120 ROOFING

120.1 GENERAL

120.1.1 CROSS REFERENCES

General

Conform to the General Requirements worksection.

Associated worksections

Conform to associated worksections as follows:

Civil and Structural Materials and Workmanship. Specification: sections >

Adhesives, Sealants and Fasteners.

Fire Stopping.

Insulation and Barriers.

Sprayed Mineral Fire Protection.

Gratings.

>

120.1.2 DEFINITIONS

All references to roofing and roofing systems in the section include external metal soffits and fascia systems.

120.1.3 DESIGN

Drawings

Contract drawings show generic design principles and design intent only.

Maintenance

The roof system shall be maintainable and replaceable in parts or whole from the outside.

120.2 QUALITY

120.2.1 PERFORMANCE CRITERIA

Minimum requirements

Provide a roofing system and associated work which

- remains intact and waterproof under the local or regional ambient climatic conditions;
- provides adequate means of dealing with vapour pressure, condensation, corrosion and thermal movement;
- supports the specified imposed loads and types of roof access without impairment of performance;
- Provides the minimum thermal resistance required by the drawings or current legislation in Singapore, whichever is the higher; and
- satisfies other specified performance requirements.

Ambient climatic conditions

Wind loading: Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

Design rainfall intensity: To match 1 in 200 year anticipated rainfall intensity, Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

Roof fall arrest system

Type: To BS EN 363.

Imposed loading

Uniformly distributed (kPa): Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

Concentrated (per 2000 mm^2 of roof space) (kN): Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

Dynamic (e.g. wheel loads) loading schedule

Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

Thermal insulation

Minimum added thermal resistance (R) (m^2.K/W):

>

Ponding

Minimum acceptable fall on flat roofing: 1 in 80.

Ensure that there is no ponding on completed roofs or gutters.

120.2.2 INSPECTION

Witness points

Give sufficient notice so that inspection may be made of the following:

- Completion of all sample panels and prototypes.
- Roof, fascia and soffit supports; and
- those parts of the roofing, sarking, vapour barrier, insulation and roof plumbing installation which will be covered up or concealed.

Hold points

- Completion of confirmation prototypes.

Corrosion

Cross refer: General Requirements Clause 20.4.1.

120.2.3 TESTS

General

Carry out all tests in accordance with Section 20.3.2 'Tests' of the General Requirements.

Metal roofing

General tests: Type test the roof sheeting and fastenings to AS 1562.1 for resistance to concentrated load and to wind pressure.

Internal downpipes

Site test each stack hydrostatically in stages maximum 6.0m high for two hours. Remedy defects and retest if necessary.

120.2.4 SAMPLES

General

Submit samples of each of the following in accordance with Section 20.3.4 'Samples', of the General Requirements.

- Each type of proposed roof finish showing how the material will be jointed both horizontally and vertically.
- Each exposed soffit material proposed showing how the material will be jointed.
- Each fascia material proposed showing how the material will be jointed.
- Each material used in the build-up to soffit and roof finishes.
- Each fixing used in the soffit and roof finishes.

Size of samples

- Roof or soffit finishes showing joints: minimum 1.0m sq.
- Linear sample : minimum 600mm.
- Unjointed materials: minimum 600mm sq.
- Materials illustrating joints: minimum 1000mm sq.

No. of samples: 3.

120.2.5 PROTOTYPES

General

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

Confirmation Prototype

Provide a confirmation prototype of all roof, fascia and soffit finishes.

Location:	As agreed with the Engineer.
Minimum size (face of panel) (mm):	2.0m x 2.0m.

Incorporating

- Horizontal and vertical joints.
- Roof penetrations.
- Upstands and associated flashing details.
- Hip and valley junctions as directed by the Engineer.
- Gutters and associated flashings.

Retain all prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

120.2.6 SUBMISSIONS

General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

Subcontractors

Submit name and contact details of proposed suppliers and specialist roofer subcontractor(s).

Shop drawings

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Submit shop drawings showing, but not limited to, the following information:

- Plan of all roof areas showing supporting structure and layout of all roof sheeting.
- Details of all primary and secondary members.
- Details of all required laps, joints, penetrations, abutments and interfaces.
- Hold down details.
- Allowances for movement.
- Disposal of rainwater.
- All interfacing details.
- Method of assembly.
- Provisions for maintenance access.

Fabric roofs: Submit shop drawings showing, but not limited to, the following:

- Arrangement of roof and supports including the size and shape of the membrane and the location of joints, connections, support and lifting points.
- Design loading and pressure level.
- Specification, grade and finish of materials and components.
- Method of fabrication including fabric joints, cable connections and terminations and support structures.
- Cutting patterns for the fabric and, where applicable, sequence of jointing.
- Fabrication tolerances.
- Control testing of materials, fabricated components and fabric joints.
- Method of erection.
- Connection to, or junction with, adjoining structures, as applicable.

No. of copies to be submitted: As Particular Specification.

Engineering endorsement

Submit calculations and drawings from a Singapore licensed Professional Engineer concurrently with the shop drawings and showing, but not limited to, the following:-

Compliance with all relevant Singapore legislation and regulations.

Manufacturers' information

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

Test Reports

Submit copies of current test reports, and certification, including drawings of tested details, for each proprietary material and roof build up in accordance with Section 20.3.2, 'Tests' of the General Requirements.

Submit PSB test reports.

No. of copies to be submitted: 3.

Method Statement

General: Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

120.3 MATERIALS AND COMPONENTS

120.3.1 MATERIALS AND COMPONENTS

General

Shelf life: Ensure materials used have not exceeded their shelf life.

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use materials which contain known carcinogenics.

Corrosivity: Non-corrosive.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building. Cross refer: Item 4.6 'Metal Separation'.

Fasteners

All fixings and fastenings shall be appropriate to the work, shall transmit all imposed loads and stresses, and shall ensure the and structural integrity of the roof.

All fixings and fastenings shall be non-corrosive.

Self-drilling screws: To AS 3566. Corrosion resistance Class 3.

Finish: Prefinish exposed fasteners with an oven baked polymer coating to match the roofing material, or provide matching purpose-made plastic caps.

>

>

120.4 EXECUTION

120.4.1 INSTALLATION

Protection

General: Keep the roofing and rainwater system free of debris and loose material during construction, and leave them clean and unobstructed on completion. Repair damage to the roofing and rainwater system.

Touch up: If it is necessary to touch up minor damage to prepainted metal roofing, do not overspray onto undamaged surfaces.

Thermal movement

Provide for thermal movement to suit the climatic conditions in Singapore in the roof installation and the structure, including movement in joints and fastenings.

Wet Weather

Provide temporary covers and drainage as required to keep unfinished areas of the roof dry.

Suspend work in severe or continuously wet weather unless an effective temporary roof is provided over the working area.

If unavoidable wetting of the construction does occur, take prompt action to minimise and make good any damage.

120.4.2 SAFETY MESH

Standard

General: To AS/NZS 4389.

120.4.3 TILING

Materials

Clay roofing tiles: To SS 70.

Accessories: Provide the accessories, compatible with the tiles, necessary to complete the tiling.

- Type: To SS 70.

Installation

Standard: To AS CP 94.

Setting out: Set out the roof to give an even tile gauge in each course, with full or saw cut tiles at verges.

Bedding and pointing: Bed and point accessories, including ridges, hips and verges, in coloured mortar.

- Colour: To match the tiles and accessories.

Tile verge: Finish the verge with cover tiles pointed to the roof tiles. Screw fix to the barge board with round head galvanized screws.

Pointed verge: Bed and point tiles on 100 x 5 mm fibre cement pointing strip.

Precautions against wind effects: Adopt the precautions identified by the Singapore licensed Professional Engineer: Cross refer “Engineering Endorsement, Item 2.6 above.

Tile schedule

Type:	>
Pattern:	>
Finish:	>
Colour:	>

120.4.4 SHEET METAL TILING

General

Type: A proprietary roofing system of interlocking prefinished steel sheets profiled to resemble tiles.

Material

Thickness:	>
Finish:	>
Colour:	>

120.4.5 SHEET METAL ROOFING AND CLADDING

General

- Comply with SS 370 and SS CP 89.

Provide a roofing system and purpose-made accessories.

Design and installation: To AS 1562.1.

Prepainted and organic film/metal laminate products: To AS/NZS 2728.

Provide ventilation to the underside of sheet metal roofing where recommended by manufacturer.

System	PRS1	PRS2	PRS3
Product type:	>	>	>
Product finish:	PVF2	>	>
Material:	Zinc coated sheet steel	>	>
Profile:	>	>	>
Thickness (base metal) (mm):	>	>	>
Grade:	>	>	>
Finish:	>	>	>
Colour:	>	>	>
Fixing:	>	>	>
- Type:	>	>	>
- Size:	>	>	>
- Spacing (mm):	>	>	>

Accessories: Provide material with the same finish as roofing sheets.

Ridges and eaves

Treat ends of sheets as follows:

- Project sheets 50 mm into gutters.
- Close off ribs at bottom of sheets using mechanical means or with purpose-made fillers or end caps.
- Turn pans of sheets up at tops and down into gutters by mechanical means.
- Provide pre-cut notched eaves flashing and birdproofing where necessary.
- Close off ridges with purpose-made ridge fillers of closed cell polyethylene.

Ridge and barge capping

Finish off along ridge and verge lines with purpose-made ridge capping or barge rolls.

Sprung curved ridge

Lay the roof in single lengths from eaves to eaves by naturally curving the sheets over the ridge.

End laps

General: Where end laps are unavoidable, and the sheet profile is not suitable for interlocking or contact end laps, construct a stepped type lap.

Length of lap (mm): >

Pan type sheets

Removal: Capable of being de-indexed and removed without damage.

Curved corrugated sheet

General: Form by rolling from material recommended for curving or bullnosing. Minimise crimping or creasing across the face of the sheet. Trim off crimped or creased edges and ends.

120.4.6 METAL SEPARATION

Prevent direct contact between incompatible metals, and between green hardwood or chemically treated timber and aluminium or coated steel, by either

- applying an anti-corrosion, low moisture transmission coating to contact surfaces; or
- inserting a separation layer.

120.4.7 FULLY SUPPORTED COPPER ROOFING

Type

Copper roofing laid on flush finished continuous decking over an underlayer and separation layer.

Underlayer

Bituminous felt. Lay loose over deck.

Separation layer

Fire resistant building paper.

Roof sheeting

Material: Soft temper copper to AS 1566.

Minimum thickness: 0.5 mm.

Profile: Roll form sheeting into pan profiles for forming into standing lock seam joints at 375mm maximum centres.

Finish: Prepatinated.

>

Fixing

Fix pans to the deck with concealed copper clips at 750 mm maximum centres.

Lock seams

Mechanically form and welt seal in situ using a self propelled seaming machine, to stand 25 mm high on completion. Dress seams flat at gutters, ridges and hips, and fold both pan and seam down into gutters and up to form stop ends at ridges and hips.

Ridge and hip capping

Lock welt to the upturn of the roofing.

120.4.8 FIBRE CEMENT ROOFING

Material

Type: 6 mm thick autoclaved fibre cement sheet, corrugated to 150 mm pitch.

Standard: To AS/NZS 2908.1.

Accessories

Provide purpose-made accessories.

Installation

Standard: To AS/NZS 1562.2.

120.4.9 PLASTIC SHEET ROOFING

Materials

Glass fibre reinforced polyester (GRP) sheet: To AS/NZS 4256.3.

Type, class or designation: >

Profile: >

Colour: >

Fire performance: >

Installation

Standard: To AS/NZS 1562.3.

Fixing: >

120.4.10 SUSPENDED FABRIC ROOFING

Description

General: Suspended coated fabric roof, including the supporting structure and anchorages, designed and constructed by a specialist firm.

Material

Type: >

Tensile strength: >

Reflectivity: >

Fire test indices to AS/NZS 1530.3: >

Colour>

Other requirements: >

Installation

Method of jointing: >

Type of supporting structure: >

Other structural requirements: >

120.4.11 ROOF VENTILATORS

Description

General: Proprietary roof mounted ventilators including fixings, trim and flashings.

Finish: Match adjacent roofing.

120.4.12 ROOF PLUMBING

General

Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

- Gratings.
- Waterproofing.

Standard: Comply with SS CP 26, SS CP 89 and membrane manufacturer's recommendations.

General: Provide the flashings, cappings, gutters, rainwater heads, outlets, overflows and downpipes necessary to complete the roof system.

The manufacturer's name, diameter of pipe, class designation, relevant standard, length of pipe and year of manufacture shall be legibly and durably marked on each pipe and fitting.

Syphonic drainage system

Provide proprietary syphonic drainage system.

Materials

Metal rainwater goods: To AS/NZS 2179.1.

Jointing sheet metal rainwater goods

Butt joints: Make joints over a backing strip of the same material.

Soldered joints: Do not solder aluminium or aluminium/zinc-coated steel.

Sealing: Seal fasteners and mechanically fastened joints. Fill the holes of blind rivets with silicone sealant.

System: >

Flashings and cappings

Flashing material: To AS/NZS 2904.

Type: >

Installation: Flash roof junctions, upstands, abutments and projections through the roof. Preform to required shapes where possible. Notch, scribe, flute or dress down as necessary to follow the profile of adjacent surfaces. Mitre angles and lap joints 150 mm in running lengths. Provide matching expansion joints at 6 m maximum intervals.

Upstands: Flash projections above or through the roof with two part flashings, consisting of a base flashing and a cover flashing, with at least 100 mm vertical overlap. Provide for independent movement between the roof and the projection.

Wall abutments: Provide overflashings where roofs abut walls, stepped to the roof slope in masonry and planked cladding, otherwise raking.

- In masonry: Build into the full width of the outer leaf. Turn up within cavity, sloping inward across the cavity and fixed to or built in to the inner leaf at least 75 mm above.
- In concrete: Turn 25 mm into joints or grooves, wedge at 200 mm centres with compatible material and point up.

Fixing to masonry or concrete: Step in courses to the roof slope. Interleave with damp proof course, if any.

Fixing to pipes: Solder, or seal with neutral cured silicone rubber and either

- secure with a clamping ring; or
- provide a proprietary flexible clamping shoe with attached metal surround flashing.

Flashings and cappings schedule

Component	Material and finish	Thickness and grade	Profile and size	Jointing method
Flashings	>	>	>	>
Cappings	>	>	>	>

Gutters

General: Prefabricate gutters to the required shape where possible. Form stop ends, downpipe nozzles, bends and returns. Dress downpipe nozzles into outlets. Provide overflows to prevent back-flooding.

Matching gutter and fascia: Provide a proprietary metal eaves gutter and accessories formed and precoated to match the fascia system.

Gutter and sump support: Provide framing and lining to support valley gutters, box gutters and sumps. Line the whole area under the gutters and sumps.

Support: >

Lining: >

Valley gutters: Profile to suit the valley supports. Turn back both edges 180° x 6 mm radius. Nail or screw to the valley supports at the top end to prevent the gutter creeping downwards.

Gratings and guards: Provide removable gratings over rainwater heads and sumps and leaf guards to gutters and gutter units.

Expansion joints: Provide expansion joints in guttering longer than 30 m.

Leaf guards to gutters >

Leaf guards to gutter outlets: >

Ball guards to gutter outlets: >

Matching fascia/barge: Where the selected eaves gutter is a proprietary high front pattern forming part of a combined system of gutter, fascia and barge, provide the matching proprietary fascias and barge cappings to roof verges and edges.

Downpipes

General: Prefabricate downpipes to the required section and shape where possible. Connect heads to gutter outlets and, if applicable, connect feet to rainwater drains.

Access cover: Provide a removable watertight access cover at the foot of each downpipe stack.

Downpipe support: Provide supports and fixings for downpipes.

Spreaders: Provide spreaders to match the downpipe materials, where required. Include all required supports and fixings.

Internal downpipes

Material: >

Size (mm): >

Jointing method: >

Access: Provide access openings as follows:

- At each junction and bend.
- At the foot of each stack.
- At every second floor level.

Type of access opening: >

Sound insulation: Mineral fibre pipe insulation 50 mm thick, spirally bound on with 1.5 mm wire at 150 mm pitch.

Building in: Where pipes are built into masonry or concrete, spiral wrap the pipe (and insulation, if any) with building paper.

Gutter and downpipe schedule

Item	Material and finish	Shape and size	Thickness and grade	Jointing method	Colour
Valley gutter	>	>	>	>	>
Eaves gutter	>	>	>	>	>
Box gutter	>	>	>	>	>
Rainwater heads and sumps	>	>	>	>	>
Downpipe	>	>	>	>	>
Overflows	>	>	>	>	>
Overflow spouts	>	>	>	>	>

120.4.13 LIGHTNING PROTECTION

General

To SS CP 33.

120.5 COMPLETION

120.5.1 COMPLETION

General

Cross refer: Item 20.5 ‘Completion’ of the General Requirements.

Operation and Maintenance Manual

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 ‘Operation and Maintenance Manuals’ of the General Requirements including, frequency of inspection and recommended methods of access, inspection, cleaning, repair and replacement.

Protection

Protect all completed roofing on site from damage until handover.

Ensure that the roof is not used as a working platform unless fully protected.

Do not allow solvents, paint or other harmful chemicals to come into contact with the roof surface.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

On or before completion of the works remove all materials used as a means of protection.

Damage

Replace damaged items with new.

Warranties

Warrant the materials and workmanship using the Authority’s standard warranty form for the period(s) stated in Item 20.5.1 ‘Warranties’ of the General Requirements.

Submit the roofing materials manufacturer’s published product warranties.

Warrant all materials and workmanship against all defects including, but not limited to, corrosion, leaks, discolouration, surface blemishes, for the entire system including, but not limited to, gutters, downpipes, connectors, fasteners accessories, sealants and gaskets.

The warranty shall be valid regardless of the fact that lightning protection tapes and other attachments as directed by the Engineer shall be fitted to, on, or through the roof, by others.

Record drawings

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

120.5.2 REPAIR

Before commencing repairs submit details of the proposed repair method for acceptance.

130 EXTERNAL CLADDING

130.1 GENERAL

130.1.1 CROSS REFERENCES

General

Conform to the General Requirements worksection.

Associated worksections

Conform to associated worksections as follows: Civil and Structural M&W Sections >
Adhesives, Sealants and Fasteners.
Windows.
Louvres.
Internal cladding.
Vitreous enamel panels.
>

130.1.2 INTERPRETATION

Fixing: the term 'fixings' shall be taken to mean:-

- Supporting fixings that transfer the self weight of the cladding to the structure. Supports may also include a restraint function.
- Restraint fixings: Fixings that tie back the cladding to the structure and resist variable loads such as wind loads, vibration, and live loads from cleaning equipment.

Authority's Sample: A sample held by the Authority and available for viewing during the tender and construction periods.

130.1.3 EQUIPOTENTIAL BONDING REQUIREMENTS (EPB)

Cross Refer: Section 20.2.7 'Design' of the General Requirements.

130.1.4 DESIGN

Drawings

Contract drawings show generic design principles and design intent only.

130.2 QUALITY

130.2.1 PERFORMANCE CRITERIA

Minimum requirements

Provide an external system and associated work which

- remains intact and waterproof under the local or regional ambient climatic conditions;
- provides adequate means of dealing with vapour pressure, condensation, corrosion and thermal movement;
- supports the specified loads and types of access without impairment of performance;
- Provides the minimum thermal resistance required by the drawings or current legislation in Singapore, whichever is the higher; and
- satisfies other specified performance requirements.

Ambient climatic conditions

Wind loading: Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

Design rainfall intensity: To match 1 in 200 year anticipated rainfall intensity, Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

Loading

Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

130.2.2 INSPECTION

Witness points

Give sufficient notice so that inspection may be made of the following:

- Completion of all sample panels.
- The fabrication of cladding panels or assemblies prior to delivery to the site.
- Framing complete with sarking and flashings ready to receive cladding.
- Those parts of the cladding installation which will be covered up or concealed.
- >

Hold points

- Completion of confirmation prototypes.
- >

Corrosion

Cross refer: General Requirements Clause 20.4.1.

130.2.3 TESTS

General

Carry out all tests in accordance with Section 20.3.2 'Tests' of the General Requirements.

130.2.4 SAMPLES

General

Submit samples of each of the following in accordance with Section 20.3.4 'Samples', of the General Requirements.

- Each type of proposed cladding material finish showing how it will be jointed both horizontally and vertically.
- Each material used in the build-up to the cladding.
- Each fixing used in the cladding.
- >

Size of samples

- Finishes showing joints: minimum 1.0m sq.
- Linear samples : minimum 600mm.
- Unjointed materials: minimum 600mm sq.

No. of samples: 3.

130.2.5 PROTOTYPES

General

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

Design Prototype

Provide a design prototype of cladding finishes identified by the Engineer.

Location:	As agreed with the Engineer.
Minimum size (mm):	2.0m x 2.0m or complete panel as directed.
Incorporating	- Horizontal and vertical joints. - Penetrations. - Edge details as directed. - Interfaces as directed. - >

Confirmation Prototype

Provide a confirmation prototype of all cladding finishes.

Location:	As agreed with the Engineer.
Minimum size (mm):	2.0m x 2.0m or complete panel as directed.
Incorporating	- Horizontal and vertical joints. - Penetrations. - Edge details as directed. - Interfaces as directed.
-	>

Retain all prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

130.2.6 SUBMISSIONS

General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

Subcontractor

Submit name and contact details of proposed suppliers and specialist installer(s).

Shop drawings

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Submit shop drawings showing, but not limited to, the following information:

- Elevations plans and sections of all clad areas showing the supporting structure and layout of all cladding components.
- Details of all primary and secondary members.
- Details of all required joints, penetrations and interfaces.
- Allowances for movement.
- Method of assembly.
- Provisions for maintenance access.
- Submit calculations and drawings from a Singapore licensed Professional Engineer.

No. of copies to be submitted: As Particular Specification.

Engineering endorsement

Submit calculations and drawings from a Singapore licensed Professional Engineer concurrently with the shop drawings and showing, but not limited to, the following:-

Compliance with all relevant Singapore legislation and regulations.

Submit a report from a Singapore registered Electrical Engineer certifying that the design and installation of internal cladding is in compliance with Section 13.9 of the Authority's Design Criteria Volume 2 of 2, and Singapore Standard CP5 and meets all of the Authority's equipotential bonding and touch voltage protection requirements.

Manufacturers' information

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

Test Reports

Submit copies of current test reports, and certification, including drawings of tested details, for each proprietary material and build up in accordance with Section 20.3.2, 'Tests' of the General Requirements.

Submit PSB test reports.

No. of copies to be submitted: 3.

Method Statement

General: Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

130.3 MATERIALS AND COMPONENTS

130.3.1 General

Shelf life: Ensure materials used have not exceeded their shelf life.

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use materials which contain known carcinogenics.

Corrosivity: Non-corrosive.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building. Cross refer: Item 4.6 'Metal Separation'.

Fasteners

All fixings and fastenings shall be appropriate to the work, shall transmit all imposed loads and stresses, and shall ensure the and structural integrity of the cladding.

All fixings and fastenings shall be non-corrosive.

Self-drilling screws: To AS 3566. Corrosion resistance Class 3.

Finish: Prefinish exposed fasteners with an oven baked polymer coating to match the cladding material, or provide matching purpose-made plastic caps.

>

>

130.3.2 MATERIALS AND COMPONENTS

Fibre cement

Standard: To AS/NZS 2908.2.

Type A Category 3 (modulus of rupture ≥ 7 megapascals).

Type A Category 5 (modulus of rupture ≤ 18 megapascals).

- Edges: Square.

130.4 EXECUTION

130.4.1 CONSTRUCTION GENERALLY

General

Ensure that the entire installation prevents the retention of water which may find its way behind the cladding system.

Ensure that the entire installation accommodates all building tolerances and anticipated movement.

Cross refer to the Civil and Structural M&W specification and ensure that tolerances and movement are adequately described.

Environment

Thermal resistance (R):	>
Fire resistance level (FRL):	>
Sound transmission	>

Substrates or framing

Before fixing cladding check and, if necessary, adjust the alignment of framing.

Accessories and trim

Provide accessories and trim necessary to complete the installation.

Lightning Protection

To SS CP 33.

130.5 CLADDING TYPES

130.5.1 FIBRE CEMENT CLADDING

Plank cladding

General: Provide pre-finished fibre cement building planks.

Finish:>

Colour:	Colour to be selected from the BS4800 or RAL colour ranges.
Width x length (mm):	>
Plank thickness:	>
Plank density	>
Movement from ambient to fully saturated	≤ 0.1%.
Tolerances	>
Joints and edges:	>
Corners:	Preformed metal joining pieces.
	>

Sheet cladding

General: Provide pre-finished fibre cement sheets.

Arrangement: Set out in even panels with joints coinciding with framing.

Finish:>

Colour:	Colour to be selected from the BS4800 or RAL colour ranges.
Width x length (mm):	>
Sheet thickness:	>

Sheet density	>
Movement from ambient to fully saturated	≤ 0.1%.
Tolerances	>
Joints and edges:	>
Corners:	Preformed metal joining pieces.
	>
Perforations:	>

Eaves and soffit lining

General: Provide pre-finished fibre cement sheet.

Finish:>

Colour:	Colour to be selected from the BS4800 or RAL colour ranges.
Width x length (mm):	>
Sheet thickness:	>
Plank density	>
Movement from ambient to fully saturated	≤ 0.1%.
Tolerances	>
Joints and edges:	
Perforations:	>

130.5.2 COMPRESSED FIBRE CEMENT CLADDING

General

Finish:>

Colour:	Colour to be selected from the BS4800 or RAL colour ranges.
Width x length (mm):	>
Sheet thickness:	>
Density	>
Tolerances	>

Flat panels

General: Smooth even edges free of imperfections such as chips, cut to suit the layout, allowing for a joint gap > mm wide between panels.

Horizontal joints: Epoxy bond a backing strip of compressed fibre cement, 4.5 mm thick, finished to match the cladding, to the rear face of the panel. Seal the joint with a 3 mm epoxy fillet.

Vertical joints: Backing strip as for horizontal joints. Seal the joint gap with two continuous beads of sealant, or with a twin-bulb neoprene gasket.

- Strip width (mm): >

Screws

General: Zinc plated, chromate passivated.

Metal framing: Self drilling self tapping. To AS 3566. Corrosion resistance Class 3.

Fixing

All fixings and fastenings shall be non-corrosive.

No visible fixings will be acceptable.

All fixings and fastenings shall be appropriate to the work, shall transmit all imposed loads and stresses, and shall ensure the and structuaral integrity of the cladding.

All fixings and fastenings shall be effectively insulated from electrochemical reaction with incompatible materials.

Drilling: Pre-drill the panels 1 mm oversize for screw fixings and countersink so that the top of the screw is 2 - 3 mm below the surface.

Finish: Stop screw heads with epoxy filler smoothed and levelled upon application and sanded flush after curing.

Intermediate supports

>

130.5.3 METAL PANEL CLADDING

General

On completion, metal cladding shall be

- free from distortion including, but not limited to, twist, oil canning and welding deformations.
- within the tolerances defined by the formula $(A \div B) \times 100 \leq 0.5\%$.

where:-

A = the greatest dimension of divergence from the design plane or curve measured at right angles from that plane or curve.

B = The shortest dimension separating points of nil and greatest divergences, measured along the plane or curve.

Type

General: Cladding system comprising

- metal panels, installed so as to be weathertight under the local and regional ambient conditions in Singapore;
- metal panels, installed as part of an open joint cladding system.
- >
- a metal substructure of stringers, carrier rails and furrings, protected against corrosion to the acceptance of the Engineer to which the panels are fixed with proprietary concealed fixings
- matching trim where required to form parapet cappings, reveals and sills to openings;
- accessories and fixings necessary to complete the installation; and
- provision for thermal movement.

Metal panels

Provide all necessary stiffeners/ backing to comply with the requirements of this specification.

System	CP1	CP2	CP3
Facing material:	>	>	>
Type	>	>	>
Thickness	>	>	>
Prefinish	>	>	>
Colour	To be selected from the BS 4800 or RAL colour ranges	To be selected from the BS 4800 or RAL colour ranges	>
Maximum wind pressure (Pa)	>	>	>
Fixing type	>	>	>
Joint type	>	>	>
Trim	>	>	>
Perforations	>	>	>
Tolerances	>	>	>

Sandwich panels
Type: Prefinished metal facings surrounding a core of inert material.

System	SP1	SP2	SP3
Facing material:	>	>	>
Type	>	>	>
Thickness	>	>	>
Prefinish	>	>	>
Colour	To be selected from the BS 4800 or RAL colour ranges	To be selected from the BS 4800 or RAL colour ranges	>
Core material	>	>	>
Backing material	>	>	>
Thickness	>	>	>
Maximum wind pressure (Pa)	>	>	>
Thermal resistance (R) (or transmittance (U)):	>	>	>
Fixing type	>	>	>
Joint type	>	>	>
Trim	>	>	>
Tolerances	>	>	>

Access Panels

Designation	AP1	AP2	AP3
Purpose	>	>	>
Materrial	To match adjacent panels	>	>
Size	>	>	>
Tolerances	>	>	>
Finish	>	>	>
Ironmongery	>	>	>
Hinges	Fully concealed	>	>
Catch	Tamper proof	>	>
Handle	Fully recessed to match panel	>	>
Locations	As shown on drawings	>	>
Signage	>	>	>

130.5.4 LOUVRED SUNSCREENS

Type
General: A fixed louvre system comprising

- prefinished profiled metal louvres attached with proprietary concealed fixings to a supporting substructure;
- a substructure of brackets, frames and carrier members, mechanically fastened to the building structure; and
- accessories and fixings necessary to complete the installation.

Designation	**LP1**	**LP2**	**LP3**
Louvres	>	>	>
Type	>	>	>
Material	>	>	>
Prefinish	>	>	>
Colour	>	>	>
Support Structure	>	>	>
Material	>	>	>
Finish	>	>	>
Fixing to building structure	>	>	>

130.6 COMPLETION

130.6.1 COMPLETION

General

Cross refer: Item 20.5 'Completion' of the General Requirements.

Operation and Maintenance Manual

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements including, frequency of inspection and recommended methods of access, inspection, cleaning, repair and replacement.

Protection

Protect all completed cladding on site from damage until handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

On or before completion of the works remove all materials used as a means of protection.

Damage

Replace damaged items with new.

Warranties

Warrant the materials and workmanship using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

Submit all proprietary materials manufacturer's published product warranties.

Warrant all materials and workmanship against all defects including, but not limited to, corrosion, leaks, discolouration, surface blemishes, for the entire system including, but not limited to, connectors, fasteners accessories, sealants and gaskets.

The warranty shall be valid regardless of the fact that attachments as directed by the Engineer shall be fitted to, on, or through the cladding, by others.

Record drawings

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

130.6.2 REPAIR

Before commencing repairs submit details of the proposed repair method for acceptance.

140 STONE CLADDING

140.1 GENERAL

140.1.1 CROSS REFERENCES

General

Conform to the General Requirements worksection.

Associated worksections

Conform to associated worksections as follows: Adhesives, Sealants and Fasteners.
Stone Masonry.
External Cladding.
>

140.1.2 STANDARD

General

Design and installation: To BS 8298.

Granite: To ASTM C-615.

Marble: To ASTM C-503.

Limestone: To ASTM C-568, type III.

140.1.3 INTERPRETATION

Cladding and lining

Stone cladding: Non-loadbearing facing units of natural stone or cast stone, mechanically fixed with metal fixings to the structural background or to precast concrete units, or to a perimeter frame forming part of a glazed curtain wall.

Cladding: Unless the context otherwise requires, the term cladding refers to both external cladding and internal lining.

Loadbearing fixings: Supporting fixings that transfer the self weight of the cladding to the structure. Supports may also include a restraint function.

Restraint fixings: Fixings that tie back the cladding to the structure and resist variable loads such as wind loads, vibration, and live loads from cleaning equipment.

Finishes

To the definitions of the American National Building Granite Quarries Association Inc. Viz:-

- Polished : Mirror glass with sharp reflections.
- Honed : Dull sheen, without reflections.
- Flamed : Produced by the application of high temperature flame to the surface. Large surfaces shall not have shadow lines caused by the overlapping of the torch.
- Fine Rubbed : Smooth and free from scratches – no sheen.
- Shot ground : Plane surface with pronounced circular markings or trails having no regular pattern.
- Sand blasted, coarse stippled : Coarse plane surface produced by blasting with an abrasive, coarseness varies with type of preparatory finish and grain structure of the granite.
- Sand blasted, line stippled : Plane surface, slightly pebbled with occasional slight trails or scratches.
- 8-cut : Fine bush hammered.
- 6-cut : Medium bush hammered.
- 4-cut : Coarse bush hammered.

Saw cut: The finish obtained from the saw used to cut the granite.

Authority's Sample: A sample held by the Authority and available for viewing during the tender and construction periods.

140.1.4 DESIGN

Drawings

Contract drawings show generic design principles and design intent only.

140.2 QUALITY

140.2.1 PERFORMANCE CRITERIA

Minimum requirements for external stone cladding

Provide an external system and associated work which

- remains intact and waterproof under the local or regional ambient climatic conditions;
- provides adequate means of dealing with vapour pressure, condensation, corrosion and thermal movement;
- supports the specified loads and types of access without impairment of performance;
- Provides the minimum thermal resistance required by the drawings or current legislation in Singapore, whichever is the higher; and
- satisfies other specified performance requirements.

Ambient climatic conditions

Wind loading: Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

Design rainfall intensity: To match 1 in 200 year anticipated rainfall intensity, Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

Loading

Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

140.2.2

140.2.3 INSPECTION

Witness points

Give sufficient notice so that inspection may be made of the following:

- Proposed stone source (quarry, storage yard).
- Proposed mason's yard.
- Materials stored at the yard or on site.
- The prepared stone sample range.
- Stone laid out before fixing.
- Items to be built-in located in their correct positions, including damp-proof course, flashings, bolts, cramps, brackets, metalwork and rainwater goods.
- Commencement of cast stone production.
- Joints prior to sealing .
- Completed stonework.

Hold points

- Completion of each confirmation prototype.

Corrosion

Cross refer: General Requirements Clause 20.4.1.

140.2.4 TESTS

General

Carry out all tests in accordance with Section 20.3.2 'Tests' of the General Requirements.

General: Obtain test samples, representative of each required type of stone, and have the tests carried out at the following stages:

- Before awarding a stone supply contract.
- On dimension stone prepared for the works, at intervals during the course of the works.

Testing authority: >

Natural stone tests schedule

Stone type: >

Property to be tested	Test standard	Test criterion (if not in the test standard)	Number and frequency of tests
Unconfined compressive strength (dry and saturated):	>	>	>
- Intact rock core specimens	>	>	>
- Dimension stone	>	>	>
Surface absorption rate	>	>	>
Porosity	>	>	>

Property to be tested	Test standard	Test criterion (if not in the test standard)	Number and frequency of tests
Wet and Dry density	>	>	>
Modulus of rupture	>	>	>
Sodium sulphate soundness	>	>	>
Flexural strength	>	>	>
Other properties	>	>	>

Natural stone tests schedule

Stone type: granite

Property to be tested	Test standard	Test criterion (if not in the test standard)	Number and frequency of tests
Unconfined compressive strength (dry and saturated):	>	>	>
- Intact rock core specimens	ASTM D2938	>	>
- Dimension stone	ASTM C170	131 MN/m^2	>
Water absorption	ASTM C72	0.4%	>
Porosity	ASTM C97	>	>
Dry density	ASTM C72	2560 kg/m^3	>
Modulus of rupture	ASTM C99	10.34 MN/m^2	>
Sodium sulphate soundness	>	>	>
Flexural strength	ASTM C880	>	>
Other properties	>	>	>

Cast stone tests schedule

Property to be tested	Test standard	Test criterion (if not in the test standard)	Number and frequency of tests
Compressive strength	BS 1217	>	>
Drying shrinkage	BS 1217	>	>
Initial surface absorption	BS 1217	>	>
Other properties	>	>	>

Mortar tests schedule

Property to be tested	Test standard	Test criterion (if not in the test standard)	Number and frequency of tests
Compressive strength	AS 2701.4	>	>
Bulk density	>	>	>
Soluble silica and calcium oxide content	AS 2701	>	>

Installed sealant tests

Sampling: For each sealant test take 3 samples of installed and cured sealant, each at least 50 mm long, from completed joints.

Testing: Test to the standard applicable to the sealant type.

Reinstatement: Make good the joints from which the samples were taken.

Installed sealant tests schedule

Item to be tested	Property to be tested	Applicable standard
>	>	>
>	>	>
>	>	>

Structural fixings tests

Sampling: Sample structural fixings at the rate of one item per 100 fixings, or part thereof, of each type.

Testing: Test to determine whether the fixing metals are of the material, grade or designation required.

Tensile tests: To BS 5080:1.

Shear tests: To BS 5080:2.

Structural fixings tests schedule

Item to be tested	Property to be tested	Applicable standard
>	>	>
>	>	>
>	>	>

140.2.5 SAMPLES

General

Submit samples of each of the following in accordance with Section 20.3.4 'Samples', of the General Requirements.

Stone samples

Stone units: For each type and grade of stone (including natural, cast, and synthetic stone), submit at least 6 quality control samples of each stone unit (e.g. block, panel, tile)

- either the full size of the unit, or 300 x 300 mm, whichever is the greater; and
- showing the expected range of variation of colour, pattern, texture, and surface finish in stone to be supplied.

Cast stone: Submit samples which consist of both facing and backing material, if different.

Associated materials and products

Sand: Submit a 2 kg sample of sand required to be from a particular source, or of a particular colour, or of a particular particle size distribution. Include a sieve analysis for particle size distribution.

Accessories: Submit 2 samples of loadbearing and restraint fixings for cladding panels.

Marking

Label natural stone samples to show the quarry source, section, bed and lift.

No. of samples: 3, unless noted otherwise above.

140.2.6 PROTOTYPES

General

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

Design Prototype

Location: As agreed with the Engineer.

Minimum size (face of panel) (mm): Panel height x 3.0m length.

Incorporating
- Door opening.
- Service outlets as identified by the Engineer.
- Corner.
- joint finishes (including mortar pointing and sealant).

Confirmation Prototype

Location:	As agreed with the Engineer.
Minimum size (face of panel) (mm):	Panel height x 3.0m length.
Incorporating	- Door opening. - Service outlets as identified by the Engineer. - Corner. - joint finishes (including mortar pointing and sealant).
Footings:	>

Retain all prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

140.2.7 SUBMISSIONS

General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

Subcontractors

Submit name and contact details of proposed suppliers and specialist installer(s).

Shop drawings

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Submit shop drawings and associated documents showing, but not limited to, the following where applicable:

- Stonework setting out.
- Position and identifying number of each stone.
- Dimensions of each stone and lay of natural bed.
- Lifting detail and fixing detail of each stone.
- Panel dimensions: Including minimum thickness and slot fixing dimensions.
- Fixings: Location and design of loadbearing and restraint fixings and their method of attachment to the cladding and structure, with calculations to verify the structural adequacy of the proposals.
- Joints: The size and shape of panel joints, including movement joints, showing
  - . the method of dealing with differential movements such as building structure creep and elastic shortening, drying shrinkage, thermal and moisture movements; and
  - . provision for three way adjustment of the panel position.
- Jointing: Methods of jointing and pointing panel joints, including movement joints, with particulars of the materials to be used.
- Cavity: Cavity width and provision for the following:
  - . Cavity insulation.
  - . Cavity drainage.
  - . Cavity damp-proofing and condensation prevention.

No. of copies to be submitted: As Particular Specification.

Engineering endorsement

Submit calculations and drawings from a Singapore licensed Professional Engineer concurrently with the shop drawings and showing, but not limited to, the following:-

Compliance with all relevant Singapore legislation and regulations.

Materials

Supplier's data: Submit statements from the stone supplier, with the following information:

- The supplier's experience in the required type of work.
- Production capacity for material of the required type, sizes and quantity.
- Particulars of established quality control procedures (if any), and the category of the procedures to the relevant standard.
- The physical properties of the required material.
- Lead times for delivery of the material to the site.
- Lead times for delivery of the material to the curtain wall fabricator.

Manufacturers' information

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with

Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

Test Reports

Submit copies of current test reports, and certification, including drawings of tested details, for each proprietary material and build up in accordance with Section 20.3.2, 'Tests' of the General Requirements.

Submit PSB test reports.

No. of copies to be submitted: 3.

Method Statement

General: Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

140.3 MATERIALS AND COMPONENTS

140.3.1 General

Shelf life: Ensure materials used have not exceeded their shelf life.

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use materials which contain known carcinogenics.

Corrosivity: Non-corrosive.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

140.3.2 NATURAL STONE

General

Provide natural stone, which is

- of the appropriate quality grade for the purpose;
- of uniform quality within that grade;
- selected for the optimum matching of visual properties such as colour and pattern; and
- sound and free from defects liable to affect its strength, appearance, durability or proper functioning under the intended conditions of use.

Use "non-rusting" granites (i.e. granites that do not develop rust spots or patches).

Stone types

Sandstone defects: Minor shale laminae or interbeds and minor concentrations of carbonaceous material (tea leaves) are acceptable in visible faces at ground level or in public areas. Neither defect is acceptable in carved or moulded work.

Marble: Marble, and dense limestone (excluding travertine and serpentinites) commercially classified as marble, and

- capable of being sawn routinely into thin slabs which remain intact;
- capable of taking an acceptably good polish; and
- with porosity < 5%.

Granite: Igneous stone (e.g. granite) obtained from quarry stone extracted in blocks sufficiently large to suit the project requirements, and containing no more than a small degree of microcracking.

Stone selection

Grading: Select stone of the appropriate quality grade for particular purposes.

Matching: Within each grade, select stone for the optimum matching of visual properties such as colour and pattern.

Source of stone supply

Nominated source: >

Alternative source: >

140.3.3 TOLERANCES

Maximum deviation from required dimensions

Face dimensions:

- Units ≤ 50 mm thick: ± 2 mm.
- Units > 50 mm thick: ± 3 mm in dimensions up to 900 mm, thereafter ± 1 mm in 300 mm or part thereof.
- Curtain walling panels with sawn edges: ± 0.5 mm per metre.
- Curtain walling panels with handworked or moulded edges: ± 1 mm per metre.

Squareness (difference between diagonals): ≤ 1.5 times the tolerance on a long edge.

Thickness:

- Generally: ± 3 mm.
- Stone panels in stone faced concrete units: + 3 mm, - 0 mm.
- Curtain walling panels: + 4 mm, - 0 mm.

Flatness:

- Polished or honed faces: ± 0.5 mm per metre.
- Sawn or sandblasted faces: ± 1.5 mm per metre.
- Flame exfoliated faces: ± 3 mm per metre.
- Fine tooled or hammered faces: ± 2 mm per metre.

Edge straightness: ± 0.5 mm per metre.

Anchor hole location: ± 1 mm.

Bow or twist

Maximum deviation of stone face from plane:

- Finishes: ± 1.5 mm in 1200 mm.
- Natural riven faces: ± 10 mm in 1200 mm.

140.3.4 MORTAR

Mortar materials

Portland cement: To SS 26.

White cement: Iron salts content ≤ 1%.

Lime: To AS 1627.1.

Sand: Fine aggregate with a low clay content and free from efflorescing salts, selected for colour and grading.

- Crushed stone: Fine aggregate consisting partly or wholly of crushed stone, made from material of the same type as the stone facing.

Same for facework:	
- Colour:	>
- Grading:	>
- Source:	>
Admixture: Do not provide admixtures.	
Colour mortar:	
- Colour:	>
- Location:	>
Premixed mortar:	>

Sand aggregate grading schedule

Sieve aperture (mm)	Percentage passing (by mass)
>	>
>	>
>	>

Mortar mix schedule

Mortar type to AS 3700	Mortar proportions (cement:lime:sand)	Location
M1	0:1:3	>
M2	1:2:9 or 1:3:12	>
M3	1:1:6 or 1:0:5 + water thickener	>
M4	1:0:5:4:5 or 1:0:4 + water thickener	>

Mortar mix

Batching: Use purpose made gauge boxes and machine mix.

Mix compressive strength: ≤ compressive strength of the stone bedded on it.

Mix permeability: ≥ stone permeability.

Preparing lime putty:

- Using hydrated lime: Add lime to water in a clean container and stir to a thick creamy consistency. Leave undisturbed for at least 16 hours. Remove excess water and protect from drying out.
- Using quicklime: Run to putty as soon as possible after receipt of quicklime. Partly fill clean container with water, add lime to half the height of the water, then stir and hoe ensuring that no lime remains exposed above the water. Continue stirring and hoeing for at least 5 minutes after all reaction has ceased, then sieve into a maturing bin. Leave undisturbed for at least 14 days. Protect from drying out.

Grout

Composition:	>
Characteristic compressive strength (Mpa):	>

140.4 CLADDING AND LINING

140.4.1 WORKMANSHIP GENERALLY

Storing

Store stone so that it is protected from the weather and atmospheric pollution, clear of the ground on its natural bed, on supports which do not locally overstress it, and in conditions suitable to promote good seasoning without staining, marking or damage.

Visual variations

If the quality control sample panels have a range of variation in colour, pattern, texture or surface finish, distribute the production panels throughout the work so that local concentrations of similar variations do not occur.

Tolerances schedule

Stone unit type	Dimension type	Tolerance
>	>	>
>	>	>
>	>	>

140.4.2 FIXINGS

Provision of fixings

Provide suitable fixings sufficient to support and restrain each stone and effectively resist the structural design actions to which it will be subject in service.

Metals for fixings

Non-ferrous metal or stainless steel, stamped for identification, compatible with the materials with which they will be in contact and effectively insulated from electrochemical reaction with incompatible materials.

140.4.3 STONE CLADDING

Building structure

Expected amounts of differential movements:

-	Elastic shortening:	>
-	Creep shortening:	>
-	Drying shrinkage of concrete:	>

- Reversible thermal movement:	>
- Reversible moisture movement:	>
- Permanent expansion of clay products:	>
Environment	
Design wind pressure (Pa):	Cross refer: Civil and Structural Materials and Workmanship Specification: sections >
Thermal resistance (R):	>
Fire resistance level (FRL):	>

Stone Cladding Schedule

System	**SC1**	**SC2**	**SC3**
Location	>	>	>
Stone type	>	>	>
Finish	>	>	>
Panel Dimensions	>	>	>
Height (mm)	>	>	>
Width (mm)	>	>	>
Thickness (mm	>	>	>

Structural fixings schedule

Type of fixing	Material, grade and designation
>	>
>	>
>	>

Fixings

Do not provide block liners or resin bonded fixings.

Joint Schedule

System	**J1**	**J2**	**J3**
Panel joints			
Width (mm)	>	>	>
Jointing and pointing material	>	>	>
Movement joints			
Width (mm)	>	>	>
Sealant Material	>	>	>
Back-up Material	>	>	>

Cavity

Minimum width: 20 mm, clear of insulation if any.

Cavity Schedule

System	C1	C2	C3
Width (mm):	>	>	>
Insulation:	>	>	>
Method of draining:	>	>	>
Method of damp-proofing:	>	>	>
Method of condensation prevention:	>	>	>
Method of ventilation	>	>	>

140.4.4 SEALANT JOINTING

Preparation for jointing

Immediately before jointing remove loose particles from the joint, using oil-free compressed air.

Taping

Protect the stonework surface on each side of the joint using 50 mm wide masking tape or equivalent means. On completion of pointing remove the tape and remove any stains or marks from the stonework surface.

Jointing materials

General: Provide recommended jointing and pointing materials which are compatible with each other and with the contact surfaces and non staining to finished surfaces. Do not provide bituminous materials on absorbent surfaces.

Priming: Apply the recommended primer to the surfaces in contact with sealant materials.

Sealant colour: >

Foamed materials (in compressible fillers and backing rods): Closed cell or impregnated types which do not absorb water.

Bond breaking: Provide backing rods, and other back-up materials for sealants, which do not adhere to the sealant.

Sealant proportions

Depth of elastomeric sealant: One half the joint width, or 6 mm, whichever is the greater.

Sealant application

Apply the sealant to dry joint surfaces using a pneumatic applicator gun. Do not apply the sealant in unsuitable weather conditions (e.g. when the ambient temperature is outside the range 5 – 50^{o}C) or outside the recommended working time for the material or the primer.

Joint finish

Produced a smooth, slightly concave surface using a tool designed for the purpose.

Protection

Protect the joint from inclement weather during the setting or curing period of the material.

Edge to edge joints

Method of sealing: >

140.4.5 SURFACE TREATMENTS

Abutting surfaces

General: Seal concealed faces of stone walling or facing panels where they abut brickwork, concrete or the sides of joints.

Sealing material: >

Dissimilar stones

Isolation: Isolate contact surfaces of dissimilar types of stone with a membrane. Isolate sedimentary stonework from brickwork and other masonry to prevent salts movement.

Isolating membrane material: >

140.4.6 LIGHTNING PROTECTION

To SS CP 33.

140.5 COMPLETION

140.5.1 COMPLETION

General

Cross refer: Item 20.5 'Completion' of the General Requirements.

Operation and Maintenance Manual

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements.

Setout a program for regular maintenance cycles at not more than five-year intervals including, but not limited to, stonework cleaning, desalination, inspection and repair of joints and flashings, and detection of potential failures arising from movement or other causes.

Protection

Protect all completed stone cladding on site from damage until handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

On or before completion of the works remove all materials used as a means of protection.

Damage

Replace damaged items with new.

Cleaning

Cleaning: Leave the stonework clean on completion.

Warranties

Warrant the materials and workmanship using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General requirements.

Submit all proprietary materials manufacturer's published product warranties.

The warranty shall be valid regardless of the fact that attachments as directed by the Engineer shall be fitted to, on, or through the cladding, by others.

Record drawings

Provide record drawings in accordance with IItem 20.5.2, Record Drawings, of the General Requirements.

140.5.2 REPAIR

Before commencing repairs submit details of the proposed repair method for acceptance.

150 CURTAIN WALLS

150.1 GENERAL

150.1.1 CROSS REFERENCES

General

Conform to the General Requirements worksection.

Associated worksections

Conform to associated worksections as follows:

Civil and Structural Materials and Workmanship Specification: sections >

Adhesives, Sealants and Fasteners.

Insulation and Barriers.

Glazing.

Metals and Pre-finishes.

>

150.1.2 STANDARDS

General

Curtain walls: To SS 96.

Aluminium framed curtain walls:

Materials and performance tests: To SS 381.

- Stress analysis of members: To AS/NZS 1664.1 or AS/NZS 1664.2.

Curtain walls framed with other materials: To the above standards where applicable.

Hot finished structural hollow sections of non-alloy and fine grain structural steel: To SS470.

150.1.3 DESIGN

Drawings

Contract drawings show generic design principles and design intent only.

Permissible-stress-design pressures

Positive (Pa): >

Negative (Pa): >

Nominal service life of the curtain wall system>

150.1.4 MOVEMENT

General

General: Provide for deflections, displacements and other movements within the curtain wall, or between the curtain wall and the building (including fire stop and smoke flashing connections), including movements caused by ambient temperature changes, wind loads, design dead and live loads and shrinkage.

Accommodation: Provide curtain walls which accommodate these movements silently and without permanent deformation, reduction of performance, or other detrimental effects such as

- damage to or undue stress on structural elements, fixings, glass and spandrel panels;
- failure of joint seals; and
- loss of normal function in operable elements such as doors and windows.

Ambient temperature range (°C): 20 – 40°C.

Sol-air index temperature (°C): >

Building movements

- General: Cross refer: Civil and Structural Materials and Workmanship Specification: clauses >

Curtain wall movements

Dead load: The vertical deflection of a structural member under dead load must not

- reduce the glass bite below 75% of the design dimension;
- reduce below 3 mm the clearance between the member and a non structural member (such as glass or spandrel panel) immediately below; or
- reduce below 3 mm the clearance between the member and operable elements such as windows and doors.

150.1.5 LOADS

Equipment loads

General: If a curtain wall framing member is required to take loads from mechanically operated window cleaning equipment or a building maintenance unit (BMU) (e.g. via a guide rail), the member must carry the loads stated in the Civil and Structural Materials and Workmanship Specification, clauses > without exceeding the maximum deflection/span ratios for framing members.

Equipment design loads (maximum):

- Type of BMU equipment: As proposed by the Contractor and accepted by the Engineer.
- Equipment design loads on framing members (kg):
  - . Normal to the wall plane: >
  - . Horizontally parallel to the wall plane: >

Displacement limits

Restrict the member displacements and maximum deflection/span ratios of structural members subject to the above loads to the performance requirements of AS/NZS 4284, except that

- where the deflection of a structural member may cause bending in a masonry, cement rendered or similar panel, restrict the deflection/span ratio of the member to a maximum of 1:360; and
- restrict the deflection of the cantilevered end of a cantilevered structural member of cantilever length L to the maximum given in the Civil and Structural Materials and Workmanship Specification clauses >. Restrict the compression or extension of sealant joints affected by the cantilever deflection to a maximum of half of the sealant depth.

Maintenance live loads

Horizontal surfaces: Horizontal or near horizontal surfaces, which form part of the curtain wall (e.g. copings, beam encasements, ledges) and which may carry human live loads (e.g. from maintenance personnel), must be capable of supporting such loads without permanent distortion, failure of seals or fastenings, or other damage.

150.2 QUALITY

150.2.1 INSPECTION

Witness points

Give sufficient notice so that inspection may be made at the following stages:

- Off site prototypes constructed and ready for inspection or testing.
- Fabricated curtain wall assemblies at the factory ready for delivery to the site.
- Prepared site storage areas for curtain wall assemblies before the assemblies are delivered.
- Commencement of delivery of fabricated assemblies to the site.
- Building substrates prepared and ready for the installation of the curtain wall assemblies, with anchor brackets and other attachments fixed in place.
- Commencement of installation of curtain wall assemblies.
- Preparation for, and commencement of, site glazing or reglazing.

Hold points

- Confirmation prototypes constructed and ready for inspection or testing.
- >

Corrosion

Cross refer: General Requirements Clause 20.4.1.

150.2.2 TESTS

General

Carry out all tests in accordance with Section 20.3.2 ‘Tests’ of the General Requirements.

In-situ tests: Prevent consequential damage to the permanent building structure and finishes.

Test all units erected on site containing unauthorised site modifications including, but not limited to,:-

- enlarged or additional lifting holes.
- drainage slots.

as required by the Engineer. All such tests shall be at the Contractor’s expense.

All testing authorities shall be accredited by SINGLAS to test in the relevant field.

150.2.3 STRUCTURAL AND WEATHER RESISTANCE TESTS

Standard

Structural performance, air infiltration, and water penetration: To AS/NZS 4284.

Additional test criteria:

- Water penetration under the test conditions:

- No leaks from a containment device (e.g. internal gutters, troughs, pressure equalised drained joints).
- Contained water drains away to the exterior within one minute of the cessation of the positive pressure differential.
- Structural performance: No permanent deflection of any member.

Previous type test

General: An independent testing authority's report on a previous type test, showing compliance with the test criteria at the permissible-stress-design pressures, is acceptable provided the manufacturer certifies in writing that the tested prototype

- is a standard proprietary curtain wall design; and
- accurately represents in all respects the proposed curtain wall.

Method: To AS/NZS 4284 or, for buildings not exceeding 15 m high, AS 2047.

Sealed metal joints

General: If the sealing of overlapping metal sections for weather resistance is such that dynamic differential movement between the sections may reasonably be anticipated, test a prototype sealed joint over 100 slow cycles equivalent to the maximum predicted movement, and demonstrate that the sealant does not fail in adhesion or cohesion and that the joint remains waterproof.

Joints to be tested: >

Test parameters

Testing authority: accredited by SINGLAS.

Test chamber type: >

Structural test pressures (Pa): >

Location of displacement transducers: >

Maximum successive member displacement (mm): >

Maximum slippage at supports and fixings (mm): >

Maximum total displacement (mm): >

Air infiltration test pressure (Pa): >

Air infiltration limit ($L/m^2.s$): >

Leaks defined as unacceptable: all leaks.

Proof test pressures (Pa): >

Other test criteria: >

Deflection/span schedule

Panel type	Maximum deflection/span ratio
>	>
>	>
>	>

Water penetration schedule

Test type	Pressure (Pa)	Duration (min)	Spray intensity ($L/m^2.s$)
Static	>	>	>
Cyclic 1	>	>	>
Cyclic 2	>	>	>
Cyclic 3	>	>	>

150.2.4 ACOUSTIC TESTS

Sound transmission tests

General: Test a representative specimen of each part of the curtain wall assembly required to have a weighted sound reduction index (R_w) rating.

Standard: To AS/NZS 1276.1.

Testing authority: accredited by SINGLAS.

Representative specimen: >

Weighted sound reduction index (R_w): >

150.2.5 THERMAL TESTS

Assembly

General: Test a representative specimen of each part of the curtain wall assembly required to have a particular condensation resistance factor (CRF) or thermal resistance (R).

Standard: To AAMA 1503.

Testing authority: accredited by SINGLAS.

Representative specimen: >

Condensation resistance factor (CRF): >

Thermal resistance (R): as required by the Building Control Regulations: Singapore.

Thermal insulating materials

General: Test a representative specimen of homogeneous insulating materials in the curtain wall required to have particular thermal transmission properties.

Standard: To AS/NZS 4859.1.

Testing authority: accredited by SINGLAS.

Representative specimen: >

150.2.6 FIRE TESTS

Fire resistance tests

General: Test a representative specimen of each part of the curtain wall system required to have a fire resistance level (FRL), including any required fire stops.

Standard: To BS 476, Part >

Additional observations: During test loading and throughout the FRL test, make additional observations of "separating elements" (e.g. spandrel panels, fire stops, smoke flashings) to demonstrate compliance with these performance criteria:

- No cracking, fusing, falling of material, spalling, melting, flaming, charring.
- No displacement permitting the passage of smoke, flame or hot gases.
- No emission of appreciable volumes of smoke or noxious vapours from unexposed faces.

Other fire tests

General: Test site installed thermal insulating materials on the exposed face.

Standard: To AS/NZS 1530.3.

Criteria:

- Ignitability, spread of flame, heat evolved: 0.
- Smoke developed: Not greater than 3.

Tests

Testing authority: accredited by SINGLAS.

Representative specimen: >

Fire resistance level (FRL): >

150.2.7 SAMPLES

General

Submit samples of each of the following in accordance with section 20.3.4 'Samples', of the General Requirements.
No. of samples: 3.

- All fixings.
- Sections proposed for frame members, accessories, cover strips, trim and gaskets.
- Joints made using proposed techniques.
- Finishes to prepared surfaces.
- Colour samples of prefinished production material (e.g. anodised or organic coated extrusions or sheet, integrally coloured glazing tapes, gaskets), showing the limits of the range of variation in the selected colour.
- Panels and other materials to be used in spandrels and other non vision areas, including the following where applicable:
    - . Face material.
    - . Insulating material.
    - . Backing material.
    - . Interlayers.
    - . Composite or sandwich panels.

- Accessory and hardware items specified descriptively or by performance (i.e. not specified as proprietary items).
- Each glazing extrusion, bracket, and assembly which will be exposed to view.

Patterned metal facing panels

Submit samples, the full size of the spandrel panel, of patterned, profiled, textured or impressed relief facings. In the case of project-unique patterned castings, submit a preliminary plaster casting showing the relief pattern.

Samples schedule

Sample	Number required	Size (if applicable)
>	>	>
>	>	>
>	>	>

150.2.8 PROTOTYPES

General

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

Design prototype

General: Provide a design prototype at least 3 curtain wall bays wide and 2 storeys high, constructed solely for the purpose of demonstrating the general external appearance.

Location: in the sub-contractor's workshop.

Modify the prototype to take account of changes made to improve the appearance of the cladding following the initial viewing.

Test prototype

General: Provide a test facade for testing to AS/NZS 4284, incorporating at least one example of each component and construction method in the system, including:

- Attachments to the structure.
- Each type and subtype of frame member.
- Penetrations in frame extrusions for lifting and installing production units in the works, with blanking off plates where applicable.
- Mullion, transom and panel junctions.
- Horizontal and vertical movement joints.
- Each type of glazing and spandrel panel.
- Structural and other sealants, gaskets, tapes and beads.
- Junctions and trim to adjoining surfaces.
- Caulking and flashing.
- Hardware, fittings and accessories.

Location: On site, as agreed with the Engineer.

Confirmation Prototype

General: The first installed portion of the complete curtain wall assembly fixed in its final position in the works, at least 2 bays wide and 2 storeys high, incorporating at least one example of each component in the system, for general appearance assessment only (not structural testing).

Location: As agreed with the Engineer.

Retain all prototype panels until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

150.2.9 SUBMISSIONS

General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

Subcontractors

Manufacturers: Submit names and contact details of proposed manufacturers of components such as extrusion suites and associated items.

Subcontractors: Submit names and contact details of proposed curtain wall subcontractors, with evidence of their experience in this type of work.

Shop drawings

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Submit shop drawings, and specifications conveying, but not limited to, the following information:

- Layout of the curtain wall assembly (sectional plans, vertical sections, and elevations of each building face) with all elements identified and numbered.
- Scale drawings, descriptions and statements, as required by AS 2047 and AS/NZS 4284, of the curtain wall prototype test glazing.
- Calculations used to determine the structural design of the curtain wall, including glass thickness, to meet the performance criteria, quoting the types and magnitudes of the design loads on the fixing anchors or attachments.
- Full size sections of typical members including mullions, transoms, glazing spiders clamps and brackets, subheads, sills, subsills, louvres, beads, sealant beads, glazing gaskets, splice plates, trays and cover strips, with notes specifying the proposed materials.
- Method of assembly including isometric or axonometric and exploded views of typical mullion, transom and panel junctions, showing
  - . mullion sleeve detail (stick systems);
  - . four way joint including sleeve (modular systems); and
  - . panel to panel joints (panel or unitised systems).
- Method of installation, including
  - . type and location of anchors and other attachments to be cast or otherwise built in to the building structure;
  - . erection tolerances;
  - . accurate locations and full size details of machined slots, keyholes and other penetrations in frame extrusions for lifting and installing the units;
  - . junctions and trim to adjoining surfaces;
  - . caulking and flashing; and
  - . locations of visible heads of fastenings.
- Provision for differential vertical or horizontal movements, including
  - . thermal expansion and contraction;
  - . column shortening; and
  - . frame deflections.
- Methods of assembly, jointing, sealing and fixing of spandrel panels and other facing panels, particularly where joined edge to edge.
- Details of shadow box spandrels.
- Method of draining the assembly, including details showing
  - . pressure equalised drained joints;
  - . location, number and size of weepholes; and
  - . method of mechanically baffling drainage outlets which are not pressure equalised.
- Methods of meeting performance requirements for thermal insulation, fire resistance and sound transmission, including
  - . spandrel backing; and
  - . closing off and sealing the assembly against other building elements such as soffits and parapets.
- Hardware, fittings and accessories including window cleaning restraints and visible heads of fasteners.
- Metal facing panel stiffening: Show the proposed type (edge flanges or other) on shop drawings.

No. of copies to be submitted: As Particular Specification.

Engineering endorsement

Submit calculations and drawings from a Singapore licensed Professional Engineer concurrently with the shop drawings and showing, but not limited to, the following:-

Compliance with all relevant Singapore legislation and regulations.

Materials and components

Product data: Submit published product data of the curtain wall or extrusion suite manufacturer, including

- technical specifications of products;
- type test or factory test data for products;
- metallurgical analysis certificates for alloy and temper of metal components;
- recommended procedures for fabrication, glazing and installation; and

- schedule of recommended glazing gaskets, sealants, glazing compounds, and the like, including supplier and catalogue number.

Anodising data: Submit a statement by the anodiser certifying that

- the alloy receiving the coating is correct for the required colour;
- the surface preparation, coating thickness and colour comply with requirements; and
- the work complies with AS 1231.

Organic film coating data: Submit test reports certifying that

- the paint coatings and thicknesses comply with the warranty conditions; and
- if no warranty condition has been stated, the conversion coating mass is 325 - 1200 mg/m^2.

Anchor manufacturer's data: Submit the manufacturers' statement certifying that the cast-in-place channel anchors have been tested to ASTM E488 for the types of loading required, quoting the test results to show that the anchors will resist the type and magnitude of the calculated design loads, and in particular that there is

- no permanent deformation of the anchor at 1.5 times the design load;
- no failure of the anchor at twice the design load; and
- no failure of the structural concrete at three times the design load.

Installation

Acceptance of substrate: In the Installer's statement make specific reference to the type, number and location of the cast-in anchors provided in the building structure for the installation, and to the provision of reference lines and marks.

Metal prefinishes restoration: If the damaged surface can be satisfactorily restored to its original condition, submit proposals. Surfaces exposed to weather, and surfaces to receive structural glazing adhesives, are deemed to be incapable of satisfactory restoration.

Test Reports

Submit copies of current test reports, and certification, including drawings of tested details, in accordance with Section 20.3.2, 'Tests' of the General Requirements.

No. of copies to be submitted: 3.

Method Statement

General: Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

150.3 MATERIALS

150.3.1 General

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use products which give off toxic emissions in the event of a fire.

Do not use materials which contain known carcinogenics. Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

150.3.2 WEATHER SEALS

Flashings

General: Provide flashings and weatherings compatible with the other materials in the installation, corrosion resistant, and warranted non-staining and non-bleeding.

Location: >

Material: >

- Thickness (mm): >
- Finish: >

150.3.3 PANELS AND FACINGS

Panel demounting and replacement >

Metal facing panels

Stiffening: Provide stiffening where necessary to single layer metal facing panels.

Single layer metal panels

Designation	**SLP1**	**SLP2**	**SLP3**
Panel location:	>	>	>
Material:	>	>	>
Form:	>	>	>
Thickness (mm):	>	>	>
Face surface:	>	>	>
Finish:	>	>	>
Finish colour	>	>	>

Multi-layer panels

General: Composite units consisting of one of a number of combinations of facings, core and backings. If the core is an absorptive material, or contains an air space, treat the edges of the unit to prevent moisture entry while providing a means of venting the core space to the outside air.

Designation	**MLP1**	**MNLP2**	**MLP3**
Panel location:	>	>	>
Type:	>	>	>
Adhesive (for bonded type):	>	>	>
R value:	>	>	>
Thickness overall (mm):	>	>	>
Facing:			
- Material:	>	>	>
- Thickness (mm):	>	>	>
- Face surface:	>	>	>
- Finish:	>	>	>
- Opacifier:	>	>	>
Core:			
- Material:	>	>	>
- Thickness (mm):	>	>	>
- Density:	>	>	>
Other interlayers:	>	>	>
Backing:			
- Material:	>	>	>
- Thickness (mm):	>	>	>
- Interior surface:	>	>	>
- Finish:	>	>	>

Bonded type: Securely bond the component layers together to form a stable and durable unit.

Mechanically assembled type: A proprietary sandwich panel of hollow box insulated construction, mechanically assembled by joining the metal exterior and interior facings at their edges with corrosion resistant fastenings or interlocking folds.

Non-metallic panels **>**

150.3.4 SPANDRELS

Shadow box spandrels

General: Construct the box so that

- there is an air space of at least 50 mm between the back of the spandrel glass and the face of the box;
- the air space is vented to the exterior;
- no part of the box is in contact with the spandrel glass or opacifier;
- the box forms a pan completely enclosing the spandrel area vertically and horizontally; and
- there is a vapour barrier surrounding the box, on the building side of any insulation, effectively sealing the air space within the box from the building interior.

Facing glass type: >

- Thickness (mm): >

Opacifier: >

Spandrel glass volatilisation: Within or around the shadow box, do not provide materials such as adhesives which may give rise to condensation on the inside glass surface.

Shadow box lining material: >

Spandrel insulation

General: If opacified glass spandrels are backed by insulation, provide an air space of at least 25 mm between the back of the spandrel glass and the insulation, and secure the insulation so that it cannot touch the glass or opacifier.

Insulation: >

- Material: >
- Thickness (mm): >

Backing: >

- Material: >
- Thickness (mm): >
- Interior surface: >
- Finish: >

150.3.5 CONTAINMENT DEVICES

General

Provide devices, including pressure equalised drained joints, gutters and troughs, which contain water which enters the curtain wall system and divert it harmlessly to the exterior.

Baffles

Containment devices not pressure equalised: Provide mechanical baffles to drainage outlets such as weepholes and slots.

Inaccessible seals

Seals inaccessible in the system as installed must remain effective for the service life of the curtain wall system.

150.3.6 FIRE-STOPPING

Requirement

General: Where fire-stops and smoke flashings are placed between inner faces of the curtain wall and building elements (such as beam, slab or column faces), provide materials and fabricate, install and seal to meet fire test requirements.

Corrosion: Provide materials which are

- non-corroding;
- protected against corrosion; or
- of such thickness that corrosion will not impair the required fire-stopping or smoke flashing function during the service life of the curtain wall system.

Fire-stop

Material: >

Smoke flashing

Material: >

Thickness (mm): >

Sealing material: >

150.3.7 MATERIALS GENERALLY

Frame

Material: >

Finish: >

Finish colour: >

Anchor brackets and attachments schedule

Item	Material	Finish
>	>	>
>	>	>
>	>	>

Fasteners schedule

Item	Material	Finish
>	>	>
>	>	>
>	>	>

150.4 EXECUTION

150.4.1 FABRICATION

Aluminium fabrication and construction

Standard: To AS\NZS 1664.1 or AS/NZS 1664.2.

Fasteners

Provide fasteners of sufficient strength and quality to perform their required function.

Joints

Make accurately fitted tight joints by methods such that neither fasteners nor fixing devices such as pressure indentations are visible on exposed faces. Where heads of fasteners are unavoidably visible, finish them to match the adjacent finished surface.

Operation

Provide moving parts which operate freely and smoothly, without binding or sticking, and at correct tensions or operating forces. Lubricate where appropriate.

Protection

Corrosion protection: Provide adequate protection against corrosion which may be caused in metals by products or processes normally employed on a building site or by normal atmospheric or other ambient conditions and by-products including rainwater, potable and non potable water and airborne salt.

Temporary measures: Do not use adhesive tape, film or paper, or applied coatings liable to bond to the substrate when exposed to sunlight or weather, as temporary measures to protect curtain wall components during the course of the works. Where temporary measures are used, remove all traces from contact mating surfaces before joining up.

150.4.2 WELDING

General

Quality: Provide finished welds descaled and free of surface and internal cracks, slag inclusion and porosity.

Restrictions: Do not weld.

- on site;
- on finished surfaces; and
- next to a finished surface or glass, unless the adjacent surface is adequately protected from damage.

150.4.3 EMBEDDED ANCHORS

Standard for embedment

Standard: To AS 3600.

Fixing brackets

Anchors and other methods of attachment of the curtain wall to the structure: Provide the following characteristics:

- Three-way adjustment to accommodate fabrication and construction tolerances.

- Fixing the curtain wall in its correct position while making provision for building and curtain wall movements.
- Adequate to carry the structural design actions.

General

Cast anchors required for the attachment of the curtain wall into the concrete of the building structure. Do not use other methods of fixing (e.g. drilling or cutting into hardened concrete, preformed pockets, chemical fixings, expanding bolt sockets, or explosive tools). Do not displace reinforcement when locating embedded items.

Anchor fixing schedule

Type of anchor	Location	Permissible method of fixing	Maximum design load (Pa)
>	>	>	>
>	>	>	>
>	>	>	>

Protection

Prevent the entry of concrete slurry into bolt holes, channels, and other openings in the anchors. Fill the openings using an easily removed water repellent material before casting in.

Tolerances on placement

Anchors generally:

- Maximum deviation from correct position: ± 13 mm.

Channel anchors embedded parallel or perpendicular to the edge of a concrete structural member:

- Minimum length of embedded anchor: 200 mm.
- Minimum distance from the concrete edge to the nearest part of the anchor: 100 mm.

150.4.4 INSTALLATION

Requirement

Install the curtain wall so that the frames

- are plumb, level, straight and true within acceptable building tolerances;
- are adequately fixed or anchored to the building structures; and
- will not carry any building loads, including loads caused by short or long term structural deflection or shortening.

Installation tolerance limits

Alignment:

- Maximum deviation of any member from its true alignment (plumb, level, or line of slope): +/- 1 mm per metre of member length, up to a maximum of 6mm in a continuous run of members in one direction.
- Maximum misalignment between adjoining members: 1 mm.

Position:

- Maximum deviation of any part from its true position: 6mm (not applicable to the positions of adjoining members relative to each other).

Marking

Before the separate parts of the curtain wall are delivered to the site, provide suitable and sufficient marks or other means for identifying each part, and for showing its correct location and orientation when installed.

Reference lines and marks

Provide on each floor, in agreed locations accurate perimeter offset reference lines, plumb with corresponding lines on other floors, and height bench marks.

Cleaning

During erection promptly remove foreign matter from the curtain wall without damage to finishes. Do not use abrasive cleaners or acid.

150.4.5 LIGHTNING PROTECTION

To SS CP 33.

150.5 COMPLETION

150.5.1 COMPLETION

General

Cross refer: Item 20.5 'Completion' of the General Requirements.

Operation and Maintenance Manual

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements.

Damage

Replace damaged items with new.

Warranties

Warranty conditions

Warrant the materials and workmanship as part of the overall cladding system using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements except as noted below.

Curtain wall warranty

General: Warrant the installed curtain wall against service defects in design, materials and workmanship, including but not necessarily limited to the following:

- Failure to meet performance criteria, including the "acceptable performance criteria" of tests for resistance to wind actions, water penetration, air infiltration and collapse.
- Structural adhesive failure in either adhesion or cohesion.
- Failure of caulking, flashing, or sealing to the building structure.
- Failure of seals which are inaccessible in the curtain wall system as installed in the building.
- Failure of glass or glazing units.
- Excessive deterioration of components and finishes caused by weathering.
- Spandrel glass volatilisation, caused by condensation of vapours trapped in shadow box spandrels.
- Defects consisting of unauthorised departures from the contract documents.

Warranty period: 15 years.

Organic film coating warranty: Submit the paint manufacturer's warranty for the specified coating, including warranty conditions, if any, applying to conversion coating mass, dry film thickness of paint coatings, and number of coatings.

Joint product warranties

Submit the following product warranties with, and as part of, the curtain wall warranty:

- Glass manufacturer's warranty.
- Toughened glass warranty.
- Aluminium finish applicator's warranty: An undertaking by the applicator of the finish to refinish or replace aluminium items where
  - . the finish cracks, peels, or shows pitting or corrosion, discernible from 1500 mm distance, resulting from atmospheric conditions normal for the environment of the installation;
  - . when tested to AS/NZS 1580.481.1.2 a coloured finish discolours in service to a degree greater than 2 on the Rating Scale of Table 1 of that standard, compared to an unweathered reference sample; or
  - . a colour change in the coloured finish of either or both of any two adjacent sections results in a colour difference between them which exceeds the Rating Scale measure of the range of colour variation accepted in the contract approved colour sample range.

Joint warranty schedule

Required warranty	Warranty period
Insulating glass units (IGUs)	>
Coated glass units	>
Toughened glass	>
Aluminium finish	>

Record drawings

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

Cleaning

Test prototype: Remove on completion.

Cleaning: Polish the glass and leave the work clean, free from defects and in good condition.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

Temporary protection measures: Remove all traces from exposed surfaces before completion of the works.

150.5.2 REPAIR

Before commencing repairs submit details of the proposed repair method for acceptance.

160 GLAZING

160.1 GENERAL

160.1.1 CROSS REFERENCES

Conform to the General Requirements worksection.

Associated worksections

Conform to associated worksections as follows:

Civil and Structural Materials and Workmanship Specification: sections >

Adhesives, Sealants and Fasteners.

Metals and Prefinishes.

Curtain Walls.

Windows.

160.1.2 CIVIL DEFENCE (CD) REQUIREMENTS

General

Where stations are identified as having Civil Defence (CD) requirements, refer to the CD Design Criteria for requirements and information relating to the upgrading of materials, material thicknesses, composition and fixing methods for CD stations.

160.1.3 DESIGN

Drawings

Contract drawings show generic design principles and design intent only.

Glass type and thickness

Standard: To AS 1288, where no glass type or thickness is given.

Design wind pressure schedule

Window designation	Design wind pressure
>	Cross refer: Civil and Structural Materials and Workmanship Specification: sections >
>	
>	

Verify and confirm that all glass thicknesses specified are sufficient to meet the anticipated loadings on the glazing.

Installation

Ensure that the entire installation accommodates all building tolerances and anticipated movement.

Building structure

Expected amounts of differential movements:

Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

Environment

Design wind pressure (Pa): Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

Thermal resistance (R): >

Fire resistance level (FRL): >

Failure

Cross refer: Item 160.2.2 below.

Ensure that glass is capable of remaining in position for a minimum of 72 hours after:

- The breakage of one layer of glass.

160.1.4 STANDARDS

Provide glass and glazing in accordance with the following standards:

a) SS 341(1998) : Safety Glazing Materials For Use In Buildings (Human Impact Considerations).
b) BS 952.1: 1995 Glass for Glazing, Classification.
c) BS 6262: 1982 B.S. Code of Practice for Glazing for Buildings.
d) AS 1288 (1994): Glass in Buildings – Selection and Installation.
e) AS/NZS 2208 (1996): Safety Glazing Materials for use in Buildings. (Human Impact Considerations).

f) AS/NZS 4667 (2000): Quality Requirements for Cut-To-Size and Processed Glass.
g) ASTM C 1048 (1997): Standard Specification for Heat Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated Glass.
h) ASTM C1036 (1997): Standard Specification for flat glass.
i) ASTM C1172 : Standard Specification for Laminated Flat Glass.
j) ASTM C162, Terminology for Glass and Glass Products.
k) DIN 18516: Part 4 German Standard for Heat Soaking.
l) DIN 52290 Part 4: German Standard for Anti-vandal Glazing. Glass to be used in roof light and canopy glazing to comply with class A2.

Structural glazing

Comply with the recommendations of AAMA CW-13.

160.1.5 INTERPRETATION

General

Twin ground plate: Plate glass ground simultaneously on both faces so that uniform glass thickness and parallel faces are maintained within close limits.

Terminology for work on glass: To AS/NZS 4668.

The terms 'tempered' and 'toughened' mean the same and are interchangeable.

Structural glazing: A glazing method in which the glass is adhered to the framing system with a structural sealant.
Structural sealant: Structural adhesive sealants or tapes.

Laminated: For the purpose's of the test Item 160.2.2, laminated glass includes glass plies laminated to accepted safety film.

Authority's Sample: A sample held by the Authority and available for viewing during the tender and construction periods.

160.2 QUALITY

160.2.1 General

Obtain each type of glass from one supplier.

160.2.2 INSPECTION

General

Glass shall be inspected from a distance of 1800mm.

Witness points

Give sufficient notice so that inspection may be made of the following:

- Completion of all sample panels.
- All tempered and heat strengthened glass immediately prior to installation.
- The fabrication of glazed panels or assemblies prior to delivery to the site.
- Fabricated glazed panels prior to installation on site.
- Openings prepared to receive glazing.
- All joints prior to sealing.
- Those parts of the glazing installation which will be covered up or concealed.
- >

Hold points

- The initial structural glazing tests.
- Completion of confirmation prototypes.
- On completion of sections of the work defined on the drawings.
- Laminated glass test: refer to Clause 160.2.3.

Corrosion

Cross refer: General Requirements Clause 20.4.1.

Sealant application

Check prior to the installation of glazing sealants that all contact porous material surfaces have been sealed.

160.2.3 TESTS

General

Carry out all tests in accordance with Section 20.3.2 of the General Requirements.

a) Weather tightness: To BS 5368: Part 2 1980 (1986) in locations agreed with the Engineer. Repair all identified leaks and retest.
b) Wind resistance: To BS 5368: Part 3 1978 (1985).
c) Resistance to Wind Load: To BS EN 12211:2000.
c) Air infiltration: To ASTM E283.
e) Sealant compatability: To ASTM C1087.
f) Rooflght and canopy glazing: To DIN 52290 Part 4: Glass to comply with class A2.

Laminated Glass

Test laminated glazing to demonstrate that it will remain in position for a minimum of 72 hours after the breakage of one ply of glass.

a)	Timing of the test:	On completion of the glazing, or as directed by the Engineer.
b)	Location of test:	On site.
c)	Item to be tested	To be agreed with the Engineer.
d)	Ply to be broken:	To be agreed with the Engineer.
e)	Loading: external glazing:	Dead load. Live load: as climatic conditions at the time of the test.
f)	Loading: internal glazing:	Dead load.

The glass will be considered to have failed this test if broken glass does not remain fixed in position for a minimum of 72 hours.

The breakage of further plies of glass during the test shall not constitute a failure provided it/they remain in position for the period of the test.

Structural glazing

Shop glazed units: Submit details of a test deglazing procedure, or a panel bond strength test procedure.

Rate of tests

- one unit in the first 10;
- one unit in the next 40;
- one unit in the next 75; and
- one unit in each 100 thereafter.

Sealant

Type test to ASTM C1087, to demonstrate compatibility with the other materials and accessories of the structural glazing system which it may contact.

160.2.4 SAMPLES

General

Submit samples of each of the following in accordance with Section 20.3.4 ‘Samples’, of the General Requirements.

Submit samples, each at least 300 x 300mm, showing specified visual properties and the range of variation, if any, for each type of glass, including, but not limited to:

- Tinted or coloured glass.
- Surface modified or surface coated glass.
- Patterned or obscured glass.
- Ceramic coated glass.
- Wired glass.
- Mirror glass.
- Laminated glass.
- Tempered glass.
- Fire resistant glass.
- >

Submit samples at least 600mm long of the following

- All joint types proposed for use in glass and framing.
- Each glazing extrusion and assembly which will be exposed to view.
- Each extrusion, accessory and fixing used in the structural glazing.
- A structurally glazed corner fully glazed and complete with all sealants.

Submit samples of all accessories and ironmongery items.

No. of samples: 3.

160.2.5 PROTOTYPES

General

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

Design Prototype

Provide a design prototype for all structural glazing.

Location:	As agreed with the Engineer.
Minimum size (face of panel):	Full size glazing panel, or as directed by the Engineer.
Incorporating	- Horizontal and vertical joints. Support details as directed by the Engineer. Interfacing materials as directed by the Engineer.

Confirmation Prototype

Provide a confirmation prototype for all types of glazing.

Location:	As agreed with the Engineer.
Minimum size (face of panel):	Full size glazing panel, or as directed by the Engineer.
Incorporating	- Horizontal and vertical joints. - Support details as directed by the Engineer. - Interfacing Materials as directed by the Engineer.

Retain all prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

160.2.6 SUBMISSIONS

General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

Subcontractors

Submit name and contact details of proposed specialist glazing subcontractor(s).

Submit name and contact details of proposed specialist glass supplier.

Shop drawings

General: Submit shop drawings in accordance with Section 20.3.6, 'submissions' of the General Requirements.

Submit shop drawings showing, but not limited to, the following information:

- Elevations plans and sections of all glazed areas showing the supporting structure and layout of all glazing identifying panel numbers and differing glass types.
- Rebate depth.
- Edge restraint.
- Clearances and tolerances.
- Glazing gaskets and sealant beads.
- All brackets, supports, fixings and accessories, including all primary and secondary support and framing members.
- Frame and support details.
- Details of all required joints, penetrations and interfaces.
- Allowances for movement.
- Method of assembly.
- Provisions for maintenance access.

No. of copies to be submitted: As Particular Specification.

Engineering endorsement

Submit calculations and drawings from a Singapore licensed Professional Engineer concurrently with the shop drawings and showing, but not limited to, the following:-

Compliance with all relevant Singapore legislation and regulations.

Engineering endorsement: structural glazing

Submit calculations and drawings from a Singapore licensed Professional Engineer to show that the structural glazing system has been designed to:

- provide a structural sealant bite adequate to restrain the glass at the ultimate limit states design wind pressure as required by the Engineer.
- provide for thermal movement between abutting glass edges by an adequate "working joint" design with the necessary clearances and dimensions to the sealant manufacturer's recommendations; and
- limit the working stress of sealants and the working stress of pressure sensitive tapes as required by the Engineer.

comply with all relevant Singapore legislation and regulations.

Manufacturers' information

Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

- No. of copies to be submitted: 3.

Test Reports

Submit copies of current test reports, and certification that materials comply with the required standards, in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

- No. of copies to be submitted: 3.

Materials and components

Laminated units: Submit joint statements from the structural glazing sealant manufacturer and the units' manufacturer certifying that the sealant will not cause delamination, or visual impairment of the laminate.

Insulating glass units (IGUs) to AS/NZS 4666: Submit a report from an independent testing authority accredited by the Insulating Glass Certification Council (USA), showing that the unit type has attained Class A as defined in ASTM E774 when tested to ASTM E773.

Fire resistant glass: Submit a report certifying that the glazing assembly meets the fire resistance requirements of >

Ceramic-coated spandrel glass: Submit a report certifying that the glass meets the Fallout Resistance Test requirements of ASTM C1048.

Noise reducing glazed assemblies: Submit a certificate from an independent testing authority showing that the glazed assemblies comply with the specified weighted sound reduction index (R_w).

Structural glazing sealant manufacturer

Submit sealant manufacturer's statements:

- Certifying that the adhesive bond of the structural sealant has been satisfactorily tested on a contact surface of the actual framing system.
- Quoting the test values obtained.
- Stating the quality of the adhesive bond.
- Giving detailed recommendations for the application of the sealant, including maximum and minimum joint configurations, clearances and dimensions.
- Giving recommended procedures for factory glazing and reglazing.
- Stating requirements for primers (if any).
- Endorsing the structural design calculations submitted; and
- Certifying that the sealant is not detrimental to the long term structural performance, weathering, and visual quality of the materials and components with which it is associated in the structural glazing system.
- Certifying that the sealant is compatible with the edge seal of any insulating glass units.
- Certifying that the subcontractor is qualified to apply the structural sealant and is experienced in its use.

Glass manufacturer's data

Submit statements from the manufacturers of the required glass types, certifying that the method of glazing and the sealants, materials, and conditions next to the glass:

- Will not be detrimental to the long term structural performance, weathering capabilities and visual qualities of the glass.

- Are compatible with the edge seal of insulating glass units (IGUs); and
- will not cause delamination or other impairment to laminated glass during the service life of the curtain wall system.

Tempered glass: Submit certificates from the glass manufacturer confirming that the anticipated number of breakages due to nickel sulphide inclusions in following the tempering process due to nickel sulphide inclusions was is no greater than 1 per 6 tonne of glass.
Heat soaked tempered glass: Submit certificates from the glass manufacturer confirming by reference to statistical analysis of past test data that the anticipated rate of failure in tempered glass due to nickel sulphide inclusions after heat soaking, will be no greater than 1 per 400 tonne of glass.

Opacified glass: Submit a statement by the manufacturer certifying that the proposed method of opacifying the glass will not be detrimental to the glass or detract in any way from the glass product warranty.

Glazier's data: Submit the glazing subcontractor's statement certifying that the assembled frame provides for the required glazing clearances and tolerances and maximum and minimum joint configurations, having regard to the bow, warp and kink characteristics of the required glass types, and is ready for glazing.

Site glazing: If site glazing is intended, submit proposals.

Design

Submit the sub-contractor's confirmation that the following are acceptable with regard to the bow, warp, and kink characteristics of the required glass types.

- the glazing clearances provided in the frames.
- the frame tolerances.
- the joint configurations.
- bracket dimensions and sizes.

Method Statement

Submit a method statement for all glazing works in accordance with Clause 20.3.6 of the General Requirements.

160.3 MATERIALS AND COMPONENTS

160.3.1 GLASS

Glass types

Classification and description: To BS 952:1.

Glass and glazing materials

Glass and glazing materials generally: Free from defects which detract from appearance or interfere with performance under normal conditions of use.

Glass tolerances

Size, squareness and flatness: To AS/NZS 2208.

Plate and sheet (i.e. not patterned):

- Roller wave: Maximum 0.15 mm.

Float glass quality

Glazing Select Quality q^3 to ASTM C1036.

Fire resistant glass

>

Safety glasses

Standard: To SS 341.

Type: Grade A when used in curtain walls.

Heat soaking: Required for all tempered glass.

Ceramic coated glass (fritted glass)

Heat strengthened or toughened glass with a coloured ceramic coating fused to and made an integral part of the surface: To ASTM C1048, Condition B.

Opacified glass

Type of opacifier >

Permanently bond to the inner face.

Low Emissivity Coatings

Apply using a pyrolitic process.

Apply prior to heat treatment or lamination.

Unacceptable blemishes in heat-treated flat glass (including tinted and coated glass)
Standard: To ASTM C1048.

Toughened glass

Roller wave to be horizontal.

Annealed glasses schedule

Generic term	Integral properties	Location(s)
Clear float, general quality	>	Glazing generally (i.e. if not otherwise shown or specified)
Body tinted float:	Colour >	>
Surface modified float:	Colour >	>
Surface coated (reflective) float:	% reflectance >	>
	Base glass >	>
	Base glass colour >	>
Plate, polished, clear	>	>
Plate, polished, body tinted:	Colour >	>
Plate, polished, twin ground	>	>
Sheet, clear	>	>
Sheet, body tinted:	Colour >	>
Patterned, clear:	Pattern >	>
Patterned, body tinted:	Pattern >	>
	Colour >	>
Wired cast (clear)	Pattern >	>
Wired cast (body tinted):	Pattern >	>
	Colour >	>
Wired polished (clear)	>	>
Wired polished (body tinted):	Colour >	>

Processed glasses schedule

Generic term	Glass type (base glass) and other properties	Location(s)
Mirrors:	Clear float, silvering quality	>
Mirrors, venetian silvered:	Clear float, silvering quality	>
Obscured glass:	Type >	>
	Process >	>
	Texture >	>
Heat strengthened:	Base glass >	>
	Base glass colour >	>
	% reflectance >	>

Toughened safety:	Base glass >	>
	Base glass colour >	>
	% reflectance >	>
Fire resistant:		
Safety organic coated	>	>

Fabricated glass units schedule

Generic term	Glass types (constituent glasses) and other properties	Location(s)
Laminated safety glass:	External sheet	>
	Internal sheet	>
	Intermediate sheet (if any)	>
	Interlayer type	>
	Interlayer thickness	>
Laminated security:	Ballistic attack resistance	>

Special glasses schedule

Generic term	Properties	Location(s)
Flashed or pot glass:	Type	>
	Colour	>
Structural glass (opaque coloured):	Colour	>
Ceramic coated glass:	Base glass	>
	Ceramic coating colour	>
Opacified glass	Base glass	>
	Opacifier material	>

Glazing plastics schedule

Generic term	Properties	Location(s)
Polycarbonate sheet:	Type	>
	Abrasion resistance	>
	Combustion resistance	>
Acrylic sheet:	Type	>
Reinforced polyester sheet:	Type	>
	Surface treatment	>
	Mass/unit area	>

160.3.2 GLAZING MATERIALS

Cross Refer: Clause 3.3.

General

Glazing materials (including, but not limited to, putty, glazing compounds, sealants, gaskets, glazing tapes, spacing strips, spacing tapes, spacers, setting blocks and compression wedges): Appropriate for the conditions of application and the required performance.

Setting Blocks

Use setting blocks comparable with the accepted sealant.

Neoprene blocks, 90 Shore A durometer hardness.

Minimum Length: 100mm.

Maximum imposed load: Cross Refer: Civil Design Criteria.

Use Silicone setting blocks of 90 Shore A durometer hardness where structural silicone occurs at sills.

Secure setting blocks against migration.

Jointing materials

Provide jointing and pointing materials which are compatible with each other and with the contact surfaces, and non staining to finished surfaces. Do not provide bituminous materials on absorbent surfaces.

Glazing tapes

Standards: To AAMA 804.3, 806.3, 807.3, as applicable.

Expanded cellular glazing tape: To AAMA 800.

Elastomeric sealants

Sealing compound (polyurethane, polysulphide, acrylic):

- Single component: Type II, Class A.
- Multi component: To ASTM C920.

Sealing compound (silicone):

- Single component: Class A.
- Multi component: To ASTM C920.

Sealing compound (butyl): To TT-S-001657.

Glazing compounds: To AAMA 802.3 (Types I or II), or 805.2, as applicable.

Narrow joint seam sealer: To AAMA 803.3.

Exterior perimeter sealing compound: To AAMA 800.

Non drying sealant: To AAMA 800.

Very high bond pressure sensitive tapes

Cross Refer: Civil Design Criteria.

- Minimum Peel strength: To ASTM D-3330.
- Minimum Normal Tensile (T-block): To ASTM D-897.
- Minimum Dynamic Shear: To ASTM D-1002.

Demonstrate U.V. resistance for external applications.

Elastomeric sealants schedule

Sealant type	Material	Location or function
>	>	>
>	>	>
>	>	>

Very high bond adhesive tape schedule

Tape type	Material	Location or function	Dimensions
>	>	>	>
>	>	>	>
>	>	>	>

Pile weather strips

Standard: To AAMA 701/702.

Location: >

Materials: Polypropylene or equivalent pile and backing, low friction silicone treated, ultra violet stabilised.

Finned type: A pile weather seal with a central polypropylene fin bonded into the centre of the backing rod and raised above the pile level.

Extruded gaskets and seals

Type: Non cellular (solid) elastopressive seals.

Location or function: >

Material:

- Rubber products (neoprene, ethylene propylene diene monomer (EPDM) or silicone rubber): To BS 4255:1.

Priming

Apply the sealant manufacturer's recommended primer to the surfaces in contact with sealant materials.

Backing Materials

Apply the sealant manufacturer's recommended backing materials,

Width: 25% wider than the joint width.

Movement joints

Depth of elastomeric sealant: One half the joint width, or 6 mm, whichever is the greater.

Foamed materials (in compressible fillers and backing rods): Closed-cell or impregnated types which do not absorb water.

Bond breaking: Provide backing rods, and other back-up materials for sealants, which do not adhere to the sealant.

160.3.3 STRUCTURAL GLAZING MATERIALS

Structural sealant

Type: A proprietary silicone sealant from an established manufacturer, recommended for use as a structural glazing sealant.

Very high bond pressure sensitive tapes

Cross refer: Section 3.2 above.

Use proprietary tapes from an established manufacturer.

Submit certification confirming their use as a structural glazing adhesive.

160.3.4 MIRRORS

Reflective surface

Type: Silver layer deposited on the glass or glazing plastic.

Protective coatings: Electrolytic copper coating at least 5 µm thick, and 2 coats of mirror backing and edge sealing paint having a total dry film thickness of at least 50 µm.

Venetian silvered mirror (one way vision glass): 15 mm wide silvered strips alternating with 3 mm wide clear strips.

Mirrors schedule

Designation	M1	M2	M3
Location	>	>	>
Size (mm)	>	>	>
Mirror type	>	>	>
Processing	>	>	>
Fixing	>	>	>

160.3.5 INSULATING GLASS UNITS (IGUs)

Standard

Selection and installation: To AS/NZS 4666.

Location(s) >

Performance

Unit shading coefficient: >

Unit U-value: >

Visible light transmittance (%): >

Solar transmittance (%): >

Reflectivity:

- Inner: >
- Outer: >

Weighted sound reduction index (Rw): >

Components

Outer pane: >

Inner pane: >

Gas filling type: >

Coatings schedule

Type	Location
>	>
>	>

Type	Location
>	>

160.3.6 PRODUCT IDENTIFICATION

General

Permanently mark each piece of glass in a discrete but visible location with the following information:

- Ttype of glass.
- manufacturer.
- properties.
- standards.

Safety glazing materials

Identify each piece or panel, to SS 341.

Noise reducing glazed assemblies

Label each panel with a legible non-permanent mark, self-destroying when removed, stating and certifying the R_w rating, and identifying the testing authority. Remove when directed.

Curtain wall glazing

Permanently mark tempered or reflective coated glass, identifying strength grade, manufacturer and orientation.

160.4 EXECUTION

160.4.1 GLASS PROCESSING

General

Processing: Perform required processes on glass, including cutting, obscuring, silvering and bending. Form necessary holes, including for fixings, equipment, access holes and speaking holes. Process exposed glass edges to a finish not inferior to ground arrised.

Glass processing schedule

Glass element	Location	Type of process	Finish
>	>	>	>
>	>	>	>
>	>	>	>

160.4.2 INSTALLATION

Substrates or framing

Before fixing cladding check and, if necessary, adjust the alignment of framing.

General

Protect all glass from all risks of chemical, physical and mechanical damage at all times.

Store all glass as recommended by the manufacturer in a covered, dry, protected and ventilated area.

Transport all glass as recommended by the manufacture.

Ensure edges of all tempered and heat strengthened glass are unchipped at the time of installation and remain so until handover.

Install the glass so that

- each piece is held firmly in place by permanent means which enable it to withstand the normal loadings and ambient conditions at its location without distortion or damage to glass and glazing materials;
- building movements are not transferred to the glass; and
- external glazing is watertight and airtight.

Temporary marking: Use a method which does not harm the glass. Remove marking on completion.

Tempered and heat strengthened glass: Do not cut, work, or permanently mark after toughening. Use installation methods which prevent the glass making direct contact with metals or other non-resilient materials.

Heat absorbing glass: In locations exposed to direct sunlight, provide wheel cut edges free from damage or blemishes, with minimum feather.

- Edge grinding or arrising: Wet process, using grit no coarser than 120 - 180. Do not work across the edge from surface to surface.
- Temporary marking: Remove before installation.

Frameless installations: Join the vertical edges of adjacent glass panels with silicone jointing compound.

Preglazing

Window assemblies and glazed doors: Supply inclusive of glazing, shop preglazed unless preglazing is impracticable.

Curtain walls: Supply inclusive of glazing, shop preglazed.

Glazing schedule

Location (panel designation)	Glass type	Glass thickness (mm)
>	>	>
>	>	>
>	>	>

Glazing method

Minimum dimensional requirements (mm):

- Edge clearance: >
- Edge cover: >
- Front clearance: >
- Back clearance: >

Vision panels: Install so that they are to be removable from:

>

160.4.3 STRUCTURAL GLAZING INSTALLATION

General

Install in accordance with the manufacturer's recommendations.

Glass support

Provide setting blocks and edge blocks compatible with the sealant.

Setting blocks: Not required for four-sided support stopless systems, factory glazed in a horizontal position, and fully cured before handling.

Mechanical fixing: >

Joint width >

Glass

Ensure that the surfaces of glass used in structural glazing do not deviate from a true plane to the extent that the recommended maximum and minimum joint configurations are exceeded.

Records

Throughout the contract maintain a logbook recording:

- a code reference identifying each structural glazed unit and its location in the building;
- the production lot numbers of the structural sealant used on each unit;
- the units subjected to field adhesion tests, and the test results; and
- site glazed or reglazed units, if any.

Site glazing

Do not site glaze.

Reglazing

Either:

- remove the entire structural sealant and weatherseal without damaging the coated metal substrate; or
- if consistent with the sealant manufacturer's recommendations for reglazing, leave a continuous sealant film 2 mm thick on the substrate. Completely remove other residues.

Reglazing procedure

Cleaning and degreasing: Immediately before reglazing clean and degrease the substrate as recommended, except that original sealant substrates need not be degreased provided reglazing immediately follows deglazing.

Locating: Mechanically locate the replacement panel in its final position using temporary fixings which do not interfere with the application and curing of the new sealant beads. Leave the temporary fixings in place until the end of the sealant cure period.

Sealing: Insert backing rods as necessary to separate structural sealant and weatherseal and where applicable to protect the seal of insulating glass units (IGUs). Apply the structural sealant and weatherseal.

Making good: On completion of the reglazing refix cover strips, attachments, trim, permanent mechanical restraints and other items removed as part of the deglazing and reglazing processes, and make good or replace damaged items.

160.4.4 FIXING MIRRORS

Screw fixing

Direct to wall plugs with dome-headed chromium-plated screws. Provide polyethylene sleeves and washers to prevent contact between screw and glass. Do not over-tension the screws.

Frame fixing

General: Proprietary aluminium frames to mirror perimeter, corners mitred. Bed glass edges in a continuous resilient gasket. Attach the frame to the substrate with concealed screw fixings. Seal the frame to the substrate with paintable sealant which will not react with the mirror coating. Do not allow the sealant to contact the mirror back.

Finish: >

Colour of frame: >

Clip fixing

Direct to wall plugs with chromium-plated fixed clip. Provide polyethylene or cork washers to prevent contact between clips and mirror back.

160.4.5 GLAZED SHOWER SCREENS

Type

Proprietary system comprising frames of extruded aluminium, stainless steel, or PVC, assembled around safety glass to form fixed panels and sliding, hinged or pivoted doors.

Shower screen systems

Dimensions (mm): >

Frame type: >

Door type: >

Glass type: Laminated with opaque interlayer.

Processing: >

Hardware: Pull handles on both sides of sash, or of leading sash in multiple sash arrangements.

Water shedding

Provide an assembly which sheds water to the inside without retaining it on the frame surfaces. Seal the edge of the frame to adjoining surfaces with a resilient strip.

Sliding assemblies

Hanging: Hang the sliding sash on stainless steel or nylon sheaves on overhead channel track formed in the frame head, and fit nylon or equivalent bottom guides.

Hardware: Pull handles on both sides of sash, or of leading sash in multiple sash arrangements.

160.4.6 PARTITION GLAZING

General

Assembly: Provide beads or snap-in beads and resilient glazing tapes, gaskets and inserts, so that the glass is held firmly without distortion and withstands the specified loadings.

Frameless installations

Join the vertical edges of adjacent glass panels with a silicone jointing compound.

160.5 COMPLETION

160.5.1 COMPLETION

General

Cross refer: Item 20.5 ‘Completion’ of the General Requirements.

Operation and Maintenance Manual

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 ‘Operation and Maintenance Manuals’ of the General Requirements.

Protection

Protect all glazing-on site from damage until handover.

Damaged glazing-will not be accepted.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

Remove temporary protection measures.

Warning Notices

Provide and fix in position, barriers and warning signs where there is easy entry onto horizontal or sloping glazing to read NO WALKING ON GLAZING in red letters no smaller than 50mm in height and to consist of a material and printing that will not degrade. The location and number of such signs to be agreed with the Engineer.

Warranties

General: Warrant the materials and workmanship using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

Submit the following:-

A warranty, undertaking to replace glass and glazing materials which, within the warranty period, become defective or prove unsuitable for the specified application; provided that the manufacturers' recommendations for the maintenance of the material have been followed during the warranty period.

A glass manufacturer's warranty conditional only on compliance with the manufacturer's recommendation for installation and maintenance, to supply replacement glass units to the site for replacement of defective units defined as follows:

- IGU units: Units in which the hermetic seal has failed as evidenced by intrusion of foreign matter, or internal condensation at temperature above 2°C.
- Coated glass units (including coated SIG units): Units in which the metallic coating shows evidence of manufacturing defects, including but not necessarily limited to cracking or peeling, as determined in accordance with ASTM C1048.

A manufacturer's warranty certifying that all toughened glass supplied for use has been subjected to a heat soaking process which has converted at least 95% of the nickel sulphide content to the stable beta-phase.

Warrant all glass and glazing for 10 years.

Provide the warranty jointly and severally by the Contractor and manufacturer, in the format shown in the General Specification.

Cleaning

Replace damaged glass and leave the work clean, polished, free from defects, and in good condition.

Record drawings

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

170 WINDOWS

170.1 GENERAL

170.1.1 CROSS REFERENCES

Conform to the General Requirements worksection.

Associated worksections

Conform to associated worksections as follows: Metals and Prefinishes.
Adhesives, Sealants and Fasteners .
Glazing.
Door and Window Hardware.

170.1.2 STANDARD

Windows

Selection and installation: To AS 2047.

Aluminium alloy windows: To SS 212.

170.1.3 INTERPRETATION

Definitions

Window: The term “window” used in this worksection also means “sliding glass door”, where applicable.

Where glazing occurs within a glazed wall or screen refer to:

- Curtain Walls.
- Structural Glazing.
- Cladding.

Tests: See General Requirements for definitions of test types.

170.1.4 DESIGN

Drawings

Contract drawings show generic design principles and design intent only.

170.1.5 PERFORMANCE

General

Provide windows in conformance with the **Window performance schedule.**

Cleaning

Design the window openings so that external faces of glazing can be cleaned from within the building.

Design the building to incorporate a fixed or movable platform so that external faces of glazing can be safely cleaned.

Standard

General: To AS 2047.

Serviceability design wind pressure (Pa) (minimum): Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

Water penetration resistance test pressure (Pa) (minimum): To match design wind pressure.

Glazing plastics

Glazing plastics will not be accepted.

170.2 QUALITY

170.2.1 INSPECTION

Witness points

Give sufficient notice so that inspection may be made at the following stages:

- Fabricated window assemblies at the factory ready for delivery to the site.
- Fabricated window assemblies delivered to the site, before installation.
- Openings prepared to receive windows (where windows are to be installed in prepared openings).
- Commencement of window installation.
- Joints prior to sealing.

Hold points

- Completion of the confirmation prototype window installation on site.

Corrosion

Cross refer: General Requirements Clause 20.4.1.

170.2.2 TESTS

General

Carry out all tests in accordance with Section 20.3.2 of the General Requirements.

Weighted sound reduction index (R_w) tests

General: Type test designated windows, to demonstrate that a representative specimen of the assembly has attained the specified R_w rating.

Test method: To AS/NZS 1276.1.

Double glazed systems: Interpolation between test results for similar systems is acceptable provided as follows:

- Dimensional (thickness or width) differences do not exceed a ratio of 1:1.5.
- Each tested system differs from the proposed system by not more than one variable of one of the following elements:
  - . Cavity: Width dimension.
  - . Cavity reveal: Acoustic absorption treatment; and
  - . First panel: Glass type, glass thickness.
  - . Mounting: Type, seal type.

Second panel: Glass type, glass thickness.

Thermal performance tests

General: Type test designated windows to demonstrate that a representative specimen of the assembly has at least the required values for

- condensation resistance factor (CRF); and
- thermal resistance (R).

Test method: To AAMA 1503.

Fire resistance level (FRL) tests

General: Type test designated windows, to demonstrate that a representative specimen of the assembly has attained the specified FRL.

Test method: To BS 476 Parts 6 & 7.

Forced entry resistance tests

General: Type test designated windows, to demonstrate that a representative specimen of the item has met the performance test requirements.

Test method: To AAMA 1302 or AAMA 1303, as applicable.

Forced entry resistance: >

- Designated windows: >

170.2.3 SAMPLES

General

Submit samples of the following in accordance with Section 20.3.4 ‘Samples’, of the General Requirements.

- Sections proposed to be used for frames, sashes, louvres and slats.
- Joints made by proposed techniques.
- Colour samples of prefinished production material (e.g. anodised or organic coated extrusions and sheet) showing the limits of the range of variation in the selected colour.
- Tinted, coloured or patterned glass showing the nominal colour or pattern.
- Accessory and hardware items specified descriptively or by performance (i.e. not specified as proprietary items) including locks, latches, handles, catches, sash operators, anchor brackets and attachments, masonry anchors and weather seals (pile or extruded).

No of samples: 3

170.2.4 PROTOTYPES

General

Construct all prototypes in accordance with the requirements of Section 20.3.5, ‘Prototypes’ of the General Requirements.

Confirmation prototypes

General: Install the designated typical window assemblies in their final position incorporating at least one example of each component in the system, including attachments to the structure, flashing, caulking, sealing, glazing, operating hardware, locks and keys.

Samples in prototypes: Required samples may form part of prototypes.

Prototypes: >

- Designated window assemblies: >

Retain all prototype panels until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

170.2.5 SUBMISSIONS

General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

Subcontractors

Submit names and contact details of proposed manufacturers and installers.

Shop drawings

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Submit shop drawings showing, but not limited to, the following information:

- General arrangement plans, sections and elevations identifying all window types and showing their location.
- Layout (sectional plan and elevation) of the window assembly.
- Full size sections of members.
- Methods of assembly.
- Methods of installation, including fixing, caulking and flashing.
- Interfaces with adjacent materials
- Provision for vertical and horizontal expansion.
- Junctions and trim to adjoining surfaces.
- Hardware, fittings and accessories.
- Lubrication requirements.
- Glazing details.

No. of copies to be submitted: As Particular Specification.

Tests

Submit copies of current test reports, and certification, including drawings of tested details, in accordance with Section 20.3.2, 'Tests' of the General Requirements.

No. of copies to be submitted: 3.

Engineering endorsement

Submit calculations and drawings from a Singapore licensed Professional Engineer concurrently with the shop drawings and showing, but not limited to, the following:-

Compliance with all relevant Singapore legislation and regulations

Manufacturers' information

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

Method Statement

Submit method statements in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

170.3 MATERIALS AND FINISHES

170.3.1 General

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

Provide windows in conformance with the **Window construction schedule**.

170.3.2 MATERIALS

General

Cross refer :

- Metals and Prefinishes.
- Adhesives, Sealants and Fasteners.

Flashings

Standard: To AS/NZS 2904.

Materials: Provide flashings and weatherings which are corrosion resistant, compatible with the other materials in the installation, and coated with a non-staining compound where necessary.

Fasteners

General: All fastenings shall be appropriate to the work, shall transmit all imposed loads and stresses, and shall ensure the structural integrity of the windows.

Stainless steel grade: 316.

No visible fixings will be acceptable.

Glass

Refer to Glazing.

170.4 COMPONENTS

170.4.1 WINDOW ASSEMBLIES

Steel

Fabricate from steel industrial sections. Mitre and weld frame and sash joints. Tenon and rivet glazing bars.

Aluminium

To SS 212.

Fabricate from aluminium extruded sections. Mitre and weld frame joints.

Double glazed

Sealed type: Glaze with insulating glass units (sealed double glazing).

Non sealed double glazed

Sash frame: An inner and outer leaf, both glazed, hinged together so that they may be separated for cleaning the internal faces of the glass, and for access to internal blinds, if any.

Pivoted sash

Type: Proprietary sash system of proven design, fitted with suitable weather seals and incorporating a locking device which deters unauthorised use.

170.4.2 INSECT SCREENS

Frame

General: Provide aluminium extruded or folded box frame sections with mesh fixing channel, mitred, staked and screwed at corners.

Mesh

Material: vinyl-coated fibreglass yarn, non combustible, and will not stretch, shrink or stain.

Finish: no metallic glare.

Mesh size: 18 x 14 (71 x 55 per 10 cm).

Mesh weight: 100 gsm.

Yarn thickness: 0.275 mm.

Bead the mesh into the frame channel with a continuous resilient gasket, so that the mesh is taut and without distortion.

Fixed screens

Attach fixed screens to the window frames with a clipping device which permits removal for cleaning.

Sliding screens

Separate screens: Provide matching aluminium head guide, sill runner, and frame stile sections for screens not part of the window frame.

Hardware: Nylon slide runners and finger pull handle. Provide pile strip closers against sash where necessary to close gaps.

Hinged screens

Hinges: Hinge at the top to give access to opening sash.

Hardware: Spring catch and handle at bottom.

170.4.3 SECURITY WINDOW GRILLES

General

Type: Proprietary metal security grille screen, or operable screen and frame, fixed to the building structure with tamper resistant fastenings.

Security window grilles: To AS/NZS 4604.

Installation: To AS/NZS 4605.

170.4.4 SCHEDULES

Window construction schedule

Element or part	Type or location			
	A	B	C	D
Window	>	>	>	>
Opening type	>	>	>	>
	>	>	>	>
Anodising	>	>	>	>
Surface texture	>	>	>	>
Colour	>	>	>	>
Thickness grade	>	>	>	>
Material	>	>	>	>
Powder coating	>	>	>	>
Colour	>	>	>	>
Type	>	>	>	>
	>	>	>	>
Glass	>	>	>	>
Glazing method	>	>	>	>
Processing	>	>	>	>
Thickness	>	>	>	>
Type	>	>	>	>
	>	>	>	>
Insect screens	>	>	>	>
Material and finish	>	>	>	>
Mesh type	>	>	>	>
	>	>	>	>
Security window grilles	>	>	>	>
Type	>	>	>	>
Size	>	>	>	>
Materials and finish	>	>	>	>

Window performance schedule

Quantity	Type or location			
	A	B	C	D
Condensation resistance factor, CRF	>	>	>	>
Fire resistance level, FRL	>	>	>	>
Thermal resistance, R or transmittance, U	>	>	>	>
Weighted sound reduction index, R_w	>	>	>	>

170.5 EXECUTION

170.5.1 GENERAL

Standards

>

General

Provide mouldings, architraves, reveal linings, and other internal trim as shown on the drawings. Install to make neat and clean junctions between frames and the adjoining building surfaces.

Installers

Have windows installed by their manufacturer or by a subcontractor recommended by the manufacturer.

Installation

Install windows so that the frames

- are plumb, level, straight and true within building tolerances accepted by the Engineer;
- are adequately fixed or anchored to the building structure; and
- will not carry any building loads, including loads caused by structural deflection or shortening.

Joints

General: Make accurately fitted tight joints so that neither fasteners nor fixing devices such as pins, screws, adhesives and pressure indentations are visible on exposed surfaces.

Sealants: If priming is recommended, prime surfaces in contact with jointing materials.

Operation

Ensure moving parts operate freely and smoothly, without binding or sticking, at correct tensions or operating forces and that they are lubricated where appropriate.

Protection

Removal: Remove temporary protection measures from the following:

- Contact mating surfaces before joining up.

Flashing and weatherings

Install flashings, weather bars, drips, storm moulds, caulking and pointing so that water is prevented from penetrating the building between the window frame and the building structure under the prevailing service conditions, including normal structural movement of the building.

Fixing

Packing: Pack behind fixing points with durable full width packing.

Prepared masonry openings: Where fixing of windows to prepared anchorages necessitates fastening from the frame face, sink the fastener heads below the surface and fill the sinking flush with a material compatible with the surface finish.

Fasteners: Conceal fasteners.

Fastener spacing (nominal): 600 mm.

170.6 COMPLETION

170.6.1 COMPLETION

General

Cross refer: Item 20.5 ‘Completion’ of the General Requirements.

Operation and Maintenance Manual

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 ‘Operation and Maintenance Manuals’ of the General Requirements.

Protection

Protect all windows on site from damage until handover.

Damaged windows will not be accepted.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

Remove temporary protection measures.

Damage

Replace damaged items with new.

Warranties

Warrant the materials and workmanship using the Authority’s standard warranty form for the period(s) stated in Item 20.5.1 ‘Warranties’ of the General Requirements.

Submit the window manufacturer’s published product warranties.

Warrant all materials and workmanship against all defects including, but not limited to, corrosion, leaks, discolouration, and surface blemishes.

Record drawings

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

170.6.2 REPAIR

Before commencing repairs submit details of the proposed repair method for acceptance.

180 DOORS AND HATCHES

180.1 GENERAL

180.1.1 CROSS REFERENCES

General

Conform to the General Requirements worksection.

Associated worksections

Conform to associated worksections as follows: Metals and prefinishes.

Painting.

Doors and Window Hardware.

180.1.2 CIVIL DEFENCE (CD) REQUIREMENTS

Where stations are identified as having Civil Defence (CD) requirements, refer to the CD Design Criteria for requirements and information relating to the upgrading of materials, material thicknesses, composition and fixing methods for CD stations.

180.1.3 EQUIPOTENTIAL BONDING REQUIREMENTS (EPB)

Cross Refer: Section 20.2.7 'Design' of the General Requirements.

180.1.4 TOUCH VOLTAGE PROTECTION

Cross Refer: Section 20.2.7 'Design' of the General Requirements.

180.1.5 DESIGN

Drawings

Contract drawings show generic design principles and design intent only.

180.1.6 INTERPRETATION

Definitions

Doorset: An assembly comprising a door or doors and supporting frame, guides, and tracks, including the hardware and accessories necessary for satisfactory operation.

Authority's Sample: A sample held by the Authority and available for viewing during the tender and construction periods.

180.2 QUALITY

180.2.1 STANDARD

Fire Doors : in accordance to Singapore Standard (SS) 332.

180.2.2 INSPECTION

Witness points

Give sufficient notice so that inspection may be made of the following:

- At production of confirmation prototype.
- Doorsets after factory applied primer and base coats of paint.
- Doorsets at the location of installation but prior to fixing.
- Door frames in place before building in to masonry.
- Door frames installed before grouting.

Hold points >

- The identification of corrosion on any part of a doorset.
- Doorsets on completion of preparatory work prior to the final coat of paint on site.

Corrosion

Cross refer: General Requirements Clause 20.4.1.

180.2.3 TESTS

General

Carry out all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

Test the largest single and double leaf fire doors, unless otherwise directed by the Engineer.

All fire doors submitted for tests shall be tested complete with hardware, accessories, signage, and system wide fittings as agreed with the Engineer prior to the test.

PSB labels : Attached to all fire doors and frames.

180.2.4 SAMPLES

General

Submit samples of each of the following in accordance with Section 20.3.4 'Samples', of the General Requirements.

- Sections proposed to be used for frames, louvres and slats.
- Joints made using proposed techniques.
- Finishes to prepared surfaces.
- Colour range samples from prefinished production material (e.g. anodised or organic coated extrusions and sheet).
- The colour range, layered to show the build up to the finished colour.
- Standard hardware items.

180.2.5 PROTOTYPES

General

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

Confirmation prototype

Provide a confirmation prototype door installation.

Location:	As agreed with the Engineer.
Number required:	One of each door type including fire and acoustically rated doors.
Incorporating	- All door hardware. - Electrical locking devices including all accessories and wiring. - Signage panels.

Retain all prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

180.2.6 SUBMISSIONS

General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

Subcontractors

- Submit names and contact details of proposed suppliers.
- Submit name and contact details of proposed specialist door installation subcontractor(s).

Shop drawings

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Submit shop drawings showing details of each assembly, component and connection and information relevant to fabrication, surface treatment and installation for the following:

- Door frames.
- Clad doors.
- Door seals.

Ensure shop drawings detail:

- All door interfaces with adjacent materials.
- Hardware interfaces.
- Information relevant to fabrication.
- Surface treatment.
- Installation.

Identify each door type and its location in the works.

No. of copies to be submitted: As Particular Specification.

Engineering endorsement

- Submit calculations and drawings from a Singapore licensed Professional Engineer concurrently with the shop drawings and showing, but not limited to, the following:-
- compliance with all relevant Singapore legislation and regulations.
- Submit a report from a Singapore registered Electrical Engineer certifying that the design and installation of internal cladding is in compliance with Section 13.9 of the Authority's Design

Criteria Volume 2 of 2, and Singapore Standard CP5 and meets all of the Authority's equipotential bonding and touch voltage protection requirements.

Manufacturers' information

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

Doorset Types

Doorset types used for scheduling of doorsets on door schedule.

Doorset types to include reference to : Doorset code, Fire resistance/acoustic/air pressure level,, Door material, Frame material, Door thickness, Core material, Edge strips thickness (mm), Door Hardware and Accessories, Door Hardware fixing details(Mortar boxes and Reinforcement), Door finish, Frame finish, Frame head and Jamb profile, Frame trim profile, Rebate details, Cladding fixing details, Louver details, Structural fixings.

Other details for the particular door and frame materials as listed in components.

Tests

Fire resistant doorsets: Submit certification showing compliance with the required fire rating.

Acoustic doorsets: If a doorset has a weighted sound reduction index (R_w) rating, submit certification from an independent testing authority showing compliance with the requirement.

Air Pressure: If a doorset is required to meet a particular pressure differential on opposite faces, submit certification from an independent testing authority showing compliance with the requirement.

Method Statement

General: Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

180.3 MATERIALS

180.3.1 MATERIALS AND COMPONENTS

General

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use products which give off toxic emissions in the event of a fire.

Do not use materials which contain known carcinogenics.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

Flashings and weatherings

Standard: To AS/NZS 2904.

General: Provide flashings and weatherings which are corrosion resistant, compatible with the other materials in the installation, and coated with a non-staining compound where necessary.

Jointing materials

Provide recommended jointing and pointing materials which are compatible with each other and with the contact surfaces and non staining to finished surfaces. Do not provide bituminous materials on absorbent surfaces.

Extruded gaskets and seals

Type: Non cellular (solid) elastopressive seals.

Material:

- Rubber products (ethylene propylene diene monomer [EPDM]): To BS 4255.1.

Nylon brush seals

Dense nylon bristles locked into galvanized steel strips and fixed in a groove in the edge of the door or in purpose-made anodised aluminium holders fixed to the door with very high bond pressure sensitive double sided tape.

Weather bars

Material: Stainless steel: grade 316.

Finish:>

180.4 EXECUTION

180.4.1 CONSTRUCTION GENERALLY

Installers

Have proprietary doorsets installed by specialist firms.

Installation

Install doors so that the frames.

- are plumb, level, straight and true within acceptable building tolerances;
- are adequately fixed or anchored to the building structure; and
- will not carry any building loads, including loads caused by structural deflection or shortening.

Joints

Make accurately fitted tight joints so that neither welding nor fasteners nor fixing devices such as pins, screws, adhesives and pressure indentations, are visible on exposed surfaces.

Operation

Ensure moving parts operate freely and smoothly, without binding or sticking, at correct tensions or operating forces and that they are lubricated where appropriate.

Protection

Surfaces: Protect door assembly, components and surfaces to prevent damage or defacement.

Window and door assemblies

If doors are to be installed in window frames as part of a combined window and door assembly, provide a door frame as specified in the Windows worksection for the relevant window type, plus appropriate modification and accessories necessary for the door installation.

Seals

Provide purpose-made proprietary seals to meet requirements for weather, draught, smoke and acoustic sealing. Provide fixings, rebates, grooves and clearances as necessary for installation and operation of the seals. Allow seals unwound from coils to settle before use.

Ensure that installed acoustic door seals are continuous.

Trim

General: Install to make neat and clean junctions between the frame and the adjoining building surfaces.

Flashings and weatherings

Installation: Install flashings, weather bars, drips, storm moulds, caulking and pointing to prevent water from penetrating the building between the door frame and the building structure under the prevailing service conditions, including normal structural movement of the building.

Weather bars

Location: Provide a weather bar under hinged external doors, locate under the centres of closed doors.

Installation:	>
Type:	>
Dimensions:	Minimum 65 x 6mm: to project 5mm above ffl
Fixing:	Cast minimum 60mm into floor finish.

180.5 COMPONENTS

180.5.1 TIMBER DOORS AND FRAMES

General

Timber doors may be used in combination with steel frames.

Standards

All timber doors and frames to Singapore Standard (SS) 347.

Door thickness (minimum)

Generally: 35 mm.

External doors and doors over 900 mm wide: 40 mm.

Flush doors

Edge strips: Minimum thickness 10 mm. Increase overall thickness to at least 15 mm to accommodate the full depth of the rebate in rebated doors. Form rebates to suit standard rebated hardware.

Cut outs: If openings are required in flush doors (e.g. for louvres or glazing) make the cut outs not closer than 120 mm to the edges of the doors.

Cellular core and intermediate rail core flush doors:

- Provide additional frame material where necessary to take hardware, fastenings and grooves.
- Provide a subframe of 25 mm minimum width timber around openings for louvres and glazing.

Medium density fibreboard (MDF) internal doors: Solid flush doors for internal use comprising a single sheet of MDF board without edgestrips. Provide the same surface finish to both faces of the door.

Laminated plastic facings: 0.8 mm minimum thickness, bonded to the door facings.

- Standard: To AS/NZS 2924.1.

Timber louvre panels: Construct by inserting the louvre blades into a louvre frame, and fix the frame into the door so that frame and blades finish flush with the door faces.

- Timber species: To match door faces.

Metal clad doors

Flush doors faced both sides with 0.6 mm thick galvanized steel sheet extended over and across hardwood edge strips on all edges and fixed with waterproof adhesive using a press.

Priming

Prime timber doors on top and bottom edges before installation.

Scheduling of doorset types

Timber doorset types to include reference to: Facing, Timber species or group, Timber grade, Top rails and stiles size, Intermediate rails size, Bottom rails size, Muntins size, Ledges size, Braces size, Diagonal braces size, Adhesive bond type, cladding type, cladding thickness.

180.5.2 SLIDING DOOR FRAMES

General

Suspend sliding doors from overhead tracks and wheel carriages appropriate to the size and mass of the doors.

Cavity sliding frames

Type: Proprietary steel construction with rigid steel top, base, and rear supporting members, incorporating the overhead door track and assembled to accurately match the thickness of the wall into which it is fitted.

Support: Support the unit at the throat entrance by steel angles and finish with split jamb linings. Fix the frame direct to studs through top, base and rear members.

Split jamb linings: To AS 2689.

Accessories

General: Provide overhead track supports and head and jamb linings appropriate to the arrangement of the door, and removable pelmets at the head to allow access to the wheel carriages for adjustment.

Guides and stops: Adjustable floor guides to suit grooved or ungrooved doors, as applicable, and buffer type track stop to limit the travel of the door leaf.

Wheel carriages: Fully adjustable precision ball race type providing smooth quiet operation.

180.5.3 STEEL DOORS & FRAMES

General

Steel Frame may be used in combination with steel, glass or timber doors.

Type: Assemble frames from zinc coated bonderized or grade 304/316 stainless steel sections, including necessary accessories such as buffers, strike plates, spreaders, mortar guards, switch boxes, fixing ties or brackets, and cavity flashing with suitable reinforcement for fixing hardware; prefinished with protective coatings, built in or fixed to prepared openings.

Sections

Rebates: Incorporate rebates or double rebates where required for side hung doors or glazed transoms.

Coated steel sheet: To AS 1397.

Minimum steel sheet thickness: 1.6mm.

Assembly methods

Welded: Shop assemble fire rated and heavy duty frames by continuous welding. Grind the welds smooth and cold galvanize the welded joints before shop priming.

Finish

Zinc coated bonderised steel Prefinish: Zinc-iron.

Stainless Steel Prefinish: Continuous hairline finish polished using grit size 180-240 unless otherwise specified.

Shop priming: Shop prime the sections for the painting system.

Finishing coats: Shop apply all paint coats except the final coat. Apply the final coat on site on completion of the works.

Cross refer: Painting.

Hardware and accessories

General: Provide for fixing hardware including hinges and closers, using backplates and lugs sufficient to carry the weight of the door and the forces acting on it. Screw fix the hinges into tapped holes in the back plates.

Spreader: Removable spreader bar for frames to be built into masonry construction.

Hardware accessories: Mortar guards and reinforcing plates for the hardware.

Silencers/Buffers: Minimum two resilient grommet type silencers/buffers per leaf.

Cavity flashing: For external frames in cavity masonry.

Glazing beads (for glazed transom lights): Fabricate from material of the same type as the frame. Mitre corners. Screw to frames with matching countersunk head screws at 300 mm maximum centres.

Installation

Building in to masonry: Attach galvanized rod ties to stiles at 600 mm maximum centres. Build in and grout up solid.

Installing in existing masonry: To the manufacturer's instructions to meet the required door performance.

Installing in existing concrete: To the manufacturer's instructions to meet the required door performance.

Scheduling of steel doorset types

Steel doorset types to include reference to : Door steel thickness, Frame steel thickness, Steel type, Steel prefinish, Paint type, Profile Type, Width between flanges (mm), Width of Architrave faces(mm), Depth of Door seat rebate (mm), Glazing beads.

180.5.4 FRAMELESS GLASS DOORS

Type

A proprietary door system, installed by the manufacturer, or a subcontractor approved by the manufacturer, consisting of toughened glass door panels hung with purpose-made metal patch fittings and including the manufacturer's standard or optional custom designed push bars or plates, and a means of locking.

Location >

Toughened glass

Thickness (mm): >

Other requirements: >

Patch fittings

Finish: >

Hanging >

180.6 HATCHES

180.6.1 NON-PUBLIC AREA ACCESS HATCHES

Hatch assembly

- Galvanised mild steel hatch frame and covers.
- Stainless steel hatch frame and covers.
- Aluminium hatch frame and covers.

Frame

Weld from minimum 50 x 50 x 6 mm angle to match hatch material, with fixing lugs each side sufficient to resist the forces acting on the hatches. Cast into concrete.

Covers

Chequer plate, with angle frame welded on all round and diagonal stiffening flats. Cut, radius and grind off 100 x 25 mm lifting slots in each end of covers and drop into position.

Design cover to carry the applied loading on the adjacent floor.

Non-public area access hatches schedule

Access hatch code	NAH1	NAH2	NAH3
Type	>	>	>
Clear opening size (mm)	>	>	>
Operating gear	>	>	>
Hardware	>	>	>
Floor Loading	>	>	>
Fire Resistance level	>	>	>

180.6.2 PUBLIC AREA ACCESS HATCHES

Hatch assembly

- Structural base framework and sides of size and configuration to allow the installation of finishes to match the adjacent finishes in all respects.
- Factory-installed finishes into the hatch system.
- Galvanised steel.
- Stainless steel.

Frame

Complete with fixing lugs each side sufficient to resist the forces acting on the hatches.

Covers

Recessed fully welded covers to take finish to match surrounding areas.

Proprietary floor hatches

- Counterbalancing gas struts to enable covers to be opened by one man.
- Integral barriers to prevent accidental falls into hatch opening.
- All ironmongery and accessories necessary to the operation of the hatch.
- Design cover to carry the applied loading on the adjacent floor.

Public area access hatches schedule

Access hatch code	PAH1	PAH2	PAH3
Type	>	>	>
Clear opening size (mm)	>	>	>
Operating gear	>	>	>
Hardware	>	>	>
Floor Loading	>	>	>
Fire Resistance level	>	>	>

180.6.3 DUCT ACCESS HATCHES

Type

Proprietary system comprising a metal faced door side hung to a steel door frame, inclusive of the necessary hardware and accessories including hinges and lock and lugs or other suitable means for installation.

Door leaf facings

Flush faces and edges pressed from hot dipped metal sheet to AS 1397, welded at joints. Apply zinc-rich primer to welds.

Finish

Factory-applied finish consisting of one coat zinc phosphate etch and one coat zinc chromate primer.

Duct access hatches schedule

Duct access hatch code	DAH1	DAH2	DAH3
Type	>	>	>
Clear opening size (mm)	>	>	>
Operating gear	>	>	>
Hardware	>	>	>
Floor Loading	>	>	>
Fire Resistance level	>	>	>

180.7 COMPLETION

180.7.1 COMPLETION

General

Cross refer: Item 20.5 ‘Completion’ of the General Requirements.

Operation and Maintenance Manual

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 ‘Operation and Maintenance Manuals’ of the General Requirements.

Protection

On or before completion of the works, or before joining up top other surfaces, remove all materials used as a means of protection.

Protect all completed doorsets on site from damage until handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

On or before completion of the works remove all materials used as a means of protection.

Damage

Replace damaged items with new.

Warranties

Warrant the materials and workmanship using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

Submit all proprietary materials manufacturer's published product warranties.

Record drawings

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

180.7.2 REPAIR

Before commencing repairs submit details of the proposed repair method for acceptance.

181 ROLLER SHUTTERS AND GRILLES

181.1 GENERAL

181.1.1 CROSS REFERENCES

Conform to the General Requirements worksection.

Associated worksections

Conform to associated worksections as follows: Metals and Pre-finishes.
Painting.
Door and Window Hardware.
Heavy Duty Galvanised Coatings.
>

181.1.2 CIVIL DEFENCE (CD) REQUIREMENTS

General

Where stations are identified as having Civil Defence (CD) requirements, refer to the CD Design Criteria for requirements and information relating to the upgrading of fixing methods for CD stations.

181.1.3 INTERPRETATION

Definition

Cycle: One complete operation from the closed position to fully open and back to closed.

Shutters: All references to shutters and grilles shall be taken to include motors and all accessories required for their operation.

181.1.4 DESIGN

Drawings

Contract drawings show generic design principles and design intent only.

181.2 QUALITY

181.2.1 INSPECTION

Witness points

Give sufficient notice so that inspection may be made of the following:

- Openings prepared for the installation of shutters and/or grilles.
- Tracks and guides installed before doors or shutters and/or grilles are hung.
- Tracks and guides installed before grouting.

Hold points >

- Completion of confirmation prototypes.
- Shutters and/or grilles. on completion of preparatory work prior to the final coat of paint on site.

Corrosion

Cross refer: General Requirements Clause 20.4.1.

181.2.2 TESTS

General

Carry out all tests in accordance with Section 20.3.2 ‘Tests’ of the General Requirements.

Test the largest fire rated shutter.

All shutters submitted for fire tests shall be tested complete with ironmongery, signage, and system wide fittings as agreed with the Engineer prior to the test.

181.2.3 SAMPLES

General

Submit samples of each of the following in accordance with Section 20.3.4 ‘Samples’, of the General Requirements.

- Sections proposed to be used for frames, grilles and slats.
- Joints made using proposed techniques.
- Finishes to prepared surfaces layered to show the build-up.
- Colour range samples from prefinished production material (e.g. anodised, powder or fluorocarbon coated extrusions and sheet).
- Manufacturer’s standard hardware items.

181.2.4 PROTOTYPES

General

General

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

Confirmation Prototype

Provide a confirmation prototype shutter and/or grille installation.

Location:	As agreed with the Engineer.
Number required:	The first installation of each type on site shall be treated as a prototype.
Incorporating	- All ironmongery. - Signage panels. - All interfaces with adjoining materials.

Retain all prototype panels until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

181.2.5 SUBMISSIONS

General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

Subcontractors

Submit names and contact details for proposed suppliers.

Submit name and contact details of proposed specialist door installation subcontractor(s).

Shop drawings

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Submit shop drawings showing details of each assembly, component and connection and information relevant to fabrication, surface treatment and installation for the following:

- Fire shutters.
- Roller shutters and grilles.

Ensure shop drawings detail all door interfaces with adjacent materials.

Identify each shutter and grille type and its location in the works.

Fire resistant shutters: Submit shop drawings showing details of each assembly, component and connection and information relevant to fabrication, surface treatment and installation.

No. of copies to be submitted: As Particular Specification.

Tests

Submit copies of current test reports, and certification, including drawings of tested details, in accordance with Section 20.3.2, 'Tests' of the General Requirements.

Fire resistant shutters: Submit certification from an independent testing authority showing compliance with the required fire rating.

Acoustic shutters: If a shutter has a weighted sound reduction index (R_w) rating, submit certification from an independent testing authority showing compliance with the requirement.

No. of copies to be submitted: 3.

Engineering endorsement

Submit calculations and drawings from a Singapore licensed Professional Engineer concurrently with the shop drawings and showing, but not limited to, the following:-

Compliance with all relevant Singapore legislation and regulations.

Manufacturers' information

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

Method Statement

General: Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

181.3 COMPONENTS

181.3.1 General

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

181.3.2 SECTIONAL OVERHEAD DOORS

Sectional overhead doors

Type: Proprietary system comprising a door of linked horizontal panels hinged together, weather lapped at the horizontal joint, fitted with rollers running in side tracks fixed to the building structure which guide the door when opened to a position above and behind the opening, and inclusive of the manufacturer's standard operating gear, hardware, and accessories necessary for satisfactory performance.

Wind and air pressure loading

Install so that the door, in its closed position, withstands the design loading on the surface without impairment of its ability to function under ambient temperature. Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

Panels

Form from sheet to standard profiles, or fix to a surround frame. Fit a PVC seal strip.

Adapt the bottom panel to follow the contour of the floor or threshold.

Side tracks

Roll form from:

- Galvanized steel sheet.
- Stainless steel
- >

Where necessary to carry door loads without distortion, reinforce horizontal track sections with a rolled channel in a matching material.

Operation

Method of raising and lowering the door:

- Direct manual: By chain.
- Motorised: Connect the motor to the door through a shock absorbing connecting arm.

Manual operation

Install so that the force required to operate the door manually does not exceed 220 N.

Motorised operation

General: Provide electric motor incorporating limit switches, manual safety stop and reversing mechanism, and overload cutout, operated by a battery-powered radio remote controller (supplied as part of the system)-Provide a motorised system which is capable of manual operation in the event of power failure.

Secure manual operation mechanism to prevent unauthorised use.

Provide automatic safety stop and reversing: >

Sectional overhead doors schedule

- See drawing number >

Door designation	SO1	SO2	SO3
Wind loading/air pressure	>	>	>
Action	>	>	>
Panels: - Panel size (mm)	>	>	>
- Panel material	Zinc coated bonderised steel To AS 1397.	>	>
- Fire rating	>	>	>
- Material thickness	1.6mm	>	>
- Finish	>	>	>
- Colour	>	>	>
Vertical guides: - Material	>	>	>
- Size	>	>	>
- Finish	>	>	>

Door designation	SO1	SO2	SO3
- Fixing method	>	>	>
Operation method	Motorized with manual over-ride	>	>
Hardware: - Item	>	>	>
- Material	>	>	>
- Finish	>	>	>
Accessories	>	>	>

181.3.3 ROLLER SHUTTERS

Roller shutters

Type: Proprietary system comprising a flexible curtain sliding between vertical guides, raised or lowered by rolling or unrolling around a horizontal drum (barrel) mounted above the opening, inclusive of the manufacturer's standard operating gear, hardware, and accessories necessary for satisfactory performance.

Wind and air pressure loading

Install so that the shutter, in its closed position, withstands the design pressure on the surface without impairment of its ability to function under ambient temperature.

Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

Curtain

Slatted curtain: A curtain of horizontal interlocking slats, incorporating interlocking hinges extending the full width of the curtain.

Bottom curtain rail: A stiffening member interlocking with the bottom edge or lowest slat of the curtain, extending between the inner faces of the vertical guides, formed or adapted where necessary to follow the contour of a sloping floor or threshold. The rail may also be adapted to house the locking device.

Drum

Drum deflection: 1/360th of the span (maximum).

Springs: Helical torsion springs housed in the drum and arranged to counterbalance the curtain weight without exceeding the safe working stress of the spring material.

Operation

Method of raising and lowering the curtain:

- Chain manual: By pulling on a chain passing over a sprocket on the drum, with reduction gears where necessary.
- Motorised

Manual operation

Install so that the force required to operate the door manually does not exceed 220 N.

Motorised operation

General: Provide electric motor incorporating limit switches, manual safety stop and reversing mechanism, and overload cutout, operated by a battery-powered radio remote controller (supplied as part of the system). Provide a motorised system which is capable of manual operation in the event of power failure.

Automatic safety stop and reversing: >

Roller shutters schedule

- See drawing number >

Door code	RS1	RS2	RS3
Wind loading	>	>	>
Slats: - Material	Zinc coated bonderised steel To AS 1397	>	>
- Material Thickness	1.6mm	>	>
- Finish	>	>	>
Perforations: - Size	>	>	>
- Pattern	>	>	>
- Colour	>	>	>

Door code	RS1	RS2	RS3
Slat end pieces: - Material	>	>	>
- Frequency	Every Slat	Every Slat	Every Slat
Vertical guides: - Material	Galvanised steel	>	>
- Size (mm)	>	>	>
- Finish	>	>	>
- Fixing method	>	>	>
Mullions: - Type	>	>	>
- Method of removal	>	>	>
Drum: - Material	>	>	>
- Size (mm)	>	>	>
- Finish	>	>	>
- Brackets: . Material . Finish . Fixing	>	>	>
Operation method	Motorised	>	>
Hardware: - Item	>	>	>
- Material	>	>	>
- Finish	>	>	>
Accessories	>	>	>

181.3.4 FIRE-RESISTANT ROLLER SHUTTERS

Standard

General: To SS 489.

Fire shutters schedule

- See drawing number >

Fire shutter designation	FS1	FS2	FS3
Fire resistance level	>	>	>
Finish: - Curtain slats	>	>	>
- Slat end pieces	>	>	>
- Vertical guides	>	>	>
- Bottom rail	>	>	>
- Barrel mechanism	>	>	>
- Hauling chains	>	>	>
Operating mechanism - Motor capacity	>	>	>
Hardware: - Item	>	>	>
- Material	>	>	>
- Finish	>	>	>

181.3.5 ROLLER GRILLES

General

Type: A roller shutter in which the curtain consists of a grille of horizontal members spaced apart and connected by vertical links.

Roller grilles schedule

- See drawing number >

Designation	RG1	RG2	RG3
Horizontal grille members: - Material	Stainless Steel Grade 316	>	>
- Size (mm)	>	>	>
- Finish	Continuous Hairline Polish using 180-240 grit	>	>
Links: - Material	Stainless Steel Grade 316	>	>
- Finish	Continuous Hairline Polish using 180-240 grit	>	>
- Locating	>	>	>
- Spacing and pattern	>	>	>
Sleeves: - Material	>	>	>
- Finish	>	>	>
End pieces	>	>	>
Bottom curtain rail: - Form	>	>	>
- Material	Stainless Steel Grade 316	>	>
- Size (mm)	>	>	>
- Finish	Continuous Hairline polish using 180-240 grit	>	>
Vertical guides: - Material	Stainless Steel Grade 316	>	>
- Size (mm)	>	>	>
- Finish	Continuous Hairline Polish using 180-240 grit	>	>
- Fixing method	>	>	>
Mullions: - Type	>	>	>
- Method of removal	>	>	>
Drum: - Material	>	>	>
- Size	>	>	>
- Finish	>	>	>
- Brackets: . Material . Finish . Fixing	>	>	>
Operation method	Motorised	>	>
Motorised operation: - Motor capacity	>	>	>
Hardware: - Item	>	>	>
- Material	>	>	>
- Finish	>	>	>
Accessories	>	>	>

181.4 COMPLETION

181.4.1 COMPLETION

General

Cross refer: Item 20.5 ‘Completion’ of the General Requirements.

Protection

Protect all completed overhead doors, roller shutters and grilles on site from damage until handover

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance

Temporary coating: On or before completion of the works, or before joining up to other surfaces, remove all traces of temporary coatings used as a means of protection.

On or before completion of the works remove all materials used as a means of protection.

Damage

Replace damaged items with new.

Warranties

Warrant the materials and workmanship using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

Operation and Maintenance Manual

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements.

Record drawings

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

181.4.2 REPAIR

Before commencing repairs submit details of the proposed repair method for acceptance.

182 DOOR AND WINDOW HARDWARE

182.1 GENERAL

182.1.1 CROSS REFERENCES

General

Conform to the General Requirements worksection.

Associated worksections

Conform to associated worksections as follows: Doors and Hatches.

182.1.2 CIVIL DEFENCE (CD) REQUIREMENTS

Where stations are identified as having Civil Defence (CD) requirements, refer to the CD Design Criteria for requirements and information relating to the upgrading of materials, material thicknesses, composition and fixing methods for CD stations.

182.1.3 DESIGN

Drawings

Contract drawings show generic design principles and design intent only.

182.1.4 INTERPRETATION

Definitions

Doorset: An assembly comprising a door or doors and supporting frame, guides, and tracks, including the hardware and accessories necessary for satisfactory operation.

Hardware: All fittings or fixtures to the door or hatch which includes any items traditionally specified

Authority's Sample: A sample held by the Authority and available for viewing during the tender and construction periods.

182.2 QUALITY

182.2.1 STANDARDS

Hardware : comply with the latest Singapore Standards (SS) at the time of Tender for the supply of the item. In the absence of an applicable SS the latest European standard (EN) shall apply. In the absence of an applicable SS or EN standard the latest British standard (BS) shall apply.

182.2.2 INSPECTION

Witness points

Give sufficient notice that inspection may be made of the following:

- The manufacturer's production facilities.
- Hardware items on delivery to the site.

Hold points:

- Completion of confirmation prototypes.

Corrosion:

Cross refer: General Requirements Clause 20.4.1.

182.2.3 TESTS

General

Carry out all tests in accordance with Section 20.3.2 'Tests' of the General Requirements.

182.2.4 SAMPLES

General

Submit samples in accordance with Section 20.3.4 'Samples', of the General Requirements.
Generic items: Submit samples of all hardware items offered as meeting the description of items specified in generic terms (i.e. not specified as proprietary items).

Particular samples required: >

182.2.5 SUBMISSIONS

General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

Subcontractors

General: Submit name and contact details of proposed suppliers and specialist installer(s).

Door Closers: Submit names and contact details of proposed supplier.

Shop drawings

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Shop drawings shall show, but not be limited to, the following information:

- Schedule of all hardware items to identify location and number of each item.

No. of copies to be submitted: As Particular Specification.

Materials and components

Key control system: Submit details of the proprietary key control security system proposed by the lock manufacturer for locks required to accept a group key (master, grandmaster, etc.).

Manufacturers' information

Technical Literature: Submit the manufacturer's technical literature for all harware items used.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

No. of copies to be submitted: 3.

Productivity and Standards Board (PSB) Product Listing

Compulsory for all items of hardware which have been included under the PSB Product listing scheme regardless whether they are to be fitted onto fire-rated or non-fire-rated doors. Certificates to be furnished.

Tests

General: Submit reports of all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

Fire Test reports

Submit test reports identifying all fire-rated items as suitability on the fire doors being proposed. In the absences of a test report an assessment of the item's fire performance may be submitted subject to the Authority's agreement.

Method Statement

General: Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

182.3 MATERIALS

182.3.1 MATERIALS

General

All materials used in ironmongery fitted to a fire door shall have a minimum melting point of 850^{o}C.

Metal finishes

All materials : High corrosion resistance compliant with EN 1670 :1998 (Grade 3).

Generic items: The following minima apply to the relevant finishes on hardware items described in generic terms (i.e. not as proprietary items):

- Coating class for steel sheet: At least Z275.
- Anodising class for internal applications: At least AA15.
- Brass, copper alloy or bronze surface : Coated with transparent lacquer, or equivalent coating.
- Stainless steel : Austenitic stainless steel to BS 1449, Part 2 and BS 970 Part 1, as applicable, grade 316, and subject to the approval of the Authority. No rust staining, discolouration or evidence of contamination by other metals, or corrosion by oxides, will be acceptable.

182.4 COMPONENTS

182.4.1 COMPONENTS GENERALLY

General

Hardware specified generically: Provide hardware of sufficient strength and quality to perform its function, appropriate to the intended conditions of use, suitable for use with associated hardware, and fabricated with fixed parts firmly joined.

Supply

Deliver door hardware items, ready for installation, in individual complete sets for each door, each set

- in a separate dust and moisture proof package;
- clearly labelled to show its intended location; and
- including the necessary templates, fixings and fixing instructions.

Operation

Ensure working parts are accurately fitted to smooth close bearings, without binding or sticking, free from rattle or excessive play, lubricated where appropriate.

Handing

Before supply, verify on site, the correct handing of hardware items.

Hardware systems >

Miscellaneous hardware schedule

- Arm pulls >
- Flush pulls >
- Sliding track >
- Crashbars >
- Door seals >
- Coat hooks >

182.4.2 HINGES

Butt hinge sizes

General: Minimum sizes are those in **Hinge table A** and **Hinge table B** (not applicable to cupboard doors), in which length (l) is the dimension along the knuckles, not including hinge tips, if any, and width (w) is the dimension across both hinge leaves when opened flat.

Steel, Stainless steel, brass, bronze butt hinges for timber doors in timber or steel frames: To **Hinge table A**.

Hinge table A

Nominal hinge size l x w x t (mm)	Door leaves not exceeding any of the following:		
	Mass (kg)	Width (mm)	Thickness (mm)
70 x 50 x 1.6	16	620	30
85 x 60 x 1.6	20	820	35
100 x 75 x 1.6	30	920	40
100 x 75 x 2.5	50	920	50
100 x 75 x 3.2	70	1020	50
125 x 100 x 3.2*	80	1220	50
>	100	1250	50
>	120	1400	60
>	160	1550	60

- Non standard to special order only.

Number of hinges

Small door leaves: Door leaves not exceeding any of the following may have 2 hinges each:

- 2040 mm high.
- 820 mm wide.
- 30 kg mass.

Other door leaves: provide a minimum of 3 hinges for door leaves up to 2340 mm high, and 4 for door leaves between 2340 mm and 3050 mm high. Provide at least 3 low friction bearing hinges for door leaves controlled by door closers.

Fire doors: To Singapore Standard SS 332.

Hinges per sash: Provide 3 hinges per sash to butt hinge-hung awning or hopper sashes over 1200 mm wide or casement sashes over 1200 mm high.

Hinge materials

Doors fitted with closers: Provide low friction bearing hinges.

Brass hinges: For brass hinges used for door leaves exceeding 30 kg or door leaves controlled by door closers, provide bronze or stainless steel washers to each knuckle joint.

Stainless steel hinges: grade 316 stainless steel.
to BS EN 1935.

Doors fitted with closers: Provide low friction bearing hinges.

Wide throw

Where necessary provide wide throw hinges to achieve the required door swings in the presence of obstacles such as nibs, deep reveals and architraves.

Hinge pins

Exterior or security doors opening out: Provide fixed pin hinges or security hinges.

182.4.3 KEYING

Lock material

Pin tumbler locks: Nickel alloy, not brass.

Lever locks: Malleable cast iron or mild steel.

Identification

Supply each key with a purpose-made plastic or stamped metal label legibly marked to identify the key, attached to the key by a metal ring. Key rack to be provioded per site for contractor's keys.

Group and master keying

Keying control security system: Where cylinder or pin-tumbler locks accept a group key (e.g. master key, maison key) provide to those locks a proprietary keying control security system.

Existing system: Obtain the details of existing group or master key systems to which a new system is required to be an extension.

Future extensions: Provide master and grandmaster group keying systems which are capable of accommodating future extensions.

- Extensions to existing system: >

Stamping: Stamp keys and lock cylinders to show the key codes and/or door number as scheduled.

Contractor's keys

Master key systems: Do not use any key under a master key system.

Key code schedule legend

Code	Description and function
KD	Keyed to differ: Each lock has a unique key which will operate that lock only.
KA	Keyed alike: All locks in the group will pass the same key, but that key will not operate any locks outside the group.
MK	Master keyed: The master key will operate all the locks in the MK group, in addition to their KD or KA keys.
GMK	Grandmaster keyed: The grandmaster key will operate all the locks in the group, in addition to their KD, KA or MK keys.
GGMK	Great Grandmaster keyed: The great grandmaster key will operate all the locks, in addition to their KD, KA, MK or GMK keys.

Key code schedule

Door no.	KD	KA group	MK group	GMK group	GGMK group	Maison keyed, to doors numbered

Key code schedule entries: In the KD and KA, MK, GMK and GGMK group columns

- any entry, including *, means that the lock is a member of that key code type;
- the entry * means the lock is a member of the key code type, but that code stamping is not required; and
- any other entry is the code required to be stamped on key and cylinder.

Maison keyed: In the Maison keyed: column, the entries are the door numbers of the doors whose keys will operate the lock of the door in the Door no.: column. Code stamping not required.

Number of keys table

Code	Key type	Minimum number of keys
GGMK	Great grandmaster keys	>

Code	Key type	Minimum number of keys
GMK	Grandmaster keys	>
MK#	Master keys	>
KD	Locks keyed to differ	>
KA#	Locks keyed alike:	
	- 2 locks in code group	>
	- 3-10 locks in code group	>
	- 11-40 locks in code group	>
	- 41 and over locks in code group	>

Windows

Where window locks are included in building key code groups, provide cylinder or pin tumbler locks coded accordingly.

182.4.4 LOCKS AND LATCHES

General

Door locks and latches :To meet the operational and security requirements of the project. The use of locks and latches are scheduled in accordance with the requirements of the system operator.

Name	**Sashlock lockset**
Description	Lockcase with latch activated by lever handle, deadbolt activated by cylinder - including strike plate and face plate.
Minimum Standard	EN 1303: 1998, BS 5872:1980 (1995).
Quality	• It shall pass the fire test of BS 476 Part 22. Certificates of compliance shall be submitted. • Loss of tension of springs for latches, push bars or handles are considered a defect.
Materials	• Cases - are to be closed on all sides to protect internal parts and manufactured from galvanised heavy gauge steel. • Follower - 8mm square, made of hardened or stainless steel. • Latch bolt, latch cam, anti-thrust bolt, pre-formed strike-plate and face-plate - from stainless steel. • Nylon, brass or any parts with a melting point below 850 degrees centigrade are not permitted.
Critical Dimensions	• Compatible with Europrofile cylinder. • Compatible with 8mm square spindle. • 60 – 70mm backset. • Minimum 20mm throw for dead bolt.
Performance	• Heavy duty. • Reversible latchbolts and strike plate without removing the lockcase cover. • Cases are threaded for securing through bolt. • Single sided lever handle fixing if necessary. • Stainless steel countersunk fixing screws are used throughout. • Spring action for handle included in lockcase.
Fire Requirements	All proposed locksets must be suitable for fire doors up to 2 hours fire rating. The Supplier must ensure that their locksets have the necessary test reports certifying their suitability on fire doors supplied by the Contractor.
Variations	V1 – Lockset is suitable for fire doors up to 4 hours fire rating. V2 – Modular - compatible with other lockcases 9.2, 9.3, 9.4, 9.5. Combinations - V1&V2.
Examples where it may be used	Electrically Locked Plant Room doors.

Name	Nightlatch lockset (Automatic locking)
Description	Lockcase with latch activated by cylinder - including strike-plate and face-plate.
Minimum Standard	EN 1303: 1998, BS 5872:1980 (1995).
Quality	• It shall pass the fire test of BS 476 Part 22. Certificates of compliance shall be submitted. • Loss of tension of springs for latches, push bars or handles are considered a defect.
Materials	• Cases - are to be closed on all sides to protect internal parts and manufactured from galvanised heavy gauge steel. • Follower - 8mm square, made of hardened or stainless steel. • Latch bolt, latch cam, anti-thrust bolt, pre-formed strike-plate and face-plate – made from stainless steel. • Nylon, brass or any parts with a melting point below 850 degrees centigrade are not permitted.
Critical Dimensions	• Compatible with 17mm diameter Europrofile cylinder. • 60 – 70mm backset.
Performance	• Heavy duty. • Anti thrust bolt function for security. Its position and the hole on the strike plate shall be relatively apart so that should the door sag, the anti-thrust bolt will not engage the strike plate thereby rendering its function ineffective. • Reversible latchbolts and strike plate without removing the lockcase cover. • Cases are threaded for securing through bolt. • Stainless steel countersunk fixing screws are used throughout. • Suitable for use with pull handle or ring pull on outside, and lever handle on inside. • Spring action for handle included in lockcase.
Fire Requirements	All proposed locksets must be suitable for fire doors up to 2 hours fire rating. The Supplier must ensure that their locksets have the necessary test reports certifying their suitability on fire doors supplied by the Contractor.
Variations	V1 – Lockset is suitable for fire doors up to 4 hours fire rating. V2 – Modular - compatible with other lockcases 9.1, 9.3, 9.4, 9.5. V3 – Narrow lockcase with 20 to 30 mm backset. Combinations - V1&V2.
Examples where it may be used	Self locking key operated doors.

Name	Deadbolt lockset
Description	Lockcase with deadbolt activated by cylinder - including strike-plate and face-plate.
Minimum Standard	EN 1303: 1998, BS 5872:1980 (1995).
Quality	• It shall pass the fire test of BS 476 Part 22. Certificates of compliance shall be submitted. • Loss of tension of springs for latches, push bars or handles are considered a defect.
Materials	• Cases - are to be closed on all sides to protect internal parts and manufactured from galvanised heavy gauge steel. • Follower - 8mm square, made of hardened or stainless steel. • Pre-formed strike-plate and face-plate – made from stainless steel. • Nylon, brass or any parts with a melting point below 850 degrees centigrade are not permitted.

Critical Dimensions	• Compatible with 17mm diameter Europrofile cylinder. • 60 – 70mm backset. • Minimum 20mm throw for dead bolt.
Performance	• Heavy duty. • Cases are threaded for securing through bolt. • Stainless steel countersunk fixing screws are used throughout. • Suitable for use with pull handle or ring pull.
Fire Requirements	All proposed locksets must be suitable for fire doors up to 2 hours fire rating. The Supplier must ensure that their locksets have the necessary test reports certifying their suitability on fire doors supplied by the Contractor.
Variations	V1 – Lockset is suitable for fire doors up to 4 hours fire rating. V2 – Modular - compatible with other lockcases 9.1, 9.2, 9.4, 9.5. V3 – Narrow lockcase with 20 to 30mm backset. V4 – Key can't be released unless deadbolt is projected. V5 – Thumbturn can only retract and not project deadbolt. Combinations - V1/V2, V1/V3, V3/V4, V3/V5, V4/V2, V5/V2.
Examples where it may be used	Toilet doors.

Name	**Latch Lockset**
Description	lockcase with latch activated by lever handle - including strike-plate and face-plate.
Minimum Standard	EN 1303: 1998, BS 5872:1980 (1995).
Quality	• It shall pass the fire test of BS 476 Part 22. Certificates of compliance shall be submitted. • Loss of tension of springs for latches, push bars or handles are considered a defect.
Materials	• Cases - are to be closed on all sides to protect internal parts and manufactured from galvanised heavy gauge steel. • Follower - 8mm square, made of hardened or stainless steel. • Latch bolt, latch cam, pre-formed strike-plate and face-plate – made from stainless steel. • Nylon, brass or any parts with a melting point below 850 degrees centigrade are not permitted.
Critical Dimensions	• Modular - compatible with other lockcases 9.1, 9.2, 9.3, 9.5. • 60 – 70mm backset.
Performance	• Reversible latchbolts and strike plate without removing the lockcase cover. • Heavy duty. • Stainless steel countersunk fixing screws are used throughout. • Spring action for handle included in lockcase.
Fire Requirements	All proposed locksets must be suitable for fire doors up to 2 hours fire rating. The Supplier must ensure that their locksets have the necessary test reports certifying their suitability on fire doors supplied by the Contractor.
Variations	V1 – Lockset is suitable for fire doors up to 4 hours fire rating. V2 – Anti thrust bolt function for security. Its position and the hole on the strike plate shall be relatively apart so that should the door sag, the anti-thrust bolt will not engage the strike plate thereby rendering its function ineffective. V3 – Strength required to turn spindle suited to flush cup ring pull. V4 – Modular - compatible with other lockcases 9.1, 9.2, 9.3, 9.5. Combinations - V1&V4, V2&V4, V3&V4.
Examples where it may be used	Non lockable doors.

Name	Nightlatch lockset (Classroom function)
Description	Lockcase with latch activated by lever handles, cylinder locks/releases external handle, including strike-plate and face-plate.
Minimum Standard	EN 1303: 1998, BS 5872:1980 (1995).
Quality	• It shall pass the fire test of BS 476 Part 22. Certificates of compliance shall be submitted. • Loss of tension of springs for latches, push bars or handles are considered a defect.
Materials	• Cases - are to be closed on all sides to protect internal parts and manufactured from galvanised heavy gauge steel. • Follower - 8mm square, made of hardened or stainless steel. • Latch bolt, latch cam, anti-thrust bolt, pre-formed strike-plate and face-plate – made from stainless steel. • Nylon, brass or any parts with a melting point below 850 degrees centigrade are not permitted.
Critical Dimensions	• Compatible with 17mm diameter Europrofile cylinder. • 60 – 70mm backset.
Performance	• Heavy duty. • Anti thrust bolt function for security. Its position and the hole on the strike plate shall be relatively apart so that should the door sag, the anti-thrust bolt will not engage the strike plate thereby rendering its function ineffective. • Reversible latchbolts and strike plate without removing the lockcase cover. • Cases are threaded for securing through bolt. • Stainless steel countersunk fixing screws are used throughout. • Suitable for use with lever handle on both side. • Locking mode can be changed through use of the cylinder. In unlocked mode the door acts as a latch, in locked mode the external lever handle in rendered inoperative. • Spring action for handle included in lockcase.
Fire Requirements	All proposed locksets must be suitable for fire doors up to 2 hours fire rating. The Supplier must ensure that their locksets have the necessary test reports certifying their suitability on fire doors supplied by the Contractor.
Variations	V1 – Lockset is suitable for fire doors up to 4 hours fire rating. V2 – Modular - compatible with other lockcases 9.1, 9.2, 9.3, 9.4. Combinations - V1&V2.
Examples where it may be used	Self locking key operated doors.

Name	Sliding Door Hookbolt Lockset
Description	Lockcase with hookbolt activated by cylinder - including strike-plate and face-plate.
Minimum Standard	EN 1303: 1998, BS 5872:1980 (1995).
Quality	• It shall pass the fire test of BS 476 Part 22. Certificates of compliance shall be submitted.
Materials	• Cases - are to be closed on all sides to protect internal parts and manufactured from galvanised heavy gauge steel. • Pre-formed strike-plate and face-plate – made from stainless steel. • Nylon, brass or any parts with a melting point below 850 degrees centigrade are not permitted.
Critical Dimensions	• Compatible with 17mm diameter Europrofile cylinder.

Performance	• Heavy duty. • Cases are threaded for securing through bolt. • Stainless steel countersunk fixing screws are used throughout. • Suitable for use with pull handle.
Fire Requirements	All proposed locksets must be suitable for fire doors up to 2 hours fire rating. The Supplier must ensure that their locksets have the necessary test reports certifying their suitability on fire doors supplied by the Contractor.
Variations	V1 – Lockset is suitable for fire doors up to 4 hours fire rating.
Examples where it may be used	Sliding Doors.

Name	**Patchlock Lockset**
Description	Lockcase with deadbolt activated by cylinder for mounting on underside of glass doors – includes socket for floor.
Minimum Standard	EN 1303: 1998, BS 5872:1980 (1995).
Quality	• It shall pass the fire test of BS 476 Part 22. Certificates of compliance shall be submitted.
Materials	• Cases - are to be closed on all sides to protect internal parts and manufactured from stainless steel. • Nylon, brass or any parts with a melting point below 850 degrees centigrade are not permitted.
Critical Dimensions	• Compatible with 17mm diameter Europrofile cylinder. • Minimum 20mm throw for dead bolt.
Performance	• Heavy duty. • Suitable for mounting on varieties of glass thickness. • Cases are threaded for securing through bolt. • Stainless steel countersunk fixing screws are used throughout.
Fire Requirements	-
Variations	-
Examples where it may be used	Shop Glass Entrance doors.

Name	**Roller Latch Lockset**
Description	Recessed Roller latch enabling opening by pulling and pushing door. Includes plate for mounting on door frame.
Minimum Standard	-
Quality	-
Materials	Stainless Steel.
Critical Dimensions	-
Performance	Must be capable of adjustment to alter the force required to open and close the door.
Fire Requirements	-
Variations	-
Examples where it may be used	-

Name	**PUB Lockset**
Description	-
Minimum Standard	As required by PUB.
Quality	-
Materials	-

Critical Dimensions	-
Performance	-
Fire Requirements	-
Variations	-
Examples where it may be used	-

Name	**Single Cylinder**
Description	17mm diameter Europrofile Single key access Cylinder with three keys.
Minimum Standard	EN 1303: 1998, ANSI A156.5.
Quality	• Cylinders shall be designed for tensile loading of 12800 Newtons against wrenching and pulling of the plug within the cylinder. • Cylinders shall be provided with 6 or more pins. For added security the cylinder shall possess multi-part construction of the pin mechanism coupled with rotation factor and off centre pin to key alignment features. • The cylinders shall have detainer pins to protect against picking. • Cylinders shall have minimum grades under EN 1303 of ; 5 for durability (50,000 cycles) and 4 for Security.
Materials	Nylon, brass or any parts with a melting point below 850 degrees centigrade are not permitted.
Critical Dimensions	The cylinder shall suit door thickness from 30mm up to a maximum door thickness of 60mm. Exact projection from the door to be subject to the Authorities agreement.
Performance	Each Cylinder has a different key with one masterkey per station.
Fire Requirements	All proposed cylinders must be suitable for fire doors up to 4 hours fire rating. The Supplier must ensure that their cylinders have the necessary test reports certifying their suitability on fire doors supplied by the Contractor.
Variations	V1 - Offset cylinder length to suit offset clad door arrangement with additional thickness to that listed in item 5 on one side of 20mm to 60mm.
Examples where it may be used	Locked access hatches.

Name	**Single Cylinder with Thumb Turn**
Description	17mm diameter Europrofile Cylinder with key access from one side and thumb turn the other. Includes three keys.
Minimum Standard	EN 1303: 1998, ANSI A156.5.
Quality	• Cylinders shall be designed for tensile loading of 12800 Newtons against wrenching and pulling of the plug within the cylinder. • Cylinders shall be provided with 6 or more pins. For added security the cylinder shall possess multi-part construction of the pin mechanism coupled with rotation factor and off centre pin to key alignment features. • The cylinders shall have detainer pins to protect against picking. • Cylinders shall have minimum grades under EN 1303 of ; 5 for durability (50,000 cycles) and 4 for Security.
Materials	Nylon, brass or any parts with a melting point below 850 degrees centigrade are not permitted.
Critical Dimensions	The cylinder shall suit door thickness from 40mm up to a maximum door thickness of 60mm. Exact projection either side of the door to be subject to the Authorities agreement.
Performance	Each Cylinder has a different key with one masterkey per station.

Fire Requirements	All proposed cylinders must be suitable for fire doors up to 4 hours fire rating. The Supplier must ensure that their cylinders have the necessary test reports certifying their suitability on fire doors supplied by the Contractor.
Variations	V1 - Offset cylinder length to suit offset clad door arrangement with additional thickness to that listed in item 5 on one side of 20mm to 60mm. V2 – Thumbturn can only retract and not project deadbolt. Combination – V1/V2.
Examples where it may be used	Normal Doors.

Name	**Double Cylinder**
Description	17mm diameter Europrofile Cylinder with key access from both sides. Includes three keys.
Minimum Standard	EN 1303: 1998, ANSI A156.5.
Quality	• Cylinders shall be designed for tensile loading of 12800 Newtons against wrenching and pulling of the plug within the cylinder. • Cylinders shall be provided with 6 or more pins. For added security the cylinder shall possess multi-part construction of the pin mechanism coupled with rotation factor and off centre pin to key alignment features. • The cylinders shall have detainer pins to protect against picking. • Cylinders shall have minimum grades under EN 1303 of ; 5 for durability (50,000 cycles) and 4 for Security.
Materials	Nylon, brass or any parts with a melting point below 850 degrees centigrade are not permitted.
Critical Dimensions	The cylinder shall suit door thickness from 40mm up to a maximum door thickness of 60mm. Exact projection either side of the door to be subject to the Authorities agreement.
Performance	Each Cylinder has a different key with one masterkey per station. The cylinders shall be capable of being unlocked from either side if another key is already inserted.
Fire Requirements	All proposed cylinders must be suitable for fire doors up to 4 hours fire rating. The Supplier must ensure that their cylinders have the necessary test reports certifying their suitability on fire doors supplied by the Contractor.
Variations	V1 - Offset cylinder length to suit offset clad door arrangement with additional thickness to that listed in item 5 on one side of 20mm to 60mm.
Examples where it may be used	Toilet Doors.

Name	**Lever Handles**
Description	2 Cylindrical unsprung lever handles with return and spindle.
Minimum Standard	EN 1906 : 2002. Unless stated otherwise, handles shall comply with the requirements of the current edition of the Code on Barrier Free Access in Buildings.
Quality	The handle shall be heavy duty and scratch proof.
Materials	Stainless steel handle in satin finish. High tensile Steel Spindle with Zinc and passivate finish.

Critical Dimensions	Handle: • Minimum 65mm from face plate to centre line of handle. • Minimum 110mm from centre line of spindle to centre line of return (130mm length with 20mm diameter). • 20mm Minimum diameter. Spindle: • Length suited to door thickness up to 60mm. • 8mm square thickness.
Performance	Snap on assembly with Allan keys or stainless steel screw from one side only.
Fire Requirements	Suitable for door with fire rating of up to 4 hours.
Variations	V1 – Only one Handle with spindle. V2 – Spindle length customised for door thickness more than 60mm. Combination - V1/V2.
Examples where it may be used	Normal Doors.

Name	**Standard Pull handle**
Description	1 Cylindrical pull handle of minimum 150mm long.
Minimum Standard	EN 1906 : 2002. Unless stated otherwise, handles shall comply with the requirements of the current edition of the Code on Barrier Free Access in Buildings.
Quality	The handle shall be heavy duty and scratch proof.
Materials	Stainless steel handle in satin finish.
Critical Dimensions	Handle: • Minimum 65mm from face plate to centre line of handle. • Minimum 130mm from centre line of two ends. (150mm length with 20mm diamater). • 20mm Minimum diameter.
Performance	No visible fixings on face of door, no escutcheons.
Fire Requirements	Suitable for door with fire rating of up to 4 hours.
Variations	V1 – 300mm long overall V2 – 600mm long overall. V3 – Offset from lockcase by a distance dependent on backsets.
Examples where it may be used	Toilet Doors.

Name	**Plates**
Description	Pair of Standard stainless steel cover plates fixed by counter-sunk screws.
Minimum Standard	-
Quality	• Cut outs for lever handle, pull handle and cylinders to be exact and predrilled in factory. • Counter-sunk screws to be in stainless steel with philips head and fixed in four corners and visible from inside room only. • No on-site cutting of holes is permitted. • Outside plate to be fixed from behind, welding not to leave any visible distortions from the front.
Materials	Stainless Steel, finish to be fine continuous hairline brush with 180 to 240 grit.
Critical Dimensions	Each plate to be 200mm x 200mm x 2.0mm thickness with rounded corners.
Performance	-
Fire Requirements	Suitable for door with fire rating of up to 4 hours.

Variations	V1 – Only one plate -without visible screws. V2 – Only one plate - dimensions to be 100mm width x 200mm height x 2.0mm thickness (for pull handle with no keyhole). V3 – Only one plate - dimensions to be 200mm width x 400mm height x 2.0mm thickness (as push plate).
Examples where it may be used	Normal Doors.

Name	**Flush Cup Ring Pull Handle**
Description	Flush Cup Ring pull handle with spindle.
Minimum Standard	EN 1906 : 2002.
Quality	-
Materials	Stainless steel handle in satin finish. Mild Steel Spindle with Zinc and passivate finish.
Critical Dimensions	Handle: • Maximum protrusion of 15mm from door. • Diameter of fixing between 70 and 100mm. Spindle: • Length suited to door thickness up to 60mm. • 8mm square thickness.
Performance	-
Fire Requirements	Suitable for door with fire rating of up to 2 hours.
Variations	V1 – Spindle length customised for door thickness more than 60mm. V2 – No spindle.
Examples where it may be used	Cladding hatches.

Name	**Panic Push Bar**
Description	Bar extending across width of door for release of latch when pressed inwards in panic situations.
Minimum Standard	• EN 1125 : 1997, EN 179 : 1997.
Quality	• All Panic Hardware shall have a proven efficiency rating after 100,000 test cycles. Test reports to be submitted. • Panic bar shall spring back once released and allow re-latching of the door.
Materials	• All external elements shall be stainless steel. • Internal construction of corrosive resistant steel to give long, trouble free operation. • Nylon, brass or any parts with a melting point below 850 degrees centigrade are not permitted.
Critical Dimensions	• The length of the bar shall be customised for leaf widths between 900mm and 1200 mm in width. • Protrusion of the push bar from the door shall not exceed 90mm. • Push bar shall have minimum diameter of 25mm.

Performance	• All Panic Hardware shall provide easy operation and long life under heavy traffic conditions. • All panic hardware shall be weather proof and rust resistant. • The force required to operate the push bar shall not exceed 67 Newtons. • Internationally recognised photoluminescence signage complying with BS5499 Part 1 1990 (1995) shall be used. • For unlockable doors; panic bar can be used in conjunction with Latch lockset, lever handle (Single – V1) and cover plate (Single - V1). • For lockable doors; panic bar can be used in conjunction with Nightlatch lockset, Single cylinder, pull handle and cover plate (Single V1).
Fire Requirements	All Panic Hardware must be suitable for fire doors up to 2 hours fire rating. The Supplier must ensure that the Panic Hardware has the necessary assessment or test reports certifying their suitability on fire doors supplied by the Contractor.
Variations	V1 – Push bar is suitable for fire doors up to 4 hours fire rating.
Examples where it may be used	Public Escape routes.

Name	**Handicapped Indicator Bolt and lever handle**
Description	Handicapped indicator bolt and lever handle including strike plate to receive bolt.
Minimum Standard	EN 1906 : 2002. Unless stated otherwise, handles shall comply with the requirements of the current edition of the Code on Barrier Free Access in Buildings.
Quality	The handle shall be heavy duty and scratch proof.
Materials	Stainless steel handle in satin finish. Stainless steel indicator bolt.
Critical Dimensions	Lever handle: • Minimum 65mm from face plate to centre line of handle. • Minimum 110mm from centre line of spindle to centre line of return (130mm length with 20mm diameter). • 20mm Minimum diameter. Indicator Bolt: • Suited to door widths upto 50mm thick.
Performance	• Bolt can be activated by pushing lever upwards to vertical position and released by returning lever to horizontal position. • An indicator shall be provided on the outside to reflect occupancy. • A strike plate shall be provided on the door frame to receive the bolt. • Bolt to be capable of release from outside in the event of an emergency.
Fire Requirements	-
Variations	-
Examples where it may be used	Handicapped toilet.

Name	**Electromagnetic Lock**
Description	>
Minimum Standard	>
Quality	>
Materials	>
Critical Dimensions	>
Performance	>
Fire Requirements	>

Variations	V1 - Mounted on pull side of door (bracketry).
Examples where it may be used	>

Name	**Door Contact**
Description	>
Minimum Standard	>
Quality	>
Materials	>
Critical Dimensions	>
Performance	>
Fire Requirements	>
Variations	V1 - Mounted on pull side of door (bracketry).
Examples where it may be used	>

Name	**Electronic bolt**
Description	>.
Minimum Standard	>
Quality	>
Materials	>
Critical Dimensions	>
Performance	>
Fire Requirements	>
Variations	>
Examples where it may be used	>

Name	**Additional Key**
Description	Additional key above the three supplied as standard with each cylinder (Items 9.10, 9.11 or 9.12).
Minimum Standard	EN 1303: 1998, ANSI A156.5.
Quality	• Identical to the original keys for that cylinder.
Materials	-
Critical Dimensions	-
Performance	-
Fire Requirements	-
Variations	-
Examples where it may be used	-

Name	**Escutcheon**
Description	1 Stainless Steel Escutcheon or Rose.
Minimum Standard	-
Quality	• Cut outs for lever handle, pull handle and cylinders to be exact and predrilled in factory. • To be firmly fixed to the door and allow unobstructed movement of any lever handle.
Materials	Stainless Steel, finish to be fine continuous hairline brush with 180 to 240 grit.

Critical Dimensions	50mm Diameter.
Performance	-
Fire Requirements	Suitable for door with fire rating of up to 4 hours.
Variations	-
Examples where it may be used	Alternative to plates.

Name	**>**
Description	>
Minimum Standard	>
Quality	>
Materials	>-
Critical Dimensions	>
Performance	>
Fire Requirements	>
Variations	>
Examples where it may be used	>

182.4.5 DOOR CONTROLLERS

General

Door controllers specified generically: Provide door controllers, including door closers, door selectors and floor or head spring pivots, which are suitable for the door type, size, and weight, the door swings required and the operating conditions, including wind pressure.

Name	**Door Closer (DC)**
Description	Surface mounted door closers.
Minimum Standard	EN 1154:1997.
Quality	A proven efficiency rating after 500,000 cycles (Grade 8 of EN standards). Test report to be submitted.
Materials	Arms shall be solid forged metal. Hydraulic fluid shall be able to withstand extreme temperatures and be non-combustible.
Critical Dimensions	-
Performance	• Able to operate door leafs of up to 80kg in weight and between 750 and 1100mm in Width. EN Standard Adjustable between Grade 2 and 4 test door mass. • Maximum opening of 180°. • Be designed and installed to prevent damage to adjacent walls. • Have an adjustable latching force, including at least 30Nm, to ensure that the door is properly closed and latched. • A back-check feature to prevent the door handle from hitting the adjacent wall operational from 85° to 180°. • Be totally reversible without adjustment. • Include Power adjustment. • A Delayed closing: Operational from 85° to 180°. • Speed adjustable so that closing time between 90° and 12° can take more than 3 seconds. • Include a pressure relief valve to prevent oil leakage and damage to the back check valve.

Fire Requirements	General: Provide closers tested and certified for use as components of fire door assemblies. Standard: To BS EN 1154: 1997 and Certifire approved.
Variations	V1 - Able to operate door leafs of up to 100kg in weight and 1250mm in width. . EN Standard test door mass Grade 5. V2 - Able to operate door leafs of up to 120kg in weight and 1400mm in width. EN Standard test door mass Grade 6. V3 - Able to operate door leafs of up to 160kg in weight and 1550mm in width. EN Standard test door mass Grade 7. V4 - Able to operate door leafs less than 750mm in width. V5 – Modified for push side fixing for opening into public areas: parallel arm for rack and pinion, slide arm fixing to door for cam action, or other alternative. V6 – Able to close and latch door leafs under pressure of up to 400 Pascal's acting against the motion of the closer and suitable for doors up to 4 hours fire rating. V7 - Door fitted with closer can be pushed or pulled open with a maximum force of 22N during the full arc of opening the door(For doors used by public). V8 – Suitable for doors up to 4 hours fire rating. Combinations :V1/V5, V2/V5, V4/V5, V6/V5, V7/V5, V1/V6, V2/V6, V3/V6, V1/V8, V2/V8, V3/V8, V4/V8, V5/V8.
Examples where it may be used	All Fire rated doors (Not on inactive leaf of equipment access doors).

Name	**Floor Spring (FS)**
Description	floor flush mounted closers.
Minimum Standard	EN 1154:1997.
Quality	• A proven efficiency rating after 500,000 cycles (Grade 8 of EN standards).. Test report to be submitted.
Materials	Hydraulic fluid shall be able to withstand extreme temperatures and be non-combustible.
Critical Dimensions	-
Performance	• Be available in with varying closing forces up to 25NM. • Be suitable for doors up to 120kg : EN Standard Adjustable between Grade 2 and 6 test door mass, and suitable for glass doors. • Be available with interchangeable spindle from 5mm to 50mm. • Be provided with pressure relief valve to prevent overloading and oil leaking . • Be of a depth of not more than 60mm. The Supplier shall work with the Contractor to ensure that the floor spring is flush with the surrounding floor finish. • Maximum opening of 180°. • Be designed and installed to prevent damage to adjacent walls. • Have an adjustable latching force to ensure that the door is properly closed and latched. • A back-check feature to prevent the door handle from hitting the adjacent wall operational from 85° to 180°. • A Delayed closing: Operational from 85° to 180°. • Speed adjustable so that closing time between 90° and 12° can take more than 3 seconds.
Fire Requirements	Suitable for fire doors with up to 2 hours fire rating.

Variations	V1 – Provided with a hold open of 90 degrees and a delayed closing of up to 45 seconds. V2 – Suitable for doors up to 4 hours fire rating. V3 – Suitable for doors up to 250kg in weight, EN Standard test door mass Grade 9. V4 – Able to close and latch door leafs under pressure of up to 400 Pascal's acting against the motion of the closer and suitable for doors up to 4 hours fire rating. V5 – Able to close and latch door leafs under pressure of up to 1200 Pascal's acting against the motion of the closer and suitable for doors up to 4 hours fire rating. Combinations : V2/V3, V3/V4.
Examples where it may be used	Clad doors, Glass doors.

Name	**Recessed Door Selector (DS)**
Description	Door selector recessed into frame header.
Minimum Standard	EN 1158:1997.
Quality	• Be of stainless steel finish. • Have a proven efficiency rating after 50,000 cycles (Grade 5 of EN standards). Test report to be submitted. • Use arms that are shock absorbing.
Materials	-
Critical Dimensions	-
Performance	• Able to operate door leafs of up to 80kg in weight and between 750 and 1100mm in Width.
Fire Requirements	Suitable for fire doors with up to 2 hours fire rating.
Variations	V1 - Able to operate door leafs of up to 120kg in weight and 1400mm in width. EN Standard test door mass Grade 6. V2 – Suitable for doors up to 4 hours fire rating. Combinations : V1/V2.
Examples where it may be used	All Fire rated public escape doors.

Name	**Electrically Operated Hold-open**
Description	Electrical Flush mounted floor spring.
Minimum Standard	EN 1155:1997.
Quality	A proven efficiency rating after 50,000 cycles (Grade 5 of EN standards). Test report to be submitted.
Materials	-
Critical Dimensions	-

Performance	• Adjustable Electrical hold open angle from 85° to180°. • Able to operate door leafs of up to 100kg in weight and between 950 and 1250mm in Width. EN Standard Adjustable between Grade 3 and 5 test door mass. • Maximum opening of 180°. • Be designed and installed to prevent damage to adjacent walls. • Have an adjustable latching force to ensure that the door is properly closed and latched. • A back-check feature to prevent the door handle from hitting the adjacent wall operational from 85° to 180°. • Include Power adjustment for leaf widths between 750mm and 1250mm. • A Delayed closing: Operational from 85° to 180°. • Automatic release on receipt of a signal from a central fire alarm so that the door properly closes. • Automatic release if physically pushed, if test button is pressed or if power fails.
Fire Requirements	Suitable for fire doors with up to 2 hours fire rating.
Variations	V1 - A Surface mounted hydraulic door closers.
Examples where it may be used	Smoke stop lobby doors in public access routes.

Name	**Automatic Electrical Door Operators**
Description	Complete automatic door operators for opening and closing doors, including door hanging (hinges, pivots or sliding gear) and electrical connection to distribution board. Operation mode: >\ Electric locking: >\ Access key switch: >\ Power failure: >\ Manually adjustable function: >\ Automatic activation options: >\
Minimum Standard	
Quality	• A proven efficiency rating after 200,000 cycles (Grade 7 of EN standards).. Test report to be submitted. • Installation: Provide necessary recesses and cores, grout in components where required, and make good. Provide cover plates for access to units in door heads, frames or transoms. • Automatic adjustable function: If the door opening angle or width is manually set below the maximum possible, under conditions of continuous traffic the doors must automatically creep to full opening, returning to reduced opening on the next cycle.
Materials	-
Critical Dimensions	-

Performance	• Automatic opening to 90° with adjustable delayed closing. • Opening via sensors placed on either side of the door or from receipt of a central signal. • Fail safe in the open position. • Able to operate door leafs of up to 80kg in weight and between 750 and 1100mm in Width. EN Standard Adjustable between Grade 2 and 4 test door mass. • Be designed and installed to prevent damage to adjacent walls. • Include Power adjustment for leaf widths between 750mm and 1100mm. • A Delayed adjustable closing time. • Automatic opening on receipt of a signal from a central fire alarm so that the door opens fully. • Automatic opening if physically pushed, if test button is pressed or if power fails.
Fire Requirements	Suitable for fire doors with up to 2 hours fire rating.
Variations	V1 - Includes full installation (closing devise and double swing door).
Examples where it may be used	Air-con separation doors, entrance doors.

Name	**Outward Facing Door Selector (DS)**
Description	Door selector device fixed to front face of frame and includes connectors to the door. May drop down under gravity or spring outwards upon opening of door.
Minimum Standard	EN 1158:1997.
Quality	• Have a proven efficiency rating after 50,000 cycles (Grade 5 of EN standards). Test report to be submitted. • Use arms that are shock absorbing.
Materials	-
Critical Dimensions	-
Performance	• Able to operate door leafs of up to 80kg in weight and between 750 and 1100mm in width.
Fire Requirements	Suitable for fire doors with up to 2 hours fire rating.
Variations	V1 - Able to operate door leafs of up to 120kg in weight and 1400mm in width. EN Standard test door mass Grade 6. V2 – Suitable for doors up to 4 hours fire rating. Combinations : V1/V2.
Examples where it may be used	All Fire rated public escape doors.

Name	**Standard Arm Door Selector (DS)**
Description	Standard arm with roller fixed below frame header.
Minimum Standard	EN 1158:1997.
Quality	• Be of stainless steel finish. • Have a proven efficiency rating after 50,000 cycles (Grade 5 of EN standards). Test report to be submitted. • Be approved under the appropriate Singapore Productivity and Standards Board (PSB) Label Scheme. • Use arms that are shock absorbing.
Materials	-
Critical Dimensions	-
Performance	• Able to operate door leafs of up to 80kg in weight and between 750 and 1100mm in width.

Fire Requirements	Suitable for fire doors with up to 2 hours fire rating.
Variations	V1 - Able to operate door leafs of up to 120kg in weight and 1400mm in width. EN Standard test door mass Grade 6. V2 – Suitable for doors up to 4 hours fire rating. Combinations : V1/V2.
Examples where it may be used	All Fire rated public escape doors.

Name	**Integrated Door Selector (DS)**
Description	Integrated selector for use with slide arm closer if proposed.
Minimum Standard	EN 1158:1997.
Quality	• Be of stainless steel finish. • Have a proven efficiency rating after 500,000 cycles (Grade 8 of EN standards). Test report to be submitted.
Materials	-
Critical Dimensions	-
Performance	• Able to operate door leafs of up to 80kg in weight and between 750 and 1100mm in width.
Fire Requirements	Suitable for fire doors with up to 2 hours fire rating.
Variations	V1 - Able to operate door leafs of up to 140kg in weight and 1400mm in width. EN Standard test door mass Grade 6. V2 – Suitable for doors up to 4 hours fire rating. Combinations : V1/V2.
Examples where it may be used	All Fire rated public escape doors.

Name	**>**
Description	>
Minimum Standard	>
Quality	>
Materials	>-
Critical Dimensions	>
Performance	>
Fire Requirements	>
Variations	>
Examples where it may be used	>

182.4.6 DOOR BOLTS

General

Bolting Hardware : Set code to be defined by the designer to cover all variants of performance requirements and door details. Items included within these sets are outlined below. Any additional items to be highlighted to the Authority.

Name	**Surface Mounted Bolt**
Description	Bolt including bolt receiver for securing door/hatch to frame.
Minimum Standard	EN 12051 : 1999.
Quality	• Minimum Grade 2 of 'Category of use' under the EN standard. • Have a proven efficiency rating after 10,000 cycles (Grade 3 of EN standards). Test report to be submitted.
Materials	Stainless steel.

Critical Dimensions	Bolt shall have a throw of 20mm and minimum diameter of 8mm.
Performance	• Exact type of receiver shall be co-ordinated with the Contractor to suit the frame. • Capable of operating with a side load of 250 N, and also after a side load of 1000 N has been applied (safety in use Grade 1 of EN standard). • Resistance to end load of 3000N and side load of 4500N (Security Grade 3 of EN standard).
Fire Requirements	-
Variations	-
Examples where it may be used	Hatches to outside of room.

Name	**Flush Bolt**
Description	Concealed bolt recessed at door edge.
Minimum Standard	EN 12051 : 1999.
Quality	• All fixings shall be concealed. • Minimum Grade 2 of 'Category of use' under the EN standard. • Have a proven efficiency rating after 10,000 cycles (Grade 3 of EN standards). Test report to be submitted.
Materials	Stainless steel.
Critical Dimensions	Bolt length of 300mm. Bolt shall have a throw of 20mm and minimum diameter of 8mm.
Performance	• Bolt shall be flush and lever action with dovetail returns to resist forcing and/or frame damage. • Capable of operating with a side load of 250 N, and also after a side load of 1000 N has been applied (safety in use Grade 1 of EN standard). • Resistance to end load of 3000N and side load of 4500N (Security Grade 3 of EN standard).
Fire Requirements	Suitable for doors up to 4 hours fire rating.
Variations	V1 – Increased bolt length to 600mm for doors between 2200mm and 2550mm in height. V2 – Increased bolt length to 1000mm for doors above 2550mm in height.
Examples where it may be used	All inactive leaves.

Name	**Easy Clean Socket**
Description	Socket for receive bolt.
Minimum Standard	-
Quality	-
Materials	Stainless Steel.
Critical Dimensions	Able to take Bolt with throw of 20mm and diameter of 12mm.
Performance	Curved to allow easy cleaning.
Fire Requirements	-
Variations	-
Examples where it may be used	For receiving flush bolt.

Name	**Dust Proof Strike**
Description	Socket for receiving bolt with spring loaded cover.
Minimum Standard	-

Quality	-
Materials	Stainless steel.
Critical Dimensions	Able to take Bolt with throw of 20mm and diameter of 12mm.
Performance	-
Fire Requirements	-
Variations	-
Examples where it may be used	For receiving flush bolt.

Name	**Automatic Flush Bolt**
Description	Concealed bolt recessed at door edge, releases upon active leaf opening.
Minimum Standard	EN 12051 : 1999.
Quality	• All fixings shall be concealed. • Minimum Grade 2 of 'Category of use' under the EN standard. • Have a proven efficiency rating after 10,000 cycles (Grade 3 of EN standards). Test report to be submitted.
Materials	Stainless steel.
Critical Dimensions	Bolt shall have a throw of 20mm and minimum diameter of 8mm.
Performance	• Capable of operating with a side load of 250 N, and also after a side load of 1000 N has been applied (safety in use Grade 1 of EN standard). • Resistance to end load of 3000N and side load of 4500N (Security Grade 3 of EN standard).
Fire Requirements	Suitable for doors up to 4 hours fire rating.
Variations	-
Examples where it may be used	For double doors on public escape routes.

Name	**>**
Description	>
Minimum Standard	>
Quality	>
Materials	>-
Critical Dimensions	>
Performance	>
Fire Requirements	>
Variations	>
Examples where it may be used	>

182.4.7 ACCESSORIES

Name	**Door/Wall Stops**
Description	Rubber stops mounted to wall or door to prevent door hitting obstruction.
Minimum Standard	
Quality	
Materials	Stainless steel and Rubber.
Critical Dimensions	They shall be approximately 75mm long and diameter no less than 10mm.

Performance	• They shall have a rubber buffer at its tip which cannot be easily removed. • Door stop shall have concealed fixing. • Capable of being mounted on either wall or door.
Fire Requirements	-
Variations	-
Guidance on use	Where the door or its ironmongery would hit an obstruction if opened beyond 170 degrees. Alternative use of floor stop.

Name	**Floor Stops**
Description	Rubber stops mounted to floor to prevent door hitting obstruction.
Minimum Standard	
Quality	
Materials	Stainless steel and Rubber.
Critical Dimensions	They shall be approximately 40mm long and diameter no less than 40mm.
Performance	• They shall have a rubber buffer around the top which cannot be easily removed. • Floor stops shall be provided with expandable bolts 70mm long x 8mm in diameter. • Floor stop mounting shall be concealed under the floor stop.
Fire Requirements	
Variations	
Guidance on use	Where the door or its ironmongery would hit an obstruction if opened beyond 170 degrees. Alternative use of wall/door stop.

Name	**CD Hold Open Lock**
Description	Deadlock mounted on bottom of door with bolt for holding door open.
Minimum Standard	EN 1303 : 1998, BS 5872 : 1980.
Quality	• It shall pass the fire test of BS 476 Part 22. Certificates of compliance shall be submitted.
Materials	• Cases - are to be closed on all sides to protect internal parts and manufactured from galvanised heavy gauge steel. • Pre-formed strike-plate and face-plate – made from stainless steel. • Nylon, brass or any parts with a melting point below 850 degrees centigrade are not permitted.
Critical Dimensions	• Minimum 20mm throw for dead bolt.
Performance	• Includes easy clean socket for receiving bolt in the floor. • Includes simple cylinder (not necessarily under master-keying system) all with the same locking. • Heavy duty. • Cases are threaded for securing through bolt. • Stainless steel countersunk fixing screws are used throughout.
Fire Requirements	All proposed locksets must be suitable for fire doors up to 2 hours fire rating. The Supplier must ensure that their locksets have the necessary assessment or test reports certifying their suitability on fire doors supplied by the Contractor.
Variations	V1 – Lockset is suitable for fire doors up to 4 hours fire rating.
Guidance on use	CD ventilation routes.

Name	**Padlock**
Description	Padlock.
Minimum Standard	EN 12320 : 2001.

Quality	The core pins shall be made of resistant hardened bronze and it shall have detainer pins to protect against picking.
Materials	Solid stainless steel body and shall be weatherproof and rust resistant.
Critical Dimensions	Shackle clearance shall be no less than 60mm height and 35mm wide.
Performance	• Padlock shall be suited under the same masterkey system with a minimum of 6 tumbler pins. • All padlocks to be delivered directly to the Authority. • Security Grade 4 (according to EN standard).
Fire Requirements	-
Variations	-
Examples where it may be used	-

Name	**Hasp and Staple**
Description	Stainless steel loop and retainer for fixing padlock across doors.
Minimum Standard	EN 12320 : 2001.
Quality	-
Materials	Stainless Steel.
Critical Dimensions	Able to take standard padlock.
Performance	• Fixed to door with countersunk stainless steel screws. Hasp to return over screws to render them inaccessible in the closed position. • Security Grade 4 (according to EN standard).
Fire Requirements	-
Variations	-
Examples where it may be used	-

Name	**Kick Plates**
Description	Stainless steel Kick plate fixed by counter-sunk stainless steel screws.
Minimum Standard	-
Quality	• No on-site cutting of holes is permitted. • Counter-sunk screws to be located as required to hold kick plate tight against door.
Materials	Stainless Steel, finish to be fine continuous hairline brush with 180 to 240 grit.
Critical Dimensions	Each plate to be 200 high and 2.0mm thickness with rounded corners. Length to be 20mm less than the visible width of the door in the closed position. Length to suit leaf width which varies between 900 and 1200mm.
Performance	-
Fire Requirements	Suitable for door with fire rating of up to 4 hours.
Variations	-
Guidance on use	On push side of well used active leaves only (corridors and staff rooms).

182.5 EXECUTION

182.5.1 INSTALLATION

Fixings

General: Provide materials compatible with the item being fixed, matching where exposed, and of sufficient strength, size and quality to perform their function. Provide a corrosion resistant finish to concealed fixings, and match exposed fixings to the material fixed.

Support: Provide appropriate back support (for example lock stiles, blocking, wall noggings and backing plates) for hardware fixings.

- Hollow metal sections: Provide backing plates drilled and tapped for screw fixing, or provide rivet nuts with machine thread screws, not self tapping screws or pop rivets.

Security: Locate exposed fixings to lock furniture on the inside faces of external doors and on the inside faces of internal doors to lockable rooms.

Window hardware

Proprietary window systems: Provide stainless steel hardware and internal fixing points for personnel safety harness attachment, where required by and complying with the governing regulations.

Door hardware

Mounting heights: Mount locks and latches so that the centreline of the door knob or lever spindle is 1000 mm above finished floor.

Hinges

Timber doorsets: Install butt hinges in housings equal in depth to the thickness of the hinge leaf (except for hinges designed for mounting without housing), and fix with countersunk screws.

Metal frames: Fix hinges using metal thread screws.

Floor springs

Form a recess in the floor slab for the floor spring box and grout the box in place so that the cover plate is flush with the finished floor.

182.6 COMPLETION

182.6.1 COMPLETION

General

Cross refer: Item 20.5 'Completion' of the General Requirements.

Protection

On or before completion of the works remove all materials used as a means of protection.

Protect all hardware items on site from damage until handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

Damage

Replace damaged items with new.

Product warranties

Warrant the materials and workmanship using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

General: Submit the warranties offered by the manufacturer for the hardware items used in the works.

In the event that defects are encountered after installation: Rectifying/repairing/replacing the defective item to be undertaken by the Supplier including all labour.

Record documents

Door hardware schedule: Submit an amended schedule, prepared by the door hardware supplier, showing changes to the contract door hardware schedule caused by

- the approval of a hardware sample;
- the acceptance of an equivalent to a specified proprietary item; or
- a contract variation to a door hardware requirement.

Key codes: Submit the lock manufacturer's record of the key coding system showing each lock type, number and type of key supplied, key number for re-ordering, and name of supplier.

Operation and Maintenance Manual

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements.

Keys

Contractor's keys: Immediately before practical completion, replace cylinders to which the contractor has had key access during construction with new cylinders which exclude the contractor's keys.

Keys: For locks keyed to differ and locks keyed alike, verify quantities against key records, and deliver to the contract administrator at practical completion.

Great grandmaster, grandmaster and master keys: Arrange for the manufacturer or supplier to deliver direct to >.

Adjustment

General: Leave the hardware properly adjusted with working parts in working order, and clean, undamaged, properly adjusted, and lubricated where appropriate.

Automatic door operators: Maintain and adjust the system throughout the defects liability period.

Maintenance

Automatic door operators: Submit the installer's proposal for continuing maintenance after completion on an annual renewal basis.

190 LOUVRES

190.1 GENERAL

190.1.1 CROSS REFERENCES

Conform to the General Requirements worksection.

Related worksections

Conform to associated worksections as follows: Metals and Prefinishes.
Adhesives, Sealants and Fasteners.

190.1.2 STANDARD

>

190.1.3 INTERPRETATION

Definitions

Tests: See General Requirements for definitions of test types.

190.1.4 DESIGN

Drawings

Contract drawings show generic design principles and design intent only.

Building structure

Expected amounts of differential movements:

Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

190.1.5 PERFORMANCE

Serviceability

Design wind pressure (Pa) (minimum): Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

Water penetration resistance test pressure (Pa) (minimum): To match design wind pressure.

Pressure drop performance requirements (E&M): >

190.2 QUALITY

190.2.1 INSPECTION

Witness points

Give sufficient notice so that inspection may be made at the following stages:

- Fabricated louvre assemblies at the factory ready for delivery to the site.
- Fabricated louvre assemblies delivered to the site, before installation.
- Openings prepared to receive louvres prior to commencement of louvre installation.
- Joints prior to sealing.

Hold points

- Completion of design prototype louvres
- Prototype tests as identified by the Engineer.
- Completion of the confirmation prototype louvre on site.

>

Corrosion

Cross refer: General Requirements Clause 20.4.1.

190.2.2 TESTS

General

Carry out all tests in accordance with Section 20.3.2 of the General Requirements.

Site tests

General: Test louvre assemblies delivered to the site for inclusion in the works, in the ratios given in the **Site tests table** for each louvre type specified.

Site testing:

- Required for the following louvre types >
- As identified on site by the Engineer.

Site tests table

Area of louvre assembly type to be supplied to the works	Minimum number of site tests
< 50 m^2	1
50 – 150 m^2	2
150 – 450 m^2	3
450 – 1000 m^2	4
> 1000 m^2	1 per 250 m^2

Louvre test schedule

Louvre designation	Required tests
>	>
>	>
>	>

Louvre test parameters schedule

Test	Parameter
Superimposed wind loading: At least (Pa)	>
Static loading: Equivalent to a wind load of (km/h)	>
Water penetration: Ensure that water does not penetrate the system when directed - towards it at the rate of (L/s.m^2)	>
- in an airstream moving at (m/s)	>

Louvre noise parameters schedule

Louvre designation	Location	Parameter
>	>	>
>	>	>
>	>	>
>	>	>

Louvre pressure drop parameters schedule

Louvre designation	Location	Parameter
>	>	>
>	>	>
>	>	>
>	>	>

Security grilles test

Type test: To AS/NZS 4604 Appendix E.

190.2.3 SAMPLES

General

Submit samples of the following in accordance with Section 20.3.4 ‘Samples’, of the General Requirements.

- Sections proposed to be used for frames, louvres and slats.
- Joints made by proposed techniques.
- Colour samples of prefinished production material (e.g. anodised or organic coated extrusions and sheet) showing the limits of the range of variation in the selected colour.

- Accessory and hardware items specified descriptively or by performance (i.e. not specified as proprietary items) including, but not limited to, anchor brackets and attachments, and masonry anchors.

190.2.4 PROTOTYPES

General

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

Design Prototype

Construct design prototypes of the following louvres:

>

>

Confirmation Prototype

General: Install designated louvre assemblies in their final position incorporating at least one example of each component in the system.

Samples in prototypes: Required samples may form part of prototypes.

Prototypes: >

- Designated louvre assemblies: >

Retain all prototype panels until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

190.2.5 SUBMISSIONS

General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

Subcontractors

Submit names and contact details of proposed manufacturers and installers.

Shop drawings

General: Submit shop drawings in accordance with Section 20.3.6, 'submissions' of the General Requirements.

Submit shop drawings showing, but not limited to, the following information:

- General arrangement plans, sections and elevations identifying all louvre types and showing their location.
- Layout (sectional plan and elevation) of each louvre assembly.
- Full size sections of members.
- Methods of assembly.
- Methods of installation, including fixing, caulking and flashing.
- Interfaces with adjacent materials and surfaces.
- Provision for vertical and horizontal expansion.
- Hardware, fittings and accessories.

No. of copies to be submitted: As Particular Specification.

Tests

Submit copies of current test reports, and certification, including drawings of tested details, in accordance with Section 20.3.2, 'Tests' of the General Requirements.

No of copies to be submitted: 3.

Engineering endorsement

Submit calculations and drawings from a Singapore licensed Professional Engineer concurrently with the shop drawings and showing, but not limited to, the following:-

Compliance with all relevant Singapore legislation and regulations.

Manufacturers' information

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

Method Statement
Submit method statements in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

190.3 MATERIALS AND FINISHES

190.3.1 General

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

190.3.2 MATERIALS

General
Cross refer:
- Metals and Prefinishes.
- Adhesives, Sealants and Fasteners.

Flashings
Standard: To AS/NZS 2904.

Materials: Provide flashings and weatherings which are corrosion resistant, compatible with the other materials in the installation, and coated with a non-staining compound where necessary.

Fasteners
All fastenings shall be appropriate to the work, shall transmit all imposed loads and stresses, and shall ensure the structural integrity of the louvre assemblies.

Stainless steel grade: 316.

No visible fixings will be acceptable.

190.3.3 FINISHES

Louvre finishes schedules

Element or part	Type or location			
	L1	L2	L3	L4
Frame				
Anodising	>	>	>	>
Surface texture	>	>	>	>
Colour	>	>	>	>
Thickness grade	>	>	>	>
Material	>	>	>	>
Powder coating	>	>	>	>
Colour	>	>	>	>
Type	>	>	>	>
Blade				
Anodising	>	>	>	>
Surface texture	>	>	>	>
Colour	>	>	>	>
Thickness grade	>	>	>	>
Material	>	>	>	>
Powder coating	>	>	>	>
Colour	>	>	>	>
Type	>	>	>	>

190.4 COMPONENTS

190.4.1 LOUVRE ASSEMBLIES

General

Mount louvre blades in a metal surround frame or subframe.

Ensure entire assembly is able to withstand the design wind pressure for that location without failure or permanent distortion of members, and without blade flutter.

Expansion joints

Provide for expansion and contraction in continuous sections (e.g. continuous louvres, interlocking mullions) at spacings not exceeding those recommended by the manufacturer, or 6 m, whichever is the lesser.

Louvre blades

Provide metal louvre blades mounted in a metal surround frame or subframe.

Louvre arrangement:

- Horizontal: Louvres span between frame stiles or mullions.
- Continuous horizontal: Louvres run continuously past, and are supported by, concealed mullions.
- Vertical: Louvres span between frame heads and sills.

Frames

Include the necessary sills, jambs, mullions, transoms, internal and external corners, beads, brackets, anchors, straps and accessories.

Adjustable louvres

Provide louvre blades clipped into blade holders pivoted to stiles or coupling mullions, linked together in banks, each bank operated by an operating handle incorporating a latching device, or by a locking bar.

Installation: Screw fix the main frame to the building structure with stainless steel screws or masonry anchors of the type recommended by the louvre manufacturer. Provide weather strips to heads and sills.

Framed adjustable louvres

Type: Louvre blades beaded into steel blade surround frames (sash) pivoted to pressed steel main frames, linked together in banks, each bank controlled by a proprietary sash operator.

Installation: Screw fix the main frame to the building structure with stainless steel screws or masonry anchors of the type recommended by the louvre manufacturer.

Louvre materials schedule

Louvre designation			>		
Component	Material	Finish	Type	Size (mm)	Thickness (mm)
Stiles and mullions	>	>	>	>	>
Accessories	>	>	>	>	>
Frame	>	>	>	>	>
Blade	>	>	>	>	>
Holding clips	>	>	>	>	>

Louvre assemblies schedule

Louvre designation	L1	L2	L3	L4
Louvre arrangement	>	>	>	>
Pitch	>	>	>	>
Accessories	>	>	>	>
Method of operation	>	>	>	>
Minimum free area (mm^2)	>	>	>	>
Overall size (mm)	>	>	>	>
Pressure drop	>	>	>	>

190.4.2 LOUVRED SUNSCREENS

Type

General: A fixed louvre system comprising

- prefinished profiled metal louvres attached with proprietary concealed fixings to a supporting substructure;
- a substructure of brackets, frames and carrier members, mechanically fastened to the building structure; and
- accessories and fixings necessary to complete the installation.

Designation	LS1	LS2	LS3	LS4
Louvres				
Type	>	>	>	>
Material	>	>	>	>
Prefinish	>	>	>	>
Colour	>	>	>	>
Support Structure				
Material	>	>	>	>
Finish	>	>	>	>

190.4.3 INSECT SCREENS

Frame

General: Provide aluminium extruded or folded box frame sections with mesh fixing channel, mitred, staked and screwed at corners.

Mesh

Material: vinyl-coated fibreglass yarn, non combustible, and will not stretch, shrink or stain.

Finish: no metallic glare.

Mesh size: 18 x 14 (71 x 55 per 10 cm).

Mesh weight: 100 gsm.

Yarn thickness: 0.275 mm.

Bead the mesh into the frame channel with a continuous resilient gasket, so that the mesh is taut and without distortion.

Fixed screens

Attach fixed screens to the frames with a clipping device which permits removal for cleaning.

Sliding screens

Separate screens: Provide matching aluminium head guide, sill runner, and frame stile sections for screens not part of the louvre frame.

Hardware: Nylon slide runners and finger pull handle. Provide pile strip closers against sash where necessary to close gaps.

Hinged screens

Hinges: Hinge at the top to give access to opening sash.

Hardware: Spring catch and handle at bottom.

Insect screens schedule

Louvre designation	Frame material	Frame finish	Insect mesh
L1	>	>	>
L2	>	>	>
L3	>	>	>
L4			

190.4.4 BIRD MESH SCREENS

Frame

Provide aluminium extruded or folded box frame sections with mesh fixing channel, mitred, staked and screwed at corners.

Mesh

Material: grade 316 stainless steel.

Mesh size: 19mm x 19mm maximum: 12mm x 12mm minimum.

Bead the mesh into the frame channel with a continuous resilient gasket, so that the mesh is taut and without distortion.

Bird mesh screens schedule

Louvre designation	Frame material	Frame finish	Bird mesh
L1	>	>	>
L2	>	>	>
L3	>	>	>
L4			

190.5 EXECUTION

190.5.1 CONSTRUCTION GENERALLY

Standards

>

Installers

Have louvres installed by their manufacturer or by a subcontractor recommended by the manufacturer.

Protection

Removal: Remove temporary protection measures from the following:

- Contact mating surfaces before joining up.

Installation

Install louvres so that the frames

- are plumb, level, straight and true within building tolerances accepted by the Engineer
- are adequately fixed or anchored to the building structure.
- will not carry any building loads, including loads caused by structural deflection or shortening.

Install the louvres and frames to resist unauthorised removal.

Joints

General: Make accurately fitted tight joints so that neither fasteners nor fixing devices such as pins, screws, adhesives and pressure indentations are visible on exposed surfaces.

Sealants: If priming is recommended, prime surfaces in contact with jointing materials.

Operation

Ensure moving parts operate freely and smoothly, without binding or sticking, at correct tensions or operating forces and that they are lubricated where appropriate.

Trim

General: Provide mouldings, architraves, reveal linings, and other internal trim as shown on the drawings. Install to make neat and clean junctions between frames and the adjoining building surfaces.

Flashing and weatherings

Install flashings, weather bars, drips, caulking and pointing so that water is prevented from penetrating between louvre frame and the building structure under the prevailing service conditions, including normal structural movement of the building.

Fixing

Packing: Pack behind fixing points with durable full width packing.

Fasteners: Conceal fasteners.

Fastener spacing (nominal): 600 mm.

Installation method schedule

Louvre designation	Installation method
L1	>
L2	>
L3	>
L4	>

190.6 COMPLETION

190.6.1 COMPLETION

General

Cross refer: Item 20.5 'Completion' of the General Requirements.

Operation and Maintenance Manual

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements.

Protection

Protect all louvres on site from damage until handover.

Damaged louvres will not be accepted.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

Remove temporary protection measures.

Damage

Replace damaged items with new.

Warranties

Warrant the materials and workmanship using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

Submit the louvre manufacturer's published product warranties.

Warrant all materials and workmanship against all defects including, but not limited to, corrosion, leaks, discolouration, coating failures and surface blemishes.

Record drawings

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

200 INTERNAL CLADDING

200.1 GENERAL

200.1.1 CROSS REFERENCES

General

Conform to the General Requirements worksection.

Related worksections

Conform to associated worksections as follows:

Vitreous Enamel Panels.
Adhesives, Sealants and Fastenings.
Metals and Pre-finishes.
Glass Reinforced Gypsum.
Partitions.
>

200.1.2 CIVIL DEFENCE (CD) REQUIREMENTS

General

Where stations are identified as having Civil Defence (CD) requirements, refer to the CD Design Criteria for requirements and information relating to the upgrading of materials, material thicknesses, composition and fixing methods for CD stations.

200.1.3 EQUIPOTENTIAL BONDING REQUIREMENTS (EPB)

Cross Refer: Section 20.2.7 'Design' of the General Requirements.

200.1.4 TOUCH VOLTAGE PROTECTION

Cross Refer: Section 20.2.7 'Design' of the General Requirements.

200.1.5 INTERPRETATION

Fixing: the term 'fixings' shall be taken to mean:-

Supporting fixings that transfer the dead and imposed loads on the cladding to the structure. Supports may also include a restraint function.

200.1.6 DESIGN

Drawings

Contract drawings show generic design principles and design intent only.

200.2 QUALITY

200.2.1 INSPECTION

Witness points

Give sufficient notice so that inspection may be made at the following stages:

- Completion of the support framing.
- Unfixed proprietary cladding panels on arrival on site.
- Cladding prior to the sealing of joints.

Hold points

- Completion of all prototypes.

Corrosion

Cross refer: General Requirements Clause 20.4.1.

200.2.2 TESTS

Carry out all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

Steel based cladding

- 1,000 hour intermittent salt spray test to ASTM B117-02. Pass criteria, no visible changes.

Sandwich Panels

- To ASTM C 481-62 'Standard Test Method for Laboratory Aging of Sandwich Constructions.

200.2.3 SAMPLES

General

Submit samples of each of the following in accordance with Section 20.3.4 'Samples', of the General Requirements.

- Each pre-finished cladding material used to show the extent of colour variation.
- Each type of cladding panel showing proposed edge and jointing details.
- The support structure.
- All accessories and fixings.
- All jointing materials.
- >

Size of samples

- Sample panels: minimum 600mm sq.
- Panels showing jointing techniques 1.0m sq.
- Linear samples : minimum 600mm.

No of samples: 3.

200.2.4 PROTOTYPES

General

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

Design Prototype

Cross refer; General Requirements.

Location:	As agreed with the Engineer.
Minimum size (mm):	- 2.0m x2.0m. - complete wall panel as directed.
Incorporating	- Horizontal and vertical joints. - Internal and external corners. - Edge details as directed. - Interfaces as directed.

Confirmation Prototype

Location:	As agreed with the Engineer.
Minimum size (mm):	- 2.0m x2.0m. - complete wall panel as directed .
Incorporating	- Horizontal and vertical joints. - Corners as directed by the Engineer. - Edge details as directed. - Interfaces as directed. - >

Retain all confirmation prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

200.2.5 SUBMISSIONS

General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

Subcontractors

Submit names and contact details of proposed manufacturers and installers.

Shop drawings

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Shop drawings shall show, but not limited to, the following information:

- Elevations plans and sections of all cladding showing the supporting structure and, where appropriate, panel layout.
- A numbering system enabling all panels to be identified.
- Details of all supporting structure.

- Details of all required joints and interfaces.
- All components interfacing with the cladding.
- Details of all penetrations.
- Touch voltage electrical insulation and EPB provisions.
- Allowances for movement.
- Method of assembly.

No. of copies to be submitted: As Particular Specification.

Engineering endorsement

- Submit calculations and drawings from a Singapore licensed Professional Engineer concurrently with the shop drawings and showing, but not limited to, the following:-
- compliance with all relevant Singapore legislation and regulations.
- Submit a report from a Singapore registered Electrical Engineer certifying that the design and installation of internal cladding is in compliance with Section 13.9 of the Authority's Design Criteria Volume 2 of 2, and Singapore Standard CP5 and meets all of the Authority's equipotential bonding and touch voltage protection requirements.

Manufacturers' information

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

Tests

- Submit reports of all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

No. of copies to be submitted: 3.

Method Statement

Submit method statements in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

200.3 MATERIALS AND COMPONENTS

200.3.1 MATERIALS AND COMPONENTS

General

Provide all metal panels and framework components containing, or immediately adjacent to, electrical socket outlets or other sources of electricity with Equipotential bonding conductors.

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use products which give off toxic emissions in the event of a fire.

Do not use materials which contain known carcinogenics.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

Corrosivity: Non-corrosive.

Plasterboard

Standard: To AS/NZS 2588.

Location:	>
Grade:	Moisture resistant.
Thickness (mm):	Minimum 12.7mm.
Sheet width (mm):	>
Sheet length (mm):	>
Edge finish:	Tapered.

Fibrous plaster sheet

Standard: To AS 2185.

Glass fibre plasterboard

Standard: To AS 2590.

Fire resistant: Formulated for additional resistance to fire exposure.

Fibre cement

Standard: To AS/NZS 2908.2./ISO 8336.

Wall cladding: Type A category 4.

Minimum thickness:	9mm.
Location:	>
Type:	Autoclaved compressed panel.
Category:	>
Edges	Square.
	Pre-finished to match face of board.
Fire Performance	Non-combustible to BS476 Part 4 : 1970 and Class I surface spread of flame to BS476 Part 7 : 1971.
Movement from ambient to fully saturated	≤ 0.1%.
Alkalinity	Less than pH value 10.
Finish: Double faced	
	Pre-coated, U.V., graffiti and abrasion resistant.
Colour:	To AS 2700: BS 4800: Any RAL Colour.
Tolerance:	
- Length	+0/-2mm.
- Diagonal	+/- 2mm.

High pressure decorative laminate sheet

Standard: To AS/NZS 2924.1.

Coated steel

Coating class: Z200.

Thickness:	0.8mm.
Backing:	Calcium silicate board.
Thickness:	12mm.
Backing sheet:	Zinc coated bonderized steel.

Stainless Steel:

Grade: 316	
Finish:	Continuous hairline polished using 180 - 240 grit.
	>
Thickness:	0.8mm.
Backing:	Calcium silicate board.
Thickness:	12mm.
Backing sheet:	Zinc coated bonderized steel.
	Electro-galvanised steel sheet.

Composite Panels

Face material:	Aluminium.
Thickness:	0.5mm.
Core:	Non-combustible mineral filled.
	Aluminium honeycomb.
	>
Backing material	Aluminium.
Thickness:	0.5mm.
Panel thickness:	Minimum 4mm.
Finish :	Pre-finish: fluorocarbon paint.
Tolerance:	
Width and length	+/-2mm.
Thickness	+/- 0.2mm.
Diagonal	+/- 4mm.

Support Framework

Cross refer Metals and Prefinishes.

Material	Proprietary galvanised mild steel channel support system complete with all fixings and brackets. Proprietary grade 316 stainless steel support system complete with all fixings and brackets. Proprietary cold-formed galvanized steel framing.

Fasteners

Cross refer: Adhesives, Sealants and Fastenings.

All fixings and fastenings shall be non-corrosive.

No visible fixings will be acceptable.

All fixings and fastenings shall be appropriate to the work, shall transmit all imposed loads and stresses, and shall ensure the and structural integrity of the cladding.

All fixings and fastenings shall be effectively insulated from electrochemical reaction with incompatible materials.

Steel nails: Hot dip galvanized.

Adhesives

Cross refer: Adhesives, Sealants and Fastenings.

Contact adhesives: To AS 2131.

For plasterboard: To AS 2753.

For wallboards: Mastic adhesive.

Very high bond pressure sensitive tapes

Cross Refer: Civil Design Criteria.

- Minimum Peel strength: To ASTM D-3330.
- Minimum Normal Tensile (T-block): To ASTM D-897.
- Minimum Dynamic Shear: To ASTM D-1002.

Demonstrate U.V. resistance for external applications.

Cladding Schedule

Designation	**IL1**	**IL2**	**IL3**
Material	>	>	>
Grade	>	>	>
Finish	>	>	>
Colour	>	>	>
Backing	>	>	>
Backing sheet	>	>	>
Edge	>	>	>
- colour	>	>	>
- finish	>	>	>
Tolerance			
Width	>	>	>
Length	>	>	>
Thickness	>	>	>
Diagonal	>	>	>
Framing			
Material	>	>	>
Thickness	>	>	>
Background	>	>	>
Fixing			
Cladding fixing	>	>	>
Material	>	>	>

Fire resistance level schedule

Element	Location	Fire resistance level (to BS 476)
>	>	>

Element	Location	Fire resistance level (to BS 476)
>	>	>
>	>	>

200.4 EXECUTION

200.4.1 CONSTRUCTION GENERALLY

Substrates or framing

Before fixing cladding check and, if necessary, adjust the alignment of substrates or framing.

Proprietary cold-formed galvanized steel furring channels

Fix direct to solid walls. Provide wall plugs in solid backgrounds. Do not provide explosive powered fastenings.

Pack as required behind each fixing point using slotted non-shrink, non corrosive shims, positioned such that they will not fall out should the fixing slacken.

Accessories and trim

Provide accessories and trim necessary to complete the installation.

Equipotential bonding

Connect all EPB conductors to the main earth of the station.

Adhesives

General: Provide adhesives of types appropriate to their purpose, and apply them so that they transmit the loads imposed, without causing discolouration of finished surfaces.

Tolerances

On completion, cladding shall be

- within the tolerances defined by the formula $(A \div B) \times 100 \leq 0.5\%$

where:-

A = the greatest dimension of divergence from the design plane or curve measured at right angles from that plane or curve.

B = The shortest dimension separating points of nil and greatest divergences, measured along the plane or curve.

Lipping between adjacent panels in expressed joint systems shall be +/-0.5mm.

Ensure that the entire installation accommodates all building tolerances and anticipated movement.

200.4.2 PLASTERBOARD PANELLING

Supports

General: Install proprietary cold-formed galvanized steel furring channels on proprietary cold-formed galvanized steel framing:-

- here framing member spacing exceeds the recommended spacing; and
- where direct fixing of the plasterboard is not possible due to the arrangement or alignment of the framing or substrate.

Transverse walls: Locate noggings:-

- at least 150 mm from the horizontal joint; or
- ensure that noggings do not protrude beyond the face of studs.

Installation

Gypsum plasterboard: To AS/NZS 2589.1.

- Level of finish: >

Fibre reinforced gypsum plaster: To AS/NZS 2589.2.

Metal stud frames: Screw using galvanized self drilling, self tapping screws, or retain using proprietary clamping straps and cover trims.

Masonry construction: Fix using adhesive direct to masonry, but do not fix direct to masonry as a substrate for tiled finish.

To furring channels: Fix using screw or screw and adhesive.

Recess all screw heads and fill over to render location invisible in the completed work.

Joints

Flush joints: Provide tapered edge sheets and finish flush using perforated paper reinforcing tape.

Butt joints: Make joints over framing members or otherwise provide back blocking.

External corner joints: Make joints over metallic-coated steel corner beads.

Dry joints: Provide square edged sheet and finish with a UPVC joining section.

Control joints: Install purpose-made metallic-coated control joint beads at not more than 12 m centres in walls and ceilings and to coincide with structural movement joints.

Wet areas: Install additional supports, flashings, trim and sealants as required.

Joints in tiled areas: Do not apply a topping coat after bedding perforated paper tape in bedding compound.

200.4.3 FIBRE CEMENT PANELLING TO TAKE FINISHES

Supports

Install proprietary cold-formed galvanized steel furring channels.

- where framing member spacing exceeds the recommended spacing; and
- where direct fixing of the fibre cement is not possible due to the arrangement or alignment of the framing or substrate.

Installation

General: Run sheets across the framing members. In flush jointed applications, stagger end joints in a brick pattern and locate them on framing members, away from the corners of large openings. Provide supports at edges and joints.

Steel framed construction: Screw only or combined with adhesive.

Wall framing: Do not fix to top and bottom plates or noggings.

- In tiled areas: Provide an extra row of noggings immediately above wall-to-floor flashings. Fix sheet at 150 mm centres to each stud and around the perimeter of the sheet.

Masonry construction: Fix using adhesive direct to masonry, but do not fix direct to masonry as a substrate for tiled finish.

Wet areas: To AS 3740.

Recess all screw heads and fill over to render location invisible in the completed work.

Joints

Flush joints: Provide recessed edge sheets and finish flush using perforated paper reinforcing tape.

- Movement joints in walls: Position a stud parallel to the joint on each side.
- Movement joints in ceilings and soffits: Provide movement joints to divide ceilings into bays not larger than 10.8 x 7.2 m and soffit panelling into bays not larger than 4.2 x 4.2 m or 5.4 x 3.6 m. Provide framing parallel to the joint on each side. Do not fix panelling to abutting building surfaces.

External corner joints: Make joints over metallic-coated steel corner beads.

Dry joints: Provide square edged sheet and finish with a UPVC joining section.

Control joints: Provide purpose-made metallic-coated control joint beads at 7.2 m maximum centres in walls and ceilings and to coincide with structural movement joints.

Wet areas: Provide additional supports, flashings, trim and sealants as required.

Joints in tiled areas: Bed perforated paper tape in bedding compound. Do not apply a topping coat.

- Movement joints: Space to suit joints required in tiling.
- Internal corners: Reinforce with metallic-coated steel angles. In corners subject to continuous moisture, flash over the angle and under the sheeting with continuous bitumen coated aluminium flashing.

200.4.4 PRE-FINISHED FIBRE CEMENT PANELLING

Supports

Install proprietary cold-formed galvanized steel framing.

Installation

General: Run sheets parallel to the framing members. Provide supports at edges and at mid span to limit deflection of the sheet to 1/300 span.

Fix using double sided tape in accordance with the tape manufacturers instructions.

Joints

Flush joints:

- Size +/-2mm.

Tolerances:

- Level across joint +/-0.5mm.

External corner joints: Make joints over zinc-coated steel corner beads.

Internal corners: Reinforce with zinc-coated steel angles.

200.4.5 METAL PANELLING

General

Do not cut or drill panels on site without the Engineer's acceptance.

Substrates or framing

Before fixing framing check the alignment of substrates and amend framing design if necessary.

Panel Construction

Weld joints in steel panels using a welding rod appropriate to the grade of steel used in the panel construction.

Panel Installation

Install paneling such that any one panel may be easily removed and re-erected without requiring the prior removal of adjacent panels.

200.4.6 CALCIUM SILICATE BOARD PANELLING

Material

Rigid low-density autoclaved calcium silicate board.

Provide accessories, fastenings, adhesives, fillers and protective coatings.

200.4.7 ACCESS PANELS

Size:	>
Tolerances:	>
Finish:	To match adjacent panels.
Ironmongery:	
HingesFully concealed.	
Catch	Tamper proof.
Handle	Fully recessed finished to match Panel.
Locations	As shown on drawings.

200.4.8 PROTECTION

Surfaces: Protect all finished surfaces to prevent damage or defacement.

Items to be protected schedule

Item	Temporary protective coating
Installed panels	Sufficient to protect against likely damage on site
>	>
>	>
>	>

200.4.9 COMPLETION

General

Cross refer: Item 20.5 'Completion' of the General Requirements.

Operation and Maintenance Manual

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements.

Protection

On or before completion of the works, or before joining up to other surfaces, remove all materials used as a means of protection.

Protect all completed cladding on site from damage until handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

Damage

Replace damaged items with new.

Warranties

Warrant the materials and workmanship using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

Record drawings

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

200.4.10 REPAIR

Before commencing repairs submit details of the proposed repair method for acceptance.

210 VITREOUS ENAMEL PANELS

210.1 GENERAL

210.1.1 CROSS REFERENCES

General

Conform to the General Requirements worksection.

Related worksections

Conform to associated worksections as follows: Adhesives Sealants and Fasteners.
Metals and Pre-finishes.
Doors and Access Panels.
Lining.
>

210.1.2 CIVIL DEFENCE (CD) REQUIREMENTS

General

Where stations are identified as having Civil Defence (CD) requirements, refer to the CD Design Criteria for requirements and information relating to the upgrading of materials, material thicknesses, composition and fixing methods for CD stations.

210.1.3 EQUIPOTENTIAL BONDING REQUIREMENTS (EPB)

Cross Refer: Section 20.2.7 'Design' of the General Requirements.

210.1.4 TOUCH VOLTAGE PROTECTION

Cross Refer: Section 20.2.7 'Design' of the General Requirements.

210.1.5 INTERPRETATION

Fixing: the term 'fixings' shall be taken to mean:-

Supporting fixings that transfer the dead and imposed loads on the vitreous enamel panelling to the structure. Supports may also include a restraint function.

210.1.6 DESIGN

Drawings

Contract drawings show generic design principles and design intent only.

210.2 QUALITY

210.2.1 INSPECTION

Witness points

Give sufficient notice so that inspection may be made at the following stages:

- Completion of the support framing.
- Unfixed panels on arrival on site.
- Panels prior to the sealing of joints.

Hold points

- Completion of all prototypes.
- The production of the first artwork panel.

Corrosion

Cross refer: General Requirements Clause 20.4.1.

210.2.2 TESTS

Carry out all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

Vitreous Enamel Panels

- To BS 1344 Part 1 – 7 Methods Of Testing Inclusive 1965 – 1975 Vitreous Enamal Finishes.
- BS 476 Part 4: 1970 Non Combustibility Test For Materials.
- To ASTM C 481-62 'Standard Test Method for Laboratory Aging of Sandwich Constructions.
- 1,000 hour salt spay test to ASTM B117-02. Pass criteria, no visible changes.

210.2.3 SAMPLES

General

Submit samples of each of the following in accordance with Section 20.3.4 'Samples',of the General Requirements.

- Each colour used. Samples must demonstrate the proposed backing and panel edge protection. Illustrate the maximum variation expected in each colour.
- Each type of proposed enamel panel showing proposed backing and edge details.
- Vitreous enamel artwork as instructed by the Engineer.
- The support structure.
- All accessories and fixings.
- All jointing materials.
- >

Size of samples

- Sample panels: minimum 600mm sq.
- Linear samples : minimum 600mm.

No of samples: 3.

210.2.4 PROTOTYPES

General

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

Confirmation Prototype

Provide confirmation prototypes of all vitreous enamel panelling.

Location:	As agreed with the Engineer.
Minimum size (mm):	3.0m x 3.0m or complete wall panel as directed.
Incorporating	- Horizontal and vertical joints. - Edge details as directed. - Interfaces as directed. - >

Retain all prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

210.2.5 SUBMISSIONS

General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

Subcontractors

Submit names and contact details of proposed manufacturers and installers.

Shop drawings

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Shop drawings shall show, but not limited to, the following information:

- Elevations plans and sections of all vitreous enamel panelling showing the supporting structure and panel layout.
- A numbering system enabling all panels to be identified.
- Details of all supporting structure.
- Details of all required joints and interfaces.
- Touch voltage electrical insulation and EPB provisions.
- Allowances for movement.
- Method of assembly.

No of copies to be submitted: As Particular Specification.

Engineering endorsement

Submit calculations and drawings from a Singapore licensed Professional Engineer concurrently with the shop drawings and showing, but not limited to, the following:-

- compliance with all relevant Singapore legislation and regulations.

Submit a report from a Singapore registered Electrical Engineer certifying that the design and installation of the vitreous enamel panels is in compliance with Section 13.9 of the Authority's Design Criteria

Volume 2 of 2, and Singapore Standard CP5 and meets all of the Authority's equipotential bonding and touch voltage protection requirements.

Manufacturers' information

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No of copies to be submitted: 3.

Tests

- Submit reports of all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

Method Statement

- General: Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

210.3 MATERIALS AND COMPONENTS

210.3.1 MATERIALS AND COMPONENTS

General

Provide all metal panels and framework components containing, or immediately adjacent to, electrical socket outlets or other sources of electricity with Equipotential bonding conductors.

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use products which give off toxic emissions in the event of a fire.

Do not use materials which contain known carcinogenics.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

Corrosivity: Non-corrosive.

Provide all panels complete with fixing clips to match framing materials.

Provide all panels pre-drilled to suit fixing details proposed.

Dimension all fixing holes to allow the passage of the required fixing without any damage occurring to the vitreous enamel.

Provide all heavy gauge panels complete with a seal between the backing board and the panel return flange as recommended by the panel manufacturer.

Provide all panels and framework components containing, or immediately adjacent to, electrical socket outlets or other sources of electricity with Equipotential bonding conductors.

Colour accuracy

Judged during manufacture in accordance with BS 950 Part 1.

In the event of a disagreement, colour accuracy shall be judged using a calibrated reflectometer. The acceptable deviation in the Delta E figure shall not exceed 0.1.

Heavy Gauge Vitreous Enamel Panels

Standard:	To BS 3830: 1973. To BS 4900: 1976.
Location:	>
Steel Grade:	decarbonized "zero carbon" steel.
Maximum carbon content	0.005% with a good sag resistance.
Chemical Analysis:	C:0.005% max. Mn:0.27% min., 0.40% max. P: 0.030% max. S: 0.030% max. H: 0.007% max.
Max. Yield:	24 kg/mm².
Max. Tensile:	34 kg/mm².
Elongation minimum:	37%.
Steel thickness	1.6mm.

Panel width (mm):	As shown on drawings.
Panel length (mm):	As shown on drawings.
ColourTo BS 4900:1976 or any standard RAL colours.	
Edge finish:	Returned 38mm minimum and protected with PVC waterproof impregnated self adhesive cloth tapes.
Backing	Calcium Silicate. Aluminium honeycomb.
Backing sheet	>

Light Guage Vitreous Enamel Panels

Standard:	>
Location:	>
Steel Grade:	Decarbonized "zero carbon" steel.
Maximum carbon content	0.005% with a good sag resistance.
Chemical Analysis:	C:0.005% max. Mn:0.27% min., 0.40% max. P: 0.030% max. S: 0.030% max. H: 0.007% max.
Max. Yield:	24 kg/mm².
Max. Tensile:	34 kg/mm².
Elongation minimum:	37%.
Steel thickness	0.6mm.
Panel width (mm):	As shown on drawings.
Panel length (mm):	As shown on drawings.
Colour	To BS 4900: 1976.
Edge finish:	to pass salt spray test to ISO 9227 >
Backing	Calcium Silicate. Aluminium honeycomb.
Backing sheet	>

Panel Tolerances

Radius:	+/- 1mm.
Length and width:	+ 2mm.
Width of flange:	+ 1mm.
Deviation from the nominal chord:	+ 1mm.
Deviation across the face of the panel in any 2.0m lengths:	+ 1mm.

Vitreous Enamel Coating

Ground coat:	100 – 150 microns + 25 microns.
Finish Coating (Inclusive of ground coat:	300 – 400 microns +30, -0 microns.
Rear coating:	300 – 400 microns +30, -0 microns.

Support Framework

Cross refer	Metals and Prefinishes.
Material	Proprietary galvanised mild steel channel support system complete with all fixings and brackets. Proprietary grade 316 stainless steel support system complete with all fixings and brackets.

Fasteners

Cross Refer: Adhesives Sealants and Fasteners:

- Hot dip galvanized.
- Stainless steel.

Provide electrically insulated fixings accepted by the Engineer for use in the touch protection zone.

Adhesives

Cross Refer: Adhesives Sealants and Fasteners.

= Contact adhesives: To AS 2131.

Very high bond pressure sensitive tapes

Cross Refer: Civil Design Criteria.

- Minimum Peel strength: To ASTM D-3330.
- Minimum Normal Tensile (T-block): To ASTM D-897.
- Minimum Dynamic Shear: To ASTM D-1002.

Demonstrate U.V. resistance for external applications.

Protection

Surfaces: Protect all finished surfaces to prevent damage or defacement.

Items to be protected schedule

Item	Temporary protective coating
Installed vitreous enamel panels	Sufficient to protect against likely damage on site.
>	>
>	>

Vitreous Enamel Schedule

Designation	VE1	VE2	VE3
Type	>	>	>
Location	>	>	>
Colour	>	>	>
Edge detail	>	>	>
- colour	>	>	>
- finish	>	>	>
Backing	>	>	>
Backing sheet	>	>	>
Joint width	>	>	>
- horizontal	>	>	>
- vertical	>	>	>
Joint infill	>	>	>
- colour	>	>	>
- finish	>	>	>
Support framing	>	>	>
EPB requirements	>	>	>
Touch voltage protection	>	>	>

210.4 EXECUTION

210.4.1 CONSTRUCTION

General

Do not cut or drill panels on site.

Substrates or framing

Before fixing framing check the alignment of substrates and amend framing design if necessary.

Fix each structural framing member direct to solid walls. Provide anchors into solid backgrounds to carry the anticipated dead and live loads.

Panel Construction

Weld joints in panels using a welding rod appropriate to the grade of steel used in the panel construction.

Panel Installation

Install all panels making allowance for all anticipated building and thermal movement.

Install paneling such that any one panel may be easily removed and re-erected without requiring the prior removal of adjacent panels.

Install panels to the following tolerances.

Deviation from level	>
Deviation from plumb	>
Joint width	>

Equipotential bonding

Connect all EPB conductors to the main earth of the station.

Accessories and trim

Provide all accessories and trim necessary to complete the installation.

Adhesives and Fixings

Cross Refer: Adhesives Sealants and Fasteners.

210.4.2 COMPLETION

General

Cross refer: Item 20.5 ‘Completion’ of the General Requirements.

Operation and Maintenance Manual

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 ‘Operation and Maintenance Manuals’ of the General Requirements.

Protection

On or before completion of the works, or before joining up to other surfaces, remove all materials used as a means of protection.

Protect all completed cladding on site from damage until handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

Damage

Replace damaged items with new.

Warranties

Warrant the materials and workmanship using the Authority’s standard warranty form for the period(s) stated in Item 20.5.1 ‘Warranties’ of the General Requirements.

Record drawings

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

210.4.3 REPAIR

Before commencing repairs submit details of the proposed repair method for acceptance.

220 PARTITIONS

220.1 GENERAL

220.1.1 CROSS REFERENCES

General

Conform to the General Requirements worksection.

Related worksections

Conform to associated worksections as follows: Civil and Structural Materials and Workmanship. Specification: sections >

Metals and Prefinishes.

Heavy Duty Galvanized Coatings.

Adhesives Sealants and Fastenings.

Doors and Hatches.

220.1.2 CIVIL DEFENCE (CD) REQUIREMENTS

General

Where stations are identified as having Civil Defence (CD) requirements, refer to the CD Design Criteria for requirements and information relating to the upgrading of materials, material thicknesses, composition and fixing methods for CD stations.

220.1.3 INTERPRETATION

Definitions

Fully demountable partitions: Dry construction used such that components can be demounted without damage using small hand tools, and subsequently reassembled within the dimensional limitations of the original system without cutting, trimming or refinishing. The method of attachment to the original structure must cause no surface damage, require only minor local refinishing after demounting and leave no permanent depression on the floor covering.

Semi-demountable partitions: Major components (e.g. frame and panels or linings) may be demounted without damage and reassembled within the dimensional limitations of the original system without cutting or trimming. Surface refinishing or rejointing, or new minor components such as fixings or jointing materials, may be required.

Non-demountable partitions: Wet construction methods may be used for assembly and jointing.

Non-demountable partitions, removable panels: A non-demountable system in which certain designated panels are demountable and re-useable without damage except for accidental damage to surface finish.

Frameless partitions: The panels (including glazed panels) are joined at their edges by an edge jointing system (e.g. splines, tongues and grooves, adhesive jointing), are fixed to the building structure at head and foot, and themselves provide the necessary resistance to external forces.

Partly framed partitions: Structural frames occur only at designated locations, e.g. at doorways, or as glazing mullions; otherwise frameless.

Fully framed partitions: Each partition panel, or the partition lining is supported by a separate structural frame.

220.1.4 DESIGN

Drawings

Contract drawings show generic design principles and design intent only.

220.1.5 PERFORMANCE

General

Provide partitions in conformance with the **Partition performance schedule** and as follows, where H is the height of the partition:

- To remain stable and do not show signs of deflection, permanent deformation, or rattling.
- To support structural design actions, including designated eccentric loads (e.g. loads on attached shelves or brackets), so that deflections will not exceed:
  - H/180 in door frames.
  - H/500 for eccentric loads on partitions.
  - The lesser of H/240 or 30 mm for partitions subjected to wind actions and lined with a flexible cladding.

. The lesser of H/360 or 20 mm for partitions subjected to wind actions and lined with a brittle material.

Imposed loads

Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

Fire performance

Non combustible to BS 476, Part 4.

Fire resistance >

Acoustic properties

Sound absorption coefficient: >

Sound reduction index: >

Field transmission loss: >

Noise reduction coefficient range: >

220.2 QUALITY

220.2.1 INSPECTION

Witness points

Give sufficient notice so that inspection may be made at the following stages:

- Setting out.
- Completion of framing before lining.
- Completion of first side cladding.
- Immediately prior to cladding second side.

Hold points

- Completion of prototype.
- Completion of cladding prior to jointing and taping.

Corrosion

Cross refer: General Requirements Clause 20.4.1.

220.2.2 TESTS

General

Carry out all tests in accordance with Sub-section 20.3.2 of the General Requirements.

Type-test to verify conformance with the **Partition performance schedule** and as follows:

- Fire hazard properties: To AS/NZS 1530.3.
- Fire resistance level: To AS 1530.4.
- Impact resistance: To withstand impact without permanent deformation, damage, failure of fastenings and the like.
  - . Energy level (J):203.
  - . Test method: Use the apparatus and procedure of the shot-bag test of SS341.
- Pressure resistance: To withstand a uniformly distributed load normal to the plane of the partition without permanent deformation or damage or excessive deflection:
  - . Load: >
  - . Test method: ASTM E72 and BCA Specification C1.8.
- Weighted sound reduction index (R_w): To AS/NZS 1276.1.

220.2.3 SAMPLES

General

Submit samples of each of the following in accordance with Section 20.3.4 ‘Samples’, of the General Requirements.

- A sample, at least 600 mm square, of each panel type, including finish.
- Samples at least 600 mm long of each structural section, including posts, sills, transoms, ceiling channels and metal channel headrails, and each moulding, cover strip and bead.
- Skirting, skirting duct, skirting duct stop ends, returns and removable covers.
- Floor and ceiling fixings and adjustments.
- Door hardware specified generically.

No of samples: 3.

220.2.4 PROTOTYPE

General

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

Confirmation Prototype

Erect a confirmation prototype of each partition system specified, including at least one example of each component in the system.

Location:	As agreed with the Engineer.
Minimum size (face of panel) (mm):	3.0m x height as required on site
Incorporating	- Horizontal and vertical joints. - Service penetrations. - Door opening. - Edge details as directed by the Engineer. - Fire stopping. - Acoustic insulation. - Removable/access panel as directed by the Engineer.

Retain all prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

220.2.5 SUBMISSIONS

General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

Subcontractors

Submit name and contact details of proposed manufacturers and installers.

Shop drawings

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Submit shop drawings of each partition system, showing, but not limited to, the following details and associated information:

- General arrangement of partition layout.
- Partition elevations to a scale of 1:50 showing the partition grid and panel types.
- Large scale details of construction methods of assembly, trim, jointing and finishing.
- All interfacing details.
- Methods of fixing partitions and linings.
- Glazing methods.
- Methods of achieving demountability.
- Dimensions, clearances, tolerances.
- Specification of materials and finishes.
- Performance data of components and assemblies.
- Method of providing access to services, and service outlets.

No. of copies to be submitted: As Particular Specification.

Installation

Setting out: Submit proposed set-out.

Engineering endorsement

Submit calculations and drawings from a Singapore licensed Professional Engineer concurrently with the shop drawings and showing, but not limited to, the following:-

Compliance with all relevant Singapore legislation and regulations.

Submit a report from a Singapore registered Electrical Engineer certifying that the design and installation of fixtures is in compliance with Singapore Standard CP5 and meets all of the Authority's equipotential bonding requirements.

Tests

Submit copies of current test reports, and certification, including drawings of tested details, for each proprietary material and build up in accordance with Section 20.3.2, 'Tests' of the General Requirements.

Type test modifications: Submit details of modifications made to partitions intended for the works compared with type tested units.

Partition tests: Submit an independent testing authority's report, showing compliance, on either

- previous type tests of an identical partition design; or
- project tests of the actual partition or a representative prototype.

Manufacturers' information

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

Method Statement

Submit method statements in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

220.3 MATERIALS AND COMPONENTS

220.3.1 General

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use materials which contain known carcinogenics.

Corrosivity: Non-corrosive.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

220.3.2 MATERIALS AND COMPONENTS

Coated steel

To AS 1397.

Proprietary galvanised mild steel support system.

Mild steel panel facings and trim: A factory-applied high performance pigmented powder or fluorocarbon coating of minimum thickness 60 µm. Cross refer: Metals and Prefinishes.

Aluminium

Framing members: Alloy 5005.

Cross refer: Metals and Prefinishes.

Metal fittings and hardware

Stainless steel surfaces: Satin self finish.

Recoating

Provide prefinishes which do not require site recoating either before or after installation.

Fire hazard

General: Do not provide materials which, when subject to fire conditions, will emit excessive smoke or dangerous fumes.

Fire hazard limits schedule

	Index to BS 476 Part 6&7	Applies to (location)
Spread of flame	0	All materials
Smoke developed	>	>

220.3.3 PARTITION PANELS

Plasterboard panels

Plasterboard: To AS/NZS 2588.

Use moisture resistant plasterboard

Minimum thickness: 12mm.

Edges: Tapered.

Glass fibre reinforced gypsum plasterboard: To AS 2590.

Fibrous plaster sheet

Standard: To AS 2185.

Glass fibre plasterboard
Standard: To AS 2590.
Fire resistant: Formulated for additional resistance to fire exposure.

Steel sandwich panels
Steel sheet laminated to both sides of a core of 12 mm thick compressed fibre cement sheet.

Fibre cement panels
Standard: To AS/NZS 2908.2./ISO 8336.
Wall linings: Type A category 4.

Minimum thickness:	9mm.
Type:	Autoclaved compressed panel.
Category:	>
Edges	Square.
Perforations	>
Movement from ambient to fully saturated	≤ 0.1%.
Alkalinity	Less than pH value 10.
Finish:	Smooth sanded on one face.
	>
	Tolerance:
- Length	+0/-2mm.
- Diagonal	+/- 2mm.

Coated steel
Coating class: Z200.

Thickness:	0.8mm.
Backing:	Calcium silicate board.
Thickness:	12mm.
Backing sheet:	Zinc coated bonderized steel.

Stainless Steel:
Grade: 316

Finish:	Continuous hairline polished using 180-240 grit.
	>
Thickness:	0.8mm.
Backing:	Calcium silicate board.
Thickness:	12mm.
Backing sheet:	Zinc coated bonderized steel.
	Electro-galvanised steel sheet.

Composite Panels

Face material:	Aluminium.
Thickness:	0.5mm.
Core:	non-combustible mineral filled.
	Aluminium honeycomb.
	>
Backing material	Aluminium.
Thickness:	0.5mm.
Panel thickness:	Minimum 4mm.
Finish :	Pre-finish: fluorocarbon paint.
Tolerance:	
Width and length	+/-2mm.
Thickness	+/- 0.2mm.
Diagonal	+/- 4mm.

220.3.4 PARTITIONS

General

Provide proprietary non-load-bearing partition wall framing and lining comprising cold formed steel or extruded aluminium members, or both, in conformance with the **Partition construction schedule**.

220.4 EXECUTION

220.4.1 CONSTRUCTION GENERALLY

Preparation and protection

Preparation: Prepare the base to receive the partitions.

Protection: Protect existing work from damage during the installation and make good any damage. Provide temporary coverings if necessary.

Set out

General: Set out the partitions as shown on the drawings. Ensure that the partition grid, as expressed in panel joints and centrelines of frame members, coincides with the ceiling grid and the building grid, as applicable.

Misalignment (of adjoining surfaces at grid junctions): 1 mm maximum.

Deviation (from true grid lines and planes): up to 3 mm maximum.

Panel thickness: + 1 mm maximum, - 0.

Installation

General: Install the partitions plumb, level, on their correct alignments, and firmly fixed.

Building movements: Provide clearances or movement joints so that partitions are not damaged by structural building movements such as long term slab deflection. Where fire resistance or acoustic properties are specified provide a resilient foam or mastic seal having properties equal to those required for the partition.

Fixing

General: Conceal fixings. For demountable items provide fixings capable of being repeatedly removed and replaced without damage to finishes.

Fixing to masonry: Provide expansion type masonry anchors. Do not provide explosive-driven fastenings.

Fixing to suspended ceilings: Do not fix to suspended ceilings.

Exposed joints

Hairline: Edges sharp, square and in continuous contact.

Shadowline: Edges bevelled, chamfered or splayed to 1 mm maximum radius, and in continuous contact.

Fully demountable partitions

Height adjustment: Provide a suitable height adjustment device in fully demountable systems, designed to minimise the permanent marking of building surfaces, and to permit height adjustment of the partition whilst remaining in contact with the floor.

Acoustic installations

General: Preserve the sound reduction properties of R_w rated partitions by sealing flanking sound transmission paths during installation, including junctions between partitions and other building surfaces, air gaps around doorsets, recesses, such as pelmets and blind boxes and cut-outs for services. Avoid cut-outs next to or back-to-back with each other.

Sealing methods: Use appropriate sealing methods, such as purpose-made solid profiled inserts, durable resilient gaskets, or an accepted proprietary acoustic sealant.

Identification: Mark demountable panels with a stamped or engraved code mark or equivalent means of identification, placed in an inconspicuous but accessible position.

220.4.2 METAL FRAMES

Type

Proprietary non-load-bearing partition wall framing system comprising cold formed galvanised steel or extruded aluminium members, or both.

Additional support

Provide additional support in the form of noggings, trimmers and studs for fixing hardware, fixtures and fittings. Box studs to frame door openings, and provide additional top support independent of the ceiling, where the studs are fixed to the underside of an exposed grid ceiling.

Control joints

Provide for control joints in sheet finishes where required by the structural frame or the Internal Cladding (Lining) worksection.

Erection

Fix bottom plates as directed by the manufacturer's printed instructions but not greater than at 600 mm centres, and 100 mm from ends. Provide top support by fixing the top plate to the slab soffit at matching centres, or stabilise the partition by lapping and fastening intersecting or butting plates together. Fix studs to the bottom plates at door frames, corners and intersections with self-tapping screws, not with pop rivets or crimping.

Stud spacing

Space the studs as required by the lining, but in any case at 600 mm maximum centres.

Bracing

Independently brace the partition if sufficient bracing is not provided by the building structure.

Splicing

Splice plates at ends to maintain continuity and alignment.

Fastening

Assemble the frames at door openings with self-drilling self-tapping screws or with blind rivets.

Service holes

For services within the partition provide either factory precut flared holes, or site cut holes punched or drilled on the centreline of the member. Provide proprietary plastic bushes or grommets to site cut holes. Where service holes cut on site exceed D/3 provide additional strengthening to the member. D is the depth of the member.

220.4.3 SERVICES INSTALLATION

General

Co-ordinate the installation of building services, within cavities in the partition structure.

Access

Provide removable or demountable components of the partition system, for access to services concealed within partition cavities.

220.4.4 TOILET AND SHOWER CUBICLES

General

Provide a cubicle system complete with doors and hardware in conformance with the **Cubicle construction schedule**.

Suspension beam

For suspended systems provide a suspension beam consisting of a galvanized mild steel channel, located immediately above the ceiling framing along the line of the partition fronts. Provide end fixings to the structure as necessary to transfer the load. Drill the bottom flange of the channel as required for the partition fixing bolts.

Compressed fibre cement system

Panels: Factory prefinished double faced autoclaved high density fibre cement sheets with square edges ground smooth and arrised.

Panel thickness: Divisions 18 mm; fronts 24 mm; shower seats (where required) mm. minimum.

Doors: Solid core flush doors to AS 2688.

- Core: Double faced autoclaved high density fibre cement sheets.

Finish: Faced on all visible surfaces with laminated sheet to AS/NZS 2924.1.

Installation

Suspended fronts: Hang the fronts from a suspension beam with galvanized mild steel bolts and attachments, incorporating a means of height adjustment, supplied as part of the system.

Floor mounted fronts: Fix to the floor with proprietary fittings, and fix at the top to a corrosion resistant metal channel headrail, supplied as part of the system, running continuously across the fronts and fixed to the walls at each end. Form the channel into a box section over doorways by snapping in a mating channel insert.

Assembly fixings: Attach divisions and nibs to walls and fronts with purpose-made proprietary fixings.

Fixing shower seats: Secured to walls at each end.

Door hardware

Spring hinges (hold closed) and indicator catch.

Cubicle construction schedule

Cubicle designation	C1	C2	C3
Panels: - Type	>	>	>
- Finish	>	>	>
- Colour	>	>	>
Mounting type	>	>	>
Suspension beam	>	>	>
Panel dimensions (mm): - Divisions	>	>	>
- Front	>	>	>
- Nib	>	>	>
- Door	>	>	>
- Shower seat	>	>	>
Clearances (mm): - Finished floor to underside	>	>	>
- Finished floor to top	>	>	>
Hardware	>	>	>

220.4.5 PARTITION SYSTEMS

Partition construction schedule

Partition designation	P1	P2	P3
Location	>	>	>
Partition grid	>	>	>
Demountability	>	>	>
Stud configuration	>	>	>
Stud size (mm)	>	>	>
Stud base metal thickness (mm)	>	>	>
Stud condition	>	>	>
Stud type	>	>	>
Stud material and finish	>	>	>
Insulation	>	>	>
Lining: - Side A	>	>	>
- Side B	>	>	>
- Fixing	>	>	>
- Edge	>	>	>
Trim: - Skirting	>	>	>
- Head	>	>	>
Glazing	>	>	>
Framing	>	>	>
Plenum baffles	>	>	>

Panel size schedule

Panel type	Panel size (h x w) (mm)
>	>
>	>
>	>

Partition performance schedule

	Type or location		
	P1	P2	P3
Additional structural actions	>	>	>
Weighted sound reduction index, R_w	>	>	>
Fire resistance level, FRL	>	>	>
Fire hazard properties	>	>	>
Ignitability index	>	>	>
Spread of flame index	>	>	>
Heat evolved index	>	>	>
Smoke developed	>	>	>

220.5 COMPLETION

220.5.1 COMPLETION

General

Cross refer: Item 20.5 'Completion' of the General Requirements.

Protection

Surfaces: Protect all finished surfaces to prevent damage or defacement.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

On or before completion of the works, or before joining up to other surfaces, remove all materials used as a means of protection.

Damage

Replace damaged items with new.

Warranties

Warrant the materials and workmanship using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

Operation and Maintenance Manual

On completion submit an Operation and Maintenance Manual in accordance with item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements including, including recommendations for the care and maintenance of the partitions, and instructions for demounting and relocation where applicable, for the reinstatement of acoustic properties after relocation and for the attachment of fixtures. Include a list of manufacturers and suppliers of the various partition system components.

Record drawings

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

220.5.2 REPAIR

Before commencing repairs submit details of the proposed repair method for acceptance.