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NOTE: This schematic sketch plan is intended to indicatively show the provision of signage; it may not be a true representation of a bus stop shelter design.

Reference Manual: Bus Stop Shelter Signs

Bus Stop Shelter Signs

Bus stop shelters shall be provided with the following signs:-

- -Bus Stop Shelter Address sign : Sign code: IP4(AP)
- -Bus Stop Shelter Information / Notice Boards: Sign code: NP6
- No Smoking Prohibition sign: Sign code: PR1c

-Bus Stop Pole sign: Sign code: IP4 (consult Public Transport Promotion Division - PTP)

SPECIAL NOTE on BUS STOP POLE:

Positioning of Bus Stop Pole:-

 LTA's Road Infrastructure Management (RIM) Division and PTP Division should be consulted on the guidelines for the settingout and positioning of the Bus Stop Pole.

Provision of Bus Stop Pole:-

- For Reconstruction / Relocation of <u>Existing</u> Bus Stops/Shelters:
 - The <u>existing</u> Bus Pole Shall be <u>reinstated</u> by the Civil Contractor.
- For <u>New</u> Bus Stops/Shelters:
 - It is the <u>scope of the Civil Contractor</u> to provide the <u>new</u> Bus Stop Pole; the Civil Contractor must procure it through the <u>Authority's term contractor</u> for Bus Stop Pole (consult LTA's PTP Division).

SPECIAL NOTE on NOTICE BOARDS:

Although the minimum provision is stipulated as 2 nos. please note the following:-

- For Reconstruction / Relocation of <u>Existing</u> Bus Stops/Shelters:
 - The existing quantity of Notice Boards must be provided; i.e. if there are 3 or more Notice Boards, the same quantity must be provided. LTA's PTP Division must be consulted for confirmation.
- For <u>New</u> Bus Stops/Shelters:
 - LTA's PTP Division must be consulted to determine the auantity of Notice Boards to be provided.



ELEVATION - BUS STOP SHELTER NOTICE BOARD SURFACE MOUNTED - A SET OF 2 PANELS (e.g. on Wall or Glazed Panel)



ELEVATION - BUS STOP SHELTER NOTICE BOARD FLOOR MOUNTED - A SET OF 2 PANELS

GENERAL REQUIREMENTS:-

- EACH DOUBLE-SIDED NOTICE BOARD HAS 2 POSTERS, ONE VIEWED FROM THE FRONT AND THE OTHER FROM THE REAR.
- ACCESS FOR MAINTENANCE & INSTALLATION OF THE POSTER/S SHALL BE FROM THE OPENABLE FRONT PANEL. THE REAR GLASS PANEL IS FIXED.
- POWDER-COATED ALUM FRAME, PANEL & SUPPORTS TO GRAY:RAL9007
- SLIM PANEL WITH DEPTH OF 60mm MAXIMUM.
- OPENABLE FRONT PANEL WITH 4mm THK TEMPERED GLASS; SWING TO 60 DEGREES MINIMUM; VIEW SIZE OF THE GLASS FOR BOTH SIDES OF THE NOTICE BOARD IS 900mmx900mm.
- THE INTERNAL FACE OF BOTH GLAZED PANELS SHALL BE DESIGNED TO SECURE POSTERS OF <u>940mmx940mmx1mm</u>.
- POSTERS SHALL BE SECURED WITH STAINLESS STEEL CLIPS THAT ARE PERMANENTLY FIXED ONTO THE ALUM FRAME OF THE PANELS. THE POSTERS SHALL FIT EXACTLY, BE VERTICALLY FLAT & SHALL NOT SLIP OR WARP. THE CLIPS SHALL NOT BE VISIBLE FROM THE VIEW AREA (THE FRONT OF THE GLASS PANEL)
- INTERNALLY, THERE SHALL BE AN OPENABLE (SWING) SEPARATOR OF 2mm THK ALUMINIUM COMPOSITE PANEL (GRAY COLOUR), HINGED ON ONE SIDE AND WITH A SIMPLE SECURING DEVICE AT THE OTHER SIDE. THIS SEPARATOR VISUALLY ISOLATES THE INTERNAL FACES OF THE FRONT AND REAR POSTERS. THE CLIPS SHALL NOT BE VISIBLE FROM THE VIEW AREA (THE FRONT OF THE CLASS PANEL)
- THE DESIGN OF THE NOTICE BOARD SHALL FACILIATE QUICK, EASY & UNOBSTRUCTED CHANGE OF THE POSTERS.
- LOCKING DEVICE 3 NOS. PER PANEL: M6 STAINLESS STEEL SCREW WITH 4mm HEX-PROFILE SCREWED INTO THREADED BLIND (CONCEALED) RIVET NUTS.
- THE SIGN-BOX SHALL BE CONSTRUCTED TO A RATING OF IP65.
- STAINLESS STEEL HINGE or INTEGRATED CONCEALED HINGE.
- ALL COMPONENTS & MATERIALS SHALL BE DURABLE & CORROSION-RESISTANT; FIXING MATERIALS SHALL BE STAINLESS STEEL.
- CIRCULAR STAINLESS STEEL (GRADE 316) COVER PLATE WHERE REQUIRED TO CONCEAL THE BASE-PLATE; SECURED BY RECESSED STAINLESS STEEL HEX-PROFILE SCREWS.
- A REGISTERED PROFESSIONAL CIVIL ENGINEER SHALL BE ENGAGED FOR THE DESIGN AND ENDORSEMENT.
- FOR FLOOR MOUNTED VERSIONS, THE REQUIREMENT FOR ELECTRO-POTENTIAL BONDING/EARTHING SHALL COMPLY WITH CURRENT REGULATIONS, AND SHALL BE VERIFIED BY A LICENSED ELECTRICAL WORKER.

Reference Manual: Bus Stop Shelter Signs

Bus Stop Shelter Notice Board (for Bus Service Information) Sign code: NP6 Double-sided panels

Basic specifications

Each bus stop shelter shall be provided with a minimum of 2 nos. Notice Board. More notice boards may be required for bus stops in the city or around town centres. This can be verified in consultation with the LTAS <u>Public Transport Promotion (PPI Division</u>.

The information incorporated on the posters (provided by Transit Link) are basically bus services and their respective service routes, street index and fare pricing.

The Notice Boards shall be positioned under shelter, clear of obstructions to allow comfortable viewing and provided with concealed lighting. All electrical elements shall be concealed.

They can be either floor mounted on supports, or surface mounted on a wall or tempered glass panel.

Each notice board is typically double-sided, i.e. a poster at the front and another at the rear.

Single-sided Notice Boards: Where viewing is obstructed at the rear of the bus shelter, single-sided notice boards are allowed. In such instances, the rear of the notice board shall be sealed with a powdercoated aluminium panel.

SPECIAL NOTE on NOTICE BOARDS:

Although the minimum provision is stipulated as 2 nos. please note the following:-

- For Reconstruction / Relocation of <u>Existing</u> Bus Stops/Shelters:
 - The existing quantity of Notice Boards must be provided; i.e. if there are 3 or more Notice Boards, the same quantity must be provided. LTA's PTP Division must be consulted for confirmation.

• For <u>New</u> Bus Stops/Shelters:

 Especially for bus stops in the city area, around housing estate town centres, outside MRT stations and Bus Interchanges, LTA's PTP Division must be consulted to determine if more Notice Boards need to be provided





ELEVATION - BUS STOP SHELTER NOTICE BOARD FLOOR MOUNTED - A SET OF 2 PANELS

GENERAL REQUIREMENTS:-

- SINGLE-SIDED NOTICE BOARDS ARE VIEWED FROM FRONT ONLY.
- POWDER-COATED ALUM FRAME , PANEL & SUPPORTS TO GRAY:RAL9007
- SLIM PANEL WITH DEPTH OF 60mm MAXIMUM.
- OPENABLE FRONT PANEL WITH 4mm THK TEMPERED GLASS; SWING TO 60 DEGREES MINIMUM; VIEW SIZE OF THE GLASS IS 900mmx900mm.
- THE SIGNBOX SHALL BE DESIGNED TO INTERNALLY FIT A POSTER OF <u>940mmx940mmx1mm</u>.
- THE POSTER SHALL BE SECURED WITH STAINLESS STEEL CLIPS. THEY SHALL FIT EXACTLY, BE VERTICALLY FLAT & SHALL NOT SLIP OR WARP. THE CLIPS SHALL NOT BE VISIBLE FROM THE VIEW AREA (THE FRONT OF THE GLASS PANEL)
- THE DESIGN OF THE NOTICE BOARD SHALL FACILITATE QUICK, EASY & UNOBSTRUCTED CHANGE OF THE POSTER.
- LOCKING DEVICE 3 NOS. PER PANEL: M6 STAINLESS STEEL SCREW WITH 4mm HEX-PROFILE SCREWED INTO THREADED BLIND (CONCEALED) RIVET NUTS.
- THE SIGN-BOX SHALL BE CONSTRUCTED TO A RATING OF IP65.
- STAINLESS STEEL HINGE or INTEGRATED CONCEALED HINGE.
- ALL COMPONENTS & MATERIALS SHALL BE DURABLE & CORROSION-RESISTANT; FIXING MATERIALS SHALL BE STAINLESS STEEL.
- CIRCULAR STAINLESS STEEL (GRADE 316) COVER PLATE WHERE REQUIRED TO CONCEAL THE BASE-PLATE; SECURED BY RECESSED STAINLESS STEEL HEX-PROFILE SCREWS.
- A REGISTERED PROFESSIONAL CIVIL ENGINEER SHALL BE ENGAGED FOR THE DESIGN AND ENDORSEMENT.
- FOR FLOOR MOUNTED VERSIONS, THE REQUIREMENT FOR ELECTRO-POTENTIAL BONDINGEARTHING SHALL COMPLY WITH CURRENT REGULATIONS, AND SHALL BE VERIFIED BY A LICENSED ELECTRICAL WORKER.

Reference Manual: Bus Stop Shelter Signs

Bus Stop Shelter Notice Board (for Bus Service Information) Sign code: NP6 Single-sided panels

Basic specifications

Each bus stop shelter shall be provided with a minimum of 2 nos. Notice Board. More notice boards may be required for bus stops in the city or around town centres. This can be verified in consultation with the LTA's <u>Public Transport Promotion (PTP) Division</u>.

The information incorporated on the posters (provided by Transit Link) are basically bus services and their respective service routes, street index and fare pricing.

The Notice Boards shall be positioned under shelter, clear of obstructions to allow comfortable viewing and provided with concealed lighting. All electrical elements shall be concealed.

They can be either floor mounted on supports, or surface mounted on a wall or tempered glass panel.

SPECIAL NOTE on NOTICE BOARDS:

Although the minimum provision is stipulated as 2 nos. please note the following:-

For Reconstruction / Relocation of <u>Existing</u> Bus Stops/Shelters:

 The existing quantity of Notice Boards must be provided; i.e. if there are 3 or more Notice Boards, the same quantity must be provided. LTA's PTP Division must be consulted for confirmation.

• For <u>New</u> Bus Stops/Shelters:

 Especially for bus stops in the city area, around housing estate town centres, outside MRT stations and Bus Interchanges, LTA's PTP Division must be consulted to determine if more Notice Boards need to be provided



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ELEVATION - NO SMOKING SIGN SURFACE MOUNT Reference Manual: Bus Stop Shelter Signs

alum. brackets

No Smoking Prohibition Sign Sign code: PR1c

This sign is displayed at all bus stop and taxi shelters. For adequate coverage, one sign is provided for every 9metre length of shelter.

Location It is centrally located at the bus stop shelter, usually on a column structure.

The text message on this sign was advised by the National Environmental Agency (NEA). Public enforcement is by NEA.

<u>Materials and Finishes</u> (1) 'ultra violet (UV)-cured' printed graphics on 2mm thk anodised alum. installed with very high bond double-sided adhesive tape or

(2) If the sign needs to be installed to conform to the profile of a circular structure: 'ultra violet (UV)-cured' printed graphics on outdoor heavy-duty vinyl sticker against a backing of 1mm thick polycarbonate. installed with very high bond double-sided adhesive tape.





This sign is displayed at all bus stops. It identifies the bus stop and provides some basic information for commuters.

IP4(Type D) - for bus stops within HDB Town centres and around MRT

Public Transport Promotion Division (PTP) Whilst the system-wide identity and branding is derived from the transit signage guidlines (DGM), the regulator & custodian of the bus stop pole implementation, application and specifications, is the <u>Public Transport</u> <u>Promotion (PTP) Division</u>. The division should be contacted for further

SPECIAL NOTE on BUS STOP POLE:

Positioning of Bus Stop Pole:-

 LTA's Road Infrastructure Management (RIM) Division and PTP Division should be consulted on the guidelines for the settingout and positioning of the Bus Stop Pole.

- For Reconstruction / Relocation of Existing Bus
 - The existing Bus Pole Shall be reinstated by the Civil

• For <u>New</u> Bus Stops/Shelters:

 It is the scope of the Civil Contractor to provide the new Bus Stop Pole; the Civil Contractor must procure it through the Authority's term contractor for Bus Stop Pole (consult LTA's PTP Division).



Reference Manual: Bus Stop Shelter Signs

Bus Stop Shelter Notice Board (for Bus Service Information)

The drawing is indicative only. Primarily, it illustrates design intent and performance criteria. Where proposed aluminium profile and detailing are different, design intent, peformance criteria and dimensions must be complied.

Generally:-

Notice Board to fit 1 poster.
 View size of the glazing is 900 x 900.
 Poster size is 940 x 940 x 1.
 Stainless steel clips to secure posters.
 Locking Device: stainless steel M6 screws with 4mm hex-profile.
 Lonstructed to 1P65 rating.
 Facilitates quick change of poster
 Safe & Durable
 Maintenance-free

Basic Specifications & Performance Criteria

Powder-coated (Gray: RAL9007) aluminium panel and supports.

Slim panel of depth 65mm (maximum)

Designed & constructed to IP65 rating, weather & insect resistant

Stainless steel hinge or integrated aluminium profile hinge

Openable front panel up to minimum of 60 degrees swing; the rear panel is fixed.

Glazing: 4mm thk (mininum) tempered glass (verified with embossed markings).
 Glazing shall be mechanically fixed. Fixing with silicone only is not acceptable

 Display/View Size is <u>900 x 900</u> i.e. the glass panel seen by the viewer shall be <u>exactly</u> this size.

 Poster Material Size is <u>940 x 940 x 1</u>; the securing of the posters shall fit this size exactly. There shall be no curling, sagging, warping, slipping of the posters installed. The contractor shall verify the fit with templates of the same size & thickness.

The front poster is secured onto the front panel.

 Maintenance of poster: The design and construction of the notice board shall facilitate quick, easy and unobstructed installation and change of poster. When installing poster, the notice board there shall be no loose parts, or parts that need to be removed and/or replaced.

 Internal: Stainless steel clips with indentations for grip, shall be incorporated to hold the poster securely and to aid ease of poster change/updating; 1 pair at the top and another pair at the bottom; concealed from external view.

•The innards of the panel i.e. the fixing, clips, etc. shall not be seen by the viewer.

 Locking device: stainless steel button-head M6 screws with 4mm hex-profile with threaded blind rivet (concealed) nuts; 3 nos, per notice board

 All components and materials shall be corrosion resistant; stainless steel where available.

 Base cover where required to conceal base plate and bolts/nuts: Stainless steel in Grade 316. Secured with a stainless steel screw to a pre-installed bracket on the base plate. Fixing with silicone only is not acceptable.

 The design and construction of all details of the notice board shall be safe (no sharp pertuberances), and durable.

The construction of the notice board shall be to a rating of IP65.

 Equipotential/earthing bonding (concealed) shall comply with current statutory regulations, verified and endorsed by a Licensed Electrical Worker.

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Reference Manual: Taxi Signs

Inventory of Taxi Signage Graphics

The Taxi Identity Marker sign pole is used for the identification of Taxi Shelters/Stands/Stops and displaying taxi regulation messages.

•The Transport Symbol represents the public transit network which includes the various mode of transport - MRT, LRT, Bus, Taxi.

-The Taxi Transport Mode Logo identifies the mode of transport and the facility it serves.

-The Taxi Oueue Number restricts the number of Taxis that can wait at the shelter/stand/stop.

-The Taxi Stand/Stop Location Number/Code helps to identify its location, which commuters can use when booking for a taxi.

•The Taxi Advisory is a regulatory message with a hotline to call for feedback. Generally, they are required as a reminder to taxi-drivers and as advice to commuters.

Graphics See illustration.

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Reference Manual: Taxi Signs

Taxi Identity signs for Taxi Stand or Taxi Stop Identity Differentiation

This sign identifies the Taxi Stand or Taxi Stop.

Graphics -See illustration. -Note different colours for Taxi Stand and Taxi Stop

Material and Construction •Note different materials and finishes for Taxi Stand and Taxi Stop, •See separate drawings for details.



TAXI IDENTITY SIGN FOR 'TAXI STAND' & 'TAXI STOP'







Annex A17

SIGN GRAPHICS Dimensions refer to graphic display size



Dimensions refer to graphic display size

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TAXI SHELTER NOTICE BOARDS SURFACE-MOUNTED - A SET OF 2 PANELS (e.g. on Wall or Glazed Panel)



TAXI SHELTER NOTICE BOARDS FLOOR-MOUNTED - A SET OF 2 PANELS

GENERAL REQUIREMENTS:-

- SINGLE-SIDED NOTICE BOARDS ARE VIEWED FROM FRONT ONLY.
- POWDER-COATED ALUM FRAME, PANEL & SUPPORTS TO GRAY:RAL9007
- SLIM PANEL WITH DEPTH OF 60mm MAXIMUM.
- TAXI SHELTER NOTICE BOARD SHALL BE INSTALLED WITH LED LIGHT STRIP C/W CLIPS SECURED ON ALUMINUM FRAME
- OPENABLE FRONT PANEL WITH 4mm THK TEMPERED GLASS; SWING TO 60 DEGREES MINIMUM; VIEW SIZE OF THE GLASS IS 1190mmX600mm.
- THE SIGNBOX SHALL BE DESIGNED TO INTERNALLY FIT A POSTER OF 605mmX1210mmX1mm.
- THE POSTER SHALL BE SECURED WITH STAINLESS STEEL CLIPS. THEY SHALL FIT EXACTLY, BE VERTICALLY FLAT & SHALL NOT SLIP OR DISTORT. THE CLIPS SHALL NOT BE VISIBLE FROM THE VIEW AREA (THE FRONT OF THE GLASS PANEL)
- THE DESIGN OF THE NOTICE BOARD SHALL FACILIATE QUICK, EASY & UNOBSTRUCTED CHANGE OF THE POSTER.
- LOCKING DEVICE 3 NOS. PER PANEL: M6 STAINLESS STEEL SCREW WITH 4mm HEX-PROFILE SCREWED INTO THREADED BLIND (CONCEALED) RIVET NUTS.
- THE SIGN-BOX SHALL BE CONSTRUCTED TO A RATING OF IP65.
- STAINLESS STEEL HINGE or INTEGRATED CONCEALED HINGE.
- ALL COMPONENTS & MATERIALS SHALL BE DURABLE & CORROSION-RESISTANT; FIXING MATERIALS SHALL BE STAINLESS STEEL.
- CIRCULAR STAINLESS STEEL COVER PLATE WHERE REQUIRED TO CONCEAL THE BASE-PLATE; SECURED BY RECESSED STAINLESS STEEL HEX-PROFILE SCREWS
- A REGISTERED PROFESSIONAL CIVIL ENGINEER SHALL BE ENGAGED FOR DESIGN AND ENDORSEMENT.
- FOR FLOOR MOUNTED VERSIONS, THE REQUIREMENT FOR ELECTRO-POTENTIAL BONDING/EARTHING SHALL COMPLY WITH CURRENT REGULATIONS, AND SHALL BE VERIFIED BY A LICENSED ELECTRICAL WORKER
- A BLANK LOOSE SHEET OF POLYCARBONATE OF 605MM X1210MM X 1MM THK SHALL BE PROVIDED IN EACH NEW SIGNBOX TO SIMULATE THE POSTER

Reference Manual: Taxi Signs

Taxi Notice Board (for Taxi Information) Sign Code : NP5-D

The panels accommodate the Taxi Information poster

The poster may contain information such as fares, booking and waiting times. Please refer to separate drawing for the graphics of the poster.

The poster is regulated, installed and maintained by LTA's division in charge of Taxi Services

Location and Application •The set of 2 panels are positioned for the convenient viewing by commuters.

Material and Construction -See illustration for specifications

-see mustration for speci

Miscellaneous:

•The tempered glass shall have embossed marking at a corner. Glazing shall be mechanically fixed. Fixing with silicone only is not acceptable

 Internal: Stainless steel clips with indentations for grip, shall be incorporated to hold the poster/s securely and to aid ease of poster change/updating; minimum 1 pair at the top and another pair at the bottom; concealed from external view.

 Internal: The backing surface to receive the poster shall be durable & permanently flat. Materials can be aluminium or polycarbonate.
 Softboard, corksheet, or timber is not acceptable.

 Base cover where required to conceal base plate and bolts/nuls: Secured with a stainless steel screw to a pre-installed bracket on the base plate. Fixing with silicone is not acceptable; silicone may be used as a sealant.

 The design and construction of all details of the notice board shall be durable and have safety in mind (no sharp protrusion).

Taxi information 🚔 Common Taxi Booking Number 6-DIAL-CAB 6 555 3333 6 342 5222 REN: KENtyCab 6 552 1111 6 485 7777 **P** <u> SIIIRI</u> 6 555 8888 6 778 0808 For future operator 6 363 6888 **OPREMIER** How to book a Taxi LTA Taxi Advisory 1. Call the hotine. It is illegal for taxi drivers to tout 2. Inform operator you are at: and overcharge must be charged according to the tasimeter applicable such arges. Taxi Stand location description In English & Chinese plus applicable • Receipt must b • Limoutine task or authorized call-becking. ior can endy be hired from sine counter or through LOCATION DESCRIPTION 3. Note Taxi number siven by operator. ON SEPARATE 160 x 30 When Taxi arrives, confirm with Taxi driver on booking and destinution. (A call booking surcharge is applicable) For any enquiry or feedback, please call <u>
1890-CALL LTA</u>. LABEL STICKER Taxi Fares Com/ort/ CityCala SHRT Trans-Cale Premier Smart Components Prime Netered Fare Flagdown fare (1st km) \$2.00 to \$3.20 20 cents per 385 metres (1 to 10 km) 20 cents per 330 metres (after 10 km) Distance fare Waiting time 20 cents per 45 seconds Surcharges Current call basking <u>Nine (ine iterator</u> 1965) 7 per la tri per la Tri per <u>Sangeler (ne</u> All effective) \$3.50 for prime time \$2.50 for non-prime time \$5.00 \$5.20 Advance booking \$5.20 \$5.20 \$5.20 \$5.00 City Area \$3.00 Peak Hours 35% of metered fare Nontas is Piles Tax is 5.0 pr. Spirite Can. Not applicable of Pile Salarday. Midnight 50% of metered fare Public holiday (2 ministration for Public Index), Includes (3 ministration for Teal, Italian Fuest, Italian Fue (from 6 per ver the costs they Than 5 per 4 \$1.00 Passenger Weiding Time at Taol Stand (Minutes) 原本主助士以的特征対策(分下) Range (Average) 信頼(可用)(平均) Time HTM 1700 - 1800 2 to 27 mina (12 mina) Map of taxi stands/stops 1800 - 1900 2 to 38 mins /12 mins) 1800 - 2900 within vicinity 2 to 31 mine (10 mine) (to be drawn by contractor) 2000 - 2100 2 to 22 mins (il mins) 2100 - 2200 2 to 35 mins (12 miss) 2200 - 2300 2 to 59 mins (25 mins) Parameter welling live is based on (37% initial survey constants) have $3d^2 \approx 2d^2$ have determined welling of a 2000 in 11 A 24 110 20 Match. Land Transport QA

Reference Manual:

Taxi Signs

Taxi Information Poster

The poster may contain information such as fares, booking and waiting times. Please refer to separate drawing for the graphics of the poster.

The poster is regulated, installed and maintained by LTA's division in charge of Taxi Services.

Material and Finish

 All materials, finsihes & printing shall be for long-term outdoor usage.

 Main Poster: High-resolution Ultra-Violet light resistant digital print on vinyl with compatible matt overlaminate; mounted on a 1mm thick polycarbonate backing.

 Labels/Stickers on poster: High-resolution ultra-violet light resistant digital print on vinyl sticker with compatible matt overlaminate.

 Other stickers for updating information on the poster: specifications similar to Labels/Stickers above.

TAXI INFORMATION POSTER -INDICATIVE GRAPHICS

Material Size: 605mm x 1210mm x 1mm

NOTE:

For detailed & current information on the poster, please refer to LTA's division in charge of Taxi Services



SKETCH PLAN OF INTEGRATED PICK-UP POINT AND TAXI STAND NOTE: This schematic sketch plan is intended to indicatively show the provision of signage; it may not be a true representation of a taxi stand/pick-up point design.





GENERAL REQUIREMENTS:-

- SIGN PLATE: 2mm THK POWDER-COATED ALUMINIUM WITH UV-CURED DIGITALLY PRINTED GRAPHICS WITH MATT OVERLAMINATE; ALL CORNERS ROUNDED TO 15mm RADIUS.
- GRAPHICS SHALL BE REPEATED ON BOTH SIDES OF THE SIGN PLATE (UNLESS STATED OTHERWISE).
- GRAPHICS SHALL COMPLY WITH THE AUTHORITY'S TRANSIT SIGNAGE GUIDELINES.
- FIXING: CEILING-MOUNTED WITH POWDER-COATED GRAY (RAL-7012) ALUMINIUM BRACKET WITH RIGID HANGERS.
- ALL COMPONENTS & MATERIALS SHALL BE DURABLE & CORRSION-RESISTANT; ALL SIGNAGE FIXING MATERIAL SHALL BE IN STAINLESS STEEL
- FIXING WITH SCREWS & BOLTS SHALL BE USED WITH BLIND RIVET NUTS. SELF-TAPING ONTO STRUCTURE IS NOT ACCEPTABLE.
- SIGN PLATES & GRAPHICS: THE DIMENSIONS ILLUSTRATED HERE DEPICTS THE DISPLAY SIZE. THE FIXING SHALL BE KEPT CLEAR OF THE DISPLAY SIZE.
- A REGISTERED PROFESSIONAL CIVIL ENGINEER SHALL BE ENGAGED FOR DESIGN AND ENDORSEMENT.

Reference manual: Taxi Signs

Taxi Queue Here Sign Sign code: IS11

This sign marks the head of the commuter's queue for taxis. It should be in full line-of-sight for commuters to be able to determine the start of the queue.

Location and Application

 This sign is located at the head of the queue, coinciding with the floor queue arrow (at the 1st taxi lot); it is mounted perpendicular to pedestrian traffic.
 Height clearance is 2200mm from the finished floor level.

Materials and Finishes •See Annotation & Notes

Graphics

Graphics shall be on both sides of the sign plate
 NOTE: Only circumstances with double-sided graphics results in the queue becoming ambiguous, then graphics shall be applied on one side only (facing the designated queue).

- Main background: colour in 'pale-green'- PMS558c
- Main text: Ocean Sans MM 512/475 or Ocean Sans Standard Semi-bold at 218pt; colour in 'rainforest-green'-PMS316c
 Taxi Logo: Top background in 'khaki'-PMS153c, taxi-head
- Taxi Logo: Top background in 'Knaki -PMS155c, taxi-nead pictogram in white.
 Taxi Logo: Rottop background in 'tainfarest-groop' RMS'
- Taxi Logo: Bottom background in 'rainforest-green'-PMS316c; text in white; typeface is 'LTA-identity'.

SKETCH PLAN OF TAXI QUEUE HERE SIGN

NOTE: This schematic sketch plan is intended to indicatively show the provision of signage; it may not be a true representation of a taxi stand design.

SKETCH ELEVATION

steel chain-link

Ceiling-mounted: Suspended from the

roof structure with a flexible stainless

Ring hooks welded or bolted

to sign plate -

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Taxi Signs

Shelter Height Limit Sign Sign code: SHL

This sign is displayed as a mandatory instruction on the allowable height dearance of the taxi shelter roof over the taxi bay.

Location and Application

This sign is suspended from the edge of the roof structure, facing oncoming traffic.

Graphics

See illustration.
 The sign is finished on both sides with the similar artwork/text.

Mounting

- Fixing detail to be proposed by the Designer/Contractor to suit shelter roof detail.
- Detailing, material, specifications and construction shall take into consideration durability of the fixing against the wear and tear caused by the swaying of the hung sign plate.
- Robust design with safety factor to be considered in the event of vehicles knocking into the sign.

_ _ _

GENERAL REQUIREMENTS:-

- ALL COMPONENTS & MATERIALS SHALL BE DURABLE & CORRSION-RESISTANT; ALL SIGNAGE FIXING MATERIAL SHALL BE IN STAINLESS STEEL
- A REGISTERED PROFESSIONAL CIVIL ENGINEER SHALL BE ENGAGED FOR DESIGN AND ENDORSEMENT.

Annex B1: Reference Table

- 1. Active Mobility Act (AMA)
- 2. LTA Standard Details of Road Elements (SDRE)
- 3. LTA Civil Design Criteria (CDC)
- 4. LTA Code of Practice on Street Works Proposals Relating to Development Works
- 5. LTA Code of Practice on Vehicle Parking Provision in Development Proposals
- 6. LTA Public Street Lighting Guidelines
- 7. LTA Transport Impact Assessment Guidelines for Developments 2019 Edition
- 8. URA Walking and Design Guide
- 9. BCA Universal Design Guide for Public Places
- 10. BCA Code on Accessibility in the Built Environment
- 11. Singapore Standard SS485 Specification for Slip Resistance Classification of Pedestrian Surface Materials
- 12. Singapore Standard NA to SS EN 1994 Singapore National Annex to Eurocode 4 : Design of Composite Steel and Concrete Structures

Annex B2: Path Types

	TYPE 1 -	TYPE 2 –	TYPE 3 –	
	Pedestrian-	Footpath	Shared Path	
Present	Pedestrian	Footpath	Shared path	Cycling path
Terms	Overhead			• , •
	Bridge (POB), selected			
	bridges and			
Active	underpass Pedestrians	Pedestrian Conventional Bioveles	Pedestrian Convention	al Ricycles, Power-
Mobility	*Personal	Non-Motorised Personal Mobility	Assisted Bicycle (PAB)	(i.e. electric bicycle),
Users /	Mobility Aid	Device (PMD) only (i.e. manual kick	Motorized and Non-Motorized Personal Mobility	
Allowed	wheelchair,	Mobility Aid (PMA) (i.e. wheelchair,	unicycles, electric skateboard, hoverboards) and	
	motorized	motorized wheelchair, mobility	*Personal Mobility Aid (PMA) (i.e. wheelchair,
	mobility scooter)	scooler)	motorized wheelchair, h	nobility scooler)
Demarcation	"No Riding" sign	No marking	- Grey concrete / tiles	- Darker shade of grey
			continuous dash red	concrete/ red colour path/ tiles finishes
			line demarcation.	with two continuous
			- Pedestrian +	solid red (or yellow)
			PCN/Cyclist signs/	
			markings at start of path and intersection	 Cyclist/Bicycle signs or markings
			 Cyclist signs/ markings at 	 Cyclist signs/ markings at
			intersection	intersections
Typical	~	1 5m ~ 1 8m	>= 2.5m	2m cycling path
Width			2 = 2.011	accompanied by 1.5m
Speed Limit	~	10km/br	25k	footpath m/br
opecu Linit			25000	
	 The maximum device speed for 	* The maximum device speed for motorised PMAs is 10km/hr.	 The maximum device speed 10km/hr. 	for motorised PMAs is
	motorised PMAs is 10km/hr.			
Examples				
				510
	DODo	Mejority of pothe clong roads and		
	- Certain	within housing estates		
	underpass /	-		
	assessed to		Ser Same Se	50
	be unsafe for			
	riding			
			The second secon	
			6	
			- Shared path that	 LTA- built cycling paths
			connect cycling path	- TC-built cycling paths
			- PCNs	 NParks-built cycling path (PCN)

ANNEX C1: Technical Specification for M&E Services

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1 Codes and Regulations

The M&E services works shall comply strictly with all statutory regulations, by-laws and orders currently in force and to the satisfaction of all government authorities and all statutory authorities.

Where equipment or material are specified to conform to requirements of certain standard, evidence including written certificates and full testing reports from an accepted/ recognised testing organisation stating that the proposed equipment or material have been tested and conform to the specified standard shall be submitted.

Where no standards are stated in the Authority's Requirements, all details, materials, equipment and workmanship shall be in accordance with the relevant local and international standards.

Local codes, regulations, and standards shall take precedence. In addition to local requirements, the M&E services works shall comply with the various international standards and manuals as follows:

- British Standards (BS)
- International Electrotechnical Commission (IEC)
- International Standards Organization (ISO)
- ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers
- Guidelines for Good Indoor Air Quality in Office Premises
- AMCA Air Movement and Control Association (USA)
- ANSI American National Standards Institute (USA)
- ARI Air-conditioning & Refrigeration Institute
- ASTM American Society of Testing and Materials
- VCA Heating and Ventilation Contractors Association (UK)
- SMACNA Sheet Metal and Air-conditioning Contractors' National Association Inc. (USA)
- UL Underwriters Laboratory

- 2 LV Distribution Boards (DBs)
- 2.1 General
- 2.1.1 The distribution boards shall be of metal enclosed indoor, factory built type corresponding principally to the latest IEC-Recommendations No. 61439, 60529 and 60947. A minimum protection of enclosure IP 42 shall be provided. Distribution boards that are exposed to weather elements or not housed within the electrical rooms or closets shall be provided with a minimum protection of IP 54, double door and shall come with glass viewing panel. Distribution boards installed in tunnel shall be provided with a minimum protection of IP65. Distribution boards of 100A and above shall be provided with voltmeter and ammeter complete with selector switches. All distribution boards shall be provided with incoming and outgoing LED indication lights.
- 2.1.2 Each distribution board shall be provided with 20% spare breakers and spare space. The overall rating, incoming cables and upstream provision shall be such that a 20% load increase for future expansion can be accommodated without alteration to the distribution system.
- 2.1.3 The Contractor shall provide glands and LSOH shrouds of an approved type for all cables entering and terminating in enclosures. Cable entries shall be sealed by an approved means on completion of installation of all cables.
- 2.1.4 Each distribution board is to be labelled properly with reverse engraved name plate secured by stainless steel screws. The details of the labels are to be approved by the Authority before fabrication.
- 2.2 Panel Construction
- 2.2.1 The distribution board enclosure (panels/doors) shall be made of electrogalvanised steel sheets (minimum thickness 2 mm) and finished with epoxy powder coating (minimum 60 micron) colour to the acceptance. 2.2.1 The enclosure shall be completed with hinged doors and to be provided with standardised lockset type of "A Series cam lock with Alloy Key" and 3 sets of keys shall be provided for each distribution board. The distribution boards' doors opening shall be coordinated on Site. All DB doors shall be provided with separate latches in addition to the door locks.
- 2.2.2 The distribution boards shall be supplied fully equipped, wired, and proofed against vermin, dust and moisture, designed for free-standing or for wall-mounting, and cable access from beneath or above. Proper warning signs indicating danger and voltage level shall be provided.
- 2.2.3 The distribution board shall be composed from standardised items, enabling easy exchange or replacement of faulty equipment.
- 2.2.4 Each distribution board shall be supplied complete with top and bottom removable fibre gland plates which shall be drilled to suit cable glands, trunking or conduit entry. The gland plates shall be made of non-ferromagnetic material or proper means shall be provided to avoid any induced current flow around the single core ac cable entering the board. Spare holes shall be provided at the top and bottom of the distribution board and fitted with stopping plugs and lock nuts.
- 2.2.5 Unless otherwise approved, access to the boards shall be from the front, the doors shall be furnished with lift off hinges to permit an opening enabling an unrestricted access to the board interior. Suitable protective shields with handle shall be provided at the internal compartment to protect against live parts or terminals. All doors and covers shall be fitted with moulded gaskets of non-ageing material.
- 2.2.6 The board interior apparatus shall be fixed mounted on back plates of reinforced steel for rigid support and covered with a front panel making the access to the live parts impossible. The circuit breakers shall be mounted such that the above-mentioned front panel need not be removed in order to operate any breakers. The meters and indication lights shall be installed in the door openings and be visible without opening the door.
- 2.2.7 Fibre boards of appropriate dimensions and thickness shall be provided at the front of each distribution board to protect against all live parts. Suitable protective shields shall be provided at the back of all front panels with lamps/instruments to protect against all exposed terminals. Danger signs shall be provided on all protective shields or barriers. Each switchboard shall be labelled properly with reverse engraved nameplate secured by stainless steel screws.
- 2.2.8 The distribution boards shall be provided with tinned copper conductor busbars rated for the appropriate continuous current and short circuit current. The busbars shall be designed to withstand dynamic forces due to peak short circuit current. All busbars including droppers and termination to the circuit breakers shall be provided with permanent heat shrink sleeve colour bands and alphanumeric markers.
- 2.2.9 Tinned copper busbar shall be used for connection between circuit breakers to the main busbars. The size of copper busbars shall be sized according to circuit breakers' ampere frame (AF).
- 2.2.10 Each distribution board shall also be furnished with neutral and earthing busbars having the same rating as the phase buses.
- 2.2.11 Each distribution board shall be fitted with a multi-terminal earth bar and neutral bar with one terminal for each outgoing circuit. Connection to this earth bar shall be direct without dependence on exposed conductive parts of the enclosure and shall reflect the circuits served, i.e. circuit no. 1 in terminal no. 1 etc.

- 2.2.12 Each distribution board shall be fitted with an earth stud located in an accessible position on the inside of the board. All metal parts of the board except current carrying parts shall be bonded together electrically and to the earth bar.
- 2.2.13 The voltage/current measuring equipment, control gear, signalling lamps, small switches, fuses, contactors, terminal blocks, etc. shall be provided and properly arranged to complete the equipment for a satisfactory operation of the whole supply system.
- 2.2.14 Suitable labels in accordance with manufacturing drawings shall be placed on or under corresponding apparatus or terminal block. Proper labelling of cables shall be provided inside distribution panels. All major components shall be provided with label plate indicating the name of manufacturer, date and country of origin, serial number and main technical data of the item. The text shall be written in English on material resistant to the site conditions.
- 2.2.15 The construction of the distribution boards shall be such that no cable is subjected to bend of internal radius less than four times the overall diameter of the cable.
- 2.2.16 As-built single line diagram, control circuit and layout plan shall be inserted in a permanent pocket on the inner side of the panel door of each distribution board. All diagrams must be endorsed by LEW of the appropriate grade.
- 2.3 Circuit Breakers
- 2.3.1 Miniature circuit breakers shall be three phase or single phase, air-break types equipped for manual control and with automatic overcurrent trip free mechanism (bimetallic device for overload protection and electromagnetic device for short circuit instantaneous tripping). In lighting circuits with remote control an auxiliary contact shall be provided.
- 2.3.2 Miniature circuit breakers (MCBs) shall comply with the following requirement:

- a) MCBs shall be manufactured and Type tested to latest IEC 60947-2 and IEC 60898-1. The mechanical and live parts except terminals and toggles shall be contained in a completely sealed casing of high mechanical strength and non-tracking phenolic materials.
- b) Load handling contacts shall be of anti-welding silver/tungsten tips, electrolytically deposited onto high conductivity copper backing. Operation toggle shall clearly indicate the 'ON' and 'OFF'.
- c) Tripping mechanism shall be thermal magnetic fully compensated for ambient temperature and calibrated at 40°C to carry full load. MCB shall be equipped with 'trip free' mechanism.
- d) Double pole or three-pole MCB must be interlocked internally so that fault on any one phase shall trip all phases simultaneously. Three pole MCB shall not be used for single phase circuits.
- e) Unless otherwise specified, MCBs for general lighting and small power shall be of Type C tripping characteristic. MCBs for induction loads and motor circuits shall be of Type D tripping characteristic.
- f) Short circuit duty category of MCB shall be selected to match with the anticipated maximum fault level at the installation point but shall in any case not be less than 10kA.
- 2.3.3 Moulded-case circuit breakers (MCCBs) shall comply with IEC 60947-2 with appropriate rated short-circuit breaking capacity at 400V. The short-circuit performance categories shall depend on the application of the breaker. All MCCBs shall be of four-pole, three-pole or double-pole type as required, thermal magnetic type, with magnetic adjustable for MCCB's rated at 250A and above, independent manual operated to provide quick make, quick break, trip free mechanism so that the unit cannot be held closed against overload and short-circuit.
- 2.3.4 The making / breaking capacity of the MCCB shall be to the required prospective fault level. The utilisation category of MCCB shall be of type A for MCCB ampere frame less than or equal to 250A and type B for MCCB ampere frame greater than 250A.The rated service short-circuit breaking capacity (lcs) shall be 100% of short circuit ultimate breaking capacity (lcu).
- 2.3.5 Padlocking facilities to all MCCB's shall be provided.
- 2.3.6 Residual current circuit breaker (RCCB) shall be provided for protection of each socket outlets circuit. RCCB shall be listed under the Product Listing Scheme. Suitable RCCB or earth leakage relay with time delay shall also be provided for protection of each zone of lighting circuits so that any tripping shall not affect the normal operation.

- 2.3.7 Earth leakage current detection shall utilise differential current transformer for activation of trip coil. Earth Leakage Relay shall have adjustable current setting up to 20A and adjustable time setting up to 1 second. A test button shall be provided for checking the relay operation.
- 2.3.8 RCCB shall comply with the following requirement:
 - a) The RCCB shall be of current operated type in compliance with latest SS 97.
 - b) A quick make and quick break switching mechanism irrespective of toggle switching speed with trip free mechanism shall be provided and the switching mechanism shall be totally enclosed within moulded backbite case.
 - c) The RCCB shall be four-pole for three phase circuit and double pole for single phase circuit. All RCCBs shall be internally interlocked so that in the event of earth leakage, all poles shall trip simultaneously.
 - d) Operating toggle shall have distinct OPEN, CLOSED and TRIPPED position. OPEN and CLOSED position shall be clearly labelled.
 - e) The RCCB shall be equipped with durable silver tungsten contacts and complete with auxiliary switches and alarm switches as required.
 - f) Test push button shall be provided to simulate earth fault condition to enable testing of tripping mechanism. A leakage indication lamp or target indicator with manual reset button for visual indication of earth leakage tripped condition shall also be provided.
- 2.4 Contactors
- 2.4.1 Contactors shall comply with IEC 60947-4 and of suitable rating. They shall be provided with main contacts capable of at least 105 switching operations and at least two auxiliary contacts for remote control (230V, AC). Contactors for lighting control shall be of Utilisation Category AC3 unless specified otherwise. All contactors shall be of minimum 20A rating.
- 2.5 Current Transformers
- 2.5.1 Current transformers shall be tape wound ring type and type-tested in compliance with latest IEC 61869. They shall withstand a continuous overload of 120%. The type, burden and accuracy class shall be suitable for its purpose.
- 2.6 Instruments

- 2.6.1 The indicating instruments shall be flush-mounted, measuring 96mm high and 96mm wide.
- 2.6.2 The instruments shall be of Class 1 accuracy or better.
- 2.6.3 The voltmeters shall be provided with a selector switch, for reading the values of the three phases (i.e. phase-to-phase, phase to neutral voltages).
- 2.6.4 The scales shall not be less than 90 angular degrees and the designation shall be in Amps or Volts on matt-white plate. Anti-parallax and anti-reflecting types of platforms / covers shall be used.
- 2.7 Surge Protection Devices (SPD)
- 2.7.1 Surge Protection Devices (SPD) shall be of either Type 1 or Type 2, DIN-rail type with standard 8/20 wave characteristics complying to IEC 61643-11.
- 2.7.2 SPD shall have a discharge rating of 40kA and protected by appropriately rated and dedicated miniature circuit breakers / fuses that have been tested to coordinate with the manufacturer's SPDs in accordance to IEC 60364.
- 2.7.3 SPD shall be reusable type and have the choice of a light indicator or mechanical indicator for end of life.
- 2.7.4 SPD shall be designed for common mode protection.
- 2.8 Programmable Timers
- 2.8.1 All time switches shall run on 240V, 50Hz supply and of a 7-day, 24-hour digital programmable type, complete with minimum 24 hours internal supply reserve or battery to retain program memory and time in event of AC power failure.
- 2.8.2 Time switches shall be housed in an IP66 enclosure with transparent cover and sealing facility so as to prevent unintentional intervention and contamination of the instrument. A dedicated local overriding switch for manual switching shall be provided within the distribution board.
- 2.8.3 Timer input voltage shall be powered by AC 100- 240VAC (+10%/-15%, 50Hz).
- 2.8.4 The timer shall conform to:
 - a) Noise Immunity: IEC6100-4-4, 2 kV (power supply line).
 - b) Ambient operating temperature: 0 to 55 °C
 - c) Humidity: 10% 100%

- 2.8.5 The Timer shall have the following programmable features:
 - a) Programmable: With input and output conditions per line
 - b) Basic CPU Input/ Output: Min 3 inputs and 3 outputs
- 2.8.6 All outputs should have a relay switching capacity of 5A at 230VAC with independent common.
- 2.8.7 The Timer Central Processing Unit (CPU) shall be provided with built-in real-time clock and calendar functions. The real time clock should have an accuracy of +/-6 mins max. per year. The data of real time clock, calendar, holding bits, holding timers and counter present value shall be held by a non-battery system for a minimum of 48 hours for prolonged power interruptions.
- 2.8.8 The Timer program and system setting data shall be stored in internal EEPROM to prevent loss of setting/program during power failure.
- 2.8.9 The Timer shall have the following features and functions:
 - a) Front panel LCD display with backlight. Backlight can be automatically cutoff through adjustable settings to save the lifespan of backlight.
 - b) Input filters settings to prevent noise-related malfunctions such as false triggering of inputs.
 - c) Password protection function to prevent unauthorized modification of Timer programs and settings.
- 2.8.10 The Timer shall provide RS232C communication port or infrared port for downloading of program and setting.
- 2.8.11 The Timer shall support communications via RS232C to host devices such as computers and Personal Digital Assistant (PDA).
- 2.8.12 The Timer system shall be equipped with the Windows Based software programming tools and drivers for the set-up of communication between Timer and host devices.
- 2.8.13 The Timer shall be provided with application software tool running on Windows CE powered PDAs to allow setting of programs and the download/upload of the settings.
- 2.8.14 All Timer technical details and full communication protocols shall be provided.

- 2.8.15 The Timer shall have self-diagnostic functions and shall be displayed on the CPU LCD. All errors shall be communicated back to host via the RS232C communication port or infrared port.
- 2.8.16 The Contractor shall provide all software programming tools, drivers, cables and a set of host device such as computer and two PDA with software programming tools fully installed for programming and downloading to timer.
- 2.8.17 Factory test certificates shall be submitted to the Authority for verification.
- 2.8.18 Contractors shall conduct functional test of the timers at the Singapore office by sampling of 10% of each batch before deliver.
- 2.9 Internal Cabling
- 2.9.1 All internal cabling in each item of equipment shall be installed in cabling channels or conduits. Exposed cabling shall be kept to a minimum but where necessary the wires shall be formed into compact groups suitably bound together and properly supported. Cable tie-wraps shall be used for the looming of internal and incoming cables within panels.
- 2.9.2 All conductors shall be terminated with suitable pressure type terminal lugs of proper sizes for terminal studs at the terminals blocks or shall be terminated in a manner compatible to the terminals of the instruments.
- 2.9.3 The control cable terminal shall be insulation displacement type or equivalent. The terminal shall also be provided with switch connection, removable switch blade.
- 2.9.4 All conductors shall run continuously between terminal studs without splices or taps. Terminal shields shall be provided for all incoming cables.
- 2.9.5 All conductors shall be labelled at each termination with wire number as designated on the circuit diagrams.
- 2.9.6 All internal cabling conductors shall be insulated stranded copper wire, rated at not less than 300V/500V for control cables; not less than 450/750 V for power cables.
- 2.9.7 Minimum cross-sectional area:
 - a) 1.5mm2 PVC cable for control/measuring circuits.
 - b) 2.5mm2 PVC cable for lightings and small power circuits.
- 2.9.8 All electrical cabling shall comply with the latest cable colour code as per SS638.

2.10 Overground (OG) Box

2.10.1 General

- a) All components of the OG box shall be housed in a weatherproof housing of robust construction. The OG box to be constructed in accordance to type tested latest edition of BS EN61439-1 and IEC 439-1. The housing shall be provided with a watershed top. For OG-Box installed near traffic junction, pitched roof shall be provided to prevent the public from littering.
- b) The housing must have a Degree of Protection of not less than IP54 and of robust construction.
- c) The OG box shall be provided with a root of ample strength and suitable for mounting on a concrete/brick footing. A concrete plinth of minimum height of 400mm shall be provided for mounting of the OG box.
- d) Each OG box shall be provided with 20% spare breakers and spare space. The overall rating, incoming cables and upstream provision shall be such that a 20% load increase for future expansion can be accommodated without alteration to the distribution system.
- e) A space shall be reserved in the OG box for kWh meter installation. The door of the OG box shall come with a transparent UV resistance window with neoprene seal for meter reading purpose.
- f) Hinged door complete with standardised lockset type of "A Series cam lock with Alloy Key" shall be provided at the front of the OG box. The door locks and keys for all the distribution boxes shall be similar and interchangeable. 3 sets of keys shall be provided for each OG box.
- g) The OG box shall be of double leaf door type.
- h) All electrical accessories such as HRC fuses, MCBs, ELR, timer, contactors, and electrical wirings in the OG box need to be neatly labelled.
- i) Cable entry to the OG box shall be from beneath ground level. All the cable glands shall be equipped with entry thread seals to maintain the IP rating across the equipment-gland interface.
- j) Inside the OG box at the bottom where the incoming underground cables are located, it shall be filled with "washed" sand to appropriate height.
- k) The earthing system shall comply with the latest requirements stated in SS 638 and SS 551 and be connected in a ring to the earth bar in the OG box.

2.10.2 Housing

- a) All components of the housing including pitched roof, except the housing bolts and nuts shall be made of at least aluminium alloy AA1100. The housing bolts and nuts shall be of stainless steel. The four (4) pillars of the housing shall be rounded with radii of not less than 25mm. This shall be extruded from 3mm thick aluminium in one homogeneous piece according to the latest edition of BS EN 1484 to provide a better mechanical strength. Roof and all other panels shall be 'pressed form' from a whole sheet of 3mm thick aluminium plate. All drilling, punching, cutting, bending and welding parts shall be completed and all burrs removed before the electrostatic powder coating process is applied.
- b) The housing shall be electrostatically coated with pure polyester powder of thickness between 80 microns and 100 microns. Materials shall be chemically treated before and oven baked after the powder coating process. The powder coating shall be weather resistant.
- c) Adequate ventilation shall be provided to permit natural circulation of air. Temperature-rise Limits of maximum 600 Amp rating to the latest edition of BS EN61439-1 and IEC 439-1. The ventilation apertures shall be suitably screened to prevent the entry of vermin and other foreign bodies.
- d) The housing shall be able withstand a high voltage surge of 12kV to the latest edition of BS EN61439-1 and IEC 439-1.

2.10.3 Danger Notice

A 'Danger' notice shall be provided, stuck on the inside and outside of the door of each OG box.

2.10.4 Data Plate

A data anodized plate shall be fixed to each OG box detailing the following information:

- i. LTA Logo
- ii. Manufacturer's name
- iii. Contract Number
- iv. Date of manufacture
- v. Serial Number
- 2.10.5 Door and Door Hinges

In general, the door shall be suitably designed to provide maximum protection from heavy driving rain and inclement weather. Access to the front of the OG box shall be by means of hinged doors. The hinges on the door shall not project outside of the shell and shall be secured by open flange fasteners. These fasteners shall be flushed and not be seen on the outside of the door. The hinges must enable the door to be swung open not less than 120 degrees from the closed position. Doors shall be easily detachable by lifting of pins from the hinges without having to use special tools and to be secured by medium security cam locks.

- 2.10.6 Pilar
 - a) The pillar shall be provided with a root of ample strength and suitable for mounting on a concrete / foundation at ground level. A removable apron of approximately 500mm with door closed height shall be provided at the front of the pillar to facilitate direct installation and jointing of cables to the distribution units. Sufficient number of uPVC pipes shall be provided and coordinated with Civil Contractor for cable entries into the box
 - b) Provision for plastic pocket to house single line drawings (endorsed by LEW of appropriate grade) fitted inside the interior of the OG box door.
- 2.10.7 Power Supply Company's Meter board
 - a) Power Supply Company's meter board shall be installed for each OG Box in accordance with the requirements of the "Handbook on application for electricity supply". There shall be one-meter board for each OG Box as shown on the drawings.
 - b) All arrangement for installation of the Power Supply Company's meter, application for supply turn-on including liaison, co-ordination and obtaining power supply company's approval for all the meter boards shall be included as part of the work. All fees and charges incurred shall be deemed to be included in the tender offer.
- 3 LV Cables
- 3.1 General
- 3.1.1 All main and sub-circuit cables shall be installed in conduits, trunkings, trays and ladders as appropriate. All the mains, sub-mains and final sub-circuits shall include insulated earthing conductor sized in accordance with latest SS 638.
- 3.1.2 All 3 phase circuits utilizing single core cables shall be laid in trefoil.
- 3.1.3 The current carrying capacities and voltage drops of cables shall be in accordance with latest SS 638, with ratings adjusted to suit local conditions.

3.1.4 The minimum size of cables shall be as specified herein, unless otherwise specified:

Lighting (10A) circuit	:	2.5sq.mm
Small Power	:	2.5sq.mm
Control	:	1.5sq.mm

- 3.1.5 Normal, essential and control cables shall be installed in separate cable containments.
- 3.2 600/1000V AC Cables
- 3.2.1 General
 - a) All cables shall be 600/1000V grade. The conductor shall be of stranded conductor of plain annealed copper wire complying with latest IEC 60228 Class 2.
 - b) All earth cable shall be of insulated copper conductor type and rated at 600/1000V.
 - c) The D.C. resistance per kilometre of the conductor at 20 deg C shall not exceed the appropriate maximum value given in IEC 60228.
 - d) For multi-core cables, each conductor core shall be of the same crosssectional area.
- 3.2.2 All normal circuits cabling shall be of anti-rodent and anti-termite type.
- 3.2.3 All circuit serving essential and critical equipment required to operate under fire conditions and for continual operation respectively shall be of the fire-resistant type, anti-rodent and anti-termite type.
- 3.2.4 All circuit cabling shall be armoured type where installed in troughs, trenches, underground pipes, ducts or exposed to weather elements.
- 3.2.5 Cables exposed to weather elements shall be UV rated.
- 3.2.6 PVC Insulated and PVC Sheathed Cables
 - a) Cables shall be 600/1000V grade complying with IEC 60502-1, IEC 60502-2 and IEC 60502-4, copper core, PVC insulated and PVC sheathed.

- b) Conductors shall be high conductivity stranded copper conductors complying with BS EN 60228 of sizes as shown in the Specification & Employer's Drawings to SS 358 and IEC 60502-1, IEC 60502-2 and IEC 60502-4.
- c) The insulation shall be PVC type A complying with BS EN 60811, IEC 60502-1, IEC 60502-2 and IEC 60502-4. Insulant colours shall be in accordance with current edition of SS 638.
- d) The over sheath of the cables shall be an extruded layer of PVC complying with the requirements of IEC 60502-1, IEC 60502-2 and IEC 60502-4, BS EN 60811 type ST1 compound and shall comply with the requirements of BS EN 60332-1-1 and BS EN 60332-1-2 for flame retardant. The PVC material shall contain approved anti-termite additives.
- 3.2.7 Cross-linked Polyethylene Insulated Cables
 - a) Cables shall be 600/1000V grade complying with IEC 60502 copper core, XLPE insulated and PVC sheathed.
 - b) Conductors shall be single core high conductivity stranded conductors complying with BS EN 60228. For multi-core cables, each conductor core shall be of the same cross-sectional area.
 - c) The insulation of cores shall be cross-linked polyethylene complying with relevant BS EN 60502-1 and BS EN 60502-2. The insulation shall have a high degree of cross-linking, free from contaminants and air voids, good heat resistant and shall be treated by the extrusion process.
 - d) The XLPE insulation shall be suitable for use on power cables in wet and dry conditions at conductor temperatures not exceeding 90oC for normal operation and 130°C for emergency overload condition.
 - e) The bedding shall be an extruded layer of type 9 compound complying with the requirements of BS EN 60811, IEC 60502-1, IEC 60502-2 and IEC 60502-4.
- 3.2.8 Steel Wire Armoured Cables
 - a) Steel wire armoured cables shall comply with BS 5467.
 - b) The bedding shall be an extruded layer of type 9 compound complying with the requirements of BS EN 60811, BS 5467, IEC 60502-1, IEC 60502-2 and IEC 60502-4.
 - c) Each core of the cable shall be identified by the appropriate colour as specified in BS 5467 throughout the whole of the insulation.

- d) Wire armour shall consist of a single layer of galvanized steel wires of sizes as shown in the appropriate table in BS 5467 and comply with BS EN 10257-1.
- 3.2.9 Fire resistant, LSOH materials shall meet the following latest requirements:
 - a) IEC 61034 and BS EN 61034-2 Measurement of Smoke Density of Cables burning under defined conditions.
 - b) IEC 60331 and SS 299 Tests for Electric Cables under fire conditions circuit integrity.
 - c) Limiting Oxygen Index of at least 30, to ASTM D-2863
 - d) Temperature Index of 260°C, to ASTM D-2863
 - e) All insulation is to be moisture and heat resistant, with temperature ratings appropriate to the application conditions and in no case lower than 90°C
 - f) When a sample of cable is subject to the combustion test for the determination of the amount of halogen acid gases (other than hydrofluoric acid) as set out in IEC 60754-1 and the amount of halogen acid evolved is less than 5mg/g, the cable shall be regarded as zero halogen.
 - g) BS 6387 and SS 299 Fire and Mechanical Test Categories C, W, Z
- 3.2.10 Steel wire armouring for the cabling shall comply with latest BS EN 10257 1 and the entire assembly shall meet the requirements of latest BS 5467.
- 3.2.11 The above requirements shall be met without compromising the anti-termite (to comply with NEA regulations), anti-rodent, mechanical and electrical properties of the cables, both during and after installation, to meet the other requirements of the Specification.
- 3.3 Colour Coding
- 3.3.1 The cable core colour code shall comply with the latest SS 638 requirements.
- 3.4 Armoured Cable Installation

- 3.4.1 Compression glands shall comply with latest BS 6121 and shall be designed for the termination and clamping of armoured wires and shall be fitted with an earth bond terminal attachment. The function of the gland shall be to secure the armoured wires and provide electrical continuity between the armour and the threaded fixing component of the gland, and to give water-tight seals between the cable outer sheath and the gland and between the inner sheath and threaded fixing components. The armour for cables shall not be used as circuit protective conductor for carrying earth fault current. All armoured cable shall be terminated using a proper gland.
- 3.4.2 Where a watertight seal is required between the gland and equipment then the cable glands shall be equipped with entry thread seals. This is to maintain the IP rating across the equipment-gland interface, and such seals shall be fitted to the external side of the equipment. Earth tags/earth bond terminal connections shall not be fitted externally to the equipment if entry thread seals are used.
- 3.4.3 Jointing and terminating accessories shall include all necessary internal and external fittings and insulating materials. They shall also include precisely dimensioned cable stripping ferrules and the mechanical gland designs. It should be possible to erect and dismantle compression glands without the use of special tools.
- 3.4.4 All cables entering or leaving equipment shall be provided with separate termination and be spaced so that any one cable out of a number of such cables can be removed without disturbing the rest.
- 3.4.5 Cable armour shall be earthed at both ends of cable circuit.
- 3.5 Control and Sensing Cables
- 3.5.1 Control and sensing cables shall be of minimum rated at 300/500V grade, copper conductor, twisted pair and insulated, screened. Fire resistant cables shall be used for critical and essential circuits.
- 3.5.2 All control and sensing cable shall be appropriately colour coded and shall be installed in its own cable support system (e.g. conduit, tray, trunking etc). Sharing with power and lighting cable support system is not allowed.
- 3.5.3 The conductors shall be annealed, circular, multi-stranded, plain copper complying with latest IEC 60228. The multi-stranded conductor shall be rope laid with concentric stranded members in accordance with latest IEC 60228 Class 5 or 6.
- 3.5.4 Screening shall be achieved by the use of laminated tape, consisting of an aluminium foil bonded to a polyester film for strength, applied to the cable with an overlap so that the conductors are fully covered.

- 3.5.5 A drain wire or continuity conductor, laid under and in contact with the aluminium foil shall be provided and shall be in accordance with BS EN 50288, as appropriate. The tinned annealed copper conductor, which may be of solid or stranded construction, in keeping with current manufacturing techniques, shall have a minimum area of 0.5 mm².
- 3.5.6 The maximum resistance of the drain wire or continuity conductor provided shall meet the requirements of BS EN 50288.
- 3.6 Cable Installation
- 3.6.1 Power cables and control cables shall be run in separate cable trays / trunkings / conduits.
- 3.6.2 Cables shall be terminated using suitably crimped cable lugs and brass glands with rubber gasket.
- 3.6.3 All cables shall be adequately protected against risk of mechanical damage to which they may be liable in normal conditions of service.
- 3.6.4 All cables shall be installed in accordance with latest SS638.
- 3.6.5 Where single-core cables are used for 3-phase circuits, the cables shall be grouped in trefoil and spaced from other cables.
- 3.6.6 Cable joints and splices shall be prohibited.
- 3.6.7 Where cables pass through holes in metalwork, precautions shall be taken to prevent abrasion of the cables on any sharp edges.
- 3.6.8 Where appropriate, final connections to fixed equipment shall be by means of cables in flexible conduits.
- 3.6.9 All cables shall be provided with identification marks for identification of circuit number and phase at each end of the cable, at entry and exit points of cable installed in ducts and in such other position as are necessary to identify and trace the route of any cable.
- 3.6.10 Every single core cable and every core of multi-core cables shall be provided with identification at its termination in form of tapes sleeves or discs of appropriate colours and alpha numeric notation in accordance with the latest revision of SS 638.
- 4 Cable Support System
- 4.1 General

- 4.1.1 All cable support and accessories (except underground uPVC pipes) shall be made of hot-dip galvanized steel in accordance with the latest relevant Clauses of BS EN ISO 1461. Standard proprietary fittings shall be used. All drilling, punching, cutting, bending and removal of burrs shall be completed before galvanising and any surfaces that have been scratched, marred or otherwise damaged shall be made good with a comparable zinc coating.
- 4.1.2 All metallic cable trays, trunking and conduits shall be earthed in accordance to SS 638.
- 4.1.3 Cables on tray work shall be single tiered and installed in a neat fashion. All cables shall be fixed to tray work using clips and straps designed for this purpose and complied with the relevant Code of Practice.
- 4.1.4 All non-sheathed electrical cables shall be installed in screwed heavy gauge welded steel conduit (surface or embedded) or trunking. All cable containment shall be of adequate size (including 20% spare capacity) and lengths for the cabling system.
- 4.1.5 All normal, essential and control cables shall be installed in separate containment.
- 4.1.6 All holes cut in cable trays or trunkings for the passage of cable shall be provided with grommets. Whenever conduits, cable trays or trunkings pass through an opening, the Contractor shall be responsible for sealing the gaps between wall/floor and conduits, cable trays or trunkings and within trunking with sealing material having the same fire-rating as the wall or floor.
- 4.1.7 Propose the colour of cable support system shall subject to Authority's acceptance prior to procurement and installation work.
- 4.1.8 The word 'ELECT-N' (for normal circuit), 'ELECT-E' (for essential circuit), 'CTR' (for control), 'TEL' (for telephone distribution) in black shall be marked on the underside of the cable trunking / tray. The spacing between markings shall not exceed an interval of 3m. The method of labelling shall be submitted for the Engineer's acceptance.
- 4.1.9 All electrical services support / bracketries shall be deemed included for completion of installation.

- 4.1.10 Draw pits, cable troughs, cable trenches shall be filled with sieved sand and covered up. Cable trenches and cable troughs that are provided with drainage will not be required to be filled up with sand.
- 4.1.11 Manufacturer's purpose-made accessories (e.g. bends, corners, intersections, tees, risers, reducing section etc.) shall be used.
- 4.1.12 All cable support and accessories installed in corrosion prone environment shall be suitably protected against corrosion and applied with rustproof paint under the environment and conditions in which the cable support and accessories are installed in.
- 4.1.13 Sufficient space shall be provided and maintained above cable supports to provide adequate access for installing and maintaining the cables.
- 4.1.14 Where cable supports pass through expansion joints, allowance shall be made for movement of the structure while maintaining earth continuity.
- 4.2 Cable Trunking
- 4.2.1 All trunking shall comply with latest SS 249 and be constructed of zinc coated mild steel sheets, finished with one coat etching primer and powder epoxy coating. Hotdip galvanised trunking shall be used for installation within corrosive areas, outdoor and in wet areas. Trunking shall be fitted with removable covers of the same material, extending over the entire length of the trunking. The thickness of the steel sheet shall be minimum 1.2mm for sizes up to 150mm x 150mm and minimum 2mm thickness for larger sizes.
- 4.2.2 Trunking supplied shall be complete with purpose made connectors, dividers, flanges and retaining clips including cable pin tacks to avoid strain on cables on extended vertical runs. Trunking for cables on extended vertical runs more than 2.5m shall come with an integrated rung slots of 50mm width and of minimum thickness of 2.0mm spaced at maximum 300mm. The contractor shall ensure that effective cross sectional area shall not be affected by the integrated rung and provision of the necessary reducers are included in this contract.
- 4.2.3 Trunking shall be fixed rigidly to walls and ceilings with appropriate brackets at not more than 1000 mm centres. Approved metal expansion anchors shall be used for fixing to walls and wooden or fibre plugs shall not be used for this purpose. The type and position of the screw heads within the cable carrying compartment shall be selected to minimise the likelihood of damage to cables during installation.
- 4.2.4 All lid fastening components shall be captive and arranged such that lids can be easily removed without damage to cables. When fastened, the lid shall be securely held tight to the trunking body along the whole length.

- 4.2.5 Suspended trunking shall be supported at not more than 1000mm centres.
- 4.2.6 Approved metal expansion anchors shall be used for fixing the support to walls and ceilings. The type and position of screw heads within the cable carrying compartment shall be selected so as to minimise the likelihood of damage to cables during installation or operation.
- 4.3 Cable Trays
- 4.3.1 Cable Trays shall be of the perforated, heavy duty return flange type and manufactured to latest IEC 61537 or BS EN 61537 and accessories to latest BS EN ISO 1461 and shall be constructed of perforated mild steel, electro-galvanised with an epoxy powder coating. The minimum thickness for cable tray up to 450mm wide shall be 1.5mm, for widths above this 2mm sheet shall be used. Hot-dip galvanised cable trays shall be used for installation in outdoor, tunnel/viaduct and wet areas.
- 4.3.2 All cable trays shall incorporate a return flange 10mm high for widths up to 250mm and 20mm above this value. Bends and tees shall be identical in construction material and profile to straight runs and all bends shall incorporate gusseting to standard radii.
- 4.3.3 Cable tray shall be supported at intervals by galvanised steel hangers fixed to walls or ceilings as applicable at maximum of 1000mm centres and 300mm on bends and at tees. Earth continuity copper links and tray connections shall be installed in accordance with the manufacturer's recommendations.
- 4.4 Standard proprietary fittings shall be used.
- 4.4.1 Cable trays shall be cut along a line of plain metal (i.e. not through perforations) only. All cut edges shall be cleared of sharp edges and burrs and treated with zinc-coated paint to ensure continuous protection.
- 4.5 Cable Conduits and Fixings
- 4.5.1 Conduits and fixings shall be manufactured in accordance with latest BS EN 61386-1 and IEC 61386-23. The minimum nominal bore diameter of conduits shall be 25 mm. Conduits shall be of heavy gauge, hot dipped galvanised welded steel, screwed and longitudinally welded and protected against corrosion to latest IEC 61386-1 and BS EN 61386-1 Class 4. Conduits shall have threaded ends and conduits embedded in concrete shall have the threads coated with jointing compound during assembly. Care shall be exercised to ensure that the conduit and boxes are water-tight before concrete is poured, this may include the use of metal caps or plugs to prevent water or entering the open ends. All conduit fittings shall be hot-dip galvanised or of corrosion resisting materials.

- 4.5.2 The ends of all conduits shall be reamed to remove all burrs and sharp edges after screw threads have been cut. The exterior shall be made free of all dirt, oil and grease and the interior swabbed through before the installation of cables. All exposed threads and bends shall be given a coat of zinc rich paint after installation. All conduits termination should be non-swivel type.
- 4.5.3 The ends of all conduits shall be installed solidly in all couplings. Where conduits terminate in fuse switches, distribution boards, adaptable boxes or similar accessories, they shall be connected by means of smooth bore male bushes, compression washers and sockets. The integrity of the protection rating of the equipment or accessory shall not be reduced as a result of the conduit connection. Final connections to motors or other equipment subject to movement or vibration shall be made with short lengths of appropriately sized flexible steel conduits with appropriate adapters. All free ends of conduits shall be fitted with a smooth bore male brass bushing.
- 4.5.4 Each run of conduit shall be assembled with draw-wires. Long radius bends shall be used although not more than two right angle bends shall be installed without the interposition of a draw box. Full size junction boxes and not box type tees, elbows, or fittings shall be used to facilitate the drawing in of cables and the possible subsequent removal and replacement of any one cable or group of cables without disturbing the rest. Draw boxes shall be installed such that the maximum run length between draw points is 10 m.
- 4.5.5 Conduits shall run parallel to walls, floors and ceiling wherever possible. Multiple conduit draw-in boxes shall be used wherever a number of conduits follow the same route. All conduit fixings and boxes shall be screwed to or on walls and ceiling independently of the conduit unless such fixing is demonstrated to be impractical due to damage of weather-proofing or similar.
- 4.5.6 Approved metal expansion anchors shall be used for fixing to walls and wooden or fibre plugs shall not be used for this purpose. Fixing holes in boxes shall be adequately countersunk to ensure that screw heads do not protrude into the wireways.
- 4.5.7 For embedded conduit runs, deep boxes or extension rings on standard boxes shall be used to ensure that the front of each box finishes flush with the surface of the wall or ceiling. All junction and pull boxes shall be installed so that covers are readily accessible and removable after completion of the installation. Boxes shall not be installed above suspended ceilings, except where the ceiling is of the removable type and definite provisions are made for access at a point close to each box.
- 4.5.8 Conduit back boxes shall be provided where conduits turn through walls. Conduits crossing expansion and contraction joints shall be provided with a short-length of flexible metal conduit, sufficient to allow for a movement of 10 mm.

- 4.5.9 Conduits shall be fixed by means of hot-dip galvanised full saddles at maximum 1000 mm centres on vertical runs and maximum 750 mm centres on horizontal runs. All conduits shall be fixed by full saddles at a maximum of 300 mm each side of a bend and vertical conduit runs shall have saddles within 300 mm from their points of emergence from floors or ceilings.
- 4.5.10 Conduits in ceiling cavities shall be supported independently of the suspended ceiling fixings. Concealed conduits chased into surfaces shall be secured such that the fixings alone hold the conduits in place. Recesses in plaster shall be deep enough to permit a full 6 mm cover over the entire run of the conduit.
- 4.5.11 The ingress protection of the boxes and fittings shall be appropriate for the environment in which the conduit shall be installed. Where appropriate, provision for tapping of condensed moisture shall be made. Watertight cast iron boxes shall be used in wet or damp locations. Outlet, junction and pull boxes for use inside the building shall be zinc-coated.
- 4.5.12 PVC coated flexible conduits and fittings shall comply with latest IEC 61386-23. The flexible conduit adapter shall be of watertight, metallic and nickel plated and shall be secured to the flexible conduit via an internal threaded appendage to ensure that the sharp edges of the flexible conduit are not in direct contact with the cables.
- 4.6 uPVC Pipe and Accessories
- 4.6.1 uPVC Pipe and accessories for underground cables shall be Class B heavy-duty type and comply with SS141.
- 4.6.2 All pipes shall not be less than 25 mm in diameter.
- 5 Electrical Fittings & Accessories
- 5.1 General
- 5.1.1 Electro-galvanised with an epoxy powder coating boxes shall be used as junction boxes (IP65), pull boxes or terminal boxes in exposed or embedded conduit. Stainless steel boxes (IP65) shall be used for installation in outdoor. The boxes used shall be sized to code requirements. Boxes shall be provided where surface mounted cables interface with embedded conduits for proper termination of cable and cable fittings. Outlet, junction and pull boxes for use indoor shall be zinc-coated.
- 5.1.2 All lighting switches, switched socket outlets, and isolators shall be labelled by an approved means to identify the circuit number and the source of supply to which they are connected.

- 5.1.3 Electrical fittings and accessories used for outdoor, tunnel, wet and dusty areas shall be IP65.
- 5.2 Lighting Switches
- 5.2.1 Lighting switches shall be of silent action type and comply with latest IEC 60669 and SS 227. Matt-chrome type shall be provided for recessed installation. Metal clad type shall be provided for surface mounted installation. All lighting switches shall be rated at a minimum of 10A each and withstand the inrush current of the LED luminaires.
- 5.2.2 Lighting switches shall be mounted at a height of 1200 mm above finished floor level to the bottom of the mounting box. All lighting switches shall be mounted on the active door side. The actual positions shall be coordinated on Site.
- 5.2.3 All lighting switches, either flush or surface mounted, shall be mounted on malleable iron or pressed steel boxes to latest BS 31.
- 5.2.4 Where switches are located in exposed situation and wet area, switches shall be non-metallic weatherproof type to IP65. In other areas, switches with the appropriate IP rating shall be provided to suit the particular location.
- 5.2.5 All light switches associated with essential supplies shall be provided with red rocker switches.
- 5.3 Intelligent Lighting Detection System (ILDS)
- 5.3.1 Controller for ILDS
 - a) The controller shall reside within the OG Box. In the event where controller is unable to be located within the OG box (for A&A works), the controller shall be housed in a separate controller box of outdoor type, weatherproof to IP 65 and of robust vandalproof construction minimum IK06.
 - b) Internal wiring conductors shall be stranded copper wire, not less than 450/750 V class PVC insulation.
 - c) Controller Box

- i. The housing shall be made of sheet steel with thickness of not less than 2.5 mm. The controller box shall be sprayed with 1 coat of anti-rust primer and 2 finishing coats of paint colour to the Authority's approval.
- ii. The metal enclosure shall be completed with hinged doors and to be provided with standardised lockset type of "A Series cam lock with Alloy Key" and 3 sets of key.
- 5.3.2 Motion Sensor
 - a) The motion sensors of the ILDS shall be encased in enclosure box to prevent from vandalism and rated to IP65.
 - b) The motion sensors shall be provided with Passive Infrared and Ultrasonic Technology to detect and confirm occupancy.
 - c) The motion sensors shall be equipped with wide angle to cover maximum area and dual pyro-electric sensing element shall be provided to reduce background noise. There shall be a visible indicating light at the individual sensor to indicate the health status of the sensor. In the event of any sensor failure, all the lights shall be automatically switched on.
- 5.4 Switched Socket Outlets
- 5.4.1 Switched socket outlets shall be single pole (13 A) metal-clad or matt-chrome, 3 rectangular pin switch shuttered outlets, either surface or flush mounting according to location. All switched socket outlets shall be EMA approved type and tested by a recognised testing body.
- 5.4.2 Switches shall be of the quick make, slow break type with silent, totally enclosed switch action and solid silver alloy contacts. Switched socket outlets for indoor use shall be housed in suitable galvanised steel boxes to BS 4662 with conduit knockouts.
- 5.4.3 Switched socket outlets located in exposed and wet areas shall be of weatherproof type to IP65. Earth terminal shall be provided inside the socket outlet. Switched socket outlets located in public areas shall be complete with padlockable cover plate.
- 5.4.4 15A switched socket outlets shall be 3 pin round type to BS 546 shuttered, of a finish similar to 13A switched socket outlets and mounted in flush steel conduit boxes. Earth terminal shall be provided inside the socket outlet.
- 5.4.5 Switched socket outlets in all mechanical plant rooms, electrical sub-stations and switch rooms shall be of the metal-clad type with surface-mounted conduit boxes.
- 5.5 Isolators

- 5.5.1 Isolators shall be of either double pole or four poles with current ratings fit for the purpose and shall be enclosed, metal-clad with positive quick-make and quick-break action. Padlock facility shall be provided such that the isolator could be locked in the "OFF" position.
- 5.5.2 Isolators shall be capable of passing and also interrupting their full rated current safely and without damage. Ferrous materials shall be galvanised, switch handles shall be interlocked to prevent opening the over with the switch "ON".
- 5.5.3 All isolators for general applications shall be of the quick-make air-break type to latest IEC 60947-3 with a Utilization Category of AC 23A.
- 5.5.4 All isolators shall be of 20A minimum rating and metal clad enclosure type. Each isolator shall be complete with dust-tight gaskets and earthing terminals, and fitted with an engraved label bearing the description of the appliances it controls and circuit label.
- 5.6 Fused Connection Unit
- 5.6.1 Fused connection unit shall be of switched or un-switched type, each comprising of a fuse carrier fitted with a 13 amps cartridge fuse link to latest BS 1362, an outlet for connection of flexible cord up to 4 sq. mm, 3 core, terminal block, etc. Each connection unit shall have a built-in safety shutter which closes over the live contacts immediately the fuse carrier is withdrawn.
- 5.6.2 The carrier shall secure firmly in position by a screw but automatically withdraw from the live socket as the screw is released. The connection units shall be of flush wall mounting type and housed in suitable galvanised steel boxes to latest BS 4662 with conduit knockouts. The finishes of fused connection units used at the various areas shall be as specified for the lighting switches.
- 6 Lighting System
- 6.1 General
- 6.1.1 All components within the luminaries shall preferably be from the same manufacturer to ensure compatibility. All similar items of equipment shall be interchangeable.
- 6.1.2 Unless otherwise specified, all luminaries offered shall be as per manufacturer's standard, except that all luminaries shall be modified, if not already catered for, to accept conduit termination, without affecting the quality of the product.
- 6.2 Luminaries
- 6.2.1 General

- a) All luminaires mentioned in this criteria shall mean Light Emitting Diode (LED) luminaires unless otherwise stated.
- b) The LED luminaire, including the LED's, its associated electronic control gears (Driver) and all accessories, shall be designed for lasting operation. The luminaire and its driver shall be able to fully withstand the current voltage surges of lightning strikes and the frequent switching operation of the power supplies. The luminaire and driver shall be carefully selected and designed to ensure that the functional characteristics, failure rate, operating life span and other requirements in the specifications are fully met.
- c) Each luminaire shall consist of 2 main components consisting of an independent LED Module and Electronic Control Gear (driver).
- d) The rated LED life L80/B20 shall be more than 50,000 hours at LED operating at 25 °C for indoor with air-conditioning and 35 °C, for all other areas, unless otherwise stated.
- e) The luminaire shall be two feet long and the main components shall be easily replaceable without removing the whole light fitting. Four feet luminaire can be considered subject to approval.
- f) Tests report from International Accredited Test Lab or local accredited SINGLAS test laboratories or independent third party test reports on safety, reliability and performance of luminaires shall be provided.
- g) A CLO (Constant Light Output) shall be provided to allow constant lumen output throughout the lifetime of the luminaire and will result in lower average power consumption.
- 6.2.2 Performance Requirement
 - a) Luminaires

The luminaires shall be of robust constructions which combine excellent functional and visual design. Where the luminaires are to be exposed to weather, it shall be of dustproof and jet-proof to IP65 and vandal-proof of minimum IK 06, unless otherwise stated.

Where the luminaires are subjected to vandalism, it shall be design with minimum IK06 rating, unless otherwise stated.

System power shall not exceed 11W and lumen output shall be more than 600 lumens for two feet long luminaire.

The luminaires shall be provided with adequate thermal performance for the continuous operation of the LED at an ambient operating temperature of not less than 35 °C in accordance with relevant local or international standards. The LED junction temperature shall be maintained at or below manufacturer's recommendation.

The luminaire shall comply with the requirements of safety extra-low voltage (SELV) system.

Each type of luminaire shall be tested to its relevant standards as follows:

IEC 60598-1	Luminaires - Part 1: General requirements and tests
IEC 60598-2-1	Luminaires - Part 2-1: Particular requirements - Fixed general purpose luminaries
IEC 60598-2-2	Luminaires - Part 2-2: Particular requirements - Recessed luminaires
IEC 60598-2-5	Luminaires - Part 2-5: Particular requirements - Floodlights
IEC 61000-3-2	Electromagnetic Compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤16A per phase)
IEC 61000-3-3	Limitation of Voltage Changes, Voltage Fluctuations and Flicker in Public Low Voltage Supply Systems, for Equipment with rated current \leq 16A per phase and not subject to conditional connection
IEC 61347-1	Lamp control gear - Part 1: General and safety requirements for the driver
IEC 61347-2-13	Lamp control gear - Part 2-13: Particular requirements for d.c or a.c supplied electronic control gear for LED modules.
IEC 61547	Equipment for general lighting purposes - EMC Immunity requirements
IEC 62031	LED module for general lighting - Safety Specification
IEC 62384	DC or AC supplied electronic control gear for LED modules - Performance requirements
IEC 62471	Photo-biological safety of lamps and lamp system
IEC 62493	Assessment of lighting equipment related to human exposure to electromagnetic fields

IEC 62778	Application of IEC 62471 for the assessment of blue light hazard to light sources and luminaires
IES LM 79	Approved method: electrical and photometric measurements of solid-state lighting products
IES LM 80	Approved Method: measuring lumen maintenance of LED light sources.
IEC 55015	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment
ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories
IEC 62717	LED Modules for General Lighting - Performance Requirements
IEC 62722-1	Luminaire Performance - Part 1: General Requirements
IEC 62722-2-1	Luminaire Performance - Particular Requirements for LED Luminaires

For information panel lighting, it shall be tested to IEC 62031, IEC 60598-1, IEC 62384, IEC 61347-1, IEC 61347-2-13 and IES LM 80.

The LED luminaires shall be of proven track records and type-tested to the requirements as specified. All tests shall be carried out by accredited bodies, laboratories or facilities certified under ISO/IEC 17025. The Contractor shall submit all relevant track records, type test reports, and test certificates for the Authority's approval.

The luminaires shall be free of light leaks when installed in their intended locations or where forming part of a ceiling system. All luminaires specified for use in metal strip ceilings shall be shrouded to prevent light leaks visible through the slits.

All fascias and other parts shall be securely located and positioned using spring clips or similar devices such that under no circumstances can the fascias or other parts become dislodged or displaced.

The trims of all recessed luminaires shall be designed to be rigid and shall finish in contact with the ceiling at all points.

Clips and other devices wherever used shall be designed not to deform under in-service conditions. Surface mounted luminaires shall be fixed by means of a minimum of two screws, caddy clips or studs with nuts.

All screws, nuts, bolts, clips, washers and similar fittings shall be galvanized. Where galvanizing is not possible owing to tolerance limitations, stainless steel shall be used.

Every luminaires shall have power factor of not less than 0.9 lagging and be complete with power factor correction component where necessary.

Cut out and recess depth dimensions shall be supplied in writing for coordination purposes.

No cabling shall be visible behind or around installed luminaires when viewed from below the ceiling.

The luminaires shall be easily installed and removable for maintenance from below the ceiling surface, or where recessed in walls, from the front.

The temperature of the outside surface of any luminaires shall not exceed 80°C or that required by the relevant Singapore Standards Code of Practice.

During normal operation, the electrical components of luminaires shall not exceed a noise level of PNC (Preferred Noise Criteria) 36, measured at 1 metre from the luminaires or that specified in ISO 3741. A predominance of audible pure tone hum buzz produced by luminaires will not be acceptable.

The earth leakage of each luminaires shall not exceed the specified value in accordance with latest IEC 60598.

Stainless steel safety chain shall be provided to hold loosed components such as reflector and diffuser. For high bay and low bay luminaires, stainless steel safety wire chain shall be provided to hold the luminaire. Appropriate cable entry opening shall be provided.

Luminaire Maintenance Factor (MF) vary according to the intervals between cleaning, the amount of atmospheric pollution and the quality of the sealing of the LED module housing of the luminaire. Their values may be established by field measurements. Luminous flux maintenance factors vary according to the type of LED and power. Values are usually available from LED module manufacturers. However, a 0.9 maintenance factor shall be adopted for the purposes of producing the lighting simulation design.

b) LED Module

The LED module shall have the following information distinctly and durably marked:

- i. Trademark or mark of origin (Brand & model of LED used)
- ii. Nominal Wattage
- iii. Correlated Colour Temperature (CCT)
- iv. Colour Rendering Index
- v. Weight
- vi. Marking requirements in accordance to relevant local or international standards

The LED Module shall have the following features:

Heat sink with high thermal dissipation properties

Provisions to prevent unauthorized removal.

Corrosion resistant.

Optics shall be UV coated

Operate in relative humidity of greater than 90%

The LED modules shall be adequately supported to ensure that breakages do not occur through vibration or shock.

The rated LED life L80/B20 shall be more than 50,000 hours, unless otherwise specified.

LED module shall have nominal colour temperature of 3000K for outdoor and 4000K for indoors, unless otherwise specified.

c) Electronic Control Gear (LED Driver)

The LED driver shall comply with the requirements of safety extra-low voltage (SELV) systems.

The LED driver shall satisfy the following requirements:

Life Span	50,000 hours of operations at max. case temperature of 70 ∘C or higher
Power factor	0.9 or better
Rated input voltage	AC 230 +/- 10 %, 50Hz
Operating Temperature	20 °C to 45 °C
Storage Temperature	20 °C to 85 °C
THD	< 15%
Efficiency	> 80%

The LED driver shall power the LED such that the LED is flicker-free and it shall be suitable for Class 1 luminaires.

LED driver shall comply with latest CISPR 15 for Limits and methods of measurement of radio disturbance characteristic of electrical lighting and similar equipment.

6.2.3 Accessories

- a) LED Module / Driver DC Cable Coordinator and Internal Wiring.
- b) DC cable connector and internal wiring shall be provided between LED driver and LED module.
- c) LED module connector shall be plug type.
- d) LED driver connector to the LED module shall be socket type.
- e) The cable length between LED module and remote LED driver shall be coordinated on site with sufficient slack and shall be compatible with the prescribed DC cable connector.
- f) DC cable connector shall be rated at IP 67.
- 6.2.4 Photometric Performance
 - a) The luminaires shall comply with the photometric performances where specified.
 - b) Where it is specified that a luminaires shall be submitted for photometric testing, or where a luminaires is submitted as an alternative to a specified item, the minimum photometric submission shall comply with the following:

- i. Light Output Ratios
- ii. Polar Lighting Distribution Diagram
- iii. Utilisation Factor Table
- iv. Coefficient of Utilization Curves
- v. Candela/m2 measurements
- vi. Isolux Diagram
- c) All photometric data shall be provided in a format acceptable to one of the following bodies:
 - i. Local SS 638, SS 530, SS 531 and SS 563
 - ii. IEC
 - iii. C.I.E
 - iv. CIBSE
 - v. BS
 - vi. I.E.S of North America
- 6.2.5 Manufacturers Catalogue Numbers
 - a) The statement of a manufacturer's catalogue number or other identifying symbol in the luminaires schedule does not relieve the Contractor's responsibility of ensuring that luminaires fully comply with the requirements of this Specification. The luminaires description and the manufacturer's catalogue numbers are intended to be complementary in describing the proposed luminaires.
 - b) Luminaires shall not have any labels showing the manufacturer's name or trademark visible on the outside. Labels inside luminaires or light shrouds shall not be of self-adhesive type.
- 6.2.6 Metal Work
 - a) Housing

Unless otherwise specified luminaires shall be constructed of not less than 0.8mm thick zinc anneal sheet steel or better. The zinc anneal grade shall be suitable for use in the specified application. The sheets shall be free from surface blemishes, scratches and other defects.

Welds, which will be visible after the luminaires is installed, shall be ground, properly filled and rubbed smooth.

The luminaires shall be truly square and rigid, free from distortion, with properly fitting parts and be totally suitable for mounting in the locations specified.

External luminaires shall be manufactured from aluminium, stainless steel or other approved corrosive resistant material.

All parts constructed of steel shall be cadmium plated or paint finished zinc anneal sheet steel.

b) Reflectors

All reflectors used in downlights and wall washers shall be high purity (99.85% pure) aluminium unless specified otherwise. The aluminium thickness shall be 1.0mm minimum, and be finished in an anodised specular finish with a minimum build-up of 25 micro-meters. Specular reflectance shall be not less than 80%.

Reflectors shall be completely free of spinning or tooling marks, indentations or scratches. Rivets or similar shall not be visible with the reflector in normal operating position.

Where stippled reflectors are specified, the surface finish shall be matte.

c) Aluminium

Aluminium and aluminium alloys used in the construction of luminaires shall be anodized. Such anodizing shall be applied after the base metal has been ground smooth and prepared.

Aluminium alloys used in outdoor fittings shall be LM6 grade or better. Anodic finishes shall be built up to conform to latest BS EN ISO 7599 and BS 3987.

d) Stainless Steel

Stainless steel materials shall comply with latest BS 1449. All soldered and welded joints shall be ground smooth.

6.2.7 Terminal Blocks

- a) Terminal blocks shall be mounted close to cable entry points using the continuous strip removable insert type, or an extended insulating base.
- b) Each terminal block shall include a spare, insulated looping terminal and shall be suitable for 2 x 2.5mm² conductor minimum. Fittings with a cord and cap need not be provided with a spare looping terminal.
- c) Terminal blocks on luminaires shall be ceramic type.
- 6.2.8 Earth Screw

A captive brass earthing screw comprising locking brass nut and two brass washers shall be located adjacent to the terminal block and shall be clearly identified.

- 6.2.9 Wiring
 - a) The inter-component wiring used shall be heat resistant type with a temperature rating of minimum 105°C. The temperature rating shall be marked on the insulation. Samples of the heat resistant cable and cable manufacturer specification shall be submitted to the Engineer for approval.
 - b) Inter-component wiring for remote LED driver, battery pack to the luminaires shall be FR cable for emergency lighting and FRT cable for normal lighting. These cables shall be housed in flexible conduits.
 - c) Clips shall neatly secure wiring and strapping with adequate slack to ensure that it is retained clear of all hot parts.
 - d) Where luminaires are intended for operation in high ambient temperature areas, suitable heat resistant type cables shall be used.
 - e) Cable entry holes in the luminaires shall be located and bushed to keep sub-circuit wiring clear of hot parts. An approved cable clamp suitable for clamping up to 3 entering cables shall be installed inside the carcass of each fitting adjacent to the entry hole.
- 6.2.10 Mounting of Components
 - a) All components in the luminaires shall be secured by means of either metal thread screws or threaded studs and nuts.
 - b) LED drivers shall be fixed in the optimal location for maximum heat dissipation.
 - c) Where remote LED driver / transformer / battery pack enclosures are provided they shall be securely mounted from the building structure and suitably positioned to allow for air circulation, preferably by rods suspension in the ceiling space.
 - d) Enclosures shall not be placed on the top surface of ceiling structures.
- 6.2.11 Diffusers and Lens
 - a) All diffusers shall be of acrylic material rigidly constructed and symmetrically formed with edges aligned and squared. Polystyrene diffusing materials shall not be used.

- b) Diffusers shall not deflect under the effects of ageing, heat, or radiation by more than 1% of the minor unsupported distance subject to bending stress.
- c) The minimum nominal thickness of any diffuser panel shall be 3.0mm.
- d) Glass spreader lens units, where specified, shall be constructed from prismatic "Pyrex" or equivalent glass. Lens shall be positively held within the luminaires by circular lens housing or pressure clips (minimum of 3 per lens).
- e) Diffusers shall be attached to the luminaires with flexible stainless steel safety wire chain to facilitate maintenance.
- 6.3 Emergency Luminaires
- 6.3.1 Emergency luminaires shall be individually equipped with battery pack to provide illumination upon sensing of power failure. All emergency luminaires shall comply with latest SS 563 and type tested by accredited testing bodies subject to acceptance by the Engineer.
- 6.3.2 Batteries shall be sealed nickel-cadmium re-chargeable type to IEC 61951-1 and shall be capable of continuous operation at cell wall temperature of 60 °C.
- 6.3.3 The charger shall be fully automatic, solid state constant voltage type, with electronic circuitry to protect the batteries against over-charge and over-discharge. The charging system shall be capable of re-charging the battery to full capacity in not more than sixteen (16) hours after a total discharge of the battery.
- 6.3.4 The control circuits shall be suitable for 230V mains operation, where applicable, and shall be designed to enable the luminaires to operate exactly like normal conventional luminaires. An unswitched live wire shall be connected to each and every luminaires with emergency pack so that the luminaires can be switched off either from the associated lighting switches, timers, contactor, etc. However, irrespective of the status of the light switch or the controlling contactor, the luminaires shall automatically illuminate or remain illuminated upon mains failure. Upon restoration of the mains supply, the luminaires shall be switched back to mains supply operation and the batteries shall be re-charged again automatically.
- 6.3.5 A circuit switch shall be incorporated in the control circuit to enable testing of the circuit to be carried out. A green LED light shall be provided to show 'mains supply healthy'.
- 6.3.6 A fused terminal block fitted with cartridge fuses of appropriate rating shall be provided separately for both the charge and the maintained circuit.

- 6.3.7 Provision of space shall be made in all luminaires to incorporate emergency battery packs. Where it is not practicable, the battery pack shall be mounted remotely within a box with brackets including proper protection to the interconnecting cables and cables entries. All cost of brackets, boxes, etc necessary for the provision of remote battery pack shall be included in the Contract.
- 6.3.8 Self-contained battery pack in all emergency luminaires shall be charged continuously and the charging wire shall be taken from the unswitched side of a circuit. Where a self contained emergency power kit complete with a separate LED module is included in a normal luminaires, the supply to the power equipment shall also be from the unswitched side of the supply.
- 6.3.9 When the emergency luminaires is worked on its own self-contained battery power, the emergency lumen output shall comply with latest SS 563. The Contractor shall submit computer lighting simulation report for Engineer's acceptance to demonstrate the minimum illuminance achieved by the proposed equipment meets the requirements.
- 6.3.10 The Contractor's Qualified Person (QP) shall submit the Qualified Person's Certification of Illuminance of Emergency Luminaires under emergency condition for the stations.
- 6.4 Bus Stop Beacon Light
- 6.4.1 The contractor shall be provided weather proof type (IP65) and vandal-proof of minimum IK06 for bus stop beacon light located at bus shelter area.
- 6.4.2 The luminaire output shall comprise of horizontal output of 360 degrees and operating temperature shall be up to 80°C.
- 6.4.3 The bus stop beacon light module shall be suitable for use on a supply voltage of 12V. The contractor shall provide Power Supply Unit (PSU) to step down the voltage. PSU shall be suitable for use on a supply voltage of 230, +/- 10%, 50Hz +/-10%.
- 6.5 LED Exit Sign
- 6.5.1 General
 - a) All LED Exit signs shall be tested by approved testing laboratories and complying with latest SS 563. A valid test certificate shall be submitted for purpose of TOP application.
 - b) LED Exit signs shall be maintained type and the control gear shall comprise an emergency lighting control unit complete with rectifier, charger and nickel cadmium batteries. Batteries shall be capable of continuous operation at cell wall temperature of 60° C.

- c) Each LED Exit sign complete with battery pack shall have its own set of green light emitting diode, charging circuit and test switch.
- 6.5.2 The control unit shall be capable of operating the lamp during emergency condition for duration of at least 2 hours. A green light emitting diode shall indicate that main supply is healthy and charging circuit is complete. Emergency operation shall be tested by a `Press to Test' switch, whilst mains supply is healthy. The LED and test switch shall be visible when viewed from below and are easily accessible.
 - a) The LED Exit Sign shall be self-contained type rated at 2 hours minimum.
 - b) The dimension of LED Exit signs for all areas shall be complete with fire retardant perspex panels and casing matching to the powder coated galvanized steel support. The LED Exit signs shall be single sided or double sided with or without directional arrows to suit the fire escape requirements of architectural layouts.
 - c) Cables for suspended and cantilevered LED Exit signs shall be run in flexible conduits encased in powder coated or galvanised steel support complete with escutcheon cap.
 - d) LED lights in LED Exit signs shall be easily replaceable.
- 7 Earthing System
- 7.1 General
- 7.1.1 All metal conduits, trunkings and tray systems, supports, cabinets, metal parts of switch gear, equipment cases, motor frames, cables screen and armour, electrical fittings and fixed appliances liable to become live in the event of insulation failure, shall be effectively earthed by means of earth continuity conductors of adequate size. The entire earthing installation shall fully comply with the latest requirements of SS 638 and SS 551.
- 7.1.2 The earthing continuity conductor shall be of high conductivity copper and continuous throughout its length without joints except by exothermic conductors.
- 7.1.3 Bonding connections shall have a warning label fitted, marked "Electrical Earth Do Not Remove".
- 7.1.4 All extraneous conductive parts e.g. metal structure, lamp post and bus service numbers post shall be bonded to the DB earth bar. The electrical bond shall be by means of purpose made clamps or welded where possible.
- 7.2 Earthing Connections

- 7.2.1 Earth continuity conductors from all exposed metal parts of equipment required to be earthed including earth connections to plug sockets shall be connected by one of the following appropriate methods:
 - a) To earth connection at the distribution board supplying the equipment on plug socket.
 - b) To any point on the sub-main or main earth continuity conductors supplying the relevant equipment.
 - c) To residual current circuit breaker where installed.
- 7.3 Labels
- 7.3.1 A label including the result and date of testing shall be provided next to the earth bar.
- 7.3.2 A label indicating the earth bar number shall be provided next to the earth bar.
- 7.3.3 All labellings for earth bar and earth termination box shall be reverse-engraved on traffolyte plate.
- 7.3.4 Both ends of the earth cable shall be labelled. The labels shall indicate the origin and the destination of the earth cable.
- 7.4 Earth Termination for OG Boxes
- 7.4.1 The earth electrode shall be housed inside heavy-duty earth pit with hinged or chained hot-dipped galvanised lid cover of dimension 300mm x 300mm haunch in concrete. Where electrodes are planted on roadside or pavement, they shall be protected by angle steel reinforced chamber with 10mm thick steel checker plates.
- 7.4.2 The earthing pit on turf area shall be reinforced with concrete support. All earth pits shall be filled with sand.
- 7.4.3 Earthing rods shall consist of a minimum of 2 nos. 1.8 m length, 16 mm diameter copper bond steel.
- 7.5 Testing of Earthing System for OG Boxes
- 7.5.1 The system shall be tested for, resistance to earth of the electrodes and electrical continuity of earthing system.
- 7.5.2 The layout drawings showing the positions of earthing termination and test results shall be submitted for Authority's acceptance.
- 7.5.3 The LED module shall have the following information distinctly and durably marked:
- 8 Lightning Protection System
- 8.1 General
- 8.1.1 This section of the specification provides for the supply and installation of a complete lightning protection system. The installation shall comply with the requirements of SS 555 and any additional requirements of this specification.
- 8.1.2 A Qualified Person (QP) shall be engaged to supervise the lightning protection system installation and submit the certificate of supervision of lightning protection system.
- 8.1.3 Any holes drilled in roof coverings and any penetrations through waterproofing membranes shall be rendered watertight to the acceptance by the Authority.
- 8.1.4 All lightning protection system components shall comply with IEC 62561.
- 8.1.5 The lightning protection system shall comprise the following:
 - a) Air Termination
 - b) Down Conductors
 - c) Joints and bonds
 - d) Earth Termination
 - e) Test Links
- 8.2 Air Termination
- 8.2.1 The conductors for air terminations shall comprise of 25 mm x 3 mm aluminium tape securely fixed in place to the building structure with the appropriate saddles.
- 8.2.2 Whenever possible, the horizontal conductors shall be of continuous lengths. Fixings shall be such that under adverse weather conditions, the lightning tapes shall remain firmly fixed in position.
- 8.2.3 Where saddled to masonry, the fixing screws shall be set in expansion type plugs contained in properly formed holes. Where saddled to roof cladding, the mounting of the lightning tapes shall not damage the integrity of waterproofing of the roof cladding and shall not in any way compromise the warranty of the roof.
- 8.2.4 All roof conductors shall be secured at intervals not exceeding 500 mm. It is required to ensure that the mounting of the lightning protection tape on the roof structure shall not in any way compromise the warranty of the roof.

- 8.2.5 The whole air termination system installed over its total route of roof areas shall be electrically continuous.
- 8.2.6 Provision shall be made with suitable fitting to allow for expansion and contraction of the horizontal conductors.
- 8.2.7 Provision shall be made with suitable fitting to allow for bonding by others to their exposed metallic equipment.
- 8.2.8 No galvanic corrosion shall take place between the lightning protection tape and the roof structure. Where possible, a narrow gap shall be maintained between the lightning protection tape and the roof structure. Insulating material shall be inserted at appropriate locations to maintain the narrow gap.
- 8.3 Down Conductors
- 8.3.1 The conductors shall comprise of 25mm x 3mm aluminium tape securely fixed in place to the building structure with the appropriate saddles down to the test links where applicable. The conductors shall comprise of 25mm x 3mm copper tape from the test link to the lightning pit.
- 8.3.2 Down conductors for interconnection between roof conductors of discharge device and the earth electrode shall be securely fixed to the building structure with approved method and the support shall not exceed 500 mm intervals.
- 8.3.3 The conductor routes shall be interfaced with the architectural design and shall be as direct as possible.
- 8.4 Joints and Bonds
- 8.4.1 All joints shall be securely sound and shall be of low resistance. The crosssectional area of the copper materials used shall not be less than the main conductor (i.e. 25 mm x 3 mm).
- 8.4.2 Where possible, joints shall be kept as few as possible.
- 8.4.3 All joints shall be tinned, soldered and double riveted.
- 8.4.4 Clamp, bolt and screw joints, shall not be used in the lightning protection system except at test or bonding points.
- 8.4.5 Joining of dissimilar metals shall be with purpose made bimetallic joints.
- 8.4.6 All structural and steel columns shall be bonded to the rebar of the floor slab to ensure a low resistance path. All bonds shall be by means of purpose made clamps or by welding where possible.

- 8.5 Test Links
- 8.5.1 Test and junction clamps shall be of phosphor bronze.
- 8.5.2 A test link shall be provided on each down conductor suitably located for ease of testing and it shall be protected from tampering and vandalism. Test clamp shall be recessed into the wall and shall be housed in an accessible secured stainless steel panel through finishes by to be provided under the Contract.
- 8.5.3 Tape clamps shall also be provided on roof conductor network and arranged such that all parts of the network can be tested independently.
- 8.5.4 After installation and completion of testing, all test clamps shall be painted with bituminous paint to prevent corrosion.
- 8.6 Earth Termination
- 8.6.1 The earth electrode shall be housed inside heavy-duty lightning pit with hinged or chained hot-dipped galvanised lid covers of dimension 300mm x 300mm haunch in concrete. Where electrodes are planted on roadside or pavement, they shall be protected by angle steel reinforced chamber with 10mm thick steel checker plates.
- 8.6.2 The copper tape connecting the earth electrode and down leads shall be run in 50mm diameter uPVC pipe.
- 8.6.3 The lightning pit on turf area shall be reinforced with concrete support. For the lightning pit on the turf area, it shall be haunch in concrete. All lightning pits shall be filled with sand.
- 8.6.4 Earthing rods shall consist of a minimum of 2 nos. 1.8 m length, 16 mm diameter copper bond steel rod.
- 8.7 Testing

The system shall be tested for, resistance to earth of the electrodes and electrical continuity of earthing system. The test results shall be submitted for Authority's acceptance.

8.8 Labels

All lightning pits shall be labelled on reverse-engraved traffolyte plate. The label including the pit number, result and date of testing shall be riveted onto the cover of the lightning pit.

9 Water Services, Sanitary Works and Pumped Drainage System

- 9.1 Pipe Work
- 9.1.1 Unless otherwise specified, only one type of pipe shall be used within any individual pipe length.
- 9.1.2 Valves shall be installed in horizontal lines with stems either horizontal or vertical. Isolation valves shall be installed at any other points indicated or required for draining, isolation, or sectionalising purposes. Valves shall be installed in such a manner that maintenance access is maintained for all parts requiring service. Control valves shall be provided in water pipes to provide complete regulation of plumbing fixtures and equipment.
- 9.1.3 All fixtures, hangers, supports and brackets for pipes, trunkings, conduits, trays, equipment etc. shall be of hot dipped galvanised to BS EN ISO 1461.
- 9.1.4 Bolts and nuts shall be accompanied with washers. All these shall be hot dipped galvanised to BS 7371 : Part 6 or sherardised to BS7371 : Part 8, Class S1.
- 9.1.5 Water Level Sensors
 - a) All water level sensors shall be of industrial grade, factory calibrated and complete with the necessary electrical/electronic circuitry.
 - b) Separate controllers shall be provided for multi-level single probe to avoid single point failure. The controllers shall be integrated with the PMCP.
 - c) The construction and installation of the sensors shall be such that the sensor operation is not affected by dirt, debris, grease, and etc. within the sump pit.
 - d) Suitable brackets shall be provided for mounting and securing of the sensors and designed such that the sensors shall not impede sump pit access and the sensors can be easily removed for inspection, servicing and maintenance without entering the sump pit. All brackets shall be of stainless steel of minimum grade 316.
 - e) All sensors, related components and accessories supplied shall comply with EMC requirements.
 - f) Multi-Level Single Probe

The multi-level single probe shall be of the single hanging rod type with multiple sensors. The proposed multi-level single probe shall be readily available without any modification required. Combining multiple rods to form a single probe is not acceptable.

Sensors at different levels shall be provided to correspond with the required depths of water to energise relevant controls to operate the pump and alarm signal.

Each sensor shall have individual sensing circuit and controller for each level and shall be stainless steel constructed.

The construction of the probe shall prevent water ingress into the sensor unit to the internal electrical components.

The multi-level single probe shall have a minimum operating life span of 10 years for use in the intended environment and constructed to IP65 rating.

The multi-level single probe shall have an operating temperature range of 0 to 40°C.

Suitable brackets of stainless steel of minimum grade 316 shall be provided to prevent lateral movement of the probe within the sump pit and provided with wiper for probe clearing purpose.

The multi-level single probe shall not be installed in a stagnant corner where grease and debris may collect and shall be installed with sufficient clearance from any surface to prevent tangling. The bottom of the probe shall be above the minimum pumping level of the sump pit.

- 9.2 Sewage Ejector Pumping System
- 9.2.1 Sewage ejector pumps shall be of the duplex non-clogging type suitable for handling raw sewage. A minimum of two pumps (duty/standby) and an ejector tank shall be provided for each sewage ejector pumping system. Each pump shall be designed for 2 times the peak sewage/wastewater inflow generated. A sewage sump pump shall be provided in the sump pit and connected to the sewage ejector pumping main for containment of over spillage of sewage from ejector tank.
- 9.2.2 All ejector pumps with motor sizes larger than 7.5 KW shall be provided with a moisture detector with alarm signal/light connected to the pump control panel.
- 9.2.3 Operation shall be automatic and controlled by multi-level single probe. If the level continues to rise after starting the duty pump the standby pump shall be started. Provide lead/lag selector switch, hour run meters for each pump and high level alarm. Gates valves shall be provided on the suction, discharge sides of the pump and before inlet to ejector tank. Discharge pipe work of minimum 100mm diameter shall consist of check valve of single flap type or ball type.
- 9.2.4 The pump shall be designed to cater for no more than 10 starts/stops per hour. However, the motor starter shall be sized to 15 starts/stops per hour.

- 9.2.5 All fixtures, hangers, supports, brackets, guide rails, chains, bolts, nuts and all related accessories in the pumped drainage system shall be of stainless steel.
- 9.2.6 The layout shall be such as to facilitate easy removal and replacement of pumps. Lifting facilities (e.g., overhead runway beam, eye bolt etc.) and equipment shall be provided to enable easy lifting of the tanks/pumps. Adequate removable chain blocks shall be provided.
- 9.3 Pumped Drainage System
- 9.3.1 The drainage pumped system shall consist of duty and standby pumps, water level sensors, electrical and control wiring/system, all associated pipe work, fittings and accessories. The system shall also include one smaller submersible drainage pump, which serve to dewater the sump pit for maintenance purposes, where applicable.
- 9.3.2 Drainage pumps shall be of vertical centrifugal submersible type, capable of handling and pumping wastewater with solid fibrous material, heavy sludge and other matters found in drainage and storm water applications. Installation of the pumps to the discharge connection shall be the result of a simple linear downward motion of the pumps guided by two guide-rails. The entire weight of the pump/motor unit shall be borne by the pump discharge elbow. No portion of the pump/motor unit shall be easily removable for inspection or service and maintenance, requiring no bolts, nuts or other fastenings to be disconnected.
- 9.3.3 The pump shall be designed to cater for no more than 10 start/stop per hour. However, the motor starter shall be sized to 15 starts/stops per hour. The design Pump Capacity, Qp shall be a minimum of Qp = 2Qin (total inflow) and ensure that the velocity of water in the discharge pipes is between 1.0m/s and 2.4m/s. Discharge pipe shall have a minimum diameter of 80mm.
- 9.3.4 Check valve of single flap type or ball type and a gate valve shall be provided on the discharge main of every pump. They shall be located above the sump such that they are accessible without the need to enter the sump and after removal of the access cover.
- 9.3.5 All fixtures, hangers, supports, brackets, guide rails, chains, bolts, nuts and all related accessories in the pumped drainage system shall be of stainless steel.
- 9.3.6 The layout shall be such as to facilitate easy removal and replacement of pumps without entering the sump. Lifting facilities (e.g., overhead runway beam, eye bolt etc.) and equipment shall be provided to enable easy lifting of the pumps. Adequate automatic mechanisms (motors) shall be provided for lifting equipment in three X-Y-Z axis to facilitate the pumps removal for maintenance and servicing purpose to the nearest loading/unloading bay within the plantroom.

- 9.3.7 For each sump pump, a control panel shall be placed at a convenient, easily accessible location and shall be constructed with a waterproof type enclosure.
- 9.3.8 Multi-level single probe for the pump controls and water level monitoring shall be provided as follows:
 - a) Redundant High water level alarm
 - b) High water level alarm
 - c) Redundant Standby Pump Start Level
 - d) Standby Pump Start Level
 - e) Redundant Duty Pump Start Level
 - f) Duty Pump Start Level
 - g) Redundant All Pumps Stop Level
 - h) All Pumps Stop Level
- 9.3.9 Control of the pump shall be carried out by the following methods:
 - a) Automatic operation by means of multi-level single probe.
 - b) Manual operation by means of start/stop push buttons at the PMCP, emergency stop buttons and bypass the water level sensors during manual mode of operation.
 - c) Automatic changeover of duty and standby pumps during each cycle of operation. This is to enable even distribution of wear and tear of the pumps.
- 9.3.10 Multi-level single probe at different levels shall be provided to correspond with the required depths of water to energise relevant controls to operate the pump and/or raise the alarm.
- 9.3.11 The audible and visible indications for the system on the PMCP shall consist of the following:
 - a) Red 'High Water Level' alarm indicator with audible buzzer
 - b) Red 'Pump Trip' alarm indicator with audible buzzer
 - c) Green 'Pump Run' indicators
 - d) Amber 'Pump Stop' indicators
 - e) White 'Pump Supply Healthy' indicator
 - f) White 'Incoming Supply' all white indicators, labelled L1, L2, and L3
 - g) White 'Outgoing Supply' all white indicators, labelled L1, L2, and L3
 - h) Amber 'Manual / Auto' status indicator
- 9.4 Pump Motor Control Panel

- 9.4.1 The pump motor control panel (PMCP) shall be of front access cubicle type of dust and vermin proof construction and is adequately ventilated. It shall be fabricated from 2mm thick sheet steel, pressed or rolled to the shape required with all necessary stiffeners, supports and return edges. All joints shall be neatly welded and finished flush. Nuts, bolts, washers, etc. shall be cadmium plated or sherardised.
- 9.4.2 The panels shall be finished with high quality enamel. A minimum of two undercoats applied, each built-up and flattened separately. The final coat shall be of an accepted gloss finish and sufficient body given to the paint films so that the final appearance of the finished units is entirely free from blemishes, undulations, foreign inclusions, scratches, patterning or any defects whatsoever.
- 9.4.3 The door of each control panel shall be furnished with a key-lock under a master key for all motor control panels installed. Cylinder locks shall be used. Three sets of keys shall be provided.
- 9.4.4 Interface compartment incorporating properly labelled terminal block shall be provided for connections to the Interface Terminal Board (ITB). The control cables shall be properly terminated in the ITB.
- 9.4.5 The PMCP enclosure shall be designed to IP 55.
- 9.4.6 The isolator shall isolate the linkage between the pump and motor control panel. The isolator shall be of IP 55.
- 9.5 Motor Starter and Motor
- 9.5.1 Starters for motors up to 5 kW shall have thermally operated overload units incorporating single phasing protection and ambient temperature compensation with under voltage release facilities. Motors over 5kW shall have thermistors fitted to operate the under voltage release and the necessary control units shall be supplied for these starters.
- 9.5.2 Each starter shall be complete with overload protection incorporating the following features:

- a) Overload protection in each phase supply.
- b) Adjustable over the range of 80 percent to 120 percent full load.
- c) Manual reset.
- 9.5.3 Motor starters shall generally be of the following types:
 - a) Motors rated up to and including 2.2 kW Direct-on-line (DOL) starters
 - b) Motors rated above 2.2 kW up to and including 11 kW Star-Delta starters
 - c) Motors rated above 11 kW Auto-transformer starters or other reduced voltage starters subject to Authority's approval.
- 9.5.4 All motors, unless otherwise specified on the Drawings or in this Specification, shall be totally enclosed fan cooled (TEFC), squirrel cage induction type conforming to either IEC 34-1 and IEC 85 or BS 5000 and BS 2757 with minimum class F insulation. All varnishes and impregnate used shall be inorganic and suitable for tropical service. Bearings shall be so selected for its duty and shall be housed in a dust tight enclosure with efficient shaft seals to prevent dust ingress and escape of grease, and be equipped with grease nipples and relief plugs. Terminal boxes shall be of cast iron and be provided with glands drilled and taped to accept conduits. Terminal blocks shall be of high quality insulating materials and be capable to support incoming cables.
- 9.5.5 All motors shall be so selected to have at least 120% of the power rating above the designed duty point. It shall also be able to operate with a power factor of not less than 0.85 at full load, otherwise, power factor correction capacitors shall be provided.
- 9.5.6 Motors shall be capable of operating continuously at rated output at any frequency between 48 and 52 Hz and at voltage within +/-10 percent of the nominal value.
- 9.5.7 Motors shall be tropicalised to BS 1156 with minimum 1 mega-ohm insulation resistance.
- 9.5.8 All motors shall be supplied complete with cable termination boxes and mounting bolts.
- 9.5.9 Single-phase motors shall be either repulsion or capacitor start and induction run. Motors rated 1 KW and above shall be operated by three-phase supply.
- 9.5.10 All motors shall be protected and a detection and tripping device shall be provided for as follows:

Phase protection	Upon failure of one phase, motor shall be protected from operation on two phases.
Overcurrent protection	Upon the detection of overcurrent to the motor, it shall shutdown automatically.

- 9.6 Special Requirement for Motor of Sump Pumps
- 9.6.1 The motor shall be housed in an air filled watertight chamber enclosure rated IP 68. The stator shall be dipped and baked three times in Class F varnish and shall be heat sink fitted into the stator housing. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be specifically designed for submersible pump usage and designed for continuous duty pumping media of up to 400oC (1040 oF). The motor should be designed for 15 starts/stops per hour.
- 9.6.2 The pump capacity of 7.5 KW and above shall have thermal switches embedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be set to open at 1250 oC and shall be used in conjunction with and supplemental to external motor overload protection. Should high temperature occur, the thermal switches should open, stop the motor and activate alarm.
- 9.6.3 The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 400 oC (1040 oF) ambient and with an average temperature rise of the stator windings not to exceed 800 oC. A performance chart shall be provided showing curves for torque, current, power factor, input/output KW and efficiency. This chart shall also include data on starting and no-load characteristics.
- 9.6.4 Water leakage/ moisture sensors shall be provided to detect liquid/ moisture in the motor housing. Use of voltage sensitive solid state sensors shall not be allowed.
- 9.6.5 The junction chamber shall contain two distinct and separate terminal boards. One terminal board shall be used for the connection of the pilot sensor leads with the pilot sensor cable. A separate terminal board shall be utilized for the line power connection to the motor stator leads. This power terminal board shall use threaded compression type binding posts to connect the cable conductors and motor stator leads.
- 9.6.6 The power terminal board shall separate and seal the junction chamber from the stator housing. The use of wire nuts or crimping type connectors is not acceptable. The cable entry junction chamber and motor shall be separated by feed through type terminal board of non-hygroscopic material, which shall isolate the stator housing from foreign material gaining access through the pump top.
- 9.6.7 The power cable shall be sized to the IEC Standards and shall be of sufficient length to reach the junction box without the need of any slices. The cables used shall be suitable for marine environment. The outer jacket of the cable shall be of oil resistant chloroprene rubber with low water absorption, and with mechanical flexibility to withstand the pressure at the cable entry. The motor and cable shall be capable of continuous submergence without loss of watertight integrity to a depth of at least 20m.

- 9.6.8 The cable entry seal design shall preclude specific torque requirements to ensure a watertight and submersible seal. The cable entry shall consist of dual cylindrical elastomer sleeves, flanked by washers, all having a close tolerance fit against the cable and the cable entry. The sleeves shall be compressed by the cable entry unit, thus providing a strain relief function.
- 9.6.9 The assembly shall permit easy changing of the cable. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable. Moisture /leakage sensors shall be incorporated to detect any leakage of liquid into the stator housing or into the cable entry of the pump and linked to the pump control and monitoring unit(s). Use of voltage sensitive solid state sensors shall not be allowed.
- 10 Passenger Lift
- 10.1 Design Requirements
- 10.1.1 Unless otherwise stated, this technical specification defines the requirements for the design, supply, delivery, installation, testing and commissioning of machine roomless lifts.
- 10.1.2 The lift shall comply strictly with all statutory regulations, by-laws and orders currently in force. Unless otherwise stated herein, the lift shall comply with the latest edition of SS 550 and Code on Accessibility in the Built Environment.
- 10.1.3 Lifts for Pedestrian Overhead Bridges and Pedestrian Underpass shall have a with minimum rated load (capacity) of 750kg shall have both car and landing entrance clear opening width and height not less than 900mm and 2100mm respectively. Lifts for Bus Interchanges and bicycle lifts for POB with minimum rated load (capacity) of 1250kg shall have both car and landing entrance clear opening width and height not less than 1100mm and 2100mm respectively. The rated speed shall be 1.0m/s in either direction for all lifts. The lift car shall be designed as squarish as possible.
- 10.1.4 Each lift shall have its own traction drive machine, which makes use of sheaves and ropes (or equivalent). The roping ratio shall be kept to maximum 2:1. Unless otherwise specified, machine roomless lift type shall be used.
- 10.1.5 The design life of the lifts shall be a minimum of 20 years with the inspections and maintenance being carried out in accordance with the supplier's Operation and Maintenance Manuals and as accepted by the Authority.
- 10.1.6 The lift shall be of proven design with track record of at least 5 years.
- 10.1.7 All electrical equipment and control panels that are installed in the lift hoistway/lift motor room/lift landings and the car top safety switches shall be rated to a minimum of IP 21 except for the door locks which, shall be at least of IP 42 or IP2X with cover to prevent water ingress.

- 10.1.8 The car operating panels (COP) and the car call buttons shall be ergonomically designed and of robust construction to the Authority's acceptance. The COP shall be supplied and flush mounted on the front return panel of each lift car entrance or the side wall panel of the lift car.
- 10.1.9 A two-panel centre-opening door system shall be provided. The door shall be of at least 1.5mm thick stainless steel, hairline (grade 304). A door vision panel, in compliance with SS 550 shall be included.
- 10.1.10 The lift car shall be ventilated to a minimum of 80 air changes per hour. The noise from the fan measured at a distance of 1 metre away within the lift car shall not exceed 60 dbA. The grille for the fans shall be designed to provide good ventilation within the lift car to achieve an average air velocity of at least 0.8m/s at the car centre and perimeter 1.2m high from the car floor.
- 10.1.11 The minimum illumination level at the floor of the lift car shall be 150 lux using LED lights located at the car ceiling.
- 10.1.12 The finishes and ceiling details of the lift car shall be co-ordinated and subjected to the Authority's acceptance. If specified, a mock-up of the lift car, lift entrance and landing equipment shall be built to assess and verify the adequacy and quality of the finishes.
- 10.1.13 The equipment shall comply with the EMC emissions and immunity tests in accordance with appropriate international standards for equipment operation in similar environment or as specified by the Authority.
- 10.1.14 A key switch that facilitates the shutting down of the lift during non-revenue hours shall be provided and recessed below the hall call button at the ground level. The lift car shall park at the designated level with the lift doors remained closed, lights and fans switched off, and all hall calls shall be ignored except the alarm bell button, intercom button and doors opening button on the COP. The Information Display Panel shall also display a suitable message indicating that the lift is no longer in operation. The keys provided should be the same for all lifts provided at POBs.
- 10.2 Safety Requirements
- 10.2.1 A battery operated Automatic Rescue Device (ARD) shall be provided to bring the lift car to the nearest landing in the event of power failure. During this operation all safety features of the lift shall remain operational. The rescue time of the device from the time of power failure to the time the doors fully open at the nearest landing shall not exceed 2 minutes. The landing accuracy shall be ± 10.0 mm.
- 10.2.2 The ARD shall not modify the lift design and all its original safety features and shall not in any way affect the performance of the lift.

- 10.2.3 The car door shall not open under any conditions (including power failure) whilst the car is in motion or stalled outside the unlocking zone of a landing. The car and landing doors shall only be opened in the unlocking zone of a landing with a landing key of an approved type.
- 10.2.4 An overload device shall operate when the car load exceeds its rated load. When activated, the lift shall not move, and a warning buzzer and an illuminated "Overload" sign shall be activated. The "Overload" sign shall be incorporated in the car position indicator.
- 10.2.5 A control panel shall be fitted on the top of the lift car for maintenance purpose. The design of the control panel shall comply with the following requirements and prevent the lift car from being operated accidentally:
 - a) It shall not be possible to control the lift car from any other position after the NORMAL/TEST changeover switch has been set to the TEST position. When in the TEST position the UP and DOWN continuous pressure push buttons within this panel shall become operative.
 - b) The lift car shall only move when all safety devices are in normal and healthy condition.
 - c) The lift car shall move in either direction only on continuous pressure of the appropriate direction button at a car speed not exceeding 0.25m/s.
 - d) An emergency mushroom stop switch shall be provided.
 - e) The control panel shall incorporate a 13A metalclad switch socket outlet and a light fixture with switch. The light fixture shall be permanently installed and adequately protected.
 - f) Means shall be provided to turn off the power to the door operating device and operate the doors for maintenance and testing purpose.
 - g) Associated with this control, terminal stop limit switches shall be provided to stop the car from travelling in an upward direction not less than 1.8m from the soffit of the lift hoistway as well as before the car reaches the down final limit switch. When these switches are activated, it shall not stop the car from operating in the opposite direction.
- 10.2.6 The lift shall have a floor levelling device which shall automatically bring the lift car to stop within ±5mm of the landing floor level for which a stop has been initiated regardless of the load or direction of travel.
- 10.2.7 Each lift car shall be provided with progressive type safety gear mounted on the lower member of the car frame structure. This safety gear shall be capable of operating only in the downward direction and capable of stopping the car with full load at the tripping speed of the overspeed governor, by gripping the guides and holding the car stationary. The motor circuit shall be opened by a switch on the safety gear before, or at the same time the safety gear is applied. It shall be possible to release the safety gear by raising the lift car without the use of any special tools.

- 10.2.8 The electrical tripping (machine brake) and mechanical tripping (car safety gear) of the overspeed governor shall occur when the car speed is at a minimum 115% and 120% of the rated speed downwards respectively. An electrically operated safety switch shall be provided to disconnect the power supply to the motor when the governor is activated. Overspeed governors, which are remote re-settable from the controller/EI panel shall be provided. Manual resetting overspeed governor shall only be considered if it is located in the lift pit or in the hoistway whereby the maintenance staff could easily and safely access to mechanically reset the governor.
- 10.2.9 A phase protection device shall be provided in the controller of each lift to prevent the lift car from moving in the event of phase failure or the phase of the power supply being reversed due to any reason whatsoever. This device, when activated, shall cause a visual indicator to illuminate on the controller, until the fault has been rectified.
- 10.2.10 Electrically operated proximity detector device(s) shall be installed on the leading edge of the car doors. The device(s) shall create a 3-dimensional zone of protection for at least 1.8m height of the door opening. This zone of detection shall extend a short distance in front of the landing doors. The zone of detection shall move forward as the doors close and the presence of a person, if within this zone, shall activate the detector to stop the closing movement of the doors and re-open them before hitting the person. After a pre-set time interval (which is programmable) the doors shall start to close again in the absence of further interruption. In addition, mechanical safety edge protection shall also be provided to the lift door.
- 10.2.11 Car and Hall position indicator shall be provided above each car door. The faceplate of the car position indicator shall be made of stainless steel grade 304 hairline-finished. Floor numbers shall be digitally displayed using yellow or light green round or square-dot LEDs panel of not less than 30mm(H) x 600mm(L). There shall be an arrow in motion vividly and dynamically indicating car movement and direction. It shall be capable of displaying scrolling and blinking messages such as, "Out of Service," "Under Maintenance" etc. The list of messages shall subject to the acceptance by the Authority. The surface of the display unit shall be of non-glare type.
- 10.2.12 A 2-level detection device, such as float sensors/switches, shall be provided in the lift pit. The 1st sensor shall notify the Operator once the pit is accumulating water, upon reaching the 2nd sensor, the lift shall home to the designated landing and render the lift inoperative. A cut off drain shall be provided across before the entrance level landing of the lifts to prevent water ingress into the lift shaft.
- 10.2.13 If the PUP or BI is linked to a Fire Command Centre (FCC), a Lift Supervisory Panel or a mimic panel indicating the position of the lifts shall be provided within the FCC. The location and contents of the panel shall be subject to the acceptance of the Authority.

- 10.2.14 The finishes of the lift car and hall equipment shall be of 1.5mm-hairline stainless steel grade 304, with flooring that commensurate or is similar with the lift lobby. All finishes shall be subject to the acceptance of the Authority.
- 10.3 Cable Requirements
- 10.3.1 All cables shall comply with the requirements of SS 638 and the EMA regulations and requirements. The main power cable providing the electricity supply to a lift installation shall be at least of FR type.
- 10.3.2 Flexible flat travelling cables shall be provided and conform to the latest SS 358/EN 50214. It shall be securely clamped at each end so that the weight is not supported by any fixing of the various cores. A total spare of 10 or 10% of the total number of wires used whichever is more and 2 spare shield cables shall be provided per lift.
- 10.3.3 All cables shall run in galvanised steel conduit or galvanised steel trunking. The steel conduit shall comply with SS100 and BS4568 Part I & II, Class 4. The steel trunking shall comply with SS249. All galvanising of cable support shall be in accordance to BS729 and BS4921.Compression glands for cables shall comply with BS6121. Flexible conduit used shall be enhanced low fire hazard, polyolefin covered galvanised steel conduit. All conduit outlets shall be bushed appropriately. All cable support connections including to all electrical fixtures shall be watertight.

- 10.4 Provisions for People with Special Needs
- 10.4.1 All lifts provided shall comply with the Code on Accessibility in the Built Environment and the following:
 - a) An international symbol of access for the disabled shall be permanently and conspicuously displayed at each and every lift landing next to the lift entrance. The size of the symbol and its position shall be subjected to the Authority's acceptance.
 - b) Braille notations and raised numerals indicating the floor levels shall be incorporated on each button at COP and the hall call buttons.
 - c) A recorded voice system for announcing the car position, opening/closing of doors, direction of travel and other messages shall be provided. The system shall be capable of storing not less than 25 recorded messages.
 - d) All buttons shall be of micro movement/pressure type. The button shall always be illuminated and change colour upon pressing or whenever car call is registered. Floor buttons shall be provided with the floor names on the right side of each button.
 - e) An intermittent buzzer tone shall be used to inform the passengers throughout the opening and closing of car doors.
 - f) An audio signal such as beep tone shall be sounded to signal each hall/car call registered.
 - g) The volume of the buzzer/beep tone shall be adjustable from 60dbA to 70dbA as measured at the centre of the door opening.
 - h) Blinking light on the emergency bell button shall be clearly visible when it is being activated.
- 10.5 Lift Inter-Communication System
- 10.5.1 A lift inter-communication system of the simultaneous communication voice activated type shall be provided in each lift.
- 10.5.2 Master stations shall comprise a receiver set, a transmitter set, a microphone/loudspeaker unit, buzzer, system-on and reset button(s) and system-on indication light. Slave stations shall comprise a transmitter set and a microphone/loudspeaker. All stations shall be equipped with handsets except those slave stations installed inside the lift cars, which shall be of the hands-free type.
- 10.5.3 A master station shall be supplied and installed in the Passenger Service Office (PSO) (at Bus interchange only) and EI panel. The stations in the EI and PSO shall alternate their role as a master station in the normal lift operation mode and special emergency operation mode (except in the event of power failure) respectively.
- 10.5.4 A slave station shall be supplied and installed in each lift car. The loudspeaker and microphone unit of the slave station in the lift car shall be concealed in the car-operating panel.

- 10.5.5 Where the intercom system is not connected to a control centre, a signal shall be sent and latched-on to the Operator through the Building Management System (BMS) when the alarm or intercom button has been depressed for more than a pre-set time.
- 10.5.6 A lift management, monitoring and fault diagnostic system that will serve the purpose of keeping track historical events to help in the analysis the lift performance when incidents occurred shall be provided subject to the Authority's acceptance.
- 11 Escalators
- 11.1 Design Requirement
- 11.1.1 This technical specification defines the requirements for the design, supply, delivery, installation, testing and commissioning of escalators.
- 11.1.2 The escalator shall comply strictly with all statutory regulations, by-laws and orders currently in force. Unless otherwise stated herein, the escalator shall comply with the latest edition of SS 626 and SS 638.
- 11.1.3 Escalators shall be reversible and capable of continuous operation in both directions for a period of 20 hours a day, seven (7) days a week 365 days per annum.
- 11.1.4 Escalators shall comply with the requirements of public service escalators as stipulated in SS 626 with a design life of at least 20 years, which requires no major repairs for the first 10 years. Major repairs shall consist of repairs to the steps, track system, step chains, main drive system, traction machines, landing plates and tension carriage due to causes other than those attributable to normal wear and tear.
- 11.1.5 The escalator shall be of proven design with minimum track record of 5 years.
- 11.1.6 When provided, escalators traversing in the up and/or down directions may be provided linking all levels of the Pedestrian Overhead Bridge (POB), Pedestrian Underpass (PUP) and Bus Interchange (BI).
- 11.1.7 Escalators shall be designed for installation and operation at an angle of inclination of 30°.
- 11.1.8 Operating speeds of the escalators shall be as follows:

	Commuter Facility	Transit Escalator with Dual Speed
	Escalator	Feature *
Rated Speed	0.50	Primary: 0.75 m/s
		Alternative:
		0.50 m/s

Manual switch over key switch

		shall be provided at ECP.
Standby Speed	Fixed at 0.13 to 0.25 m/s	Fixed at 0.15 to 0.25 m/s
Maintenance Speed	< 0.25 m/s	< 0.25 m/s

*1) Escalator that is contained in a Commuter Facility that connects directly with a transit station.

- 11.1.9 The truss shall be supported at both ends and at intermediate points where required with resilient supports and bearing plates. No intermediate support(s) shall be provided for escalators with vertical rise of 6.0m and below. The truss shall be designed to support the dead weight of the escalator plus the passenger load.
- 11.1.10 Radii of the upper and lower transitional tracks shall be equal to or greater than the following:

	Commuter Facility Escalator	Transit Escalator*
Upper	2.0m	3.6m
Lower	1.5m	2.0m

*1) Escalator that is contained in a Commuter Facility that connects directly with a transit station.

- 11.1.11 Step chains shall be of the endless roller type located on both sides of the moving step. The chains shall be provided in matched lengths and be of high quality steel construction incorporating links, pins, bushes, axles and rollers with three pitches between adjacent rollers. All chain pins shall be circlipped. Each step chain shall be provided with an automatic tension device to ensure proper tension under varying load conditions. A method shall be provided to shorten the chain by one step to compensate for chain elongation. The step chain pin pressure of all escalators shall not exceed 20N/mm2.
- 11.1.12 Steps shall have a tread width of at least 1000mm and 400mm deep and not more than 210mm high. For commercial escalators, three (3) flat steps shall be provided at both upper and lower landings. Four (4) steps shall be provided on both landings for transit escalator.
- 11.1.13 The step and step chain rollers shall have durable elastomer materials bonded to a metal die case hub. The Shore hardness of the tyre materials shall be $920 \pm 30A$ when cured. The bond shall have sufficient strength to avoid de-trying under all load conditions. The minimum diameter of the roller and the trailer rollers shall be 75mm. The roller shall have a minimum width of 20mm.
- 11.1.14 Handrails shall have a service life of at least seven (7) years under the stipulated operating conditions.

- 11.1.15 Handrails shall have inserts and sliding surfaces of endless loop construction designs, synthetic materials, traction type, with a single, smooth vulcanised joint. The minimum breaking strength of the joint shall be greater than 85% of the minimum breaking strength of the handrail. The hardness of the outer stock shall not be less than Shore 700 □ 5Ao. Handrail shall be 'V' cross section type.
- 11.1.16 Handrails shall be delivered in protective film and an endless loop with only one factory made vulcanised joint, which shall not be visible on the top surface. The endless loop handrail shall be able to be installed into the handrail drive system without the need to be cut or re-vulcanised on site.
- 11.1.17 The equipment shall comply with the EMC emissions and immunity tests in accordance with appropriate international standards for equipment operation in similar environment or as specified by the Authority.
- 11.1.18 All electrical equipment supplied and installed shall have at least IP 55 Class protection rating.
- 11.1.19 An automatic lubrication system shall lubricate the main drive chains, step chains and handrail drive chains efficiently and economically.
- 11.1.20 The lower pit of all escalators shall be provided with a detection device, such as float sensor/switch, to stop the escalators if the pit is flooded. A drainage system by means of gravity shall be provided at the lower landing pit to discharge water that may be accumulated due to rain or washing. Alternatively, a sump and pump of suitable capacity shall be provided at the lower landing, to pump out water automatically. All piping shall have a minimum 50mm diameter with suitable wire gauze at the ends. The escalator drip pan at the lower landing shall also be removable for maintenance and cleaning of the discharge points. The discharge point(s) shall come with a grease inceptor(s) complying with ENV's requirements.
- 11.1.21 A weatherproof 13A switch socket outlet and protected permanent lighting shall be provided in the upper, lower landing pits and at the controller closet of the escalator.
- 11.1.22 Comb lights of minimum lighting levels of 50 lux, shall be provided. Comb lights of PUP escalators shall be connected to an UPS unit situated in the escalator controller (ECP) closet whereas for BI, the comb lights shall be connected to the bus interchange EPS/UPS supply. Strip LED lightings integrated with combplate shall also be provided, and it shall be able to alter between green and red light automatically in accordance to the escalator travel direction.

- 11.1.23 Voice announcement system shall be provided for each escalator. The voice announcement system shall allow broadcasting of safety messages which shall be clear and audible at the escalator landings. The broadcast of messages shall only be activated when there are passengers approaching the escalators. For escalators that are located close to each other, the announcement of the messages shall be synchronised. The controller for voice announcement system shall be located inside the Escalator Control Panel (ECP) closet.
- 11.1.24 A status/fault logging system shall be provided and be able to record and display the status/fault codes in a last in first out sequence.
- 11.1.25 A display unit (with a protective cover) indicating the fault code shall be installed at an easily accessible and protected location on the handrail decking at the landing nearest to the control panel.
- 11.1.26 Faults that do not require the attendance of the maintenance staff shall be easily identified to enable the operator to reset the escalator.
- 11.1.27 Earth Leakage Relay Protection shall be provided.
- 11.1.28 Additional requirements for Transit escalators:
 - The track system shall be provided with counter guards throughout the entire step band to prevent the uplifting of the steps and step chain rollers. For areas whereby counter guards cannot be installed, step hooks shall be provided.
 - b) The tracks wearing surfaces shall be a minimum 5mm thickness. This requirement is applicable to the step roller track and the chain roller track for both the passenger side and the return side. The wearing surface of the return track can be of 3mm thick subject to design reviews and acceptance by the Authority.
- 11.1.29 Escalators installed at POBs shall be of outdoor type and suitable for use in local environmental conditions. The designs of these escalators shall be submitted to the Authority to demonstrate its suitability of use in the installation.

11.2 Energy Conservation Requirements

- 11.2.1 An energy saving device to conserve energy by the reduction of speed (standby speed) when the escalator/moving walk is operated at no load shall be provided. During an extended period of no load, the energy saving device shall also be able to reduce the speed from standby speed to stop (standby stop). Provision shall be made to allow the escalator/moving walk to be operated without this energy saving device. In any operating mode the device must not cause abrupt change in speed or jerk. The device shall not cause harmonic feedback to the power supply system or emit electromagnetic interference to other systems. Star-delta operating system shall be provided for the escalator to be operated without the energy saving device.
- 11.2.2 When the escalator is operating at no load, the quantum of energy saved with this device should not be less than 30% as compared to operation without this device.
- 11.2.3 Piezo contact mat mounted underneath the landing floor plate and radar/photo sensor installed at the newels end shall be used as the detection means for energy saving device. Other means of detection may be considered.
- 11.2.4 Data and calculation shall be provided to substantiate energy savings on various escalator loadings.
- 11.3 Machine Pits and Closets
- 11.3.1 Controllers and other accessories such as incoming isolators, ITB's and switches shall be housed outside the truss, in wall recess/closet below the escalator or adjacent to the lower/upper landings. Location of the controller shall be kept within 10m of the escalator.
- 11.3.2 The escalator/moving walk controller shall be made of an IP54 spray painted, 1.5mm thick galvanised sheet metal cabinet with hinged door, lockable with a dedicated key. The size of the controller cabinet shall be suitable for mounting into a wall recess/closet that will also be housing the incoming power supply isolator and ITB's. The wall recess/closet shall come with lockable full-louvered doors and the dimensions shall not be greater than 2700mm (wide) x 2400mm (high) x 750mm (deep).
- 11.3.3 Provision shall be made in the controller to ensure that the maximum temperature within the controller shall not exceed 38°C during operation.
- 11.3.4 Escalator landings shall be provided with easily openable, hinged landing plates suitable for access to the drive mechanism. Landing plates and the combplates shall have a non slip high wear resistant, stainless steel 316 surface that will facilitate sectional replacement. Lifting handles shall be provided to facilitate opening of the landing plate. Means, such as hydraulic/pneumatic cylinders, shall be provided so that the force required to lift the floorplate is not more than 200N. All escalator landing plates shall be individually supported without relying on the adjacent landing plates.

- 11.3.5 Corrosion resistant, oil tight drip pans of galvanised sheet of not less than 2.0mm thick shall be provided for the entire length of the truss and shall be of sufficient rigidity to support the weight of workmen. Drip pans shall be designed to collect and drain off both oil from the machines and water, which may enter through the landings, floor plates, exposed portions of escalators and moving walks or from fire suppression systems. All gaps shall be properly sealed to prevent leakage. Means shall be provided to drain and collect any excess lubricating oil from the chains to removable container(s) at the lower landing machine pit for easy removal and cleaning.
- 11.4 Cable Requirements
- 11.4.1 All cables used except those within enclosed closet or trunking/galvanised steel conduit shall be of the fire resistant/retardant type.
- 11.4.2 All cables shall run in galvanised steel conduit or galvanised steel trunking. The steel conduit shall comply with SS100 and BS4568 Part I & II, Class 4. The steel trunking shall comply with SS249. All galvanising of cable support shall be in accordance to BS729 and BS4921.Compression glands for cables shall comply with BS6121. Flexible conduit used shall be enhanced low fire hazard, polyolefin covered galvanised steel conduit. All conduit outlets shall be bushed appropriately. All cable support connections including to all electrical fixtures shall be watertight.
- 11.5 Safety Requirements
- 11.5.1 Three sides of each step/pallet shall be provided with fluorescent yellow demarcation lines of at least 20mm wide, made of one homogenous polymer material and do not emit toxic gas when burnt. The groove at the step nose shall be fluorescent yellow powder-coated with at least 20mm wide. Skirt brush guards of accepted design complying with SS626 shall be provided along the skirt panel to enhance passenger safety.
- 11.5.2 Emergency Stop Switch of the recessed, momentary pressure and emergency push button stop type with extended sleeve to protect against accidental operation shall be provided on each escalator and moving walk. A minimum of one switch shall be located in conspicuous and accessible positions at the incline section/treadway as well as at the newel at both ends of the escalator/ moving walk. The distance between the switches shall not exceed 15m and 40m for escalators and moving walks respectively. The operation of any one of emergency stop switches shall disconnect electrical power to the drive mechanism and activate the brake(s). It shall not be possible to re-start the drive mechanism by the use of these switches. To prevent vandalism, a transparent cover marked 'STOP' shall be provided over these buttons. A self-resetting, audible warning alarm/bell shall be activated once the cover is lifted. The design of these covers shall be integrated with the escalator and subject to the acceptance of the Authority.

- 11.5.3 Step and Skirt Safety Detection Devices shall be provided in escalator skirting panels in close proximity to the upper and lower comb plate tips, on the track system at the upper and lower curves and at 7.5m intervals along the incline of each escalator. Electrical power to the drive mechanism shall be disconnected and the brake(s) applied should any one of these devices be activated due to the skirt panels being forced away from the steps.
- 11.5.4 A detection device shall be provided to stop the escalator/moving walk in the event of unintentional reversal of direction from the pre-set direction of travel. The detection device shall directly detect the direction of the moving steps/step chains instead of indirect means such as directions of the motor/gear shaft or coupling.
- 11.5.5 A missing step detection device shall be provided, which shall stop the escalator before the step opening appears on the passenger side of the escalator.
- 11.5.6 Directional traffic signs shall be provided on the right side of the newel at both landings of each stainless steel balustrade escalator/moving walk. For glass balustrades, traffic signs shall be provided on the right and left inner deckings at both landings of each escalator/moving walk. The traffic signs shall be LED type indicating a green arrow for "Enter", and a white bar against red back ground for "No Entry" blinking sign.
- 11.6 Corrosion Resistance And Material Requirements
- 11.6.1 Escalator components shall be protected against corrosion as follows:

Component	Protection
Truss, balustrade supports, floorplate	Hot-dipped galvanised, minimum
and combplate supporting structure and	thickness 85µm.
backing	
Tracks	Electro-galvanised, minimum
	thickness 25µm
Handrail guides steel profiles/brackets	Stainless steel.
Step chain	Special protection against dust, water,
	mechanical damage, etc during
	installation shall be provided.
Steps	Stainless steel/Aluminium
Landing plate	Stainless steel grade 316.
All bolts, nuts, shims and other	Stainless steel/sheradised.
hardware	
Balustrade profiles, interior balustrade	2mm thick, stainless steel hairline
panels, skirt panels, outer cladding	finish.
panels	

12 Air-Conditioning And Mechanical Ventilation System

- 12.1 Pipe Works
- 12.1.1 Pipework Materials

Pipework specification for the various services shall be in accordance with the Table 12.1.1.

Table 12.1.1 Pipework Materials

Condensate Drain Pipe (for fan	UPVC pipes.
coil units and split units or PEU)	
Refrigerant Pipes	Hard copper pipes to ASTM B280.

- 12.2 Sheet Metal Ductwork and Accessories
- 12.2.1 All sheet metal ducting shall be constructed of hot-dipped galvanised steel sheet and conformed to SMACNA or BESA DW/144 Specification for Sheet Metal Ductwork, Low, Medium and High Pressure/ Velocity/ Air Systems, UK. Application and usage of ductwork accessories such as flexible joints, flanged joints, sealants, gaskets, hangers & supports shall also comply with SMACNA or BESA DW/144. The galvanised steel sheet shall comply with ASTM A1046/A1046M or equivalent and having self-healing properties that protects the cut-end surfaces from corrosion.
- 12.2.2 Smoke purging system ductwork including the sealant, flexible connection, gasket and accessories, shall be constructed to high velocity/pressure classification of SMACNA or DW/144 and shall be suitable for high temperature operation at a temperature of 250oC for at least 2 hours.
- 12.3 Ductwork Insulation
- 12.3.1 All air-conditioning system supply air and return air ductwork shall be thermally insulated. External thermal insulation shall also be applied even though these ducts are provided with acoustic internal lining.
- 12.3.2 All fresh air, exhaust air, transfer air ducts within an air- conditioned area and all air-conditioning return air ductworks shall be externally insulated with minimum 25mm thick, minimum 32 kg/m3 density semi-rigid fibre glass board wrapped with a factory applied aluminium vapour barrier jacketing.
- 12.3.3 All air conditioning supply ductwork shall be externally insulated with minimum 50 mm thick, minimum 32 kg/m3 density semi-rigid fibre glass board wrapped with a factory applied aluminium vapour barrier jacketing.

12.3.4 All air conditioning ductworks/pre-treated fresh air ductworks exposed to the weather shall be insulated with minimum 50mm thick rigid closed cell, phenolic foam (fire retardant type) insulation and minimum 15mm thick cement plaster finished on chicken wire mesh with colour painting.

12.4 Pipe work Insulation

- 12.4.1 All refrigerant and condensate pipeworks shall be insulated with a fire retardant, self-extinguishing, CFC free (ozone depletion potential of zero), flexible, black, closed cell, elastomeric nitrile rubber insulation with Class 1 surface flame spread to BS476 Part 7 1997 and Fire Propagation (Total Index of Performance (1) less than 12 and Sub Index (i) less than 6) to BS476 Part 6 1989. The insulation shall be encased in a metal jacket or trunking even though they are installed inside the ceiling void and concealed space.
- 12.4.2 Thickness of the pipework insulation shall be as shown in Table 12.4.1.

Type of Piping System	Nominal Pipe Size (mm)	Minimum Thickness of Insulation (mm)
Condensate Drain Pipework	All	15
Refrigerant Pipework	Up to 25 Above 25	25 40

 Table 12.4.1 Pipework Insulation Thickness

- 12.5 Air Filters
- 12.5.1 Provision of air filters for ECS shall comply with SS 554 requirements.
- 12.5.2 PEU shall be provided with washable air filters manufactured from anti-fungal material for primary filtration. Filters shall be rigid-frame and readily removed/ replaced.
- 12.6 Air Curtain
- 12.6.1 The air curtain shall be provided with either wall-hang or ceiling suspended mounting and interlock with the FCU / AHU.

- 12.6.2 Air curtain shall have 2-speed fan (high, low and off) with a push-button switch provided in the unit.
- 12.6.3 Air deflection vents/louvers shall be provided for adjusting the airflow direction.
- 12.6.4 The effective velocity at the design point shall not be less than 2 m/s.
- 12.6.5 1 no. 13A switch socket outlet each for air curtain above automatic sliding door.
- 12.7 Fans
- 12.7.1 The fans shall deliver the air volumes and pressures as specified when tested to the ANSI/AMCA standard 210 or equivalent ISO and EN standards.
- 12.7.2 The fans sound power levels shall be detailed in octave bands from tests carried out in accordance with ANSI/AMCA standard 300 or equivalent ISO and EN standards.
- 12.7.3 Fans with airflow rate larger than 1 m³/s shall be selected with a combined fan and motor efficiency of minimum 70%. The combined fan and motor efficiency shall be calculated using the following formula:

Efficiency (%) = $\frac{\left[\text{Airflow (m³/s) \times Total Pressure (Pa) \times 100\%}\right]}{\text{Motor Power Input (kW)}}$

- 12.7.4 The fans shall be statically and dynamically balanced and factory tested in accordance with ANSI/AMCA 204.
- 12.7.5 Terminal box for the motor cables shall be made of galvanised steel and mounted on the fan casing with sufficient space for cable entry and termination. The terminal box cover shall be provided with gaskets to prevent ingress of dirt and moisture. Stud type terminals shall be provided for termination of cables.
- 12.7.6 Motors for fans shall be of minimum Class F insulation to IEC 60034 and shall be rated for continuous operation in ambient temperature of 40°C and in humid air conditions up to 100% relative humidity.
- 12.7.7 Flexible connectors used for connection of ducts to fans shall have same temperature and fire rating as that of the associated fan and ductwork system.
- 12.7.8 The fans shall be supported by spring type vibration isolators as recommended by the manufacturer to prevent transmission of vibration to the structure.
- 12.7.9 The fans accessories such as flanges, hanger brackets, bell mouths, etc. shall be provided by the fan manufacturer.

- 12.7.10 All necessary brackets, hangers and threaded components, including bolts, nuts, inserts and washers shall be sheradised mild steel to BS EN 13811 with Class 45 coating or hot-dip galvanized steel to BS EN ISO 1461. Bolts, nuts, washers, fittings, flanges, etc. of different materials shall be suitably insulated to prevent galvanic corrosion.
- 12.7.11 An air-tight access door shall be provided on the fan housing or the adjacent ductwork to allow convenient maintenance access for inspection or cleaning of the fan impeller and motor.
- 12.7.12 Support beams, support legs, platforms, hangers, anchor bolts and vibration isolators for the proper installation of equipment and maintenance of equipment shall be designed. Sufficient numbers of permanently attached lifting eyes for on-site assembly and disassembly of fan units shall be provided.
- 12.7.13 Fans for smoke control systems shall be suitable for operation in atmosphere of 250°C for 2 hours and shall also conform to the following:
 - a) Motors shall have minimum Class H insulation to IEC 60034.
 - b) Motor winding shall be insulated to permit the motor operation at the design conditions for a period of not less than two hours in an air temperature of 250°C.
 - c) All finishes shall be factory-applied and shall be certified by the respective manufacturer that the finishing materials are capable of withstanding exposure to an air temperature of 250°C for a period of not less than two hours without producing smoke or toxic fumes.
- 12.8 Air-cooled Split-type Variable Refrigerant Flow (VRF) Air Conditioning Units
- 12.8.1 Air-cooled split-type air-conditioning units shall consist of one or more indoor package evaporator units (PEUs) and an outdoor package condensing unit (PCU), control and the inter-connection wiring, piping and accessories.
- 12.8.2 Air-cooled variable refrigerant flow (VRF) air-conditioning units shall consist of multiple PEUs connected to one PCU, control and the inter-connection wiring, piping and accessories.
- 12.8.3 Capacity of the air-conditioning units selected shall comply with both the minimum sensible and total cooling capacities specified.

- 12.8.4 PEUs installed inside electrical and electronic rooms shall be of ducted type and provided with secondary drain pans. The secondary drain pans shall be connected to the condensate drainpipe. Avoid locating PEUs and their associated pipe connections, joints, valves, refrigerant pipes, condensate drain pipes, etc. directly above electrical/electronic equipment. Refrigerant pipe runs within the equipment rooms shall also be minimised to reduce the risks of water damage to the electrical/electronic equipment. If unavoidable, drip trays/pans shall be provided for refrigerant pipes or wet pipes which are routed above electrical/electronic equipment. If unavoidable, drip trays/pans shall be provided for refrigerant pipes or wet pipes which are routed above electrical/electronic equipment.
- 12.8.5 Secondary drain pans shall be constructed of stainless steel sheets and epoxy coated and provided with adequate fire retardant closed cell foam type insulation sandwiched in between the stainless steel sheets. The secondary drain pan shall cover the entire PEU and all associated valves/fittings at the inlet and outlet pipe connections.
- 12.8.6 Air-conditioning units shall be tested and rated in accordance with AHRI 210. They shall also comply with the applicable provisions of AHRI and SS 530. The efficiency of the air-conditioning units shall be 0.9kW/RT or better.
- 12.8.7 When sizing the refrigerant pipes, the piping length between the PEU(s) and PCU(s) shall be take into consideration. The number of bends shall not exceed the manufacturer's recommendation.
- 12.8.8 Refrigerant for the air-conditioning units shall have ozone depletion potential (ODP) of zero or with a global warming potential (GWP) of less than 100
- 12.8.9 Units shall be entirely assembled, completely piped, wired, charged and factory tested.
- 12.8.10 All components shall be dehydrated, sealed and shipped with holding charge/refrigerant.
- 12.8.11 Equipment shall be properly stored, well covered and protected until ready for installation.
- 12.8.12 Equipment shall be protected from either mechanical or corrosive damage during storage and installation.
- 12.8.13 All necessary supporting steelworks required for the proper installation of the units shall be provided. All supporting steelwork including bolts, nuts, washers and screws shall be galvanized to BS EN ISO 1461.
- 12.8.14 Air-conditioning units shall generate minimum vibration and noise during operation. Additional vibration isolators and sound attenuators shall be provided by the Contractor without extra cost if noise and vibration are found excessive and not within the acceptable limits.

- 12.8.15 All acoustical and thermal insulation including facings and adhesive shall be non combustible with a surface flame spread rating of not lower than Class O and shall comply with the latest requirements of the local fire regulations.
- 12.8.16 All cold parts e.g. accumulator, air dryer, pipes etc. shall be insulated to prevent condensation occurring and wetting of the floor.
- 12.8.17 The manufacturer's name, serial and model number and data of manufacture shall be securely attached to each unit.
- 12.8.18 The equipment and appurtenance shall fit into the space provided and shall be easily serviceable.
- 12.8.19 After completion of testing of piping and accessories, the system shall be charged with refrigerant in accordance with the manufacturer's recommendation.
- 12.8.20 For system with multiple PEU(s), isolating valves shall be provided on the refrigerant piping for isolation of individual PEU.
- 12.8.21 Where PEUs share a common condensate drain pipe, an isolation valve shall be provided near to each PEU drain outlet to facilitate isolation for maintenance. Not more than three PEUs shall be connected to a common drain pipes.
- 12.8.22 For brazing of refrigerant pipework, nitrogen gas shall be continuously charged into the pipe from one end and discharged from the other end of the pipe. This is to prevent oxidation occurring on the internal surface of the pipe during brazing.
- 12.8.23 Noise level for the condensing unit shall not exceed 55dBA when measured at 1m in free field condition in any direction and shall not exceed NEA noise level requirement.
- 12.8.24 The sound pressure level at 1m away from the PEU shall not exceed 54dBA at its highest fan speed.
- 13 Fire Sprinkler System
- 13.1 The Fire Sprinkler System shall comprise the following:
 - a) One sprinkler jockey pump and two main sprinkler pumps.
 - b) Sprinklers, pipework, valves, fittings and etc.
 - c) Electrical control panels, wirings, accessories and etc.
- 13.2 The sprinkler control valve set(s), sprinkler pumps and control panel shall be housed in the fire pump room.
- 13.3 Sprinkler Heads

- 13.3.1 Tools shall also be provided to facilitate removal of sprinkler heads.
- 13.3.2 Sprinklers shall be of FM approved or UL listed.
- 13.3.3 Sprinkler heads shall be glass bulb type with temperature rating of 68°C and shall be colour coded according to the approved standards. In areas of above normal temperature, high temperature sprinklers suitable for the temperature condition shall be provided in accordance with SS CP 52.
- 13.3.4 Sprinklers shall be of conventional pattern designed to produce a spherical type of discharge with a portion of water being thrown upwards to the ceiling. Sprinkler shall be designed with universal deflector enabling the sprinkler to be installed in either the upright or pendant position. Where applicable, the sprinkler heads shall be fitted with water shields and/or protective guards of an approved type.
- 13.3.5 Exposed sprinklers for areas with false ceiling such as shops, offices, corridors etc. shall be designed for use with pipework within the ceiling space and shall be installed complete with ceiling plate (rosette) flush to the false ceiling. Sprinklers shall be of standard chrome finish. Ceiling plates shall be chrome plated or finish to the acceptance of the Authority.
- 13.3.6 Protective guards of approved type shall be fitted to each sprinkler head in the area where sprinklers are located less than 2 metres above floor level and where they are liable to accidental and mechanical damage. Sprinkler heads installed in the escalator pits shall be fitted with protective guards. Where applicable or required, these sprinkler heads shall be of the side throw type.
- 13.3.7 The Contractor shall ensure that the regulations in SS CP52, are complied within his installation with regards to maximum and minimum spacing between sprinklers on range pipes and between adjacent rows of sprinklers, maximum distance of sprinklers from walls or partitions, maximum distance of sprinkler heads below ceiling or roofs, minimum horizontal distance of sprinklers from beams etc.
- 13.3.8 Easily accessible flushing facilities shall be provided for each zone to discharge to the nearest drainage outlet.

- 13.4 Sprinkler Control Valve Set, Electrically Supervised Gate Valve and Accessories
- 13.4.1 Sprinkler control valves shall be supplied and installed. Each sprinkler control valve set shall comprise the following:
 - a) Main stop valve
 - b) Alarm valve
 - c) Alarm devices including water motor alarm gong, pressure switch, etc.
 - d) Facilities for water proving testing to suit the SCDF and SS CP52 requirements
 - e) Glycerine-filled pressure gauges to indicate 'upstream' and 'downstream' system pressures
 - f) Electrically supervised device for valve closures.
 - g) Other equipment as necessary
- 13.4.2 The stop valves must be 'right handed' and the controlling wheels shall be clearly marked showing in which direction the wheels are to be turned to close the valves. There must be individual indicators which shall show whether the respective valves are open or shut. The stop valves controlling water supplies shall be secured open by individual pad-locked straps.
- 13.4.3 The alarm valve shall be fixed on the main supply pipe immediately above the main stop valves. The alarm valves shall be of an approved type and shall have all necessary connections of the correct size for connections to glycerine-filled pressure gauges, water motor alarm, combined drain and test valve etc.
- 13.4.4 The electrically supervised gate valves shall be with integral limit switches.
- 13.5 Alarm Gong
- 13.5.1 Water motor alarms of approved type shall be supplied and fitted close to the sprinkler control valve set. Each water motor alarm shall comprise a fire alarm gong with a turbine to operate whenever the alarm check valves are being operated. The water motor alarms shall be suitably mounted on the wall above the alarm valves and all pipe connections shall not be less than 20mm diameter. Each water motor alarm shall be arranged to drain through a non-ferrous fitting with an orifice. Drain lines shall be connected to water drain or sump pit in which the water will ultimately be discharged to surface water drains.
- 13.6 Pressure Switches
- 13.6.1 Pressure switches shall be provided for the control of the pumps. They shall be of the approved type and in compliance with the requirements of the relevant standards and codes. Pressure switches shall have adjustable settings which shall be set to comply with the requirements of the relevant codes and standards for all pumps in a chart.

- 13.6.2 Settings of pressure switches shall be labelled for all pumps in a chart. The chart shall made of perspex complete with reverse colour silk-screen printing and labels indicating clearly the pressure settings. The chart is to be located near to the pressure switches.
- 13.7 Flow Switches
- 13.7.1 Flow switches shall be of paddle type and of approved type. The paddle shall be suitable for the pipe size installed. Flow switches shall be complete with addressable interfacing unit.
- 13.7.2 The flow switch shall have a single pole double throw (SPDT) mechanism which makes or breaks the electric circuit when water flows. All components of the flow switch that come in contact with the water shall be made of <u>polyethylene or polypropylene</u>.
- 13.7.3 Contacts shall be suitable for the working voltage and current of the circuits controlled, and shall be of silver or approved alloy.
- 13.7.4 Adequate space shall be allowed above the pipework for the installation of flow switches.
- 13.7.5 Flow switches, which shall be of the self-resetting type and shall be installed in accordance with the manufacturer's recommendations.
- 13.7.6 Flow switches shall incorporate retards or time-delay devices to avoid false alarms due to surges.
- 13.7.7 The electrical contact block shall be completely sealed from the water in the pipeline.
- 13.7.8 Where flow switches are installed within ceiling spaces, access panels shall be provided to facilitate maintenance of the flow switch. The location of each flow switch shall be clearly identified on the access panel. The flow switch interfacing module shall be provided with enclosure of IP rating 55.
- 13.7.9 Test valves shall be installed immediately down stream of each flow switch to enable local testing. Short drainpipe shall be provided after each test valve and properly terminated with cap. The test valves shall be padlocked in close position and accessible from the floor level.
- 13.8 Pressure Gauges

- 13.8.1 Glycerne-filled pressure gauges shall be provided. Pressure gauges shall be of minimum 100mm diameter, threaded chromium plated brass ring with heavy glass, bronze spring tube, precision movement and micrometer adjustment. Pulsation dampeners, steel pipe fittings and shut off cocks of needle point globe type, all brass, rated for 1035kPa or 1.5 times the working pressure whichever is higher shall be provided. Pressure gauges shall be installed with gauge cocks mounted in a location where they can be easily read. Pressure gauges shall be complete with built-in compensators for fluctuation in external factors such as temperature, humidity and etc.
- 13.9 Flow Meter
- 13.9.1 Flow meters with direct readings shall be provided for control valve installation. They shall be suitable for the system operating range. Data on flowrate and operating pressure shall be engraved on metal plate and installed near the equipment subject to the Authority's acceptance.
- 13.10 Sprinkler Tank
- 13.10.1 The installation of the water storage tank for sprinkler (preferably RC construction) shall comply with the PUB requirements.
- 13.10.2 The tank shall be water tight and free from leaks, wetness and dampness.
- 13.10.3 The tank shall be rendered mosquito proof when installed.
- 13.10.4 Pilot float valve shall be provided for control of incoming water to the sprinkler water storage tank. Pilot float valve shall be of approved type to BS1212 and approved by PUB. It shall be ductile iron construction with stainless steel seat and stem. The valve shall be capable of withstanding a 1550KPa test pressure. The connection shall be of flange joint for size diameter 100mm and above.
- 13.10.5 The tank shall be internally partitioned into two separate compartments. Each compartment shall be provided with one access manholes of minimum 600 mm x 600 mm with hinged covers. The manhole shall be used for access into the water tank compartment and inspection and maintenance of the float valve. Edges of the manhole shall be properly finished smooth or trimmed. Floats for the float valves shall be fabricated from copper with all joints brazed.
- 13.10.6 Cowl type vents of 100 mm diameter and overflow fittings shall be provided for each compartment.
- 13.10.7 Holes for tapping pipe connections shall be machined out.
- 13.10.8 The tank shall be provided with access cat ladders permanently fixed in place. The ladders shall be provided adjacently to the manholes and shall be non-corrosive type.

- 13.10.9 Visual water level indicators, with the necessary levels and lettering neatly and clearly marked, shall be provided. Electrode type "High/low" water level sensors shall be provided and these shall be wired back to the pump control panels and MAP. The indicators shall show high level and low level. Visual water level indicators shall not be glass tube type.
- 13.10.10 Vortex inhibitor for the sprinkler tank shall be incorporated so that the effective capacity can be maximised.
- 13.10.11 Adequate clearance of minimum 1000 mm shall be provided all round the tank to facilitate erection, inspection and maintenance of the tank. The clearance at the top of the tank shall not be less than 750 mm for access to the top of the tank. The access manholes or the cat ladders shall not be obstructed by other services.
- 13.10.12 Overflow and warning pipes shall be provided. Flow switch for warning pipe shall be provided and to be wired to the MAP.
- 13.10.13 Puddle flanges for connection shall be provided.
- 13.10.14 Air vents and overflow fittings shall be provided for each compartment.
- 13.10.15 The ladders, concrete platforms hand railings and access doors shall be supplied and installed for tank access.
- 13.10.16 All pipe penetrations provided shall be complete with puddle flanges and cast in the tank wall.
- 13.10.17 The pipes penetration through the tank wall and the position of the cat ladders and the concrete platforms shall be co-ordinated so as to avoid any clashes with the fire protection system and to ensure that they are suitable for their intended purposes.
- 13.10.18 All exposed opening for the tank and pipe ends (such as drain pipes, vent pipes and overflow pipes, etc.) shall be completed with insect screen.
- 13.11 Sprinkler Breeching Inlets
- 13.11.1 The breeching inlets shall be approved by the local authorities and listed under the Product Listing Scheme.
- 13.11.2 All fittings shall be on the external wall and enclosed in a glass-fronted stainless steel cabinet complying with the requirements of BS 5041 : Part 5. The breeching inlet shall be recessed.

- 13.11.3 The breeching inlet connection shall be electrically earthed and it shall be properly earthed to ground using properly sized copper tapes. The Contractor shall provide an independent earthing system. A weep hole or drain outlet shall be provided to drain off any residual water within the breeching inlet box. The earthing continuity across pipe joint shall be maintained using copper tape with proper metal to metal contact. The maximum allowable earth impedance shall be less than 10 ohms.
- 13.11.4 Caps for the breeching inlet shall be of approved brass type and held close by means of a spring lock with a sufficient length of stainless steel chain.
- 13.12 Pumps
- 13.12.1 This part specifies the furnishing and installation of sprinkler, jockey pumps.
- 13.12.2 Pumps shall be capable of achieving the nominal flow rate against the head of the system.
- 13.12.3 The operating head shall be designed and verified based on the equipment selected and upon the characteristics of the pipework system actually installed.
- 13.12.4 Calculations together with certified performance curves of the pumps with the operating range indicated shall be submitted for Authority's acceptance.
- 13.12.5 Pumps shall be furnished by experienced manufacturers normally supplying this type of equipment, and who can show evidence of having furnished such equipment that has been in successful operation for at least five years.
- 13.12.6 Pumps shall be listed under the Product Listing Scheme and shall be affixed with labels from the listing agency.
- 13.12.7 Pump Construction
 - a) Sprinkler pumps shall be of the centrifugal volute, constant speed, single stage, single end suction, base or frame mounted and flexible coupled to motor drive. The casing shall be arranged for easy removal of impeller, bearings and seals without dismantling connecting piping. Casing shall be provided with drain and vent cocks.
 - b) Jockey pumps shall be of centrifugal vertical-in-line type. The sprinkler jockey pumps shall have rated capacities not less than any normal leakage rate and not more than the flowrate when any one of the sprinkler is burst. They shall have discharge pressures sufficient to maintain the desired system pressure.
 - c) The pump casings shall be of close-grain cast-iron accurately machined and assembled with metal to metal joint.

- d) The impellers shall be made of bronze and designed to give nonoverloading characteristics over a large range of head variations. The impeller shall be statically and dynamically balanced. Impeller rings shall be of cast-iron and removable, secured from relative movement by stainless steel and rotation ring. The shaft shall be of machine ground stainless steel.
- e) Bearings shall be self-aligning, radial and thrust ball-type, grease lubricated. Bearings shall be of the silent type.
- f) Pump glands shall be packing seal type. Shaft sleeves shall be bronze removable type. Drain pipe shall be provided to drain any leakage's through the pump seal into the nearest floor waste or sump pit.
- g) Pumps shall be capable of running under conditions of zero or low 'drawoff' continuously without overheating. This shall be achieved by an automatic bypass circuit arrangement i.e. an automatic pressure relief valve and pipe at the pump discharge side.
- h) The pumps shall be directly driven by a totally enclosed fan cooled motor. Motors shall be equipped with sleeve bearings and speed shall be compatible with pump speed and shall not exceed 2900 r.p.m.
- Flexible coupling shall be provided between the pump and motor, and shall be of the steel pin/rubber bush type, accurately aligned. It shall be noted that the coupling is required to reduce shock, excessive wear and tear to the bearings etc. and is not there to compensate for misalignment. The pin and bush coupling require the same accuracy of alignment as rigid couplings, and the Contractor shall demonstrate correct alignment.
- j) Removable hot-dip galvanised sheet metal coupling guard shall be provided.
- 13.12.8 Pump Base Plate and Plinth
 - a) The pump and motor combination shall be mounted on a substantial machined baseplate of fabricated steel and a suitable inertia block and the complete unit mounted on a suitably reinforced concrete plinth with anti-vibration mounting. Concrete plinth of at least 150mm shall be provided.
 - b) The base depth shall be as recommended by the pump manufacturer for mass or rigidity, but shall not be less than 150mm.
 - c) The inertia block shall be sized to obtain minimum 1.5 : 1 ratio (inertia block/equipment mass ratio). Thickness of the inertia block shall be at least 150mm and not exceeding 300mm. The inertia blocks shall support the pipework up to and including the first elbow before the vertical riser. The minimum total static deflection shall be 20mm.
- d) Holes for foundation bolts, or the bolts shall be cast into the block. Foundation bolts shall be painted with anti-rust primer before installation.
- e) Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflection during pump running.
- f) Spring-type isolators shall be completed with 8mm neoprene acoustical friction pads between the baseplate and support.
- g) All mountings shall have levelling bolts that must be rigidly bolted to the equipment.
- 13.12.9 Maintenance Facilities

Pump installation shall be complete with adequate facilities for maintenance and future replacement of Plant. Lifting eyes shall be provided for pumps and motors.

13.12.10 Guards

All moving parts of the pump and motor shall be adequately guarded by a wire mesh screen of sufficient strength to avoid distortion under normal usage.

- 13.12.11 Flexible Connectors
 - a) Flexible connectors shall be used on the pump outlet and inlet.
 - b) Flexible connectors shall be of stainless steel of grade 316 convoluted bellows type expansion compensators complete with all necessary guides, etc.
 - c) Flexible connectors shall be manufactured with floating steel flanges recessed to lock the connector's raised face neoprene flanges.
 - d) All connectors shall be rated at a minimum of 1.5 times of the working pressure of the system.
 - e) All connections shall be made with flanged sphere properly pre-extended as recommended by the manufacturer to prevent additional elongation under pressure.
- 13.12.12 Automatic Pressure Relief Valve

- a) Each pump shall be provided with an automatic pressure relief valve set slightly below the shut-off pressure of the pump. It shall provide circulation of sufficient water to prevent the pump from overheating when operating with no discharge. Provisions shall be made for a discharge back to the sump. The relief valve shall be labelled with the setting pressure.
- b) When the jockey pumps have a shut-off (churn) pressure exceeding the working pressure of the fire protection equipment, a suitable relief valve shall be installed on the pump discharge to prevent damage to the fire protection system. An orifice plate shall be installed at the discharge pipe of the jockey pump.
- 13.12.13 Electric Motor for Fire Pumps
 - a) The correct selection of the electric motors for the fire pumps shall be the responsibility of the Contractor.
 - b) Motor rating shall be rated for continuous operation at the ambient temperature of 40°C. Motors shall be totally enclosed fan cooled type and motor insulation shall be BS EN 60085 class 130 or better.
 - c) Motors shall be suitable for continuous operation on voltages within ±10% of the supply voltage. Motors above 2.2kW shall be three phase 400V or 415V (where applicable), 50Hz. Motors up to and including 2.2kW shall be single phase 230V or 240V (where applicable), 50Hz.
 - d) Bearings shall be precision grade, anti-friction, deep grooved ball type and extra quiet.
 - e) All motors shall be suitably earthed to meet SS 638 requirements.
- 13.13 Fire Pump Motor Control Panel
- 13.13.1 The fire pump motor control panels shall be supplied and installed.
- 13.13.2 The fire pump control panel and the associated components, accessories, instruments and relays shall comply with British Standard Specifications, AS, IEC or SS.
- 13.13.3 The control panel shall be of the self-contained, metal clad, cubicle type with flush hinged doors lined with rubber gaskets for front access. Doors shall be provided with car type lockable handles with standardised key locks and 3 sets of keys. The panels shall be suitable either for floor or wall mounting. The panel shall be isolated before the door can be opened for access or maintenance purposes. Floor trunkings supported on C-Channels between the control panel and pump are strictly prohibited.

- 13.13.4 LEDs shall be used to indicate various functions on the control panel. A test and selector switch and ammeter for each pump shall be included in the panel.
- 13.13.5 The control system shall be capable of both manual and automatic operation of the installation.
- 13.13.6 Manual/Off/Auto, manual duty pump selector and pressure switches, and start/stop push button shall be provided. "Manual, Off and Auto" signal shall be transmitted to the MAP. A visual and audio alarm shall also be provided to raise an alarm when the pump trips.
- 13.13.7 The panels shall comprise standardised items, enabling easy exchange or replacement of faulty equipment.
- 13.13.8 There shall be no thermal overload trips for the fire pumps.
- 13.13.9 Any no-volt release mechanism must be of the automatic resetting type such that on restoration of the supply the motor can restart automatically.
- 13.13.10 Each panel shall include an incoming section equipped with load switch and feeder-section furnished with incoming breaker rated to provide protection for the connected cables in accordance with the definition in SS 638.
- 13.13.11 Moulded Case Circuit Breakers (MCCBs)
 - a) MCCBs shall comply with and fully type-tested to IEC 60947-2, shortcircuit performance utilization category A and shall have all mechanical and live metallic components completely enclosed within an all insulating moulded case.
 - b) The operating mechanism shall be independent of operating speed and the over centre toggle action shall provide a quick-make and quick-break switching. Handles shall be trip free. Contacts shall be non-welding.
 - c) MCCB shall have over-current tripping mechanism of the magnetic, circuit protection and instantaneous short-circuit interruption.
- 13.13.12 Single line diagram complete with control circuitry shall be laminated and affixed to the interior of all door panels.
- 13.13.13 Motor Starters
 - a) Motors up to and including 2.2kW shall have direct-on-line starter.
 - b) Motors above 2.2kW up to and including 11kW shall have star-delta starters.

- c) Motors above 11kW shall have automatic transformer or other reduced voltage starters subject to Authority's approval. Taps of 50%, 65%, 80% and 100% of full-load voltage shall be provided for the automatic transformer starters. The starter circuit shall not have any tripping devices.
- d) Starters and contactors contained therein shall comply with the Singapore and/or British Standards and SS CP52. Starters shall be classed for intermittent duty. Contactor type motor starters shall conform to BS EN 60947-4-1.
- e) The starters shall be housed in the appropriate control cabinet board and arranged for automatic and manual control as required. The starters shall have flush mounting START/STOP push buttons, 'on load' integral isolating switch mechanically interlocked with the access door, auxiliary contacts, red pilot lamp to indicate motor 'running' and control circuit fuses.
- f) All starters shall be of electrically held on pattern with no-volt release characteristics but shall not release until the voltage falls below 85% of nominal. Any no-volt release mechanism must be of the automatic resetting type and that on restoration of the supply the motor can restart automatically.
- g) All contactors shall comply with IEC 60947-4-1, utilisation category AC-3.
- 13.13.14 Cabinet Construction
 - a) The cabinet shall be of dead front type and manufactured from minimum 2mm thick electro-galvanised steel sheet using folded sections or angle iron bracing for rigidity of construction.
 - b) The cabinet shall have adequate ventilation, double layer enclosure, weatherproof and be dust, drip and vermin proof, and shall be at least rated to IP55 in accordance with IEC EN 60529. The construction shall be such that it allows for ready access to the interior of the cubicles for operation and maintenance purposes. The opening of a door or the withdrawing of a circuit breaker shall allow access to that compartment only. Continuous galvanised steel sheets shall be provided to completely separate adjacent cubicles or switchgear.
 - c) The cabinet shall be provided with non-ferrous gland plates for the entry of all incoming and outgoing cables. The gland plates shall be drilled on site to suit each appropriate cable.
 - d) Instruments, LED indicating lights, switches, etc. shall be mounted directly on a fixed fascia panel suitably stiffened to hold such items firmly in position under all conditions of operation.

- e) All sheet steel, angles and channel for construction of the panel shall be galvanised and epoxy coated to a minimum thickness of 60 microns.
- f) The front doors shall be electrically interlocked such that doors can only be opened after the power supply is isolated via manual shut down of the circuit breaker. All doors shall be provided with dust-excluding gasket of neoprene or other equivalent and approved material.
- g) Individual pump control panel shall be provided for each fire pump.

13.13.15 Busbars

- a) The panels shall be provided with 3 phase tinned copper conductor busbars. All panels shall also be furnished with neutral (N) having the same rating as the phase busbars.
- Busbars shall be of equal size, rectangular High Density High Conductivity (HDHC) copper section capable of carrying for 3 seconds a through-fault current.
- c) Current ratings shall comply with IEC 61439. Phase indication shall be provided on all busbars.
- d) All connections in busbars shall be bolted or clamped with contact surfaces suitably prepared to prevent oxidation in service, and all through joints and contact parts shall be tinned before connection.
- e) All bolts shall be tightened with an even tension. Approved washer shall be used at all joints. Sherardised to BS 7371: Part 8, class S1, high tensile steel bolts with BSP threads and plated lock nuts shall be used.
- f) A copper earthing bar shall be provided and installed at the base of the full length of the panel. A tee connection from the earthing bar shall project into each breaker compartment for automatic grounding of the chassis when the breaker is inserted into the compartment. The cross-sectional areas of these earthing bars shall be sized for fault currents for faults of negligible impedance in accordance with SS 638.
- g) Sharp right angle bend and twisting of copper bars shall not be allowed.
- h) Minimum spacing between copper bars shall not be less than 60mm.
- i) All copper bars must be hard drawn and tinned and shall have heat sink sleeves to indicate their respective phase.

13.13.16 Earthing

- a) All metal raceway (conduit / trunking / cable tray) systems, supports, cabinets, panels, equipment cases and motor frames shall be permanently, solidly and effectively grounded (earthed). Continuity of equipment grounding shall be maintained throughout the system. Ground clamps shall be approved type, specifically designed for grounding.
- b) Copper-clad strap metal is unacceptable for earthing or bonding purposes.
- c) All non-current carrying metal parts of electrical equipment installations shall be connected to the ground loop as required. These will include wireway, busways, raceways, switchgear enclosures, motor-control centre enclosures, pushbutton stations, motors and any other non-current carrying metal parts which may become energised by accidental contact with line electrical conductors.
- d) The earthing (earth continuity) system shall be fully tested in strict conformance with SS 638.

13.13.17 Instruments

- a) Instruments shall be suitable for flush mounting and shall have square or rectangular type face with moulded plastic escutcheons.
- b) The ammeters and voltmeters shall be of the moving coil type and shall have accuracy class of the instruments of 3 or better.
- c) The voltmeter shall be provided with a selector switch for reading the values of the 3 phases i.e. phase to phase, and phase to neutral voltages.
- d) The scales-width shall not be less than 240 angular degrees and the designation shall be in amperes or volts on matt-white plate. Anti-parallax and anti-reflecting types of platform/covers shall be used. Ammeters shall have compressed scales to cater for motor starting where necessary.
- e) Hour-count meters shall be provided to measure the operating period of each individual pump.
- f) A minimum of 2 nos of anti-condensation heaters shall be installed inside the panel. The power rating of these heaters shall be equivalent to the power dissipated by the panel during normal operation. These heaters shall only be activated when the process system is shut down or inoperative.

13.13.18 Indicator Lights

a) All indicator lights shall be of pilot light and shall be provided in duplicate. The pilot light when lighted shall be visible in lit rooms.

- b) Light Emitting Diode (LED) indicator (green) shall be provided to show that there is electrical supply available to the control panel and this shall be labelled 'MAINS SUPPLY ON'.
- c) LED indicator (colour to latest SS638 requirement) shall be provided to indicate clearly each phase of the electrical power supply for both incoming and outgoing and to indicate the status of each electric motor.
- d) LED indicator (orange) shall be provided to show the failure of any one phase of the electric power supply to the electric motor driven fire pump which shall be labelled 'Pump Fail'.
- e) LED Indicator (red) shall be provided to show that the pumps are not operating and shall be labelled 'Pump Stop'.
- f) LED indicator (green) shall be provided to show that the pumps are running and shall be labelled 'Pump Running'.

13.13.19 Relays

- Relays shall be of first grade, with continuously rated coils and contacts to suit voltages and currents requirements. Relay holders for 24 V DC and 230 V ac shall have different pin configurations and placed at a distance apart.
- b) Care shall be taken in the selection of relays with regard to the use of cables. The Contractor shall ensure that there is no possibility of cable insulation breakdown due to surge voltages which may occur when inductive circuits are opened and closed. If necessary, limiting devices shall be installed and connected.
- c) The phase failure relay shall be of the star-capacitor type, arranged to close its contacts in the event of failure of one or more phases under any condition.
- d) Time delay relays shall be of synchronous motor type, with adjustable time setting up to five (5) minutes and instantaneous reset. The minimum setting shall be one (1) second.
- e) Earth leakage protective relays shall be of the instantaneous type with adjustable settings from 5% to 40% in 5% steps.
- 13.13.20 Nameplates

Each circuit, equipment and instrument of the control panel as well as the control panel itself shall be clearly identified and designated according to its function. The nameplate shall be of white traffolyte laminated white/black/white engraved with black lettering and affixed with stainless steel screws. Details of the labels shall subject to the Authority's Acceptance before fabrication.

13.13.21 Internal Wiring

- a) Wiring within the control panel shall be neatly arranged laced into forms and suitably clamped. All internal wiring shall be installed in wiring channels or conduits as far as possible. Exposed wiring shall be kept to a minimum but where necessary, the wires shall be formed into compact groups suitably spiral-bound together and properly supported. Nonmetallic material is preferred for the channels or conduit. Adhesive cable supports shall be the high bond type and shall not be easily dislodged.
- b) All conductors shall be terminated with suitable pressure type terminal lugs of proper sizes for terminal studs at the terminal blocks or shall be terminated in a manner compatible with the terminals of the instruments. Terminal block shall be appropriately rated. Plug-in type of terminal blocks shall not be used.
- c) All conductors shall run continuously between terminal studs without splices or tape.
- d) All conductors shall be identified by colour coding and labelled at each termination using numbered ferrules with wire number to correspond with Contractor's circuit diagrams. Terminal strips shall also be clearly numbered to conform to the wiring diagram and they shall be provided for all incoming and outgoing cables. In addition, all cable terminations and component circuit references shall be properly labelled.
- e) Terminals shall be of the tunnel type of suitable size for the wire it is to accommodate. Terminals shall be installed in readily accessible positions.
- f) The conductor colour coding shall comply with SS 638 requirements.

13.13.22 Switches

- a) Push button controls shall be of the momentary contact type, and suitable for current of 6A at 230V ac.
- b) Key-operated switches shall be of a rotary type such that the key can only be removed in the normal position. Alternatively, a rotary selector switch may be used with an integral lock, the key of which shall only be removable in the normal position. Rotary switches, with shafts that wear off easily during operation, shall not be used.

- c) Toggle switches shall be of a two-position switch of robust construction and have silver contacts having minimum rating of 5 amperes for 230V ac and 3 amperes for 30V DC.
- 13.14 Miscellaneous
- 13.14.1 The Contractor shall supply and install the following in the pump room:
 - a) Non-fading single line/control wiring diagram (endorsed by PE), etc., shall be framed in a non-reflective transparent plastic/glass board.
 - b) Operation / Maintenance instruction to be framed in a non-reflective transparent plastic/glass board.
- 13.14.2 Fibreboards shall be transparent type and provided at the front and rear of each panel to prevent accidental contact with all live parts. Suitable protection shields shall also be provided at the rear of all front panels with lamps/instruments. Danger signs shall be provided on all protective shields and/or barriers. Carrying handles are to be provided for all removable covers.
- 13.15 Pump Controls
- 13.15.1 The automatic control of the sprinkler pump sets shall provide for the complete system pipework to be pressurised at the adjustable pre-set level. When the system pressure falls, initially the jockey pump shall come into operation to bring the pressure to the required value and then stop when the high limit pressure is reached. Adjustable time delay shall be provided.
- 13.15.2 If the system pressure continues to fall with of the jockey pump operating, the duty sprinkler pump shall come into operation when the pressure falls to another preset level. The jockey pump shall stop when the duty sprinkler pump or standby sprinkler pump come into operation. Once started the sprinkler pump shall run continuously until stopped manually.
- 13.15.3 If the duty pump fails to operate, the standby pump shall automatically come into operation. The pump shall continue to operate until it is manually switched off.
- 13.15.4 Suitable pressure switches and gauges complying with Clauses 13.6 and 13.8 shall be provided to activate the pumps and to monitor the system pressure.
- 13.15.5 Means shall be provided for the sprinkler pumps to be set for lead-lag duty (with changeover) and for the standby pump to operate should the duty pump fail to function after a time lapse (adjustable) upon closing of the starting circuit.
- 13.15.6 Light indicators showing the status of the pumps and the water level in the sprinkler water tank shall be provided on the sprinkler pump control panels and MAPs.

- 13.15.7 The pumps shall be fully operational within 30 seconds after starting.
- 14 Analogue Addressable Automatic Fire Alarm System
- 14.1 General
- 14.1.1 This section specifies the design, supply, and install, testing and commissioning of the electric fire alarm system.
- 14.1.2 The fire alarm system shall comply strictly with the requirements of the FSSD and SS 645.
- 14.1.3 The fire alarm system component shall comprise of the following:
 - a) Micro-Processor Based Main Alarm Panel (MAPs), Sub Alarm Panels (SAPs) and Repeater Panels (RPs)
 - b) Addressable detection devices (such as smoke detectors, heat detectors, linear heat detectors, optical beam smoke detectors, etc.)
 - c) Audio and visual devices (such as alarm bells, buzzers, beacon lights and addressable manual call-points, etc.)
 - d) Coloured mimic panels with LED indicators
 - e) Batteries and chargers
 - f) Electrical wiring, conduits, trunkings, accessories, and etc.
 - g) Communication equipment terminal of the MAPs for interfacing with other SWCs
 - h) Flow switches for the sprinkler system which shall be monitored at the MAPs, SAPs, and RPs
 - i) Flow switches for the hosereel system which shall be monitored at the MAPs, SAPs, and RPs.
 - j) ITBs for interfacing with other systems
- 14.1.4 The system shall operate on 24V DC supply and was designed to give an early visual and audible alarm in the event of fire when any of the manual call points are activated.
- 14.1.5 The system must be protected against lightning and/or voltage surges.
- 14.2 Operational Requirement
- 14.2.1 Upon activation of the manual call point, the alarm signal shall be automatically transmitted directly to the Main Alarm Panel giving both visual and audible indication at the Main Alarm Panel.
- 14.3 Main Alarm Panel

14.3.1 Construction

- a) The Main Alarm Panel shall be wall mounted type and of weatherproof construction.
- b) The cabinet of the Main Alarm Panel shall be fabricated from minimum 2mm thick electro-galvanised steel sheet, epoxy powder coated (signal red in colour to BS 381c requirements) to a minimum thickness of 60 microns. All angles and channels shall also be electro-galvanised.
- c) The cabinet shall be fitted with a lockable door with hardened tempered glass panel. All alarm group indicators and associated switches, voltmeters, ammeters etc shall be visible behind the locked door without opening the door. The door shall be provided with appropriate hinges and lockset and shall not sag when opened, due to its own weight.
- d) The manufacturer's name, model and equipment identification of the alarm system shall be clearly and permanently labelled on the Main Alarm Panel. The above information shall include the type of board and the model number. All brand names, model nos. and other identifications of components shall be left intact to facilitate replacement. A laminated control circuit diagram shall be housed within the cabinet.
- e) The Main Alarm Panel shall be of solid state modular design and with capacity of increasing by 25% the number of zones, by simple addition of zone modules. All spare zones shall be indicated.

14.3.2 Equipment within Main Alarm Panel

a) The Main Alarm Panel and associated control and supervisory equipment shall as a minimum, consist of the following items:

Alarm group or zone facilities. Individual reset switches per indicator. Facilities for testing and maintenance in accordance with the requirements of the FSSD. Battery test facilities with voltmeter and ammeter. Battery test switch. Audible fault alarm. Audible fault alarm. Audible fault isolation switch. Lamp test button. Indications for mains power supply on. Indications for mains power failure. Alarm / Fault acknowledge. Reset buttons. Trickle / Boost charge. Indications for charge failure.

- 14.3.3 Self-monitoring of MAP
 - a) The MAP shall have a continuous automatic self-monitoring capability. In the event of a malfunction / failure of any component or device, an audible and visual fault alarm shall be triggered and displayed on the LCD screen with indication of the location and nature of the fault. The following shall be continuously monitored:

Fault in microprocessor unit Fault in ROM/EPROM memory Fault in power supply/charger/battery Fault in communication system/modem Error in software (program) configuration Error in hardware configuration

- b) For accurate location of faulty parts within the MAP, each plug-in card shall have LED indicators. The fault warning audible signal shall be distinctive and of a different tone from the audible fire alarm.
- c) Provision shall be made for cancelling the audible signal only while the fault visual indication remains on. Upon removal of the fault, the MAP shall automatically reset the fault signal.

14.3.4 Alarm group or zone testing

a) The switches, which shall preferably be of the push button type, and indicating facilities listed below shall be provided for each alarm group or zone. Means shall be provided to enable each switch or indicator to be readily identified; a common identification of the switch positions on the front of the Panel is acceptable.

Alarm Indicator: A red indicator designated 'alarm' for each zone or group which indicates on alarm only. Two bulbs are to be provided per indicator.

Fault indicator: An amber indicator designated 'fault' for each zone or group, which indicates on fault only. Two bulbs are to be provided per indicator.

Inhibit indicator: A green indicator designated 'inhibit' for each zone or group, which indicates on inhibition only. Two bulbs are to be provided per indicator.

Alarm test: Test facilities to simulate the action of the manual call-point in the alarm condition for each group or zone.

Fault test: Test facilities to produce a circuit fault condition in the supervisory circuit of the wiring to the manual call-points. The fault test facilities shall simulate also both the positive to earth and negative to earth fault conditions.

Inhibition facility: An alarm group or zone inhibition switch clearly designated 'inhibited' to disconnect each individual alarm group or zone from the Panel common circuitry. Operation of the switch shall prevent the alarm group from initiating either alarm or fault signals but shall not impair the normal functioning of any other alarm groups or zones associated with the Main Alarm Panel alarm.

- b) A common indicator designated 'group inhibited' shall be lighted on the Panel to show when any group is inhibited; the particular group inhibited being indicated by the position and labelling of the 'inhibited' switch.
- c) The alarm and fault signals for each alarm group or zone shall be latched on at the existing Main Alarm Panel. The panel shall be reset after the alarm or fault condition has been cleared. Different audible alarms shall be provided to differentiate between that for "Fault" and for "Alarm".
- d) When the audible signal is silenced by manual operation of a silence or acknowledge switch, any flashing signal then existent shall be replaced by a steady signal.

- e) All indicators shall be long-life low quiescent current LED's (light emitting diodes).
- 14.3.5 Power
 - a) The source of electricity supply for the alarm system shall not exceed 24V DC. In no case shall the voltage be less than 6V.
 - b) The power supply equipment for the fire alarm system shall be exclusive to the alarm system. The supply shall be in the form of storage batteries designed for float charge and maintained by a continuous constant voltage charger.
 - c) An approved self-resetting current-limiting device shall be installed in the circuit between the battery and the system, and such device shall be located at or adjacent to the battery location.
- 14.3.6 Battery Charger and Capacity
 - a) A battery charger of the appropriate type and rating shall keep the storage batteries under constant voltage charge. The charger shall incorporate automatic control features with output designed to charge and maintain the cells within the limits specified by the battery manufacturer, taking into account any quiescent load imposed by the associated system. The charger shall be connected to a separate circuit with a switch that shall be satisfactorily labelled to indicate that it controls the fire alarm system. Fault warning shall be given in the event of failure of the main supply or of the charger. The charger shall also be designed to provide for a short duration boost charge.
 - b) An isolating switch to interrupt the battery charger 'mains' supply shall be provided adjacent to the charger. This switch shall be within the cabinet when the charger is fitted in the Main Alarm Panel and the condition of the 'mains on' shall be indicated by a LED.
 - c) The storage batteries shall be 24V DC sealed and maintenance-free dry type and compatible with the charger. Calculations to substantiate the compatibility with the charger shall be provided.

- d) The capacity of the storage battery used to energise the alarm system shall be such that in the event of mains failure, the battery is capable of maintaining the system in normal working condition to comply with SS 645. Thereafter it shall be capable of supplying an additional load, resulting from an alarm originating in two separate alarm groups for a period of half an hour. In addition it shall be capable of supplying the full emergency evacuation alarm load for a period of at least 10 minutes. The Contractor shall submit detailed calculations to justify the capacity of the battery and the battery charger and their compatibility. A switch for disconnection of the battery shall be provided.
- 14.3.7 Identification and Labelling

Each alarm zone indicator, test switch and control etc on the Main Alarm Panel shall be clearly identified by the use of engraved laminated labels. The zone number and area, room served shall also be identified.

- 14.3.8 Mimic Panels
 - a) Mimic Panels (MPs) with LED indications of the development's layout and details relating to the fire alarm zones, hosereels, breeching inlets, standby hoses, alarm bells, call points, electrically supervised gate valves, landing valves, flow switches, sprinkler control valves, fire extinguishers, MAPs, SAPs, CGPs, LHDPs and RPs locations, etc. shall be supplied and installed. The MP layout drawings shall be submitted for the Authority's review and acceptance prior to fabrication.
 - b) The MP shall be of perspex sheet silk screened on the reverse side. The MP shall be installed within a locked enclosure. Where space permits, the mimic diagram shall be installed within a recessed space besides the MAPs and SAPs. The MP shall not fade on exposure to sunlight and ultraviolet light.
 - c) One red LED light shall be provided on the MPs for each zone and it shall light up when fire or smoke is detected in that zone. One red LED light shall also be provided on the Mimic Panel for each clean gas cylinder room and it shall flash when clean gas leakage is detected in that room or when low pressure in the clean gas cylinder bank is detected.
 - d) The following shall be provided on the MP with LED indicators:

Sprinkler and hydrant pumps "RUN/STOP" and jockey pumps "RUN/STOP/TRIP" status

Sprinkler water tank and hydrant tank "high" and "low" level alarms Control valve status

Electricity supply per phase failure indication alarm zones "L1/L2/L3" Electrically supervised gate valves "CLOSED"

Clean gas panels summary fault, 1st alarm, 2nd alarm, gas discharged and clean gas panel disabled

Alarm status; pump control panel local/off/auto switch status; close/open status of all supervised valves, main stop valves and solenoid valves, etc.; and activation of water flow switch, etc. Lamp test button

- e) The buzzer shall sound when any of the alarm is activated.
- 14.4 Fire Alarm Bell
- 14.4.1 All alarm bells shall be iron clad and shall be of weatherproof construction and installation.
- 14.4.2 It shall operate on 24V DC and shall be 150mm round red gong pattern suitable for 20mm conduit entry except otherwise stated.
- 14.4.3 Bells should be labelled 'FIRE ALARM' in English.
- 14.4.4 Bell circuits shall be 'interleaved' and separately fused at the control unit.
- 14.4.5 The alarm bells shall be mounted at a height of 2250mm above the finished floor level or otherwise as directed by the Authority.
- 14.4.6 The sound level at 3m away shall be at least 82 dBA and it shall comply with the sound level requirements as stated in SS645.
- 14.4.7 The alarm bells shall be wired such that it will be activated automatically upon activation of the manual call-point.
- 14.4.8 The alarm bell shall be UL listed and/or approved by other international approval bodies.
- 14.5 Manual Call Point

- 14.5.1 Manual call point shall be arranged to operate automatically upon breaking of the glass and shall comply with the requirements of SS645. The cover shall have sealing facilities to prevent vandalism and locked in position with a special key with the glass panel shall be clipped firmly into place. The unit shall be of pleasing appearance and styling and finish enamelled red. The words: "IN CASE OF FIRE BREAK GLASS" shall be included. The voltage and current ratings of the contacts shall be marked within the unit.
- 14.5.2 Contacts shall be of silver or approved non-deteriorating alloy for normally closed alarm system. A concealed 'test' device shall be included.
- 14.5.3 Manual call-points installed outdoors shall be of weatherproof construction and installation and shall be at least rated to IP55. Those installed within the public area shall be vandal-proof.
- 14.6 Beacon Light
- 14.6.1 Flashing beacon lights shall operate on 24V DC and shall be of wall-mounted type. These lights shall be mounted within the noisy rooms to provide visual warning. The noisy rooms include but not limited to smoke extract fan room, AHU room and generator room. The beacon light shall be visible when operated within a lighted room.
- 14.7 Automatic Clean Gas Total Flooding System
- 14.7.1 The automatic clean gas total flooding system shall be designed, supplied, installed, tested and commissioned.
- 14.7.2 The fire extinguishing clean agent shall comply with NFPA 2001 and shall have the following characteristics:
 - a) Fastened Zero ozone depletion potential
 - b) Global warming potential (GWP) of less than or equal to 1
 - c) Suitable for use in human occupied rooms i.e.the gas at its designed discharged concentration shall be safe to human in the discharged room
 - d) The gas is widely used in Singapore and around the world
- 14.7.3 All components of the Clean Gas System shall be specifically listed or approved by recognised institutions.
- 14.7.4 Hydraulic calculations c/w isometirc diagrams shall be submitted for verification of pipework sizes for Authority's acceptance prior to commencement of work.
- 14.7.5 The discharge nozzles used shall comply with the requirements of NFPA 2001.
- 14.7.6 The automatic clean gas total flooding system shall be capable of being operated automatically and/or manually and shall comprise the following equipment:

- a) Analogue addressable clean gas control panels with standby batteries and chargers
- b) Analogue addressable smoke detectors
- c) Audible warning system alarm bells and sirens
- d) Visible warning system beacon lights and warning signs
- e) Manual release (breakglass) units
- f) Discharge nozzles and pipework
- g) Clean gas cylinders, associated equipment mounting brackets and accessories
- h) Positive gas pressure switches
- i) All necessary electric and/or pneumatic actuated valves
- j) Pressure monitoring devices
- k) Supervisory disconnect switch
- 14.7.7 The control panel and equipment installed outdoors and in sprinkler protected areas shall be rated to IP 55.
- 14.7.8 Automatic Operation of System:

The automatic clean gas total flooding system shall operate automatically by the activation of at least two smoke detectors in the gas protected room to minimise false discharges.

- 14.7.9 Manual Operation of System:
 - a) The The clean gas system shall be capable of being manually activated by a manual gas release station (breakglass unit) provided outside the clean gas protected room beside the exit door(s).
 - b) An approved independent means for emergency manual operation shall be provided at the clean gas control panel for automatically operating the valves controlling agent release and distribution.
- 14.7.10 Fire alarm panel(s) shall transmit voltage free signals to activate and deactivate the respective ACMV equipment.
- 14.7.11 Pressure monitoring devices shall be provided to monitors leakage at all the cylinders and send the status signals to the nearest clean gas control panel.
- 14.7.12 The clean gas control panel shall be provided such that it is within sight from the doors of the rooms protected by it.
- 14.7.13 The clean gas control panel shall monitor detectors and manual clean gas release break glasses and operate valves, alarm bells, beacon lights, evacuate and fired signs serving the respective gas protected room.

- 14.7.14 The capacity of the battery shall be such that in the event of mains failure or charging disconnected power, the battery shall be capable of maintaining the system in normal working condition for at least 24 hours. Thereafter it shall be capable of supporting one complete operation from receiving the first alarm signal to completion of gas discharge and maintaining the alarm i.e. sounding alarm bells, sirens and illuminating beacon lights and warning signs for a duration of at least 10 minutes after the discharge.
- 14.7.15 Piping and Installation

Refer to section 17, "Pipeworks" section in this Specification.

- 15 Fire Hosereel & Hydrant System
- 15.1 General
- 15.1.1 The construction and installation shall comply with SS 575, "Fire Hydrant Systems and Hosereel" and comply with all regulations and requirements of the Fire Services Safety Department (FSSD) and Building Control Authority (BCA).
- 15.2 Hosereel System
- 15.2.1 Hose reels shall be of the double swing-recessed type. Each hose reel shall be an integral unit consisting of a stop valve, reel, hose, and shut-off assembly. It shall be designed so as to facilitate the swift withdrawal of the hose in any direction with the reel axis horizontal. Stainless steel of grade 316 cabinets shall be provided for non-recessed hose reels. Exposed hosereel type without cabinet shall be provided in plantroom areas. The door of the hose reel cabinet shall include the following features:
 - a) Fastened only by means of spring lock
 - b) The door shall be labelled 'Fire Hose Reel' and the label shall be submitted to the Engineer for acceptance
- 15.2.2 The hose reels shall be listed under the Product Listing Scheme.
- 15.2.3 Drums shall be constructed of die-cast light alloy, hydraulically balanced, free from denting and twisting, and finished in red enamel. The hub and shaft shall be of brass, fitted with a device to prevent overrun of the hose, having glandless centre seal. The whole unit shall be drip free.

- 15.2.4 The length of the hose shall be 30 metres and bore 25mm. It shall be terminated in 'shut-off' branches with 6mm jet spray nozzle. Nozzles made of plastic are not accepted. Nozzle holders shall be cast aluminium type and firmly secured to the wall using bolts and nuts. Nozzle holder shall be provided in a readily accessible position at a height in accordance with SS 575. Hoses shall be of non-kinking reinforced rubber tubing. Hoses shall not suffer any deformation when it is fully reeled into the drum. Hose reels shall conform to BS EN 671-1 and hose reel tubing to Type A of BS 3169.
- 15.2.5 Hose reels shall be installed in recesses so that they do not form obstructions on escape routes. Recessed hose reels shall be installed such that the drum can be swung out of the recess totally enabling a single person to pull out the hose on his own. Any doors provided for hose reel recesses shall be hinged so that they can open approximately 1800 so as not to cause any obstruction to the hose being run out in either direction. Appropriate signs on the doors in accordance with BS 5499: Part 1 shall be provided to indicate that the hose reels are installed within cabinet.
- 15.2.6 Hose reel brackets shall be firmly fixed to the wall and the stresses incurred during use for fire-fighting, shall not prevent the unimpeded use of the hose reel.
- 15.2.7 An indication of the open and shut positions shall be fixed or marked on the wheel and the body of the valve, except for the gate valve, which shall be marked with a directional arrow indicating the direction of flow through the valve.
- 15.2.8 Every hose reel shall be marked with the following information in a prominent position:
 - a) The manufacturer's name, trade name or mark or the name, trade name or mark of the responsible vendor
 - b) Instructions for operation shall be in accordance with SS 508.
 - c) The year of manufacture
 - d) The test pressure
 - e) The relevant Standard
- 15.2.9 All burrs and sharp edges shall be removed. The exterior of all components shall be rounded and smoothened to prevent injury during use. All threaded parts of aluminium alloy components shall be coated in molybdemised litate grease.
- 15.3 Hydrant System
- 15.3.1 Hydrant outlets shall be twin-head type with the outlet size for 65mm diameter and complete with minimum 100mm-diameter pillar.
- 15.3.2 Hydrant material shall be of gunmetal construction.
- 15.3.3 Outlets shall be provided with protective standard caps of cast iron or gunmetal and attached to the standpipe by chains.

- 15.3.4 Suitable size of control valve shall be supplied and installed to each hydrant. The valve shall be able to open and close from the surface of the ground level.
- 15.3.5 Hydrants together with valve pit shall be installed on concrete plinths with size of 1400mm x 700mm x 100mm thick.
- 15.3.6 Valve pits should be of adequate size and readily accessible for inspection, operation, testing, maintenance and removal of equipment contained therein. They should be so constructed and arranged as to properly protect the installed equipment from ground movement and accumulation of water.
- 15.3.7 Cast in-situ or precast concrete, with or without reinforcement, or brick (depending on soil conditions and size of pit) are appropriate materials for construction of valve pits. Where the water level is low, and the soil is porous, crushed stone or gravel may be used for the floor of the pit.
- 15.3.8 For Fire hydrants sited in roadways, care shall be taken that the pits and covers are capable of bearing the heaviest vehicle, which may use the roadways.
- 15.4 Water Supply
- 15.4.1 Fire Hosereel system and fire hydrant system shall be direct feed from PUB water mains wherever possible.
- 15.5 Piping and Installation

Refer to section 17, "Pipework" section in this Specification.

- 16 Portable Fire Extinguishers
- 16.1 General
- 16.1.1 The type, location and quantity of portable fire extinguishers to be installed shall be in accordance to architectural requirements.
- 16.1.2 Every fire extinguisher shall be manufactured to comply with the Local codes and shall be approved for use by the FSSD and Singapore Standard 578 Code of Practice for the Use and Maintenance of Portable Fire Extinguishers.
- 16.1.3 Fire extinguishers shall be filled with appropriate fire extinguishing agents under pressure and shall be labelled in accordance to the classification of fire hazard as well as weights of the extinguishing agent.
- 16.1.4 All fittings and safety features necessary for the fire extinguisher to be approved for use as a complete unit shall be incorporated.

- 16.2 Installation
- 16.2.1 Each fire extinguisher shall be suitably installed for upright instantaneous operation.
- 16.2.2 For units to be wall mounted, it shall be mounted at a maximum height of 1 metre above the finished floor level. Suitable hangers or brackets of corrosion resisting material shall be provided.
- 16.2.3 Instructions shall be labelled and displayed permanently on the body of the extinguishers clearly showing the necessary operation, maintenance and reloading equipment.
- 16.2.4 Locations of all fire extinguishers shall tally with the approved architectural fire plans or as directed by the Architect.
- 17 Pipework
- 17.1 General
- 17.1.1 This section specifies the design, supply, installation, testing and commissioning of pipework for the fire sprinklers and hose reels, and automatic clean gas total flooding systems.
- 17.1.2 All pipework delivered to site shall be new, cleaned, capped, deburred, free from scale, rust, grease and colour banded to identify different grade. All black steel pipes and fittings shall be cleaned and thoroughly wire brushed and prime coated prior to installation. All galvanised steel pipes and fittings shall be cleaned and prime coated prime coated prior to installation.
- 17.1.3 Pipework shall be installed with correct fall to ensure adequate venting and draining.
- 17.1.4 Pipework installed in trenches, ducts, voids and inaccessible places shall have welded joints except where screwed or flanged joints are necessary for connecting to valves etc. The pipework shall be inspected and tested by the Authority prior to concealment.
- 17.1.5 No pipe joints or fittings shall be permitted within the thickness of walls or floors etc.
- 17.1.6 All exposed pipeworks shall be installed so that minimum clearance of 100mm is left between the outside of the pipe and the nearest wall equipment surface and minimum 100mm from ceiling or slab. Pipes shall be run at a minimum distance apart to enable them to be individually painted.

- 17.1.7 The gap between pipes sleeve and pipe shall be fire-stopped using approved firestopping material having fire resistance not less that required for fire compartment wall.
- 17.1.8 All pipework shall be installed in accordance with the relevant standards, codes and to the approval of the local authorities. The Contractor shall check and ensure that the design meets the requirements of the local authorities having jurisdiction without additional cost.
- 17.1.9 The Contractor shall submit manufacturer's printed installation, operation and maintenance instructions, consisting of installation and operation procedures, detailed parts list, recommended spare parts list, and complete maintenance procedure of all valves and piping accessories.
- 17.1.10 The Contractor shall submit pipe support and anchor details.
- 17.1.11 The Contractor shall submit pipe testing and cleaning procedures for Authority's acceptance.
- 17.1.12 No pipe shall be installed at low level across route of egress or maintenance access routes causing obstruction to access.
- 17.1.13 All angle brackets and support installed at low level shall have all sharp edges padded and warning signs shall be provided.
- 17.2 Piping Installation
- 17.2.1 All pipes shall be installed parallel to walls, clear of obstructions, preserving head room and keeping passageways clear.
- 17.2.2 All pipes shall be cut in a neat and workman like manner without damage to the pipe. Cutting shall be done with an approved type mechanical cutter. The Contractor shall use wheel cutters where practicable. Pipe ends shall be reamed to remove burrs. Cutting of pipes and fittings with gas torch is not acceptable.
- 17.2.3 Welding of pipes shall only be undertaken by qualified welders with certificates(s) of competence issued by an approved local authority or equivalent which shall be submitted to the Authority for acceptance.
- 17.2.4 All pipes shall be so installed that the system can be thoroughly drained. Sprinkler pipework shall be arranged to drain to the installation drain valve. Auxiliary drain valves shall be provided for the trapped section of the system.
- 17.2.5 Automatic air vents shall be provided at each high point of each water pipe line and where necessary, it shall be complete with isolating cock.

- 17.2.6 All pipes shall be stored with closed ends, which shall not be opened until erection. All pipes shall be flushed to prevent foreign material being left in the pipe.
- 17.2.7 As soon as pipe lines have been installed openings shall be covered to prevent ingress of debris and materials that would obstruct the flow of water. Covers shall be left in place until necessary for completion of Works.
- 17.2.8 Supports shall be attached only to structural framing members. Where supports are required between structural framing members, a suitable intermediate metal frame shall be provided.
- 17.2.9 Screwed joints shall be made with tapered threads properly cut. Joints shall be made with Polytetra-fluoroethylene tape, or other approved thread joint compound applied to the male threads only. Not more than three threads shall show after the joint is made up. However, the thread shall not be cut too deep where leakage might occur.
- 17.2.10 Flanges and unions shall be faced true and provided with approved gasket, and made square and tight. Union or flange joints shall be provided in each pipe immediately preceding the connection to each piece or equipment or material requiring maintenance, such as pumps, control valves, and other similar items. Gaskets shall conform to ASME B16.21 and ASTM D2000.
- 17.2.11 Pipe grooving and coupling shall be installed in accordance with the manufacturer's recommendations. The pipe grooving shall be formed and not cut which weaken the pipe joint and for pipe.
- 17.2.12 Valves installed in horizontal pipes with stems horizontal or above shall have isolation valves at any points indicated or required for draining, isolation, or sectionalising purposes.
- 17.2.13 Pipes connected to equipment shall be supported independently such that the equipment is not stressed by piping weight or expansion.
- 17.2.14 Unions or flanges shall be provided to facilitate maintenance, repair and replacement.
- 17.2.15 Drawn bends shall not be used unless otherwise accepted by the Authority.
- 17.2.16 Where pipes pass through a building expansion joint, and/or are subjected to movement, approved flexible connections shall be provided to eliminate any stress.

- 17.2.17 All drainage pipework shall be installed plumb, level or true to the gradient and shall be neatly grouped with the minimum number of crossovers and adequate provision for venting, expansion, contraction and movement. Pipework shall be substantially supported to the acceptance of the Authority, and shall not be located less than 100mm above finished floor levels. Adequate clearances shall be maintained from all other services and from the building structure.
- 17.3 Installation of Pipe Hangers and Supports
- 17.3.1 All necessary hangers and supports, including rods, angles, channels and plates shall be subject to the Authority's Acceptance.
- 17.3.2 Vertical piping shall be guided or supported in the centre of each mains with approved steel brackets to prevent swaying, sagging, vibration and resonance. Strains shall be avoided that may cause pipeworks to snake or buckle between supports or anchors.
- 17.3.3 Anchors and guides shall be provided for all horizontal and vertical piping for proper control of thermal movement, this is required to prevent undue strain on branches, provide proper performance of expansion loops and to avoid overloading of hangers and supports.
- 17.3.4 Spacing of supports shall not exceed the centres given in the table below unless otherwise agreed by the S.O.

Piping Materials	Nominal	Bore	Centre of Support (m)	
	(mm)		Vertical	Horizontal
Steel pipe	15 - 40		2.5	1.8
	50		2.7	1.8
	65 - 80		3.5	3.5
	100		4.0	4.0
	150		4.5	4.5
	200		5.0	5.0

- 17.3.5 Pipe hangers shall be placed not more than 600mm from each change of direction where possible.
- 17.3.6 All hangers and supports shall be of hot-dipped galvanised mild steel of adequate dimensions and approved design. The pipe shall be restrained to prevent movement by a horizontal thrust when flexible fittings are used. However, threaded components, including bolts, nuts, inserts and washers shall be of sheradised mild steel to BS 7371 Part 8, Class S1.
- 17.4 Protection of Pipeworks

- 17.4.1 All piping work shall be protected during and at the end of each day's work to prevent ingress of moisture or dirt or contamination of the systems.
- 17.5 Pipework Materials
- 17.5.1 Pipework material specification for the fire protection system shall be as follows:

Hosereel pipes	Stainless steel tube to BS EN 10312 for direct feed from PUB mains Galvanised steel, BS EN 10255 for pump feed
Sprinkler pipes	Black steel, BS EN 10255 or equivalent
Air vent pipework	Copper BS EN 1057 or Galvanised ASTM A53 and others, Schedule 40
Clean Gas pipes	Seamless galvanised steel to ASTM A106 Grade B Schedule 120 or Schedule 80 for upstream and Schedule 40 for downstream of the pressure reducer.
Underground pipes	Ductile iron cement lined BS/EN 545 Class C100 and wrapped with 2 layers of petrolatuem tape.

- 17.6 Pipe Joints
- 17.6.1 For steel pipework, all joints up to and including 50mm diameter shall be made by means of screwed socketed connections. Pipes of 65mm diameter and above shall be joined by means of mechanical groove coupling.
- 17.6.2 All pipeworks within pump rooms shall be of flanged joints. Joints shall not be closer than 3000mm except where necessitated by fittings. Flanges shall be wrought iron or annealed steel, machined full face, suitable for the working pressures to which they will be subjected. Flanges shall conform to the relevant ANSI Standard and pressure rating.
- 17.7 Pipe Fittings
- 17.7.1 Pipe fittings shall be provided as specified in the following table and conform to the requirements of the relevant standards for the various pipe materials.

Piping Materials	Specification of Fittings
Galvanised steel to BS EN	Galvanised malleable iron screwed fittings to
Stainless steel BS EN 10312	Stainless steel to BS EN 10312/ BS EN 1254
Black steel ASTM A53 or Black	Malleable iron screwed fittings to BS EN
steel, BS EN 10255, heavy	<u>10242</u>
series	

Piping Materials	Specification of Fittings				
Ductile iron cement lined	Ductile iron BS EN 545, Class C100				
BS/EN545 Class C100					
Galvanised steel pipe to ASTM	In accordance with latest NFPA 2001				
A106 Schedule, 120 Grade B					
Galvanised steel pipe to ASTM In accordance with latest NFPA 2001					
A106 Schedule, 80 Grade B					
Galvanised steel pipe to ASTM In accordance with latest NFPA 2001					
A106 seamless Schedule 40,					
Grade B					
A106 Schedule, 120 Grade B Galvanised steel pipe to ASTM A106 Schedule, 80 Grade B Galvanised steel pipe to ASTM A106 seamless Schedule 40, Grade B	In accordance with latest NFPA 2001 In accordance with latest NFPA 2001				

- 17.7.2 Eccentric reducing sockets shall be used where a reduction in pipe size is required, to ensure proper drainage or elimination of air pockets and at the pump suction. Concentric reducing sockets shall be used for vertical pipes only. No bushes shall be used.
- 17.7.3 Long sweep bends shall be used in preference to round elbow bends whenever practicable. Mitre elbows shall not be used.
- 17.7.4 Long radius elbow and sweep or 'pitcher' tees shall be used on all changes of direction. Bends and off-sets formed by welding together of segmented pieces shall not be used.
- 17.7.5 Pipe fittings for joining pipes of 65mm diameter and larger shall be standard mechanical groove coupling. Pipe fitting for joining pipes of 50mm diameter and smaller shall be of screwed socket connection. Welding for such shall not be allowed unless accepted by the Authority.
- 17.8 Gaskets
- 17.8.1 Gaskets shall be suitable for temperature, service and pressure of system, installed in accordance with manufacturer's recommendations. All gaskets for flanged joints shall be of one-piece ring.
- 17.8.2 Insulating gaskets, washers and sleeves shall be provided for flanged joints in between dissimilar metals.
- 17.9 Vertical and Riser Pipe Isolation
- 17.9.1 Risers shall be suspended from or supported by hangers or mountings. In general, all riser pipes in duct shafts shall be resiliently suspended at the top of the pipe duct shafts. "Duck foot" supports for pipe elbows connecting to equipment shall rest on resilient mounts having minimum deflection not less than that of the isolators for the respective equipment.
- 17.9.2 In general, all resilient mounts and hangers shall have a minimum static deflection of 20mm.

17.10 Horizontal Pipe Isolation

- 17.10.1 Vibration hangers shall be provided generally for pipes inside the pump room.
- 17.10.2 Minimum static deflection of hangers for the first three supports for pipes from equipment shall be as follows:

Pipe Sizes(mm)	Minimum Static Deflection (mm)
Up to 75	20
Up to 150	38

- 17.10.3 All other hangers and mounts shall have a minimum of 20mm deflection.
- 17.11 Sleeves and Covers
- 17.11.1 Pipe sleeves shall be provided where pipes pass through walls, floors etc. All sleeves shall be of short pipe lengths and galvanised. Pipe sleeves fitted in walls or partitions shall be flush with the plaster or other surface finish. Pipe sleeves fitted in floors shall generally end 25mm above the finished floor level, except in plant rooms and other areas where 'wet floors' are expected whereby the sleeves shall end 50mm above the finished floor level.
- 17.11.2 All sleeves shall be of sufficient size to allow free movement of pipes. The gap between pipe and its sleeve shall be firmly packed with fibreglass blanket material. However, for pipes/sleeves passing through fire barriers, the gap between the pipes and sleeves shall be packed with approved type fire resistance material of at least equal fire rating to the fire barriers. The ends of the sleeves shall be caulked with non-hardening mastic to the Authority's acceptance. The fibreglass, fire resistance materials or non-hardening mastic shall be provided and installed by the Contractor.
- 17.11.3 Contractor's attention is drawn to the vertical pipe ducts. At floor levels in the building, the pipe ducts shall have floor slab and where pipes through these slab sleeves shall be provided.
- 17.11.4 Brass or copper plates, chrome plated in public areas, shall be slipped over pipes before installation, to cover raw ends of pipe sleeves. Split cover plates will not be accepted. The 20mm projection of pipe sleeves may be reduced after all construction work has been finished such that the cover plates attached to the finished work in an acceptable manner.
- 17.12 Stainless Steel Bellow Expansion Joints
- 17.12.1 Stainless steel expansion joints shall be provided wherever expansion loops or changes in direction of pipework (for allowing expansion and contraction of pipework) is not feasible.
- 17.13 Pipe Anchors

- 17.13.1 Anchors shall be positioned in association with pipework changes in direction and at expansion joints and loops so as to absorb stresses due to pipework expansion and internal pressure by transmission of such forces to the ground or structure at appropriate points.
- 17.13.2 Anchors shall be constructed to withstand the hanger thrust during piping hydraulic pressure testing.
- 17.13.3 All details and sizes of anchors shall be submitted for Authority's acceptance prior to installation.
- 17.14 Valves, Cocks etc.
- 17.14.1 Valves and cocks shall be provided for the proper operation of the system.
- 17.14.2 All valves, cocks etc. shall comply with the requirements of PUB and the relevant code of practices for fire protection system.
- 17.14.3 Service isolating valves shall be fitted to all items of Plant including tanks, pumps etc.
- 17.14.4 All valves shall be suitable for the working and test pressure of the system concerned.
- 17.14.5 Valves shall be fitted in accessible positions for operation and repair. The connection between each valve and the adjacent equipment shall be made either with a union or flange for ease of dismantling.
- 17.14.6 Regulating valves shall be of globe type for fitting on branch pipes, by-passes etc. and where regulation of flow is required for balancing the systems.
- 17.14.7 All valves shall be of heavy-duty type suitable for the working hydraulic pressure stated and installed with the valve stems truly vertical or horizontal.
- 17.14.8 All valves shall be arranged so that clockwise rotation of the spindle closes the valve. Handwheels shall have cast-on direction arrows. Where installed at changes in direction of the pipework, angle valves are preferred to straight through valves and bends.
- 17.14.9 Sprinkler control valves and dry main system valves shall be secured in open/close position with leather strap and padlock. The Contractor shall provide two sets of common keys for all padlocks. Open/close position indicators shall be provided for the valves as per the requirements of the relevant codes and standards.

- 17.14.10 Isolating valves up to and including 50mm bore shall be of copper alloy construction full-way split disc wedge pattern to BS 5154 and BS EN 12288. Valves shall have inside screw gate, non-rising stem, high tensile bronze spindle and screwed bonnet. Valves shall have screwed female ends.
- 17.14.11 Valves of 65mm bore and over shall be flanged cast-iron, fully sluice with inside screw solid wedge, non-rising stem to BS 5163-1. Valves shall have bolted bonnets. Flanges of flanged valves shall be made to BS EN 1092 or other equivalent standards. In addition, valve for sprinkler system shall be of outside screw and yoke type in accordance with the requirement of SS CP52.
- 17.14.12 At the pressure gauge, stainless steel bleed valve shall be provided.
- 17.14.13 Valve Identification: All valves shall be identified by means of suitable tag or sign which shall clearly indicate the following:
 - a) Section under control or served.
 - b) Valve number.
- 17.14.14 Non-Return Valves: On the discharge end of each pump, a non-return valve shall be fitted. Valves shall be non-slamming hinged swing type to BS EN 12334, having cast iron body with bronze trim and be suitable for the working pressure of the system. Valves shall be suitable for installation in horizontal or vertical pipework. The valves shall be selected in relation to the velocity of the water in the pipes. In all cases, the valves are required to operate silently on reversal of water flow.
- 17.14.15 Drain Valves/Cocks: Drain cocks of gland pattern shall be provided in such locations that all sections of piping systems can be drained in compliance with SS 575. Drain cocks shall be complete with stainless steel hose union.
- 17.14.16 Air Release Valves: Automatic air eliminators, air bottles or air cocks of approved manufacture shall be provided at all high points where venting may be required.
- 17.14.17 Strainers: Strainers shall be installed at the outlet of each water tank, water pump inlets, water gong inlets control valves and other areas where necessary. Strainers shall be of "Y-type", flanged end, with stainless steel mesh of not less than 2mm x 2mm mesh. The bodies shall be of cast iron, with drain plug and end flange for draining and cleaning out purposes.
- 17.14.18 Orifice Plates: Orifice plates shall be fitted as necessary in order to assist in controlling the pressure in the system and to provide the specified pressure/flow condition at the sprinkler. The orifice plates shall be approved type and installed in accordance with approved standards. Contractor shall submit calculation to the Authority to determine the size of the orifice to achieve the desired pressure drop across the orifice plate.
- 17.15 Cleaning Procedure

- 17.15.1 Every precaution shall be exercised to avoid introducing foreign matter such as welding beads and slag or dirt into piping system. Completed welds shall be hammered to loosen debris. All piping, valves and fittings shall be internally cleaned of oil, grease or dirt, prior to assembly into system, by use of wire brush and swab.
- 17.15.2 Following fabrication and erection, all piping 150mm and smaller shall be cleaned by flushing with clean water and ran to waste until thoroughly free of all dirt, oil and cuttings, etc. Each size of pipe shall be flushed separately before being joined with larger size piping.
- 17.15.3 Pipe of 20mm in diameter and larger shall be cleaned by pulling through a steel brush the entire length of each pipe size, followed by fibre brush or swab. Brushes and swabs shall be slightly larger than the inside diameter of the pipe being cleaned.
- 17.15.4 All cleaning operations shall be continuous throughout the piping system, except at joints required for final jointing of various sections of cleaned piping. After cleaning and when the final joints have been made, the end of sections of piping shall be adequately and tightly sealed off to prevent any dirt, water or other foreign matter from entering through the ends of the pipe.
- 17.15.5 All strainers shall be inspected and thoroughly cleaned. Before submitting piping systems for acceptance, Contractor shall provide temporary strainers where required for cleaning and flushing operation.
- 17.15.6 The Contractor shall allow for the draining down of the entire system before commencing any alteration and modification Works.
- 18 Surface Treatment
- 18.1 Corrosion Protection
- 18.1.1 All materials and equipment supplied shall be suitable for being delivered stored and operated under tropical conditions of high temperature, high humidity, heavy rainfall and fungus-conducive environment.
- 18.2 Metal
- 18.2.1 Iron and steel shall in general be painted or galvanised or metal-sprayed as appropriate. Indoor parts may alternatively have chromium or other suitable protective finish. When it is necessary to use dissimilar metals in contact, these shall be so selected that the potential difference between them in the electro-mechanical series shall not cause galvanic corrosion.

- 18.2.2 If this is not possible, the contact surface of one or both of the metals shall be electro-plated or otherwise finished in such a manner that the potential different is reduced within the required limits or, alternatively, the two metals shall be insulated from each other by a suitable insulating material or a coating of varnish compound.
- 18.3 Non-Metallic Materials
- 18.3.1 Non-metallic materials such as polycarbonate, glass-reinforced polyester, etc., which are exposed to weather, shall be resistant to deterioration by ultraviolet rays.
- 18.4 Bolts, Screws, Nuts
- 18.4.1 Steel bolts, screws and nuts shall be sherardized as per BS 7371: Part 8 (1998).
- 18.4.2 Corrosion-resisting steel, copper-nickel alloy or bronze, shall also be used for bolts and nuts throughout the works, when they are subject to frequent adjustment or removal.
- 18.4.3 Connection shall be such that potential differences do not cause galvanic corrosion.
- 18.5 Painting
- 18.5.1 Metal Items and Structures

All surfaces to be painted shall be thoroughly cleaned of all dirt, dust, grease, oil and rust before the paint application.

18.5.2 Priming

The primer serves as a basic protection against corrosion and additionally to guarantee adherence between surface and the finish paint. Zinc-epoxy, zinc-chromate or red lead primers are suggested for this purpose.

- 18.5.3 Finishing
 - a) Two finish coatings of minimum 0.05mm thickness shall be applied to painted surfaces. The proposed materials (epoxy resin base preferred), coat thickness, colours, etc. are subject to the Authority's approval.
 - b) For items that are not painted, the zinc coating shall have minimum 500g/sqm of coated surface.
 - c) Any electrical boxes or other housing enclosures outdoors shall be of weather-proof type.

ANNEX C2: M&E Services Drawings

DRAWING NO.	REV	DRAWING TITLE	SCALE	CAD FILE	REMARK
GENERAL					
ROAD/MES/ZZ/0001	-	M&E SERVICES DRAWINGS	NTS	LROADMES-ZZ0001-	
/ROAD/MES/SD/1002	В	TYPICAL SINGLE LINE DIAGRAM FOR NEW OG BOX (POB/COVERED LINKWAY AND BUS STOP/TAXI/PUDO SHELTER)	NTS	LROADMES-SD1002B	
./ROAD/MES/SD/1003	В	TYPICAL SINGLE LINE DIAGRAM FOR NEW OG BOX (BUS STOP/TAX/PUDO SHELTER)	NTS	LROADMES-SD1003B	
/ROAD/MES/SD/1004	В	TYPICAL SINGLE LINE DIAGRAM FOR EXISTING OG BOX (BUS STOP/TAXI/PUDO SHELTER/POB/COVERED LINKWAY)	NTS	LROADMES-SD1004B	
ROAD/MES/SD/1005	-	TYPICAL SINGLE LINE DIAGRAM FOR NEW OG BOX (POB WITH LIFTS)	NTS	LROADMES-SD1005-	
/ROAD/MES/SD/1006	В	TYPICAL DETAIL OF OG BOX (POB/COVERED LINKWAY AND BUS STOP/TAXI/PUDO SHELTER)	NTS	LROADMES-SD1006B	
/ROAD/MES/SD/1007	В	TYPICAL LIGHTNING PROTECTION SYSTEM FOR BUS STOP/TAXI/PUDO SHELTER	NTS	LROADMES-SD1007B	
/ROAD/MES/SD/1008	В	TYPICAL LIGHTING AND ELECTRICAL INSTALLATION DETAILS FOR COVERED LINKWAY/BUS STOP/TAX/PUDO SHELTER PART 1	NTS	LROADMES-SD1008B	
/ROAD/MES/SD/1009	В	TYPICAL LIGHTING AND ELECTRICAL INSTALLATION DETAILS FOR COVERED LINKWAY/BUS STOP/TAX/PUDO SHELTER PART 2	NTS	LROADMES-SD1009B	
/ROAD/MES/SD/1010	В	TYPICAL LIGHTNING PROTECTION SYSTEM FOR COVERED PEDESTRIAN OVERHEAD BRIDGE	NTS	LROADMES-SD1010B	
/ROAD/MES/SD/1011	В	TYPICAL LIGHTNING PROTECTION SYSTEM FOR NEW ROOF OVER EXISTING PEDESTRIAN OVERHEAD BRIDGE	NTS	LROADMES-SD1011B	
/ROAD/MES/SD/1012	В	TYPICAL LIGHTING AND ELECTRICAL INSTALLATION DETAILS FOR COVERED LINKWAY/BUS STOP/TAX/PUDO SHELTER PART 3	NTS	LROADMES-SD1012B	
/ROAD/MES/SD/1013	-	TYPICAL DETAIL OF POB/COVERED LINKWAY AND BUS STOP/TAXI/PUDO SHELTER OG BOX WITH PITCHED ROOF (FOR OG BOX NEAR TRAFFIC JUNCTION)	NTS	LROADMES-SD1013-	
/ROAD/MES/SD/1014	В	TYPICAL LIGHTNING PROTECTION SYSTEM FOR COVERED LINKWAY	NTS	LROADMES-SD1014B	
/ROAD/MES/SD/1015	A	TYPICAL LIGHTING AND ELECTRICAL INSTALLATION DETAILS FOR NEW POB AND NEW ROOF OVER EXISTING POB	NTS	LROADMES-SD1015A	
/ROAD/MES/SD/1016	A	TYPICAL LIGHTING AND ELECTRICAL INSTALLATION DETAILS FOR HIGH COVERED LINKWAY	NTS	LROADMES-SD1016A	
/ROAD/MES/SD/1017	A	TYPICAL LIGHTNING PROTECTION SYSTEM FOR HIGH COVERED LINKWAY	NTS	LROADMES-SD1017A	
/KUAD/MES/SD/2001	-	I YPICAL IRRIGATION INSTALLATION DETAILS AND SECTIONS FOR NEW POB	NTS	LRUADMES-SD2001-	
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		NOTES:
		<ol> <li>ALL DIMENSION ARE IN mm UNILESS OTHERWISE STATED.</li> <li>THIS DRAWING SHALL BE READ IN CONJUNCTION WITH SPECIFICATIONS.</li> <li>ALL ARCHITECTURE DETAILS TO ARCH'S ACCEPTANCE.</li> <li>CONTRACTOR SHALL CARRY OUT A SITE SURVEY BEFORE COMMENCEMENT OF WORK.</li> <li>SINGLE LINE DIAGRAMS SHALL BE SUBMITTED TO THE AUTHORITY FOR ACCEPTANCE PRIOR TO COMMENCEMENT OF INSTALLATION.</li> <li>ALTERNATE CIRCUITING SHALL DESIGN THE ELECTRICAL INSTALLATION IN ACCORDANCE WITH THE LATEST SS 638.</li> <li>OUTCOING LIGHTING CIRCUIT BREAKERS SHALL BE APPROPRIATELY DESIGNED WITH MINIMUM CABLE SIZE ALLOWED IS 2.5mm'</li> </ol>
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June 2022

# ANNEX D – COMMUTER FACILITY EQUIPMENT MONITORING SERVICES (CFEMS)

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## ANNEX D1: Lift Interface Requirements with CFEMS

The Lift Contractor shall provide three (3) RS485 ports in each lift controller. One serial link shall be used to communicate between the RTU and the lift controller, for IO status including digital/analog input data and digital output control. The Contractor shall ensure that the lift controller can communicate with the RTU, the functions and the protocol of the serial RS485 interface is as shown below. The Contractor shall label all the wires and crimped with ferrule at the RTU end, to be connected to RTU RS485 port. The Contractor shall terminate its RS485 end with 120 Ohm resistor.

Serial RS485 Port Interface for Lift IO Protocol:



The Lift Contractor shall provide two (2) numbers of RS485 cables (including one spare) from the lift controller to the RTU for each lift. The RS485 cable shall be type AWG 20, twisted pair with aluminium foil shielding. The cable shall be fire retardant with semi-rigid PVC sheathing. The Contractor shall develop user-friendly software compatible with the latest Windows software, come with USB converter for RS485 to communicate with and test the two serial interfaces with the lift controller through RS485 interface.

The Contractor shall provide all the equipment, for example, notebook for testing the RS485 port I/O points and signals interface board, required for the interfacing test.

RS485 Communication Protocol:

- a) 38400 bps (bits per second)
- b) 8 bit data
- c) No parity.
- d) 1 stop bit
- e) +, and GND
- Lift controller shall reply within 100 milliseconds after CPU receives last packet of bytes

Please refer to ANNEX D2 for the Protocol from RTU to Lift Controller and Lift Controller to RTU.

#### CFEMS Requirements

Table 1 in Annex D7 shows all the various points required by CFEMS. This table also shows the voltage requirement and associated logic of each point.

The Contractor shall note the following:

- (i) All wires for CFEMS, terminating on the lift controller circuits shall be marked with the designation of the CFEMS points (see TABLE 1 in ANNEX D7) for ease of repairs and trouble shooting.
- (ii) As can be seen from TABLE 1 in ANNEX D7, all the voltage levels are in DC. The Contractor shall use a regulated power supply (with ripple less than 1%) or direct from a battery source (UPS battery). The regulated supply shall be 24V DC ±5% under load, measured at the connectors. However, the Contractor shall take the supply from a battery source for those points where detection is still needed when a power failure occurs (as shown in TABLE 1 in ANNEX D7). The Contractor can group the points into groups of the same common return. The Contractor is to note that common return is positive unless otherwise stated in TABLE 1 in ANNEX D7. For the group with same common return, the Contractor need only terminate the negative points on the terminal blocks and two common return points. Please refer to ANNEX D3 for points in detail.

## ANNEX D2: Protocol from RTU to Lift Controller and Lift Controller to RTU

Header	Data Length	Function	Sequence	Address	Error	Data	CRC		
	Lengin	Code	Number	INU	Coue				
Header (HD)		- 21	Bytes in hex (0xA	5A5)					
Data Length	(DL)	- 11	Byte of no of byte	es (payload) to	follow except C	Cylical			
		Re	dundancy Check	(CRC)					
Function Co	de (FC)	- 11	Byte of type of m	essage					
0v1	1	- Po	Doll digital input status						
01	1.2	Pa	ll analog input st	atus					
		- PC	ii analog input st	atus					
UX1	13	- Se	t digital output c	ontrol					
Sequence No	o (SN)	- 11	Byte of sequence	no in hex, high	ı bytes goes firs	st			
Address No	(AN)	- 11	Byte of Lift Addre	ess i.e. 1 is for li	ft A, 2 is for lift	B, etc.			
Error code (I	EC)	- 11	1 Byte of error code, to be sent if the received message has erro						
		(D	ata length error (	or function cod	e error or CRC	error)			
Data (DD)		- Da	Data content						
CRC		- 21	2 Bytes of CRC (See ANNEX D6)						

Note: For Lift IO protocol, function codes 0x11, 0x12 and 0x13 are used.

## a) Function code 0x11, poll digital input status

From RTU- HD = 0xA5A5 DL = 0x03 FC = 0x11 SN = 0xFF AN = Lift AddressCRC = 2 bytes

From Lift Controller -

- HD = 0xA5A5
- DL = n bytes
- FC = 0x11
- SN = 0xFF
- AN = Lift Address
- EC = 0x00 (no error)
  - 0x01 0xFF (see ANNEX D5 Error Code)
- DD = 15 bytes
- CRC = 2 bytes

Number Group (NG)	Group (G)	Number Point (NP)	Start Point (SP)	Value	Group (G)	Number Point (NP)	Start Point (SP)	Value	
8 bit	8 bit	8 bit	8 bit	4 X 8 bits	8 bit	8 bit	8 bit	4 X 8 bits	
0x02	0x01	0x04	0x01		0x02	0x04	0x01		
NG -	NG - Number of groups 0x02, refers to 2 groups of digital input (DI): battery backup points and non-battery backup point								
G -	Group 0	01, refers to	battery	backup digital i	nput				
NP -	Number	Number of bytes 0x04, refers to 4 bytes of data. Each byte represents 8 points							
SP -	Starting	Starting point 0x01							
Value -	<ul> <li>4 bytes refer to 32 battery backup digital input points. Refer to detail of value for DI group</li> </ul>								
G -	Group 0	Group 0x02, refers to non-battery backup digital input							
NP -	Number	Number of bytes 0x04, refers to 4 bytes of data. Each byte represents 8 points							
SP -	Starting	channel 0x01							

## Details of Data Requirements

Value - 4 bytes refer to 32 non-battery backup digital input points. Refer to detail of value for DI group

## Details of Definition of DI Group

During transmission, Lift Controller will reply 4 byte of battery backup digital input data and 4 bytes of non-battery backup digital input data when RTU send Directive (DIR) function code.

Battery backup digital input bit definition:

Bit	7	6	5	4	3	2	1	0
Byte 1	P22	P17	P16	P15	P14a	P14	P13	P12
Byte 2			P11	P10	P38	P67	P26	P25
Byte 3	SPB13	SPB12	SPB11	SPB10	SPB09	SPB08	P29	P18
Byte 4	SPB21	SPB20	SPB19	SPB18	SPB17	SPB16	SPB15	SPB14

Non-battery backup digital input bit definition:

Bit	7	6	5	4	3	2	1	0
Byte 1	P32	P31	P30	P28	P24	P23	P21	P20
Byte 2	P52	P51	P50	P40	P37	P35	P34	P33
Byte 3	UPS	ARD	SPARE	P57	P56	P55	P54	P53
Byte 4	SPN08	SPN07	SPN06	SPN05	SPN04	SPN03	P36	UPDOWN

UPS remote testing – Set to high when the RTU instruct the lift to cut off single phase supply to the UPS and the lift is successfully carried out instruction.

ARD – Set to high when the RTU instruct the lift to cut off supply to the lift and the lift has successfully carried out the instruction.

b) Function code 0x12, poll analog input status

From RTU -HD = 0xA5A5

Details of Data Requirements

Number Group (NG)	Group (G)	Number Point (NP)	Start Point (SP)	Value
8 bit	8 bit	8 bit	8 bit	3 X 32 bits
0x01	0x03	0x03	0x01	

NG = Number of groups 0x01, refers to AI (0x03) groups

G = Group 0x03, refers to the analog input

NP = Number of channels 0x03, refers to 3 analog input channels

- SP = Starting channel 0x01
- Value = 12 bytes, each channel takes 4 bytes. Refer detail of value for Al group

## Details of Definition for Analog Input (AI) Group

Lift Controller must send the engineering value (i.e. Short Floating Point Number IEEE STD 754, stored in 32 bit) of the analog input channel.

Each analog input channel will take 4 bytes.

During transmission, LC sends byte 4, 3, 2 and 1 of channel 1, 2 and 3.



Channel 1	ARDBAT
Channel 2	UPS BAT
Channel 3	UPS SENSOR (5V)

c) Function code 0x13, send digital output control

From RTU-

HD = 0xA5A5DL = 9 bytesFC = 0x13SN = 0xFFAN = Lift AddressDD = 6 bytesCRC = 2 bytes

From LC -

- HD = 0xA5A5
- DL = 10 bytes
- FC = 0x13
- SN = 0xFF
- AN = Lift Address
- EC = 0x00 (no error)
  - 0x01 0xFF (see ANNEX D5 Error Code)
- DD = 6 bytes
- CRC = 2 bytes

# **Details of Data Requirements**

Number	Group	Number	Start	Value
Group	(G)	Point	Point	
(NG)	. ,	(NP)	(SP)	
8 bit	8 bit	8 bit	8 bit	2 X 8 bit
0x01	0x4	0x02	0x01	

NG = Number of group 0x01

G = Group 0x04, refers to the digital output

NP = Number of bytes 0x02, value field takes 2 bytes

SP = Starting point 0x01

Value = 2 bytes of value, which represents 16 output channels.

## Details of Definition for Digital Output Group

Byte 1	Byte 2

Bit	7	6	5	4	3	2	1	0
Byte 1	OP7	OP6	OP5	OP4	OP3	OP2	OP1	OP0
Byte 2	SPO08	SPO07	SPO06	SPO05	SPO04	SPO03	SPO02	SPO01

OP0	Call lift up
OP1	Call lift down
OP2	On Lift
OP3	Off Lift
OP4	Off UPS
OP5	SPARE
OP6	On UPS
OP7	SPARE

# ANNEX D3: Monitoring Points In Detail

Most of the points as shown in TABLE 1 in ANNEX D7 are self-explanatory. Points which need further elaboration are found hereunder:

## P11- Flood Sensor High Level Alarm

The Contractor shall provide a Flood Sensor High Level Alarm. When the level sensor does not detect water level in pit as high, P11 shall be low. When the level sensor detects high water level, P11 shall be high.

#### P12 – Lift Maintenance Switch

When the key operated switch is in the "Normal" position, P12 input shall be low. When the key operated switch is in the "Maintenance" position, P12 input shall be high and it shall disable the remote switching off of lift by CFEMS. The Contractor should ensure that the key cannot be removed when in the "Maintenance" position. <u>The CFEMS</u> requires that this key be inserted during the maintenance operation. This key can only be removed after the last personnel complete the maintenance operation.

#### P15, P16, P17 - Power Supply Detection

Three relays designated as (R1, R2, R3) shall be used to sense the power supply to the lift. Each of these relays shall sense a line to line voltage at 3 different locations, as shown in TABLE 1 in ANNEX D7.

The Contractor shall house these three relays outside the lift controller in a transparent fronted box (with holes drilled on the cover for ventilation purpose). To safeguard those using the lift closet, the Contractor shall place the following sign on the front of the box:

## DANGER RELAY TERMINALS ARE LIVE EVEN WHEN MAIN SWITCH IS OFF

These relays shall have normally open contacts. The Contractor shall wire one end of the contact to a battery source (UPS) and the other end to the respective sensing point. The sensing point for R1 is P15, R2 is P16 and R3 is P17. The cables for P15-P17 shall be housed in separate trunking. If this is not possible, screen cables shall be used.

# P30, P31, P32, P34 - 4 Bits Error Code

These four points represent in binary code any lift faults occurring on the lift.

These 4 bits shall not be the same as the breakdown codes of the lift, but shall only represent final breakdown codes.

The Contractor shall group the final breakdown conditions according to the different categories as listed hereunder:

	Out	tput		Condition Breakdown		Auto-reset	
P34	P32	P31	P30	Condition	Breakdown		
0	0	0	1	(a)	Yes	No	
0	0	1	0	(b)	No	Yes	
0	0	1	1	(c)	Yes	No	
0	1	0	0	(d)	No	Yes	
0	1	0	1	(e)	Yes	No	
0	1	1	0	(f)	No	Yes	
0	1	1	1	(g)	(i) No (ii) No (iii) No	Yes Yes Yes	
1	0	0	0	(h)	Yes	No	

## Condition Breakdown Conditions

- (a) Safety line
  - (i) Any safety device tripped
- (b) Lift door-opening problem

(i) Door failed to open at landing after two attempts, error code is issued after which

(ii) Lift move to the another landing (for which a car or hall call is made) to try and so on

(iii) The error code cannot be cleared unless the doors can open at the landing where the problem occurred

- (c) Lift speed controller failure
- (d) Any hall button jammed
   (i) Landing button(s) either up or down jammed for three minutes after which
   (ii) Error code is issued. Lift move to the other landings. The fault code shall be set till the jammed button(s) is cleared.
- (e) Miscellaneous Interface Card (MIC) boards failure

- (i) Auxiliary Board failed
- (f) Reverse phase or under-voltage

(i) Under or over voltage, reverse phase or one phase no supply occurred.

(ii) If this fault is restored, the lift shall resume normal operation and the error code shall be cleared.

(g) Lift door-closing problem

(i) If the door cannot close due to object stuck in the sill or other reasons not due to (ii) or (iii) below, the lift shall try to close the door. After trying unsuccessfully to close the door for four (4) times the lift shall be parked with the door open and all outstanding car calls cancelled. The lift shall not be shut down. Subsequently if a new car call is registered, the lift shall try to close the door for another four (4) times, failing which the lift shall again be parked with door open and all car calls cancelled. This process shall be repeated. If after 10 minutes the door still cannot close the error code shall be set. Even though the error code is set the lift shall continue to try to close the door if a car call is registered as explained above. If the lift is successful in closing the door the error code shall be reset and the lift shall resume normal operation. Or

(ii) Safety edge is jammed for ten minutes or infra-red beam is broken (apply to safety edge using single beam infra-red light), the error code shall be set. Lift shall be taken out of group control if applicable but shall not be shut down. After fault has been cleared and there is new car call registered, lift should resume normal operation and error code should be cleared. Or

(iii) In the event the 2D/3D curtain door sensor is blocked for more than 10 minutes (adjustable), an error code will be set. The error code will be cleared once the blockage is removed.

# (h) Shorting of door contacts (bypass)

Whenever the car or landing door lock(s) are shunted when the lift is in automatic mode the lift shall be rendered inoperative and this error code shall be set. The lift can only resume operation and the error code cleared when the shunt(s) are taken out.

For condition (e), MIC boards failure shall represent failure of auxiliary boards or certain parts of Mother board, whereby the CPU is still active.

Condition (f) may be a subset of condition (a). However, when condition (a) occurs due to condition (f), the code received by CFEMS must reflect condition (f) and not condition (a).

It is the Contractor's responsibility to ensure that all final breakdowns shall be detectable by one of the above codes. The Contractor shall include a list of possible final breakdowns and their associated codes in the documentation submitted to SO Rep.

## P35 - Lift Car Emergency Exit Cover

When the lift car emergency exit cover is opened, the alarm bell shall sound (P26 = 1) and the error code due to safety line problem (0001) shall be issued. The error code remains the same even when the trapped door is closed.

#### P36 – Signal Board DC Supply

This is the DC supply to the RS485 Signal board. When there is no DC supply to the RS485 Signal board, P36 shall be low. When there is DC supply to the RS485 Signal board, P36 shall be high.

## P40 - Any Car Call

The Contractor shall provide the signal pattern of the car call signal as shown below:



Where there is more than one car-call, the signal shall continue until the last car-call is answered.

## P52, P53---P57 - 6 Bits Lift Position Code

The Contractor shall group the lift position into 6 bits binary code as shown below:

<u>Output</u>					<u>Condition</u>
P57(MSB)	P55	P54	P53	P52(LSB)	
0	0	0	0	1	Lift at 1st Landing
0	0	0	1	0	Lift at 2nd Landing
0	0	0	1	1	Lift at 3rd Landing

The Contractor is to note that notwithstanding the fact that the lift position is depicted through the above points, the bottom and top positions shall still be terminated at points P50-, P51- on plugs T1 and T3 respectively. These two points shall be high when the lift is at the ground and top floor respectively. **Please note that the requirement is to detect landing and not storey**.

#### P75A - UPS CURRENT SENSING POINT

ANNEX D4 gives the connection diagram as well as the design requirements for the UPS voltage sensor. The Contractor shall submit any calculation or experimental results for the approval of the final design of the voltage sensor. The Contractor shall mount this sensor in the UPS set. The mounting arrangement shall be subjected to SO's approval.

# OUTPUT (OP) POINTS

The OP points are used to control the lift. The function of each of these points is summarised below:

Point Name	Function
OP0	Call lift to top floor
OP1	Call lift to down floor
OP2	On Lift
OP3	Off Lift
OP4	Off UPS
OP5	SPARE
OP6	On UPS
OP7	SPARE

OPO <u>+</u> - This point is used to call the lift to the top floor

OP1  $\pm$  - This point is similar to the previous point, except that this point once activated will cause the lift to travel to the ground floor.

 $OP2 \pm$ ,  $OP3 \pm$  - These two points shall be used by the RTU to initiate the ARD test to lift controller. Point OP3 shall be used to switch off the power supply to the lift so that the ARD will take over. Point OP2 shall be used to switch on the supply after the testing. In the event of ARD failure, the Regulated supply M+ & M- should still remain during ARD operation. This supply should be available as long as the SPPL supply is available.

The Contractor shall use these two points in conjunction with two relays or any other method (to be approved by SO Rep) which shall produce the desired results. The contractor is to take note that once OP3 is activated, the ARD must take over. Upon activating OP3 to switch off the lift, the lift shall issue the error code 0110 (P34, P32, P31, P30) to the CFEMS and the code shall clear when OP2 is activated to turn on the lift. The relay designation control OP2 and OP3 are RO4 RO3 respectively.

 $OP4 \pm -$  This point is used to test the UPS. The Contractor shall switch off the single phase supply of the UPS when this point is activated.

OP6  $\pm$  - This point is used by the RTU to inform Lift Controller to restore single phase supply to UPS.

## ANNEX D4: UPS Current Sensor

<u>UPS Current Sensor, (P75A- & P75-)</u> - used to detect the flow of current when the UPS is **on inverter only.** 



#### Note

- The current-to-voltage device is made up of any electronic circuitry (eg. op-amp, current transducer..etc) that will energise Relay E when <u>3 Amp or more</u> (adjustable with a port) is discharged by the battery during **inverter mode**. Any value below 3 Amp will not cause this device to work.
- 2. The contacts of the Relay E of rating 1 Amp are connected as shown on the above right.
- 3. The cable connection of P75A- and P75-, which is laid from UPS to lift controller, shall use screened cable with one end of the screen wire connected to earth. P75- shall be used exclusively for this purpose. It shall be different from the source requirement of the controller, which in this case shall be named as EB-.

#### How it works:

- 1. UPS is on **inverter mode** with a discharge current of 3 Amp or more at 24VDC.
- 2. The current-to-voltage device will cause Relay E to energise.
- 3. The regulated +5 VDC and 100 mA or above will appear across P75A- and P75.
- 4. When UPS battery is at charging mode, Relay E shall not energised.
- 5. P75A- with respect to P75- must be at zero volts when Relay E is not energised.

# ANNEX D5: Error Code

Error Code	Description
0x00	No Error
0x01	Data Length Error. Mismatched with actual data.
0x02	Device Address Error.
0x03	Function Code Error. Unsupported Function code.
0x04	Sequence Number Error. Current Sequence Number less than previous Sequence Number.
0x05	Control Request failed.
0xFF	CRC Error

## ANNEX D6: CRC Generation (To Be Coordinated with CFEMS Contractor)

The CRC employed is a CRC-16 and it is calculated using the following polynomial:-

 $CRC-16 = X^{16} + X^{15} + X^2 + 1$ 

The Cyclical Redundancy Check (CRC) field is two bytes (transmitted least significant byte first), containing a 16-bit binary value. The CRC value is calculated by the transmitting device, which appends the CRC to the message. The receiving device recalculates a CRC during receipt of the message, and compares the calculated value to the actual value it received in the CRC field. If the two values are not equal, an error results.

The CRC is started by first preloading a 16-bit register to all 1's. Then a process begins of applying successive 8-bit bytes of the message to the current contents of the register. Only the eight bits of data in each character are used for generating the CRC. Start and stop bits, and the parity bit, do not apply to the CRC.

During generation of the CRC, each 8–bit character is exclusive ORed with the register contents. Then the result is shifted in the direction of the least significant bit (LSB), with a zero filled into the most significant bit (MSB) position. The LSB is extracted and examined. If the LSB was a 1, the register is then exclusive ORed with a preset, fixed value. If the LSB was a 0, no exclusive OR takes place.

This process is repeated until eight shifts have been performed. After the last (eighth) shift, the next 8–bit character is exclusive ORed with the register's current value, and the process repeats for eight more shifts as described above. The final contents of the register, after all the characters of the message have been applied, is the CRC value.

A procedure for generating a CRC is:

- 1. Load a 16-bit register with FFFF hex (all 1's). Call this the CRC register.
- 2. Exclusive OR the first 8-bit byte of the message with the low-order byte of the 16bit CRC register, putting the result in the CRC register.
- 3. Shift the CRC register one bit to the right (toward the LSB), zero-filling the MSB. Extract and examine the LSB.
- 4. (If the LSB was 0): Repeat Step 3 (another shift). (If the LSB was 1): Exclusive OR the CRC register with the polynomial value A001 hex (1010 0000 0000 0001).
- 5. Repeat Steps 3 and 4 until 8 shifts have been performed. When this is done, a complete 8-bit byte will have been processed.
- 6. Repeat Steps 2 through 5 for the next 8-bit byte of the message. Continue doing this until all bytes have been processed.
- 7. The final contents of the CRC register is the CRC value.
- 8. When the CRC is placed into the message, its upper and lower bytes must be swapped as described below.

## Placing the CRC into the Message

When the 16-bit CRC (two 8-bit bytes) is transmitted in the message, the high-order byte will be transmitted first, followed by the low-order byte.

# ANNEX D7: Lift Monitoring Points by CFEMS System

Table 1

				SENSING REQUIRED EVEN DURING POWER	
POINT	DESCRIPTION	VOLTAGE	LOGIC	FAILORE	REMARKS*
P11	Flood Sensor HIGH Level Switch	DEPENDS ON UPS BATTERY VOLTAGE	P11 IS HIGH when sensor detects high water level	YES	
P12	LIFT MAINTENANCE(LM) SWITCH		P12 IS HIGH WHEN KEY IS INSERTED	YES	OP2 SHOULD PULSED WHEN LM IS TURNED ON
P14	ARD SWITCH	DEPENDS ON ARD BATTERY VOLTAGE	P14 IS LOW WHEN ARD IS MANUALLY SWITCHED OFF	YES	CONTRACTOR TO PROVIDE P14 + & P14- AT THE SWITCH
P15	INCOMING POWER (provided by Electrical Contractor)	DEPENDS ON UPS BATTERY VOLTAGE	SENSING OF ONE PHASE OF THE 3-PHASE SUPPLY BEFORE MAIN SWITCH. IF SUPPLY IS ON, P15 IS HIGH	YES	IT SHALL MONITOR SUPPLY ACROSS 1ST & 2ND PHASE
P16	ISOLATOR POWER		SENSING OF ONE PHASE OF THE 3-PHASE SUPPLY AFTER MAIN SWITCH. IF SUPPLY IS ON, P16 IS HIGH.	YES	IT SHALL MONITOR SUPPLY ACROSS 2ND & 3RD PHASE
P17	CONTROLLER POWER	u	SENSING OF ONE PHASE OF THE 3-PHASE SUPPLY AFTER CONTROLLER SWITCH. IF SUPPLY IS ON P17 IS HIGH	YES	IT SHALL MONITOR SUPPLY ACROSS 1ST & 3RD PHASE
P20	DOOR OPENING	24V DC	P20 IS HIGH WHEN DOOR IS OPENING	NO	
P21	RUNNING CONFIRMATION		P21 IS HIGH WHEN LIFT IS RUNNING	NO	
P22	LEVELLING INDICATION	DEPENDS ON UPS BATTERY VOLTAGE	P22 IS LOW WHEN LIFT IS LEVEL AT LANDING	YES	SEPARATE INDUCTOR SHOULD BE PROVIDED
P23	DOOR SWITCH	24V DC	P23 IS LOW WHEN ANY LANDING DOOR IS OPENED	NO	
P24	GATE SWITCH	"	P24 IS LOW WHEN CAR DOOR IS OPENED	NO	
P25	CAR DOOR ONE THIRD OPENED	DEPENDS ON UPS BATTERY VOLTAGE	P25 IS HIGH WHEN THE CAR DOOR IS MORE THAN DOCOPENED	YES	FOR PASSENGER TRAPPED CASES, IF P25 = 1, WE ASSUME HE/SHE IS RELEASED FROM THE CAR.
P26	ALARM BELL/INTERCOM		P26 IS HIGH WHEN ALARM BELL SOUND/ INTERCOM SOUND	YES	CONTRACTOR TO PROVIDE 1 POINT P26+ THE NEGATIVE RETURN IS P75- WHICH IS ALREADY PROVIDED

## Infrastructure Design & Engineering Group Key Document Infrastructure Design Criteria – Volume C Chapter 4

POINT	DESCRIPTION	VOLTAGE	LOGIC	SENSING REQUIRED EVEN DURING POWER FAILURE	REMARKS*
P28	FIRE LIFT SWITCH (if applicable)	24V DC	P28 IS HIGH WHEN FIRE LIFT SWITCH IS ACTIVATED	NO	
P30 P31 P32	) 4 BITS LIFT FAULT CODE ) )	24V DC	) AS GIVEN IN THE SPECIFICATIONS ) )	NO NO NO	
P34	)		)	NO	
P35	TRAP DOOR	24V DC	P35 IS HIGH WHEN CAR TRAP DOOR IS OPENED	NO	P35 once activated can only be reset by the LM key or when main
P36	SIGNAL BOARD DC SUPPLY	DC	P36 IS HIGH WHEN SIGNAL BOARD HAS DC SUPPLY	NO	switch is off.
P40	ANY CAR CALL	"	P40 IS HIGH WHEN IF THERE IS ANY CAR CALL, P40 IS LOW WHEN THE LAST CAR CALL IS ANSWERED	NO	
P50	LIFT AT 1ST FLOOR	11	P50 IS HIGH IF LIFT IS AT 1ST FLOOR	NO	
P51	LIFT AT TOP FLOOR		P51 IS HIGH IF LIFT IS AT TOP FLOOR	NO	
P52 P53	) ) )	)	) )	) )	
P54	) ) 6 BITS BINARY CODE ) FOR LIFT POSITION	) "	) ) AS GIVEN IN THE SPECIFICATIONS )	) NO )	
P55 P56		)		)	
P57	)	)	)	)	
P73	ARD BATTERY	DEPENDS ON ARD BATTERY VOLTAGE	ACROSS ARD BATTERY		
P75	UPS BATTERY	DEPENDS ON UPS BATTERY	ACROSS UPS BATTERY		CONTRACTOR TO PROVIDE POINTS P75+ P75-
P75A	UPS CURRENT SENSOR		SEE ANNEX D4		
OPO	TO CALL LIFT TO TOP FLOOR		SEE SPECIFICATIONS		
OP1	TO CALL LIFT TO GROUND FLOOR				
OP2	TO RESTORE POWER SUPPLY TO LIFT				
OP3	TO CUT OFF POWER SUPPLY TO LIFT				BREAKDOWN ERROR CODE 0110 MUST BE ISSUED (REFER TO 4 BIT ERROR CODE).
OP4	TO CUT OFF SINGLE PHASE SUPPLY TO UPS				
OP6	RESTORE SINGLE PHASE SUPPLY TO UPS				

# Annex F: Legal Register for Safety, Health & Environmental Management

Title of Legislation	Year
Workplace Safety & Health Act and Subsidiary Legislation	
<ul> <li>1. 2009 Revised Edition - Workplace Safety and Health Act</li> <li>✓ G. N. No. S 72/2007 - Workplace Safety and Health (Workplaces Subject to Act) Order 2007</li> <li>✓ G. N. No. S 634/2007- Workplace Safety and Health Act (Amendment of First Schedule) Order 2007</li> <li>✓ Act 9 of 2008 - Workplace Safety and Health (Amendment) Act 2008</li> <li>✓ Act 18 of 2011 - Workplace Safety and Health (Amendment) Act 2011</li> <li>✓ Act 44 of 2017 - Workplace Safety and Health (Amendment) Act 2017</li> </ul>	2009
<ul> <li>2. 2007 Revised Edition - Workplace Safety &amp; Health (General Provision) Regulations</li> <li>✓ G. N. No. S 463/2009 - WSH (General Provisions) (Amendment) Regulations 2009</li> <li>✓ G. N. No. S 609/2009 - WSH (General Provisions) (Amendment No. 2) Regulations 2009</li> <li>✓ G. N. No. S 517/2011 - WSH (General Provisions) (Amendment) Regulations 2011</li> <li>✓ G. N. No. S 277/2014 - WSH (General Provisions) (Amendment) Regulations 2014</li> </ul>	2007
<ul> <li>3. Workplace Safety &amp; Health (Construction) Regulations</li> <li>✓ G. N. No. S 608/2009 - WSH (Construction) (Amendment) Regulations 2009</li> <li>✓ G. N. No. S 224/2013 - WSH (Construction) (Amendment) Regulations 2013</li> <li>✓ G. N. No. S 278/2014 - WSH (Construction) (Amendment) Regulations 2014</li> </ul>	2007
4. 2007 Revised Edition - Workplace Safety & Health (Risk Management) Regulations	2007
<ul> <li>5. Workplace Safety &amp; Health (Operation of Crane) Regulations</li> <li>✓ G. N. No. S 4/2016 - WSH (Operation of Crane) (Amendment) Regulations 2016</li> </ul>	2011
<ul> <li>6. 2020 Revised Edition - Workplace Safety &amp; Health (Incident Reporting) Regulations</li> <li>✓ G. N. No. S 460/2011 - WSH (Incident Reporting) (Amendment) Regulations 2011</li> <li>✓ G. N. No. S 7/2014 - WSH (Incident Reporting) (Amendment) Regulations 2014</li> <li>✓ G. N. No. S 7/2020 - WSH (Incident Reporting) (Amendment) Regulations 2020</li> </ul>	2007
<ul> <li>7. 2007 Revised Edition - Workplace Safety &amp; Health (First-Aid) Regulations</li> <li>✓ G. N. No. S 514/2011 - WSH (First-Aid) (Amendment) Regulations 2011</li> </ul>	2007
8. Workplace Safety & Health (Noise) Regulations	2011
9. Workplace Safety & Health (Work At Heights) Regulations ✓ WSH (Work At Heights) (Amendment) Regulations 2014	2013
10. Workplace Safety & Health (Scaffold) Regulations	2011
<ul> <li>11. Workplace Safety &amp; Health (Registration of Factories) Regulations</li> <li>✓ G.N. No. S 57/2010 WSH (Registration of Factories) (Amendment) Regulations 2010</li> <li>✓ G.N. No. S 203/2017 WSH (Registration of Factories) (Amendment) Regulations 2017</li> </ul>	2008

<ul> <li>✓ G.N. No. S 206/2019 WSH (Registration of Factories) (Amendment) Regulations 2019</li> </ul>	
12. Workplace Safety & Health (Confined Space) Regulations	2009
13. Workplace Safety & Health (Asbestos) Regulations	2014
14. Workplace Safety & Health (Explosive Powered Tools) Regulations	2009
<ul> <li>15. Workplace Safety &amp; Health (Medical Examination) Regulations</li> <li>✓ G. N. No. S 320/2013 - WSH (Medical Examination) (Amendment) Regulations 2013</li> </ul>	2011
16. Workplace Safety & Health (Safety & Health Management System & Auditing) Regulations	2009
17. Workplace Safety & Health (Workplace Safety & Health Committee) Regulations	2008
18. 2007 Revised Edition — WSH (Workplace Safety & Health Officer) Regulations	2007
19. Workplace Safety & Health (Workplace Subject To Act) Order	2007
<ul> <li>20. 2002 Revised Edition - Factories (Safety Training Course) Order</li> <li>✓ G. N. No. S 673/2002 - Factories (Safety Training Course) (Amendment) Order 2002</li> </ul>	2002
21. Workplace Safety & Health (Design for Safety) Regulations	2015
22. 2007 Revised Edition - Workplace Safety & Health (Composition of Offences) Regulations	2007
23. 2007 Revised Edition - Workplace Safety & Health (Offences and Penalties) (Subsidary Legislation Under Section 66(14) Regulations	2007
24. Workplace Safety & Health (Learning Report) Regulation 2019	2019
25. 2009 Revised Edition — Work Injury Compensation Act	2009
<ul> <li>✓ Act 21 of 2011 - Work Injury Compensation (Amendment) Act 2011</li> <li>✓ G. N. No. S 200/2012 - Work Injury Compensation Act (Amendment of Second and Third Schedules) Order 2012</li> <li>✓ G. N. No. S 586/2015 - Work Injury Compensation Act (Amendment of Third Schedule) Order 2015</li> </ul>	
Work Injury Compensation Regulation 2020	
Covid 19-Act and Regulation	
COVID-19 (Temporary Measures) Act 2020	2020
<ul> <li>COVID-19 (Temporary Measures) (Amendment No. 2) Act 2021</li> <li>COVID-19 (Temporary Measures) (Amendment) Act 2021</li> <li>COVID-19 (Temporary Measures) (Amendment) Act 2020</li> <li>COVID-19 (Temporary Measures) (Amendment No. 2) Act 2020</li> <li>COVID-19 (Temporary Measures) (Amendment No. 3) Act 2020</li> </ul>	
<ul> <li>COVID-19 (Temporary Measures) (Control Order) Regulations 2020</li> <li>✓ COVID-19 (Temporary Measures) (Control Order) (Amendment No. 8) Regulations 2021</li> </ul>	

<ul> <li>COVID-19 (Temporary Measures) (Control Order) (Amendment No. 7) Regulations 2021</li> <li>COVID-19 (Temporary Measures) (Control Order) (Amendment No. 6) Regulations 2021</li> <li>COVID-19 (Temporary Measures) (Control Order) (Amendment No. 5) Regulations 2021</li> <li>COVID-19 (Temporary Measures) (Control Order) (Amendment No. 4) Regulations 2021</li> <li>COVID-19 (Temporary Measures) (Control Order) (Amendment No. 4) Regulations 2021</li> <li>COVID-19 (Temporary Measures) (Control Order) (Amendment No. 3) Regulations 2021</li> <li>COVID-19 (Temporary Measures) (Control Order) (Amendment No. 2) Regulations 2021</li> <li>COVID-19 (Temporary Measures) (Control Order) (Amendment No. 2) Regulations 2021</li> <li>COVID-19 (Temporary Measures) (Control Order) (Amendment No. 1) Regulations 2021</li> </ul>	
COVID-19 (Temporary Measures) (Foreign Employee Dormitories — Control Order) Regulations 2020	
Fire Safety Act and Subsidiary Legislation	
2000 Revised Edition - Fire Safety Act	2000
<ul> <li>Act 5 of 2000 - Fire Safety (Amendment) Act 2000</li> <li>G. N. No. S 449/2000 - Fire Safety Act (Amendment of First Schedule) Notification 2000</li> <li>Act 7 of 2004 - Fire Safety (Amendment) Act 2004</li> <li>Act 14 of 2013 - Fire Safety (Amendment) Act 2013</li> <li>Act 31 of 2016 - Fire Safety (Amendment) Act 2016</li> </ul>	
Revised Edition 2008 Fire Safety (Petroleum and Flammable Materials) Regulations	2008
<ul> <li>G. N. No. S 625/2006 - Fire Safety (Petroleum and Flammable Materials) (Amendment) Regulations 2006</li> <li>G. N. No. S 546/2013 - Fire Safety (Petroleum and Flammable Materials) (Amendment) Regulations 2013</li> <li>G. N. No. S 552/2013 - Fire Safety (Petroleum and Flammable Materials) (Amendment No. 2) Regulations 2013</li> <li>G. N. No. S 547/2013 - Fire Safety (Petroleum and Flammable Materials) (Amendment No. 2) Regulations 2013</li> <li>G. N. No. S 547/2013 - Fire Safety (Petroleum and Flammable Materials - Exemption) (Amendment) Order 2013</li> <li>G. N. No. S 188/2014 - Fire Safety (Petroleum and Flammable Materials) (Amendment No. 2) Regulations 2014</li> <li>G. N. No. S 189/2014 - Fire Safety (Petroleum and Flammable Materials - Exemption) (Amendment) Order 2014</li> <li>G. N. No. S 189/2015 - Fire Safety (Petroleum and Flammable Materials) (Amendment No. 2) Regulations 2015</li> <li>G. N. No. S 186/2018 - Fire Safety (Petroleum and Flammable Materials) (Amendment No. 2) Regulations 2015</li> <li>G. N. No. S 186/2018 - Fire Safety (Petroleum and Flammable Materials) (Amendment No. 2) Regulations 2015</li> <li>G. N. No. S 186/2018 - Fire Safety (Petroleum and Flammable Materials) (Amendment No. 2) Regulations 2018</li> </ul>	2008
2008 Revised Fire Salety (Composition of Orience) Regulations	2008
Electricity Act and Subsidiary Legislation	rear
2002 Revised Edition - Electricity Act	2002
<ul> <li>✓ Act 18 of 2006 - Electricity (Amendment) Act 2006</li> <li>✓ Act 42 of 2018 - Electricity (Amendment) Act 2018</li> </ul>	
2004 Revised Edition Electricity (Electrical Installation) Regulation	2004
<ul> <li>G. N. No. S 334/2007 - Electricity (Electrical Installations) (Amendment) Regulations 2007</li> </ul>	
<ul> <li>G. N. No. S 185/2018 - Electricity (Electrical Installations) (Amendment) Regulations 2018</li> </ul>	
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2004 Revised Edition Electricity (Electrical Workers) Regulation	2004
<ul> <li>G. N. No. S 332/2007 - Electricity (Electrical Workers) (Amendment) Regulation 2007</li> <li>G. N. No. S 22/2015 - Electricity (Electrical Workers) (Amendment) Regulation 2015</li> <li>G. N. No. S 862/2018 - Electricity (Electrical Workers) (Amendment) Regulation 2018</li> </ul>	
<ul> <li>2004 Revised Edition Electricity (Cable Detection Workers) Regulation</li> <li>✓ G. N. No. S 333/2007 - Electricity (Cable Detection Workers) (Amendment) Regulation 2007</li> <li>✓ G. N. No. S 863/2018 - Electricity (Cable Detection Workers) (Amendment) Regulation 2018</li> </ul>	2004
2004 Revised Edition - Electricity (Composition of Offences) Regulation	2004
Mass Rapid Transit Legislation	
2004 Revised Edition - Rapid Transit System Act ✓ Act 21 of 2010 - Rapid Transit System (Amendment) Act 2010 ✓ Act 9 of 2014 - Rapid Transit System (Amendment) Act 2014	2004
<ul> <li>1997 Revised Edition Rapid Transit (Railway Protection Restricted Activities) Regulations</li> <li>✓ G. N. No. S 280/2000 - Mass Rapid Transit (Railway Protection Restricted Activities) (Amendment) Regulations 2000</li> <li>✓ G. N. No. S 163/2003 - Mass Rapid Transit (Railway Protection Restricted Activities) (Amendment) Regulations 2003</li> </ul>	1997
2002 Revised Edition - Rapid Transit Systems (Development and Building Works in Railway Corridor and Railway Protection Zone) Regulations	2002
Code of practice for Railway Protection	2004
Guide to Carrying out Restricted Activities within Railway Protection and Safety Zones	2009
Building Control Act and Regulation	Year
1999 Revised Edition - Building Control Act	1999
<ul> <li>Act 4 of 1999 – Building &amp; Construction Authority Act 1999</li> <li>Act 36 of 1999 - Building Control (Amendment) Act 1999</li> <li>Act 26 of 2000 - Building Control (Amendment) Act 2000</li> <li>Act 18 of 2003 - Building Control (Amendment) Act 2003</li> <li>Act 34 of 2004 - Building Control (Amendment) Act 2004</li> <li>Act 47 of 2007 - Building Control (Amendment) Act 2007</li> <li>Act 22 of 2012 - Building Control (Amendment) Act 2012</li> </ul>	
Building Control (Temporary Buildings) Regulation	2018
<ul> <li>2000 Revised Edition - Building Control (Inspection of Buildings) Regulation</li> <li>✓ G.N. No. S 508/2017—Building Control (Inspection of Buildings) (Amendment) Regulations 2017</li> </ul>	2000
1996 Revised Edition - Street Works Act	1996
✓ Act 11 of 2003—Street Works (Amendment) Act 2003	

2000 R	evised Edition - Telecommunication Act	
✓	Act 10 of 2005 - Telecommunications (Amendment) Act 2005	2000
$\checkmark$	Act 19 of 2005 - Telecommunications (Amendment) Act 2011	
~	Act 30 of 2016 - Telecommunications (Amendment) Act 2016	

Approved Codes of Practice	Year
Workplace Safety & Health (Approved Code of Practice) Notification 2020	2020
1. Code of Practice for Working Safely at Heights (Second Revision: 2013)	2013
2. Code of Practice on WSH Risk Management (Second Revision: 2015)	2015
3. Code of Practice on Safe Lifting Operations in the Workplaces (First Revision: 2014)	2014
4. SS 98: Specification for Industrial safety helmets	2013
5. SS 280: Specification for Metal scaffoldings Part 1: Frame scaffoldings	2006
6. SS 280: Specification for Metal scaffoldings Part 2: Modular scaffoldings	2009
7. SS 311: Specification for Steel tubes and fittings used in tubular scaffolding	2005
8. SS 473: Specification for Personal eye-protectors Part 1: General requirements	2011
9. SS 473: Specification for Personal eye-protectors Part 2: Selection, use and maintenance	2011
10. SS 497: Code of Practice for Design, safe use and maintenance of gantry cranes, overhead travelling cranes and monorail hoists	2011
11. SS 506: Occupational safety and health (OSH) management system Part 1: Requirements	2009
12. SS 506: Occupational safety and health (OSH) management system Part 2: Guidelines for the implementation of SS 506: Part 1: 2009	2009
13. SS 508: Specification for Graphical symbols — Safety colours and safety signs Part 1: Design principles for safety signs in workplaces and public areas	2013
14. SS 508: Specification for Graphical symbols — Safety colours and safety signs	2008
Part 2: Design principles for product safety labels	(2013)
15. SS 508: Specification for Graphical symbols — Safety colours and safety signs Part 3: Design principles for graphical symbols for use in safety signs	2013
16. SS 508: Specification for Graphical symbols — Safety colours and safety signs	2013
Part 4: Colorimetric and Photometric properties of safety sign material	
17. SS 508: Specification for Graphical symbols — Safety colours and safety signs Part 5: Registered Safety Signs	2013

18. SS 510: Code of Practice for Safety in welding and cutting (and other operations involving the use of heat) (Formerly CP 50)	2017
19. SS 511: Code of Practice for Diving at work	2018
20. SS 513: Specification for Personal protective equipment — Footwear Part 1: Safety footwear	2013
21. SS 513: Specification for Personal protective equipment — Footwear Part 2: Test methods for footwear	2013
22. SS 514: Code of Practice for Office ergonomics	2016
23. SS 528: Specification for Personal fall-arrest systems Part 1: Full-body harnesses	2006 (2014)
24. SS 528: Specification for Personal fall-arrest systems Part 2: Lanyards and energy absorbers	2006 (2014)
25. SS 528: Specification for Personal fall-arrest systems Part 3: Self-retracting lifelines	2006 (2014)
26. SS 528: Specification for Personal fall-arrest systems Part 4: Vertical rails and vertical lifelines incorporating a sliding-type fall arrester	2006 (2014)
27. SS 528: Specification for Personal fall-arrest systems Part 5: Connectors with self- closing and self-locking gates	2006 (2014)
28. SS 528: Specification for Personal fall-arrest systems Part 6: System performance tests	2006 (2014)
29. SS 531: Code of Practice for Lighting of work places Part 1: Indoor	2006 (2019)
30. SS 531: Code of Practice for Lighting of work places Part 2: Outdoor	2006 (2019)
31. SS 531: Code of Practice for Lighting of work places Part 3: Lighting requirements for safety and security of outdoor work places	2019
32. SS532: Code of Practice for The storage of flammable liquids	2016
33. SS 536: Code of Practice for The safe use of mobile cranes (Formerly CP 37)	2008
34. SS 537: Code of Practice for Safe use of machinery Part 1: General requirements	2008
35. SS 537: Code of Practice for Safe use of machinery Part 2: Woodworking machinery	2009
36. SS 541: Restraint belts Amendment 1 (2012)	2008
<ul> <li>36. SS 541: Restraint belts Amendment 1 (2012)</li> <li>37. SS 548: Code of Practice for Selection, use, and maintenance of respiratory protective devices (Formerly CP 74)</li> </ul>	2008 2009
<ul> <li>36. SS 541: Restraint belts Amendment 1 (2012)</li> <li>37. SS 548: Code of Practice for Selection, use, and maintenance of respiratory protective devices (Formerly CP 74)</li> <li>38. SS 549: Code of Practice for Selection, use, care and maintenance of hearing protectors (Formerly CP 76)</li> </ul>	2008 2009 2009
<ul> <li>36. SS 541: Restraint belts Amendment 1 (2012)</li> <li>37. SS 548: Code of Practice for Selection, use, and maintenance of respiratory protective devices (Formerly CP 74)</li> <li>38. SS 549: Code of Practice for Selection, use, care and maintenance of hearing protectors (Formerly CP 76)</li> <li>39. SS 550: Code of practice for installation, operation and maintenance of electric passenger and goods lifts</li> </ul>	2008 2009 2009 2020

41. SS 554: Code of Practice for Indoor air quality for air-conditioned buildings	2016
42. SS 557: Code of Practice for Demolition (Formerly CP 11)	2010
43. SS 559: Code of Practice for Safe use of tower cranes (Formerly CP 62)	2010
44. SS 562: Code of Practice for Safety in trenches, pits and other excavated areas	2010
45. SS 567: 2011 Code of Practice for Factory layout — Safety, health and welfare considerations (Formerly CP 27)	2011
46. SS 568: 2011 Code of Practice for Confined spaces (Formerly CP 84)	2011
47. SS 569: Code of Practice for Manual handling (Formerly CP 92)	2011
48. SS 570: Specification for Personal protective equipment for protection against falls from a height — Single point anchor devices and flexible horizontal lifeline systems	2011
49 SS 571: Code of Practice for Energy lockout and tagout (Formerly CP 91)	2011
50. SS 573: Code of Practice for The safe use of powered counterbalanced forklifts (Formerly CP 101) Incorporating Corrigendum No 1 – July 2012	2012
51. SS580: Code of Practice for Formwork (Formerly CP 23) Incorporating Corrigendum No 1 – May 2016	2012
52. SS 586: Specification for Hazard communication for hazardous chemicals and dangerous goods Part 1: Transport and storage of dangerous goods	2014
53. SS 586: Specification for Hazard communication for hazardous chemicals and dangerous goods Part 2: Globally harmonised system of classification and labelling of chemicals Singapore's adaptations	2014
54. SS 586: Specification for Hazard communication for hazardous chemicals and dangerous goods Part 3: Preparation of safety data sheets (SDS) Incorporating Amendment No.1 (2014)	2008 (2014)
55. SS 638: Code of Practice for Electrical installations (Formerly CP 5)	2018
56. SS588: Personal equipment for protection against fall – Rope Access Systems. Part 1 – Fundamental principle for a system of work	2013
57. SS588: Personal equipment for protection against fall – Rope Access Systems. Part 2 – Code of Practice	2013
58. SS598: Code of Practice for Suspended scaffolds	2014
59. SS595 Steel Wire Ropes for Hoisting – Part 3: Code of Practice for the care, inspection and maintenance of steel wire ropes for hoisting.	2014
60. SS659 : 2020 Code of Practice for Scaffolds (Formerly CP14)	2020
61. SS 617:2016 on Code of practice for the lifting of persons in work platforms suspended from cranes (formerly CP 63)	2016

62. CP 79: Code of Practice for Safety management system for construction worksites	1999
63. SS650: Code of Practice for Temporary electrical installations Part 1: Construction and building sites (Formerly CP 88)	2019
64. SS 657: Code of practice for workplace noise control ((Formerly CP 99)	2020
65. SS343: Specification for lifting gear – Part 1: Wire rope sling	2014
66. SS343: Specification for lifting gear – Part 2: Hooks	2014
67. SS343: Specification for lifting gear – Part 3: Shackles	2014
68. SS607: Specification for design of active fall-protection systems	2015
69. SS 616: Code of practice for safe use of mobile elevating work platforms	2016
70. SS 176: Portable aluminium ladder	1996
71. SS ISO 45001:2018 Occupational health & safety management systems – Requirements with guidance for use.	2018
72. SS ISO 10218:2016 Robots and robotic devices – Safety requirements for industrial robots Part 1: Robots.	2016
73. SS ISO 10218:2016 Robots and robotic devices – Safety requirements for industrial robots Part 2: Robots systems and integration	2016
<ul> <li>76. SS 639: Code of practice for the filling, inspection, testing and maintenance of gas cylinders for the storage and transport of compressed gases</li> <li>Part 3: Acetylene cylinders - periodic inspection and maintenance</li> </ul>	2018
77. SS EN 13374: Temporary edge protection systems - Product specifications - Test methods	2018

Other Codes of Practices and requirements	Year
Code of Practice for Traffic Control at Work Zone Revision	2018
78. SS576 Code of Practice for earthworks in the vicinity of electricity cables	2019
79 <u>SS 663 : 2020</u> - Code of practice for safe loading on vehicles	2020
80. SS 578 Code of Practice for use and maintenance of portable fire extinguisher	2020
81. Requirements for Safe management Measures at the Workplace	2021
82. BCA COVID-Safe Restart Criteria	2021

Title of Legislation	Year
Environmental Protection and Management Act and Subsidiary Legislation	
Environmental Protection and Management Act	2002
<ul> <li>✓ G. N. No. S 492/2004—Environmental Pollution Control Act (Amendment Of Second Schedule) Order 2004</li> </ul>	

✓	G. N. No. S 78/2005—Environmental Pollution Control Act (Amendment Of Second	
✓	G. N. No. S 571/2005—Environmental Pollution Control Act (Amendment Of Second	
	Schedule) (No. 2) Order 2005	
$\checkmark$	G. N. No. S 296/2007—Environmental Pollution Control Act (Amendment Of Second	
/	Schedule) Order 2007	
v √	Act 26 of 2007—Environmental Pollution Control (Amendment) Act 2007	
√	G. N. No. S 43/2008—Environmental Protection And Management Act (Amendment	
	Of Second Schedule) Order 2008	
√	G. N. No. S 62/2009—Environmental Protection And Management Act (Amendment Of Second Schedule) Order 2009	
$\checkmark$	Act 12 of 2011—Environmental Protection And Management (Amendment) Act 2011	
✓	G. N. No. S 441/2011—Environmental Protection and Management Act (Amendment of Second Schedule) (No. 2) Order 2011	
✓	G. N. No. S 373/2011—Environmental Protection and Management Act (Amendment	
✓	G. N. No. S 373/2013—Environmental Protection and Management Act (Amendment	
✓	G. N. No. S 374/2013—Environmental Protection and Management Act (Amendment	
,	of Second Schedule) (No. 2) Order 2013	
~	G.N. No. S 688/2014—Environmental Protection and Management Act (Amendment of Second Schedule) Order 2014	
$\checkmark$	Act 4 of 2016—National Environment Agency (Miscellaneous Amendments) Act 2016	
$\checkmark$	G.N. No. S 378/2016—Environmental Protection and Management Act (Amendment	
,	of Second Schedule) (No. 2) Order 2016	
~	G.N. No. S 263/2016—Environmental Protection and Management Act (Amendment	
✓	G.N. No. S 27/2017—Environmental Protection and Management Act (Amendment of	
✓	G.N. No. S 783/2017—Environmental Protection and Management Act (Amendment	
,	of Second Schedule) (No.3) Order 2017	
V	G.N. No. S 359/2018—Environmental Protection and Management Act (Amendment of Second Schedule) Order 2018	
$\checkmark$	G.N. No. S784/2017—Environmental Protection and Management Act (Amendment of	
	Second Schedule) (No.4) Order 2017	
✓	G.N. No. S 491/2019—Environmental Protection and Management Act (Amendment	
1	of Second Schedule) Order 2019 Act 40 of 2019 Supreme Court of Judicature (Amendment) Act 2019	
•	Act 40 01 2019—Supreme Court of Sudicature (Amenument) Act 2019	
Env	vironmental Protection and Management (Trade Effluent) Regulations	2008
	G.N. No. S 485/2011—Environmental Protection and Management (Trade Effluent)	
$\checkmark$	(Amendment) Regulations 2011	
Env	vironmental Protection and Management (Vehicular Emissions) Regulations	2008
✓	G.N. No. S 877/2018—Environmental Protection and Management (Vehicular	
✓	Emissions) (Amenament No. 3) Regulations 2018 G.N. No. S 57/2019—Environmental Protection and Management (Vehicular	
	Emissions) (Amendment) Regulations 2019	
$\checkmark$	G.N. No. S 322/2019—Environmental Protection and Management (Vehicular	
	Emissions) (Amendment No. 2) Regulations 2019	
Env	vironmental Protection and Management (Air Impurities) Regulations	2008
$\checkmark$	G. N. No. S 369/2015—Environmental Protection and Management (Air Impurities)	
•	(Amendment) Regulations 2015	

Environmental Protection and Management (Control of Noise At Construction Sites) 2 Regulations	2008	
<ul> <li>G. N. No. S 484/2011—Environmental Protection and Management (Control of Noise at Construction Sites) (Amendment) Regulations 2011</li> </ul>		
Environmental Protection and Management (Hazardous Substances) Regulations		
<ul> <li>✓ G. N. No. S 59/2009—Environmental Protection and Management (Hazardous Substances) (Amendment) Regulations 2009</li> <li>✓ G. N. No. S 553/2010—Environmental Protection and Management (Hazardous Substances) (Amendment) Regulations 2010</li> <li>✓ G.N. No. S 440/2011—Environmental Protection and Management (Hazardous Substances) (Amendment) Regulations 2011</li> <li>✓ G.N. No. S 675/2014—Environmental Protection and Management (Hazardous Substances) (Amendment) Regulations 2014</li> <li>✓ G.N. No. S 675/2014—Environmental Protection and Management (Hazardous Substances) (Amendment) Regulations 2014</li> <li>✓ G.N. No. S 790/2014—Environmental Protection and Management (Hazardous Substances) (Amendment No. 2) Regulations 2014</li> <li>✓ G.N. No. S 782/2017—Environmental Protection and Management (Hazardous Substances) (Amendment No. 2) Regulations 2017</li> <li>✓ G.N. No. S 360/2018—Environmental Protection and Management (Hazardous Substances) (Amendment) Regulations 2017</li> <li>✓ G.N. No. S 360/2018—Environmental Protection and Management (Hazardous Substances) (Amendment) Regulations 2018</li> <li>✓ G.N. No. S 360/2019—Environmental Protection and Management (Hazardous Substances) (Amendment) Regulations 2018</li> <li>✓ G.N. No. S 537/2019—Environmental Protection and Management (Hazardous Substances) (Amendment) Regulations 2019</li> <li>✓ G.N. No. S 537/2019—Environmental Protection and Management (Hazardous Substances) (Amendment) Regulations 2019</li> </ul>		
Environmental Protection and Management (Off-Road Diesel Engine Emissions) Regulations		
Environmental Protection and Management (Prohibition on the Use of Open Fires) Order	2008	
Control of Vectors and Pesticides Act and Subsidiary Legislation		
<ul> <li>Control of Vectors and Pesticides Act</li> <li>✓ Act 24 of 1988- Control of Vectors and Pesticides Act 1988</li> <li>✓ 1999 Revised Edition- Control of Vectors and Pesticides - Act</li> <li>✓ Act 4 of 2002- National Environmental Agency Act 2002</li> <li>✓ 2002 Revised Edition Control of Vectors and Pesticides Act</li> <li>✓ Act 4 of 2016- National Environment Agency (Miscellaneous Amendments) Act 2016</li> <li>✓ Act 40 of 2019- Supreme Court of Judicature (Amendment) Act 2019</li> </ul>	2002	
Infectious Diseases Act and Subsidiary Legislation		
<ul> <li>Infectious Diseases Act</li> <li>G.N. No. S 794/2005— Infectious Diseases (Amendment of first schedule) notification 2005</li> <li>✓ Act 10 of 2008- Infectious Diseases (Amendment) Act 2008</li> <li>✓ G.N. No. S 614/2008— Infectious Diseases Act (Amendment of first schedule) notification 2008</li> <li>✓ G.N. No. S 720/2014— Infectious Diseases Act (Amendment of sixth schedule) notification 2014</li> <li>✓ G.N. No. S 37/2016— Infectious Diseases Act (Amendment of first schedule) notification 2016</li> <li>✓ G.N. No. S 61/2019— Infectious Diseases Act (Amendment of first schedule) notification 2019</li> <li>✓ Act 5 of 2019— Infectious Diseases (Amendment) Act 2019</li> <li>✓ Act 11 of 2019— Singapore Food Agency Act 2019</li> </ul>	2003	

<ul> <li>✓ G.N. No. S 68/2020— Infectious Diseases Act (Amendment of first and second schedules) Notification 2020</li> <li>✓ G.N. No. S 140/2020— Infectious Diseases Act (Amendment of first and second schedules) (No.2) Notification 2020</li> </ul>	
Sewerage and Drainage Act and Subsidiary Legislation	
Sewerage and Drainage Act	2001
<ul> <li>Act 9 of 2002—Sewerage and Drainage (Amendment) Act 2002</li> <li>Act 10 of 2012—Sewerage and Drainage (Amendment) Act 2012</li> <li>Act 10 of 2012—Sewerage and Drainage (Amendment) Act 2012</li> <li>Act 5 of 2012—Subordinate Courts (Amendment) Act 2014</li> <li>Act 12 of 2015—Land Acquisition (Amendment) Act 2015</li> <li>Act 11 of 2018— Public Utilities (Amendment) Act 2018</li> <li>Act 40 of 2019- Supreme Court of Judicature (Amendment) Act 2019</li> <li>Sewerage and Drainage (Surface Water Drainage) Regulations</li> </ul>	2007
Occurrence and Decimentary (Treads Effluence) Decivelations	0007
Sewerage and Drainage (Trade Effluent) Regulations	2007
<ul> <li>G. N. No. S 30/2008—Sewerage and Drainage (Trade Effluent) (Amendment) Regulations 2008</li> <li>G.N. No. S 46/2013—Sewerage and Drainage (Trade Effluent) (Amendment) Regulations 2013</li> <li>G.N. No. S 710/2014—Sewerage and Drainage (Trade Effluent) (Amendment) Regulations 2014</li> <li>G.N. No. S 73/2015—Sewerage and Drainage (Trade Effluent) (Amendment) Regulations 2015</li> <li>G.N. No. S 590/2015—Sewerage and Drainage (Trade Effluent) (Amendment No. 2) Regulations 2015</li> <li>G.N. No. S 483/2016—Sewerage and Drainage (Trade Effluent) (Amendment No. 2) Regulations 2015</li> <li>G.N. No. S 483/2016—Sewerage and Drainage (Trade Effluent) (Amendment) Regulations 2015</li> </ul>	
Sewerage and Drainage (Exemption — Approval for Discharge of Trade Effluent) Notification	2013
Environmental Public Health Act and Subsidiary Legislation	
<ul> <li>Environmental Public Health Act</li> <li>Act 26 of 2007—Environmental Pollution Control (Amendment) Act 2007</li> <li>Act 26 of 2008—Environmental Public Health (Amendment) Act</li> <li>G.N. No. S 442/2013—Environmental Public Health Act (Amendment of Fourth Schedule) Notification 2013</li> <li>Act 15 of 2014—Environmental Public Health (Amendment) Act 2014</li> <li>Act 15 of 2016—National Environment Agency (Miscellaneous Amendments) Act 2016</li> <li>Act 16 of 2016—Statutes (Miscellaneous Amendments) Act 2016</li> <li>Act 48 of 2017—Sale of Food (Amendment) Act 2017</li> <li>Act 11 of 2019—Singapore Food Agency Act 2019</li> <li>G.N. No. S 747/2020—Environmental Public Health Act (Amendment of Fourth Schedule) Notification 2020</li> <li>Act 40 of 2019- Supreme Court of Judicature (Amendment) Act 2019</li> </ul>	2002
Environmental Public Health (Cooling Towers and Water Fountains) Regulations	2002
Environmental Public Health (Registration of Environmental Control Officers) Regulations	2001
Environmental Public Health (Employment of Environmental Control Officers) Order	2001
Environmental Public Health (Qualifications of Environmental Control Officers) Notification	2001

Env	ironmental Public Health (Food Hygiene) Regulations	2000
$\checkmark$	G. N. No. S 222/2000 - Environmental Public Health (Food Hygiene) (Amendment)	
$\checkmark$	G. N. No. S 622/2004 - Environmental Public Health (Food Hygiene) (Amendment)	
$\checkmark$	Regulations 2004 G. N. No. S 872/2005 - Environmental Public Health (Food Hygiene) (Amendment)	
$\checkmark$	Regulations 2005 G. N. No. S 522/2010 - Environmental Public Health (Food Hygiene) (Amendment)	
~	Regulations 2010	
•	Regulations 2011	
Env	ironmental Public Health (Public Cleansing) Regulations	2000
$\checkmark$	G. N. No. S 221/2000 - Environmental Public Health (Public Cleansing)	
$\checkmark$	G. N. No. S 49/2001 - Environmental Public Health (Public Cleansing) (Amendment)	
$\checkmark$	Regulations 2001 G. N. No. S 176/2001 - Environmental Public Health (Public Cleansing) (Amendment	
/	No. 2) Regulations 2001	
v	No. 3) Regulations 2001	
$\checkmark$	G. N. No. S 287/2001 - Environmental Public Health (Public Cleansing) (Amendment No. 4) Regulations 2001	
$\checkmark$	G. N. No. S 316/2001 - Environmental Public Health (Public Cleansing) (Amendment	
$\checkmark$	G. N. No. S 359/2001 - Environmental Public Health (Public Cleansing) (Amendment	
✓	No. 6) Regulations 2001 G. N. No. S 360/2001 - Environmental Public Health (Public Cleansing) (Amendment	
/	No. 7) Regulations 2001	
v	(Amendment) Regulations 2002	
✓	G. N. No. S 377/2004 - Environmental Public Health (Public Cleansing) (Amendment) Regulations 2004	
$\checkmark$	G. N. No. S 639/2004 - Environmental Public Health (Public Cleansing) (Amendment	
$\checkmark$	G. N. No. S 589/2005 - Environmental Public Health (Public Cleansing)	
$\checkmark$	(Amendment) Regulations 2005 G. N. No. S 168/2006 - Environmental Public Health (Public Cleansing)	
/	(Amendment) Regulations 2006	
v	(Amendment) Regulations 2006	
✓	G. N. No. S 168/2006 - Environmental Public Health (Public Cleansing) (Amendment) Regulations 2006	
$\checkmark$	G. N. No. S 168/2006 - Environmental Public Health (Public Cleansing)	
$\checkmark$	G. N. No. S 168/2006 - Environmental Public Health (Public Cleansing)	
✓	(Amendment) Regulations 2006 G. N. No. S 500/2006 - Environmental Public Health (Public Cleansing) (Amendment	
/	No. 2) Regulations 2006	
v	(Amendment) Regulations 2006	
✓	G. N. No. S 712/2006 - Environmental Public Health (Public Cleansing) (Amendment No. 3) Regulations 2006	
$\checkmark$	G. N. No. S 402/2010 - Environmental Public Health (Public Cleansing)	
$\checkmark$	(Amenament) Regulations 2010 G. N. No. S 17/2009 - Environmental Public Health (Public Cleansing) (Amendment)	
	Regulations 2009	

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$\checkmark$	G. N. No. S 405/2009 - Environmental Public Health (Public Cleansing) (Amendment	
	No. 2) Regulations 2009	
~	G. N. No. S 402/2010 - Environmental Public Health (Public Cleansing)	
	(Amendment) Regulations 2010	
v	G. N. NO. 5 554/2010 - Environmental Public Realth (Public Cleansing) (Amendment	
1	G N No. S 596/2011 - Environmental Public Health (Public Cleansing) (Amendment)	
	Regulations 2011	
~	G N No. S 300/2012 - Environmental Public Health (Public Cleansing) (Amendment)	
	Regulations 2012	
✓	G.N. No. S 165/2013 - Environmental Public Health (Public Cleansing) (Amendment)	
	Regulations 2013	
✓	G.N. No. S 165/2013 - Environmental Public Health (Public Cleansing) (Amendment)	
	Regulations 2013	
$\checkmark$	G.N. No. S 626/2013 - Environmental Public Health (Public Cleansing) (Amendment	
	No. 2) Regulations 2013	
~	G.N. No. S 626/2013 - Environmental Public Health (Public Cleansing) (Amendment	
	NO. 2) Regulations 2013 CNL No. S 626/2012 Environmental Dublic Health (Dublic Cleansing) (Amondment	
v	No. 2) Regulations 2013	
$\checkmark$	G N No. S 367/2014 - Environmental Public Health (Public Cleansing) (Amendment)	
	Regulations 2014	
~	G.N. No. S 367/2014 - Environmental Public Health (Public Cleansing) (Amendment)	
	Regulations 2014	
$\checkmark$	G.N. No. S 794/2014 - Environmental Public Health (Public Cleansing) (Amendment	
	No. 2) Regulations 2014	
$\checkmark$	G.N. No. S 799/2014 - Environmental Public Health (Public Cleansing) (Amendment	
	No. 3) Regulations 2014	
$\checkmark$	G.N. No. S 162/2015 - Environmental Public Health (Public Cleansing) (Amendment)	
	Regulations 2015	
V	G.N. No. S 379/2016 - Environmental Public Health (Public Cleansing) (Amendment)	
1	CN No. S 620/2016 - Environmental Public Health (Public Cleansing) (Amendment	
•	No. 2) Regulations 2016	
~	G.N. No. S 111/2017 - Environmental Public Health (Public Cleansing) (Amendment)	
	Regulations 2017	
$\checkmark$	G.N. No. S 220/2018 - Environmental Public Health (Public Cleansing) (Amendment)	
	Regulations 2018	
✓	G.N. No. S 394/2018 - Environmental Public Health (Public Cleansing) (Amendment	
	No. 2) Regulations 2018	
$\checkmark$	G.N. No. S 394/2018 - Environmental Public Health (Public Cleansing) (Amendment	
	No. 2) Regulations 2018	
V	G.N. No. S 220/2018 - Environmental Public Health (Public Cleansing) (Amendment)	
1	REYUIDIIS 2010 G.N. No. S 304/2018 - Environmental Public Health (Public Cleansing) (Amondmont	
ľ	No. 2) Regulations 2018	
✓	G.N. No. S 172/2019 - Environmental Public Health (Public Cleansing) (Amendment)	
1	Regulations 2019	
✓	G.N. No. S 173/2020 - Environmental Public Health (Public Cleansing) (Amendment)	
1	Regulations 2020	
✓	G.N. No. S 975/2020 - Environmental Public Health (Public Cleansing) (Amendment	
	No. 2) Regulations 2020	
Er	vironmental Public Health (General Waste Collection) Regulations	2000
<b>✓</b>	G. IN. INO. 5 480/2002-Environmental Public Health (General Waste Collection)	
./	(Amenument) Regulations 2002 G. N. No. S 562/2008-Environmental Public Health (Constal Maste Collection)	
	(Amendment) Regulations 2008	
✓	G. N. No. S 557/2010-Environmental Public Health (General Waste Collection)	

<ul> <li>(Amendment) Regulations 2010</li> <li>✓ G.N. No. S 792/2014-Environmental Public Health (General Waste Collection)</li> </ul>		
<ul> <li>(Amendment) Regulations 2014</li> <li>✓ G.N. No. S 585/2016-Environmental Public Health (General Waste Collection)</li> </ul>		
<ul> <li>(Amendment) Regulations 2016</li> <li>✓ G.N. No. S 707/2017-Environmental Public Health (General Waste Collection)</li> <li>(Amendment) Regulations 2017</li> </ul>		
<ul> <li>(Amendment) Regulations 2017</li> <li>✓ G.N. No. S 387/2019 -Environmental Public Health (General Waste Collection) (Amendment) Regulations 2019</li> </ul>		
Environmental Public Health (Toxic Industrial Waste) Regulations		
<ul> <li>✓ G. N. No. S 130/2000-Environmental Public Health (Toxic Industrial Waste) (Amendment) Regulations 2000</li> </ul>		
<ul> <li>✓ G. N. No. S 716/2006-Environmental Public Health (Toxic Industrial Waste) (Amendment) Regulations 2006</li> </ul>		
<ul> <li>✓ G. N. No. S 60/2009-Environmental Public Health (Toxic Industrial Waste) (Amendment) Regulations 2009</li> </ul>		
<ul> <li>✓ G. N. No. S 76/2010-Environmental Public Health (Toxic Industrial Waste) (Amendment) Regulations 2010</li> </ul>		
<ul> <li>✓ G. N. No. S 556/2010-Environmental Public Health (Toxic Industrial Waste) (Amendment No. 2) Regulations 2010</li> </ul>		
<ul> <li>✓ G.N. No. S 796/2014-Environmental Public Health (Toxic Industrial Waste) (Amendment) Regulations 2014</li> </ul>		
Environmental Public Health (Burning of Joss Sticks and Candles) Regulations		
Environmental Public Health (Water Suitable for Drinking) Regulations 2019	2019	
Prevention of Pollution of the Sea Act and Subsidiary Legislation		
Prevention of Pollution of the Sea Act and Subsidiary Legislation Prevention of Pollution of the Sea Act	1999	
Prevention of Pollution of the Sea Act and Subsidiary Legislation         Prevention of Pollution of the Sea Act         ✓ Act 26 of 2017—Prevention of Pollution of the Sea (Amendment) Act 2017	1999	
Prevention of Pollution of the Sea Act and Subsidiary Legislation         Prevention of Pollution of the Sea Act         ✓       Act 26 of 2017—Prevention of Pollution of the Sea (Amendment) Act 2017         Prevention of Pollution of the Sea (Reporting of Pollution Incidents) Regulations	1999 2001	
Prevention of Pollution of the Sea Act and Subsidiary Legislation         Prevention of Pollution of the Sea Act         ✓       Act 26 of 2017—Prevention of Pollution of the Sea (Amendment) Act 2017         Prevention of Pollution of the Sea (Reporting of Pollution Incidents) Regulations         Prevention of Pollution of the Sea (Garbage) Regulations 2012	1999 2001 2012	
Prevention of Pollution of the Sea Act and Subsidiary Legislation         Prevention of Pollution of the Sea Act         ✓       Act 26 of 2017—Prevention of Pollution of the Sea (Amendment) Act 2017         Prevention of Pollution of the Sea (Reporting of Pollution Incidents) Regulations         Prevention of Pollution of the Sea (Garbage) Regulations 2012         Parks and Trees Act and Subsidiary Legislation	1999 2001 2012	
Prevention of Pollution of the Sea Act and Subsidiary Legislation         Prevention of Pollution of the Sea Act         ✓ Act 26 of 2017—Prevention of Pollution of the Sea (Amendment) Act 2017         Prevention of Pollution of the Sea (Reporting of Pollution Incidents) Regulations         Prevention of Pollution of the Sea (Garbage) Regulations 2012         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act	1999 2001 2012 2006	
Prevention of Pollution of the Sea Act and Subsidiary Legislation         Prevention of Pollution of the Sea Act         ✓ Act 26 of 2017—Prevention of Pollution of the Sea (Amendment) Act 2017         Prevention of Pollution of the Sea (Reporting of Pollution Incidents) Regulations         Prevention of Pollution of the Sea (Garbage) Regulations 2012         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act         ✓ Act 15 of 2010—Criminal Procedure Code 2010	1999 2001 2012 2006	
Prevention of Pollution of the Sea Act and Subsidiary Legislation         Prevention of Pollution of the Sea Act         ✓ Act 26 of 2017—Prevention of Pollution of the Sea (Amendment) Act 2017         Prevention of Pollution of the Sea (Reporting of Pollution Incidents) Regulations         Prevention of Pollution of the Sea (Garbage) Regulations 2012         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act         ✓ Act 15 of 2010—Criminal Procedure Code 2010         ✓ Act 9 of 2017—Parks and Trees (Amendment) Act 2017         ✓ Act 10 of 2019—National Parks Board (Amendment) Act 2019	1999 2001 2012 2006	
Prevention of Pollution of the Sea Act and Subsidiary Legislation         Prevention of Pollution of the Sea Act         ✓ Act 26 of 2017—Prevention of Pollution of the Sea (Amendment) Act 2017         Prevention of Pollution of the Sea (Reporting of Pollution Incidents) Regulations         Prevention of Pollution of the Sea (Garbage) Regulations 2012         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act         ✓ Act 15 of 2010—Criminal Procedure Code 2010         ✓ Act 9 of 2017—Parks and Trees (Amendment) Act 2017         ✓ Act 10 of 2019—National Parks Board (Amendment) Act 2019         ✓ Act 40 of 2019- Supreme Court of Judicature (Amendment) Act 2019	1999 2001 2012 2006	
Prevention of Pollution of the Sea Act and Subsidiary Legislation         Prevention of Pollution of the Sea Act         ✓ Act 26 of 2017—Prevention of Pollution of the Sea (Amendment) Act 2017         Prevention of Pollution of the Sea (Reporting of Pollution Incidents) Regulations         Prevention of Pollution of the Sea (Garbage) Regulations 2012         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act         ✓ Act 15 of 2010—Criminal Procedure Code 2010         ✓ Act 9 of 2017—Parks and Trees (Amendment) Act 2017         ✓ Act 10 of 2019—National Parks Board (Amendment) Act 2019         ✓ Act 40 of 2019- Supreme Court of Judicature (Amendment) Act 2019         Parks and Trees Regulations	1999 2001 2012 2006 2006	
Prevention of Pollution of the Sea Act and Subsidiary Legislation         Prevention of Pollution of the Sea Act         ✓ Act 26 of 2017—Prevention of Pollution of the Sea (Amendment) Act 2017         Prevention of Pollution of the Sea (Reporting of Pollution Incidents) Regulations         Prevention of Pollution of the Sea (Garbage) Regulations 2012         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act         ✓ Act 15 of 2010—Criminal Procedure Code 2010         ✓ Act 9 of 2017—Parks and Trees (Amendment) Act 2017         ✓ Act 10 of 2019—National Parks Board (Amendment) Act 2019         ✓ Act 40 of 2019—Supreme Court of Judicature (Amendment) Act 2019         Parks and Trees Regulations	1999 2001 2012 2006 2006	
Prevention of Pollution of the Sea Act and Subsidiary Legislation         Prevention of Pollution of the Sea Act         ✓ Act 26 of 2017—Prevention of Pollution of the Sea (Amendment) Act 2017         Prevention of Pollution of the Sea (Reporting of Pollution Incidents) Regulations         Prevention of Pollution of the Sea (Garbage) Regulations 2012         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act         ✓ Act 15 of 2010—Criminal Procedure Code 2010         ✓ Act 9 of 2017—Parks and Trees (Amendment) Act 2017         ✓ Act 10 of 2019—National Parks Board (Amendment) Act 2019         ✓ Act 40 of 2019- Supreme Court of Judicature (Amendment) Act 2019         Parks and Trees Regulations         ✓ G. N. No. S 425/2008—Parks and Trees (Amendment) Regulations 2008         ✓ G. N. No. S 484/2009—Parks and Trees (Amendment) Regulations 2009	1999 2001 2012 2006 2006	
Prevention of Pollution of the Sea Act and Subsidiary Legislation         Prevention of Pollution of the Sea Act         ✓ Act 26 of 2017—Prevention of Pollution of the Sea (Amendment) Act 2017         Prevention of Pollution of the Sea (Reporting of Pollution Incidents) Regulations         Prevention of Pollution of the Sea (Garbage) Regulations 2012         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act         ✓ Act 15 of 2010—Criminal Procedure Code 2010         ✓ Act 10 of 2019—National Parks Board (Amendment) Act 2017         ✓ Act 10 of 2019—National Parks Board (Amendment) Act 2019         ✓ Act 40 of 2019-Supreme Court of Judicature (Amendment) Act 2019         ✓ Act 40 of 2019-Parks and Trees (Amendment) Regulations 2008         ✓ G. N. No. S 425/2008—Parks and Trees (Amendment) Regulations 2009         ✓ G. N. No. S 379/2011—Parks and Trees (Amendment) Regulations 2011         ✓ G. N. No. S 379/2011—Parks and Trees (Amendment) Regulations 2011	1999 2001 2012 2006 2006	
Prevention of Pollution of the Sea Act and Subsidiary Legislation         Prevention of Pollution of the Sea Act         ✓ Act 26 of 2017—Prevention of Pollution of the Sea (Amendment) Act 2017         Prevention of Pollution of the Sea (Reporting of Pollution Incidents) Regulations         Prevention of Pollution of the Sea (Garbage) Regulations 2012         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act         ✓ Act 15 of 2010—Criminal Procedure Code 2010         ✓ Act 9 of 2017—Parks and Trees (Amendment) Act 2017         ✓ Act 10 of 2019—National Parks Board (Amendment) Act 2019         ✓ Act 40 of 2019- Supreme Court of Judicature (Amendment) Act 2019         ✓ Act 40 of 2019- Supreme Court of Judicature (Amendment) Regulations 2008         ✓ G. N. No. S 425/2008—Parks and Trees (Amendment) Regulations 2009         ✓ G. N. No. S 379/2011—Parks and Trees (Amendment) Regulations 2009         ✓ G.N. No. S 224/2012—Parks and Trees (Amendment) Regulations 2011         ✓ G.N. No. S 224/2013—Parks and Trees (Amendment) Regulations 2012	1999 2001 2012 2006 2006	
Prevention of Pollution of the Sea Act and Subsidiary Legislation         Prevention of Pollution of the Sea Act         ✓ Act 26 of 2017—Prevention of Pollution of the Sea (Amendment) Act 2017         Prevention of Pollution of the Sea (Reporting of Pollution Incidents) Regulations         Prevention of Pollution of the Sea (Garbage) Regulations 2012         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act         ✓ Act 15 of 2010—Criminal Procedure Code 2010         ✓ Act 15 of 2010—Criminal Procedure Code 2010         ✓ Act 10 of 2017—Parks and Trees (Amendment) Act 2017         ✓ Act 10 of 2019—National Parks Board (Amendment) Act 2019         ✓ Act 40 of 2019- Supreme Court of Judicature (Amendment) Act 2019         ✓ Act 40 of 2019- Supreme Court of Judicature (Amendment) Regulations 2008         ✓ G. N. No. S 425/2008—Parks and Trees (Amendment) Regulations 2009         ✓ G. N. No. S 484/2009—Parks and Trees (Amendment) Regulations 2011         ✓ G.N. No. S 224/2012—Parks and Trees (Amendment) Regulations 2011         ✓ G.N. No. S 74/2013—Parks and Trees (Amendment) Regulations 2012         ✓ G.N. No. S 160/2015—Parks and Trees (Amendment) Regulations 2013	1999 2001 2012 2006 2006	
Prevention of Pollution of the Sea Act and Subsidiary Legislation         Prevention of Pollution of the Sea Act         ✓ Act 26 of 2017—Prevention of Pollution of the Sea (Amendment) Act 2017         Prevention of Pollution of the Sea (Reporting of Pollution Incidents) Regulations         Prevention of Pollution of the Sea (Garbage) Regulations 2012         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act and Subsidiary Legislation         Parks and Trees Act         ✓ Act 15 of 2010—Criminal Procedure Code 2010         ✓ Act 9 of 2017—Parks and Trees (Amendment) Act 2017         ✓ Act 9 of 2019—National Parks Board (Amendment) Act 2019         ✓ Act 40 of 2019. Supreme Court of Judicature (Amendment) Act 2019         ✓ Act 40 of 2019. Supreme Court of Judicature (Amendment) Regulations 2008         ✓ G. N. No. S 425/2008—Parks and Trees (Amendment) Regulations 2008         ✓ G. N. No. S 425/2008—Parks and Trees (Amendment) Regulations 2011         ✓ G. N. No. S 224/2012—Parks and Trees (Amendment) Regulations 2012         ✓ G.N. No. S 160/2015—Parks and Trees (Amendment) Regulations 2012         ✓ G.N. No. S 160/2015—Parks and Trees (Amendment) Regulations 2013         ✓ G.N. No. S 530/2015—Parks and Trees (Amendment) Regulations 2015         ✓ G.N. No. S 160/2015—Parks and Trees (Amendment) Regulations 2015         ✓ G.N. No. S 160/2015—Parks and Trees (Amendment) Regulations 2015	1999 2001 2012 2006 2006	

Parks and Trees (Preservation of Trees) Order       1998         ✓       G.N. No. S 661/2017—Parks and Trees (Preservation of Trees) (Amendment) Order 2017         Parks and Trees (Heritage Road Green Buffers) Order       2006         Wildlife Protection Act and Subsidiary Legislation       2000         Wild Animals and Birds Act       2000         ✓       Act 10 of 2019 – National Parks Board (Amendment) Act 2019       2000         ✓       Act 10 of 2019 – National Parks Board (Amendment) Act 2019       2000         ✓       Act 10 of 2019 – National Parks Board (Amendment) Act 2019       2002         ✓       Act 30 of 2004—Public Utilities (Amendment) Act 2012       2002         ✓       Act 9 of 2012—Public Utilities (Amendment) Act 2012       2014         ✓       Act 10 of 2018—Public Utilities (Amendment) Act 2014       2014         ✓       Act 10 of 2018—Public Utilities (Amendment) Act 2015       2014         ✓       Act 10 of 2018—Public Utilities (Marendment) Act 2018       2004         ✓       Act 10 of 2018—Public Utilities (Water Supply) (Amendment) Regulations 2005       2004         ✓       G. N. No. S 97/2005—Public Utilities (Water Supply) (Amendment) Regulations 2011       2014         ✓       G. N. No. S 161/2011—Public Utilities (Water Supply) (Amendment) Regulations 2011       2014         ✓       G. N. No.	<ul> <li>✓ G.N. No. S 205/2016—Parks and Trees (Amendment No. 2) Regulations 2016</li> <li>✓ G.N. No. S 561/2016—Parks and Trees (Amendment No. 3) Regulations 2016</li> <li>✓ G.N. No. S 660/2017—Parks and Trees (Amendment) Regulations 2017</li> <li>✓ G.N. No. S 122/2018—Parks and Trees (Amendment) Regulations 2018</li> <li>✓ G.N. No. S 847/2019—Parks and Trees (Amendment) Regulations 2019</li> <li>✓ G.N. No. S 502/2020—Parks and Trees (Amendment) Regulations 2020</li> </ul>		
✓         G.N. No. S 661/2017—Parks and Trees (Preservation of Trees) (Amendment) Order 2017           Parks and Trees (Heritage Road Green Buffers) Order         2006           Wildlife Protection Act and Subsidiary Legislation         2006           Wild Animals and Birds Act         2000           ✓         Act 10 of 2019 – National Parks Board (Amendment) Act 2019         2000           ✓         Act 18 of 2020 – Wild Animals and Birds (Amendment) Act 2019         2000           ✓         Act 18 of 2020 – Wild Animals and Birds (Amendment) Act 2020         2002           Public Utilities Act and Subsidiary Legislation         2002           ✓         Act 39 of 2004 – Public Utilities (Amendment) Act 2012         2012           ✓         Act 9 of 2012—Public Utilities (Amendment) Act 2012         2014           ✓         Act 19 of 2014—Public Utilities (Amendment) Act 2015         2014           ✓         Act 19 of 2019—Supreme Court of Judicature (Amendment) Act 2019         2014           ✓         Act 10 of 2019—Supreme Court of Judicature (Amendment) Act 2019         2014           ✓         Act 13 of 2020—Public Utilities (Water Supply) (Amendment) Regulations 2005         2014           ✓         G. N. No. S 832/2010—Public Utilities (Water Supply) (Amendment) Regulations 2011         2014           ✓         G. N. No. S 161/2011—Public Utilities (Water Supply) (Amend	Parks and Trees (Preservation of Trees) Order		
Parks and Trees (Heritage Road Green Buffers) Order       2006         Wildlife Protection Act and Subsidiary Legislation       2000         Wild Animals and Birds Act       2000         ✓ Act 10 of 2019 – National Parks Board (Amendment) Act 2019       2000         ✓ Act 18 of 2020 – Wild Animals and Birds (Amendment) Act 2020       2000         Public Utilities Act and Subsidiary Legislation       2002         Public Utilities Act and Subsidiary Legislation       2002         ✓ Act 39 of 2004—Public Utilities (Amendment) Act 2012       2012—Public Utilities (Amendment) Act 2012         ✓ Act 9 of 2012—Public Utilities (Amendment) Act 2012       2014—Public Utilities (Governance) Act 2018         ✓ Act 3 of 2013—Public Utilities (Amendment) Act 2018       2000         ✓ Act 10 of 2019—Supreme Court of Judicature (Amendment) Act 2019       2004         ✓ Act 13 of 2020—Public Utilities (Water Supply) (Amendment) Regulations 2005       2004         ✓ G. N. No. S 870/2008—Public Utilities (Water Supply) (Amendment) Regulations 2016       2004         ✓ G. N. No. S 161/2011—Public Utilities (Water Supply) (Amendment) Regulations 2016       2004         ✓ G. N. No. S 161/2013—Public Utilities (Water Supply) (Amendment) Regulations 2016       2004         ✓ G. N. No. S 161/2014—Public Utilities (Water Supply) (Amendment) Regulations 2011       2004         ✓ G. N. No. S 161/2013—Public Utilitities (Water Supply) (Amendment) Regulations	<ul> <li>✓ G.N. No. S 661/2017—Parks and Trees (Preservation of Trees) (Amendment) Order 2017</li> </ul>		
Wildlife Protection Act and Subsidiary Legislation       2000         Wild Animals and Birds Act       2000         ✓ Act 10 of 2019 – National Parks Board (Amendment) Act 2019       2000         ✓ Act 18 of 2020 – Wild Animals and Birds (Amendment) Act 2020       2000         Public Utilities Act and Subsidiary Legislation       2002         Public Utilities Act and Subsidiary Legislation       2002         ✓ Act 39 of 2004—Public Utilities (Amendment) Act 2012       2012—Public Utilities (Amendment) Act 2012         ✓ Act 9 of 2012—Public Utilities (Amendment) Act 2015       2015—Land Acquisition (Amendment) Act 2015         ✓ Act 10 of 2018—Public Utilities (Amendment) Act 2018       2004         ✓ Act 30 of 2019—Supreme Court of Judicature (Amendment) Act 2019       2014         ✓ Act 30 of 2020—Public Utilities (Water Supply) (Amendment) Regulations 2005       2004         ✓ Act 30 of 2020—Public Utilities (Water Supply) (Amendment) Regulations 2006       2004         ✓ G. N. No. S 83/2010—Public Utilities (Water Supply) (Amendment) Regulations 2010       2014         ✓ G. N. No. S 161/2011—Public Utilities (Water Supply) (Amendment) Regulations 2011       2014         ✓ G. N. No. S 161/2011—Public Utilities (Water Supply) (Amendment) Regulations 2011       2014         ✓ G. N. No. S 152/2015—Public Utilities (Water Supply) (Amendment) Regulations 2011       2014         ✓ G. N. No. S 153/2017—Public Utilities (Water Supply) (	Parks and Trees (Heritage Road Green Buffers) Order	2006	
Wild Animals and Birds Act       2000         ✓ Act 10 of 2019 – National Parks Board (Amendment) Act 2019       2001         ✓ Act 18 of 2020 – Wild Animals and Birds (Amendment) Act 2020       2002         Public Utilities Act and Subsidiary Legislation       2002         Public Utilities Act and Subsidiary Legislation       2002         ✓ Act 39 of 2004—Public Utilities (Amendment) Act 2014       2002         ✓ Act 9 of 2012—Public Utilities (Amendment) Act 2012       2004         ✓ Act 9 of 2012—Public Utilities (Amendment) Act 2012       2001         ✓ Act 9 of 2013—Public Utilities (Amendment) Act 2015       2014         ✓ Act 10 of 2018—Public Utilities (Manendment) Act 2018       2004         ✓ Act 10 of 2019—Public Utilities (Amendment) Act 2018       2004         ✓ Act 30 of 2020—Public Utilities (Water Supply) (Amendment) Regulations 2005       2004         ✓ G. N. No. S 87/2005—Public Utilities (Water Supply) (Amendment) Regulations 2014       2004         ✓ G. N. No. S 161/2011—Public Utilities (Water Supply) (Amendment) Regulations 2013       2014         ✓ G. N. No. S 25/2013—Public Utilities (Water Supply) (Amendment) Regulations 2014       2014         ✓ G. N. No. S 163/2017—Public Utilities (Water Supply) (Amendment) Regulations 2017       2014         ✓ G. N. No. S 164/2018—Public Utilities (Water Supply) (Amendment) Regulations 2017       2014         ✓ G. N. No. S 164/2018—Pub	Wildlife Protection Act and Subsidiary Legislation		
<ul> <li>Act 10 of 2019 – National Parks Board (Amendment) Act 2019</li> <li>Act 18 of 2020 – Wild Animals and Birds (Amendment) Act 2020</li> <li>Public Utilities Act and Subsidiary Legislation</li> <li>Public Utilities Act</li> <li>2002</li> <li>Act 39 of 2004—Public Utilities (Amendment) Act 2014</li> <li>Act 9 of 2012—Public Utilities (Amendment) Act 2012</li> <li>Act 9 of 2012—Public Utilities (Amendment) Act 2015</li> <li>Act 12 of 2015—Land Acquisition (Amendment) Act 2015</li> <li>Act 13 of 2018—Public Utilities (Amendment) Act 2018</li> <li>Act 14 of 2018—Public Utilities (Amendment) Act 2018</li> <li>Act 14 of 2018—Public Utilities (Amendment) Act 2019</li> <li>Act 13 of 2020—Public Utilities (Mater Supply) (Amendment) Regulations 2005</li> <li>G. N. No. S 703/2005—Public Utilities (Water Supply) (Amendment) Regulations 2005</li> <li>G. N. No. S 703/2005—Public Utilities (Water Supply) (Amendment) Regulations 2010</li> <li>G. N. No. S 616/2013—Public Utilities (Water Supply) (Amendment) Regulations 2011</li> <li>G. N. No. S 52/2010—Public Utilities (Water Supply) (Amendment) Regulations 2011</li> <li>G. N. No. S 512/2014—Public Utilities (Water Supply) (Amendment) Regulations 2011</li> <li>G. N. No. S 133/2017—Public Utilities (Water Supply) (Amendment) Regulations 2017</li> <li>G. N. No. S 133/2017—Public Utilities (Water Supply) (Amendment) Regulations 2017</li> <li>G. N. No. S 133/2017—Public Utilities (Water Supply) (Amendment) Regulations 2017</li> <li>G. N. No. S 133/2017—Public Utilities (Water Supply) (Amendment) Regulations 2017</li> <li>G. N. No. S 53/2018—Public Utilities (Water Supply) (Amendment) Regulations 2017</li> <li>G. N. No. S 133/2017—Public Utilities (Water Supply) (Amendment) Regulations 2017</li> <li>G. N. No. S 133/2017—Public Utilities (Water Supply) (Amendment) Regulations 2017</li> <li>G. N. No. S 53/2018—Public Utilities (Water Supply) (Amendment) Regulations 2017</li></ul>	Wild Animals and Birds Act	2000	
Public Utilities Act and Subsidiary Legislation       2002         Public Utilities Act       2002         ✓ Act 39 of 2004—Public Utilities (Amendment) Act 2004       2002         ✓ Act 9 of 2012—Public Utilities (Amendment) Act 2012       202         ✓ Act 9 of 2012—Public Utilities (Amendment) Act 2012       202         ✓ Act 10 for 2018—Public Utilities (Amendment) Act 2015       2014         ✓ Act 10 of 2018—Public Utilities (Governance) Act 2018       2004         ✓ Act 13 of 2020—Public Utilities (Amendment) Act 2018       2004         ✓ Act 13 of 2020—Public Utilities (Mater Supply) (Amendment) Regulations 2005       2004         ✓ G. N. No. S 707/2008—Public Utilities (Water Supply) (Amendment) Regulations 2005       2004         ✓ G. N. No. S 161/2011—Public Utilities (Water Supply) (Amendment) Regulations 2011       2004         ✓ G. N. No. S 161/2013—Public Utilities (Water Supply) (Amendment) Regulations 2013       2014         ✓ G.N. No. S 161/2013—Public Utilities (Water Supply) (Amendment) Regulations 2014       2014         ✓ G.N. No. S 163/2013—Public Utilities (Water Supply) (Amendment) Regulations 2015       2014         ✓ G.N. No. S 133/2017—Public Utilities (Water Supply) (Amendment) Regulations 2017       2014         ✓ G.N. No. S 133/2017—Public Utilities (Water Supply) (Amendment) Regulations 2017       2017         ✓ G.N. No. S 133/2017—Public Utilities (Water Supply) (Amendment) Regulations 2017	<ul> <li>✓ Act 10 of 2019 – National Parks Board (Amendment) Act 2019</li> <li>✓ Act 18 of 2020 – Wild Animals and Birds (Amendment) Act 2020</li> </ul>		
Public Utilities Act       2002 <ul> <li>Act 39 of 2004—Public Utilities (Amendment) Act 2014</li> <li>Act 9 of 2012—Public Utilities (Amendment) Act 2012</li> <li>Act 30 of 2012—Public Utilities (Amendment) Act 2015</li> <li>Act 12 of 2015—Land Acquisition (Amendment) Act 2015</li> <li>Act 13 of 2018—Public Utilities (Governance) Act 2018</li> <li>Act 10 of 2019 Supreme Court of Judicature (Amendment) Act 2019</li> <li>Act 13 of 2020—Public Utilities (Manendment) Act 2020</li> </ul> <li>Public Utilities (Water Supply) Regulations</li> <li>G. N. No. S 97/2005—Public Utilities (Water Supply) (Amendment) Regulations 2005</li> <li>G. N. No. S 97/2008—Public Utilities (Water Supply) (Amendment) Regulations 2010</li> <li>G. N. No. S 161/2011—Public Utilities (Water Supply) (Amendment) Regulations 2011</li> <li>G. N. No. S 161/2013—Public Utilities (Water Supply) (Amendment) Regulations 2013</li> <li>G. N. No. S 161/2013—Public Utilities (Water Supply) (Amendment) Regulations 2013</li> <li>G. N. No. S 163/2014—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2014</li> <li>G. N. No. S 55/2015—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2017</li> <li>G. N. No. S 133/2017—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2017</li> <li>G. N. No. S 164/2018—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2017</li> <li>G. N. No. S 164/2018—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2017</li> <li>G. N. No. S 164/2018—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2017</li> <li>G. N. No. S 164/2018—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2018</li> <li>G. N. No. S 163/2019—Pub</li>	Public Utilities Act and Subsidiary Legislation		
<ul> <li>Act 39 of 2004—Public Utilities (Amendment) Act 2004</li> <li>Act 9 of 2012—Public Utilities (Amendment) Act 2012</li> <li>Act 9 of 2012—Public Utilities (Amendment) Act 2012</li> <li>Act 12 of 2015—Land Acquisition (Amendment) Act 2015</li> <li>Act 12 of 2018—Public Utilities (Governance) Act 2018</li> <li>Act 10 of 2019—Public Utilities (Governance) Act 2018</li> <li>Act 10 of 2019—Public Utilities (Amendment) Act 2018</li> <li>Act 10 of 2019—Public Utilities (Amendment) Act 2020</li> <li>Public Utilities (Water Supply) Regulations</li> <li>G. N. No. S 97/2005—Public Utilities (Water Supply) (Amendment) Regulations 2005</li> <li>G. N. No. S 703/2008—Public Utilities (Water Supply) (Amendment) Regulations 2001</li> <li>G. N. No. S 832/2010—Public Utilities (Water Supply) (Amendment) Regulations 2010</li> <li>G. N. No. S 161/2011—Public Utilities (Water Supply) (Amendment) Regulations 2011</li> <li>G. N. No. S 866/2014—Public Utilities (Water Supply) (Amendment) Regulations 2011</li> <li>G. N. No. S 826/2014—Public Utilities (Water Supply) (Amendment) Regulations 2014</li> <li>G. N. No. S 55/2015—Public Utilities (Water Supply) (Amendment) Regulations 2015</li> <li>G. N. No. S 133/2017—Public Utilities (Water Supply) (Amendment) Regulations 2017</li> <li>G. N. No. S 133/2017—Public Utilities (Water Supply) (Amendment) Regulations 2017</li> <li>G. N. No. S 133/2017—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2017</li> <li>G. N. No. S 164/2018—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2017</li> <li>G. N. No. S 164/2018—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2017</li> <li>G. N. No. S 164/2018—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2018</li> <li>G. N. No. S 153/2019—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2018</li> <li>G. N. No. S 192/2019—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2019<td>Public Utilities Act</td><td>2002</td></li></ul>	Public Utilities Act	2002	
Public Utilities (Water Supply) Regulations       2004         ✓ G. N. No. S 97/2005—Public Utilities (Water Supply) (Amendment) Regulations 2005       2008         ✓ G. N. No. S 703/2008—Public Utilities (Water Supply) (Amendment) Regulations 2008       2004         ✓ G. N. No. S 832/2010—Public Utilities (Water Supply) (Amendment) Regulations 2010       2004         ✓ G. N. No. S 832/2010—Public Utilities (Water Supply) (Amendment) Regulations 2011       2004         ✓ G. N. No. S 161/2011—Public Utilities (Water Supply) (Amendment) Regulations 2011       2014         ✓ G.N. No. S 616/2013—Public Utilities (Water Supply) (Amendment) Regulations 2013       2014         ✓ G.N. No. S 55/2014—Public Utilities (Water Supply) (Amendment) Regulations 2014       2014         ✓ G.N. No. S 55/2015—Public Utilities (Water Supply) (Amendment) Regulations 2017       2014         ✓ G.N. No. S 133/2017—Public Utilities (Water Supply) (Amendment) Regulations 2017       2017         ✓ G.N. No. S 133/2017—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2017       2017         ✓ G.N. No. S 164/2018—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2018       2018         ✓ G.N. No. S 112/2019—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2019       2018         ✓ G.N. No. S 192/2019—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2019       2019         ✓ G.N. No. S 341/2020—Public Utilities (Water Supply) (Amendment No. 3) Regulations 2020       2020<	<ul> <li>Act 39 of 2004—Public Utilities (Amendment) Act 2004</li> <li>Act 9 of 2012—Public Utilities (Amendment) Act 2012</li> <li>Act 9 of 2012—Public Utilities (Amendment) Act 2012</li> <li>Act 12 of 2015—Land Acquisition (Amendment) Act 2015</li> <li>Act 5 of 2018—Public Utilities (Governance) Act 2018</li> <li>Act 11 of 2018—Public Utilities (Amendment) Act 2018</li> <li>Act 40 of 2019- Supreme Court of Judicature (Amendment) Act 2019</li> <li>Act 13 of 2020—Public Utilities (Amendment) Act 2020</li> </ul>		
Public Utilities (Reservoirs, Catchment Areas and Waterway) Regulations 2006         2006	<ul> <li>Public Utilities (Water Supply) Regulations</li> <li>G. N. No. S 97/2005—Public Utilities (Water Supply) (Amendment) Regulations 2005</li> <li>G. N. No. S 703/2008—Public Utilities (Water Supply) (Amendment) Regulations 2008</li> <li>G. N. No. S 832/2010—Public Utilities (Water Supply) (Amendment) Regulations 2010</li> <li>G. N. No. S 161/2011—Public Utilities (Water Supply) (Amendment) Regulations 2011</li> <li>G.N. No. S 616/2013—Public Utilities (Water Supply) (Amendment) Regulations 2013</li> <li>G.N. No. S 721/2014—Public Utilities (Water Supply) (Amendment) Regulations 2014</li> <li>G.N. No. S 55/2015—Public Utilities (Water Supply) (Amendment) Regulations 2015</li> <li>G.N. No. S 55/2015—Public Utilities (Water Supply) (Amendment) Regulations 2017</li> <li>G.N. No. S 133/2017—Public Utilities (Water Supply) (Amendment) Regulations 2017</li> <li>G.N. No. S 133/2017—Public Utilities (Water Supply) (Amendment) Regulations 2017</li> <li>G.N. No. S 133/2017—Public Utilities (Water Supply) (Amendment) Regulations 2017</li> <li>G.N. No. S 133/2017—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2017</li> <li>G.N. No. S 164/2018—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2018</li> <li>G.N. No. S 112/2019—Public Utilities (Water Supply) (Amendment No. 2) Regulations 2018</li> <li>G.N. No. S 153/2019—Public Utilities (Water Supply) (Amendment No.2) Regulations 2019</li> <li>G.N. No. S 192/2019—Public Utilities (Water Supply) (Amendment No.2) Regulations 2019</li> <li>G.N. No. S 192/2019—Public Utilities (Water Supply) (Amendment No.3) Regulations 2019</li> <li>G.N. No. S 192/2019—Public Utilities (Water Supply) (Amendment No.3) Regulations 2019</li> <li>G.N. No. S 192/2019—Public Utilities (Water Supply) (Amendment No.3) Regulations 2019</li> <li>G.N. No. S 341/2020—Public Utilities (Water Supply) (Amendment No.3) Regulations 2019</li> </ul>	2004	
	2006		

Approved Codes of Practice	Year
Code of Practice on Environmental Health	2020
Code of Practice for Environmental Control Officers	2020
Code of Practice for Vector Control Operators, Technician and Worker	2020
Code of Practice for Licensed General Waste Collectors	2020
Code of Practice for the Control of Legionella Bacteria in Cooling Towers	2001
Code of Practice on Drinking Water Sampling and Safety Plans	2019
Code of Practice on Surface Water Drainage	2021
Code of Practice on Sewerage and Sanitary Works	2021
SS 636: 2018 Code of Practice for Water Services	2020
SS 547: 2009 Code of Practice for Temporary housing quarters in Construction sites	2009
SS 554: 2016 Code of practice for indoor air quality for air-conditioned buildings	2016
SS 602: 2014 Code of practice for noise control on construction and demolition sites	2014
SS 593:2013 Code of Practice for Pollution Control	2014
SS 603: 2014 Code of practice for hazardous waste management	2014
SS ISO 46001: 2019 Water efficiency management systems – Requirements with guidance for use	2019