ref. K.1], safety glazing for use in critical locations shall conform to the minimum classifications in either Table K.16 or Table K.17.

Critical location	Height	Classification in test standard BS EN 12600
Low-level areas	All height	Class 1
Doors Doors side panel	Below 900 mm from FFL	Class 2
	Above 900 mm from FFL	Class 3

Table K.16 Minimum classification for safety glazing requirements

Area of glazing in critical location (m^2)	Classification in test standard	
	ANSI Z97.1	CPSC 16 CR 1201 [Ref. K.13]
≤0.9	A	I
>0.9	B	I

Table K.17 Minimum classification for safety glazing requirements

K.7.6.2 Containment

Glazing at areas lower than 800 mm from FFL and protecting a change in level greater than 760mm shall provide containment, as shown in Figure K.54.

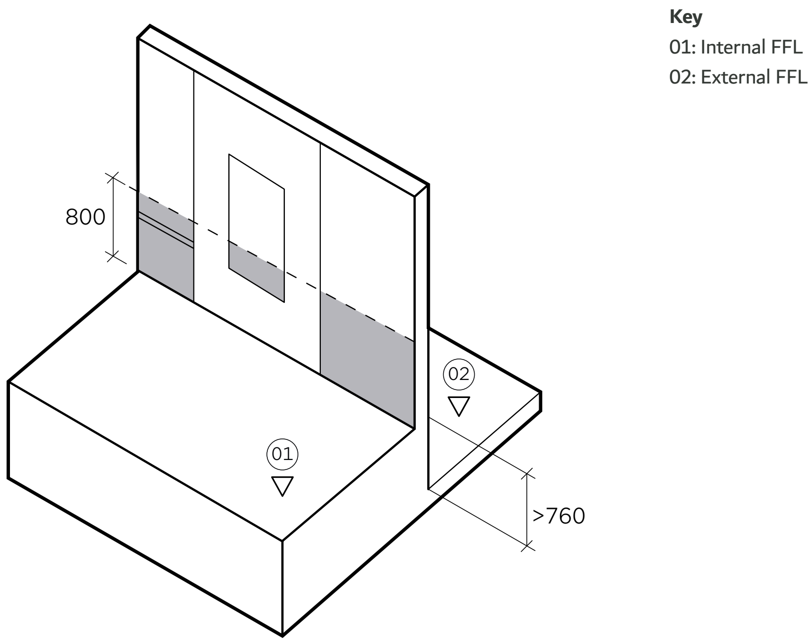


Figure K.54 Examples of glazed areas that need to provide containment

If a glazing panel covers areas above and below 800mm from FFL, the entire glazing panel shall provide containment.

K.7.6.3 Overhead glazing

Overhead glazing shall be laminated. It shall include a post-breakage containment system, such that if the glass breaks, the glass is held in place until it can be replaced.

The safety and fragility of overhead glazing shall be determined in accordance with CWCT TN 66 [Ref. K.14].

Overhead glazing shall be tested in accordance with CWCT TN 67 [Ref. K.15].

K.7.7 Fire safety

K.7.7.1 General

The fire safety of building envelopes (façade and roofs) shall conform to Ch. 1 of UAE FLSC [Ref. K.1] and the specific requirements of this section.

The requirements for guardrails and balustrades as described in Section 2.17, Ch. 1 of UAE FLSC [Ref. K.1] are superseded by K.5.2.5.2.

The requirements for safety glazing in Sections 5.4.2 to 5.4.4, Ch. 1 of UAE FLSC [Ref. K.1] are superseded by K.7.6.

K.7.7.2 Fire testing of non-fire-rated, non-load-bearing façades and aesthetic features/mashrabiya

The requirements of Section 4.2.1, Ch. 1 of UAE FLSC [Ref. K.1] shall be met, with the following amendments.

a) The exceptions listed in Section 4.2.1, Ch. 1 of UAE FLSC [Ref. K.1] are expanded to include concrete, terracotta, glass, ceramics and mineral wool.
b) In addition to the materials listed in Section 4.2.1, Ch. 1 of UAE FLSC [Ref. K.1], solid metal panels conforming to K.7.7.3 may be used.

The requirements in Section 4.5, Ch. 1 of UAE FLSC [Ref. K.1] shall be met, with the following amendments.

1) Steel flashing is not required around window openings.
2) Flashing shall match the flashing included in the NFPA 285 fire test(s) forming the basis of the fire safety design(s) of the façade.

K.7.7.3 Solid metal panels

Solid metal panels, including any coatings, shall conform to Sections 4 to 7, Ch. 1 of UAE FLSC [Ref. K.1] and shall achieve the fire safety classifications and fire safety performance criteria of Table K.18 where applicable.

Occupancy and type of building	Fire testing required for solid metal panel	Fire testing required for façade assembly
Low-rise building (e.g. villa, townhouse)	Panel shall be tested in the thickness intended to be used, including any coatings to BS EN 13501-1 with pass criteria B-s1-d0	BS 8414-1 or BS 8414-2 with pass criteria in accordance with BR 135 [Ref. K.16]. or NFPA 285 with pass criteria “pass” or FM 4881 with pass criteria “pass” or ISO 13785-2 with pass criteria “pass”

Table K.18 Fire test requirements for solid metal panels on non-fire resistance rated and non-load-bearing exterior building envelope and aesthetic features/mashrabiya.

K.7.7.4 Roof assemblies

Roofing systems shall conform to the performance requirements of Section 6, Ch. 1 of UAE FLSC [Ref. K.1].

K.7.8 Solar panels

Photovoltaic (PV) cells or panels installed on roofs or façades shall conform to Section 2.2, Ch. 14 of UAE FLSC [Ref. K.1]. If PV panels are attached to or integrated with the façade then they shall also be tested in accordance with Section 4, Ch.1 of UAE FLSC [Ref. K.1].

K.7.9 Maintenance

A method of safely maintaining the building envelope shall be provided.

Permanent maintenance equipment attached to either roof or façades shall be treated as permanent fixture loading (see K.7.1.1.4).

Hard or sharp components of the maintenance equipment shall be covered with soft protection prevent the building envelope from being impacted.

The energy impact that the maintenance equipment or operator might exert on the building envelope shall be calculated. The building envelope shall be capable of withstanding applied or transferred impacts that might occur during maintenance without sustaining damage that is not repairable and without deterioration of its performance.

K.8 Structure

K.8.1 Structural system requirements

K.8.1.1 General conditions

The structural design of buildings shall be undertaken by the Engineer. The Engineer shall only use appropriate structural analysis and design software, approved by the Authority.

Villas/townhouses and all their components, as well as materials, shall satisfy the minimum safety standards defined herein and the referenced documents.

The design shall facilitate safe fabrication, transport, handling and erection with due regard to site-specific conditions. As far as is reasonably practicable, it shall also take account of the needs of maintenance, final demolition, recycling and reuse of materials.

Typical design issues are presented in Figure K.55 for inclusion in the design stages.

K.8.1.2 Design life

The recommended minimum design life for villas/townhouses is 50 years. The Engineer shall discuss and agree the design life of the structure with the Owner and the Authority before the design commences. The Engineer shall clearly specify the adopted design life in the design documentation.

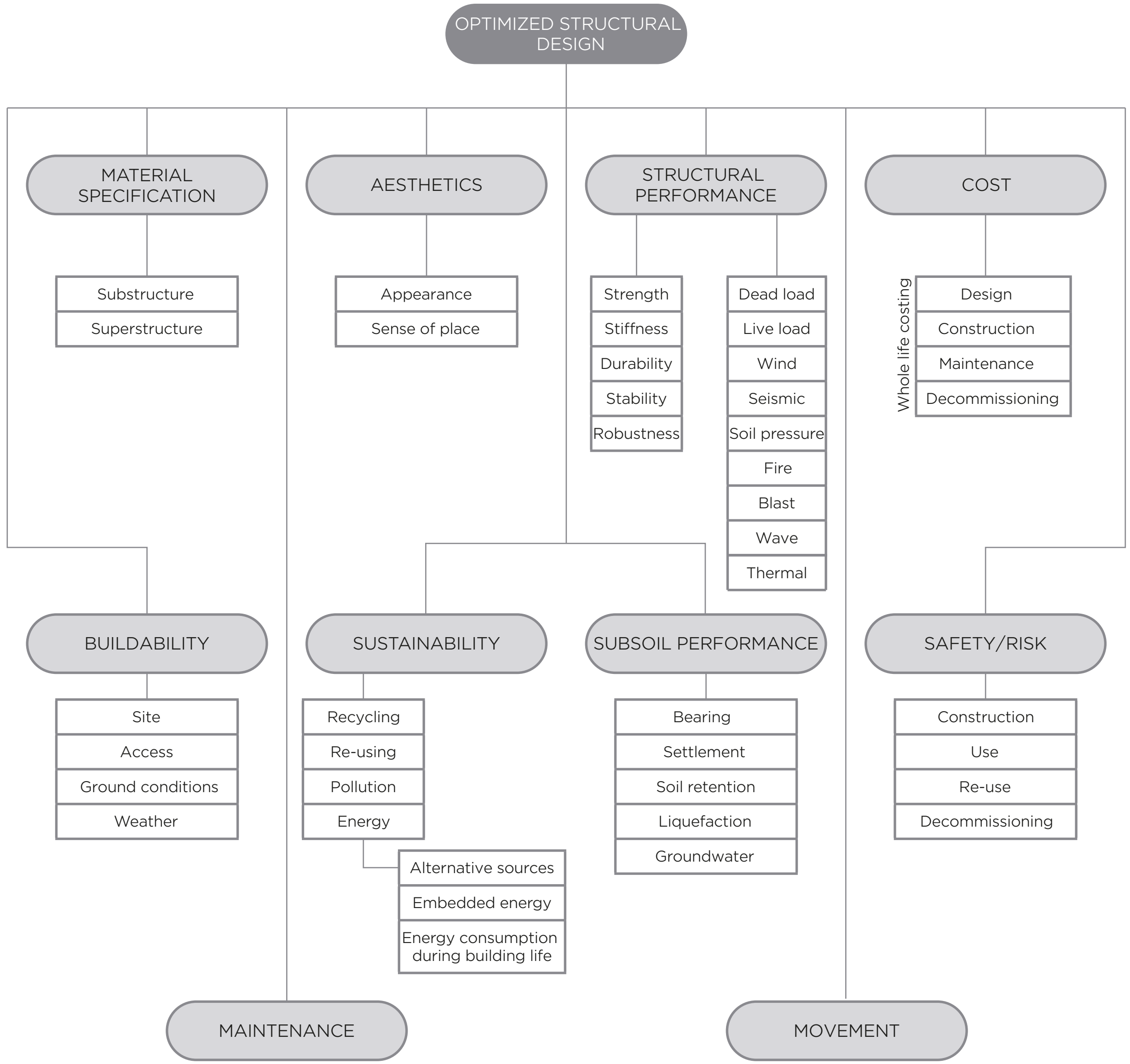


Figure K.55 Typical issues in relation to structural design requirements

K.8.1.3 Design acceptance criteria

The design shall honour all design acceptance criteria defined by the design basis codes and standards (see K.3.5).

Ordinarily, these acceptance criteria are defined as limit states. As applicable, designs shall include:

a) strength limit states including general yielding, rupture, buckling and transformation into a mechanism;
b) serviceability limit states including member and global deflections, vibration and occupancy comfort;
c) stability against overturning and sway;
d) fracture due to fatigue and brittle fracture;
e) corrosion and durability;
f) fire; and
g) accidental loads (blast, impact, etc.).

K.8.1.4 Structural system and robustness

Measures shall be taken to ensure that the building is stable under the design basis load conditions. Where necessary, these measures shall also allow for the maximum credible loads for which the collapse limit state might be chosen as being applicable.

Any features of the structure that have a critical influence on its overall stability shall be identified and included in the design, including all members that provide restraint to critical members in compression.

A structure shall be designed to behave as one three-dimensional entity. The layout of its constituent parts, such as foundations, primary frame, steelwork, joints and other structural components should constitute a robust and stable system under normal loading to ensure that, in the event of misuse or accident, damage will not be disproportionate to the cause.

Measures shall be taken to ensure that the building is robust and resistant to disproportionate collapse under the specified load conditions. The Engineer shall include implicit considerations of resistance to progressive collapse during the design process through the provisions stipulated under Appendix C of ASCE/SEI 7-16 (indirect design approach).

K.8.1.5 Durability

All elements shall be designed with appropriate detailing and material specifications to achieve the specified design life, considering the environment of the project and the whole lifecycle of the building.

The following specific requirements shall be met.

a) For concrete structures, the Engineer shall implement the recommendations of BS EN 206 and BS 8500-1 in the design and specifications of concrete structures. The criteria listed under F.11 shall also be followed.
b) For steelwork structures, the Engineer shall provide the steelwork material specifications, stating the steel grades and protective paint systems which are durable and compatible with the climate of Dubai. The paint protective coatings for steelwork shall be specified in accordance with BS EN 12944 as a minimum, with additional requirements to address the susceptibility of the protective coatings to ultra violet degradation.

K.8.2 Fire resistance

Villas shall be classified group A or group B in accordance with Table 1.1, Ch. 1 of UAE FLSC [Ref. K.1].

Construction type and fire resistance of the structure shall be defined based on the classification of the villa, the height and general arrangement of the largest storey of the villa and whether it is sprinkler protected or not in accordance with Table 1.7, Ch. 1 of UAE FLSC [Ref. K.1].

Villas/townhouses do not require fire-rated or listed roof assemblies (see Section 6.3.7, Ch. 1 of UAE FLSC [Ref. K.1]).

The structure supporting 2 h fire-rated walls between townhouses (see K.5.11) shall also achieve 2 h fire resistance.

K.8.3 Materials

The structural design shall meet the material requirements specified in the codes and standards listed in Table K.19.

Material	Code of reference	Remarks
Reinforced concrete	ACI 318-19	—
Post-tensioned concrete	ACI 318-19	TR43 [Ref. K.20] can be adopted as further reference
Pre-cast concrete	ACI 318-19 and Precast/ prestressed Concrete Institute (PCI) design handbook [Ref. K.21]	—
Steel	AISC 360 and AISC 341-16	—
Masonry	TMS 402/602:2016 or BS EN 1996-1, 2 and 3	Load-bearing masonry shall conform to TMS 402/602:2016.
Aluminium	IBC Ch. 20 [Ref. K.2]	IBC refers to AA ASM 35, Aluminium Sheet Metal Work in Building Construction, and AA ADM 1, Aluminium Design Manual.
Wood	IBC Ch. 23 [Ref. K.2]	—
Gypsum board	IBC Ch. 25 [Ref. K.2]	—
Plastic	IBC Ch. 26 [Ref. K.2]	—

Table K.19 Codes of reference for the material requirements

Other materials, such as aluminium, timber, gypsum board, glass and plastic, shall be used only where also permitted by Ch. 1 of UAE FLSC [Ref. K.1].

The specification of all constituent materials of the structural system shall be compatible with the specified codes and clearly detailed in the design documentation.

Structural designs can be prepared by referring to building codes and standards other than those mentioned in Table K.19, subject to obtaining the approval of the Authority.

K.8.4 Loads

K.8.4.1 General

Loads shall be defined in accordance with ASCE/SEI 7-16 and this section.

K.8.4.2 Load combinations

Loads shall be factored and combined in accordance with Ch. 2 of ASCE/SEI 7-16.

The results from compatible linear analyses of load cases acting individually may be combined and summed algebraically.

K.8.4.3 Dead loads

Dead loads shall be calculated using the densities and volumes of the materials making up the construction.

Default densities of common materials are scheduled in Table K.20.

NOTE: More refined densities and the densities of other materials can be sourced from the referenced codes and standards, material data sheets, or obtained via testing. The Engineer is responsible for ensuring the densities assumed in design align with those of the specified construction materials.

Description	Load (kN/m^3)
Concrete (normal weight, including allowance for reinforcement)	25
Concrete (lightweight, including allowance for reinforcement)	18
Concrete blockwork (normal weight)	20
Concrete blockwork (autoclave aerated block)	7
Steel	78
Screed and blinding	20
Float glass	25

Table K.20 Default material densities

Where appropriate, dead loads shall make provision for additional weight concentrated at structural connections.

K.8.4.4 Superimposed dead loads

The Engineer is responsible for determining the superimposed dead loads for components not included as either live or dead loads (including the anticipated internal partitions, floor and ceiling finishes, facades and external cladding). Loads shall be defined as concentrated point loads, uniform loads on plan, and/or uniform loads on elevation, as appropriate.

The following minimum load allowances (defined as average uniform loads on plan) shall be adopted for the purpose of evaluating the maximum load effect:

a) internal drywall partitions: 0.75 kN/m^2;

b) suspended services with ceiling finishes: 0.50 kN/m^2;

c) suspended services without ceiling finishes: 0.30 kN/m^2.

The Engineer shall provide detailed calculations supporting the superimposed dead load assumptions. If supporting calculations are not provided, the vertical load listed in Table K.21 shall be included for the partition assumptions.

Type of wall	Superimposed dead load applied vertically, including finishes (kN/m^2)
Lightweight block wall	4.5
Normal weight block wall	5.5
Drywall	4.0

Table K.21 Minimum superimposed dead load

Loading plan drawings showing the load provision should be submitted for approval.

The design assumptions shall be validated against the systems installed. Any late amendments and/or retrospective changes shall not be made without new approval.

K.8.4.5 Live loads

Minimum uniform live loads shall be not less than those listed in Ch. 4 of ASCE/SEI 7-16. The following requirements shall also be followed.

a) Concentrated live loads shall be evaluated for objects creating significant point loads, including machinery, vehicles and storage racks.

b) The minimum live load for garage and car parking is 3.5 KN/m^2 which should be validated based on the type of vehicles accessing the facility.

c) The live load for drained areas of floor surrounding a swimming pool is 2 kN/m^2. Pool tanks and other areas susceptible to flooding shall be designed for a load not less than the maximum retained head of water.

d) The Engineer shall design the supporting structure to withstand the loading imposed by the mechanical, electrical and public health (MEP) equipment in the designated areas and along the proposed equipment access route.

K.8.4.6 Soil loads and hydrostatic pressure

Minimum soil and hydrostatic pressures shall be not less than those listed in Table K.22. Lower values shall not be used without project specific justification.

Description	Minimum load (kN/m^3)
Soil for planters (saturated)	19
Compacted soil for trafficable areas	22
Water	10
Brackish water	10.3

Table K.22 Material densities

In addition to the geotechnical requirements specified under K.8.6, the Engineer shall include the following aspects in the design of permanent structures:

a) All foundation elements and retaining walls shall be designed by the recommendations given in the geotechnical interpretive report (GIR).
b) The design water table shall be established in the GIR considering the fluctuation of the water table level during the design life of the structure. In particular, the effect of dewatering in the neighbouring areas, the seasonal variation of the water table, future developments (such as canal, water bodies, landscaping and similar) and potential impact of climate change shall be included in the definition of the design groundwater level. The design groundwater level and its fluctuations shall be stated by the Engineer in the design drawings and agreed with the Authorities.
c) In any case, the minimum water table level shall be assumed as follows:
   1) in proximity to bodies of water: ±0.00 m Dubai Municipality Datum (DMD) plus 1.0 m for seasonal and tidal variations and
   2) away from bodies of water: actual water table level with dewatering taken into account, as defined in the GIR, plus 1.0 m for seasonal and tidal variations.
d) For structures below the water table, hydrostatic uplift and lateral pressures shall be checked in accordance with Section 10 of BS EN 1997-1:2004+A1:2013 and the associated UK NA. Any dewatering system, whether used for construction or throughout the design life, is temporary unless the system can be demonstrated to be reliable throughout the design life.
e) Where construction of the project is staged, or in case of construction on an adjacent plot, any possibility of unbalanced lateral soil load shall be included.
f) Any retaining wall assumed to be subjected to lateral pressure during construction shall be designed according to possible surcharge and hydrostatic loading. The lateral soil pressure arising from compacted soil placement shall be included where this exceeds the at rest or passive pressure (as relevant).
g) Bracing conditions of the retaining structure and construction sequence shall be carefully captured in the analysis and design.
h) Uplift due to heave shall also be included for both permanent and temporary conditions whenever applicable.

K.8.4.7 Construction load

Minimum design load requirements during construction of buildings shall be defined in accordance with ASCE 37.

Construction-stage loads, including locked-in stresses arising from the construction sequence and affecting the overall behaviour of the structure, shall be included by the Engineer.

The Engineer shall clearly state the construction load assumptions on the detailed design drawings and verify that the structural system can withstand these loads during all stages of construction.

Any departure from the Engineer’s assumptions that are invoked by the Contractor’s construction sequence shall be assessed.

K.8.4.8 Accidental impact load

Structural elements shall be designed to resist accidental impact loading conditions specified under Section 4.6 of ASCE/SEI 7-16. A secondary protection system should be provided to all primary structural members to avoid accidental impact load.

K.8.4.9 Self-straining forces

Structures shall be designed to resist any self-straining forces arising from the contraction or expansion of structural elements.

Such volume changes can result from shrinkage, creep and/or moisture change in component materials, including the soil. It might occur at any stage in the structure’s lifecycle.

The use of details to alleviate self-straining forces may be used when practical and not in violation of any assumed load paths. Such details, where permanent, shall be durable and/or have provision for maintenance.

K.8.4.10 Thermally induced forces

Thermally induced forces shall be derived considering the structural restraints, and the changes in temperature of structural members arising across the construction/operational phases, seasonal and daily variations.

For effects on covered concrete structural members, mean monthly temperatures should be used to establish an appropriate range. A default thermal range of ±20 °C may be used for exposed concrete elements and ±15 °C for non-exposed concrete elements.

For steel structural members and structural members exposed to solar radiation, a range equivalent to the maximum temperature swing is appropriate. A default thermal range of ±25 °C may be used for protected steel elements. For exposed steelwork, this can arise from hourly maxima and minima. The Engineer shall assess the thermal range and assess the thermally induced forces on a case by case basis considering the construction stages, exposure and when the steel structure is locked in the final configuration.

NOTE: Relative humidity values and mean monthly temperature for specific sites are available from the National Centre for Meteorology and Seismology website **[Ref. K.17]**.

K.8.4.11 Design for wind loading effects

K.8.4.11.1 General

The Engineer shall calculate the effects of wind loading, taking into account strength for life safety, and serviceability for building movements affecting cladding or building occupant comfort.

Calculations for wind design shall be based on ASCE/SEI 7-16 and additional rules for application in Dubai from this section.

K.8.4.11.2 Wind pressures

This subclause provides the basis for calculation of wind pressures to be used with ASCE/SEI 7-16.

The wind speeds of Table K.23 replace the use of the wind maps of Section 26.5 or ASCE/SEI 7-16. Wind reference speed for 50 MRI shall be used only for strength design in accordance with Clause 5.3.5 of ACI 318 19.

Application – risk category	Reference wind speed, V = Vref (m/s)	ASCE/SEI 7-16 MRI (years)
Strength	38	50
Strength – category II*	47	700
Serviceability – deflections	30	10
* Risk category is described in Section 1.5 of ASCE/SEI 7-16. For villas/townhouses in Dubai, use category II.		

Table K.23 Reference wind pressures and speeds per risk category and mean recurrence interval (MRI) (extracted from **[Ref. K.18]**)

In all cases, the design wind pressure shall be not less than 1 kN/m^2.

K.8.4.12 Design for earthquake effects

Every villa/townhouse, and portion thereof, including non-structural components that are permanently attached to structures and their supports, shall be designed and constructed to resist the effects of earthquake motions in accordance with ASCE/SEI 7-16 (Section 11.1.2) and **F7.13**.

K.8.5 Structural performance and serviceability requirements

K.8.5.1 Design basis

The basis of design for villas/townhouses shall include these aspects as a minimum:

a) strength;
b) deflection control in concrete and steel structures;
c) crack control in concrete structures;
d) building movement and motions due to wind;
e) building movement due to seismic;
f) movement joint and building separation;
g) vibration;
h) lateral acceleration;
i) fatigue; and
j) additional requirements for transfer elements.

K.8.5.2 Strength

Villas/townhouses and parts thereof, shall be designed and constructed to support safely the factored loads in load combinations defined in this section without exceeding the appropriate strength limits states for the material of construction.

K.8.5.3 Deflection control

Deflection limits shall be adopted that enable functional requirements to be maintained. Limits may be governed by the requirements of internal and/or external furniture, finishes, fixtures and fittings.

Vertical and horizontal deflections shall be within the limits specified in the referenced design standards, as applicable, and the project specific requirements.

When checking for deflections the most adverse realistic combination and arrangement of serviceability loads shall be included.

The Engineer shall verify that the adopted deflection limits will enable the functional performance of the building to be maintained. In particular, the following apply.

a) Deflection limits for steel structures shall conform to the requirements stipulated in AISC 360 and AISC design guide 3 [Ref. K.24].
b) Deflection limits for concrete slabs and beams shall be in accordance with 24.2.2 of ACI 318-19. The value of the incremental deflection shall not exceed 20 mm after the installation of partition and finishes and shall be calculated in accordance with ACI 435R-95 and ACI 318-19. When evaluating the deflection of concrete structures, the detrimental effects of cracking shall be included by modifying the stiffness (EI) for areas which have exceeded the allowable tensile stresses. The modified EI shall be chosen based on the extent of cracking under the design load. Default stiffness modifiers given in ACI 318-19 may be followed for regular structures subject to approximately uniform loads.
c) Design for strength and serviceability requirements of post-tensioned concrete members shall conform to ACI 318-19. Structural calculations shall verify that both short and long-term deflections, camber, vibration frequency and amplitude are within permissible limits.

K.8.5.4 Crack control in concrete structure

The Engineer shall perform crack width calculation checks for reinforced concrete structures in accordance with ACI 224R.

In the absence of more specific requirements, the following maximum crack width limits shall be adopted:

a) For section of the structure in contact with groundwater, the crack width limits (w_k) are defined as a function of the ratio of the hydrostatic pressure, h_D to the wall thickness of the containing structure, h_w.
   1) For h_D/h_w <5, w_k = 0.2 mm.
   2) For h_D/h_w >35, w_k = 0.05 mm.

b) For intermediate values of h_D/h_w, linear interpolation between 0.2 mm and 0.05 mm may be used.

c) Section of the structure not in contact with water: w_k = 0.3 mm.

d) Structural elements (such as piles) under permanent tension loads: w_k = 0.1 mm.

The above listed limits may be adopted providing that they do not contradict the requirements of ACI 224R and a proprietary waterproofing system is provided for structural elements in contact with water in accordance with BS 8102.

It is also recommended that basements and liquid retaining structures are classified in relation to the degree of protection against leakage. An appropriate limit to cracking depending on the classification should be selected by the Engineer and Owner's representative, paying due regard to the required function of the structure, the intrinsic durability requirements, soil and water properties. Where structural walls, columns and piles provide significant restraint to shrinkage and temperature movements, it is recommended that the reinforcement provisions are verified against the requirements stated under either ACI 89-S15 (as in R24.4.2 of ACI 318-19) or CIRIA C766 [Ref. K.22].

K.8.5.5 Drift and deformation

K.8.5.5.1 General

The Engineer shall assess the drift and deformation of the building considering the whole life of the structure, including the construction stages.

K.8.5.5.2 Drift and deformation due to wind

Building overall displacements shall be calculated using 10-year return (MRI) wind pressures and total building height (H). The overall displacement of the building due to wind action shall be limited to H/500 using the serviceability parameters listed in Table K.23.

The displacement limits may be varied provided that provision for any larger than normal movements is clearly specified on drawings and implemented.

The purpose of this calculation is to control displacements of the building which can cause overstress or fatigue damage or loss of effectiveness to cladding, internal partitions or other non-structural components of buildings.

K.8.5.5.3 Drift and deformation due to seismic

Movements of buildings due to earthquake effects shall conform to the requirements stipulated under Section 12.12 of ASCE/SEI 7-16.

K.8.5.6 Movement joints and building separation

Movement joints shall be provided, where necessary, to address the requirements of expansion and/or deflection under load for above-ground structures.
The minimum separation between a structure and any surrounding obstructions shall be not less than the total maximum displacement, as specified in Section 12.12 of ASCE/SEI 7-16.

Movement joints are a common source of water infiltration. Structures below ground level should be designed without movement joints to mitigate the risk of water ingress. Design for construction without permanent joints below ground level can be achieved by following the recommendations provided in CIRIA C766 [Ref. K.22].

K.8.5.7 Vibration

Vibration and oscillation of building structures should be limited to avoid discomfort to the users, damage to contents or damage to the structure, as detailed below.

a) Steelwork. The natural frequency of steelwork floor systems for normal occupancy shall be evaluated in accordance with AISC Design guide 11 [Ref. K.25] or SCI P354 [Ref. K.26].

b) Reinforced concrete. Cast-in-place floor systems designed in accordance with the minimum thickness and deflection requirements of ACI 318-19 have generally been found to provide vibration performance suitable for human comfort under typical service conditions. However, there might be situations where serviceability conditions are not satisfied, for example:
   1) long spans and open floor plans;
   2) facilities subject to rhythmic loadings or vibrating mechanical equipment.

NOTE: Further guidance is given in the ATC Design Guide 1 [Ref. K.23].

c) Post-tensioned slab. The performance of post-tensioned concrete floors may follow the recommendation of TR43 [Ref. K.20] Table 1 and Appendix G.
d) Precast concrete. Structures shall be checked for vibration as detailed in Section 9.7 of PCI design handbook [Ref. K.21].

K.8.5.8 Fatigue

Structural members that support significant vibrating machinery, vehicles or plant should be checked for fatigue resistance. Where fatigue is critical, all design details shall be fully defined, including clear specification of the workmanship and quality assurance tests. The design shall be checked in accordance with the following codes:

a) Appendix 3 of AISC 360-16 for steel; and
b) ACI 318-19, ACI 215R and ACI 408.2R for concrete.

K.8.5.9 Transfer elements

Any beam, slab or truss structure used to redirect the vertical gravity or lateral load path of upper storeys to the vertical structure of the lower storeys shall be treated as a transfer element.

Such elements are typically used where a change of use on a floor dictates a different column or wall arrangement, or to accommodate architectural features.

Transfer structures have significant design, cost, material and construction schedule implications, requiring careful consideration of construction logistics, as well as consideration of the impact of long-term deflections of the transfer members and supporting elements. As such, transfer structures should be avoided where possible.

The following requirements shall be met in the design of transfer elements.

a) Transfer beams shall be supported on at least two direct supports.
b) Eccentricity between the column axis and the longitudinal axis of the beam is not permitted. The load transferred to the planted column, transfer beam or slab shall be not less than the loads calculated by manual method (tributary area).
c) Any structural elements supporting planted/floating columns that might cause a progressive collapse shall to be included as a key element. Reinforcement shall be detailed to facilitate robustness by means of provision of adequate peripheral, vertical and horizontal ties.
d) The entire length of the supporting columns shall be included as critical length and the stirrups shall be spaced to provide effective confinement for the columns.
e) Structural system elements of the planted portions of the structure shall have redundancy to facilitate alternative load paths in the case of failure of any structural member, as specified under K.8.1.4.
f) Any structural members or elements that do not fall under the purview of the adopted design codes should be analysed and designed for various possible critical combinations.
g) Transfer structure should be capable of withstanding the reactions from any attached building components. The reactions should be the maximum values that might reasonably be transmitted considering the strength of the connecting component and its connection.
h) The Engineer shall check that the deflections of the structural members supported by the transfer elements are within the deflection limits specified in K.8.5.3.

K.8.6 Geotechnics

K.8.6.1 General

This subsection provides minimum geotechnical requirements that are appropriate for the geology, stratigraphy, geotechnical and groundwater conditions of Dubai. A major characteristic of the ground in Dubai is its calcareous origin for both soils (e.g. calcareous sand) and soft calcareous rocks, with clay minerals of various expansion potential. Groundwater is saline with chlorites and sulphates that make a very aggressive environment for concrete and reinforcement in the ground.

The geotechnical requirements and design aspects are discussed in K.8.6.3 to K.8.6.5.

The geotechnical design of buildings in Dubai shall be based on the requirements stated herein and the referenced standards (see Figure K.56 for piling works). This subsection should also be read in conjunction with all the other relevant subsections of K.8.

Additional studies should be conducted for unusual constructions and might result in a variation from these requirements which would require approval from the Authority.

The geotechnical site investigations and testing shall be undertaken by the geotechnical laboratory. All geotechnical reports submitted by the geotechnical laboratory shall be reviewed and approved by the Engineer who witnessed the execution of soil testing.

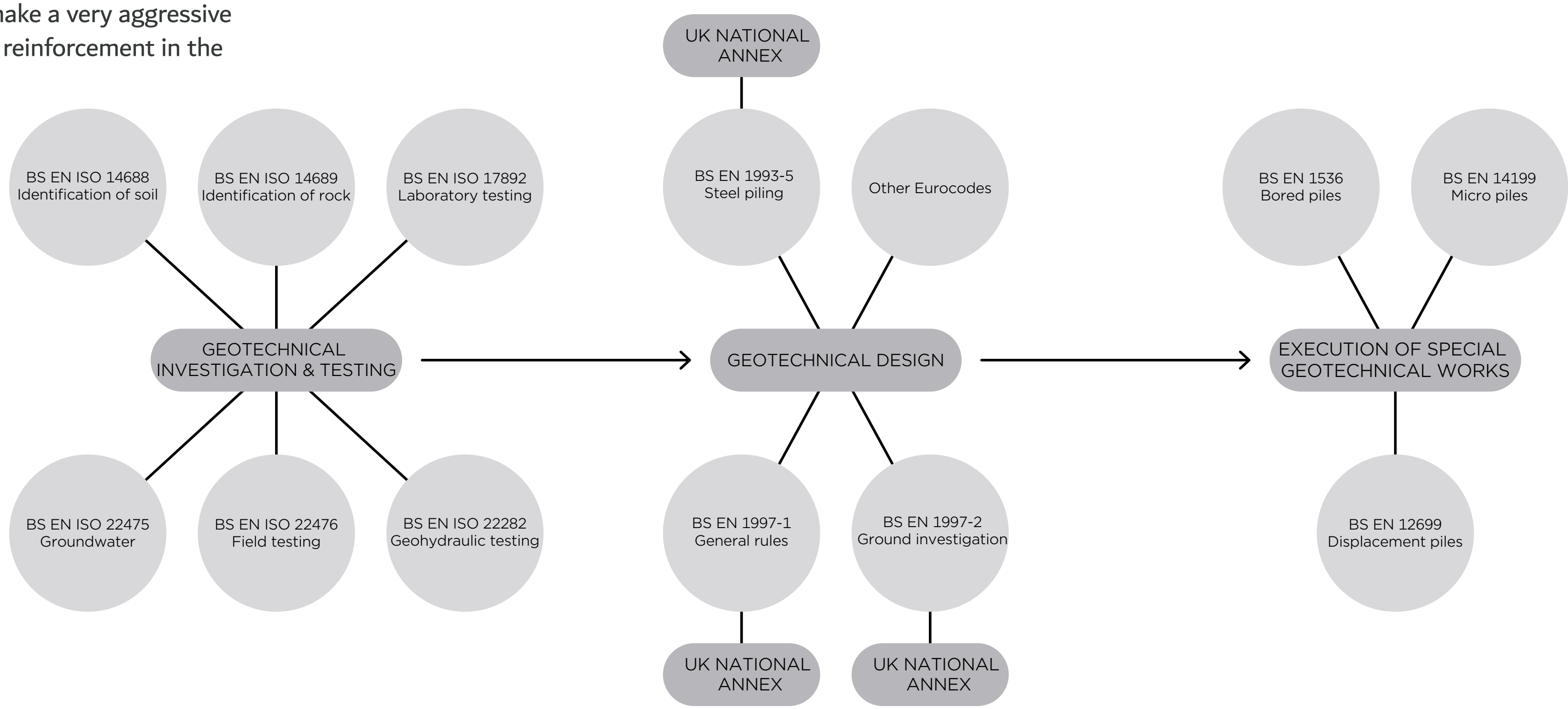


Figure K.56 Suite of standards for geotechnical investigation and testing, design and execution of piling works.

Any geotechnical design packages submitted and executed by the Geotechnical Specialist Contractor shall be reviewed and approved by the Engineer.

All the geotechnical design works and site investigation reports shall be submitted to the Authority for the necessary approval.

All the geotechnical design and execution packages shall be undertaken by a qualified Geotechnical Civil Engineer.

K.8.6.2 Standards

Geotechnical site investigations and geotechnical works shall be designed to meet or exceed the minimum requirements of the codes and standards listed in K.3.5.5.

K.8.6.3 Geotechnical site investigation

K.8.6.3.1 General

Geotechnical site investigations shall be planned and carried out in accordance with BS 5930, BS EN 1997-2 and the associated UK NA, BS 1377 and BS 10175.

As indicated in BS 5930, the primary objectives of a geotechnical investigation are as follows:

a) to assess the general suitability of the site for the proposed works;
b) to enable an adequate and economic design to be prepared;
c) to foresee and provide against difficulties that may arise during construction due to ground and local conditions; and
d) to predict any adverse effect of the proposed construction on neighbouring structures.

A schematic representation of the geotechnical site investigation is illustrated in Figure K.57.

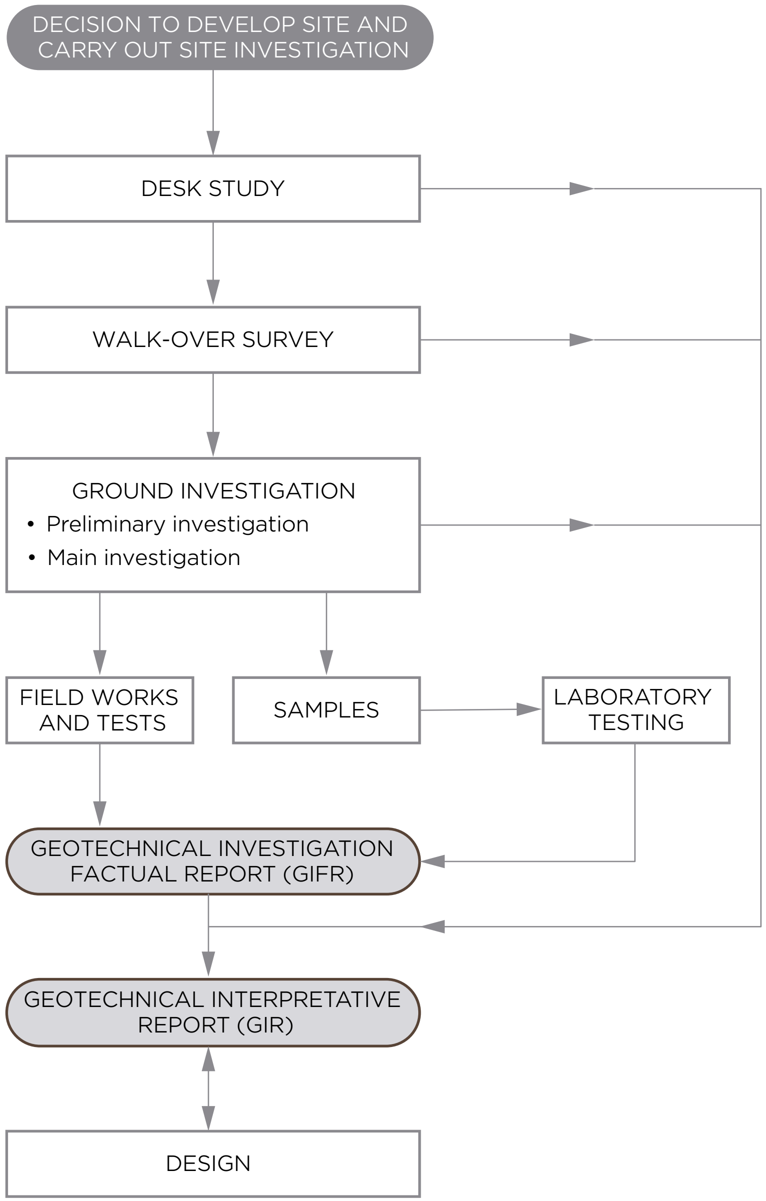


Figure K.57 Schematic organization of a site investigation

K.8.6.3.2 Geotechnical desk study

The geotechnical desk study shall provide a conceptual model of the site based on all the available morphological, geological, hydrological, geotechnical information, and land use history from public sources and technical literature. The extent of the study shall be determined according to the nature of the project and the anticipated ground conditions.

K.8.6.3.3 Planning geotechnical investigation

The extent of the geotechnical investigation is dependent on the complexity, size and criticality of the development. Guidance on the spacing and depth of the investigation points is given in Annex B of BS EN 1997-2:2007 and the associated UK NA. Soil investigation for any building shall be defined by:

a) the location of the building;
b) the magnitude of the imposed loads;
c) the number of floors;
d) the shape of the building;
e) previous uses of the land;
f) terrain surface features;
g) geological features; and
h) surface water drainage.

K.8.6.3.4 Geotechnical on-site investigations

The requirements for geotechnical soil investigations are provided in BS EN 1997-2 and the associated UK NA and BS 5930. As a minimum, the investigations shall include the following:

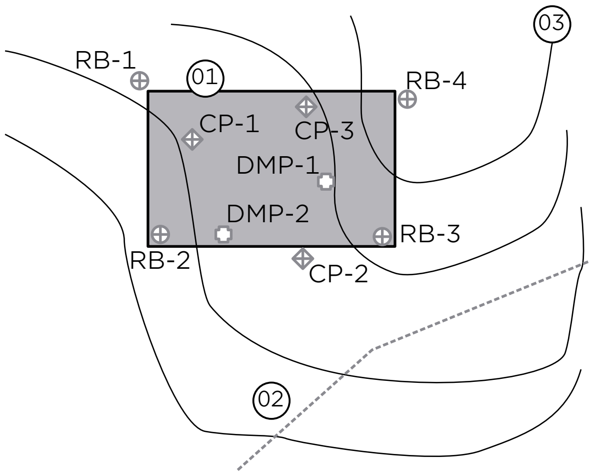
a) non-intrusive investigations (mapping, geophysics);
b) intrusive investigations (boreholes, trial pits, observation wells);
c) sampling of soils, rocks and groundwater;
d) in-situ testing including:
    1) standard penetration test (SPT);
    2) cone penetration test (CPT);
    3) pressure meter;
    4) permeability;
    5) in-situ strength; and
    6) deformability.

The depth of investigation shall extend at least three times the shortest plan dimension of the proposed foundation as specified in Annex B of BS EN 1997-2:2007.

The minimum number of boreholes shall be in accordance with BS EN 1997-2 and the following:

a) for a community of villas/townhouses: one borehole for each plot; and
b) for single villas: minimum two boreholes per villa.

An example of organization and phasing of on-site investigation is given in Figure K.58.



Key

01: Soil test boring with SPT

02: CPT

03: Dilatometer test

Figure K.58 Typical organization and phasing of on-site investigation

K.8.6.3.5 Geotechnical laboratory testing

The requirements for geotechnical soil investigations shall conform to BS 1377, BS EN 1997-2 and the associated UK NA, and BS 5930. The following list indicates a minimum level of laboratory testing:

a) soil classification/index tests;
b) soil engineering properties tests (strength, stiffness, deformability);
c) rock classification/index tests;
d) rock engineering properties tests; and
e) soil, rock and groundwater chemical tests.

Soil tests shall be conducted in laboratories licensed and approved by EIAC. All soil tests shall conform to EIAC approved standards.

K.8.6.3.6 Geotechnical reporting

Throughout, and particularly at the end of, the investigation, the geotechnical laboratory shall issue the geotechnical investigation factual report (GIFR) and geotechnical interpretative Report (GIR) which are reviewed and approved by the Engineer.

For major developments and special projects, the GIR should be issued by the Engineer based on the GIFRs issued by the geotechnical laboratory.

The following items shall be as a minimum included in the GIFR:

a) clear definition of the site, general topography;
b) site plan/drawing with all as-completed investigation location coordinates;
c) time and duration of on-site investigations;
d) meteorological/weather conditions at the time of investigations;
e) the use and state of the site at the commencement of the on-site investigation;
f) accurate account of the equipment with key specifications mobilized and used for the on-site investigation and in-situ testing and the methodologies and standards adopted;
g) all levels of topography including any lidar scans or other means of obtaining point cloud data, all site investigation points (e.g. trial pits, boreholes, CPTs, SPTs), all stratigraphic levels, groundwater levels recorded and similar, to be specified in the DMD;
h) groundwater monitoring level, period and frequency;
i) groundwater temperature;
j) borehole and trial pit logs with coordinates and description of encountered strata and levels, levels and types of all specimens taken (soil, rock and groundwater);

k) qualitative and quantitative description of boring (e.g. rock quality designation, total core recovery, etc.);

l) levels and results of all in-situ tests (e.g. SPT);

m) borehole logs shall be supplemented with all relevant laboratory tests that facilitate classification of strata (e.g. uniaxial compressive strength);

n) colour photos of borehole cores, including depth labels and colour chart;

o) full documentation of all performed laboratory tests, with suitable illustrative plots/diagrams;

p) ground profile plot with key information of stratigraphy and groundwater level (see Figure K.59).

The GIR shall include the following details as a minimum when submitted to the Authority:

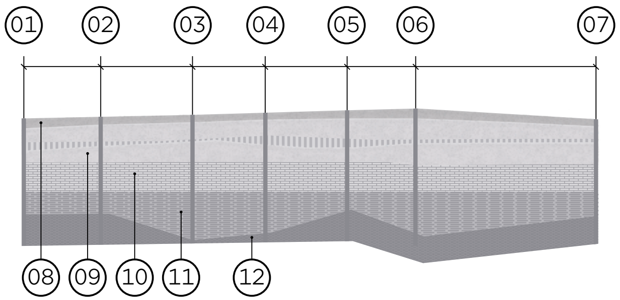


Figure K.59 Typical geological section

Key

01–07: Boreholes
08: Ground fill
09: Sand
10: Sandstone
11: Conglomerate
12: Calcisiltite

1) details of the recommended foundation system, with allowable bearing capacity, modulus of sub-grade reaction and allowable settlement;
2) provision to mitigate the effects of expansive and collapsible soils in accordance with the recommendations provided in Ch. 32 and 33 of the ICE Manual of geotechnical engineering (vol. I) [Ref. K.27];
3) provision to mitigate the effect of soil liquefaction, which shall be assessed as stipulated in K.8.9.4;
4) provision to mitigate the effect of soil settlement and loads from adjacent plots;
5) various seismic parameters for the uppermost 30 m, in accordance with the specified codes;
6) piles working load capacity under compression and tension for different sizes, at varying depths and effective length (all levels should be in DMD);
7) if applicable, recommendations for pile groups with modification factors for load and settlement;
8) values of modulus of elasticity of soil (Es);
9) horizontal modulus of sub-grade reactions (Kh);
10) constant of horizontal sub-grade reaction (nh);
11) vertical spring constants (Kv);
12) Poisson's ratio;
13) piles stiffness (Ks);
14) optimal spacing between piles within a pile group;
15) soil parameters required for shoring and basement wall design, such as:
    i) average bulk density;

ii) angle of shearing resistance;
iii) cohesion;
iv) coefficients of soil pressure at rest (K0) pressure; and
v) coefficient of active and passive soil pressure for all soil layers.

16) soil classification and index test results (particle size distribution, plasticity chart);
17) rock classification and index test results;
18) permeability of soil and rock layers;
19) plan showing boreholes, in-situ test location and coordinates;
20) water table level (in DMD) and temperature;
21) laboratory test results on soil and groundwater samples for the presence and concentration of pH, sulphate and chloride, or any other chemicals or components that might affect the structure;
22) type of cement based on the chemical test results of soil types;
23) summary of soil parameters;
24) subsoil conditions and description;
25) recommendation on the earth work, excavation, filling and compaction; and
26) recommendations for suitability of site material to be used as fill material.

K.8.6.4 Geotechnical design

K.8.6.4.1 Earthworks (excavation and fill)

Excavation works shall be designed in accordance with BS EN 1997-1 and the associated UK NA, and BS 6031. The design recommendations of Ch. 23 of the ICE manual of geotechnical engineering (vol. I) [Ref. K.27] should also be followed for the slope stability analysis.

The Geotechnical Specialist Contractor shall provide slope stability analysis for any open cut excavation (see Figure K.60).

Figure K.60 Open cut excavation

The Geotechnical Specialist Contractor shall design remedial actions when slopes display signs of instability or the geotechnical analysis confirms the risk of failing. The list below presents some of the common slope stabilization techniques which may be used in Dubai.

a) Regrading of the slope. If the available land plot permits, the slope can be regraded to reduce the slope angle.

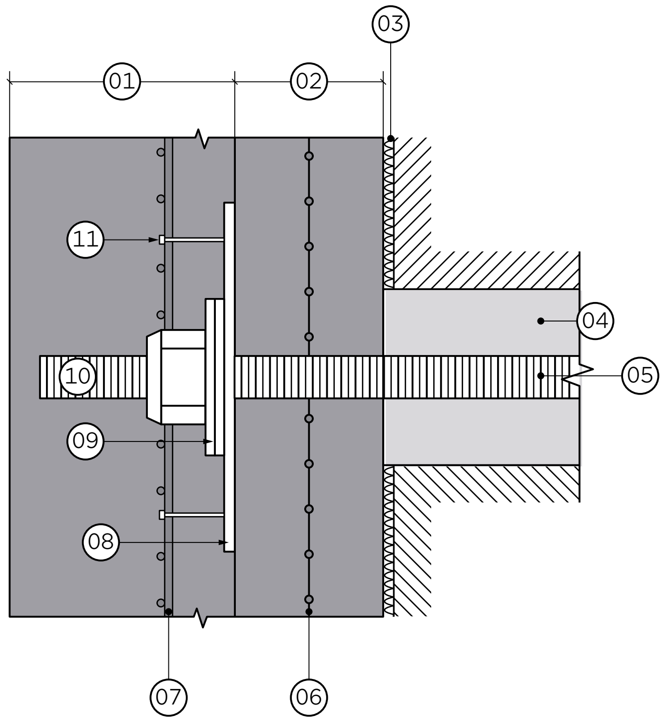
b) Drainage. Deep drains are perforated plastic tubes that can be embedded into the slope to reduce the pore water pressure.

c) Retaining wall. Retaining walls shall be designed in accordance with K.8.6.4.3.1.

d) Soil nailing. An in-situ reinforcement technique consisting of drilling or driving steel bars into the soil mass (see Figure K.61 and Figure K.62). The soil nails are secured to steel plates at the surface and optional erosion and vegetation control geosynthetic mesh can be placed over the slope face. If the soil is loose on the surface, concrete can be sprayed to cover the slope face (see Figure K.61). Further guidance can be sought in Ch. 74 of the ICE manual of geotechnical engineering (vol. II) [Ref. K.27].

e) Filling material. The material used for backfilling purposes shall be of selected fill composed of sand/granular mixture. The plasticity index of the backfill material should not exceed 10%. The maximum particle size of backfill material shall not exceed 75 mm. The percentage passing through a 75 mm sieve shall not exceed 20%. The organic materials content shall not exceed 2% and the water-soluble salt content shall not exceed 5%

f) Compaction. The backfill materials shall be placed in layers of thickness 150 mm to 250 mm and compacted to not less than 95% of the maximum dry density. The Engineer shall state whether the material available on site could be used for general backfilling or not after performing the necessary analysis.



Key

01: Permanent facing (e.g. cast-in-place reinforced concrete)

02: Temporary facing (shotcrete)

03: Geocomposite strip drain

04: Grout

05: Steel bar

06: Welded wire mesh

07: Reinforcement

08: Bearing plate

09: Washers

10: Nail head

11: Studded head

Figure K.61 Soil nailing detail (modified figure based on Figure 2.1 from CIR 7 FHWAO-IF-03-017 Geotechnical engineering circular no.7 Soil nail walls, 2003, United States Department of Transportation Federal Highways Administration)

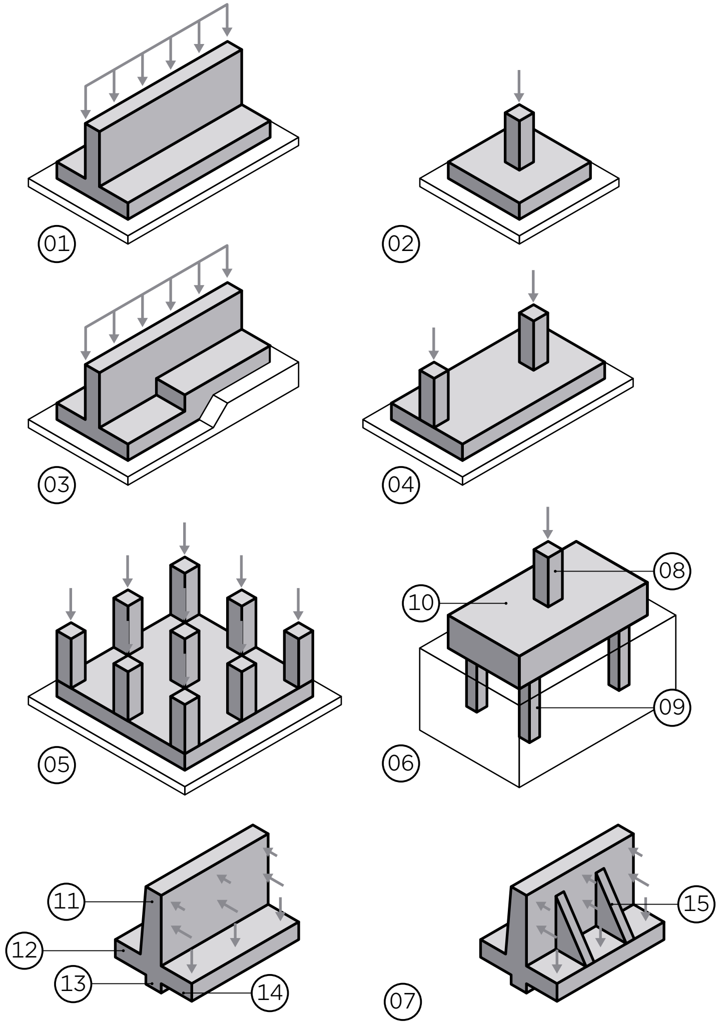
Figure K.62 Installation of soil nailing system

K.8.6.4.2 Foundations design

K.8.6.4.2.1 General

The geotechnical design of foundations shall be undertaken in accordance with BS EN 1997-1 and the associated UK NA.

The typical foundation systems in Dubai are illustrated in Figure K.63.



Key
01: Strip footing
02: Isolated footing
03: Stepped footing
04: Combined footing
05: Mat foundation
06: Deep foundation system with piles and pile cap
07: Retaining and buttressed wall foundation
08: Column
09: Piles
10: Pile cap
11: Stem
12: Toe
13: Key (optional)
14: Heel
15: Counterfort

Figure K.63 Types of foundation (© ACI. Modified figure based on Figure R13.1.1, ACI 318-19, pg.192)

K.8.6.4.2.2 Shallow and raft foundations

The geotechnical design of shallow foundations (i.e. isolated, strip, stepped, combined footing and raft) shall be in accordance with Section 6 of BS EN 1997-1:2004 and the associated UK NA.

The most common limit states for spread foundations are:

a) loss of overall stability;
b) bearing resistance failure (the equations for bearing capacity are given in Annex D, BS EN 1997-1 and the associated UK NA);
c) failure by sliding;
d) combined failure in the ground and in the structure;
e) structural failure due to foundation movement;
f) excessive settlements (refer to Annex H of BS EN 1997-1:2004 and the associated UK NA);
g) excessive heave due to swelling, frost and other causes; and
h) unacceptable vibrations.

Design of the permanent concrete structural elements shall follow **F.6**, **F.8** and ACI 318-19.

Raft foundations shall be designed as “rigid” unless a specific geotechnical model and calculation are adopted to validate the design approach.

K.8.6.4.2.3 Deep and piled foundations

The geotechnical design of deep and piled foundations shall be in accordance with Section 7 of BS EN 1997-1:2004 and the associated UK NA.

The following limit states shall be included in the design of deep foundations:

a) loss of overall stability;
b) bearing resistance failure of the pile foundation;
c) uplift or insufficient tensile resistance of the pile foundation;
d) failure in the ground due to transverse loading of the pile foundation;
e) structural failure of the pile in compression, tension, bending, buckling or shear;
f) combined failure in the ground and in the pile foundation;
g) combined failure in the ground and in the structure;
h) excessive settlement;
i) excessive heave;
j) excessive lateral movement;
k) unacceptable vibrations; and
l) liquefaction effects on piles.

The load-bearing mechanism (i.e. end bearing, friction, friction with end bearing piles) shall be recommended in the GIFR. In particular, the end bearing capacity shall be agreed with the Authority before the design is commenced.

Design of the permanent concrete structural elements shall be in accordance with **F.6**, **F.8** and ACI 318-19.

The design criteria listed in Table K.24 are applicable to reinforced concrete foundations on piles.

Design criterion	Minimum requirement
Pile design: general	Ensure pile design allows for both gravity and lateral loads. Piles to be designed for out of verticality tolerance of 1/75. Piles to be designed for eccentricity of vertical load of 75 mm. Factor of safety shall be at least 2.5, unless geotechnical model and geotechnical calculations based on the geotechnical site investigation are provided. Minimum rock socket length of three times pile diameter. The use of bentonite is not recommended. If it is used, the shaft capacity shall be reduced. Pile caps shall be designed in accordance with the requirements specified under ACI 318-19.
Crack width limit for tension piles (w_k)	0.2 mm considering the tension load. 0.1 mm considering the uplift load due to permanent tension load (i.e. groundwater uplift, out of balance gravity loads).
Geotechnical design parameters	The recommendations provided in the GIR shall be followed unless a specific geotechnical model and geotechnical calculation are developed.
Materials test reports (aggregate, steel, concrete, etc.)	To be implemented by laboratories approved by DM or EIAC.
Minimum bar diameter	12mm
Minimum number of bars	Six bars evenly spaced.
Minimum percentage of reinforcement	To be provided for the full length of the piles in order to provide ductility and in accordance with Table 18.13.5.7.1 of ACI 318-19.
Minimum stirrup reinforcement	Bars of 10 mm diameter for all the piles. The top region of the pile below the caps or raft, shall be confined effectively with closely spaced stirrups, for a length of three times the pile diameter. Stirrup reinforcement shall be in accordance with Table 18.13.5.7.1 of ACI 318-19.
Minimum design of horizontal/ lateral force	For the lateral pile design, the following requirements shall be included: a) minimum 5% of pile capacity and not less than the horizontal loads resulting from the superstructure and foundation analysis; b) moments due to out of position (75 mm) piles; and c) horizontal force due to verticality (1/75). The above design (a) may be excluded if geotechnical calculations and geotechnical models are provided and the following items are included in the design: 1) isolated temperature changes within raft, and temperature distribution from column to raft; 2) detailed pile group assessment considering soil-structure interaction, building stiffness and foundation stiffness; 3) moments due to slab dishing; 4) kinematic effects of earthquake loading; 5) sensitivity checks should piles be constructed out of position; 6) embedment of raft; and 7) lateral load path analysis and load transfer into the raft slab.
Rational study of pile spacing not available	Minimum pile spacing shall be 2.5 times the diameter.
Pile stress under compression load	Maximum 25% of concrete strength.
Lateral stiffness of piles	50% to 100% of vertical stiffness. Any other percentage (such as 10% to 15% of vertical stiffness) shall be justified by geotechnical models and calculations including the piles lateral group effect.
Vertical stiffness of piles	The impact of subsidence of the piles group on vertical stiffness, as well as its effect on the raft and piles, shall be validated by geotechnical models and calculations.

Table K.24 Piles foundation minimum design criteria

K.8.6.4.3 Shoring and retaining systems

K.8.6.4.3.1 General

The geotechnical design of earth retaining systems shall be performed in accordance with Section 9 of BS EN 1997-1:2004+A1:2013 and the associated UK NA. Design of the concrete structural elements shall be in accordance with **F.6**, **F.8** and ACI 318-19.

Shoring systems and retaining structures are deemed to be temporary if the design life of the system is less than two years. They shall not be treated as part of the permanent structures. A physical segregation shall be provided between temporary and permanent structural systems.

The shoring and retaining systems shall be designed to retain the soil and actual groundwater pressure (including tidal effect).

NOTE: Shoring and earth retaining systems typically used and accepted in Dubai are as follows:

a) non-watertight shoring systems:
   1) soldier piles with lagging system/king post walls;
   2) contiguous pile walls;
   3) slurry walls;
b) watertight shoring systems:
   1) secant pile walls;
   2) diaphragm walls;
   3) sheet piles;
c) bracing for temporary earth retaining systems:
   1) anchors;
   2) rakers; and
   3) struts.

Alternative techniques specified in accordance with international codes and standards may also be accepted.

The shoring and bracing systems are further described in Ch. 62, 63 and 64 of the ICE manual of geotechnical engineering (vol. II) **[Ref. K.27]**.

K.8.6.4.3.2 Required shoring systems

Table K.25 should be followed for different depths of excavation and site conditions.

Type of shoring system	Permitted under following criteria
All types	up to 5 m deep excavation; one basement.
All types, except soldier pile with lagging	up to 9 m depth and no buildings in the adjacent plots.
Shoring system preventing water leakage	presence of buildings in the adjacent plots; high groundwater level; proximity to water bodies.

Table K.25 Type of shoring system

It is possible to adopt shoring systems other than those in Table K.25, based on the soil examination report, groundwater level, presence of water sources, adjacent buildings and surrounding constructions.

The minimum requirements listed in Table K.26 shall be included in the design of temporary shoring systems.

Design criteria	Minimum requirement
Minimum additional loads	Additional uniform distributed load of 20 kN/m^2 shall be taken into consideration in proximity to roads and land plots. The additional surcharge load needs to be assessed based on the actual conditions on-site and adjacent structures.
Minimum distance between anchors	1.2 m
Maximum length of anchors	10 m
Minimum length of anchors	3 m
Maximum lateral displacement	40 mm
Unplanned excavations	Retaining walls shall be designed assuming presence of unplanned excavations in front of the wall, with depth of not less than 10% of the total height of vertical walls, or 10% of vertical distance between the lowest anchor and the bottom of the excavation, but not less than 0.5 m.
Heave	The geotechnical design shall assess heave if swelling and collapsible soils have been identified in the GIFR. Further guidance can be sought in Ch. 32 and 33 of the ICE Manual of geotechnical engineering (vol. I) [Ref. K.27].

Table K.26 Minimum requirements for earth retaining system

K.8.6.4.3.3 Permanent earth retaining system

Any retaining structure is deemed to be permanent if the design life of the system is more than two years. The permanent retaining system shall be designed to retain the soil and future groundwater pressure (including tidal effect) without allowing for the temporary retaining system.

The temporary retaining structures listed under the NOTE to K.8.6.4.3.1 may be designed as permanent structures, provided they are included in the analysis of the overall structure. The same design life, performance and durability requirements shall be applied to both the main structural system and the permanent retaining system.

In addition to the requirements for temporary retaining systems stipulated under K.8.6.4.3.2, the Engineer shall design the retaining systems considering the intended design life. In particular, the Engineer shall consider the applicable performance, serviceability and durability requirements of **F.6** and **F.8**.

The geotechnical design of permanent earth retaining systems (including counterfort/buttressed wall systems) shall be performed in accordance with Section 9 of BS EN 1997-1:2004 and the associated UK NA. Design of the concrete structural elements shall be in accordance with **F.6**, **F.8** and ACI 318-19.

K.8.6.4.3.4 Basement walls

A permanent basement concrete wall should be provided in front of the temporary retaining systems detailed in K.8.6.4.3.1. The permanent basement wall shall be designed to retain the soil and future groundwater pressure (including tidal effect) without considering the temporary retaining system.

The permanent basement wall shall be fully integrated with the main structural system of the building. The same design life, performance and durability requirements shall be applied to the main structural system and the basement walls.

The geotechnical design of permanent basement walls shall be performed in accordance with Section 9 of BS EN 1997-1:2004 and the associated UK NA. Design of the concrete structural elements shall follow **F.6**, **F.8** and ACI 318-19.

K.8.6.4.4 Groundwater control and dewatering

Dewatering systems shall be designed in accordance with BS EN 1997-1 and the associated UK NA and CIRIA C750 [Ref. K.28], taking into account the following:

a) All existing facilities shall always be protected.
b) The dewatering system shall reduce the loss of soft materials in the soil and any effect on the surrounding structures. The hydrogeological model shall identify and assess any piping effect. (see Figure K.64).

c) The depth of shoring systems and internal excavations shall prevent soil heave. This is to avoid the possibility of seepage, and to ensure compatibility between the designs of the shoring systems and the dewatering system (see Figure K.65).

d) A seepage analysis and groundwater/hydrogeological model shall be prepared for at least 20 m below the bottom of the excavation. The model shall determine the following:

1) type of soil and rocks;
2) horizontal permeability of each layer;
3) incoherent or gypsum soils; and
4) other areas exposed to water leakage under the surface.

Figure K.66 shows the permeability of different soil types and recommended dewatering systems.

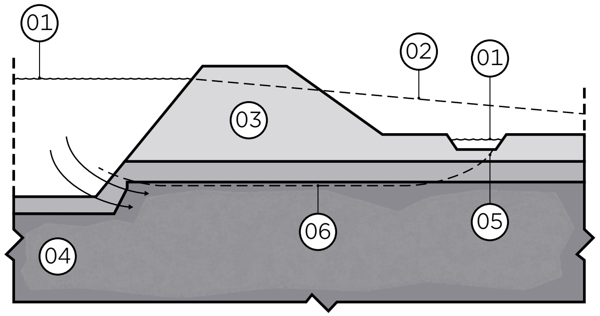
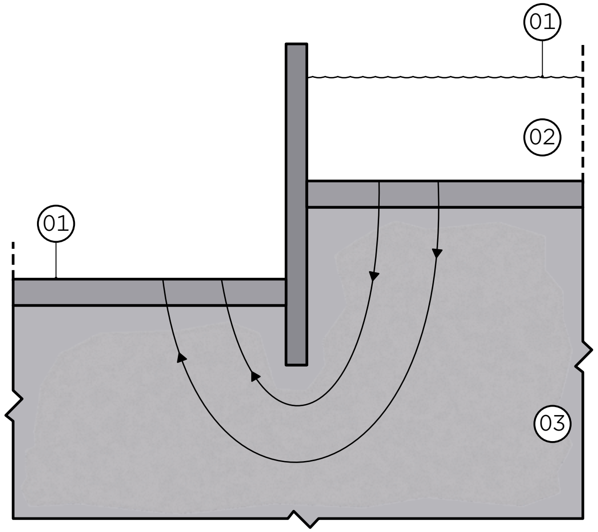


Figure K.64 Example of situation that might cause piping (© British Standards Institute. Figure extracted from BS EN 1997-1:2004. Permission to reproduce extracts from British Standards is granted by BSI Standards Limited (BSI). No other use of this material is permitted).

Key

01: Free water level
02: Piezometric level in the permeable subsoil
03: Low permeability soil
04: Permeable soil
05: Possible well; starting point for pipe
06: Possible pipe



Key

01: Excavation level (left); free-water level (right)
02: Water
03: Sand

Figure K.65 Example of situation where heave might be critical (© British Standards Institute. Figure extracted from BS EN 1997-1:2004. Permission to reproduce extracts from British Standards is granted by BSI Standards Limited (BSI). No other use of this material is permitted).

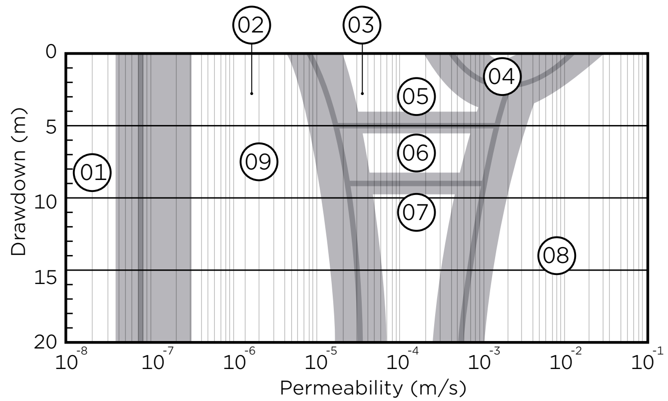


Figure K.66 Permeability of soil and dewatering systems

Key

01: Dewatering not feasible and may not be necessary
02: Vacuum necessary
03: Vacuum beneficial
04: Sump pump
05: Single stage well point system
06: Two stage well point system/Deepwell system
07: Deepwell systems
08: Excessive seepage flows: cut-off or wet excavation may be necessary
09: Ejectors

K.8.6.4.5 Liquefaction

This section shall be read in conjunction with F.7.13 and Section 11.8 of ASCE/SEI 7-16.

The 2% probability of exceedance within a 50-year period hazard parameters are given in Table K.27. Specifically, the values of peak ground acceleration (PGA) and the life safety, 5% damped spectral responses acceleration parameter at short period ($S_{S\,LS}$) and at a period of 1s ($S_{1\,LS}$) are given. The long-period transition period (T_L) is also provided.

Location	PGA	$S_{S\,LS}$	$S_{1\,LS}$	T_L (s)
Dubai	0.13	0.33	0.11	24

Table K.27 Life safety seismic ground motion parameters for Dubai (site class B)

The following amendments to ASCE/SEI 7-16 Section 11.8 shall be used.

Section 11.8.1 of ASCE/SEI 7-16 does not apply to Dubai.

Liquefaction shall be assessed using a PGA determined based on either (1) a site-specific study considering soil amplification effects as specified in F.7.13.9 or (2) the PGA_M, from Eq. K.1.

$$PGA_M = F_{PGA} \,.\, PGA \qquad \text{Eq. K.1}$$

Where PGA is the MCE_G peak ground acceleration taken from Table K.27 and F_{PGA} is the site coefficient from Table K.28.

Site class	Short period F_{PGA}
A	0.80
B	0.90
C	1.27
D	1.54
E	2.25
F	*

*A site response analysis shall be performed in accordance with 21.1 of ASCE/SEI 7-16 for structures on site class F sites. A site response study or a ground motion hazard analysis is not required in any other circumstances unless specifically requested by the Authority.

Table K.28 PGA site coefficient F_{PGA} for liquefaction assessment in Dubai

The factor of safety (FS) against the occurrence of earthquake-induced liquefaction shall be defined as the available soil resistance to liquefaction, the cyclic resistance ratio (CRR) divided by the cyclic stress generated by the design event, the cyclic stress ratio (CSR) as shown in Eq. K.2. The FS shall be not less than 1.5.

$$FS \geq 1.5\ (CRR/CSR) \qquad \text{Eq. K.2}$$

The groundwater level shall be selected based on the peak over the design period, which allows natural changes (such as the "spring" tide peak), land use changes and considerations for global warming.

In calculating the CSR, a magnitude of 6.2 shall be used for Dubai.

When assessing the potential for liquefaction any published and internationally accepted methodology [Ref. K.19] can be used provided it is internally consistent. The impact of carbonate sands on the liquefaction potential should also be included.

The requirements for foundations design in liquefiable sites shall follow the requirements in Section 12.13.9 of ASCE/SEI 7-16 and associated subclauses. This shall include consideration of the following issues regarding liquefaction, namely:

a) lateral spreading;

b) global and differential settlements;

c) provision of ties between individual foundations; and

d) negative skin friction (i.e. downdrag) on vertical capacity of piles.

Where the impact of liquefaction exceeds the requirements of ASCE/SEI 7-16 (Table 12.13-2 for lateral spreading and Table 12.13-3 for differential settlement thresholds), suitable ground improvement shall be required.

K.8.6.4.6 Ground improvement

Ground improvement shall be designed according to BS EN 1997-1 and ICE Manual of geotechnical engineering (vol. I) Ch.25 [Ref. K.27].

Note: The following ground improvement techniques are accepted in Dubai (see Figure K.67):

a) dynamic compaction;

b) vibro-compaction;

c) soil replacement;

d) soil mixing;

e) grouting; and

f) vertical drains.

Alternative techniques specified in accordance with international codes and standards may also be accepted.

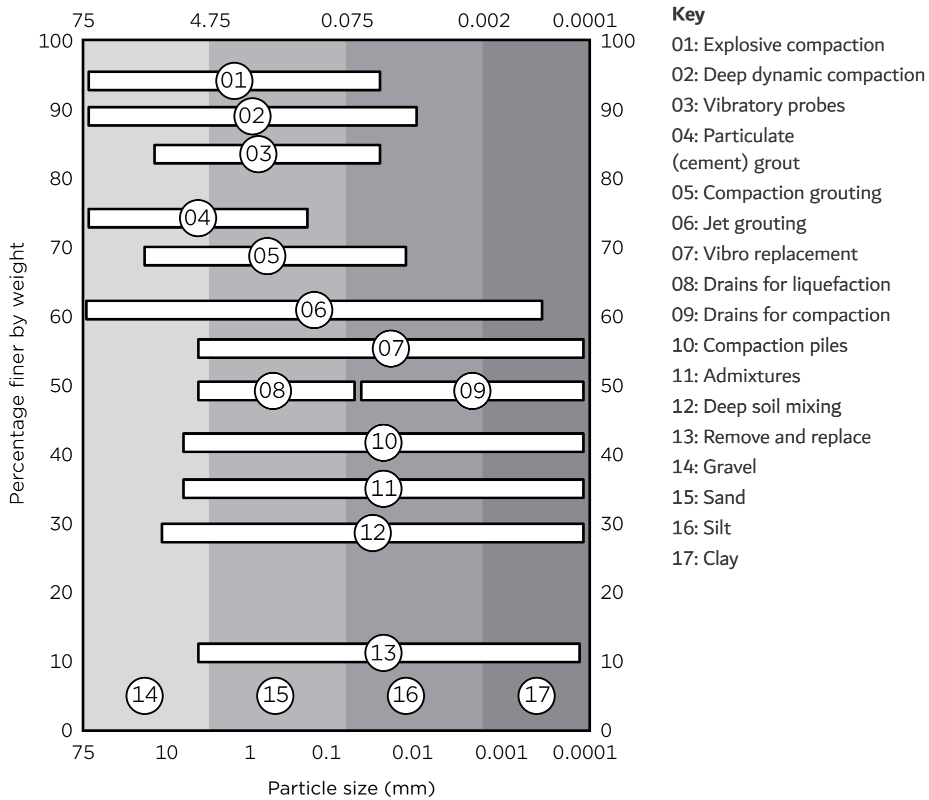


Figure K.67 Type of ground improvement systems and type of soil

Figure K.68 illustrates the indicative range of soil type (particle size sieve analysis) suitable for compaction techniques.

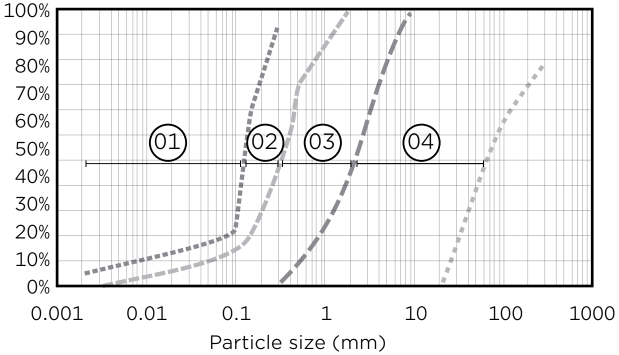


Figure K.68 Range of soil types suitable to compaction

Key

01: Stone columns are a solution for a foundation in these soils. There is a resulting increase in bearing capacity and reduction on total and differential.

02: Compaction is only possible by adding suitable backfill (material from zones 03 or 04) from the surface (stone columns or sand columns).

03: The soils in this zone are suited for vibro compaction. They have a fines content of less than 10%.

04: The soils of this zone are very well compactable.

The right borderline indicates an empirically found limit where the amount of cobbles and boulders prevents compaction because the vibroprobe cannot reach the compaction depth.

K.8.6.5 Execution of geotechnical works

K.8.6.5.1 General

Geotechnical works shall be carried out in accordance with the BS EN standards listed in K.3.5.5. The Engineer and Geotechnical Specialist Contractor shall also conform to the following subclauses.

K.8.6.5.2 Earthworks (excavation and filling)

In addition to the requirements specified BS EN 6031, the following requirements shall be included in the execution of excavation and backfill activities.

a) The materials used for backfilling purposes shall consist of selected materials such as sand/granular mixture free from organic materials or other biodegradable materials. The Engineer shall determine whether excavated materials can be used in general backfilling works after conducting necessary testing.

b) All excavations exceeding 1.2 m in depth require an excavation permit issued by the Authority.

c) All health and safety requirements shall be strictly followed while executing any excavation works.

d) All excavation activities shall be carried out inside the plot limits only. A no encroachment, no parking, and no stopping zone with a minimum width of 1 m shall be provided in proximity to the excavated area.

e) For any works required outside of the plot limits, NOC approval from the relevant Authorities, departments or plot Owners shall be submitted.

f) Execution of excavation and filling activities should meet the requirements stipulated in Ch. 75 of the ICE Manual of geotechnical engineering (vol. II) [Ref. K.27].

g) Installation of soil nails shall conform to the requirements of BS EN 14490. Further guidance can be sought in Ch. 88 of the ICE Manual of geotechnical engineering (vol. II) [Ref. K.27].

K.8.6.5.3 Shoring retaining systems

In addition to the requirements of BS 8081, BS EN 1536, BS EN 1537, BS EN 1538 and BS EN 12063, the following requirements shall be included in the construction of earth retaining structures:

a) All existing structures and utilities shall always be protected.

b) All works of shoring systems shall be carried out within the land plot.
The Geotechnical Specialist Contractor shall obtain all required approvals from all concerned Authorities and owners of the adjacent plots regarding any shoring system or anchors protruding outside the land plot limits.

c) The top 2 m of the shoring systems on the roads or services side shall be removed upon completion of the basement wall works.

d) All works of shoring systems shall be continuously monitored by the Geotechnical Specialist Contractor.

e) Anchors can be removed on site only after obtaining the written consent of the Engineer.

K.8.6.5.4 Foundations

It is envisaged that the following foundation systems will be typically provided for buildings in Dubai:

a) shallow foundations;

b) deep foundations; and

c) raft foundations.

In addition to the requirements of BS EN 1536, BS EN 12699 and BS EN 14199, the minimum testing criteria listed in Table K.29 shall be followed during and after the execution of reinforced concrete foundations on piles.

Test	Minimum requirement
Static test on working piles	Minimum 1% of all piles and each different diameter
Dynamic test on working piles	5% of all piles
Cross-hole sonic logging (for more than 1 m diameter and 20 m length)	10% of all piles 900 mm or greater with minimum four tubes/holes and minimum three tubes for 750 mm. Minimum length of testing 20 m or full length if shorter. End bearing piles full length testing
Integrity test working piles	100%
Cubes test (concrete)	as per technical specification
Reinforcement test	as per technical specification

Table K.29 Minimum testing requirements for pile foundation

It is the responsibility of both the Engineer and the Geotechnical Specialist Contractor to select a test location which does not interfere with the location of the permanent structural piles of the main structure. The Geotechnical Specialist Contractor may propose test locations to be reviewed by the Engineer who may accept them or propose alternative locations. Non-working preliminary test pile (PTP) location and arrangement shall be submitted officially to the Authority during the design stage and shall at least include the following.

1) Detailed drawings that clearly show the location of the test pile and instrumentation.

2) Information detailing the planned duration of the PTP.

3) An official covering letter from the Engineer and/or the Geotechnical Specialist Contractor.

4) Minimum 1No. PTP for each project. The maximum diameter and length of pile should be considered, assuming that they are the most representative for the site.

PTP results shall be used to optimize the pile design in accordance with BS EN 1997-1 and the associated UK NA.

K.8.6.5.5 Groundwater control and dewatering

In addition to the requirements given in CIRIA C750 [Ref. K.28], the following requirements shall also be included during the execution of dewatering on site.

a) All existing facilities and utilities shall always be monitored and protected by the Geotechnical Specialist Contractor.

b) A network shall be developed to monitor the groundwater pressure/piezometric pressure separated from the dewatering system, the vertical groundwater gradients as well as the horizontal gradients, and the water rises inside and outside the excavations/shoring systems.

c) Dewatering works shall not be stopped without the written approval of the Engineer, after achieving balance between water pressure and the weight of construction. The factor of safety shall be at least 1.1, irrespective of the friction between walls and soil.

d) Care shall be taken during the dewatering process to ensure that fine particles soil is not removed during pumping as this might lead to unexpected subsidence in the surrounding lands and the associated structures.

K.8.6.5.6 Ground improvement

Ground improvement shall be executed in accordance with BS EN 12715, BS EN 12716, BS EN 14199, BS EN 14475, BS EN 14679, BS EN 14731, BS EN 15237.

In addition to the requirements specified in the referenced codes and standards, the following requirements shall also be included during the execution of ground improvement on site.

a) The technical design should be prepared by the Geotechnical Specialist Contractor and approved by the Engineer prior to submission to the Authority.

b) Tests shall be conducted before and after the ground improvement activities. Tests shall be proposed by the Geotechnical Specialist Contractor, reviewed by the Engineer and approved by the Authority. The Geotechnical Specialist Contractor should perform the following tests as a minimum.

   1) Bearing capacity:

      i) One plate load test per each 750 m^2 area (minimum one test for each building) shall be carried out in accordance with ASTM D1195M.
      The recommended acceptance criterion is to achieve the targeted bearing pressure with total settlements less than 25 mm.

      ii) One zone load test in accordance with ASTM D1195M shall be performed for major development comprising more than one building and special structures.

   2) Improvement to mitigate liquefaction risk: The efficiency of the improvement shall be verified with CPT readings (in accordance with ASTM D5778 or BS EN ISO 22476). The pre-improvement CPT tests should be carried out every 900 m^2 maximum (or as stipulated in project specifications) to compare the results with the post-improvement CPT tests. The locations of post-improvement CPT tests should be selected at the central points between the improved points. Weighted average of CPT tip resistance for near and far tested points, should be not less than 6.0 MPa for shallow foundations.

   3) Deep piled foundation: It is recommended that, after completion of the ground improvement, the weighted average of the CPT tip resistance profile is at least 8.0 MPa.

c) A ground improvement report, based on tests conducted after performing the ground improvement, shall be approved by the Engineer and submitted to the Authority.

d) All existing facilities and utilities shall always be monitored and protected by the Geotechnical Specialist Contractor.

e) All activities shall be carried out inside the plot limits only. For any activity outside of the plot limits, a NOC from all of the relevant Authority departments (e.g. DEWA, RTA. etc.) or plot Owners shall be submitted to the Authority.

K.9 Incoming utilities

K.9.1 Design, erection and installation of electrical systems

K.9.1.1 General

This section outlines the requirements for the design of electrical installations. It is based on the latest edition of BS 7671 and Institution of Engineering and Technology (IET) documents [Ref. K.29 and Ref. K.30].

Subsections K.9.1 to K.9.3 are not intended to:

a) take the place of a detailed specification;

b) instruct untrained persons; or

c) provide for every circumstance.

Where a situation arises which is not covered or allowed for within these subsections, DEWA shall be consulted to obtain further clarity and guidance.

K.9.1.2 Electrical supply

The nominal electric supply voltage from DEWA (IEC 60038) is 230/400 V ± 10%, 50 Hz, three-phase, 4-wire with separate neutral and protective conductor (generally metallic armour of the DEWA service cable). The neutral is solidly earthed at DEWA's substations and shall not be earthed elsewhere in the consumer's electrical installations. The design fault level within the substation is 40 kA (fault duration 1 s), except for fuse protected equipment/circuits.

All equipment, apparatus, materials and accessories used in electrical installations shall be designed and rated for operation on this electric supply. Overload, short circuit and earth leakage protective devices shall be provided. Depending on the design of consumer installations, protective devices shall also be provided to protect against the following as required:

a) over voltages;

b) fluctuations;

c) transients and harmonics;

d) loss of one or more phases; and

e) unforeseen interruptions.

K.9.1.3 Incoming and metering

Before commencing building design, the consumer shall obtain confirmation of the availability of a power supply from DEWA. Power supply from DEWA's network is subject to all applicable terms and conditions as issued by DEWA.

The consumer shall protect all elements of DEWA installations provided for and within the premises. Any violation, defect or damage to DEWA lines, equipment or metering shall be reported immediately.

Where the total connected load (TCL) exceeds 400 kW, provision shall be made within the building or plot for a DEWA substation. In some circumstances a DEWA substation might be required for connected loads less than 400 kW.

Meters shall be installed to measure and record the electricity demand and consumption of the facility. All tariff meters shall conform to DEWA specifications. Tariff meters are supplied and installed by DEWA.

Tariff metering shall be in accordance with K.9.1.5.

K.9.1.4 Point of supply

K.9.1.4.1 General

Point of supply shall be made available at one location within a plot/project, unless otherwise approved by DEWA. The point of supply defines the boundary of DEWA equipment, and shall be decided by DEWA.

The circuit breaker(s) and/or main distribution board (MDB) provided at the point of supply shall be designed and rated to suit the required application, and to conform to all applicable requirements of K.9.

All incoming cable terminations/live connections in metering cabinets, MDBs and SMDBs shall be adequately shrouded and insulated.

All exposed live terminal connections and busbars in any low voltage (LV) distribution board (DB) shall be shrouded and/or insulated.

Refer to G.4.4 in the event of a main electrical switchroom and LV distribution panel being required.

K.9.1.4.2 Switchgear locations

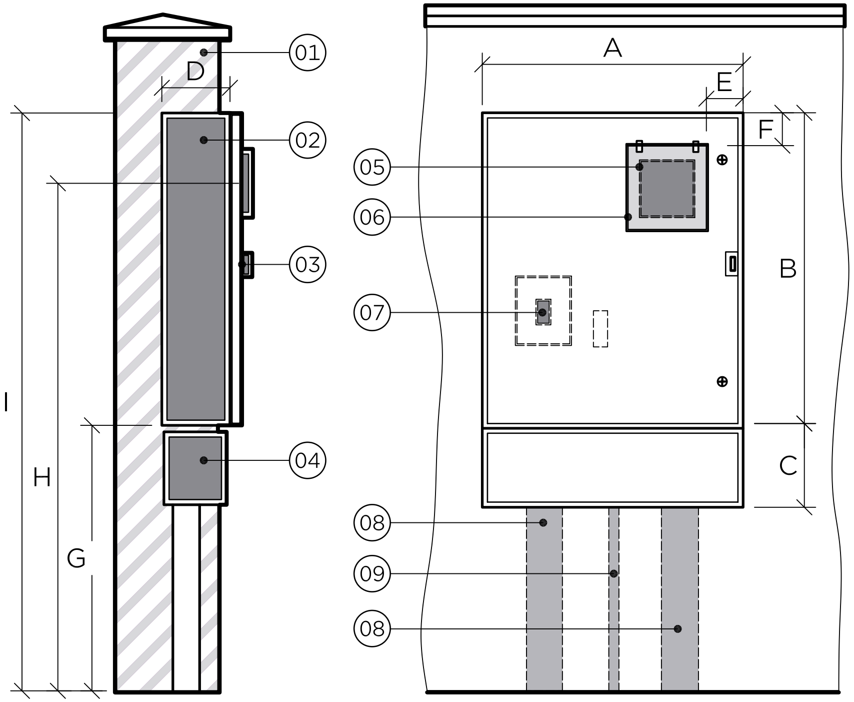
Where a main or submain electrical switchroom is required, refer to G.4.4 for further details and requirements.

K.9.1.5 Tariff metering

K.9.1.5.1 Individual consumers premises

Individual consumer premises include villas, townhouses, farms, gardens and accommodation blocks. The metering cabinet (including main incomer circuit breaker) in such premises shall be installed in the compound wall as illustrated in Figure K.69.

A minimum clearance of 2 m shall be maintained between electricity and water service cabinets/points.



Type of kWh metering	Dimensions (mm)								
	A	B	C	D	E	F	G	H	I
Direct connected metering (Up to 125 A)	600	800	250	200	60	60	800 (min.)	1,600 (max.)	1,800 (max.)
CT. Operated metering (5 A meter and CT ratio up to 400/5 A)	800	1,000	300	250	80	80	800 (min.)	1,600 (max.)	1,800 (max.)

Figure K.69 Typical arrangement for tariff metering cabinet recessed within compound wall

Key

01: Compound wall.
02: Weatherproof (IP 55) metering cabinet.
03: Hinged door with provision for wire sealing and pad locking (hole size: min. 10 mm diameter).
04: Cable (gland) box.
05: Transparent meter viewing window (min. 5 mm thickness, size: 150 mm × 150 mm).
06: Protection cover with hinges on top (size: 200 mm × 200 mm).
07: Position of incomer breaker.
08: 150/100 mm PVC pipe sleeve for service cable.
09: Conduit/s for earthing conductors (ECC).

For CT operated meters, VT fuses shall be sealed type, located in a sealable enclosure.

All tariff metering shall be smart meters, normally provided by DEWA and restricted to one for each consumer installation, unless otherwise approved/specified by DEWA.

K.9.1.5.2 CT metering requirements

Metering by means of current transformers (CTs) shall be installed where the circuit breaker rating at the point of supply is 160 A and above.

NOTE 1: DEWA provides the smart kWh meter(s) and associated CTs for all tariff metering. In some circumstances the consumer might be permitted to provide the kWh meter and CTs as private check meters for energy monitoring purposes.

Refer to G.4.5 for further details and requirements for CT metering.

K.9.1.6 Ambient design conditions

All equipment, apparatus, materials and accessories used in electrical installations shall be suitable for the purpose intended. They shall be capable of operating with satisfactory performance in the climatic conditions described in Table K.30.

Parameter	Condition
Altitude:	Sea level (coastal)
Maximum outdoor ambient temperature (shade):	48 °C
Minimum ambient air temperature	2.8 °C
Maximum ambient air temperature	48 °C
Maximum average temperature over 24 h	37.8 °C
Maximum average temperature over 1 year	26.9 °C
Relative humidity	100% (max)
Thunderstorms per year	Occasional
Earthquake loading	0.07 g
Wind speed	45 m/s at 10 m height
Ground temperature	40 °C
Soil thermal resistivity	2.0 °C/m/w at depth of 0.9 m
NOTE: Heavy condensation and sandstorms also prevail	

Table K.30 Ambient design conditions for Dubai

K.9.1.7 Cables and conductors

K.9.1.7.1 General

For general purposes and in normal situations, LSF/XLPE insulated, stranded copper conductor cables shall be used for all fixed wiring installations. The cables shall be appropriate to the building type and conform to the respective standard from the following list:

a) BS 5467;
b) BS 6004;
c) BS 6724;
d) BS 7211;
e) BS 7629-1;
f) BS 7846;
g) BS 7889;
h) BS 8436.

In certain circumstances, PVC insulated cabling may be used for general purpose installations, subject to approval by DEWA.

In flammable/explosive situations, cables shall be selected to meet the requirements of UAE FLSC [Ref. K.1].

Flexible cables and cords for use in electrical installations shall be LSF insulated and sheathed, stranded copper conductors conforming to BS 7211.

Cables for connection between ceiling roses and luminaires for pendant type light fittings and for enclosed luminaires shall be heat resistant silicone rubber insulated with stranded copper conductor conforming to BS EN 50525.

For elevators and similar applications, rubber insulated or PVC insulated flexible cables conforming to BS EN 50214 shall be used.

kWh meter tails shall normally be single core PVC insulated and sheathed cables conforming to BS 6004.

The cables used for control, relays, instrument panels, etc. shall conform to BS 6231. Single core cables armoured with steel wire or tape shall not be used for AC circuits.

K.9.1.7.2 Minimum size of conductors

The size of conductor used for lighting circuits shall be not less than 2.5 mm^2.

The size of conductor used for utility sockets shall be not less than 4 mm^2.

K.9.1.7.3 Current rating, size and voltage drop

All cables shall be adequately sized to continuously carry the normal current of the individual circuits based on various laying conditions as applicable and the maximum ambient temperature (BS 7769).

A typical selection of the cables recommended for villa and townhouse applications is shown in Table K.31, Table K.32 and Table K.33.

Size of cables in concealed conduits		Max. rating of MCB/ MCCB (A)	Max. load current/ demand (A)
2 × 1C, single-phase (mm^2)	3/4 × 1C, three-phase (mm^2)		
2.5	2.5	10/15	10/15
4	4	20	20
6	6	25	25
6	10	30	30
10	16	40	40
16	25	50	50
25	25	60	60
35	50	80	80
—	70	100	100
—	95	125	125
—	120	150/160	150/160

Table K.31 Typical recommended cable sizes – Single-core LSF insulated, non-armoured, stranded copper conductors

Size of one 3/4 C LSF/SWA/ LSF cable installed in normal situations (mm^2)	Max. rating of MCB/MCCB (A)	Max. load current/demand (A)
2.5	10/15	10/15
4	20	20
6	30	30
10	40	40
16	50	50
25	60	60
35	80	80
50	100	100
70	125	125
65	160	160
120	180	180
150	200	200
185	250	250
240	300	300
300	350	350
400	400	400

Table K.32 Typical recommended cable sizes – Multicore armoured LSF insulated, copper conductors

Size of one cable installed in normal situations (mm²)	Max. rating of MCB/MCCB (A)	Max. load current/demand (A)
10	50	50
16	60	60
25	80	80
35	100	100
50	125	125
70	160	160
95	200	200
120	225	225
150	250	250
185	300	300
240	350	350
300	400	400

Table K.33 Typical recommended cable sizes – Multicore armoured XLPE insulated, copper conductors

NOTE: The following process can be used to determine which cable size to select from Table K.31 to Table K.33.

a) Assess initial demand with safe diversity and anticipated demand in future, if any, as applicable to individual circuits, for selection of cable size, breakers rating, etc.

b) Assess individual fault levels and select MCBs/MCCBs accordingly.

c) Refer to manufacturer's catalogues and select MCBs/MCCBs, cable sizes, etc. for specific applications, considering inductive/capacitive loads, laying conditions, voltage drop, correction factors, etc.

The voltage drop from the point of supply to any point in the wiring installation shall be not more than 4% of the nominal voltage of the electric supply, unless otherwise specified.

K.9.1.7.4 Cable colour identification

The colour identification of insulated cable cores of unarmoured, armoured and flexible cables and of sleeve, band or disc of bare conductors shall be as indicated in Table K.34 and Table K.35.

Function	Colour identification		
Earth continuity conductor (ECC)	Green	and Yellow	
Neutral conductor in single-phase and three-phase circuits (N)	Black		
Phase conductor in single-phase circuits	Red		
	or		
	Red (R)	Yellow (Y)	Blue (B) as applicable
Phase conductor in three-phase circuits			
R-phase	Red		
Y-phase	Yellow		
B-phase	Blue		

Table K.34 Non-flexible cables and bare conductor identifiers

Function	Colour identification	
Live	Brown	
Neutral	Blue	
Earth	Green	and Yellow

Table K.35 Flexible cables and cores colour identifiers

K.9.1.8 Wiring installation exposed to high temperatures

Any part of a wiring installation (such as the individual circuit cables, final connections to equipment, appliances and light fittings) shall be rated to maintain its performance at the temperatures likely to be encountered. Heat-resistant sleeves shall be provided for individual cores and/or heat-resistant cables.

For end connections to luminaries with incandescent and halogen lamps, and fixed heating appliances, heat-resistant sleeves and cables shall be rated for a minimum operating temperature of 85 °C.

K.9.1.9 Wiring installations in hazardous areas

All light fittings, wiring accessories and other electrical equipment in potentially hazardous atmospheres shall be selected in accordance with BS EN 60079.

K.9.1.10 Load balancing

In all cases where a three-phase supply is provided to a premises, the various categories of connected load such as lighting, socket outlets, water heaters, single-phase air-conditioning units, equipment, apparatus, etc. shall be distributed and connected on red, yellow and blue phases as evenly as possible, to ensure load balance between the phases at all distribution levels.

K.9.1.11 Wiring accessories

K.9.1.11.1 Conduits and fittings

High impact rigid PVC conduits and fittings shall conform to all relevant parts of BS 4607, BS EN 60423 and BS EN 61386. They shall meet the following requirements:

a) be suitable for use at a maximum ambient temperature of 48 °C;

b) not soften or suffer structural degradation at a temperature of 70 °C;

c) be non-hygroscopic; and

d) be heat-resistant

PVC conduits shall be provided with copper/brass terminals.

Steel conduits and fittings shall conform to the relevant specifications in BS EN 60423 and BS EN 61386. They shall be hot-dip galvanized to class 4 protection, both inside and outside.

Flexible steel conduits and fittings shall conform to BS EN 61386.

Conduit systems shall be designed and installed to exclude moisture, dust and dirt. Small drainage holes shall be provided at the lowest part of the system to avoid the accumulation of condensation.

K.9.1.11.2 Trunking

Where applicable, surface and underfloor (duct) trunking and their fittings shall conform to BS EN 50085. Trunking and fittings shall be constructed of steel, hot-dip galvanized both inside and outside, or non-combustible insulating material with removable covers. Installation of the trunking shall be carried out strictly in accordance with the manufacturer’s guidelines.

The protective conductor shall run inside the trunking and not in parallel.

Internal fire barriers shall be provided where long run trunking crosses the floors/walls. The requirements for fire barriers are specified in UAE FLSC [Ref. K.1].

Small insulated cables shall not be installed in perforated trunking.

Additional supports shall be provided where trunking changes direction.

Earth bonding shall be provided between sections/gaps in all trunking runs and bolted connections.

K.9.1.11.3 Cable trays and supports

Cable trays, accessories and supports shall be either hot-dip galvanized or PVC-coated steel. Cable trays shall be either the perforated type or ladder type. They shall have sufficient strength and rigidity to support the cables installed, and be provided with upstands of adequate dimensions on both sides.

Cable tray systems, cable ladder systems and their fittings shall conform to BS EN 61537.

All fittings, bends, tees, elbows, couplers, etc. and supports shall be of substantial sections and of the same quality as the trays. Cables shall be fastened securely by purpose-made clips, cleats or saddles.

Earth bonding shall be provided between sections/gaps in all cable tray runs and bolted connections.

Internal fire barriers shall be provided where cable trays cross the floors/walls.

Small insulated cables shall not be installed in perforated cable trays.

Additional supports shall be provided where cable trays change direction or cable drops out of the cable tray.

Installation shall be carried out in accordance with G.4.17.

K.9.1.12 Distribution boards and consumer units

DBs and consumer units installed for connection of the final circuits within electrical installations shall be factory-built conforming to BS EN 61439/IEC 61439. An integral isolator shall be provided for isolation of the incoming supply.

The circuit breaker accessories, etc. shall conform to the standards specified.

Rewireable type fuses shall not be used in any wiring installation. Table K.36 may be used to indicate the preferred details and parameters of the equipment and components in DBs for an individual application.

Refer to G.4.12 in the event of a MDB/SMDB being required.

Parameter	Specification
I. Reference standards	BS EN 61439, BS EN 60947, IEC 61439
II. Rating of incoming supply breaker/isolation+	40 A [ ] 60 A [ ] 100 A [ ] 125 A [ ] ………………. [ ]
(+On-load)	Breaker [ ] Isolator [ ]
III. Construction	
1. Mounting	Wall [ ] Pedestal [ ] Surface [ ] Recessed [ ]
2. Degree of protection of the enclosure for installation	Indoor-IP41/42 [ ] Outdoor-IP54/55 [ ] ……………………………[ ]
3. Painting/finish (internal/external)	Stove enamelled [ ] Epoxy [ ] Polyester [ ] Galvanized [ ] ……………………………[ ]
4. Front cover (+neoprene)	Hinged [ ] Bolted [ ] Panel lock [ ] Gasketted+ [ ]
5. Cable tray/conduit entry	Top [ ] Bottom [ ] Top and bottom [ ]

Table K.36 Specification of DBs

Parameter	Specification
6. Assembly	Factory assembled [ ] ....[ ]
IV. Internal layout/arrangement and fault training	
1. Segregation of live parts: Incoming supply terminals/lugs	Barrier [ ] Shroud [ ] Firmly secured [ ] *Separately mounted and removable by tool [ ]
Busbar, tap-out connections and terminals (*Separate and independent of each other)	Barrier [ ] Firmly secured [ ] *Separately mounted and removable by tool [ ]
Neutral and earth busbars and terminals	Separately mounted with adequate working clearances/spacing from incoming supply terminals/lugs [ ] and outgoing terminals of MCBs/FS [ ]
2. Arrangement of busbars and tap-out connections to outgoing circuit breakers/neutral busbars	Segregated for each: Group of MCBs/TP ways [ ] ELCB Section [ ] Rigid, firmly secured, supported, direct and as short as possible [ ] Adequately sized [ ] Min. number of bolted joints [ ] Min. number of looped connections [ ]
3. Rating/size of phase and neural busbars and terminals (at max. 50 °C ambient)	Rated for max. 70 °C internal ambient, consistent with the rated incoming supply breaker/isolator [ ] Tinned electrolytic copper [ ] ....[ ]
4. Min. fault rating of circuit breakers	6 kA (as per designed downstream short circuit current) [ ]
5. Provision of supports/facility for dressing clamping outgoing circuit cables	Channels [ ] Trunking [ ] .... [ ]
6. Operational access/convenience for switchgear. Incoming supply circuit breaker/isolator Outgoing circuit breakers	Max. height 1.8 m (from FFL) [ ] From outside of hinged door/bolted cover [ ] Restricted/lockable [ ]
7. Maintenance access/replacement convenience for switchgear components	Breaker(s) [ ] Isolators [ ] ELCB/s [ ] UV relays [ ]
8. Provision for termination of PVC/SWA/PVC/XLPE/SWA/PVC cables	Gland plate [ ] Cable gland [ ]
9. ELCBs/RCCBs	Window A/C [ ] Split A/C [ ] Lighting [ ] Small power [ ] Others..................... [ ]
10. UV Relays with auto-reset timer	Window A/C [ ] Split A/C [ ] Others.................... [ ]
V. Identification	
1. Rating of incoming supply and outgoing circuit breakers: (For details of the specified rating – refer to approved SLD/distribution schedules)	Thermal [ ] Fault [ ] Discrimination [ ]

Table K.36 Specification of DBs (continued)

Parameter	Specification
Type of circuit breakers: Incoming Outgoing (C/L-Current Limit)	Isolator [ ] MCCB [ ] C/L MCCB [ ] C/L MCCB [ ] F/S [ ] C/L [ ] For general loads, Type 1/L[ ] For motor load, Type 2/G [ ]
2. Colour codes for internal, main circuits wiring: Phase Neutral Earth	 Red/yellow/blue [ ] Black [ ] Green and yellow [ ]
3. Terminal ferrules for control/auxiliary circuits	Indicating instruments [ ] Others.................... [ ]
4. Permanent labels, engraved, “trafolite” or similar	Board designation [ ] Controls [ ] Circuit designation [ ] Indications [ ] Warning notice(s) [ ] ELCB/UV relay section [ ]
VI. Earthing	Compliance with K.9.1.18.................... [ ]
1. Rating/size of earth busbar and terminals	Adequate, consistent with the min. fault rating specified under IV.4 [ ] Adequate no. and size to terminate main and circuits ECCs [ ]
2. Earthing of conductive parts	Enclosure [ ] Hinged door [ ] Cable glands [ ]
3. Termination of ECCs	Copper lugs [ ]

Parameter	Specification
VII. Tests/certification	
1. Type test 2. Routine tests and checks: Visual checks Screwed/bolted connections; Operational checks Dielectric test	As specified by the Consultants/Owner [ ] Certificate for review/reference [ ] Compliance with specifications [ ] Tightness [ ] Mechanical/electrical [ ] 2,500/2,125 V (85%) [ ]

Table K.36 Specification of DBs (continued)

K.9.1.13 Apparatus and accessories

K.9.1.13.1 Switches

Switches provided for local isolation of electric supply to individual apparatus and/or circuits shall conform to BS EN 60669. The rating of the switches shall be selected based on individual applications, such as for resistive or inductive loads. The current rating shall be not less than 5 A.

Switches installed for control of discharge lighting shall have a minimum current rating that is twice the steady state continuous current of the circuits.

For large groups of lighting, a gang switch shall be provided with a phase barrier inside the switch boxes.

For outdoor locations, switches with weather protection in accordance with IP55 shall be used.

For areas with a high risk of fire or explosion, gas sealed switches conforming to BS EN 60079 shall be used.

For appliances rated 20 A and above, and where visual indication of the presence of power is desired, a DP switch with neon indicator shall be provided.

K.9.1.13.2 Plugs and socket outlets

Single-phase plugs and socket outlets used in domestic installations shall conform to BS 1363. The socket outlets shall be of the type illustrated in Figure K.70.

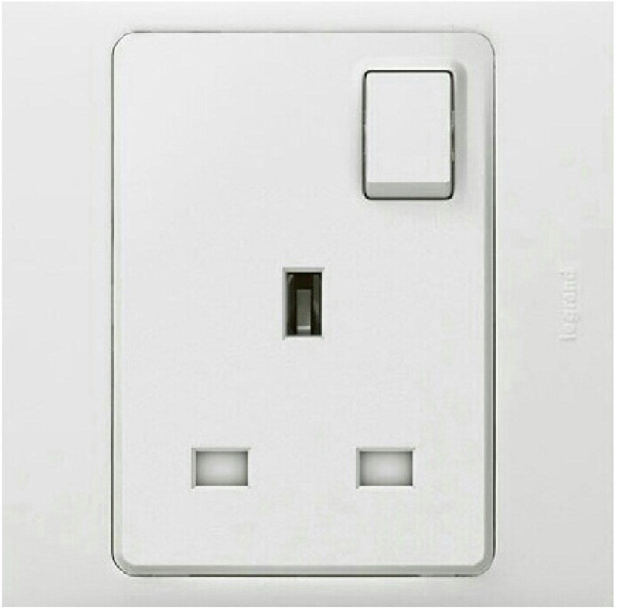


Figure K.70 Typical 3-pin flat, double-pole, shuttered, switched twin socket

15 A plugs and socket outlets used in domestic installations shall conform to BS 546.

Shaver socket outlets shall conform to:

a) BS EN 61558 in bathrooms; and
b) BS 4573 in rooms other than bathrooms.

Industrial plugs and socket outlets shall conform to BS EN 60309. They shall feature a switch that is integrally built in or attached to it. The rating and type of socket outlets with plugs shall be selected to suit individual applications and shall not be interchanged for different current ratings.

Weather protected type (IP55) socket outlets shall be used for outdoor applications.

K.9.1.13.3 Arc fault detection devices (AFDDs)

Additional protection to mitigate the risk of fire due to arcing is recommended in certain applications. AFDDs protect against series and parallel arcing by detecting low-level hazardous arcing that circuit breakers, fuses and RCDs are not designed to detect.

AFDDs shall be selected in accordance with BS EN 62606. An AFDD shall be placed at the origin of the circuit to be protected.

AFDDs are available in the following types:

a) one single device, comprising an AFD unit and opening means, intended to be connected in series with a suitable short circuit protective device declared by the manufacturer as conforming to one or more of the following standards:
   1) BS EN 60898-1;
   2) BS EN 61009-1; or
   3) BS EN 60269 series;
b) one single device, comprising an AFD unit integrated in a protective device conforming to one or more of the following standards:
   1) BS EN 60898-1;
   2) BS EN 61008-1;
   3) BS EN 61009-1; or
   4) BS EN 62423;
c) an AFD unit (add-on module) and a declared protective device, intended to be assembled on-site.

Examples of where such devices can be used include:

1) premises with sleeping accommodation;
2) locations with a risk of fire due to the nature of processed or stored materials;
3) locations with combustible construction materials;
4) structures having fire propagating features; and
5) locations with endangered or irreplaceable objects (such as museums, libraries, art galleries).

K.9.1.13.4 Cooker control units

All stationary cooking appliances in domestic premises shall have a cooker control switch. The switch shall conform to BS 4177 and be located separate from the appliance (see Figure K.71). The cooking appliance shall incorporate an integral earthing terminal.

The cooker control switch shall be two-pole (for a single-phase appliance) or four-pole (for a three-phase appliance). It shall be connected to a separate final sub-circuit from the DB, through a 100 mA ELCB.

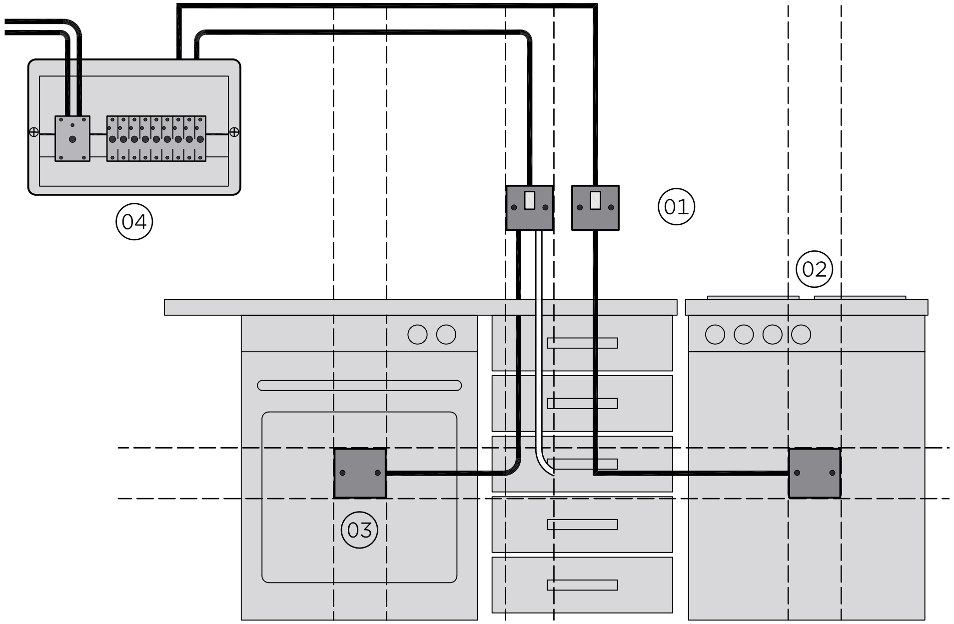


Figure K.71 Cooker control unit installed within 2 m of appliance (© Institution of Engineering and Technology. Figure based on Figure 4.4 in Institution of Engineering and Technology, 2018. Electrician's guide to the building regulations **[Ref. K.29]**)

Key

01: Control switch to be located within 2 m from controlled appliance

02: Electric hob

03: Electric oven

04: Consumer unit

Cooker control units incorporating a general purpose socket outlet shall be avoided, to allow grouping of socket outlet circuits in a separate 30 mA RCD/ELCB section.

The breaker rating and wire size shall be selected to be compatible with the connected load of the appliance.

K.9.1.13.5 Kitchen appliances

Electrical appliances used in consumer installations (such as water heaters, cookers, hot plates, etc.) shall generally conform to BS EN 60335. Figure K.72 illustrates the typical setting-out details of a kitchen.

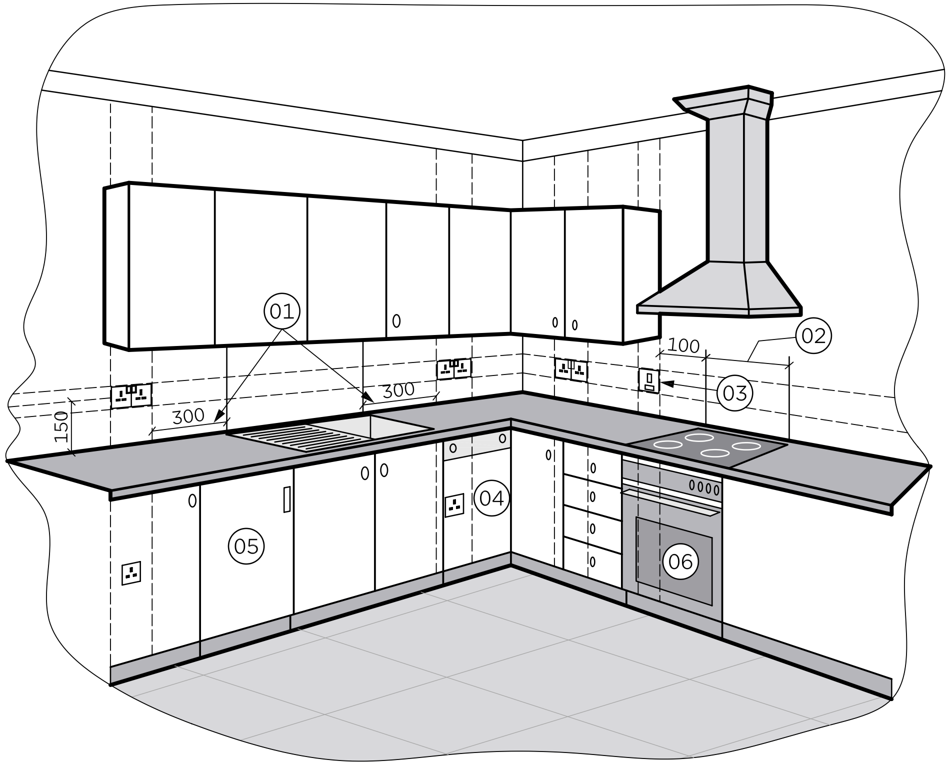


Figure K.72 Cooker and kitchen typical installation setting out details (© Institution of Engineering and Technology. Figure based on Figure 5.2.2 in Institution of Engineering and Technology, 2018. Electrician's guide to the building regulations **[Ref. K.29]**)

Key

01: No sockets within 300 mm of edge of sink

02: No sockets or accessories above gas or electric hobs

03: Cooker switch

04: Dishwasher

05: Fridge

06: Cooker connection

K.9.1.13.6 Control of water heaters, saunas, Jacuzzis and washing machines

Double-pole switches with neon indicator shall be provided, appropriately rated for control of the equipment. The final connection to the equipment shall be made from a flex outlet plate. The plate shall be mounted adjacent to the equipment.

For water heaters installed in a bathroom or water closet, the control switch shall be installed immediately outside the room. For saunas and Jacuzzis, the control gear shall be placed outside the sauna room/cabin.

Water heaters, saunas, Jacuzzis and washing machines shall be connected to a separate final sub circuit from the DB.

Water heaters shall incorporate an integral earthing terminal adjacent to the phase and neutral terminals. All terminals shall be housed in a suitable recess with a splash proof removable cover. Every heater circuit shall be protected by a 30 mA RCCB/ELCB.

K.9.1.13.7 Control of air-conditioning unit/equipment

For other room air-conditioning units other than window type, a double-pole switch of appropriate rating, with flex outlet, shall be provided and mounted adjacent to the unit.

Each room air-conditioning unit shall be connected to a separate final sub-circuit from the DB.

A maximum of two window type air-conditioning units are permitted to connect on a single-phase supply. Where three or more window type units are installed, they shall be balanced as evenly as possible over a three-phase supply.

The breaker rating and wire size shall be selected based on the connected load of the air-conditioning unit, subject to minimum 20 A with 4 mm^2 circuit wires.

K.9.1.13.8 Extra LV safety apparatus

Extra-LV safety apparatus includes:

a) electric buzzers and bells;
b) mirror lights and shaver socket outlets in bathrooms;
c) light fittings for underwater installations.

Extra LV safety apparatus shall incorporate an appropriately rated double wound safety isolation transformer. The transformer shall either be integral or mounted separately. A cartridge fuse or MCB shall be incorporated in the secondary circuit. The safety isolation transformer shall conform to BS EN 61558. Segregation of LV and extra-LV circuits shall be in accordance with K.9.1.17.3.

K.9.1.13.9 Electric motors and starters

Control of electric motors shall conform to BS EN 60204 where the equipment is within the scope of the standard.

All motors shall be protected against overload, short circuit and earth leakage. They shall also be protected against voltage fluctuations and the loss of one or more phases, as necessary for the individual application.

Every motor having a rating exceeding 0.37 kW shall be provided with control equipment incorporating means of protection against overload of the motor.

Only the installation of single-phase motors rated up to 3.7 kW, and three-phase motors up to 110 kW, is permitted, unless otherwise approved by DEWA. Where multiple motors above 110 kW are proposed, the advice of DEWA shall be sought on obtaining a bulk supply.

Starters shall be provided with overload relays of the thermal type. Relays shall have automatic compensation for variations in ambient temperature between 28 °C and 48 °C.

Starting equipment to limit current shall consist of any of the following:

a) adjustable speed drive;

b) intelligent controllers;

c) another type of device approved by DEWA.

All motors shall be provided with an isolator, to isolate the motor from the supply during inspection and maintenance. The isolator shall interrupt the supply on all phases. The isolator may be integral with the control gear or separate but shall be in close proximity to the motor. The control gear shall incorporate emergency stop pushbutton(s).

When motor starting gear is energized from an auxiliary circuit, the auxiliary circuit shall also be isolated during inspection and maintenance.

All starters, isolators and pushbuttons (see Figure K.73) shall be clearly marked in Arabic and English stating which machine they control and their function. To avoid confusion, the words “START” and “STOP” shall be used (and not “OPEN” and “CLOSED”).

Figure K.73 Push buttons

Motors and their control gear shall be located in well-ventilated areas with adequate space for operation, inspection and maintenance.

K.9.1.14 Standby generators

If the permanent installation of a standby generator is required, it shall meet the requirements in G.4.14.

K.9.1.15 Assessment of connected load and maximum demand

K.9.1.15.1 Lighting and small power circuits

All lighting and fan circuits shall be installed as follows:

a) maximum load per circuit of 2,000 W;

b) minimum circuit wire/EEC size of 2.5 mm^2 LSF copper, with maximum circuit breaker protection of 16 A.

If light fixtures are not selected at design stage, a minimum of 100 W shall be used for each normal lighting and fan point. Fluorescent lamps shall be assessed as 1.8 times the lamp wattage.

Wherever fittings with discharge light, compact fluorescent lamps or low-volt lamps are installed, the circuit breaker rating, circuit conductor sizes and number of fittings shall be selected based on the actual load, including losses, for the specific application. Prior approval from DEWA shall be obtained for every installation.

A radial final sub-circuit shall be installed to serve a maximum of five 13 A switched socket outlets in rooms other than the kitchen. It shall be controlled by a 20 A circuit breaker in the DB. A maximum of ten socket outlets in rooms other than the kitchen shall be connected to a ring circuit, controlled by a 30 A circuit breaker.

A current demand of 13 A shall be assumed for each 13 A switched socket outlet circuit. A minimum of 200 W per point shall be considered for each 13 A switched socket outlet, installed for general utility purpose, other than the kitchen. All twin socket outlets shall be taken to be as two separate socket outlet points. Kitchen areas might need separate circuits.

A current demand of 15 A shall be assumed for each 15 A switched socket outlet circuit. However, for general purpose utility socket outlets, an assumed load of 1,000 W per socket outlet installed in commercial and industrial premises, and 500 W per socket outlet in residential premises, is permitted.

For stationary appliances and equipment, including air-conditioners, the actual load of each appliance and equipment shall be taken to be a connected load.

The current demand of specific equipment such as an electric clock, and other current-using equipment with a maximum rating of 5 VA, may be omitted from the assessment of load.

The assumed connected load of additional spaces/circuits shall also be indicated in the load distribution schedules submitted for DEWA's approval (see K.9.1.15.2).

K.9.1.15.2 Maximum demand

All DBs shall be rated for the TCL before a demand factor is applied.

The demand load of each final sub-circuit is determined by adding the actual or assumed load of individual points/appliance/equipment, whichever is higher. An allowance for diversity shall be applied where appropriate.

The details of load distribution schedules shall be submitted for DEWA's approval in the format identified in Table K.37 to Table K.40. The TCL of individual distribution levels/circuits shall be determined as recommended in K.9.1.15. An appropriate demand factor worked out by a qualified electrical Engineer is permitted, to determine the maximum demand at the main or submain distribution level.

DETAILS OF CONNECTED LOAD, MAX. DEMAND & kWh METERING

PROJECT: **BUILDING/ ________** **OWNER:** **AREA:**

PLANNED COMPLETION DATE: **CONSULTANT:** **PLOT NO.:**

LVP/MDB/SMDB ______ (OF) ________ **LOCATION OF LVP/MDB:**

CIRCUIT/ FEEDER SMDB/DB NO.	1-PH/ 3-PH	ACB/ MCCB/ ISOLATOR RATING (A)	FAULT DUTY kA	CABLE SIZE, TYPE AND NO. OF CORES			ECC SIZE 1C, mm²	LENGTH OF CABLE (m)	CONNECTED LOAD (kW)			TOTAL CONNECTED /INSTALLED LOAD (TCL) * kW	MAX. DEMAND/ OPERATIONAL LOAD (MDL) * kW	PROPOSED TYPE & NO. OF kWh METERS			REMARKS
				NO. OF CORES 1C/2C/ 4C	TYPE XLPE/ PVC/ SWA	SIZE			R-PH kW	Y-PH kW	B-PH kW			1-PH (1)	3-PH (2)	* LV/ HV CT (3)	
Incomer:																	
Out going:																	
MDB CONNECTED TO: DEWA LV/DB TRANSFORMER SMDB CONNECTED TO: MDB.....						TOTAL CONNECTED LOAD PER PHASE:											TOTAL:
DEMAND FACTOR:			MAX. DEMAND: ______ kW				* OVERALL TOTAL CONNECTED/INSTALLED LOAD (TCL): __________kW							TOTAL BUILT-UP AREA:			

CONSULTANT/CONTRACTOR: TEL: FAX:

* TCL - shall include all loads proposed to be installed including standby, spare and future load provisions..
Type of meter (rating of incomer): (1) Up to 60 A (2) Up to 125 A (3) LV CT ... / ... A /HV CT ... / ... A (* 200/5 Amps CT metering)

(1)Phase	(3)Phase

Table K.37 Typical details of connected load, maximum demand and kWh metering schedule

LOAD DISTRIBUTION SCHEDULE (1-Phase)

PROJECT: **BUILDING/_______** **LOCATION OF DB:___________**

DB No.:

FED FROM: **MDB/SMDB _________/ METER ENCLOSURE**

RATING OF INCOMER	RATING OF ELCB	SL. No.	CIR. No.	MCB RTG. IN AMPS	CCT WIRE SIZE mm^2	ECC WIRE SIZE mm^2	ROOM/AREA	CONNECTED LOADS/POINTS														WATT/UNIT	LOAD PER CIRCUIT - WATT			REMARKS
								LTG	C. FAN	EX. FAN	SH. S/O	13 A S/O	W/H	H/D	COOKER	15 A S/O	'W' A/C	'S' A/C	WAT. PUMP				R	Y	B	
		1	C1																							
		2	C2																							
		3	C3																							
		4	C4																							
		5	C5																							
		6	C6																							
		7	C7																							
		8	C8																							
		9	C9																							
																						TOTAL				

CABLE SIZE: 1x 2/3/4C... mm^2 Cu. PVC/XLPE/SWA/PVC +1 X 1C,.... mm^2 Cu. PVC, ECC

OR

CABLE SIZE: 2 x 1C... mm^2 Cu. PVC +1 X 1C,.... mm^2 Cu. PVC, ECC

C. fan = ceiling fan, ex. Fan = exhaust fan, sh. S/o = shaver socket - outlet

W/h = water heater, h/d = hair dryer, 'w' = window type & 's' = split type

Table K.38 Typical load distribution schedule

TYPICAL CONNECTED LOAD/POINTS SCHEDULE																									
																					LOCATION OF DB:				
												LOAD:				**SCHEDULE:**									
RATING OF INCOMER	RATING OF ELCB	SL. No.	CIR. No.	MCB RTG IN AMPS	CCT WIRE SIZE mm²	ECC WIRE SIZE mm²	ROOM/AREA	CONNECTED LOADS/POINTS													WATT/UNIT	LOAD CIRCUIT			REMARKS
								LTG	C_FAN	EX_FAN	SH_S/O	13A S.S/O	W/H	H/D	COOKER	15A S./O	'W' A/C	'S' A/C	WAT_PUMP			R	Y	B	
		1	R1																						
		2	Y1																						
		3	B1																						
		4	R2																						
		5	Y2																						
		6	B2																						
		7	R3																						
		8	Y3																						
		9	B3																						
		10	R4																						
		11	Y4																						
		12	B4																						
		13	R5																						
		14	Y5																						
		15	B5																						
		16	R6																						
		17	Y6																						
		18	B6																						
																					TOTAL				

CABLE +1X mm² Cu, G/Y PVC, ECC C_ Fan, Socket

OR

CABLE X 1C, mm² Cu, G/Y PVC, ECC W/H = Split

Table K.39 Typical connected load/points schedule

DETAILS OF MAXIMUM CURRENT ON TRANSFORMER WITH CHILLER/MOTOR LOADS							
PROJECT:		**OWNER:**		**PLOT NUMBER:**		**AREA:**	
LV Panel No.:		**Rating:**					
Sr. No.	Type of load (chiller, motor, etc.)	kW	No. of compressors per chiller	Starting current of one compressor/ motor	Full load current with all compressors/motors running + other loads (A)	Max. current when largest compressor starts + all other compressors/motors and other loads running (A)	Remarks (model no., make, type of starter, etc.)
Total							

Table K.40 Typical details of maximum current on transformer with chiller/motor loads

Table K.41 gives the maximum demand permitted at a DB/consumer unit connected to DEWA's supply for the distribution to individual premises without connecting large motor loads.

Item	Feeder/transformer rating (A)	Load (kW)
1	60 A – feeder	30
2	100 A – feeder	50
3	125 A – feeder	60
4	160 A – feeder	80
5	200 A – feeder	100
6	300 A – feeder	150
7	400 A – feeder	200

Table K.41 Limit of maximum demand loads

Other methods of establishing maximum demand are permitted, where calculated by a qualified electrical Engineer with a suitable degree of knowledge and experience of the diverse applications of a particular installation. The design method and proposed diversity at each level of the distribution shall be submitted to DEWA for approval. They shall also be clearly indicated in the design drawings and schedules submitted to DEWA.

Refer to G.4.16 for greater load requirements.

K.9.1.16 Design criteria for the installation of conduits, trunking, trays and accessories

K.9.1.16.1 Trunking and conduits

Trunking and conduits shall be selected to meet the requirements of K.9.1.11.

Cable trunking may be used for housing single core LSF cables where the installation of conduits is difficult due to space limitations.

Surface exposed trunking and conduit installations shall, as far as possible, have straight runs with branches at right angles only.

Draw-in boxes shall be provided in all straight conduit runs exceeding 15 m. Conduit runs having 90° bends shall be provided with draw-in boxes for every two bends.

Trunking and conduit shall be completely installed before any cable is drawn in.

Draw-wires shall be provided in all concealed conduits (and ducts) with the ends left free at the outlet boxes for pulling the wiring cables. Permitted cable routes for concealed cables are illustrated in Figure K.74.

Key
01: No protection needed
02: Protection required unless depth greater than 50 mm

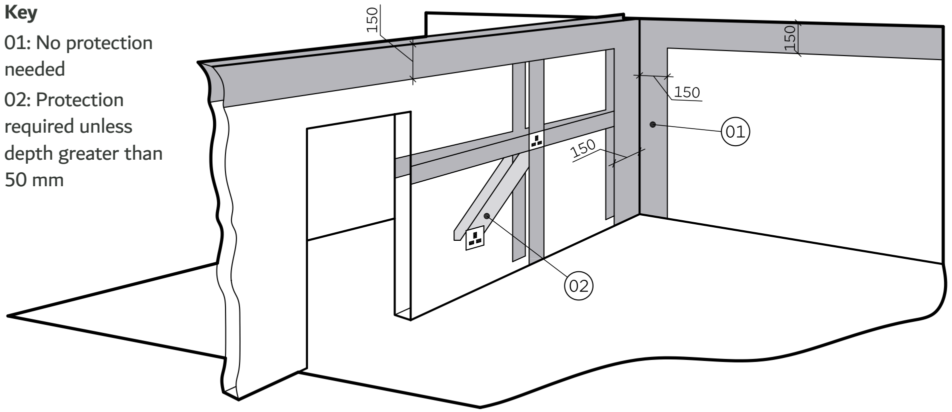


Figure K.74 Permitted cable routes for concealed cables within walls with a depth of less than 50 mm (© Institution of Engineering and Technology. Figure based on Figure 2.3.3 in Institution of Engineering and Technology, 2018. Electrician's guide to the building regulations [Ref. K.29])

All the trunking and conduit runs shall be free from sharp edges and burrs throughout their lengths. Suitable grommets and bushes shall be provided at the terminal outlets.

Trunking and conduit runs shall be supported at regular intervals (see Table K.42 to Table K.44).

Method of installation	Spacing of support (mm)	
	Steel	Rigid PVC
Horizontal	1,500	1,000
Vertical	1,800	1,200

Table K.42 Trunking – Maximum spacing of clips, cleats, saddles or supports

Method of installation	Spacing of support (mm)	
	Steel	Rigid PVC
Horizontal	1,200	1,000
Vertical	1,500	1,200

Table K.43 Conduit – Maximum spacing of clips, cleats, saddles or supports

Method of installation	Spacing of support (mm)	
	Overall diameter 20 mm to 40 mm	Overall diameter >40 mm
Horizontal	350	600
Vertical	600	800

Table K.44 Armoured cables – Maximum spacing of clips, cleats, saddles or supports

Entries to trunking shall be placed to prevent the ingress of water and all dead ends shall be closed. Only unbroken lengths of trunking shall be used for crossing partitions and walls.

Where cable trunking passes through walls, floors or other barriers, it shall be provided with a continuous cover and an internal fire barrier where fire separation is specified for the premises.

The trunking shall be provided with separate compartments for the different types of circuits in the following situations:

a) where a common cable trunking is used for housing both power and communication circuits; or

b) for housing circuits operating at different voltages.

All bends, tees and other accessories of cable trunking shall be of substantial sections and of the same quality as the trunking itself.

The different sections of trunking shall be bonded by copper links although the trunking shall not be used as ECC.

The minimum internal radius of any bend or elbow fitting in a conduit shall be 2.5 times the diameter of the conduit, as shown in Figure K.75.

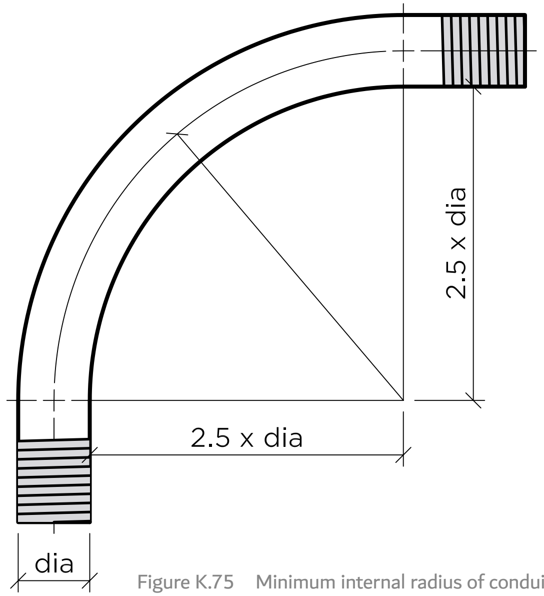


Figure K.75 Minimum internal radius of conduit elbow fitting

All terminal and intermediate ends of PVC conduits shall be firmly secured with suitable adhesives as recommended by the manufacturer.

Circuit wires, bunched and installed in vertical trunking runs, shall be clamped/secured within the trunking at regular intervals not exceeding 2 m, and at the terminal ends.

Standard conduit boxes, draw-in boxes and mounting boxes of light fittings and appliances shall be fixed to the building structure independently of the wiring conduits.

All exposed threads, tool-marks or visible damage to the protective finish of the steel trunking and conduits shall be coated with zinc-rich paint immediately after installation.

Suitable expansion couplers shall be provided in all trunking and conduit runs at the expansion joints in the building structure. They shall also be provided at regular intervals in all runs exceeding 7 m in length or as recommended by the manufacturer.

Suitable purpose-made boxes with adaptors, ceiling roses, etc. shall be provided at all individual outlet points of the wiring installations.

Light fittings used to house tungsten filaments and halogen lamps shall be segregated protected by PVC sheathing and terminal outlet boxes so as to prevent degradation due to the associated high temperatures.

Conduit runs concealed within the building structure shall be provided with not less than 10 mm of screed cover.

When the trunking and conduit runs are installed with chases in the building structure, they shall be firmly fixed at regular intervals in accordance with the manufacturer's recommendations, using purpose-made crimpers and/or saddles.

The standard conduit boxes, draw-in boxes, floor-outlet boxes, etc. shall be installed with the cover/lid flush with the outer finish of the building structure (see BS 4662, BS 5733, BS EN 61535).

Only flush-type switches, socket outlets and accessories shall be used for concealed wiring.

Where conduit and/or conduit fittings are attached to equipment, smooth bore male brass brushes and flanged coupling shall be used.

Except where provision is made for fastening, conduits shall be saddled to the structure of the building in accordance with the following:

1) within 150 mm of each terminal angle box, bend or other conduit fittings;
2) at maximum intervals of 1.5 m couplings and through fittings;
3) at maximum intervals of 15 m couplings.

Through-type draw boxes shall be counted as part of a straight run conduit.

Non-metallic conduits shall not be used in the following locations and circumstances:

i) where the conduit is exposed to outside ambient temperatures;
ii) where the conduit is at risk of being affected by chemicals which cause deterioration in its construction;
iii) plant rooms;
iv) elevator motor rooms;
v) elevator shafts.

All conduit accessories shall be of substantial sections and of the same quality as the conduit itself.

K.9.1.16.2 Flexible conduits

Flexible conduits shall not be used for complete fixed wiring installations. They shall only be used as and where permitted.

A flexible conduit run shall be not more than 2.5 m in length.

Metallic flexible conduits may be used for connecting electrical motors and other equipment to the fixed wiring, subject to adjustment of position and vibration.

Flexible conduits shall only be run exposed and shall be so positioned that they are not susceptible to mechanical damage. Wherever necessary, flexible conduits shall be supported in accordance with the manufacturer's recommendations.

The end of flexible conduits shall be securely anchored to the fixed conduit or equipment to which it is attached. Approved flexible conduit adaptors shall be used that maintain effective mechanical continuity without distorting the conduit.

Flexible conduit shall not be used as part of the earth conductor. A separate earth conductor shall be installed to meet the same requirements for rigid conduit installation.

K.9.1.16.3 Cable trays

Trays for supporting cables shall be used in warehouses, industrial plant and equipment rooms, cable trenches, shafts in buildings, etc.

The type and material of the cable trays shall be selected to suit individual site locations and shall meet the relevant requirements specified in K.9.1.11.3.

The cable trays shall be supported at regular intervals with purpose-made supports (see Table K.43).

Cable trays installed in outdoor locations and in locations where cables are exposed to the sun shall be provided with sun-shade covers. Covers shall be secured to the trays, and adequate ventilation provided, in accordance with the manufacturer's instructions.

Cables shall be fastened securely by purpose-made clips, cleats or saddles and spaced as shown in Table K.44.

Cable ties shall not be used to support multicore cables installed on cable trays that are fitted vertically.

Cable trays shall not be used in locations where they are likely to be subjected to severe physical damage.

Sufficient space shall be provided and maintained around cable trays to permit access for installing and maintaining the cables without causing unnecessary damage. Vertical clearance above the tray shall be not less than 1.5 times the height of the tray, or as given in the cable and cable tray manufacturer's recommendations.

Cable trays shall be installed as complete systems with bends and other accessories. Each run of cable trays shall be completed before the installation of cables. All sharp edges, burrs and projection shall be removed, and the tray shall be finished smooth to prevent injury to cables.

Metallic cable trays shall not be used as an ECC, although sections shall be bonded using copper links.

Cable trays shall be installed in such a way as to provide ease of access to cables through the route.

K.9.1.17 Design criteria for the installation of cables, equipment, accessories and wiring systems

K.9.1.17.1 Armoured cables

Armoured cables shall be installed in one of the following ways:

a) directly buried in the ground;
b) drawn through ducts;
c) laid in concrete trenches;
d) cleated to a wall;
e) mounted on cable trays.

Cables shall be installed and used in association with other equipment in accordance with BS 7671. For environments or installations not explicitly described within this Part, the appropriate regulations and standards shall be observed.

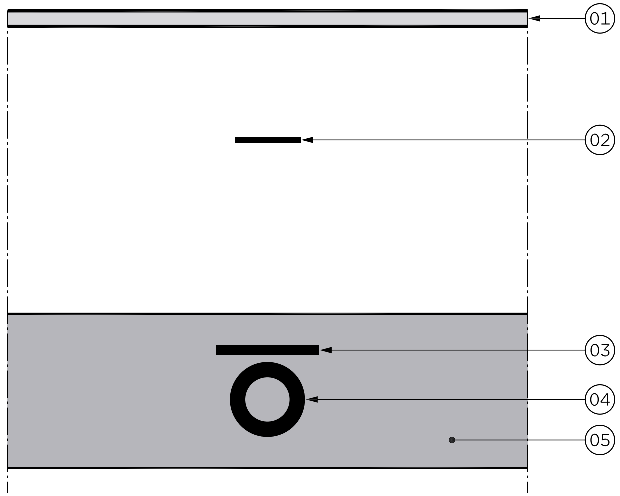
The current-carrying capacity of cables shall be determined after applying suitable correction factors based on the installation method of the cables.

Cables shall be selected ensuring voltage drops within the limit described in K.9.1.7.3 and G.4.7.3.

Only armoured cables shall be used for underground installations. Precautions shall be taken to avoid mechanical damage to the cables before and during installation. Cables shall be laid as shown in Figure K.76. Where protective covers are required, they shall be centred over the cables, throughout their length.

Where cables pass underneath driveways or roads, PVC-U ducts shall be provided with heavy-duty (HD) manhole covers.

Cable routes shall be marked by cable route markers/marking tape, placed at maximum intervals of 10 m along straight runs and 2 m at deviations (see Figure K.77). Route markers shall indicate the voltage level in Arabic and English.



Key

01: Ground

02: Warning tape at 300 mm below ground

03: 50 mm overlap on either side

04: Armoured cable at 900 mm below ground

05: 150 mm impervious soil layer

Figure K.76 Typical armoured cable installation below ground

Heavy-duty conduit shall be provided for motor connections, external applications and locations subject to vibration, risk of mechanical damage or exposure to moisture.

Cables shall be installed on cable trays at specific locations and as stipulated in K.9.1.11.

In the event of crossing or proximity of underground telecommunication cables and underground power cables, a minimum vertical clearance of 100 mm shall be maintained.

Figure K.77 Typical cable route marker (DEWA)

For cables in fixed wiring installations, the internal radius of the bend shall be not less than eight times the cable diameter (see Figure K.78).

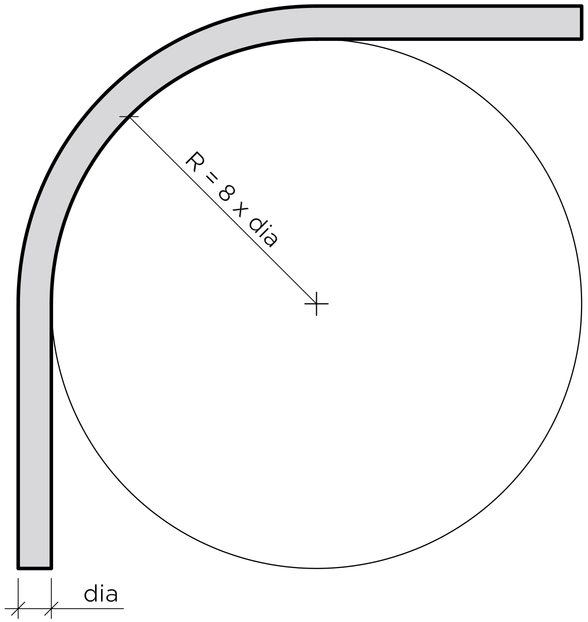


Figure K.78 Cable bending radius (Eland Cables)

No joints shall be included in any cable runs in the consumer's fixed wiring installation.

Where cables or wiring systems pass through floors, walls, partitions or ceilings, the openings remaining after passage of the wiring systems shall be sealed by a listed fire stopping system to the degree of fire resistance required by UAE FLSC **[Ref. K.1]**.

Cable glands used for armoured cables shall be of brass compression type, conforming to BS 6121, with earth tags and PVC shroud.

All terminations of cable conductors shall be mechanically and electrically sound. Terminations shall be made using a terminal or compression type socket/lug, approved by DEWA. Terminations shall not impose any mechanical strain on the terminal or socket/lug.

Separate ECCs shall be installed and terminated for each feeder/circuit, as specified in K.9.1.18.

Single core cable shall be arranged in trefoil formation. Non-ferrous cable gland plate shall be used for termination of single core armoured cables. The armour shall be earthed.

No cables shall run in an elevator or hoist shaft unless the cables are part of the elevator/hoist installation.

K.9.1.17.2 Distribution boards

All DBs shall be installed in locations to which access is available at all times for operation, testing, inspection, maintenance and repair.

DBs shall not be installed in the following locations:

a) bathrooms and toilets;
b) damp or wet locations;
c) bedrooms;
d) kitchens;
e) above sinks;
f) store rooms;
g) rooms with an ambient temperature exceeding the ambient design conditions of the equipment;
h) dangerous or hazardous locations; or
i) below any staircase.

DBs shall be selected and designed in accordance with K.9.1.12.

DBs shall incorporate means for isolation of mains supply in the form of either a circuit breaker or an incomer isolator, as applicable.

Every circuit breaker or fuse within the DB shall be identified and labelled to indicate the apparatus or circuit it controls. Table K.38 and Table K.39 show single-phase and three-phase DB schedules.

Incoming supply cable installed to any DB shall be segregated and identified from the outgoing circuit cables/wiring.

All DBs shall be installed flush or surface mounted at a maximum height of 2 m to the top of the DB as shown in Figure K.79.

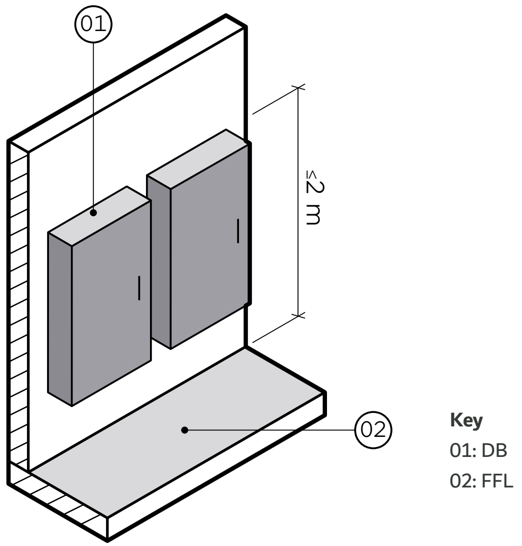


Figure K.79 Maximum DB mounting height diagram

K.9.1.17.3 Segregation of circuits, phases and wiring systems

All wiring and accessories shall be selected and installed to suit individual locations. They shall conform to K.9.1.11 and the following requirements.

Circuits from different DBs shall not be installed in a common conduit or trunking.

The circuit wires of individual categories and of different voltage grades shall be installed in separate conduits, or segregated with barriers where installed in the same trunking run.

The circuit wires of individual categories (such as lighting, power and emergency) shall be segregated with barriers in trunking runs or installed in separate conduits.

Where residential premises are supplied with a three-phase supply, the light fittings, socket outlets, water heaters, cookers and other single-phase apparatus in any room shall not be connected to more than one phase, unless this is unavoidable. If connection to more than one phase cannot be avoided, a minimum distance of 2 m shall be maintained between outlets, accessories or appliances connected to different phases.

Where a switch box contains more than one phase, for group switching, approved switch boxes with phase barriers shall be used and labelled to indicate that 400 V is present within the box. All circuit wires shall be identified by colour as shown in Table K.34 and Table K.35.

Where a wiring system is in close proximity to non-electrical services, the wiring system shall be segregated and protected against hazards that are likely to arise from the presence of the other service(s) in normal use. Provision shall be made for safe and adequate access to all parts of the wiring system which might require inspection, maintenance or replacement.

Switches controlling light fittings, water heaters, etc. shall not be installed in bathrooms. In kitchens and other areas where water is regularly used, switches shall not be mounted within 2 m of any water tap, wash basin or sink where possible. If there is insufficient space to allow for this, ceiling mounted, insulated, cord-operated switches shall be used.

Socket outlets shall not be installed in bathrooms.

A track system for luminaires shall conform to BS EN 60570.

K.9.1.17.4 Mounting heights of accessories

Accessories (as described in K.9.1.13) shall be mounted as follows (and as shown in Figure K.80).

a) All lighting switches, DP switches of air-conditioning units and water heaters, ceiling fan regulators, shaver socket outlets, etc., provided as part of the electrical installation shall be mounted 1.25 m above FFL.
b) 13 A switched socket outlets used for general purpose shall be installed at 450 mm above FFL. 13 A switched socket outlets provided in kitchens shall be installed 150 mm above the worktop.

All switches shall be mounted in readily accessible positions.

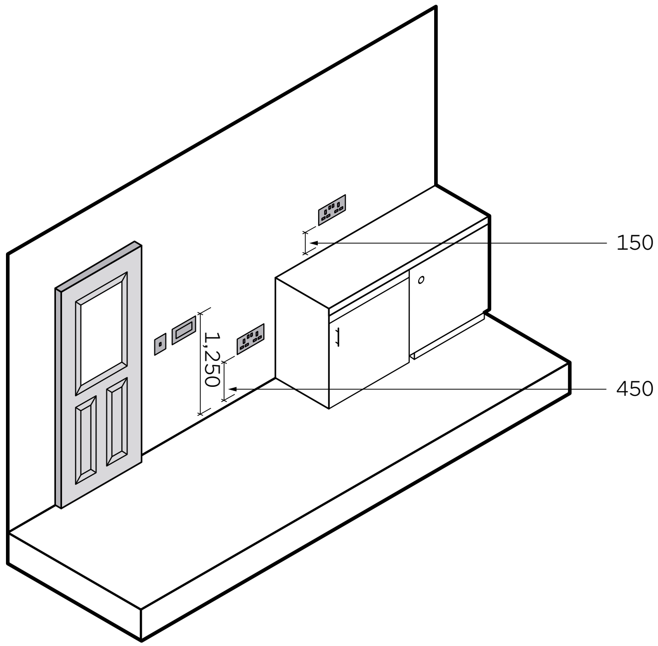


Figure K.80 Typical mounting heights of electrical accessories

K.9.1.17.5 Identification labels and notices

All sections of the consumer installation at the DBs shall be provided with identification labels to indicate the location and purpose of each protection device, piece of connected equipment and circuit. Instructions or caution notices for correct operation shall also be provided where necessary. All labels shall be in both English and Arabic as shown in Figure K.81. Font sizes shall be chosen to suit the individual application.

Figure K.81 Typical electrical warning label

K.9.1.18 Earthing and earth leakage protection

K.9.1.18.1 General

Earthing systems shall be designed and installed in such a way that they remain safe and do not endanger the health and safety of persons or their surroundings. Every consumer installation shall be provided with a separate earthing system within the plot limits, installed and maintained by the consumer.

An earth system shall remain perform effective throughout the life of the plant. It is difficult in many cases to continuity check after installation; the system shall therefore be robust and protected from mechanical damage and corrosion where necessary.

Each consumer's earthing system shall comprise the earth electrode(s) main earth lead conductor connected between the earth electrode(s) and the consumer's main earthing terminal(s) or earth busbar.

ECCs shall be provided for every outgoing circuit from the DBs, equipotential bonding of all metalwork and exposed conductive parts and enclosures, etc. BS 7430, BS EN 50522 and IEC 60364 shall be referred to for guidance.

Selection of the earthing conductor material shall be based on its compatibility with the material of the earth electrode. For a conductor installed in the ground, the corrosive effect of the soil shall also be taken into account.

The consumer's earthing system shall be connected to the DEWA earthing system [either the incoming supply cable armour or the earth continuity conductor (ECC), as approved by DEWA].

The following shall have separate earthing networks and shall not be connected to the main electrical earthing system:

a) LV networks;
b) Extra LV networks;
c) private generators;
d) lightning protection systems.

The earthing system shall be of low electrical resistance, good corrosion resistance, and able to dissipate high fault current repeatedly.

The consumer main earthing connection shall be a TN-S system (see Figure K.82). The exposed conductive parts of all the electrical equipment of the installation shall be connected by circuit ECCs to the main earthing terminal. The earth fault loop impedance shall be sufficiently low for the protective device (fuse, circuit breaker, RCD) to operate in the required time in the event of a fault to earth.

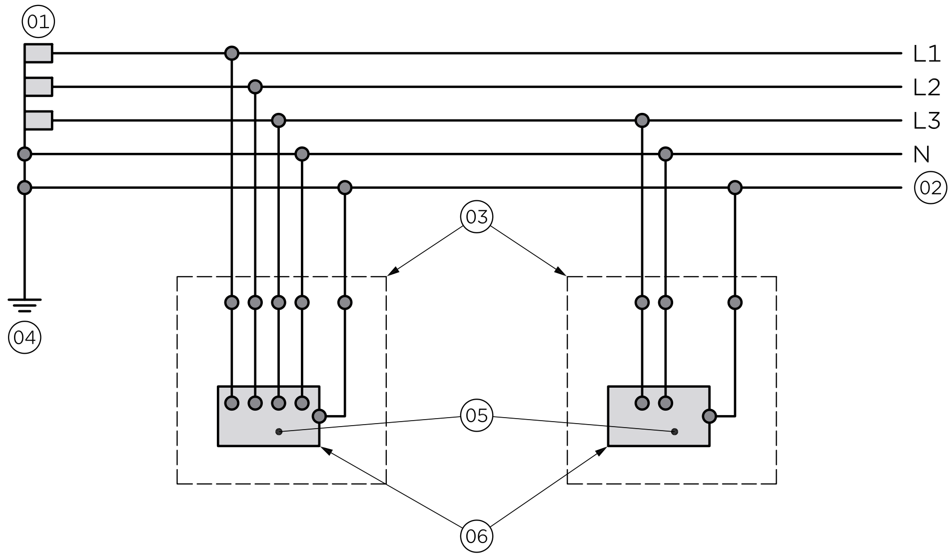


Figure K.82 Typical TN-S earthing arrangement (© British Standards Institute. Figure extracted from BS 7671:2018. Permission to reproduce extracts from British Standards is granted by BSI Standards Limited (BSI). No other use of this material is permitted.)

Key

01: Source of energy
02: Protective conductor (PE)
03: Consumers' installations
04: Source earth
05: Equipment in installation
06: Exposed-conductive-parts

The neutral and earth conductors shall be kept separate. They shall not be connected together at the main earth terminal or at any other point in the consumer's installation.

Foundation metalwork in concrete may be used as a ready made and effective earth electrode. The total electrode area formed by the underground metalwork of a large structure can be used to provide an earth resistance lower than that obtainable by other methods. It is important that consideration is given to the possibility of corrosion of the metalwork reinforcement. The products of corrosion occupy a greater volume than the original metal, and cracking might occur.

Continuous earth currents shall be resolved by the designer of the electrical system.

NOTE: A possible source of such current might be incompatible with other buried metalwork, including other types of earth electrode to which foundation metalwork could be bonded, such that it might be necessary to consider the need for cathodic protection.

Damage to the concrete in the form of cracking, due to arcing or the rapid evaporation of moisture, can occur where the long-term duration earth fault currents exceed the carrying capability of the electrode. This situation is unlikely to arise if the electrode has a resistance sufficiently low to avoid dangerous voltages to earth. Where, in structures made of bolted sections, the electrical continuity of the structural joints cannot be relied upon to form permanent and reliable earth bonds, it is necessary to install loops bonding across these joints.

Water mains shall not be used for earthing purposes. Metal pipes (e.g. for gas, oil, compressed air or drainage) carrying other services shall only be bonded to the protective conductors and not used for the sole means of earthing.

Earth electrodes shall not be installed close to a metal fence, unless they are used for earthing that fence. This is to avoid the possibility of the fence becoming live and thus dangerous at points remote from the substation, or alternatively giving rise to danger within the resistance area of the electrode by introducing a good connection with the general mass of the earth.

K.9.1.18.2 Consumer's main earth electrode

A minimum of one main earth electrode shall be provided for each incoming point of supply/consumer's DB, within the consumer's premises. For installations with a main incomer of 200 A and above, a minimum of two earth pits shall be provided.

The earthing systems shall consist of copper conductors or steel rods (austenitic steel or copper clad) of appropriate dimensions, set with a driving pin and head driven to a minimum depth of 3 m. The earth electrode shall be installed inside a 300 mm × 300 mm × 300 mm earth pit with inspection cover. The connection of the earthing conductor to the earth electrode or other means of earthing shall be made using compound filled, encapsulated or substantial clamps of non-ferrous material.

NOTE: Uncoated buried copper is electro-positive to uncoated buried steel. When interconnected by a current-carrying conductor, these metals form an electrochemical cell that can cause accelerated corrosion of steel.

The consumer's main earth electrode shall be installed within 1.5 m of the DB. Where more than one earth electrode is installed within the premises, they shall be spaced not less than 6 m apart.

Apart from the risk of corrosion to the earthing system, the chemical treatment of soil has environmental implications and is not a long-term solution to meet a specified level of resistance. Coke breeze shall not be used due to its highly corrosive nature.

For each incoming DEWA supply/DB, the main earth electrode resistance shall not exceed 1 Ω.

The resistance from any point of the earth continuity conductor (ECC) to the main earth electrode shall not exceed 0.5 Ω.

The consumer's earth electrode resistance and the continuity of ECCs shall be periodically checked and maintained to ensure consumer safety as outlined in BS 4444.

Lightning protection earthing, if required, shall be separate from the earthing of the incoming DEWA supply/MDBs. A minimum distance of 7 m shall be maintained between the earthing inspection pits.

K.9.1.18.3 Earth continuity conductor (ECC)

Every circuit in the MDBs, SMDBs and final DBs shall be provided with a separate green and yellow (G/Y) LSF insulated copper ECC. The minimum size of ECCs shall be selected as specified in Table K.45.

Cross-sectional area of phase/neutral conductor (S) (mm^2)	Minimum cross-sectional area of ECC (G/Y LSF insulated copper conductors) (mm^2)	Minimum cross-sectional area of equipotential bonding conductors (mm^2)
S ≤ 16	S	S/2 (not less than 6)
16 < S < 35	16	10
S > 35	S/2	S/4 (need not exceed 25)

Table K.45 Minimum size of earth continuity cables (ECC)

ECCs shall be terminated with tinned copper lugs at both ends, on purpose-made earth terminals at:

a) electrical equipment, apparatus and distribution switch gear;
b) light fittings; and
c) mounting boxes of switches and socket outlets.

Joints shall be made such that their current-carrying capacity is not less than that of the conduit itself. Joints shall also have the same insulation, mechanical strength and protection properties as those of the wiring system or conduit of which they are part.

ECCs shall be covered with green and yellow LSF insulation and terminated with purpose-made lugs or fixings.

Where associated with circuits, ECCs shall be labelled at their termination points with circuit identification numbers.

Circuit ECCs shall run alongside the associated phase and neutral conductor.

The following shall not be used as an ECC:

1) gas pipes;
2) oil pipes;
3) metallic conduit, support wires or other flexible metallic parts; or
4) construction elements other than metalwork as described in K.9.1.18.

ECCs shall be protected against mechanical and chemical deterioration and electrodynamics effects in accordance with the manufacturer's requirements.

Where two ECCs are used, the ends of the ECC shall be terminated independently of each other at all connection points throughout the circuit, the DBs, junction boxes and socket outlets. To achieve this, an accessory shall be provided with two separate earth terminals.

Where the cable incorporates metallic armouring, this shall be clamped to the cable gland. The main earth conductors shall be placed such that the metallic cable sheaths are reliable and readily connected to it by bonds made to the cable gland.

Earthing conductors shall be accessible for the connection of any detachable earthing devices used with the electrical equipment.

K.9.1.18.4 Earth leakage protection

Earth leakage protection shall be designed and incorporated in consumer installations in accordance with BS EN 61140 and IEC 61140.

The ELCBs/RCCBs shall generally conform to BS EN 61008-1 and BS EN 61009-1. Recommended values of operating current of ELCBs/RCCBs are specified in Table K.46, though the designer shall verify with the manufacturer's recommendations.

Serial. No.	Circuit/equipment/apparatus	Rated operating current (mA)
1	13 A switched socket outlets	30
2	Water heater/coolers/dishwashers	30
3	Refrigerator/washing machine and similar apparatus	30
4	Domestic water pumps	30
5	Jacuzzi pups	10
6	Under water lighting	10
7	15 A switched socket outlets (general purpose)	30
8	General lighting	30/100
9	Flood lighting	100/300
10	Window/split type air conditioner	100
11	Fan coil/AHU/VAV	100
12	Package type air-conditioning unit	100/300
13	Chiller	100/500/1,000
14	Irrigation pump	100
15	Electric cooker	100
16	Industrial machine	100/300
17	Elevators/escalators/hoist	300/500
18	Neon sign	300

Table K.46 Recommended value of operating current for ELCB/RCCB in consumer installations

NOTE: Grouping of circuits under one ELCB/RCCB is permitted for lighting circuits, general purpose switched socket outlets, single-phase equipment/appliances, etc. The maximum number of circuits proposed under each group should be selected taking into account the building type and the possible interruptions.

K.9.1.18.5 Equipotential bonding

All metalwork of the consumer's installation, other than current-carrying parts, shall be provided with equipotential bonding conductors as shown in Figure K.83. This shall include:

a) cable armour;
b) metal conduits;
c) metal cable tray/trunking sections;
d) metal accessory boxes;
e) exposed metalworks of consumers' appliances;
f) apparatus;
g) equipment;
h) machines;
i) building structures;
j) metallic enclosures and parts;
k) metal water pipes.

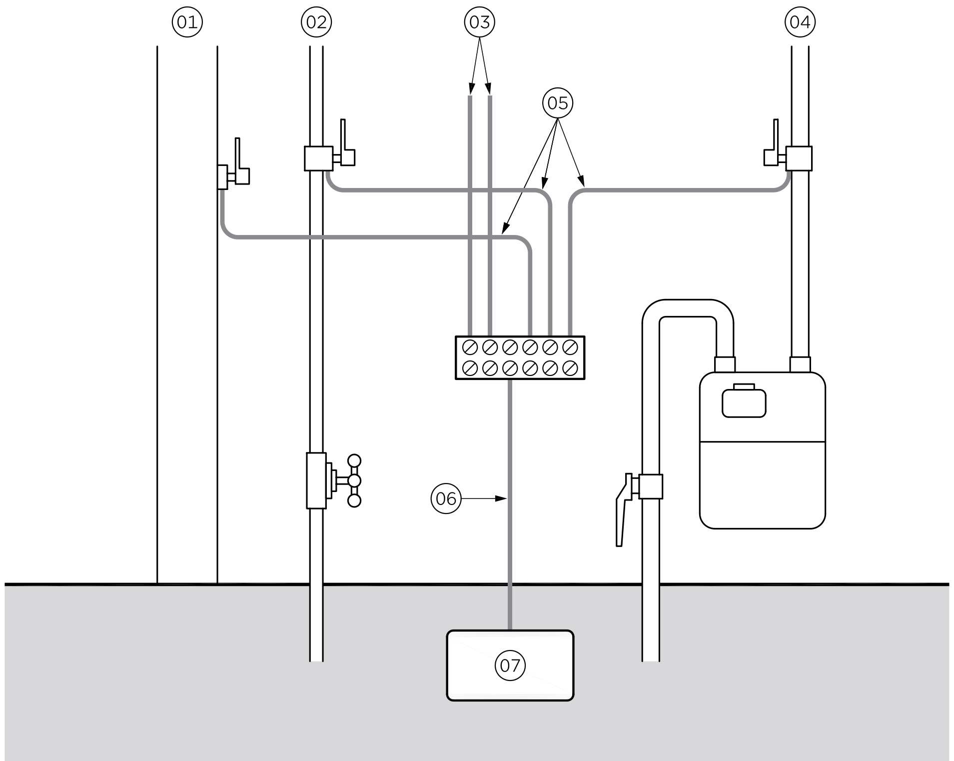


Figure K.83 Typical example of main equipotential bonding of services (© Institution of Engineering and Technology. Figure based on Figure 5.6 in Guidance Note 8: Earthing and Bonding **[Ref. K.30]**)

Key

01: Other extraneous conductive part
02: Water installation pipe
03: Circuit protective conductors
04: Gas installation pipe
05: Main protective bonding conductors
06: Earthing conductor
07: Means of earthing

The cross-sectional area of equipotential bonding conductors shall be selected using Table K.45.

A main protective bonding conductor shall have a minimum cross-sectional area not less than half the cross-sectional area required for ECC of the installation, and not less than 6 mm^2. The cross-sectional area need not exceed 25 mm^2 if the bonding conductor is of copper or a cross-sectional area affording equivalent conductance in other metals.

The equipotential bonding conductors shall be connected to the main earthing terminal within the consumer's wiring installations. The continuity shall be tested and maintained by the consumer.

K.9.2 Electrical vehicle charging points

Electrical vehicle charging points should conform to G.5.

K.9.3 Renewable energy

K.9.3.1 General

As a type of renewable energy, solar energy is clean and secure. DEWA encourages the use of solar energy to reduce reliance on traditional energy sources (such as gas, oil and coal), which are diminishing.

Where a building incorporates on-site generation of electricity from a solar photovoltaic system, it can be a solar grid-connected system or a solar off-grid system. Grid-connected solar generators shall be connected to the DEWA network, operated and maintained according to DEWA regulations.

For off-grid solar system, the backup off-grid allowed for emergency load shall be indicated in the TCL along with the grid-based battery charger load, if applicable.

Connection of solar PV systems/distributed renewable resource generation (DRRG) to the DEWA grid shall be subject to DEWA approval.

The designer shall refer to DEWA specifications, acceptable standards, procedures and other requirements as published on the DEWA website (Shams Dubai section), which are updated regularly and form an integral part of DBC.

Solar power generation systems shall conform to K.9.3 and to Section 2, Ch. 14 of UAE FLSC [Ref. K.1].

Building attached photovoltaic (BAPV) systems attached to roofs, excluding curved or special roofs, are permitted to achieve a minimum fire classification of Class C when tested in accordance with Section 2.2.4, Ch. 14 of the UAE FLSC [Ref. K.1].

The minimum fire classification permitted for building integrated photovoltaics (BIPV) and BAPV systems other than the above shall be confirmed with DEWA and DCD upon commencement of design.

K.9.3.2 System documentation requirements

Consultants and Contractors registered with DEWA for activities related to grid-connected solar PV systems (DRRG Solar PV Consultants and DRRG Solar PV Contractors) shall refer to DEWA guidelines published on the DEWA website for this requirement. Applications for solar connections shall be submitted online and shall include the following documents:

a) basic system information;

b) details of the system designer information; and

c) details of the system installer, operation and maintenance procedure.

K.9.3.3 Wiring diagram datasheets

A single line wiring diagram, annotated/table form, which includes the information identified in Table K.47, shall be uploaded along with DEWA application.

Heading	Information required
Array - general specifications	Module type(s) Total number of modules Number of strings Modules per string
PV string information	String cable specifications – size and type String fuse specifications (where fitted) – type and voltage/current ratings
Array electrical details	Array main cable specifications, AC and DC – size and type Array junction box locations (where applicable) DC isolator type, location and rating (voltage/current)
Earthing and overvoltage protection	Details of all earth/bonding conductors – size and connection points. To include details of array frame equipotential bonding cable where fitted Design verification and details of any connections to an existing lightning protection system or additionally provided lightning protection system Details of any surge protection device installed (both on AC and DC lines) to include location, type and rating
AC electrical details, in-built and external protections	AC isolator location, type and rating AC overcurrent protective device location, type and rating Residual current device location, type and rating

Table K.47 PV systems wiring diagram requirements

K.9.3.4 Labelling and identification

The entire solar PV installation shall be provided with identification and labelling as follows.

a) All circuits, protective devices, switches and terminals shall be suitably labelled.
b) All DC junction boxes (PV generator and PV array boxes) shall be provided with caution labels indicating the risk due to duel source.
c) The main AC isolating switch shall be clearly labelled.
d) A single line wiring diagram shall be displayed within the respective electrical rooms/panels.
e) Inverter protection settings and installation details as applicable shall be displayed.

The procedures for emergency shutdown shall be displayed.

All signs and labels shall be suitably affixed and durable copies of all test and commissioning data shall be made available to the customer.

K.9.3.5 Metering and metering provision

Meter cabinet (installed by the Contractor) shall be located at an easily accessible location for installing smart meters by DEWA, both for generation (PV generation check meter) and net metering purposes (tariff meter).

K.9.4 LPG

LPG cylinders are not permitted indoors except where there is no other option and as permitted by DCD. Where DCD agree that indoor installation is unavoidable, LPG cylinder installation shall conform to Table 11.2, Ch. 11 of UAE FLSC [Ref. K.1].

K.9.5 Water supplies

K.9.5.1 Water metering and water conservation

DEWA-approved meters shall be installed to measure and record water demand and consumption of the facility as a whole. The facility shall also provide accurate records of consumption (tariff class meters).

For all buildings having a cooling load of at least 1 MW or gross floor area of 5,000 m^2 or greater, additional water metering shall be installed to record consumption data for major water use of the building and major water uses in and around the building.

K.9.5.2 Design and installation of water meters

The design and installation of DEWA water meters, including smart metering communications requirements, shall follow the specifications and sample drawings in the DEWA Circulars and Regulations [Ref. K.38] and as listed in Table K.48.

DEWA specification	Sample drawing number	Sample drawing title
Domestic meter installation in villas and sheds – guidelines	PEW-STD-AMI-001	Advanced metering infrastructure – water meters on wall (for villas and sheds)

Table K.48 DEWA specifications and sample drawings for design and installation of water meters

K.9.6 District cooling

Where villa or townhouse communities are to be provided with district cooling systems, the system shall conform to G.10.

K.9.7 Telecommunications

K.9.7.1 Design and installation of telecom infrastructure

K.9.7.1.1 General requirements

This subsection provides the requirements for the design of all telecommunications (telecom) infrastructure installations to private residential villas and townhouses.

The requirements herein are based on version 2 of the Telecommunication Regulatory Authority (TRA), In-Building Telecommunication Network – Specification Manual Guidelines for FTTx in new buildings [Ref. K.31]. If the TRA is updated to give more stringent requirements, these shall be used in preference to the DBC.

This section specifies the minimum requirements to provide a baseline infrastructure. There is no restriction to extending the baseline, provided that the design meets the requirements in this section and does not prevent competition, e.g. by using proprietary standards.

All telecom infrastructure shall enable each user/tenant freedom of choice between telecommunication service providers (SPs).

The code includes all aspects of infrastructure for:

a) civil infrastructure and entry ducts;
b) building pathways;
c) ISP cables.

Passive optical fibre infrastructure shall be provided to support deployment of FTTH broadband networks.

Copper access networks shall not be used for SP services.

All villas/townhouses shall be equipped with physical infrastructure capable of supporting multiple high-speed SP networks which can be easily accessed by the SP. The Developer shall assume a minimum of two active SPs in the region but may future-proof the infrastructure by incorporating provision to support a possible third SP.

New installations shall be based upon a minimum of category 6 balanced twisted pair cabling as specified in ISO 11801 1. Designers may future-proof designs by providing category 6 A cabling, which supports higher data rates and provides support for newer power-over-ethernet (PoE) standards that are typically used for video surveillance camera and wireless local area network access points. Where category 6 A is specified, unshielded twisted pair (UTP) or shielded twisted pair (STP) may be utilized.

Category 6 cabling (structured cabling system) shall as a minimum conform to the requirements specified in K.9.7.4.4.

Cabling within the tenant space for onward distribution of services beyond the tenant equipment is not in the scope of these requirements.

Installations where special telecom requirements might exist shall be referred to a registered Dubai SP at the preliminary design stage to incorporate any specific requirements above that of this section.

K.9.7.1.2 Telecoms service

To support the deployment of SP optical broadband networks and services, the Developer shall design and install in-building elements of telecom infrastructure up to and within villas/townhouses.

Standardized telecom infrastructure shall be provided for FTTx, to enable seamless interworking of all network parts. All designed infrastructure shall support Ethernet and GPON.

To optimize investments, SPs shall share essential infrastructure elements including telecom rooms, ducts, cable pathways and cabling.

K.9.7.1.3 Reference architecture

The reference architecture allows the end user to change SPs. It also allows services to be provided by multiple SPs in parallel if required.

The design shall include all the following elements of reference architecture:

a) pull box inside the villa/townhouse boundary;

b) duct from pull box to villa/townhouse building entry point (BEP) including handholes, turning chambers and pulling chambers as required;

c) BEPs to accommodate SP cabling;

d) in-building cabling.

The design standards applied shall be ISO/IEC 11801-1, ISO/IEC 11801-4 and ISO/IEC 11801-6.

The design shall include:

1) shared SP infrastructure;
2) a roles and responsibilities matrix (see K.9.7.2);
3) provision or cessation of service to enable each tenant to adopt either SP without on-site intervention;
4) a choice of SP;
5) provisions for a minimum of two SPs;

NOTE: The design may include an option to enhance this provision to support a future third SP.

6) a minimum of four optical fibre cores per premise, for a two-SP design, enabling the possibility for either SP to provide an ethernet-based service;
7) SP OLTs/fibre switches connected directly to the dedicated fibre cores allocated to them;
8) dedicated end-to-end FTTx network with full-service delivery control for each SP;
9) at least one dedicated fibre from each SP OLT to each villa/townhouse; and
10) within each villa/townhouse, a consolidation cabinet configured to house a minimum of two ONTs in parallel.

K.9.7.2 Responsibility matrix

Table K.49 is a summary responsibility matrix for villas/townhouses

No.	Item description	Masterplan Developer	Villa/townhouse Developer	Service Provider (SP)
1	Lead-in ducts including connection to manhole outside villa/townhouse boundaries	✓		
2	Manholes outside villa/townhouse boundaries (including cover)	✓		
3	Pull box inside the villa/townhouse boundaries (including the cover)		✓	
4	OSP fibre optic cables for single villa/townhouse or community connections (including supply, termination and testing)			✓
5	Supply and installation of 4 core SM fibre terminal box		✓	
6	Patch cords supply		✓	
7	Connection point cabinet supply and installation (including accessories, power outlet and related elements)		✓	
8	Supply and installation of optical splitters inside the standalone MMR's racks			✓
9	Plot of 10 m × 10 m to be provided for each MMR	✓		
10	Construction and commissioning of MMR	✓		

Table K.49 Responsibility matrix

K.9.7.3 Outside plant (OSP) common infrastructure specifications

A series of lead-in ducts shall be provided from the BEP to the plot entry box and onward to the plot boundary.

The BEP is the point where external ducts physically enter the villa/townhouse. This will be a standalone location designated for telecom equipment.

Transition from outdoor to indoor cable shall be performed within 2 m of the cable exiting the duct where sheath material of OSP cables is not suitable for installation within buildings or where metallic armouring forms part of the cable construction.

Entry boxes shall be provided for SPs to install their cables through the lead-in ducts. Examples of acceptable arrangements are provided in Figure K.84 to Figure K.87. Alternative arrangements can be proposed.

A maximum of two shallow bends up to 90° each shall be permitted on any duct section between chambers. The maximum distance between entry box/maintenance holes/handholes shall be not more than 200 m. Handholes shall not be used for turns, junctions or accommodating any FTTx equipment.

The work required to connect a project's infrastructure to any SP infrastructure shall be minimized.

Connection points at the plot boundary shall be designed after consulting with utilities records to establish existing SP infrastructure in the site area.

All lead-in ducts shall be designed in coordination with the design of other buried services.

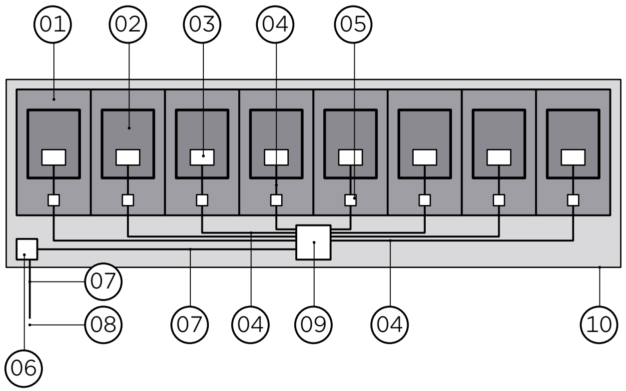
All ducts designed and installed by the Developer shall:

a) be made from black PVC-U or HDPE;
b) be of smooth bore construction;
c) be buried to a depth of 600 mm below the finished ground level;
d) be sloping away from the building;
e) be protected by concrete when running under permanent paved surfaces;
f) be sealed at each end to prevent the ingress of water, sub soil, gas, or pests;
g) have an entry/pull box installed for any right-angled or sharp bends in the lead-in duct route; and
h) include a draw rope in each duct made of twisted mildew resistant polypropylene; minimum outside diameter of 6 mm; minimum tensile strength of 1,000 kg.

OSP shall meet the requirements that are summarized in Table K.50.

No.	Item	Provision
1	Development duct	2 × D54 (100 mm) stubs from the entry box to the plot boundary
2	Entry box	600 mm × 600 mm × 800 mm up to 2 villas
3	Entry duct	2 × D56 (50 mm) per villa
4	Riser cable containment between floors	2 × 50 mm conduit

Table K.50 OSP requirements



Key

01: Villa boundary

02: Villa

03: Fibre termination box

04: Two D56 ducts

05: Entry box 600 x 600 x 800

06: JRC-12 chamber

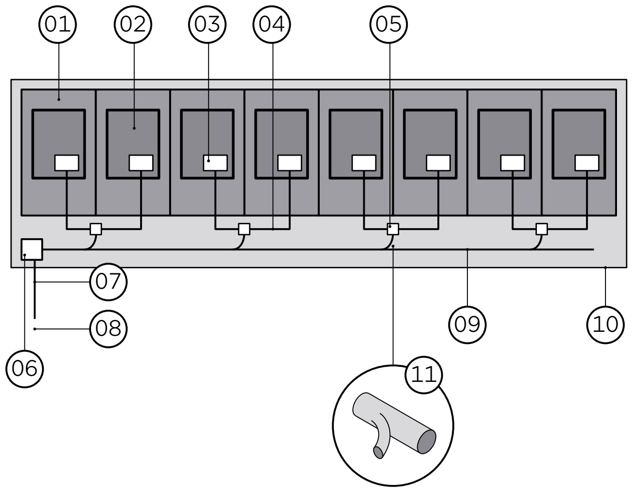
07: Two D54 ducts

08: Connection to OSP ducts

09: JRC-4 chamber, serving maximum 8 villas, additional JRC required for more villas

10: Plot boundary

Figure K.84 Lead in duct arrangement entry box per villa



Key

01: Villa boundary

02: Villa

03: Fibre termination box

04: Two D56 ducts

05: Entry box 600 x 600 x 800

06: JRC-12 chamber

07: Two D54 ducts

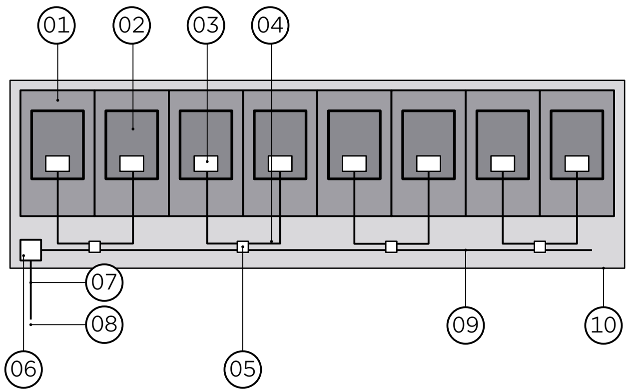
08: Connection to OSP ducts

09: D54 duct

10: Plot boundary

11: Swept Tee

Figure K.86 Lead in duct alternate arrangement entry box serving two villas



Key

01: Villa boundary

02: Villa

03: Fibre termination box

04: Two D56 ducts

05: Entry box 600 x 600 x 800

06: JRC-12 chamber

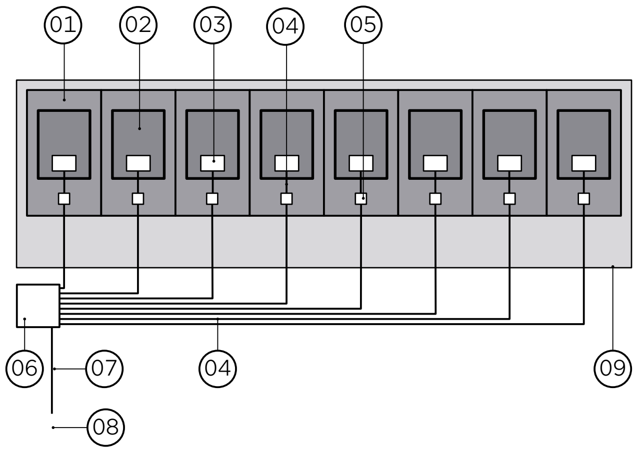
07: Two D54 ducts

08: Connection to OSP ducts

09: D54 duct

10: Plot boundary

Figure K.85 Lead in duct arrangement entry box serving two villas



Key

01: Villa boundary

02: Villa

03: Fibre termination box

04: Two D56 ducts

05: Entry box 600 x 600 x 800

06: JRC-12 chamber

07: Two D54 ducts

08: Connection to OSP ducts

09: Plot boundary

Figure K.87 Typical pull box set-up for attached villas

K.9.7.4 Inside plant common infrastructure specifications (ISP)

K.9.7.4.1 Telecom spaces

Space shall be provided in a villa/townhouse to accommodate the consolidation cabinet used for termination of fibre and locating SP ONTs.

Spaces for telecom equipment shall be located away from any sources of:

a) heat;
b) moisture;
c) corrosive atmospheric or environmental conditions;
d) high voltages;
e) radio frequency interference (RFI); and
f) electro-magnetic interference (EMI).

Telecom spaces shall not be located directly beneath or next to wet areas such as showers, washrooms, swimming pools and waste areas.

Telecom spaces shall be designed to be free from any of the following items unless otherwise indicated in this section:

1) equipment not associated with the space;
2) utility pipes;
3) cables;
4) sprinkler systems;
5) windows.

Rodents often gnaw cables resulting in damage and service disruption. Best practice pest control methods shall be used to prevent pests from entering telecom spaces and cable pathways.

Additional measures to protect against pests may involve the installation of covers to cable trays. If used, covers shall be removable to allow for the installation of additional cables.

K.9.7.4.2 Consolidation cabinets

Each villa/townhouse shall be provided with a consolidation cabinet (see Figure K.88 or Figure K.89). Each cabinet shall be capable of accommodating two telecom operators' requirements at the same time (see Figure K.90).

Optical fibre cabling to the consolidation cabinet shall be installed and terminated by the SPs.

Copper cabling to final TO positions shall be a minimum specification of category 6. Developers may future-proof the installation through use of category 6 A cabling, especially if future use of a WiFi overlay is anticipated.

Consolidation cabinets shall be provided in accordance with Table K.51.

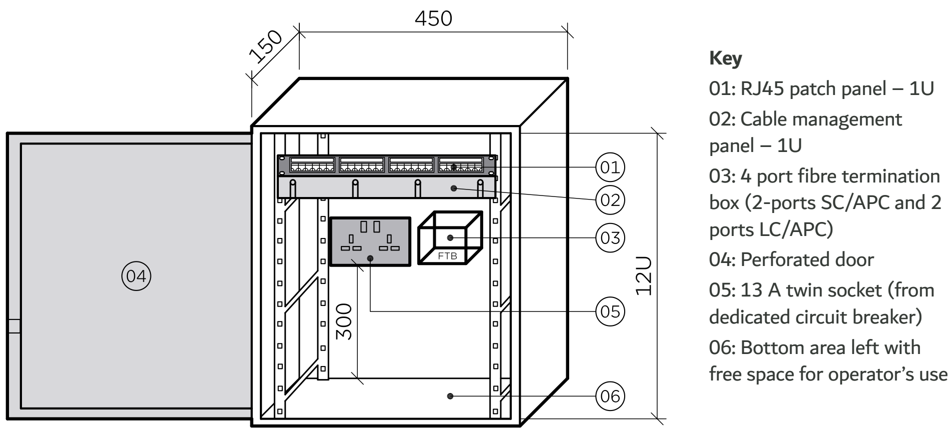
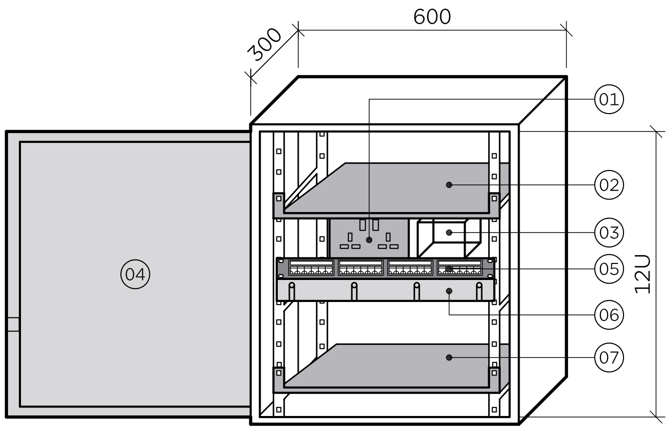


Figure K.88 Consolidation cabinet 450 mm ×150 mm – to serve up to 8-port



Key

01: 13 A twin socket (from dedicated circuit breaker)

02: 1U metallic shelf for Etisalat

03: 4 port fibre termination box (2-ports SC/APC and 2 ports LC/APC)

04: Perforated door

05: Category 6 RJ45 patch panel – 1U

06: Cable management panel – 1U

07: 1U metallic shelf for du

Figure K.89 Consolidation cabinet 600 mm × 300 mm – to serve more than 8-port

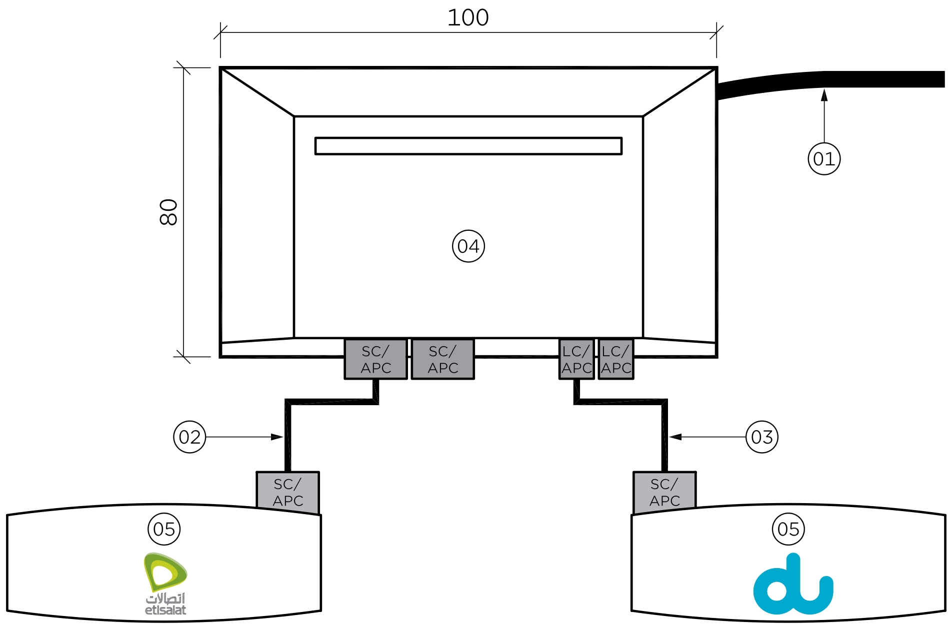


Figure K.90 Fibre termination box fitted within consolidation cabinet

Key

01: 4 core SM indoor drop fibre cable – flat cross section

02: SC/APC to SC/APC simplex patch cord

03: LC/APC to SC/APC simplex patch cord

04: Fibre termination box with 2-port SC/APC and 2-port LC/APC

05: Optical network terminal

Parameter	Details and requirements	
	Small to medium villa/townhouse up to eight loaded copper port	Large villa/townhouse eight to 24 loaded copper ports
Minimum internal dimension (h × w × d)	12U, 450 mm × 150 mm	12U, 600 mm × 300 mm or 150 mm
Mounting location	Concealed in the wall with the front of the cabinet flush with the wall	
Mounting restrictions	Located in an accessible area inside the premises close to the entrance and not inside the kitchen, pantry, washroom, laundry room or bedroom Not close to sources of water or heat Not close to any electrical distribution or busbars	
Mounting height	Installed with the bottom of the cabinet at a height of 600 mm to 1,200 mm above FFL, according to site conditions	
Equipment clearance	An adequate safe working space around the location	
Area lighting	Minimum of 500 lux maintained at 1,000 mm above finished floor	
Ventilation	Minimum of one air change per hour	
Copper cabling patch panel	24 port 450 mm copper patch panel	24 port 600 mm copper patch panel
Twisted pair copper cabling	24 copper cables or less	More than 24 copper cables
Cable management	Cable entries to accommodate incoming fibre optic and copper cables. Horizontal cable management for copper patch cables	
Optical fibre termination	Fibre terminal box with adapters and pigtails for two LC/APC ports and two SC/APC ports for a four core SM fibre drop cable termination.	
Security	Lockable front door	
Power	13 A dual socket inside the consolidation cabinet with dedicated circuit breaker on the domestic supply and not looped with other general power sockets	
Labelling	Villa/townhouse number	

Table K.51 Minimum specifications for consolidation cabinet

K.9.7.4.3 Cable pathways

Cable pathway specifications shall conform to Table K.52.

The following requirements shall be met for all cable tray and conduit pathway systems.

a) Pathways shall be designed such that installed cables do not exceed the minimum specified bend radius during or after installation.
b) Day one cable installation shall not exceed 50% of the pathway capacity.
c) All cable trays shall be hot-dip galvanized slotted steel and shall be HDRF construction.
d) All metal parts shall be free from sharp edges and shall be earth bonded in accordance with ISO/IEC 30129.
e) Slab penetrations and wall penetrations for pathways passing through fire-rated construction shall be sealed with approved fire stopping material in accordance with Section 3, Ch.1 of UAE FLSC [Ref. K.1]. Fire stopping shall be reinstated whenever cables are installed after completion of initial fire stopping works.
f) Vertical pathways shall be continuous between all levels with no reduction of capacity through penetrations.
g) Pathways shall not run through areas exposed to:
    1) excessive heat;
    2) moisture;
    3) corrosive atmospheric or environmental conditions;
    4) high voltages;
    5) RFI; or
    6) EMI.
h) The separation of telecom and electrical pathways shall conform to ISO/IEC 14763-2.

i) All conduit junction/pull box dimensions shall be 300 mm × 300 mm × 150 mm (w × h × d) minimum internal dimension.

Pathway	Specification
Via slab opening	To allow vertical routing of telecom conduits
Vertical pathway	Two × 50 mm conduits (copper), junction/pull box per floor per conduit
Horizontal pathway	One × 25 mm conduit per dual copper outlet from cabinet Increase conduit size if multiple dual outlets fed on the same route Junction/pull boxes at sharp/90° bends or routes over 30 m

Table K.52 Cable pathway specifications

K.9.7.4.4 Cables and termination equipment

All fixed and permanently installed telecom cables shall be halogen-free and achieve a minimum rating of Cca-s1b, d2, a2 when tested in accordance with BS EN 13501-6 and be CE marked.

NOTE: CE marking represents a manufacturer's declaration that products conform to the applicable manufacturing and testing standard.

All other cables, microduct and conduit including patch cords shall meet the minimum requirements of IEC/EN 60332-1-2.

All optical fibre components shall be selected from the approved product list held by SPs.

For villas/townhouses, fibre optic cables shall be provided by SPs.

Within each villa/townhouse the Developer shall supply a 12U consolidation cabinet with a four port fibre terminal box (with LC/APC and SC/APC pigtails and adaptors) fitted inside the cabinet to all SPs to terminate the 4 core SM drop cable.

To deliver services from the consolidation cabinets to building outlets, twisted pair copper cables shall be provided. The full design is the responsibility of the developer; however, the following minimum requirements shall be followed for the efficient and effective provision of services.

a) The cables and components shall conform as a minimum to the requirements of category 6 as specified in ISO 11801-1.
b) The wiring shall be a star topology from the consolidation cabinet.
c) Dual RJ45 TOs with spring loaded sliding shutters shall be provided wherever service is required.
d) The design shall include additional spare TOs to provide service flexibility for tenants.
e) Each socket in the dual RJ45 outlet shall be wired back to the consolidation cabinet with an individual cable.
f) TOs shall not be cascaded or looped.
g) Cable pairs shall not be split between outlets.
h) The permanent link cable length from consolidation cabinet to TO shall not exceed 90 m.
i) Cable lengths shall be de-rated where required due to local temperature conditions and cable specifications to enable end-to-end error free channel performance up to 1 Gbps for category 6 and 10 Gbps for category 6 A.
j) At the consolidation cabinet, copper cables shall be terminated on an RJ45 patch panel and labelled with the socket and outlet served. Terminations shall be to the TIA 568B pair scheme.
k) In each TO, each cable shall be terminated such as to maintain the twists in each pair up to the termination. The termination shall be in accordance with the selected manufacturer installation instructions.
l) Strain relief shall be provided at the terminated ends of each cable.

m) The components of the system shall all be of the same category (6 or 6 A) and type (UTP or STP), and from a single manufacturer, to ensure optimum performance and compatibility.

n) Test results for copper cable tests shall be saved and recorded for future reference purposes.

K.9.7.4.5 Labelling scheme

K.9.7.4.5.1 General

The installed system shall be administered in accordance with ISO/IEC-14763-1.

All sections of the installation shall be provided with suitable identification labels to clearly indicate the location and purpose of each item or cable.

Instructions and “Optical Fibre Caution” notices shall also be provided. All labels shall be in both English and Arabic and of font sizes to suit individual applications.

K.9.7.4.5.2 SP GAID and EID identification plate for each villa/townhouse

The SP identification plate (see Figure K.91) shall be installed at each villa/townhouse. The identification plate shall be made of plastic plate or light metal plate with the alphanumeric characters (GAID or EID) engraved on it.

The GAID and EID reference number details shall be made available to the Developer during the inspection stage.

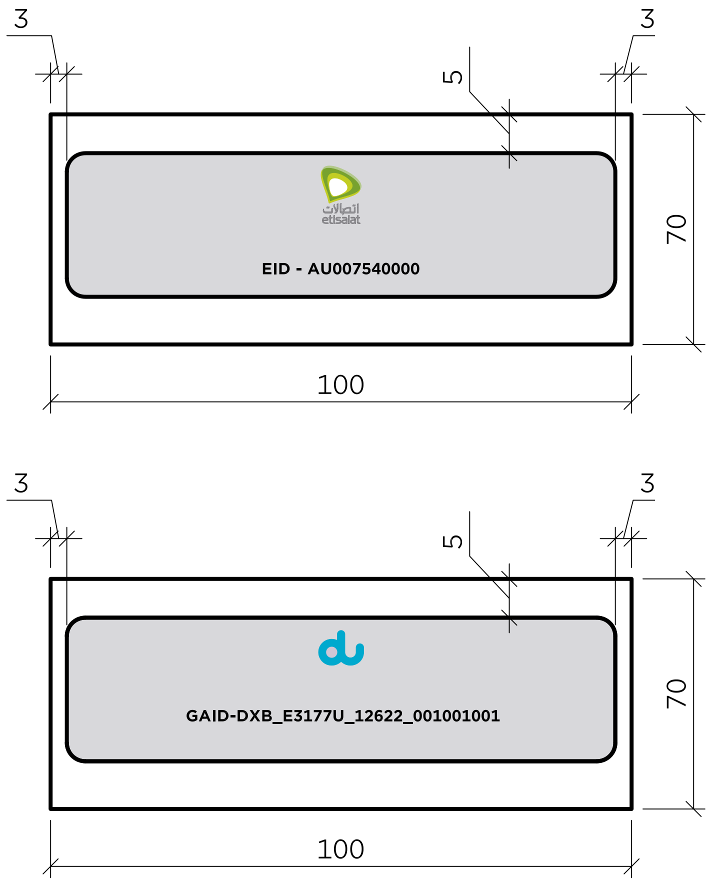


Figure K.91 Example EID and GAID identification plate with labelling details

K.9.7.4.5.3 Component and location labelling

When labelling telecom cabling and equipment, common suffixes and designations shall be used in label text as detailed in Table K.53 and Table K.54.

Location	Labelling designation
Equipment rack	RCK
Floor	FL

Table K.53 Labelling designations

Label type	Format	Example
Labelling of cabinet inside villa/ townhouse	"Floor number/name" – "Location + Number"	FL01-ACP12
Labelling for 4 core fibre terminal box (always terminate pigtail 1 to core 1 of the SM fibre cable)	MMR rack number-ODF number-ODF row/slot number-core numbers	RK2-ODF1-S1-C1,C2,C3,C4

Table K.54 Labelling scheme for equipment

The labelling scheme for 2 core adapters inside the fibre terminal box shall follow Figure K.92 depending upon the orientation of the adaptor.

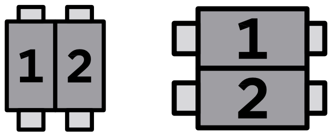


Figure K.92 Labelling scheme for 2 core adapter inside the fibre terminal box

K.10 Indoor environment

K.10.1 HVAC systems and occupant comfort

K.10.1.1 General

This section sets out the minimum requirements, basis of design for heating, ventilation and air-conditioning (HVAC) systems and thermal comfort within buildings. Relevant sustainability criteria and cross-references to UAE FLSC [Ref. K.1] are included.

HVAC systems shall be designed to minimize energy usage and ensure the comfort of building occupants. Systems shall be selected to ensure long life, easy maintenance and simple and effective controls.

For systems or applications not covered by this section, design solutions and guidance shall be obtained from the current edition of the ASHRAE handbooks, guides and standards.

K.10.1.2 Acoustic requirements and noise criteria

Ch. 49, Table 1 of the ASHRAE HVAC applications handbook [Ref. K.32] identifies design guidelines for acceptable noise levels for HVAC-related background noise for a range of typical building and room types. These design guidelines shall be used as the basis for determining acceptable noise levels for the specific room types within a villa. If a higher or lower value is considered desirable, an analysis of economics, space use and user needs shall be obtained from an acoustic Consultant to determine an appropriate value.

K.10.1.3 Building HVAC energy load

K.10.1.3.1 Outdoor design conditions

The design criteria values shown in Table K.55. shall be used for outdoor design conditions in Dubai.

Design criteria	Value to be used
Dry bulb temperature	46 °C
Wet bulb temperature	29 °C
Dubai City latitude (North)	25 °N
Extent of variation in the temperature on the day of design (outdoor daily range)	13.8 °C
Climate zone	0B (as given in Table A-6 in ASHRAE 169- 2013)

Table K.55 Outdoor design conditions for Dubai

K.10.1.3.2 Indoor design conditions

The design criteria values shown in Table K.56 shall be used for indoor design conditions in Dubai.

Design criteria	Value to be used
Dry bulb temperature	24 °C ± 1.5 °C
Relative humidity	50% ± 5%

Table K.56 Indoor design conditions for Dubai

Indoor design conditions can vary depending on the occupancy or use of the rooms in the villa. The ASHRAE HVAC applications handbook [Ref. K.32] shall be used as the reference for all indoor design conditions for specific occupancies or usage.

When diversity factors to be used in heat load calculations are not known, the coefficients indicated in Ch. 18 of the ASHRAE Fundamentals handbook [Ref. K.33] shall be used.

The following safety factors shall be applied:

a) sensible heat: ≤10%;

b) latent heat: ≤5%.

K.10.1.3.3 Outdoor air design conditions

All buildings that are fully air-conditioned shall be provided with an outdoor air system. The system shall ensure that the building is provided with outdoor air for at least 95% of the year. The following maximum design temperatures shall be used, where outdoor air is treated:

a) dry bulb temperature: 34 °C;

b) wet bulb temperature: 32 °C.

K.10.1.3.4 Heat gain and loss calculations

Heat load calculations shall be carried out for each air-conditioned space, including peak load incidence in that space. The calculations shall be carried out using software registered with the Authority.

K.10.1.3.5 External load criteria

The building envelope shall meet the requirements in K.7.2 to determine thermal transmittance and shading coefficients.

The following parameters shall be taken into account in the building load calculations:

a) building envelope orientation;

b) building envelope design and construction details;

c) building floor plans;

d) building elevations and sections;

e) impact of external shading factors (see K.7.2.3); and

f) any special requirements for the building use or operation.

K.10.1.3.6 Internal load criteria

K.10.1.3.6.1 Occupancy

The total number of occupants shall be determined based on ASHRAE 62.2- 2019.

K.10.1.3.6.2 Lighting

Project specific lighting loads shall be used. Where lighting loads are not available, they shall be determined based on the recommendations in ASHRAE 90.1.

K.10.1.3.6.3 Electrical equipment loads

Project specific electrical equipment loads shall be used. Where equipment loads are not available, they shall be as recommended in ASHRAE 90.1 for each application type.

K.10.1.3.7 Building energy simulation and modelling

Energy simulation and modelling can be undertaken, if required, to evaluate the energy performance and the predicted annual energy consumption/CO_2 emissions of all villas/townhouses with a floor area greater than 2,000 m^2.

The modelling software package should be capable of determining the energy load requirements as set out in ASHRAE standard 90.2. The energy modelling should be carried out using licensed software registered with the Authority having jurisdiction.

K.10.1.4 Thermal comfort criteria

HVAC systems shall be capable of providing the range of internal conditions in Table K.57, for 95% of the year:

Variable	Lower limit	Upper limit
Dry bulb temperature	22.5 °C	25.5 °C
Relative humidity	30% (min)	60% (max)

Table K.57 Thermal comfort requirements

For occupant comfort, normal occupied spaces shall have an average air velocity between 0.2 m/s and 0.3 m/s.

K.10.1.5 Energy conservation and efficiency: building systems

K.10.1.5.1 Minimum efficiency of HVAC systems

HVAC equipment and systems shall meet the minimum energy efficiency requirements and test procedures approved by:

a) UAE.S 5010-1: Labelling – Energy efficiency label for electrical appliances, Part 1: Household air-conditioners by Emirates Authority for Standardisation and Metrology (ESMA); and

b) ASHRAE 90.2.

Chillers shall meet the minimum efficiency requirements and test procedures given in Table 6.8.1 to Table 6.8.3 of ASHRAE 90.1:2019.

The chiller equipment requirements shall be met for all chillers, including those where the leaving fluid design temperature is <4.5 °C.

K.10.1.5.2 Efficient sizing of HVAC systems

HVAC systems shall be efficiently sized to minimize energy use of the building.

Thermal energy load calculations shall be carried out for all the conditioned areas of the building and the results of these calculations shall be used as the basis for selecting the air-conditioning equipment.

Ventilation calculations shall be carried out. The results of such calculations shall be used for sizing the outdoor air systems, exhaust systems and energy recovery units (if applicable).

K.10.1.5.3 Central air-conditioning units equipped with Energy Recovery Units and regulated air intake system

To prevent energy loss by exhausting conditioned air to the atmosphere, energy recovery systems shall be used in all combined supply and extract air handling units where applicable and found practical in terms of:

a) quantity of air extracted;

b) availability of energy recovery systems for that capacity; and

c) assessment of the benefits.

For villas with a requirement for treated outdoor air of over 1,000 l/s, energy recovery systems shall be provided to handle at least 50% of the total exhausted air. The energy recovery systems shall have at least 70% sensible load recovery efficiency.

Figure K.93 shows a typical energy recovery wheel.

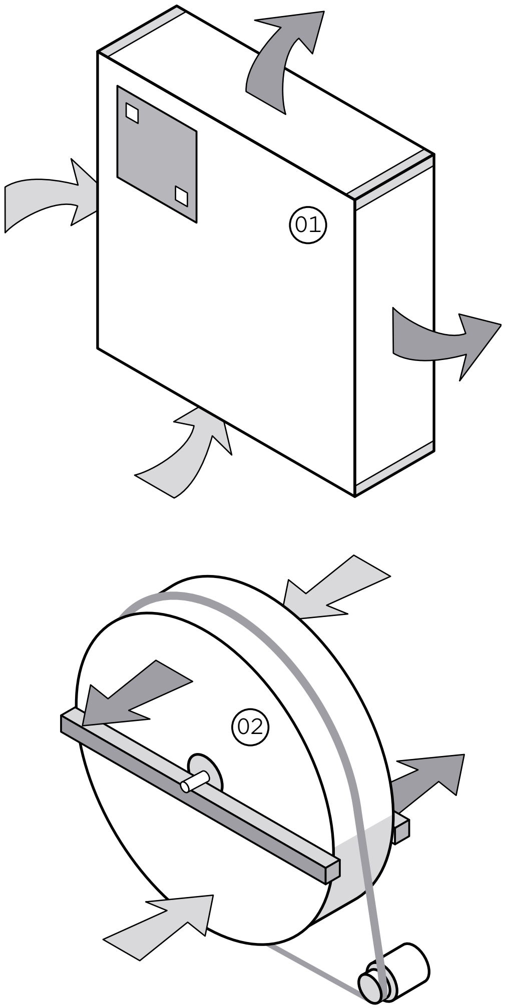


Figure K.93 Ventilation energy recovery thermal wheel

Key

01: Plate heat exchanger

02: Rotary heat exchanger

K.10.1.5.4 Pipe and duct insulation

The following shall be insulated to minimize heat loss and prevent condensation:

a) all pipes carrying refrigerant, hot water or chilled water; and

b) ducts supplying conditioned air (including prefabricated ducts).

This shall include pipes and ducts passing through conditioned and unconditioned spaces.

Pipes and ducts shall be encased in thermal insulation in accordance with BS 5422 or ASHRAE 90.1.

K.10.1.6 Ventilation and air quality

K.10.1.6.1 General

An adequate supply of outdoor air shall be provided to facilitate the health and comfort of the occupants of buildings and to limit condensation.

Adequate space pressurization shall be provided to reduce moisture and contaminant transfer between adjacent spaces, thereby reducing contamination in occupied spaces and unwanted condensation and mould growth. Space pressurization (via return, transfer or exhaust air) in space or location shall be designed in accordance to ASHRAE 62.2 or as approved by the Authority.

K.10.1.6.2 Minimum ventilation requirements for adequate indoor air quality

Outdoor air rates shall meet the minimum requirement of ASHRAE 62.2.

K.10.1.6.3 Indoor air quality

Air filters for general ventilation shall meet the efficiency classification given in ISO 16890-1 based upon particulate matter.

Paints, coatings, adhesives and sealants used in the building shall not exceed the permitted limits for volatile organic compounds (VOCs) specified by the Dubai Central Laboratory [Ref. K.34]. These materials shall be accredited/certified from Dubai Central Laboratory, or any other laboratory approved by the Authority.

Carpet systems (carpets or new permanently installed carpet padding) shall be certified/accredited by the Dubai Central Laboratory, or any other laboratory approved by the Authority.

NOTE: Alternative filtration techniques, such as electronic filters and air cleaners using photocatalytic oxidation, should be approved by the Authority prior to installation/use due to negative health effects that can arise from exposure to ozone and its volatile reaction products. Substantial technical evidence is required on the use of these techniques and should be validated by international agencies and test standards. They are not considered to be a replacement for mechanical filtration but can be used as aids to achieve better indoor air quality.

K.10.1.6.4 Air inlets and exhausts

Outdoor air inlets for all ventilation systems, including doors, operable windows and mixed mode ventilation systems, shall be located at a suitable distance from potential sources of contamination as specified in ASHRAE 62.2 and ASHRAE HVAC applications handbook **[Ref. K.32]**.

NOTE: This is to reduce the possibility of odour, smoke or other air contaminants entering the ventilation system.

Exhaust air shall be discharged in such a way that it does not get drawn back into the building or the building ventilation system. It shall also not become a nuisance to the building occupants or occupants of nearby buildings, or to pedestrians.

Air inlets and exhaust louvers/vents shall be positioned such as to prevent recirculation of air and separated by a distance not less than the minimum given in ASHRAE 62.2. Air inlets and exhaust shall be located relative to prevailing wind directions, using wind rose diagrams for the building. Air inlets shall be positioned at upwind or windward direction. Exhausts (such as from kitchens and toilets) shall discharge at downwind or leeward direction.

Intake air shall be drawn into the system through sand trap louvers sized for at least 1 m/s across the face area of the louver, to provide an 80% or higher filtration efficiency at coarse sand grain size (355 μm to 425 μm).

K.10.1.6.5 Chlorofluorocarbon (CFC) free and ozone friendly materials

All thermal insulation shall be CFC-free.

All fire suppressants shall use substances with zero ozone depletion potential (ODP).

K.10.1.7 Natural ventilation

Natural ventilation of occupied spaces via windows, doors or other openings is permitted but shall not be relied upon to provide ventilation and thermal comfort. The operating mechanism for such openings shall be accessible so that the openings are readily operable by the building occupants.

K.10.1.8 Mechanical ventilation

K.10.1.8.1 General

The ventilation system design and selection shall be determined by the mechanical Engineer for the given application, taking into account all relevant issues associated with the building design, usage, configuration and commissioning, operation and maintenance of the system.

The mechanical ventilation system shall consist of one or more supply or exhaust fans and associated ducts and controls. Outdoor air ducts connected to the return side of a fan coil unit or air handler plenum box shall be permitted as supply ventilation, provided that manufacturer requirements for return air temperature are met and the ventilation load at peak condition is accounted for when sizing the fan coil unit or air handler, in order to control the temperature and remove excess humidity.

A mechanical exhaust system, supply system or combination thereof shall be installed to operate for each villa or townhouse unit to provide ventilation with outdoor air in accordance with ASHRAE 62.2- 2019.

Local exhaust systems shall be provided in kitchens, bathrooms and toilet rooms and shall have the capacity to exhaust the minimum airflow rate determined in accordance with ASHRAE 62.2- 2019.

Mechanical ventilation installations shall conform to the requirements of ASHRAE Fundamentals handbook chapter 16 [Ref. K.33] and ASHRAE 62.2- 2019.

K.10.1.8.2 Ducts and duct connectors

Duct sizing shall be based on the recommended velocity and pressure drop ranges given in Ch. 21 of the ASHRAE Fundamentals handbook [Ref. K.33].

All metallic duct systems shall be constructed in accordance with SMACNA HVAC duct construction standards – Metal and flexible [Ref. K.35].

Ch. 10 of UAE FLSC [Ref. K.1] requires flexible air ducts to be tested and classified in accordance with ANSI/UL 181, and only used when the air temperature in the ducts does not exceed 250 °C or as vertical ducts serving not more than two adjacent stories in height.

In accordance with Ch. 10 of UAE FLSC [Ref. K.1], pipe and duct insulation and coverings, duct linings, vapour retarder facings, adhesives, fasteners, tapes and supplementary materials added to air ducts, plenums, panels, and duct silencers used in duct systems, shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with ASTM E84 or UL 723. When fire testing pipe and duct insulation and coverings, duct linings and their adhesives, and tapes, the specimen preparation and mounting procedures of ASTM E2231 shall be followed.

K.10.1.8.3 Air filters

HVAC systems shall be provided with approved air filters to the minimum recommended filter efficiency reporting value in accordance with ASHRAE HVAC systems and equipment handbook [Ref. K.36]. Filters shall also be installed in the return air system, upstream from any heat exchanger or cooling coil.

Media-type air filters shall conform to UL 900.

High efficiency particulate air filters shall conform to UL 586.

Electrostatic-type air filters shall conform to UL 867.

Air filters utilized within dwelling units shall be designed for the intended application and are not required to be approved.

Ducts shall be constructed to allow an even distribution of air over the entire filter.

Ductwork shall be effectively sealed to limit air leakage in the system. The application of duct sealing and air leakage shall meet the requirements of ASHRAE 111 and SMACNA HVAC duct construction standards, depending on the specific application.

K.10.1.8.4 Domestic kitchen exhaust equipment

Where domestic range hoods and domestic appliances equipped with downdraft exhaust are located within dwelling units, such hoods and appliances shall discharge to exterior through sheet metal ducts constructed of galvanized steel, stainless steel, aluminium or copper. Such ducts shall have smooth inner walls and shall be airtight and equipped with a backdraft damper.

Where installed in accordance with the manufacturer's installation instructions and where mechanical ventilation is otherwise provided, ductless range hoods are not required to discharge to the outdoors.

K.10.1.9 Hydronic systems

K.10.1.9.1 General

This section applies to hydronic piping systems that are part of HVAC systems. They include steam, hot water, chilled water, steam condensate and ground source heat pump loop systems.

The design and installation of hydronic systems shall meet the requirements of the ASHRAE Fundamentals handbook [Ref. K.33].

K.10.1.9.2 Materials

The pipe material and associated pipeline equipment and fittings shall have the appropriate temperature and pressure rating for the system in which it is operating. They shall be suitable for the fluid or gas conveyed.

Hydronic pipe material shall conform to the relevant ASTM standards and ASHRAE Fundamentals handbook [Ref. K.33].

K.10.1.9.3 Pipe joints and connections

Pipe joints and connections shall be suitable for the pressure of the hydronic system.

K.10.1.9.4 Valves

Shutoff valves shall be installed in hydronic piping systems in order to enable the isolation of all piping equipment.

NOTE: Further details are given in Ch. 22 of the ASHRAE Fundamentals handbook [Ref. K.33].

K.10.1.9.5 Pipe installation

Piping, valves, fittings and connections shall be installed in accordance with the conditions of approval.

Hydronic piping systems shall be designed and installed to permit the system to be drained.

Openings for pipe penetrations in walls, floors or ceilings shall be larger than the penetrating pipe. Openings through concrete or masonry building elements shall be sleeved. The annular space surrounding pipe penetrations within fire-rated walls or floors shall be protected in accordance with Section 3, Ch. 1 of UAE FL.SC [Ref. K.1].

A hydronic piping system shall not be in direct contact with building materials that cause the piping material to degrade or corrode, or that interfere with the operation of the system.

Piping shall be installed to prevent detrimental strains and stresses in the pipe. Provisions shall be made to protect piping from damage resulting from expansion, contraction and structural settlement. Piping shall be installed to avoid structural stresses or strains within building components.

Pipe shall be supported in accordance with Ch. 22 of the ASHRAE Fundamentals handbook [Ref. K.33].

The flash point of transfer fluid in a hydronic piping system shall be not less than 28 °C above the maximum system operating temperature. The transfer fluid shall be compatible with the make-up water supplied to the system.

K.10.1.9.6 Pipe design

Hydronic piping design and sizing shall follow the guidelines within ASHRAE Fundamentals handbook [Ref. K.33].

For heating and chilled water services the following design criteria shall be applied.

a) The pressure drop shall not exceed 250 Pa/m for all pipe sizes.
b) The maximum pipe velocity shall not exceed 1.2 m/s for pipe size 50 mm and smaller, and 2.5 m/s for pipe size 65 mm and larger.
c) The minimum pipe velocity shall be not less than 0.45 m/s.

The above criteria shall be reviewed against the ASHRAE Fundamentals handbook [Ref. K.33] based on the particular installation and anticipated operating hours.

Piping to be embedded in concrete shall be pressure tested prior to pouring concrete.

During pouring, the pipe shall be maintained at the proposed operating pressure. Joints of pipe or tubing that are embedded in a portion of the building, such as concrete or plaster, shall meet the following requirements.

1) Steel pipe shall be welded by electrical arc or oxygen/acetylene method.
2) Copper tubing shall be joined by brazing with filler metals having a melting point of not less than 538 °C.
3) Polybutylene pipe and tubing shall be installed in continuous lengths or shall be joined by heat fusion.

K.10.1.9.7 Testing

Hydronic piping systems other than ground source heat pump loop systems shall be tested hydrostatically at 1.5 times the maximum system design pressure, but not less than 689 kPa (100 psi). The duration of each test shall be not less than 15 min.

Ground source heat pump loop systems shall be tested before connection (header) trenches are backfilled. The assembled loop system shall be pressure tested with water at 689 kPa (100 psi) for 30 min with no observed leaks. Flow and pressure loss testing shall be performed and the actual flow rates and pressure drops shall be compared to the calculated design values. If actual flowrate or pressure drop values differ from calculated design values by more than 10%, the problem shall be identified and corrected.

K.10.1.9.8 Flushing, cleaning and water treatment

Before the system is operated, all water piping shall be flushed, chemically cleaned and treated following the guidelines in the ASHRAE HVAC applications handbook **[Ref. K.32]**.

K.10.1.9.9 Refrigeration

K.10.1.9.9.1 General

The design, construction and installation of refrigeration systems shall meet the requirements of the ASHRAE Refrigeration handbook **[Ref. K.37]** and ASHRAE 15, including:

a) system requirements;
b) refrigerant types and classifications;
c) system application requirements;
d) machinery room requirements;
e) refrigerant piping installation and materials; and
f) testing.

K.10.1.9.9.2 Refrigerant and ozone depletion management

Refrigerants with zero ODP or with global warming potential less than 100 shall be used, unless the equipment contains less than 0.23 kg of refrigerant.

K.10.1.10 HVAC systems controls

K.10.1.10.1 Use of programmable controllers for HVAC system

All air-conditioning or comfort cooling systems shall be fitted with a programmable controller and temperature sensors which, at the basic level, provides on/off controls (timer controls) and temperature control functionality.

The control shall be simple and capable of operating independently without the need for any advanced integrations.

Room temperature sensors shall be installed on an interior wall, away from heating or cooling vents and other sources of heat or draughts (doorways, windows, skylights, direct sunlight or bright lamps) which can potentially influence their function.

K.10.1.10.2 Interlock of toilet/bathroom fans

To prevent the operation of extract fans of bathrooms/toilets when the rooms are not occupied, bathroom extract fans shall be controlled through the lighting switch/timers/sensors or synchronizing light sensors as relevant for the project.

K.10.1.10.3 Occupancy/motion sensors for internal lighting devices

As a minimum, occupancy sensors for control of lighting devices shall be provided in the following areas:

a) corridor/hallway;

b) bathroom/toilets.

An override auto-setting shall be provided as part of the system.

K.10.2 Water supplies

K.10.2.1 General

This subsection sets out the minimum requirements and basis of design for the water systems that serve a low-rise residential dwelling. It also includes minimum sustainability criteria.

Where systems or applications are not covered within this section, reference shall be made to the current edition of:

a) BS EN 806;

b) BS EN 8558;

c) HSE Approved Code of Practice L8 **[Ref. K.39]** and associated technical guidance documents **[Ref. K.40 and Ref. K.41]**; and

d) Water supply regulations (water fittings) **[Ref. K.42]**.

K.10.2.2 Water conservation and reuse

K.10.2.2.1 Compliance method

There are two compliance routes for water use.

a) Elemental method: All buildings shall conform to K.10.2.2.2.

b) Performance method: Alternatively, a calculation method may be employed for a villa or townhouse which might not comply with the elemental requirements for water efficient fixtures detailed in K.10.2.2.2.

The performance method shall use supporting calculations to compare the annual water consumption of the proposed building with that of a reference building which meets the elemental requirements of K.10.2.2.2. The reference building shall be equal in shape, size and operational patterns to the proposed villa.

Compliance is demonstrated if the calculated annual water consumption of the proposed building is equal to or lower than the annual water consumption of the reference building.

K.10.2.2.2 Water efficient fittings

The following water efficient fittings shall be used:

a) fixtures with a flow rate less than or equal to the flow rates shown in Table K.58;

b) dual flush toilets.

Faucets installed for specialized application may be exempt from meeting the flow rates, subject to Authority approval.

Fixture type	Maximum flow rate
Showerheads	8 l/min
Hand washbasins	6 l/min
Kitchen sinks	7 l/min
Dual flush toilets	6 l full flush
	3 l part flush

Table K.58 Maximum flow rates

K.10.2.3 Cold water services

K.10.2.3.1 General

Cold water shall be supplied to the following sanitary fittings:

a) water closet flushing;

b) washbasins;

c) sinks;

d) showers;

e) baths;

f) bidets; and

g) bib tap points.

The booster pump-set shall connect to a water storage tank. The booster set shall provide a pressurized supply of cold water to all cold water outlets and hot water plant.

The booster pump-set should incorporate a minimum of two variable speed pumps to ensure system resilience. The booster pump-set shall have an accumulator vessel and incorporate automatic controls to ensure even pump wear and prevent system stagnation.

All parts of the cold water system, including storage tanks and pipework, shall be designed to avoid water stagnation and ensure flow through all parts of the system. Dead legs in the cold water systems shall be avoided.

The cold water distribution system shall be designed to the relevant parts of the Water supply (water fittings) regulations [Ref. K.42], BS EN 806 and BS EN 8558.

Water meter and isolation valve locations shall conform to DEWA regulations [Ref. K.38].

K.10.2.3.2 Swimming pools

The cold water supply that serves the pool water treatment system shall be fed from a dedicated cold water break tank to completely isolate the chemical treatment plant from the building's cold water supply. A booster pump-set shall be connected to the break tank to provide a pressurized supply of cold water to the water treatment equipment.

The cold water break tank and booster pump-set shall be located in the pool filtration plantroom. The pool filtration system shall be designed by the pool filtration specialist.

NOTE: The objective of the pool water treatment system is to provide a hygienic, safe, comfortable and pleasant environment for bathers.

K.10.2.4 Tank pump-set installation

The pump-set shall be installed adjacent to the tank within an internal room of sufficient size for the operation, maintenance and repair of the various pumps that connect to the tank. Each pump-set shall be installed on a reinforced concrete base.

K.10.2.5 Cold water storage tanks

Cold water storage shall be provided to protect the building against interruptions to the incoming mains supplies and to ensure that water supply pressures can be safely maintained.

The capacity of domestic water supply tanks shall be calculated based on the actual demand of the building as stipulated by DEWA. As a minimum, water tanks shall be sized based on 24 h demand from all water connections. Villas or townhouses typically require 250 l to 350 l per day.

Cold water storage may be provided utilizing a single tank, a single tank with a central division or two separate cold water storage tanks.

If a continuous supply of cold water is required during periods of tank cleaning or maintenance, a tank with a central division or two separate storage tanks shall be provided. For both of these tank arrangements, each tank shall store two equal volumes (50/50 configuration) of water.

In each water tank (or water tank section when divided tanks are used), the following components shall be provided:

a) an isolation valve at the inlet and outlet of the tank division;
b) a valve strainer at the outlet of each tank division;
c) drain connection at the bottom of each tank. The invert of the drain shall be located to fully drain that division of the tank;
d) overflow pipe from each division of the tank;
e) overflow warning pipe with insect protection screen (0.65 mm mesh – the design needs to ensure that the screen area will pass the same amount of water as the overflow or warning pipe);
f) an external and internal access ladder (if required);
g) a vent pipe with an air inlet corrosion resistant mesh.

Note: Figure K.94 illustrates the typical water tank fitting connection details.

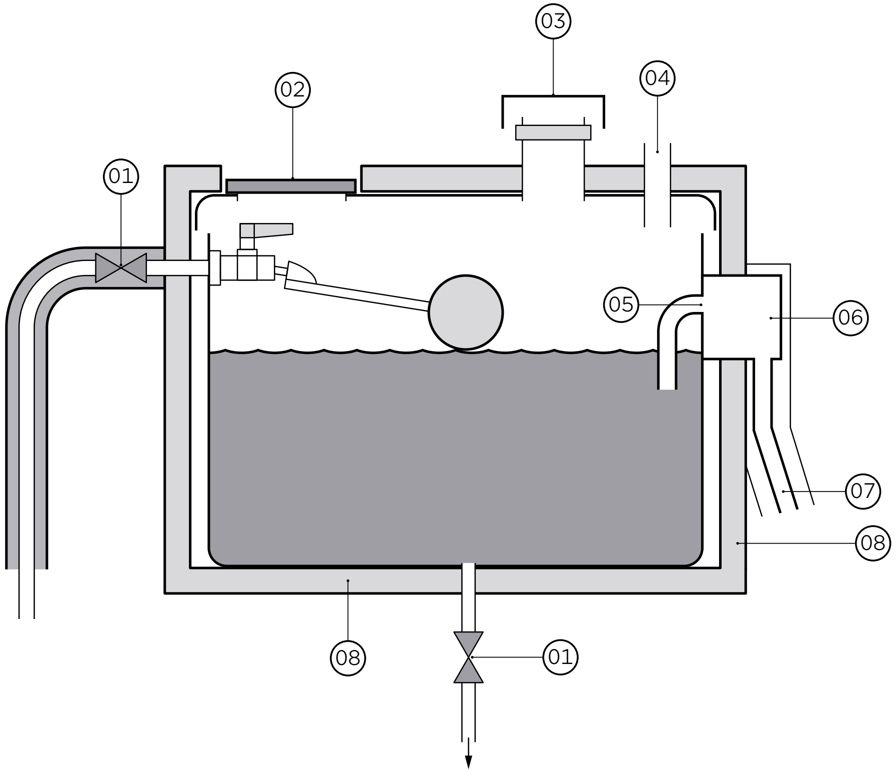


Figure K.94 Typical water tank fitting connection detail

Key
01: Servicing valve
02: Fixed access cover
03: Screened air inlet corrosion resistant mesh (0.65 mm max. opening)
04: Sleeve for vent pipe
05: Straight or dipped entry to warning pipe
06: Screen (0.65 mm max. opening) to prevent ingress of insects etc.
07: Warning/overflow pipe
08: Insulation (applicable to GRP pre-insulated panel sectional tanks and steel tanks)

All tank interconnecting pipework and valves shall be configured to ensure a balanced throughput of water through each tank mitigating the risk of deadlegs and associated water stagnation.

Above ground cold water storage tanks should be constructed of pre-insulated glass-reinforced plastic (GRP).

The tanks shall be installed in a conditioned space that is free from contamination and shall not be positioned in a location where they are exposed to the external Dubai climate.

K.10.2.6 Combined firefighting and water storage

Where water tanks are also used for firefighting purposes, the water storage capacity shall be increased to include firefighting water storage capacity. The tank and pump connection arrangements shall conform to Ch. 9 of UAE FLSC [Ref. K.1].

This water storage arrangement is not preferred unless the system can be designed to ensure regular turnover of the cold water storage volume in the tank. Where this arrangement is adopted, the fire pump test line shall not discharge back into the tank.

K.10.2.7 Servicing and isolation valves

The water servicing distribution pipework shall incorporate service valves on all items of plant and sources of supply to allow for isolation to facilitate maintenance. As a minimum, branch isolation valves shall be provided on branches and risers at the connection to the main distribution system.

Quarter turn isolation valves shall be provided on the water supply to all sanitary fittings to aid repair and maintenance.

All water servicing valves shall be positioned in an accessible location that permits maintenance and replacement without damage to wall, ceiling or floor finishes.

K.10.2.8 Backflow protection

The water systems shall be designed and installed to reduce the risk of contaminating the cold water supplies. In particular, the requirements of the Water supply (water fittings) regulations [Ref. K.42] and the classification of fluid category backflow protection shall be followed.

Where required to prevent cross contamination, the water services system shall be protected by the use of break tanks or air gaps, meeting the correct fluid category classification, as an integral part of the plant and equipment served from the water services system. This protection shall be provided in all areas of the building.

K.10.2.9 Hot water services

Hot water shall be supplied to the following sanitary fittings:

a) wash basins;
b) sinks;
c) showers; and
d) baths.

Where hot water is stored, the water storage temperature shall be kept at not less than 60 °C to prevent bacterial growth within the stagnant water. The water shall reach a temperature of 50 °C within 1 min at the outlets.

A pumped hot water return shall be provided, unless electrical trace heating tape is used. The hot water return shall be designed to maintain distribution temperatures between 50 °C to 55 °C. The hot water return system shall include thermal balancing valves for all hot water sub-circuits.

All parts of the hot water system, including storage tanks, water heaters and pipework, shall be designed to avoid water stagnation and ensure flow through all parts of the system. Dead legs in the hot water systems shall be avoided.

The hot water distribution system shall be designed to the relevant parts of the water supply (water fittings) regulations [Ref. K.42], BS EN 806 and BS EN 8558.

Thermostatic mixing valves shall be installed on all hot water outlets that are used for handwashing or bathing, including those in Table K.59.

Sanitary fitting	Maximum recommended temperature (°C)
Shower and hair washing	41
Wash basin	38 to 41
Baths	44

Table K.59 Sanitary fitting hot water outlet temperatures

Thermostatic mixing valves shall meet the requirements of HSE Approved code of practice L8 [Ref. K.39].

K.10.2.10 Use of renewable sources of energy for domestic heating

Renewable energy shall be utilized to reduce dependence on grid power for domestic hot water heating purposes. Solar water heating (solar thermal) or heat pump technology shall be employed for domestic hot water requirements.

The solar hot water heating system shall incorporate measures for efficient distribution systems, pipe insulation and use of energy efficient electric hot water system (which is normally used as backup).

NOTE: Figure K.95 illustrates the solar hot water generation details.

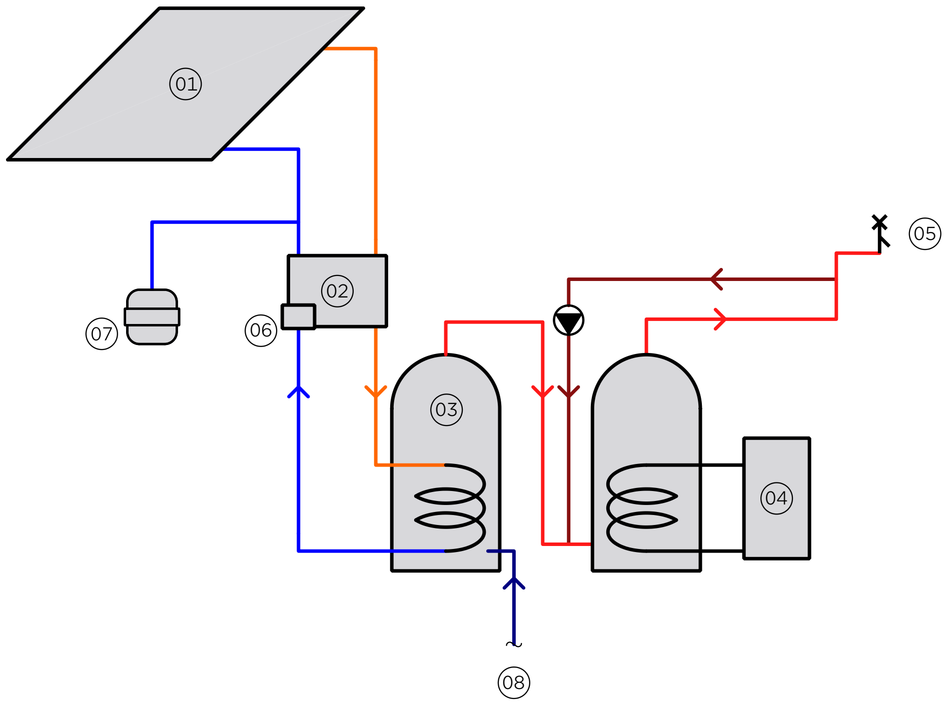


Figure K.95 Solar hot water detail

Key

01: Solar collector
02: Solar pump station
03: Hot water storage tank
04: Back-up heat source
05: Domestic hot water distribution system
06: Solar controller
07: Expansion vessel
08: Incoming cold-water feed

K.10.2.11 Water services installation requirements

Water services distribution pipework shall be sized to meet the system demands based upon the number of fittings and equipment connected to it.

Pipe velocities shall be restricted to approximately 1.5 m/s to maintain system longevity, minimize noise generation and limit pressure waves.

Interior hot and cold water pipework shall be insulated in accordance with BS 5422.

Pressure reducing valves shall be installed to ensure safe water discharge pressures do not exceed 2 bar at all sanitary fittings and kitchen appliances.

The cold water supply to all water closet ablution hoses shall incorporate a vacuum breaker.

Drain valves shall be provided at all system low points. Air vents shall be installed at all system high points.

K.10.2.12 Water treatment against microbiological bacteria growth

All water features that have a water storage volume of over 1,000 l and that create a water spray or aerosol shall be designed, installed, operated and maintained to minimize the risk of Legionella bacteria or microbiological bacteria growth in accordance with:

a) latest DM guidelines, if any;
b) Guidelines for the control of Legionella in water systems [Ref. K.43];
c) Private swimming pools safety guidelines [Ref. K.5]; and
d) HSE Approved Code of Practice L8 [Ref. K.39] and associated technical guidance documents [Ref. K.40 and Ref. K.41];

This includes, but is not limited to, hot and cold water systems, evaporative air coolers/condensers, spas, fountains and misters.

The designer shall formulate a strategy to maintain water quality and minimize the risk of Legionella bacteria for each manufactured water system from the point of supply to point of use. The suitability of the materials used in the construction of the manufactured water system shall not adversely affect water quality.

K.10.3 Drainage

K.10.3.1 General

This subsection sets out the minimum requirements and basis of design for drainage systems that serve low-rise residential dwellings.

This subsection sets out the minimum requirements and basis of design for the above and below ground drainage systems within the building and up to 1.5 m beyond the building site boundary.

For systems or applications not covered within this section, the requirements in BS EN 12056 and BS EN 752 shall be met.

K.10.3.2 Sanitary plumbing systems

K.10.3.2.1 General

A sanitary plumbing system shall be provided to all domestic sanitary fittings and kitchen appliances. The sanitary plumbing system shall:

a) convey and collect drainage flows to sewer infrastructure, cesspools, septic tanks or holding tanks;
b) minimize the risk of blockage or leakage;
c) prevent foul air from the drainage system entering the building during normal system usage; and
d) provide access provisions to clean and maintain the system.

The surface of sanitary fittings (such as toilets and wash basins) shall be of a material that is easy to clean and maintain.

All sanitary fittings shall be provided with a water trap. If a water trap forms part of a sanitary appliance, the fitting shall be removable. All other water traps shall be fitted directly after the sanitary appliance and shall be removable or be fitted with a rodding eye.

All sanitary fitting tap flow rates, and water closet cistern flush volumes, shall conform to Table K.58.

K.10.3.2.2 Sanitation system disposal

The sanitation system shall be designed to collect and convey soil and waste flows by gravity to the public drainage network. The sanitation systems shall be designed in accordance with BS EN 12056.

Sanitation pipework and ventilation pipework shall be configured to control pressure fluctuations that can occur in the system. Sanitary fitting water traps shall be maintained during normal system working conditions. Primary ventilated and secondary ventilated discharge stack arrangements may be utilized for this purpose. The discharge stack arrangement selected shall be determined according to the building height, the grouping of sanitary fittings within the building, and any other relevant factors.

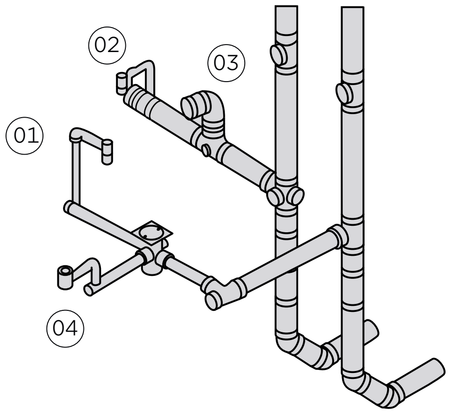
All building discharge stacks shall terminate externally to vent to atmosphere.

The routing of drainage pipework through sensitive areas of a building should be avoided. Sensitive areas include majlis, dining rooms, bedrooms, any area of architectural significance, and areas where access to drainage pipework is restricted.

Where routing drainage pipework through these areas cannot be avoided, the pipework installation shall be configured to mitigate the risk of pipework leaks. This shall be achieved by using pipework materials that have limited pipework joints, or "pipe in pipe" installation techniques.

The sanitation system shall be designed and routed through the building with attention to the acoustic requirements of the space that it passes through. Acoustic insulation shall be provided where required.

Where greywater recycling is proposed within a building, separate discharge stacks shall be provided to drain greywater appliances such as showers, hand wash basins and baths (see Figure K.96). Wastewater flows from kitchen appliances should not be recycled.



Key
01: Washbasin
02: Bidet
03: Water closet
04: Bath/shower

Figure K.96 Greywater sanitary plumbing connection detail

K.10.3.2.3 Floor drains

Floor drains (see Figure K.97) shall be installed in all building areas containing wet sanitary fittings or appliances (including kitchens, toilets, showers and ablution areas).

All floor drain body and grating materials shall be specified to suit the floor finishes within which they are installed and the imposed traffic loads to which they are expected to be subject. A waterproof seal shall be achieved between the floor finish and the edge of floor grating to prevent the migration of water at this junction.

Floor drains shall be constructed of a material that will not be degraded by the discharge they have been installed to receive.

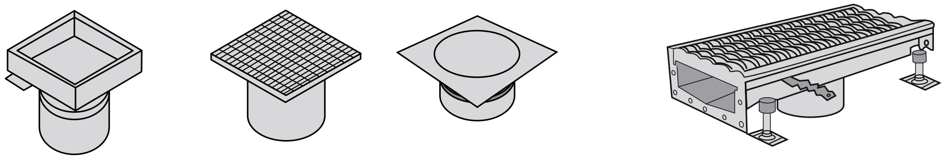
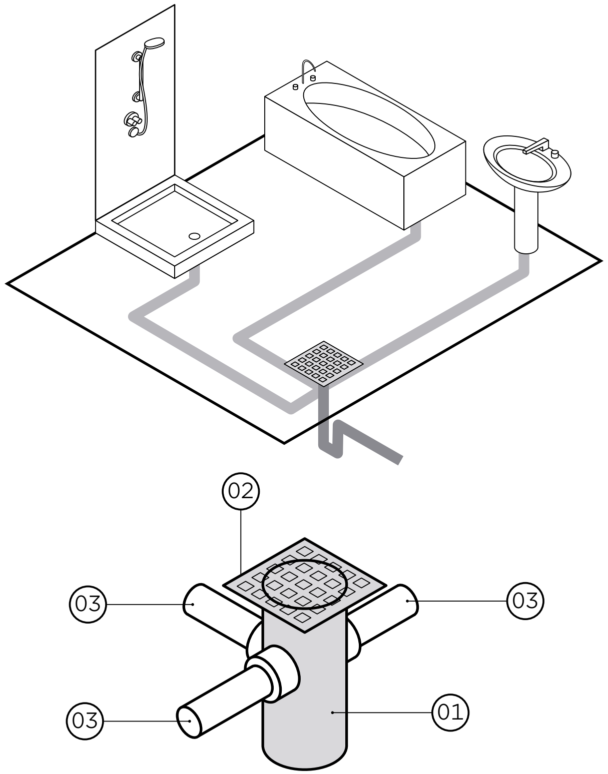


Figure K.97 Floor drain connection detail to discharge stack

In order to prevent trap seal evaporation, all floor drains shall be configured to receive wastewater flows from a sanitary fitting or condensate connection from an air-conditioning unit. Where this is not practicable, an automatic drain trap primer shall be installed. A floor gulley with a back inlet connection shall be utilized to receive the waste pipe connections from these fittings.

All floor drains shall have a minimum 75 mm deep water seal. Waste pipe connection from bidets shall connect directly to a discharge stack, not a floor drain (see Figure K.98).



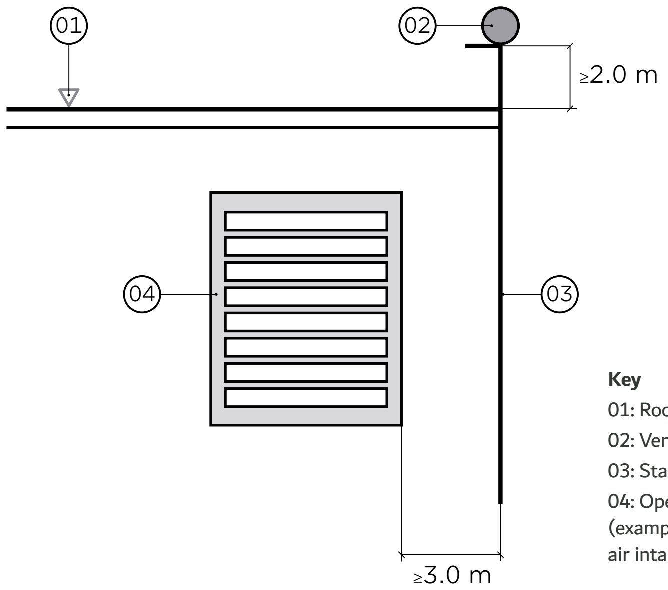
Key
01: To drainage stack
02: Floor gully
03: Sanitary fixture

Figure K.98 Floor drain with back inlet connection detail

The waste system from one floor drain to another floor drain shall not be directly connected.

K.10.3.2.4 Ventilation pipework

Vent pipes from manholes, vertical discharge stacks and vent pipes shall be positioned at least 3 m horizontally from any opening into the building and any mechanical plant air inlet. Such vent pipes shall extend at least 2 m above the roof level (see Figure K.99). All discharge stacks and vent pipes shall be fitted with a vent cowl.



Key
01: Roof level
02: Vent cowl
03: Stack vent
04: Opening into the building (examples include windows, doors and air intakes)

Figure K.99 Vent pipe location constraints

K.10.3.2.5 Access provisions

All horizontal sanitation pipes shall have rodding eyes installed at the start of all pipework runs and at all sanitation pipework change of direction to provide effective access for maintenance and cleaning.

Access junctions shall be installed in discharge stacks at every storey level to provide access to clear blockages.

K.10.3.2.6 Sanitation piping

All internal pipework shall be manufactured from PVC-U in accordance with BS EN 1329-1. Waste pipework shall conform to BS 5255 and BS EN 1329-1.

Only long radius fittings shall be permitted in the wet portion of any discharge stack.

Thermoplastic drainage pipework shall not run through electrical rooms, kitchens, kitchen food stores and bedrooms.

Drainpipes shall not be cast into a building structural element without prior approval from the structural Engineer at the Authority.

Where drainage pipework is required to pass through a structural element in a building, a cast iron sleeve shall first be fitted within the structural element to allow the drain to pass through. The sleeve shall offer a tolerance of at least 50 mm to simplify the installation of the pipe. The gap between the pipe and the sleeve shall then be filled with suitable sealant.

The size of the sanitary fitting outlet connections installed within the sanitation system shall be not less than the minimum shown in Table K.60.

Drainage discharge stack sizes shall be in accordance with Table K.61 for low-rise-residential dwellings.

Sanitary fitting	Minimum outlet size (mm)
Water closet	100
Wash basin	32
Kitchen sink	40
Floor drain	75
Bath tub/shower	40
Washing machine	40
Balcony drain	50

Table K.60 Sanitary fitting outlet sizes

Pipework system	Minimum pipe size (mm)
Soil vent pipe	100
Waste vent pipe	100
Rainwater pipe	100
Vent pipe	75
Balcony drain	50
AC drain pipe	32

Table K.61 Minimum drainage pipework sizes for low-rise residential dwellings

K.10.3.3 Below ground drainage systems

K.10.3.3.1 General

Below ground drainage systems shall collect and convey foul water flows to the external drainage network utilizing gravity flow and shall be designed in accordance with BS EN 752.

Below-ground drainage systems shall be designed in accordance with BS EN 752 to receive soil and waste flows from the above-ground sanitation system. Foul water flows shall be collected and conveyed to the external drainage network by gravity flow.

Buried drainage pipework, fittings and ring seal joints shall be specified to suit the ground conditions they are installed within and the nature of discharge they receive.

Drainpipe sizes and gradients shall be selected on the calculated flows that pass through the drainage system. In all instances, self-cleansing velocity shall be achieved through each drain section.

Drainage pipe connections shall be airtight and free from any internal obstructions. Pipe bedding and surrounding materials shall be selected to suit the prevailing geotechnical ground conditions. All drainpipe bedding and backfilling materials shall be installed in accordance with the specified pipework manufacturer's requirements.

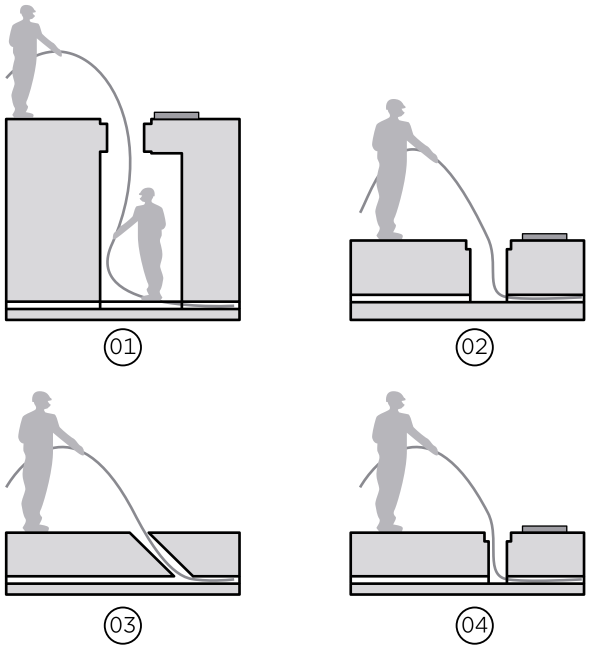
If an underground drainpipe line is installed less than 600 mm below FFL, it shall be provided with 150 mm thick concrete encasement. Underground drainage pipework and fittings shall conform to the requirements BS EN 13476.

Refer to the Authority drainage details for confirmation of approved manhole, inspection chamber, pipe bedding, gulley and pipe connection arrangements.

K.10.3.3.2 Access to drainage systems

Means of access (see Figure K.100) for cleaning and maintaining the below-ground drainage system include:

a) manholes;
b) inspection chambers;
c) rodding eyes;
d) access fittings.



Key
01: Manhole
02: Shallow inspection chamber
03: Rodding eye
04: Access fitting

Figure K.100 Different types of below ground drainage access provisions (© British Standards Institute. Figure extracted from BS EN 752:2017. Permission to reproduce extracts from British Standards is granted by BSI Standards Limited (BSI). No other use of this material is permitted).

Access shall be provided at the following points in the drainage system:

a) at or near the end of a drainage run;
b) at a bend or change in the system direction or drain gradient;
c) at the junction of drain connection (unless each junction connection can be cleared from another access point);
d) at all changes in system pipe size.

Distances between means of access shall not exceed the values in Table K.62.

Drainage pipes which extend underneath flooring and inside walls shall be protected from any external works or against the potential settlement of floors. Such installations shall be provided with access provisions at distances that do not exceed the parameters identified in Table K.62.

From	To junction/ branch (m)	To access fitting (m)	To inspection chamber (m)	To manhole (m)
From start of external drain	—	12	18	20
From rodding point	12	12	18	20
From access fitting (small 150 mm × 100 mm, large 225 mm × 100 mm)	12	12	18	20
From inspection chamber	12	18	18	20
From manhole	—	—	18	20

Table K.62 Maximum spacing of drainage access provisions

K.10.3.3.3 Sump pits

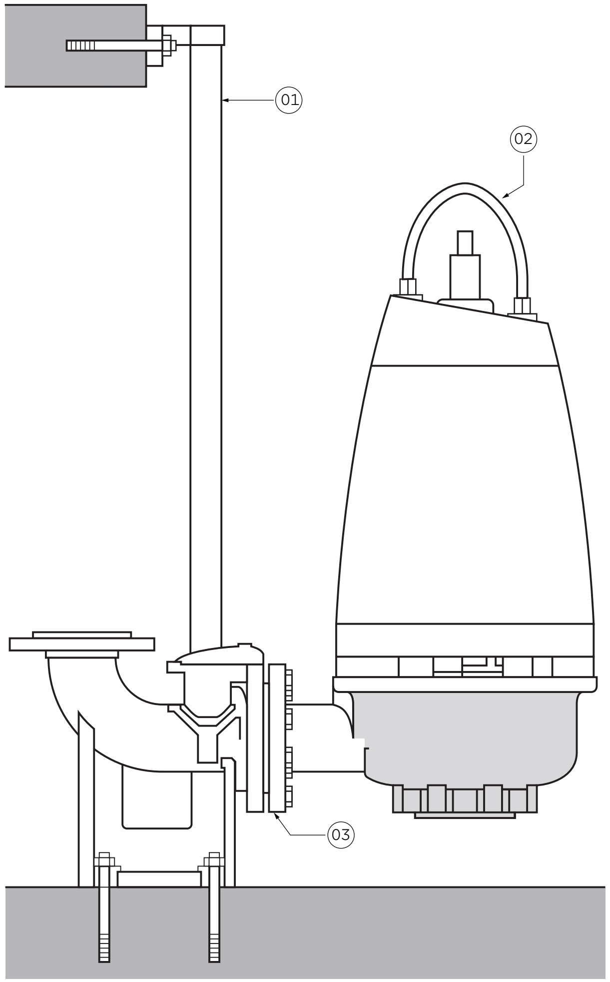
All basement levels shall be provided with appropriate means and equipment to drain and filter water (such as sand separation rooms and mechanical plantrooms). Sump pump pits (see Figure K.101) shall have a depth of not less than 1 m from the level of the lowest inlet pipe.

All sump pump pits shall be positioned in an accessible location for ease of cleaning and maintenance.

All sump pits shall incorporate two submersible pumps operating in a duty/standby configuration.

Each submersible pump shall be wired to a dedicated control panel which incorporates volt-free contacts.

Open grated sump pits do not require a vent pipe.



Key
01: Guide rail
02: Pump
03: Auto coupling

Figure K.101 Typical sump pump detail (© CIBSE. Figure based on Figure 6.13 from CIBSE, 2014. Guide G – Public health and plumbing engineering guide. London: CIBSE).

K.10.3.3.4 Manholes

All manholes shall be installed within the boundaries of the building plot. During the design, care shall be taken to select the appropriate location of the last manhole (i.e. the one before the public network) in terms of ease of connection to the public drainage network and fulfilling the conditions of the Authority.

The manhole schedule shall be arranged as shown in Figure K.102. The manhole invert level, cover level depth and distance between manholes shall be determined by the Authority public drainage connection level and the final inspection chamber (FIC). All datum units shall be produced in the International System of Units (SI units).

Manhole no.	Cover level	Invert level	Distance to next chamber (m)	Depth (m)	Cover type	Remark
Authority						
FIC						
Manhole No.						

Figure K.102 Sample manhole schedule

The invert level of the external drainage system shall be determined by the Consultant. The drainage connection level shall match that of the FIC. The depth of this last manhole shall be obtained from or approved by the Authority.

Acute angle branch connections shall not be made within manholes.

Pipework connections into a manhole shall be installed where the top of each incoming drain connect at the same level.

NOTE 1: This connection arrangement means that smaller diameter connecting pipes are not flooded when there is flow through the bigger pipes.

Backdrops shall be provided when the level difference between incoming drain and main sewer is considerable.

All inspection chambers, manholes, gully traps constructed in covered building areas shall be dry type (not open channel) and provided with recessed double seal type cover.

Manhole access cover specification shall be suitable for the wheel loads they are subjected to and their surrounding floor or road finishes in accordance with BS EN 124-1.

NOTE 2: Manholes located in garages, driveways or other areas of vehicle movement are likely to require heavy-duty covers.

If inspection chambers or manholes are installed in agricultural land, the manhole cover shall be raised 75 mm above the natural ground level.

Manhole venting shall be provided by a vent pipe serving the first and last manholes of any drainage line. Vent pipes shall be located at least 100 mm below cover level.

Manholes shall be sited away from underground water tanks, at a distance not less than the depth of the water tank.

Manholes shall not be installed inside villas, except in chutes, corridors, service rooms, car sheds and ventilated corridors. Such manholes shall be dry type (not open channel).

K.10.3.3.5 Manhole construction

Where a manhole or inspection chamber is constructed below the groundwater table level, the complete manhole construction shall be either waterproofed reinforced concrete or GRP.

All main line channels shall be in the centre of the manhole. The sides of manhole channels shall be extended vertically to the same level of the soffit of the pipe.

Benching of incoming branch drains shall be inclined towards the main direction of flow.

The diameter of semi-circular channel in the bottom of manhole shall be equal to that of the outgoing drain diameter.

The benching of inspection chamber/manholes shall have a smooth curved surface using granolithic concrete that does not restrict drainage flows.

The manhole chamber and access cover sizes shall be not less than the minimum values given in Table K.63.

Manhole depth (mm)	Minimum manhole size (mm)	Manhole cover (mm) size for sewerage and storm water
Up to 1,300	600 × 600	600 × 600
From 1,301 to 1,700	800 × 800	600 × 600
From 1,701 to 2,500	1,000 diameter (with GRP lining)	600 diameter
From 2,501 to 4,000	1,500 diameter (with GRP lining)	600 diameter

Table K.63 Minimum manhole chamber and access cover sizes

K.10.3.3.6 Final inspection chamber and provision for future connection

The FIC shall be constructed near the building compound wall and opposite the public drainage connecting chamber/manhole. The FIC cover shall be ductile iron with a GRP push-fit sealing plate. This FIC manhole shall have one incoming connection and shall operate by gravity flow.

Where there is no public drainage system, the FIC for the building shall still be provided for connection to a future public drainage network/manhole. The FIC shall be located towards the narrowest adjacent road.

K.10.3.4 Rainwater disposal

K.10.3.4.1 General

A rainwater disposal system shall be provided to remove rainwater from all building roof areas. The system shall be designed in accordance with BS EN 12056, and configured to reduce the impact of sand and dust ingress.

Rainfall intensity design criteria shall be taken from intensity duration-frequency curves developed for Dubai urban areas as shown in Table K.64.

Unless a more stringent design rainfall intensity is requested by the Authority or another party, a rainfall intensity of 75 mm/h shall be utilized for building roof disposal systems.

Return period	Intensity (mm/h) by duration (h)						
	0.50 (h)	1.00 (h)	1.50 (h)	2.00 (h)	2.50 (h)	6.00 (h)	24.00 (h)
1,000 year	103.44	70.99	52.40	43.63	34.90	20.51	7.62
200 year	83.78	57.81	42.73	35.50	28.40	16.43	6.12
150 year	80.26	55.45	41.00	34.05	27.24	15.70	5.86
100 year	75.30	52.12	38.56	31.99	25.59	14.66	5.48
75 year	71.77	49.75	36.82	30.53	24.43	13.93	5.21
50 year	66.78	46.40	34.37	28.47	22.78	12.89	4.83
40 year	64.03	44.56	33.01	27.33	21.87	12.32	4.62
30 year	60.46	42.17	31.26	25.86	20.69	11.58	4.35
25 year	58.20	40.65	30.15	24.92	19.94	11.11	4.18
20 year	55.41	38.78	28.78	23.77	19.02	10.53	3.97
15 year	51.80	36.35	27.00	22.27	17.82	9.78	3.70
10 year	46.63	32.89	24.46	20.14	16.11	8.71	3.30
5 year	37.48	26.75	19.96	16.35	13.08	6.81	2.61
4 year	34.38	24.67	18.44	15.07	12.06	6.17	2.37
3 year	30.19	21.86	16.38	13.34	10.67	5.30	2.06
2 year	23.65	17.48	13.16	10.64	8.51	3.94	1.56

Table K.64 Dubai rainfall intensity frequency data

If a public rainwater drainage network is not available in the area, it is preferable to have a rainwater storm drain within the land boundaries that is sufficient to hold rainwater for at least one day.

Rainwater disposal gutters, channels and rainwater pipes shall be:

a) installed with a gradient not greater than 1/50 and not less than 1/70;
b) made of robust material, complete with waterproof joints; and
c) installed in a safe and reliable manner that is equipped with suitable means of gutter and pipe protection (where required).

Rainwater shall be drained directly on to the surface of a road or passage. It shall not be drained into the drainage pipes of septic tanks or cesspits, or into an adjacent neighbour's premises.

Where possible, rainwater should be drained within the land boundaries at least 2 m away from the building.

K.10.3.4.2 Drainage of hardstanding or paved areas

Hardstanding paved areas shall be designed in accordance with BS EN 752. They shall be drained using floor gullies and linear drainage channels.

The design rainfall intensity shall be 65 mm/h, unless a more stringent value is requested by the Authority or another party.

The drainage of paved and hardstanding areas shall be configured to intercept sand and dust that would otherwise be washed into the drainage system during periods of rainfall.

K.10.3.4.3 Miscellaneous rainwater drainage

Rainwater pipes shall not be connected to sewer lines. They shall be terminated above ground, to allow free discharge onto the external ground surface.

Exposed roof areas or canopies shall be configured with a maximum gradient of 1/50 and not less than 1/70 in order to direct rainwater to suitable channels, gutters or outlets.

All building parapet roof areas shall incorporate emergency overflow provisions.

All internal roof or paved areas that are open to the sky (that have a catchment area of 16 m^2 or less) shall be provided with floor drains to enable rainwater pipework to connect to the nearest gully or waste discharge stack. All other open to the sky areas shall be provided with a rainwater drain that provides free discharge to an external area.

For all air ventilation shafts, access doors shall be provided at the lower level of the well to facilitate cleaning and maintenance of the rainwater drainage system.

K.10.3.5 Swimming pools

Backwash drainage flows from the pool filtration system shall discharge unattenuated into the public drainage system where this is approved by the Authority. If approval for an unattenuated discharge cannot be obtained, backwash water shall discharge into an attenuation tank to enable a reduced drainage flow rate to the public drainage system.

K.10.3.6 Septic tanks and sewage holding tanks

Where there is no public drainage network available, the building shall be provided with a sewage holding tank and septic tank.

Septic tank and sewage holding tanks shall meet the following requirements.

a) Tanks shall be situated within the plot boundaries and be easily accessible for cleaning, emptying and maintenance. They shall be included in the sanitation, architectural and construction drawings, and tank locations shall be subject to approval by the Authority.
b) Tanks shall be capable of being connected in future to the public drainage network.
c) Swimming pool water shall not be drained into a septic tank.
d) Tanks shall be constructed of reinforced concrete, GRP or brickwork. All tanks shall be installed in accordance with the tank manufacturer's requirements, and to withstand any potential vehicle loading.

e) Where a tank is to be founded at a lower level than that of an adjacent footing, the tank shall be constructed before the footing.

f) Tanks shall have openings of adequate size, with a heavy-duty lockable access cover of suitable dimensions to enable cleaning and maintenance.

g) The roof level of a tank shall not terminate above the adjacent ground level in which it is situated.

h) Tanks shall have adequate capacity, calculated on the basis of daily personal consumptions given in standard tables produced by the Authority. Tanks shall be emptied without impeding the operation of the building.

i) Provided that suitable insulation is provided to prevent leakage through walls, non-penetrating reinforced concrete tanks shall be situated at a distance not less than 1 m from nearby buildings and boundary walls, and brick tanks at a distance not less than 3 m. The reinforced concrete tanks shall be at a minimum depth of 1.5 m from the invert of the pipe connected to the tank inlet, and shall have a spacing of at least 3 m from the nearest water tank.

NOTE: Location constraints are illustrated in Figure K.103.

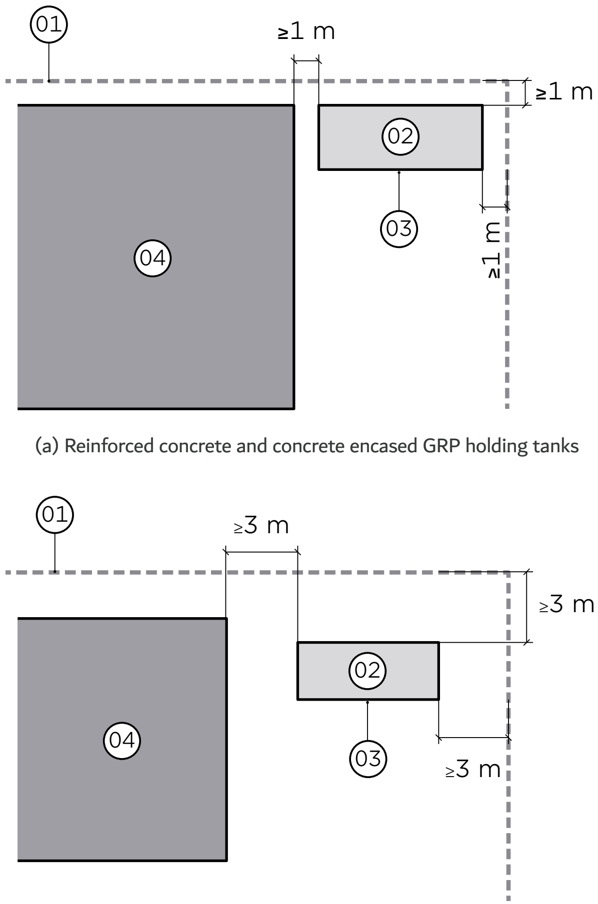
j) Tanks shall not be located within a 5.5 m set back vehicular access area unless this is unavoidable. If a tank has to be located within this area, the road and tank construction shall be sufficiently robust for road use by fire tenders and heavy goods vehicles.

k) Tanks shall be provided with a ventilation pipe.

l) All tank openings shall be covered in such a way as to prevent insects from entering.

m) In the event of wastewater overflowing, the holding tank shall have a high-level alarm facility that connects to a dedicated control panel. The control panel shall have a visual and audible alarm.

n) The tank shall be provided with a breaching pipe for pumping out operations.



(a) Reinforced concrete and concrete encased GRP holding tanks

Key
01: Site boundary/boundary wall
02: Septic/holding tank
03: No underground water tank shall be located within 1 m of the tank location
04: Building

(b) Brickwork holding tank

Key
01: Site boundary/boundary wall
02: Septic/holding tank
03: No underground water tank shall be located within 3 m of the tank location
04: Building

Figure K.103 Septic tank and sewage holding tank location constraints diagram

A GRP sealing plate shall be installed on the last manhole before the tank and on the manhole utilized for future connection before the sewer line.

Tanks shall be designed in accordance with BS 6297. A typical sewage holding tank arrangement is shown in Figure K.104.

All tank locations shall be subject to approval by the Authority and should be positioned in a location that enables the tank to be connected in future to the public drainage network.

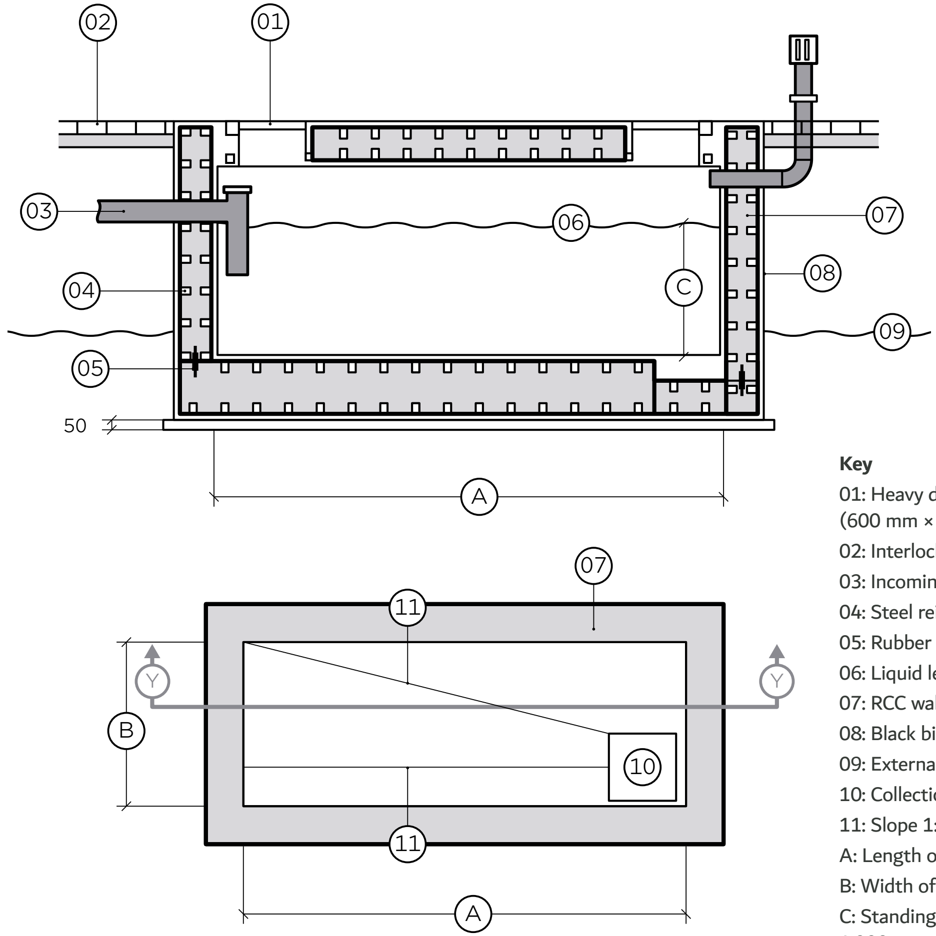


Figure K.104 Typical sewage holding tank

Key

01: Heavy duty MH cover (600 mm × 600 mm)

02: Interlock level

03: Incoming PVC-U pipe

04: Steel reinforcement rebar

05: Rubber water stopper

06: Liquid level

07: RCC wall

08: Black bitumen paint all round

09: External underground water table

10: Collection pit

11: Slope 1:10

A: Length of holding tank is variable

B: Width of holding tank

C: Standing water in the holding tank minimum 1,000 mm

NOTE: Minimum size for holding tank = A x B x C = 25 m^3

K.10.3.7 Soakaways

Where a soakaway (see example in Figure K.105) is part of the building drainage strategy, it shall be constructed in accordance with the following requirements.

a) Only the surface water drainage flows shall discharge into a soakaway.
b) The foundation level of the base of the soakaway shall be kept at least 1 m above the winter water table.
c) The soakaway shall be located at least 3 m away from a building footing or boundary wall.

Soakaways shall be filled with boulders that are 75 mm to 100 mm in size.

If the soakaway is to be founded at a lower level than that of an adjacent footing, the soakaway shall be constructed before the footing.

The floor area of the soakaway shall be determined according to the percolation rate in accordance with appropriate test in BS 6297.

The soakaway shall be not less than 1 m away from a septic or holding tank.

The soakaway shall be constructed at a level that does not undermine the adjacent footing of a building or a boundary wall.

There shall be no side leakage from the soakaway.

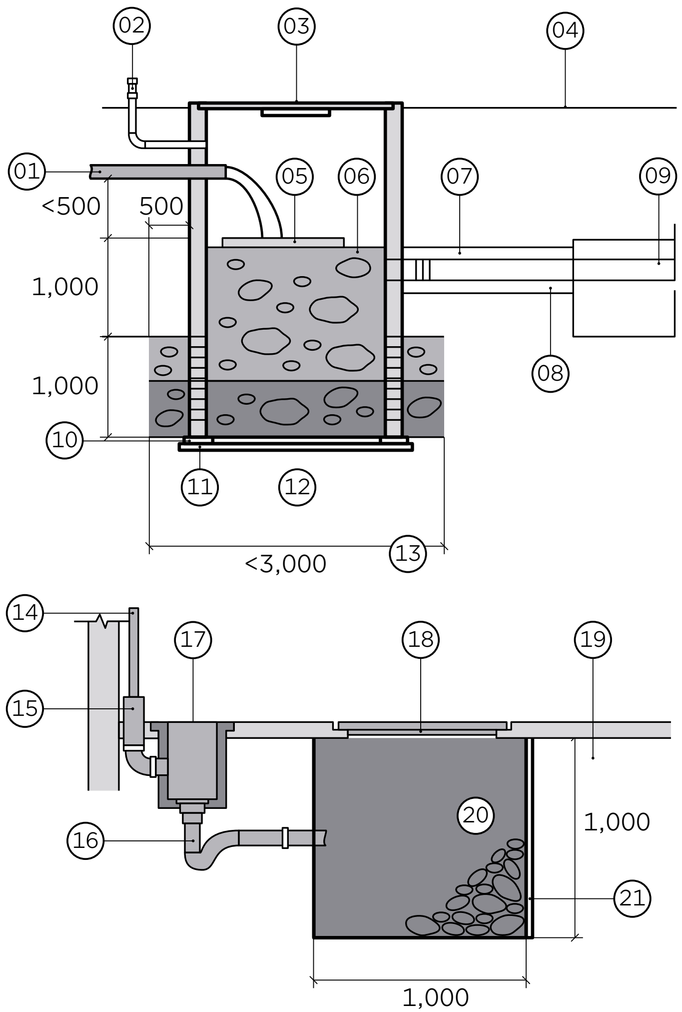


Figure K.105 Illustration of a typical soakaway

Key
01: Inlet 150ø min.
02: Vent pipe 50 mm min.
03 Cover (600 mm x 600 mm)
04: Ground level
05: Concrete slab
06: GRP filter
07: Solid pipe – 1,000mm long
08: 150 mm gravel surround
09: 200 mm diameter perforated pipe
10: RCC
11: Plain cement concrete
12: Permeable floor area
13: Min 3,000 mm
14: Condensate drain pipe
15: Copper to PVC pipe joint
16: P-trap
17: Sealed gully trap
18: 600 mm diameter clear access cover
19: Loose soil
20: 1,000 mm diameter perforate PVC chamber filler with pea gravel
21: Sand trap membrane to prevent ingress into chamber

K.10.4 Lighting

K.10.4.1 General

A suitable low-energy lighting arrangement shall be provided within each villa or townhouse.

K.10.4.2 Lighting controls

Lighting controls may consist of toggle switches, dimmer switches or a smart control system. The lighting controls system shall be selected as part of an overall energy efficient solution for the internal lighting.

As a minimum, occupancy sensors shall be provided to control interior lighting devices as required by K.10.1.10.3.

Automatic lighting control shall be provided to shut down exterior lighting during daylight hours. Occupancy sensors should be provided if exterior lighting is only used to illuminate exterior circulation paths.

K.10.5 Fire safety systems

K.10.5.1 Emergency lighting

Standalone, self-contained emergency lighting shall be provided in basements in accordance with Table 6.5, Ch. 6 of UAE FLSC [Ref. K.1].

K.10.5.2 Fire detection and alarm

Table 8.13, Ch. 8 of UAE FLSC [Ref. K.1] requires a smoke detection and alarm system in all villas/townhouses. The system shall be designed in accordance with Section 4, Ch. 8 of UAE FLSC [Ref. K.1].

The fire alarm control panel or the monitoring panel shall be located near the front door of the villa/townhouse.

Each villa/townhouse shall be provided with audio visual notification devices outside that are visible from the common approach road.

K.10.5.3 Sprinklers and hose reels

Table 9.23, Ch. 9 of UAE FLSC [Ref. K.1] requires sprinklers and hose reels in villas/townhouses with a ground floor GA >1,500 m^2. Sprinklers shall be provided in every room of the villa/townhouse. Hose reels shall be provided in the basement and ground floor. Dry landing valves and risers are not required.

Table 9.23, Ch. 9 of UAE FLSC [Ref. K.1] requires sprinklers and hose reels in basements where the GA of the basement >1,500 m^2. Sprinklers shall be provided throughout the basement (open as well as closed areas). Hose reels shall be provided in the basement and ground floor. Dry landing valves and risers are not required.

When required, the sprinklers, hose reels and yard hydrants shall be designed in accordance with Section 3, Ch. 9 of UAE FLSC [Ref. K.1].

K.10.5.4 Smart monitoring

The fire alarm system in villas/townhouses shall be connected to DCD control centres via the Hassantuk for Homes system (available at: building.moi.gov.ae/en-US/Hassantuk%20Overview/).

K.10.6 Acoustics

The sound insulation of the building envelope, internal floors and partitions of a villa or townhouse shall be designed in accordance with Approved Document E of the Building Regulations, England [Ref. K.44] to provide sound insulation between dwellings (i.e. party walls/floors) and sound insulation within a dwelling, particularly for sleeping areas.

K.11 Security

The common areas of villa or townhouse communities shall conform to the security requirements of SIRA in **Part J**.