

(41) A12-010 IRONMONGERY

1 GENERAL

Read this Section with G01-010 "General Requirements" and all other contract documents.

1.1 Scope

This Section covers the requirements for ironmongery in building projects and broadly covers supply and installation of the following:

(a) Supply and installation of all required ironmongery, fixings and accessories

- THE IRONMONGERY TO BE PROPOSED IN EXACT MATCHING LOCKSET OF MODEL, BRAND, PROFILE OF THE EXISTING SCHOOL IRONMONGERY.
- THE IRONMONGERY SHALL BE ABLE TO BE OPERATED WITH THE EXISTING MASTER KEY.

(b) Ironmongery adjustments

- FOR IRONMONGERY THAT DOES NOT REQUIRE REPLACEMENT, REPAIR SHALL BE APPLIED TO THE EXISTING IRONMONGERY FOLLOWING CONDITION WARRANT THE IRONMONGERY FROM REPLACEMENT:
 - THE HINGE HAS NO RUST, NO DEFORMITY AND ALL SCREW AND BUT ARE INTACT.
 - LOCKSET IS PROPER FORM, ABLE TO CLOSE AND LOCK, NO LOOSE COMPONENT, NO MISSING COMPONENT, NO DEFORMITY.
 - LOOSE PART THAT CAN BE TIGHTENED TO FUNCTIONAL WORKS
- FOR IRONMONGERY THAT REQUIRES REPLACEMENT, FOLLOWING PARAMETER SETS THE CONDITIONS FOR REPLACEMENT OF THE IRONMONGERY LOCKSET
 - THE IRONMONGERY IN PAIR/ IN SET OF NUMBERS HAS MISSING PARTS
 - THE IRONMONGERY COULD NOT CLOSE DUE TO DAMAGE, DEFORM, MISSING COMPONENT

(c) Fire testing and assessment of ironmongery on fire rated door assemblies

(d) All requirements pertaining to construction keys, master keys, integration with security system and all related work

(e) Any other ironmongery work described in the contract documents and drawings

1.2 Related Sections

Read this Section in conjunction with the relevant requirements of the following sections:

A02-030	Plasters and Renders
A02-020	Paintings and Coatings
A02-010	Dry Wall Partitions
A09-010	Doors
A09-020	Roller Shutters

1.3 Standards, Codes, Regulations and Technical References

1.3.1 Standards and Codes

Unless otherwise agreed by the SO, ensure all of the Works comply with the relevant requirements of the standards and codes listed below or referenced in the body of the Specification. Alternative standards and codes may be proposed for approval by the SO, provided it can be demonstrated that the alternative standards and codes comply with the requirements of the standards specified. All standards and codes quoted are the current version, unless specific year references are noted.

In the event that the standards or codes are partially superseded or have become obsolete, refer to the current edition or the approved substitution for the relevant clauses.

Singapore Standards	
SS 605	Guide for age-friendly homes
Other Standards	
BS EN 485	Aluminium and aluminium alloys
BS EN 1011-1	Welding – Recommendations for welding of metallic materials – Part 1: General guidance for arc welding (AMD 13981)
BS EN 1011-2	Welding – Recommendations for welding of metallic materials – Part 2: Arc welding of ferritic steels
BS EN 1011-3	Welding – Recommendations for welding of metallic materials – Part 3: Arc welding of stainless steel
BS EN 1011-4	Welding – Recommendations for welding of metallic materials – Part 4: Arc welding of aluminium and aluminium alloys
BS EN 1011-5	Welding – Recommendations for welding of metallic materials – Part 5: Welding of clad steel
BS EN 1125	Panic exit devices
BS EN 1154	Controlled door closing devices
BS EN 1155	Electrically powered hold open devices for swing doors
BS EN 1303	Cylinders for locks-requirements and test methods
BS EN 1935	Single axis hinges
BS EN 10088-1	Stainless steels – Part 1: Lists of stainless steels

BS EN 10088-3	Stainless steels: Part 3: Technical Delivery Conditions for Semi-Finished Products, Bars, Rods, Wire, Sections and Bright Products of Corrosion Resisting Steels for General Purposes
BS EN 10113	Hot rolled products in Weldable fine grain structural steel
BS EN 10143	Continuously hot dipped metal coated steel sheet and strip – tolerances on dimensions and shape
BS EN 10152	Electrolytically zinc coated cold rolled steel flat products
BS EN 10259	Cold rolled stainless steelstrip and cut lengths
BS EN 12540	Corrosion protection-nickel, copper, chromium coatings
BS EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles - specifications and test methods

BS EN ISO 3506-1	Mechanical properties of corrosion resistant stainless steel fasteners – Part 1: Bolts, screws and studs
BS EN ISO 3506-2	Mechanical properties of corrosion-resistant stainless-steel fasteners – Part 2: Nuts
BS 1449	Steel plate sheet and strip
BS 1453	Specification for filler materials for gas welding
BS 1461	Galvanising
BS 2901	Filler rods and wires for gas shielded arc welding
BS 2989	Continuous hot dipped metal coated steel sheet and strip
BS 3830	Vitreous enamelled steel building components
BS 3987	Anodic oxide coating-external aluminium anodising
BS 4190	Black hexagonal bolts
BS 4255	Non cellular gaskets
BS 4360	Specification for weldable structural steels
BS 4604	High strength friction grip bolts

1.3.2 Regulations

Refer to the following regulations for compliance in carrying out the Works:

Building and Construction Authority â Approved Document ("Approved Document")

Code on Accessibility in the Built Environment
Code of Practice for Fire Precautions in Buildings ("Fire Code")

The above regulations refer to the latest edition (including any amendments) that are currently in use.

1.3.3 Technical References

Refer to the following technical references for guidance in carrying out the Works:

Building and Construction Authority à Construction Quality Assessment System (CONQUAS) Manual

1.4 Trade Preamble

1.4.1 Contractor's Submissions

Engage experienced and qualified personnel for detail development based on the design intent indicated in the drawings and schedules. Allow a minimum of 14 days for the review of each submission, mock-up and associated resubmissions/amendments.

Submit the following for the SO's review:

- (a) All necessary details for the fabrication and installation of the fixtures and fittings, including interfaces with other works and connections.
- (b) Manufacturers and products for the fixtures and fitting items when called for.
- (c) Method of fabrication and erection/installation.
- (d) Co-ordinated shop drawings incorporating works from all relevant trades and adjoining parts of the building. A minimum of 14 days shall be allocated for review following each submission/resubmission until the acceptance of the SO.
- (e) Site measurements and actual size of components shall be measured and recorded in the shop drawings. Adjustments shall be proposed as required and explained to the SO for review and acceptance.

1.4.2 Co-ordination with Other Works

Co-ordinate the works particularly the interfacing with the following trades:

- (a) Internal walls including masonry and dry walls
- (b) Internal applied finishes
- (c) Mechanical and electrical services
- (d) Security devices and automatic devices
- (e) Interfacing with fire alarm

Liaise and co-ordinate all mechanical and electrical services, exposed or concealed, without compromise on the performance integrity of each individual service/system.

1.4.3 Provision of Spare Materials

Deliver to Site in strong protective packages marked for identification, and store where directed, components and materials for future replacement and repair.

Supply the following spare material and store in an area agreed with the SO:

Item	Quantity
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The confirmation of the requirement for the spare material shall be made at the time of the completion of the Works. If the SO chooses to omit the requirement, then the full cost omission shall be made to the Employer.

1.4.4 Quality Control Plan

Prepare and submit a quality control plan for the SO's review and acceptance, including the following:

- (a) Preparation and installation procedures
- (b) Co-ordination with related works
- (c) Construction programme related to this Works

Compliance to required inspections, testing, certificate, calculations and material usage. All ironmongery shall be obtainable from a single source manufacturer who is a registered supplier with BCA. Contractor shall provide proof of certification when requested. Alternatives are subject to the acceptance of the SO.

Competent technicians shall be provided to check and co-ordinate the installation.

The SO is the sole judge on the acceptance in quality of works.

1.4.5 Warranty

No item.

1.4.6 Maintenance Manual

Prepare and submit an operation/maintenance/replacement manual covering all components and accessories. Refer to G01-010:Clause:1.4.5 for details.

1.5 Definitions and Abbreviations

The following definitions and abbreviations apply within this Section.

1.5.1 Definitions

No item.

1.5.2 Abbreviations

1.5.2.1 EPDM

Ethylene Propylene Diene Monomer

2 PERFORMANCE REQUIREMENTS

2.1 Contractor's Brief

Take into account the requirements listed below.

2.1.1 Loading

The self-weight and other associated loads of the fixtures and fittings shall be supported and transferred to the main building structure.

Make allowance for the normal loading exerted on the items e.g. cabinet loads or occasional loads from users or maintenance workman using fitting for temporary foothold.

2.1.2 Building Movements and Structural Tolerance

Performance, appearance and proper functioning of the Works are not affected by any movements, settlement, deflection, expansion or contraction which can be expected to occur in the building or the construction process.

All junctions between the fixtures/fittings and adjacent work by others shall be designed for possible structural deflections or movement in that adjacent element without distortion to the Works, or disintegration of joints between Works.

2.1.3 Technical Compliance

Comply with technical requirements of authorities including BCA, FSSD and other statutory authorities having jurisdictions over the Works.

The maximum force for pushing or pulling open a door should be in compliant to prevailing authority requirements. Test report shall be provided upon request by the SO.

Maximum force for pushing or pulling for opening a door (both for exterior hinged doors and interior hinged doors) shall comply with the requirements of the relevant Authorities.

The product shall be deemed to be compatible and approved for usage in the country where the Works are to be applied. Any tests or certification required for the above-mentioned purpose shall be deemed inclusive.

2.1.4 Fire Performance

Ensure ironmongery for fire-rated doors and roller shutters (including all materials and accessories) comply with the relevant fire safety requirements as stated in the Fire Code.

2.1.5 Environmental

Take into account the nature of the environment for which the Works shall be applied, particularly the variations in humidity and temperature in the tropics. Any deviations for that purpose shall be reviewed and accepted by the SO.

Co-ordinate and comply with the SO and specialist sub-contractors to form a comprehensive list of current authority compliances required.

Where ironmongery are installed in areas accessible by the public, such ironmongery shall comply with all statutory requirements as stated in the Code on Accessibility in the Built Environment.

2.1.6 Appearance

Ensure that the surface finishes are uniform in colour, texture and appearance throughout. Any preparation, process or rectification required shall be to the satisfaction of the SO.

All fixings shall be appropriately concealed and supplied with countersunk screw fixing.

3 MATERIALS

3.1 Ironmongery

For ironmongery schedule, please refer to the schedule shown in the architectural drawings and relevant cut sheets.

Ironmongery to comply with the following:

a.	Emergency exit devices	BS EN 179
b.	Panic exit devices	BS EN 1125
c.	Controlled door closing devices	BS EN 1154
d.	Electrically powered hold open devices for swing doors	BS EN 1155
e.	Cylinders for locks-requirements and test methods	BS EN 1303
f.	Single axis hinges	BS EN 1935
g.	Door and window bolts	BS EN 12051
h.	Stainless steel fasteners	BS EN ISO 3506-1
i.	Lock strikes	BS EN 12209
k.	Handles, push plates	BS EN 1906
l	Floor springs	BS EN 1154
M	Door stops, holders, bumpers	Nil

Location and type shall be as set out on drawings/schedule. Provide proprietary products or performance specified items as indicated in Section A12-010:Clause:1.1 or submit suitable product to the SO.

Ironmongery in kitchens, bathrooms and wet areas shall be corrosion resistant.

Hinges on kitchen unit doors to open to 90 degrees.

3.2 Keys and Keying

The Contractor shall be responsible to co-ordinate master key requirements with the SO for approval. Temporary cylinder key system shall be incorporated until handover. Main Contractor shall submit master key schedule to the SO for review.

The Contractor shall provide the number of duplicate keys as specified by the SO.

Properly arrange, identify, classify and tag any lock spanner wrenches, spare parts and any other tools furnished by the manufacturers with the ironmongery for handing over at the completion of the Works.

3.3 Stainless Steel

3.3.1 Sections

Stainless steel shall be to BS EN 10088. Stainless steel sections shall comply with BS EN 10088-3.

Unless otherwise indicated, stainless steel grade shall be 1.4401 (previously 316 external grade).

3.3.1.1 Finishes

- (a) 1G/2G (3A) Ground: Coarse, unidirectional texture; low reflectivity.
- (b) 1J/2J (3B or 4) Brushed or dull polished: Unidirectional texture; smoother than 1G/2G; low reflectivity.
- (c) 1K/2K (5) Satin polished: Smoother than 1J/2J. Suitable for marine and external architectural applications.
- (d) 1P/2P (7 or 8) Bright buffed/polished: Non-directional finish with high degree of reflectivity. Achieved by mechanical polishing.

[Note: The references in brackets are the nearest equivalent finishes to the superseded BS 1449-2.]

The finish is achieved on the exposed surface only, unless specified otherwise.

3.3.2 Sheets, Strips and Plates

3.3.2.1 Grade of Stainless Steel

Comply with BS EN 10088-3.

Unless noted otherwise, grade 1.4401 (formerly 316) shall be used for visible components. In all other circumstances, grade 1.4301 (formerly 304) shall be used.

3.3.2.2 Welding of Stainless Steel

Comply with BS 1453 and BS 2901.

Use electrical fusion metal-arc method. Carbon-arc or gas welding shall not be permitted. Undertake in a thorough manner, with edging rod of same composition as sheets or part welded.

Weld complete welds, strong and ductile, with excess metal ground off and joints finish smooth to match adjoining surface. Welds shall be free of mechanical imperfections such as gas holes, pits, runs, cracks etc. and shall have same colour as adjoining surfaces. All sheets shall be continuously butt welded together with welds ground smooth and polished. Butt welds made by spot welding strips under beams and filling in the voids with solder and finishing by grinding will not be acceptable.

Wherever welds occur on surfaces not finished by grinding and polishing, such welds and the accompanying discolouration shall be suitably coated in the factory by means of metallic base paint to prevent the possibility of progressive corrosion to such joints.

3.4 Carbon Steel

3.4.1 General

Steel components shall be hot dip galvanised after fabrication unless alternative corrosion protection is approved.

Do not cut, drill or work galvanised members.

3.4.2 Metal Material

3.4.2.1 Steel Plates and Shapes

To BS EN 10113.

3.4.2.2 Cold Rolled Steel

To BS 1449: Section 1.3, matte finish.

3.4.2.3 Hot-dipped Galvanized Steel Sheets

To BS EN 10143.

3.4.2.4 Cold Formed Steel Hollow Section

To BS 6363.

3.4.2.5 Welding Materials

To BS 6363.

3.4.2.6 Concrete Inserts

Cast steel or malleable bolts, washers, and shims, hot-dipped galvanised.

3.4.2.7 Fasteners

To BS EN ISO 3506-2

3.4.3 Welding of Steel

To BS 499-1 and BS 499-2.

3.5 Aluminium Alloy Components

3.5.1 Aluminium Alloy Plate, Sheets and Strip

To BS EN 485: acceptable 3003 â H14 and 5005 â H14 alloy and temper combinations for sheet and plate subject to fabrications, finish and structural requirements. Provide 3.0 mm minimum nominal thickness.

3.5.2 Aluminium Alloy Bars

Extruded tube sections and hollow sections to BS EN 485, acceptable alloy and temper combinations for 6063-T5 and 6063-T6 for extrusion subject to fabrication, finish and structural requirement. Nominal wall thickness of 3.0 mm or greater is required for structural extrusions. Minimum nominal wall thickness for non-structural trim shall be 1.5 mm.

3.5.3 Aluminium Alloy Drawn Tubes

To BS EN 485: acceptable alloy and temper combinations 6063-T5 and 6063-T6.

3.5.4 Welding of Aluminium

Welding of aluminium shall be done in the factory and in conformance to BS EN 1011-4. Weld shall use inert gas process using an electric arc with a protective envelope of argon gas. Oxyacetylene welding is not permitted as a substitute. Do not solder aluminium.

Weld aluminium where specifically approved by the SO.

3.6 Prefinished Metals

Prefinished metals may be used if methods of fabrication do not damage or alter appearance of finish.

3.7 Fixing and Fasteners

3.7.1 General

- (a) Fasteners shall be as appropriate, and as agreed with the SO and unless otherwise stated, shall be of the same metal as the component with matching coating and finish.
- (b) Where a particular fixing or fastening is not shown or fully detailed, design the fixing in order to fulfil the performance criteria.
- (c) Stainless Steel Fasteners: Fixings and fasteners shall comply with BS EN ISO 3506-1 and BS EN ISO 3506-2. Unless noted otherwise, grade A4 shall be used for visible fasteners; in all other circumstances grade A2 shall be used.
- (d) Screws: Provide Brass countersunk head screws for all internal items and provide brass cups for screws that are likely to be removed for access.
- (e) Nails: No nail heads shall be visible on exposed surfaces. Nails in wet areas shall be corrosion protected or non-corrosive.

3.7.2 Methods

Concealed fixings shall be adopted unless otherwise shown on drawings.

Locate face fixings in unobtrusive positions.

3.7.3 Strength

Allow minimum safety factor of 2.5 in addition to the anchorage design safety factor.

Where requested on drawings, supply a torque setting for bolted or screwed fastenings.

Structural anchorage shall be by two or more fixing devices.

3.8 Protective Coatings

3.8.1 General

Apply coats after completion of fabrication and drilling of all fixing holes.

Remove all burrs and sharp amuses prior to coating.

3.8.2 Galvanising

Galvanising shall be to BS EN ISO 1461.

Provide all necessary vent and drain holes in approved locations and seal to approval after galvanising.

3.8.3 Electrolytically Zinc Coating

Electrolytically zinc coated cold rolled steel flat products shall be to BS EN 10152.

3.8.4 Chromium Plating

Chromium plating shall be to BS EN 12540.

3.8.5 Vitreous Enamelling

Vitreous enamelling to steel surfaces shall be to BS 3830.

3.8.6 Externally Painted Steel

Refer to Section A02-020:Clause:3.1.

3.8.7 Anodising

Comply with AS 1231 thickness grade 25.

3.8.8 PVF2

Wet applied fluoropolymer to comply with ASTM 2605-2.

Resin content shall be at a minimum of 70%, minimum coating at 25 microns.

3.8.9 Polyester Powder Coating

Comply with AS 3715.

Minimum thickness shall be 50 microns. Submit suitable thickness to the SO.

3.9 Facings

3.9.1 Stainless Steel Facing

Type 316, 1.5 mm thick stainless steel facing conforming to BS 4360. Finish as indicated in Section A12-010:Clause:1.1 or as shown in the drawings.

3.9.2 Plastic Laminate Facing

Unless otherwise specified, provide 0.8 mm to 1 mm thick plastic laminate facing with D4 durability classification and performance rated HD-heavy duty, complying to BS 4965 and BS EN 438-2.

3.10 Accessories

3.10.1 Gaskets

Use extruded EPDM complying with provisions of BS 4255-1 shore hardness 35-45, cellular rubber to ASTM C509.

Provide silicone-free dry PVC push-in gaskets mitred at corners.

3.10.2 Sealants

Use silicone-based sealants to BS 5889, Type B with fungicide. Where specified in the drawings and/or schedule, provide suitable proprietary products as indicated to the SO for approval.

3.10.3 Adhesives

Use proprietary products as specified in the drawings and/or schedule and submit suitable products as indicated to the SO for approval.

4 WORKMANSHIP

4.1 General Requirements

4.1.1 Fabrication

Verify dimension and clearances on site prior to shop fabrication. Raise to SOâs attention, discrepancies and deviations and submit adjustments to be made to accommodate these discrepancies and tolerances.

Co-ordinate and furnish all hardware templates to the door manufacturers prior to fabrication of all doors, and liaise with the door manufacturers and hardware suppliers to ensure proper, correct and complete installation.

Fabricate items with joints tightly fitted and secured.

Fit and shop assemble in largest practical sections for delivery to Site. Locate joints only as indicated on the architectural drawings.

4.1.2 Delivery

Materials shall be delivered in sealed packages based on the installation schedule to minimise storage and unnecessary handling.

Delivered materials shall be inspected by the appointed technical officer to ensure condition and accuracy are in accordance with approved samples.

Unloading should be carried out in good weather conditions.

4.1.3 Protection

Materials shall be stored in enclosed space that is well ventilated.

Area shall be kept clean and dry, and free from potential hazards.

Storage shall be planned to avoid unnecessary handling or shifting.

All materials shall be protected with plastic sheets during storage or upon completion of part installation whilst awaiting installation of adjacent/intersecting components.

4.1.4 Installation

Areas of installation shall be weathertight, before commencement of installation.

All surfaces shall be levelled, cleaned and finished prior to the installation.

Hardware mounting heights shall be based on recommended locations by the manufacturers, unless otherwise indicated in shop drawings approved by the SO.

Install door ironmongery plumb, level and true to line, in accordance with manufacturerâs written instruction and recommendation. Install each ironmongery and hardware item on fire rated door and frame to comply with fire test certificates and requirements.

4.1.5 Checks

Check alignments and verify smooth operation.

4.2 Interfacing with Other Components

4.2.1 Working with Timber Components

4.2.1.1 Moisture Content

During delivery, storage, and installation and thereafter to practical completion, maintain temperature and humidity levels to suit specified moisture content(s) of timber components.

4.2.2 Trims

Wherever possible, fabricate unjointed lengths between angles or ends of runs. Where running joints are unavoidable, obtain approval of location and method of jointing. Use mitre angle joints unless otherwise specified.

4.2.3 Completion

Ensure that doors and drawers are accurately aligned within tolerances of the hinges and runners as established by cabinetry ironmongery manufacturers. Adjust as necessary to ensure smooth operation.

Check, adjust and lubricate hardware as necessary to ensure correct functioning.

4.2.4 Working with Metalworks

4.2.4.1 Grinding, Polishing and Finishing

Welded exposed joints shall to be suitably ground flush with adjoining material. All ground surfaces shall be smooth and consistent with good workmanship.

Exercise care in all grinding operations to avoid excessive heating of metal and metal discoloration.

Remove grain from rough grinding by successive polishing operations. Texture of final polishing operation shall be uniform and smooth.

4.2.4.2 Joints

Butt joints and contact joints shall be close fitting and shall not require solder as filler.

Sheared edges shall be free of burrs, fins or irregular projections and shall be finished over such shear edges.

Neatly finish mitres or bull nose with under edges of material ground to uniform condition. Do not overlap materials.

4.2.4.3 Shims

Separate all pairs of moving surfaces with friction reducing pads. Pads shall:

- (a) have a minimum of 3 mm thickness;
- (b) sufficiently reduce friction to permit movement;

- (c) be resistant to wear;
- (d) be positively retained in position (open-ended slots are not acceptable);
- (e) not be subjected to heat damage from welding, cutting or to excessive pressure from over tightening of bolts.

Plastic shims are acceptable at static connections for which the shims transfer only compressive forces.

Wood shims shall not be used.

4.2.5 Doors

Where timber lipping is specified, provide 12 mm hardwood lipping, mechanically or adhesive fixed to all faces of door.

4.2.5.1 Facing

- (a) Veneer facing: Provide balancing veneer in all instances.
- (b) Laminate facing: Bond laminate facing to face of door with adhesive recommended by the laminate manufacturer. Provide balancing laminate in all instances. Laminate to be terminated 12 mm from face of door at hardwood lipping unless shown otherwise in drawings.

5 VERIFICATION AND SUBMISSION

5.1 Submissions

5.1.1 Technical Submissions

Include in construction programme, event for submission of the following information:

- (a) Name of the manufacturer of fittings and include copies of technical data relating to each of the items listed.
- (b) Information of current or completed similar jobs during the previous 5 years and details of quality control procedures adopted.

5.1.2 Work Submissions

5.1.2.1 Method Statement

Prepare an installation strategy, prior to the preparation of detailed shop drawings.

5.1.2.2 Shop Drawings

Prepare shop drawings, which shall include the following:

- (a) Elevations of all fixtures and fittings including the supply and drainage pipe work connections. Location of electrical connections and sockets associated with items.
- (b) Sections at a scale of 1:5.
- (c) Plan location of all items.
- (d) One example of each of the ironmongery items.

Fabrication shall not commence until shop drawings have been reviewed and permission to proceed has been obtained.

5.1.3 Test Reports and Certificate Submissions

5.1.3.1 Certification of Materials

Provide the SO with certification from the manufacturer of all the materials/ components, certifying that the respective material is of the correct grade, strength, size, finish, etc. and is in accordance with the relevant codes and standards specified.

5.1.4 Quality Control Plan Submissions

No item.

5.1.5 Warranty

Compile product warranty and system warranty and submit to the SO.

5.1.6 Maintenance Submissions

Compile operation and maintenance manuals and submit to the SO.

5.2 Samples and Mock-ups

5.2.1 Samples

The Contractor shall supply a door-by-door ironmongery schedule together with samples of all ironmongery items for approval by the SO, prior to ordering.

5.2.2 Mock-ups

Provide the following mock ups.

Mock-up	Requirement/Locations
Samples to be provided for approval	.
	.
	.

5.3 Inspections

Allow for inspection at the factory or off-site fabrication areas as directed by the SO.

Allow for inspection on site by technical officer following each preparation and fix.

If directed by the SO, allow access for inspection at the factory or off-site fabrication areas of fittings, for fabrication or treatment procedures, e.g. timber treatment, glass treatment, painting process.

5.4 On-Site Tests

All tests shall be witnessed by an appointed technical officer.

Tests shall include the following, and other tests as required by the SO:

- (a) Fire tests for door assemblies for fire rated doors
- (b) All ironmongery and ancillary components/hardware

Allow for tests as requested by SO for the purpose of investigation after completion of installation.

(45) A14-010 DAMP-PROOF MEMBRANES

1 GENERAL

Read this Section with G01-010 "General Requirements" and all other contract documents.

1.1 Scope

This Section covers the design development, application, installation and verification of damp-proof membrane to ground floor slab and concrete structures in contact with earth.

The Section covers various combinations of the following:

- (a) Damp-proof membrane in contact with soil
- (b) Surfacing materials.

1.2 Related Sections

Read this Section in conjunction with the relevant requirements of the following sections:

A01-010	Brickwork
A01-020	Blockwork
A01-030	Lightweight Concrete Panels
A01-040	Precision Blocks
A01-050	Precast Vent Blocks

A02-030 Plasters and Renders

A07-010 Floor Screeds and Hardeners

A14-020 Liquid-Applied Membrane

System A14-030 Cementitious System

1.3 Standards, Codes, Regulations, and Technical References

1.3.1 Standards and Codes

Unless otherwise agreed by the SO, ensure all of the Works comply with the relevant requirements of the standards and codes listed below or referenced in the body of the Specification. Alternative standards and codes may be proposed for approval by the SO, provided it can be demonstrated that the alternative standards and codes comply with the requirements of the standards specified. All standards and codes quoted are the current version, unless specific year references are noted.

In the event that the standards or codes are partially superseded or have become obsolete, refer to the current edition or the approved substitution for the relevant clauses.

Singapore Standards	
SS 133	Specification for bituminous emulsion for roof waterproofing
SS 374	Preformed waterproofing membranes for concealed roof
SS 637	Waterproofing of reinforced concrete buildings
Other Standards	
BS EN 13967	Flexible sheets for waterproofing – Plastic and rubber damp proof sheets including plastic and rubber basement tanking sheet.
BS 8000-4	Workmanship on building sites – Part 4: Code of practice for waterproofing
BS 6398	Specification for bitumen damp-proof courses for masonry

1.3.2 Regulations

Refer to the following regulations for compliance in carrying out the Works:

Building and Construction Authority à Approved Document ("Approved Document")
Code for Environmental Sustainability of Buildings
Code of Practice for Fire Precautions in Buildings ("Fire Code")

The above regulations refer to the latest edition (including any amendments) that are currently in use.

1.3.3 Technical References

Refer to the following technical references for guidance in carrying out the Works:

Building and Construction Authority à Construction Quality Assessment System (CONQUAS) Manual
Singapore Green Building Council Scheme

1.4 Trade Preamble

1.4.1 Contractor's Submissions

The intended types of damp-proof membranes are set out in Section A14-010:Clause:3.1. The locations of the damp-proof membrane in contact with soil are shown on the drawings.

Based on the information, carry out and submit the following items to the SO:

1.4.1.1 Design Development

Submit manufacturer and products for each of the components of the waterproofing system(s) damp-proof membrane to meet with specified requirements.

1.4.1.2 Design Development

Develop all necessary details including connections and interfaces etc. for the construction of the waterproofing system based on the design drawings.

1.4.1.3 Construction Methods

Submit suitable methods to carry out the works including setting out, application of waterproofing membranes, installation and fixing of insulation, surfacing and associated components, etc. Taking into account of the performance requirements as set out in Section A14-010:Clause:2.1.

1.4.1.4 Shop Drawings

Prepare co-ordinated shop drawings incorporating all developed details.

1.4.2 Co-ordination with Other Works

Co-ordinate the damp-proofing works particularly the interfacing with the following trades:

- (a) Main structural slab and substrate
- (b) External masonry and cladding
- (c) Internal masonry and partitions
- (d) Plumbing works
- (e) Mechanical services
- (f) Electrical services
- (g) Floor and wall finishes

1.4.3 Provision of Spare Materials

Deliver to site in strong protective packages marked for identification, and store where directed, components and materials for future replacement and repair. Refer to the Project Specific Data for list.

Supply the following spare material and store in an area agreed with the SO:

Item	Quantity
.	.
.	.

1.4.4 Quality Control Plan

Prepare and submit a quality control plan for the SOs review and acceptance.

1.4.5 Warranty

Provide warranty in accordance with contract conditions for the performance of the following item: 5-year warranty for damp-proof membrane of floors in contact with soil.

1.4.6 Maintenance Manual

No item.

1.5 Definitions and Abbreviations

The following definitions and abbreviations apply within this Section.

1.5.1 Definitions

No item

1.5.2 Abbreviations

1.5.2.1 DFT

Dry Film Thickness

1.5.2.2 DPC

Damp-Proof Course

1.5.2.3 DPM
Damp-Proof Membrane

1.5.2.4 HDPE
High Density Poly Ethylene

1.5.2.5 RC
Reinforced Concrete

1.5.2.6 WFT
Wet Film Thickness

2 PERFORMANCE REQUIREMENTS

2.1 Contractor's Brief

When carrying out the proposals as set out in Section A14-010:Clause:1.4.1, take account of the following requirements.

2.1.1 Structural

2.1.1.1 Dead Loads

The self-weight and other associated dead loads of the complete damp-proof membrane shall not exceed the assumed design value as indicated in the PSD.

The self-weight and other associated dead loads of the complete damp-proof membrane shall not exceed [to be inserted].

2.1.1.2 Live Loads

Unless otherwise specified, account for the live loads as stipulated in the Building Control Regulations, and additional requirements of other statutory authorities having jurisdiction over the Works, if any.

2.1.2 Thermal Stress and Structural Movement

Take into account, all thermal stress and that the performance, appearance and proper functioning of the Works are not affected by any movements, settlement or deflection in the building structure, which can reasonably be expected to occur. Also take into account the construction accuracy of works by others to which the applied finished works are attached.

2.1.2.1 Secondary Building Movements

Take into account, forces resulting from secondary support structure movements, including vibration and thermal movement from M&E equipment and related works.

2.1.3 Fire Resistance

Comply with the requirements of the FSSD and additional requirements of other statutory authorities having jurisdiction over the Works, if any.

2.1.4 Construction

Achieve the following construction accuracy:

- (a) The overall thickness of the waterproofing assembly damp-proof membrane shall not exceed that indicated in the design drawings.
- (b) Fall shall be within tolerance of the membrane manufacturer's recommendations and specifications.

2.1.5 Durability

The floor and adjacent walls to which the damp-proof membrane is applied shall remain impenetrable to water, moisture or water vapour under the normal conditions that are expected in the design life of the waterproofing system.

3 MATERIALS

3.1 Types of Damp-Proof Membrane / Damp-Proof Course

The damp-proof membrane for the project shall consist of varying combinations of different components as set out below.

Provide and lay damp-proof course to all walls complying with BS 6398 Type B (felt fibre base) weighing 3.3 kg per m² to be laid to break joint on a layer of cement and sand mortar laid immediately under the lowest course of blocks or bricks at ground floor level or at level 150 mm to 220 mm above ground level in brick walls.

Except for bath/wc and kitchen, all other areas including living rooms, bedrooms and household shelters of the first storey residential units shall be provided with damp-proof membrane. The damp-proof membrane shall be laid to the underside of RC ground floor slab.

The damp-proof membrane shall comply with BS 6398 Type B (felt fibre base) weighing 3.3 kg per m². The substrate shall be float finished to receive the damp-proof membrane. The damp-proof membrane shall be strip bonded onto the substrate with rubberised bitumen adhesive to the manufacturer's printed instructions.

Select suitable manufacturers and products to comply with the requirements listed below.

Types of damp-proof membranes for this project shall consist of the following:

Damp-Proof Membrane System Type: DPM-1		
Items	Requirements	Clause Reference
Damp-proof Membrane / Damp-proof Course	Contractor to propose for approval	.
Surfacing Materials:	Contractor to propose for approval	.
-RC topping slab	.	.
Finish over Walls	.	.
MISCELLANEOUS COMPONENTS:	.	.
-Ancillary component(s)	.	.

3.1.1 Proprietary Composite Systems

Where specified, submit to the SO, suitable suppliers for the proprietary systems specified. Ensure the individual components comply with the specified requirements and the performance as a composite system shall match or exceed the performance requirements specified for the whole system.

3.2 Materials Requirements

3.2.1 Ancillary Products and Accessories

Where ancillary products and accessories and miscellaneous components are not specified, submit suitable types for the intended purpose to the SO.

3.2.2 Length of Components

Components, particularly sheet waterproofing membrane, profile capping, and flashing shall be in the longest lengths as practical to minimise lapping, joints and wastage.

3.2.3 Compatibility of Materials and Separation

Ensure compatibility of different materials used for the damp-proof membrane, in particular:

- (a) Prevent contact between incompatible materials/components. particularly primer with metal pipes and metals with alloys.
- (b) Materials used for separation of dissimilar materials or components shall comply with the following quality: Non-conducting, non-compressible and non-water absorbing

3.3 Substrate

3.3.1 Base Slab and Screed

Construct the base slab and apply a base screed. Base screed shall be prepacked cement/sand with proprietary additives. Refer to Section A07-010:Clause:3 for general requirement of screed materials.

Provide galvanised wire mesh reinforcement when the screed is thicker than 50 mm.

3.4 Waterproofing Systems: Membranes

3.4.1 Liquid Applied Membranes

3.4.1.1 Bituminous

Bituminous liquid applied membranes to comply with SS 133.

3.4.2 Damp-Proof Course

3.4.2.1 Sheet Membranes

Sheet membranes shall be of the following types and tested to SS 374 or BS 6398 or complying with BS EN 13967 Type A or T unless otherwise agreed:

- (a) HDPE sheet
- (b) Bituminous

(c) Self-Adhesive

Table 1. Testing criteria of bituminous sheet membrane

No.	Testing Criteria	Bituminous Type		
1.	Thickness (mm)	DIN 53353	Minimum 1 mm	
2.	Dimensional stability (%)	Longitudinal	SS 374:1994	<0.5%
		Transverse	SS 374:1994	<0.5%
3.	Tensile Strength (MPa)	Longitudinal	SS 374:1994	>3
		Transverse	SS 374:1994	
4.	Elongation at break (%)	Longitudinal	SS 374:1994	>45%
		Transverse	SS 374:1994	
5.	Resistance to Impact (mm)	EN 12691 Method A	>300	
6.	Pliability Test	SS 374:1994	No visual crack shall be observed	
7.	Soluble Matter (%)	SS 374:1994	< 0.3%	
8.	Water Vapour Transmission (g/hr-sqm)	SS 374:1994	<0.5	
9.	Water tightness at 60 kPa for 24 hours	EN13967 Type A	Pass	

3.5 Waterproofing Systems: Waterproof Screed

Minimum 20 mm thick, comply with SS 637.

Where required, these shall be proprietary pre-packed product, organic or inorganic. Refer to Section A14-010:Clause:3.1 for product(s) specified for this project, if any.

3.6 Damp-Proof Systems: Primers and Bonding Compounds

3.6.1 Bonding Compounds

Unless otherwise agreed, use oxidised bitumen products recommended by the membrane manufacturer for sealing the overlapping widths conditions and type of surface.

Unless otherwise agreed, use products recommended by the membrane manufacturer for the conditions and type of surface.

3.6.2 Sealants for Joints

Sealant materials for use on joints shall be approved polyurethane or polysulphide, complying with SS 637. Sealant materials for use on tile joints shall be approved silicone, polyurethane or polysulphide, complying with CP 82.

3.6.3 Sealing Strips

Sealing strips to be mastic strips and impregnated or coated cellular strips, complying with SS 637.

3.6.4 Protection Screed

Protection screed shall be cement and sand, with proprietary additives unless otherwise indicated in the drawings. Provide galvanised steel mesh reinforcement when the screed is thicker than 50 mm.

3.7 Drainage

For requirements of waste pipes, valves and fittings, refer to the drawings and mechanical specifications.

4 WORKMANSHIP

4.1 Delivery, Storage and Handling

On delivery to Site, all materials shall be properly stacked in a dry and well-ventilated area, under cover and protected from the weather and moisture.

4.2 General Workmanship Requirements

4.2.1 Method of Works

Carry out the works in accordance with the method of works, as submitted to the SO. Ensure construction will achieve the design as set out in the approved shop and drawings.

4.2.2 Co-ordination and Setting Out

Co-ordinate the waterproofing works with all interfacing work packages and trades to ensure correct setting out and positioning of all penetrations, attachments and other constituent materials and elements.

4.2.3 Handling and Hoisting

Handle and hoist assemblies carefully, at all stages to ensure that sections and finishes are not damaged, and in accordance with the manufacturer's recommendations.

4.3 Preparation

4.3.1 Surface Preparation

Prepare all horizontal and vertical surfaces, to which membrane shall be applied (including elevations, upstands, curbs, and protrusions), ensuring that the substrates shall be clean, dry, smooth, free from honeycombs, sharp protrusions, voids, laitance, dust, loose material, sand particles, paint, oil, incompatible curing agent or any other contaminants, unwanted particles, and other defects.

4.3.2 Priming

Apply primer to substrate, ensuring full coverage and allow to dry prior to application of membrane.

4.4 Application of Damp-Proof Membranes

4.4.1 General Requirements

4.4.1.1 Extent of Damp-Proof Membrane

Apply damp-proof membrane to the entire floor in contact with soil. Lay damp-proof course to all walls complying with BS 6398 Type B (felt fibre base) weighing 3.3 kg per m² laid to break joint on a layer of cement and sand mortar laid immediately under the lowest course of blocks or bricks at ground floor level or at level 150 mm to 220 mm above ground level in brickwalls.

Except for bath/WC and kitchen, all other areas including living rooms, bedrooms and household shelters of the first storey residential units shall be provided with damp-proof membrane. The damp-proof membrane shall be laid to the underside of RC ground floor slab. The damp-proof membrane shall comply with BS 6398 Type B (felt fibre base) weighing 3.3 kg per m². The substrate shall be float-finished to receive the damp-proof membrane. The damp-proof membrane shall be strip-bonded onto the substrate with rubberised bitumen adhesive, to the manufacturer's printed instructions.

4.4.1.2 Dressing of Membrane

Dress membrane over penetrations and attachments, and down into outlets.

4.4.1.3 Perimeter of Membrane

Mechanically secure pressure seal at all edge conditions, changes of plane, curb flashings, upstands, etc.

Lay a strip of reinforced membrane at the edge of the horizontal plane and fasten mechanically.

Dress membrane over all perimeter profiles, and bond to substrate and to secured perimeter reinforcing strip.

4.4.2 Application of Liquid Applied Membranes

Apply liquid membranes to areas inaccessible to damp-proof membranes.

For 2-component (2-part) systems, ensure that the compounds are accurately measured and mixed for the time duration recommended by the membrane manufacturer.

4.4.2.1 Bituminous

Mix mechanically, the waterproofing compounds as necessary, to achieve a lump-free and workable liquid for application.

Where required, apply a proprietary recommended primer.

Apply the bituminous liquid applied membrane onto all prepared and primed surfaces, using brush, roller, spray, or squeegee, in accordance with the following product-specific requirements:

- (a) Minimum number of coats required
- (b) WFT per coat
- (c) Drying time between coats
- (d) Minimum total DFT

4.4.2.2 Flexible Non-Cementitious Liquid Applied Membrane

Mix mechanically, the waterproofing compounds as necessary, to achieve a lump free and workable liquid for application.

Where required, apply a proprietary recommended primer.

Apply the non-cementitious liquid applied membrane onto all prepared and primed surfaces to be waterproofed, using roller, spray, brush, trowel or squeegee, in accordance with the following product specific requirements:

- (a) Minimum number of coats required
- (b) WFT per coat
- (c) Drying time between coats
- (d) Minimum total DFT

4.4.3 Application of Sheet Membranes

4.4.3.1 Bituminous: Self-Adhesive

Plan the installation of the self-adhesive sheet membrane to avoid joints at corners and penetrations.

Install the membrane from lowest point to the highest point of a surface to ensure that laps are self-flashing to facilitate shedding water.

Install the membrane, by bonding the membrane to the prepared and primed substrates. Do not allow entrapment of air, bubble or wrinkles.

Lap and seal all longitudinal and transverse joints.

Apply a proprietary recommended protection course and or material(s), to protect the membrane.

Lay a proprietary recommended slip sheet over the entire membrane surface, if the protection course is a RC topping slab.

4.4.4 Surfacing

Where required, apply a 20 mm thick waterproof screed over the damp-proof membrane.

Where the surfacing material is a RC topping slab or ballast materials, add a proprietary recommended slip sheet in between the membrane and surfacing material.

4.4.5 Waterproof Screed

Apply strictly to manufacturer's recommendations and accepted methods.

4.4.6 Protection

Ensure that from completion of the damp-proof membrane works until practical completion:

- (a) The waterproofed area is not used as a working platform unless fully protected to the satisfaction of the SO.
- (b) Do not allow petroleum-based solvents or other chemicals harmful to bitumen to come into contact with the damp-proof membrane surface.

Protect the damp-proofing areas from damage by subsequent building operations.

4.4.7 Wet Weather

Provide temporary covers and drainage as required to keep unfinished areas 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.

5 VERIFICATION AND SUBMISSION

5.1 Submissions

5.1.1 Technical Submissions

Include in the construction programme, event for submission of the following information:

- (a) Damp-proof membrane system**
 - (i) Manufacturer, supplier and proprietary brand and technical details of the membrane being used**
 - (ii) Composition of the waterproofing system and other associated components**
- (b) Membrane applicator**
 - (i) Name**
 - (ii) Information of contracts, current or completed over last 5 years and details of quality control procedures adopted**

5.1.2 Work Submissions

5.1.2.1 Method Statement

Prior to commencing construction work, submit a detailed method statement to the SO. Include at least the following information:

- (a) Sequence of construction**
- (b) Application of waterproofing system**
- (c) Protection of the Works**

5.1.2.2 Shop Drawings

Prepare shop drawings, particularly include the following:

- (a) Setting out plans, including:**
 - (i) location of services and protrusions.**
 - (ii) layout of membrane.**
 - (iii) layout of surface finishes.**
- (b) Co-ordination drawings, showing integration of:**
 - (i) drainage and mechanical services system.**

- (ii) surface finishes.
- (c) Typical sectional details of:
 - (i) composition of the damp-proof membrane system.
 - (ii) flashing at upstands.
 - (iii) flashing of services and protrusions.
 - (iv) termination of surfacing materials.
 - (v) dressing of waterproofing membrane at penetrations.

Do not commence installation until shop drawings and installation drawings have been reviewed and permission to proceed has been obtained from the SO.

5.1.2.3 As-Built Drawings

One original copy of documents showing as-built information and the likes, relevant to the installation. Submit the as-built information in soft copies where directed by the SO.

The Contractor shall compile one single set of the information from various sub-contractors for submission.

5.1.3 Test Reports and Certificate Submissions

5.1.3.1 Materials Certification

Provide the SO with certification from the manufacturer(s) of the following materials/components, certifying that the respective materials are of the correct grade, strength, size, finish, etc., and is in accordance with the relevant codes and standards specified.

- (a) Damp-proof membrane
- (b) Sealant materials

5.1.4 Quality Control Plan Submissions

Prepare and submit the quality control plan to the SO prior to starting work.

5.1.5 Warranty

Submit the warranty upon completion of the Works.

5.1.6 Maintenance Submissions

No item.

5.2 Samples and Mock-ups

5.2.1 Samples

No item.

5.2.2 Mock-ups

Prepare 1 m x 1 m panel sample of each damp-proof membrane, clearly showing compositional materials and components from structural slab to finished surface. Include a sample of the floor/wall junction, the flashing around a 50 mm diameter pipe and the drain outlet.

Keep at least one panel of each respective sample on site, for use as a site quality standard for the remainder of the Works. Provide additional mock-ups for the project as follows:

Mock-up	Size of Panel (mm)
.	.
.	.
.	.

[Note: Customise table to reflect project specific requirements.]

5.3 Inspections

Prepare and submit an inspection plan to the SO.

Carry out inspections at the stages listed as follows, ensuring that the Work is carried out in a proper and orderly manner:

- (a) Preparation of the building substrate, ready for the application of the damp-proof membrane.
- (b) Application of the damp-proof membrane.
- (c) Commencement of any required testing, on or off site.

5.4 On-Site Tests

5.4.1 Test Plan

Prepare and submit test plan to the SO.

5.4.2 On-Site Water Tests

Carry out on site water tests at the stages listed below, to verify serviceability and watertightness, in accordance with the membrane manufacturer's recommendations and specifications:

- (a) Upon completion of damp-proof membrane.
- (b) Upon completion of surfacing material installation.

**Do not conduct on-site water tests until the damp-proof membrane has been laid.
Inform the SO 5 days prior to the tests being carried out.**

Carry out the water tests by blocking up the drain holes and flooding the ground floor to a depth of 25 mm above the highest point of the floor for 24 hrs.

**Any areas showing loss of water, signs of seepage or other defects, shall be made good.
Submit a method statement and remedial measures to the SO. Retest the area after the remedial works have been completed.**

(46) A14-020 LIQUID-APPLIED MEMBRANE SYSTEM

1 GENERAL

Read this Section with G01-010 "General Requirements" and all other contract documents.

1.1 Scope

This Section covers the design development, application, installation and verification of waterproofing systems for internal walls and floors of internal wet areas, such as toilets, bathrooms, kitchens and etc. It covers various combinations of the following:

- (a) Waterproofing Membranes
- (b) Waterproof Screeds
- (c) Floor Screeds and Wall Renders
- (d) Surfacing Materials

1.2 Related Sections

Read this Section in conjunction with the relevant requirements of the following sections:

A02-030 Plasters and Renders

A07-010 Floor Screeds and Hardeners

1.3 Standards, Codes, Regulations and Technical References

1.3.1 Standards

Unless otherwise agreed by the SO, ensure all of the Works comply with the relevant requirements of the standards and codes listed below or referenced in the body of the Specification. Alternative standards and codes may be proposed for approval by the SO, provided it can be demonstrated that the alternative standards and codes comply with the requirements of the standards specified. All standards and codes quoted are the current version, unless specific year references are noted.

In the event that the standards or codes are partially superseded or have become obsolete, refer to the current edition or the approved substitution for the relevant clauses

Singapore Standards	
SS 637	Waterproofing of reinforced concrete buildings
CP 68	Code of practice for ceramic wall and floor tiling – Annex A: Movement Joints
Other Standards	
BS EN 12004	
BS 6213	Guide to Selection of Construction Sealants
BS 8000-4	Workmanship on building sites – Part 4: Code of practice for waterproofing

1.3.2 Regulations

Refer to the following regulations for compliance in carrying out the Works:

Building and Construction Authority â Approved Document ("Approved Document")
Code of Practice for Fire Precautions in Buildings ("Fire Code")

The above regulations refer to the latest edition (including any amendments) that are currently in use.

1.3.3 Technical References

Refer to the following technical references for guidance in carrying out the Works:

Building and Construction Authority â Construction Quality Assessment System (CONQUAS) Manual
Building and Construction Authority â Good Industry Practices Guide Book on Waterproofing for Internal Wet Areas

1.4 Trade Preamble

1.4.1 Contractor's Submissions

The intended types of internal waterproofing are set out in Section A14-020:Clause:3.1. The locations of the internal waterproofing are shown on the drawings.

Based on the information, carry out and submit the following items to the SO:

1.4.1.1 Manufacturer and Products

Submit manufacturer's name and products for each of the components of the waterproofing system(s) to meet with specified requirements.

1.4.1.2 Design Development

Develop all necessary details including connections and interfaces etc. for the construction of the waterproofing system based on the design drawings.

1.4.1.3 Construction Methods

Submit suitable methods to carry out the works including setting out, application of waterproofing membranes, installation and fixing of insulation, surfacing and associated components, etc. Taking into account the performance requirements as set out in Section A14-020:Clause:2.1.

1.4.1.4 Shop Drawings

Prepare co-ordinated shop drawings incorporating all developed details.

1.4.2 Co-ordination with Other Works

Co-ordinate the waterproofing works particularly the interfacing with the following trades:

- (a) Main structural slab and substrate
- (b) External masonry and cladding
- (c) Internal masonry and partitions
- (d) Plumbing works
- (e) Mechanical services
- (f) Electrical services
- (g) Floor and wall finishes
- (h) Doors and windows
- (i) Fixtures and fittings

1.4.3 Provision of Spare Materials

Deliver to site in strong protective packages marked for identification, and store where directed, components and materials for future replacement and repair. Refer to Project Specific Data for list.

Supply the following spare material and store in an area agreed with the SO:

Item	Quantity
A pre-mix water proofing liquid in tin of 10L	5 Tin
	.

1.4.4 Quality Control Plan

Prepare and submit a quality control plan for the SOs review and acceptance.

1.4.5 Warranty

Provide warranty in accordance with contract conditions for the performance of the following items:

- (a) 10-year warranty for waterproofing and watertightness of walls and floors of wet areas.
- (b) 10-year warranty for waterproofing additives.

1.4.6 Maintenance Manual

Prepare and submit an operation/maintenance/replacement manual covering all components and accessories. Refer to G01-010:Clause:1.4.5 for details.

The maintenance manual and logbook shall describe the procedures for the satisfactory long-term care and regular maintenance of the materials and components identified in the Section, to be carried out by the building owners.

Include the following information, where appropriate:

- (a) An outline description of the installation and detailed description of specific terms with product names, types, serial numbers, etc.
- (b) The name, address and telephone number of each supplier, fabricator, finisher, installer etc. involved in the Works.
- (c) Recommendation on maintenance periods and planned preventive maintenance procedures.
- (d) Strategy to ensure that elements that are likely to deteriorate significantly can be replaced or rectified.

- (e) Copies of manufacturersâ warranties or guarantees, service manuals, brochures, recommendations, etc.
- (f) Copies of test and approval certificates.

1.5 Definitions and Abbreviations

The following definitions and abbreviations apply within this Section.

1.5.1 Definitions

No item.

1.5.2 Abbreviations

1.5.2.1 DFT

Dry Film Thickness

1.5.2.2 PBU

Prefabricated Bathroom Unit

1.5.2.3 PPVC

Prefabricated Prefinished Volumetric Unit

1.5.2.4 PVC

Polyvinyl Chloride

1.5.2.5 RC

Reinforced Concrete

1.5.2.6 WFT

Wet Film Thickness

2 PERFORMANCE REQUIREMENTS

2.1 Contractorâs Brief

When carrying out the proposals as set out in Section A14-020:Clause:1.4.1, take account of the following requirements.

2.1.1 Structural

2.1.1.1 Dead Loads

The self-weight and other associated dead loads of the complete water proofing system shall not exceed the assumed design value as indicated in the PSD.

The self weight and other associated dead loads of the complete waterproofing system shall not exceed [2KN/m2]

2.1.1.2 Live Loads

Unless otherwise specified, account for the Live Loads as stipulated in the Building Control Regulations, and additional requirements of other statutory authorities having jurisdiction over the works if any.

2.1.1.3 Thermal Stress and Structural Movement

Take into account, all thermal stress and that the performance, appearance and proper functioning of the Works are not affected by any movements, settlement or deflection in the building structure, which can reasonably be expected to occur. Also take into account the construction accuracy of works by others to which the applied finishes works are attached.

2.1.1.4 Secondary Building Movements

Take into account, forces resulting from secondary support structure movements, including vibration and thermal movement from M&E equipment and related works.

2.1.2 Fire Resistance

Comply with the requirements of the FSSD and additional requirements of other statutory authorities having jurisdiction over the works if any.

2.1.3 Construction

Achieve the following construction accuracy:

- (a) The overall thickness of the waterproofing assembly shall not be less than that as indicated in the design drawings.
- (b) Fall shall be within tolerance of the membrane manufacturer's recommendations and specifications.

2.1.4 Durability

The floor and adjacent walls to which the waterproofing system is applied shall remain impenetrable to water and moisture under the normal conditions that are expected in the design life of the waterproofing system.

3 MATERIALS

3.1 Types of Internal Waterproofing System

The internal waterproofing system(s) (IW) for the project may consist of varying combination of different components as set out below.

Refer to the Project Specific Data for requirements of different types of system(s) for the project.

Select suitable manufacturer and product to comply with the following requirements:

Internal Waterproofing System Type: <i>WP-01</i>		
Items	Requirements	Clause Reference
Waterproofing	.	.
- Falls in floor created by	<i>Contractor to propose. Either Screed or cast to fall depending on span of floor</i>	.
- Waterproofing Membrane	<p>Mapeplan T B – a flexible, plasticizer free TPO, thermoplastic polyolefin preformed waterproofing membrane with reinforced glass mat conformed to EN 13956 Standard, with LEED Credits, BBA and FLL certifications.</p> <p>Mapeplan T D – unreinforced flexible TPO preformed waterproofing membrane for pipe, protrusion termination/detail.</p>	.
- Membrane Reinforcement	<i>Contractor to propose</i>	.
- Primer	<i>Contractor to propose</i>	.
- Slip Sheet	<i>Contractor to propose</i>	.
- Waterproof Screed	<i>Contractor to propose</i>	.
Surfacing Materials	.	.
- Topping Screed	.	.
- RC Topping Slab	.	.
- Surface Tiling	.	.
-Finish over walls	.	.
Miscellaneous Components	.	.
Ancillary Component(s)	.	.

Internal Waterproofing System Type: <i>WP-02</i>		
Items	Requirements	Clause Reference
Waterproofing	.	.
- Falls in floor created by	<i>Contractor to propose. Either Screed or cast to fall depending on span of floor</i>	.
- Waterproofing Membrane	<p>Mapeproof FBH – a non-pressure sensitive, 1.25mm thick fully-bonded, cold-applied, high-density polyethylene (HDPE) membrane laminated with non-woven fleece backing that bond to poured concrete forming a monolithic bond with the structure and against groundwater, moisture in the ground, radon and methane.</p> <p>Polyfond Kit Drain – a high density polyethylene, HDPE protection and drainage mat laminated with a polypropylene needle-punched nonwoven, protecting waterproofing of below grade or earth retaining structures and ensuring perfect ventilation and</p>	.

	excellent water drainage.	
- Membrane Reinforcement	<i>Contractor to propose</i>	.
- Primer	<i>Contractor to propose</i>	.
- Slip Sheet	<i>Contractor to propose</i>	.
- Waterproof Screed	<i>Contractor to propose</i>	.
Surfacing Materials	.	.
- Topping Screed	.	.
- RC Topping Slab	.	.
- Surface Tiling	.	.
-Finish over walls	.	.
Miscellaneous Components	.	.
Ancillary Component(s)	.	.

3.1.1 Proprietary Composite Systems

Where specified, submit to the SO, suitable supplier for the proprietary systems specified. Ensure the individual components comply with the specified requirements and the performance as a composite system shall match or exceed the performance requirements specified for the whole system.

3.2 General Material Requirements

3.2.1 Ancillary Products and Accessories

Where ancillary products and accessories and miscellaneous components are not specified, submit suitable types for the intended purpose to the SO.

3.2.2 Length of Components

Components, particularly sheet waterproofing membrane, profile capping, and flashing shall be in the longest lengths as practical to minimise lapping, joints and wastage.

3.2.3 Compatibility of Materials and Separation

Ensure compatibility of different materials used for the waterproofing system in particular.

- (a) Prevent contact between incompatible materials / components, particularly primer with metal pipes and metals with alloys.
- (b) Materials used for separation of dissimilar materials / components shall comply with the following quality:
 - (i) Non-conducting, non-compressible and non-water absorbing.
 - (ii) Compatible with the elements with which it comes into contact.

3.3 Substrate

3.3.1 Base Slab and Screed

Where practical construct the structural base slab to a fall of 1:80.

Where not possible or practical to construct the base slab to a fall, apply a base screed to achieve a fall of 1:80. Base screed shall be prepacked cement/sand with proprietary additives. Refer to Section A07-010 "Floor Screeds and Hardener" for general requirement of screed materials.

Provide galvanised wire mesh reinforcement when the screed is thicker than 50 mm.

3.3.2 Wall Render

Refer to Section A02-030 "Plasters and Renders" for general requirement of render materials for walls.

3.4 Waterproofing Systems: Membranes

3.4.1 Liquid Applied Membranes

3.4.1.1 Flexible Non-Cementitious Waterproof Membranes

Flexible non-cementitious liquid applied membranes shall be of the following type. Submit to the SO, suitable proprietary products and submit relevant technical literatures, standards referred to and product specifications. The membrane shall be compatible and able to receive tile adhesives.

3.4.1.2 Liquid Applied Membrane

Submit to the SO, suitable proprietary products and relevant technical literatures, standards referred to and product specifications. The membrane shall be compatible and able to receive tile adhesives.

Table 1 Testing Criteria for Liquid Applied Membrane

No.	Product Performance		Testing Criteria
1	Resistance to water penetration; DIN 1048:5 (mm)		Depth of penetration should be zero when tested at 0.2 kg/cm ² for 12 hours
2	Adhesion to substrate after 28 days cure; ASTM D4541 (N/mm ²) 7 days air cure 7 days water cure		≥ 1.0N/mm ² ≥0.5 N/mm ²
3	Tensile Strength; ASTM D412:2006 (N/mm ²)	a) Before ageing	≥ 1.5 N/mm ²
		b) after ageing at 50 °C after 14 days	> 1.2 N/mm ² and –ve change < 40%. No limit for +ve change.
		After immersion in the following chemicals for 72 hr at room temp.	
		c) 0.5% (v/v) NaOCl	
		d) 1.25% (v/v) NH ₄ OH	
2	Elongation at break; ASTM D412:2006 (%)	a) Before geing	> 300%
		b) after ageing at 50 °C after 14 days	≥ 120 % and –ve change < 40%. No limit for +ve change.
		After immersion in the following chemicals for 72 hr at room temp.	
		c) 0.5% (v/v) NaOCl	
		d) 1.25% (v/v) NH ₄ OH	
4	Crack Bridging; ASTM C836:2012		1) No cracking at 2mm width
			2) No cracks after 10 cycles of stretching and closing to a width of 1mm
5	Hardness (Shore A) after 7 days cure; ASTM D2240		≥ 40

6	Set-to-touch; ASTM D1640 (mins)	Touch dry within 2 hours
7	Volatile content	< 50 %
8	Verification of base polymer	Polymer which undergoes hydrolysis should not be used
9	Adhesive compatible to bond directly onto membrane: Improved performance and deformable cementitious adhesive – ISO 13007-1 & BS EN 12004	Adhesives with the following classifications: C2TE/S1 or C2FT/S1 or C2FTES2
10	Singapore Green Building Product Certified	Yes

3.5 Waterproofing Systems: Waterproof Screed

Minimum 25 mm thick, in compliance with SS 637.

Where required, these shall be proprietary pre-packed product, organic or inorganic. Refer to Section A14-020:Clause:3.1 for product(s) specified for this project, if any.

3.6 Waterproofing Systems: Auxiliary Components

3.6.1 Membrane Reinforcement

Membranes reinforcement shall be laid in accordance with manufacturer's recommendations. unless otherwise agreed.

Membrane reinforcement that can be used shall include:

- (a) Alkali-resistant Polyester Film with Glass Fibre Matt
- (b) Alkali-resistant Perforated Fibre Glass Matt
- (c) Non-woven Polyester Fabric
- (d) Self-adhesive butyl tape with alkali-resistant, non-woven fabric

3.6.2 Slip Sheet

Submit to the SO, suitable product of the following materials:

- (a) Polyester Geotextile Fabric overlaid with Polyethylene sheeting
- (b) Polypropylene

(c) PVC sheeting

3.6.3 Pressure Seals

Pre-drilled extruded aluminium with head recess to allow for the formation of a suitably shaped sealant joint to temporary plug downpipes while carrying out water test. Submit to the SO, suitable product.

3.7 Waterproofing Systems: Primers and Bonding Compounds

3.7.1 Primer

Primer shall be proprietary type, compatible with the membrane used and does not affect metal fittings, PVC and other plastics, and recommended for the intended purpose by the membrane manufacturer, to be submitted to the SO. In this case, the primer is applied to consolidate PBU and PPVC drywall where the substrate surface is dusty.

3.7.2 Bonding Compounds

Unless otherwise agreed, use products recommended by the membrane manufacturer for the conditions and type of surface.

3.8 Waterproofing Systems: Materials for Joints

3.8.1 Sealants for Joints

Sealant materials for use on drywall joints shall be approved polyurethane which is paintable suggested in SS 637 Annex A. Sealant materials for use on tile joints shall be approved Silicone, Polyurethane or Polysulphide, suggested in SS 637 Annex A and complying with CP 68 Annex A: Movement Joints and BS 6213

3.8.2 Sealants for Use in Water

Where there is permanent contact with water, sealants shall be silicone, polyurethane or polysulphide, to be submitted to the SO.

3.8.3 Sealants for Use in Traffic Loads

Use high modulus sealants in these conditions, to be submitted to the SO.

3.8.4 Gaskets

Natural rubber compounds protected by a synthetic rubber skin. If special properties such as resistance to oils are desired, synthetic rubber and plastics materials have to be specifically formulated for the intended use.

Gaskets shall be solid or hollow sections of various profiles formed from cellular or non-cellular material or combinations of these materials or sections. Submit suitable product to the SO.

3.8.5 Sealing Strips

Sealing strips shall be mastic strips and impregnated, or coated cellular strips, complying with SS 637.

3.8.6 Joint Fillers

Joint fillers such as cellular plastics and rubbers shall comply with SS 637

3.8.7 Baffles

Materials for baffles shall comply with SS 637.

3.9 Surfacing Materials

3.9.1 Topping Screed

Topping screed shall be cement/sand and proprietary additives. Achieve a fall of 1:80 unless otherwise indicated in the drawings. Provide galvanised steel mesh reinforcement when the screed is thicker than 50 mm.

3.9.2 Reinforced Concrete Topping

Unless otherwise specified, reinforced concrete topping shall be grade 40 concrete with coarse aggregate not exceeding 14 mm, reinforced with steel reinforcement as indicated in the drawings.

For material requirements, refer to structural specifications.

Submit suitable joints and joint filler material to the SO.

3.9.3 Surface Tiling

Refer to Section A02-040 "Wall Tiling" for general requirement of materials.

Refer to Section A14-020:Clause:3.1 for type of tiles selected for the project.

3.10 Drainage

For requirements of waste pipes, valves and fittings, refer to drawings and mechanical specifications.

4 WORKMANSHIP

4.1 Delivery, Storage and Handling

On delivery to Site, all materials shall be properly stacked in a dry and well-ventilated area, under cover and protected from the weather and moisture.

4.2 General Workmanship Requirements

4.2.1 Method of Works

Carry out the Works in accordance with the method of works, as submitted to the SO. Ensure construction achieves the design as set out in the approved shop and drawings.

4.2.2 Co-ordination and Setting Out

Co-ordinate the waterproofing works with all interfacing works packages and trades to ensure correct setting out and positioning of all penetrations, attachments, and other constituent materials and elements.

4.2.3 Handling and Hoisting

Handle and hoist assemblies carefully, at all stages to ensure that sections and finishes are not damaged, and are in accordance with manufacturer's recommendations.

4.3 Preparation

4.3.1 Slope to Fall

Grade all substrate to a fall of 1:80 towards drainage outlets, either by tilting the RC structural base slab or by means of screeding. Refer to Section A07-010 "Floor Screeds and Hardener" for general requirements on workmanship for screeding.

4.3.2 Render to Walls

Flush point mortar joints and render walls with cement and sand mix to the extent of the waterproofing application. Refer to Section A02-030 "Plasters and Renders" for general requirements on workmanship for rendering.

4.3.3 Surface Preparation

Prepare all horizontal and vertical surfaces, to which membrane shall be applied (including elevations, upstands, curbs and protrusions), ensuring that the substrates are clean, dry, smooth, free from honeycombs, sharp protrusions, voids, laitance, dust, loose material, sand particles, paint, oil, incompatible curing agent or any other contaminants, unwanted particles and other defects.

4.3.3.1 Moisture Content Test

Use a moisture meter to carry out a moisture content test to verify that the moisture content of the substrate is within the product specific tolerance, suitable for the application of waterproofing membrane.

4.3.4 Cracks

Seal all cracks and movement joints with reinforcement and sealant, and allow to cure. Repair all structural cracks to the SO's approval.

4.3.5 Chamfering of Corners

Provide fillet beads to chamfer all 90 degree corners (such as those formed by RC deck to wall, RC deck to curb, RC deck to pipe, pipes in junction to floor slab and etc.), reinforce, seal, and allow to dry or cure. Provide 20 mm x 20 mm triangular beads from sealants or mortar.

4.3.6 Priming

Apply primer to substrate, ensuring full coverage and allow to dry prior to application of membrane.

4.4 Application of Membranes

4.4.1 General Requirements

4.4.1.1 Extent of Waterproofing

Apply waterproofing membrane to the entire floor of the wet area and turn up every wall to a minimum height of 300 mm from the finished floor level. In bath and shower areas, apply waterproofing membrane to a height of at least 1800 mm from the finished floor level and width of 1500 mm for all walls of the enclosure.

4.4.1.2 Dressing of Membrane

Dress membrane over penetrations and attachments, and down into floor outlets.

4.4.1.3 Perimeter of Membrane

Mechanically secure pressure seal at all edge conditions, changes of plane, curb flashings, upstands, etc.

Lay a strip of reinforced membrane at the edge of the horizontal plane and mechanically fasten.

Dress membrane over all perimeter profiles and bond to substrate and the secured perimeter reinforcing strip.

4.4.2 Application of Liquid Applied Membranes

Where liquid applied membranes consist of two formulations (one for horizontal and one for vertical application), determine the correct formulation prior to application.

For two components (two-part) systems, ensure that the compounds are accurately measured and mixed for the time recommended by the membrane manufacturer.

4.4.2.1 Flexible Non-Cementitious Liquid Applied Membrane

Mix mechanically, the waterproofing compounds as necessary, to achieve a lump-free and workable liquid for application.

Where required, apply a proprietary recommended primer.

Apply the non-cementitious liquid applied membrane onto all prepared and primed surfaces to be waterproofed, using roller, spray, brush, trowel, or squeegee, in accordance with the following product specific requirements:

- (a) Minimum number of coats required
- (b) WFT per coat
- (c) Drying time between coats
- (d) Minimum total DFT
- (e) Tile-over time (after final coat)

4.4.3 Surfacing

Where required, apply a 20-mm thick waterproof screed over the membrane.

Apply surfacing material over the waterproof screed.

Where tiles are laid directly onto the waterproof screed or membrane, use a compatible proprietary adhesive recommended by the membrane manufacturer.

Where the surfacing material is a RC topping slab or ballast materials, add proprietary recommended slip sheet in between the membrane and surfacing material.

4.5 Waterproof Screed

Apply strictly to manufacturer's recommendations and accepted methods.

4.6 Protection

Ensure that from completion of the waterproofing works until Practical Completion:

- (a) the waterproofed area is not used as a working platform unless fully protected to the satisfaction of the SO;
- (b) do not allow petroleum based solvents or other chemicals harmful to bitumen to come into contact with the waterproofed surface;
- (c) protect the waterproofed areas from damage by subsequent building operations.

4.6.1 Wet Weather

Provide temporary covers and drainage as required to keep unfinished areas 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.

5 VERIFICATION AND SUBMISSION

5.1 Submissions

5.1.1 Technical Submissions

Include in the construction programme, events for submission of the following information:

- (a) Waterproofing system
- (b) Manufacturer, supplier and proprietary brand and technical details of the membrane being used
- (c) Composition of the waterproofing system and other associated components
- (d) Membrane applicator
- (e) Name
- (f) Information of contracts, current or completed over last 5 years and details of quality control procedures adopted

5.1.2 Work Submissions

5.1.2.1 Method Statements

Prior to commencing construction work, submit a detailed method statement to the SO. Include at least the following information:

- (a) Sequence of construction
- (b) Application of waterproofing system
- (c) Protection of the works

5.1.2.2 Shop Drawings

Prepare shop drawings, particularly include the items below.

- (a) Setting out plans, including the following information:
 - (i) Location of services and protrusions
 - (ii) Layout of membrane
 - (iii) Layout of surface finishes
- (b) Co-ordination drawings, showing integration of the following items:
 - (i) Drainage and mechanical services system
 - (ii) Surface finishes
- (c) Typical sectional details of the following:
 - (i) Composition of the waterproofing system
 - (ii) Flashing at upstands
 - (iii) Flashing of Services and protrusions
 - (iv) Termination of Surfacing materials
 - (v) Dressing of waterproofing membrane at floor traps and wastes

Do not commence installation until shop and installation drawings have been reviewed and permission to proceed has been obtained from the SO.

5.1.2.3 As-Built Drawings

One original copy of documents showing as-built information and the likes, relevant to the installation. Submit the as-built information in soft copies where directed by the SO.

The Contractor shall compile one single set of the information from various sub-contractors for submission.

5.1.3 Test Reports and Certificate Submissions

5.1.3.1 Material Certification

Provide the SO with certification from the manufacturer(s) of the following materials / components, certifying that the respective materials are of the correct grade, strength, size, finish, etc, and is in accordance with the relevant codes and standards specified.

- (a) Waterproofing membrane
- (b) Sealant materials

5.1.4 Quality Control Plan Submissions

Prepare and submit the quality control plan to the SO prior to starting work.

5.1.5 Warranty

Submit the warranty upon completion of the Works.

5.1.6 Maintenance Submissions

Submit maintenance/replacement manual at the completion of the construction.

Include the following information in the maintenance manual and logbook:

- Cleaning of drain outlets

5.2 Samples and Mock-ups

5.2.1 Samples

No item.

5.2.2 Mock-ups

Prepare 1 m x 1 m panel sample of each internal floor and wall waterproofing type, clearly showing compositional materials and components from structural slab to finished surface. Include a sample of the floor-to-wall junction, the flashing around a 50 mm diameter pipe and the drain outlet.

Keep at least one panel of each respective sample on site, for use as a site quality standard for the remainder of the Works.

Provide additional mock-ups for the project as follows:

Mock-up	Size of Panel (mm)
.	.
.	.

[Note: Customise table to reflect project specific requirements.]

5.3 Inspections

Prepare and submit an inspection plan to the SO.

Carry out inspections at the following stages, ensuring that the Work is carried out in a proper and orderly manner:

- (a) Preparation of the building substrate, ready for the application of the waterproofing membrane.
- (b) Application of the waterproofing membrane.

- (c) Commencement of any required testing, on or off site.

5.4 On-Site Tests

5.4.1 Test Plan

Prepare and submit test plan to the SO.

5.4.2 On-Site Water Test

Carry out on-site water tests at the following stages to verify serviceability and water-tightness, in accordance with the membrane manufacturer's recommendations and specifications.

- (a) Upon completion of final coat of membrane.
- (b) Upon completion of surfacing material installation.

Do not conduct on-site water test until the membrane is cured and set.
Inform the SO 5 days prior to the tests being carried out

Carry out the water tests by blocking up the drain holes and flooding the floor to a depth of 25 mm above the highest point of the floor for 24 hours and the running of the shower head onto each of the tiled walls for 15 minutes.

Any areas showing water penetration through the floor, signs of seepage or other defects, shall be made good. Submit a method statement and remedial measures to the SO. Retest the area after the remedial works have been completed.

(47) A14-030 CEMENTITIOUS SYSTEM

1 GENERAL

Read this Section with G01-010 "General Requirements" and all other contract documents.

1.1 Scope

This section covers the design development, application, installation and verification of waterproofing systems for internal walls and floors of internal wet areas, such as toilets, bathrooms, kitchens and etc. It covers various combinations of the following:

- (a) Waterproofing membranes
- (b) Waterproof screeds
- (c) Floor screeds and wall renders
- (d) Surfacing materials

1.2 Related Sections

Read this Section in conjunction with the relevant requirements of the following sections:

A02-030	Plasters and Renders
A07-010	Floor Screeds and Hardeners

1.3 Standards, Codes, Regulations and Technical References

1.3.1 Standards and Codes

Unless otherwise agreed by the SO, ensure all of the Works comply with the relevant requirements of the standards and codes listed below or referenced in the body of the Specification. Alternative standards and codes may be proposed for approval by the SO, provided it can be demonstrated that the alternative standards and codes comply with the requirements of the standards specified. All standards and codes quoted are the current version, unless specific year references are noted.

In the event that the standards or codes are partially superseded or have become obsolete, refer to the current edition or the approved substitution for the relevant clauses.

Singapore Standards	
SS 133	Specification for bituminous emulsion for roof waterproofing
SS 374	Specification for preformed waterproofing membranes for concealed roofing system
SS 637	Waterproofing of reinforced concrete buildings
CP 68	Code of practice for ceramic wall and floor tiling – Annex A: Movement Joints
Other Standards	
ASTM C836	Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course
ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers
ASTM D1640	Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings
ASTM D2240	Standard Test Method for Rubber Property
ASTM D4541	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

1.3.2 Regulations

Refer to the following regulations for compliance in carrying out the Works:

Building and Construction Authority â Approved Document ("Approved Document")
Code of Practice for Fire Precautions in Buildings ("Fire Code")

The above regulations refer to the latest edition (including any amendments) that are currently in use.

1.3.3 Technical References

Refer to the following technical references for guidance in carrying out the Works:

Building and Construction Authority â Construction Quality Assessment System (CONQUAS) Manual
Building and Construction Authority â Good Industry Practices Guide Book on Waterproofing for Internal Wet Areas

1.4 Trade Preamble

1.4.1 Contractorâs Submissions

The intended types of internal waterproofing are set out in Section A14-030:Clause:3.1. The locations of the internal waterproofing are shown on the drawings. Based on the information, carry out and submit the following items to the SO.

1.4.1.1 Manufacturer and products

Submit manufacturer and products for each of the components of the waterproofing system(s) to meet with specified requirements.

1.4.1.2 Design Development

Develop all necessary details including connections and interfaces, etc., for the construction of the waterproofing system based on the design drawings.

1.4.1.3 Construction Methods

Submit suitable methods to carry out the Works including setting out, application of waterproofing membranes, installation and fixing of insulation, surfacing and associated components, etc. Take into account the performance requirements as set out in Section A14-030:Clause:2.1.

1.4.1.4 Shop Drawings

Prepare co-ordinated shop drawings incorporating all developed details.

1.4.2 Co-ordination with Other Works

Co-ordinate the waterproofing works particularly the interfacing with the following trades:

- (a) Main structural slab and substrate
- (b) External masonry and cladding
- (c) Internal masonry and partitions
- (d) Plumbing works
- (e) Mechanical services
- (f) Electrical services
- (g) Floor and wall finishes
- (h) Doors and windows
- (i) Fixtures and fittings

1.4.3 Provision of Spare Materials

Deliver to Site in strong protective packages marked for identification, and store where directed, components and materials for future replacement and repair.

Supply the following spare material and store in an area agreed with the SO:

Item	Quantity
Cementitious powder for mixture including the required component	5%
.	.

1.4.4 Quality Control Plan

Prepare and submit a quality control plan for the SOs review and acceptance.

1.4.5 Warranty

Provide warranty in accordance with contract conditions for the performance of the following items:

- (a) 10-year warranty for waterproofing and watertightness of walls and floors of wet areas.
- (b) 10-year warranty for waterproofing additives.

1.4.6 Maintenance Manual

Prepare and submit an operation/maintenance/replacement manual covering all components and accessories. Refer to G01-010:Clause:1.4.5 for details.

The maintenance manual and logbook shall describe the procedures for the satisfactory long-term care and regular maintenance of the materials and components identified in the Section, to be carried out by the building owners.

Include the following information, where appropriate:

- (a) An outline description of the installation and detailed description of specific terms with product names, types, serial numbers, etc.
- (b) The name, address and telephone number of each supplier, fabricator, finisher, installer etc. involved in the Works.
- (c) Recommendation on maintenance periods and planned preventive maintenance procedures.
- (d) Strategy to ensure that elements that are likely to deteriorate significantly can be replaced or rectified.
- (e) Copies of SO's manufacturers' warranties or guarantees, service manuals, brochures, recommendations, etc.
- (f) Copies of test and approval certificates.

One original copy of documents showing "As Built" information and the like, relevant to the installation. Submit the "As Built" information in soft copies where directed by the SO. The Contractor shall compile one single set of the information from various sub-contractors for submission.

1.5 Definitions and Abbreviations

The following definitions and abbreviations apply within this Section.

1.5.1 Definitions

No item.

1.5.2 Abbreviations

1.5.2.1 DFT

Dry Film Thickness

1.5.2.2 RC

Reinforced Concrete

1.5.2.3 WFT

Wet Film Thickness

2 PERFORMANCE REQUIREMENTS

2.1 Contractor's Brief

When carrying out the proposals as set out in Section A14-030:Clause:1.4.1, take account of the following requirements.

2.1.1 Structural

2.1.1.1 Dead Loads

The self-weight and other associated dead loads of the complete water proofing system shall not exceed the assumed design value as indicated in the Project Specific Data.

The self-weight and other associated dead loads of the complete waterproofing system shall not exceed 2 kN/m².

2.1.1.2 Live Loads

Unless otherwise specified, account for the live loads as stipulated in the Building Control Regulations, and additional requirements of other statutory authorities having jurisdiction over the Works, if any.

2.1.1.3 Thermal Stress and Structural Movement

Take into account all thermal stress and that the performance, appearance and proper functioning of the Works are not affected by any movements, settlement or deflection in the building structure, which can reasonably be expected to occur. Also take into account the construction accuracy of works by others to which the applied finishes works are attached.

2.1.1.4 Secondary Building Movements

Take into account, forces resulting from secondary support structure movements, including vibration and thermal movement from M&E equipment and related works.

2.1.2 Fire Resistance

Comply with the requirements of the FSSD and additional requirements of other statutory authorities having jurisdiction over the Works if any.

2.1.3 Construction

Achieve the following construction accuracy:

- (a) The overall thickness of the waterproofing assembly shall not be less than that as indicated in the design drawings.
- (b) Fall shall be within tolerance of the membrane manufacturer's recommendations and specifications.

2.1.4 Durability

The floor and adjacent walls to which the waterproofing system is applied shall remain impenetrable to water and moisture under the normal conditions that are expected in the design life of the waterproofing system.

3 MATERIALS

3.1 Types of Internal Waterproofing System

The internal waterproofing (IW) system(s) for the project may consist of varying combination of different components as set out below.

Refer to the Project Specific Data for requirements of different types of system(s) for the project.

Select suitable manufacturer and product to comply with the following requirements:

Type: WP-02 & WP-04		
Items	Requirements	Clause Reference(s)
Waterproofing	.	.
-Falls in floor created by	<i>Contractor to propose. Either Screed or cast to fall depending on span of floor</i>	3.3.1
-Waterproofing Membrane	Mapelastic Smart – a two-component high flexibility cementitious waterproofing membrane with crack-bridging more than 2mm.	3.4
-Membrane Reinforcement	<i>Contractor to propose</i>	3.6.1
-Primer	<i>Contractor to propose</i>	3.7.1
-Slip Sheet	<i>Contractor to propose</i>	3.6.2
-Waterproof Screed	<i>Contractor to propose</i>	3.5
Surfacing Materials	.	.
-Topping Screed	.	3.9.1
-RC Topping Slab	.	3.9.2
-Surface Tiling	.	3.9.3
Finish over walls	.	.
Miscellaneous Components	.	.
-Ancillary Component(s)	.	3.2.1

3.1.1 Proprietary Composite Systems

Where specified, submit to the SO, suitable supplier for the proprietary systems specified. Ensure the individual components comply with the specified requirements and the performance as a composite system shall match or exceed the performance requirements specified for the whole system.

3.2 General Material Requirements

3.2.1 Ancillary Products and Accessories

Where ancillary products and accessories and miscellaneous components are not specified, submit suitable types for the intended purpose to the SO.

3.2.2 Length of Components

Components, particularly sheet waterproofing membrane, profile capping, and flashing shall be in the longest lengths as practical to minimise lapping, joints and wastage.

3.2.3 Compatibility of Materials and Separation

Ensure compatibility of different materials used for the waterproofing system in particular.

- (a) Prevent contact between incompatible materials/components, particularly primer with metal pipes and metals with alloys.
- (b) Materials used for separation of dissimilar materials/components shall comply with the following quality:
 - (i) Non-conducting, non-compressible and non-water absorbing.
 - (ii) Compatible with the elements with which it comes into contact.

3.3 Substrate

3.3.1 Base Slab and Screed

Where practical, construct the structural base slab to a fall of 1:80.

Where not possible or practical to construct the base slab to a fall, apply a base screed to achieve a fall of 1:80. Base screed shall be pre-packed cement/sand with proprietary additives. Refer to Section A07-010:Clause:3 for general requirement of screed materials.

Provide galvanised wire mesh reinforcement when the screed is thicker than 50 mm.

3.3.2 Wall Render

Refer to Section A02-030:Clause:3 for general requirement of render materials for walls.

3.4 Waterproofing Systems: Membranes

3.4.1 Liquid Applied Membranes

3.4.1.1 Bituminous

Bituminous liquid applied membranes to comply with SS 133.

Flexible non-cementitious liquid applied membranes shall be of the following type. Submit to the SO, suitable proprietary products and submit relevant technical literatures, standards referred to and product specifications. The membrane shall be compatible and able to receive tile adhesives.

3.4.1.2 Flexible Cementitious Membrane

Submit to the SO, suitable proprietary products and relevant technical literatures, standards referred to and product specifications. The membrane shall be compatible and able to receive tile adhesives.

Table 1 Testing criteria for flexible cementitious membrane

No.	Tests			Testing Criteria
1	Resistance to water penetration; DIN 1048 Part 5 (mm)			Depth of penetration should be zero
2	Adhesion to substrate after 28 days cure; ASTM D4541 (N/mm2)			≥ 0.3 N/mm2
3	Tensile Strength;	a) Before ageing		≥ 1.5 N/mm2
	ASTM D412:2006 (N/mm2)	b) after ageing at 50 °C after 14 days		≥ 1.2 N/mm2 and –ve change ≤ 40%. No limit for +ve change.
		After immersion in the following chemicals for 72 hr at room temp.	c) 0.5% (v/v) NaOCl	
			d) 1.25% (v/v) NH 4OH	
e) 3.7% (v/v) HCl				
2	Elongation at break; ASTM D412:2006 days (%)	a) Before ageing		≥ 150%
		b) after ageing at 50 °C after 14 days		≥ 120 % and –ve change ≤ 40%. No limit for +ve change.
		After immersion in the following chemicals for 72 hr at room temp.	c) 0.5% (v/v) NaOCl	
			d) 1.25% (v/v) NH 4OH	
e) 3.7% (v/v) HCl				
4	Crack Bridging; ASTM C836:2012			1) No cracking at 2 mm width
				2) No cracks after 10 cycles of stretching and closing to a width of 1mm

5	Hardness (Shore A) after 7 days cure; ASTM D2240	≥ 40
6	Set-to-touch; ASTM D1640 (mins)	Touch dry within 2 hours
7	Chloride content	$< 0.1\%$
8	Verification of base polymer	Polymer which undergoes hydrolysis should not be used
9	Singapore Green Building Product Certified	Yes

3.5 Waterproofing Systems: Waterproof Screed

Minimum thickness of 20 mm; comply with SS 637.

Where required, these shall be proprietary pre-packed product, organic or inorganic. Refer to Section A14-030:Clause:3.1 for product(s) specified for this project, if any.

3.6 Waterproofing Systems: Auxiliary Components

3.6.1 Membrane Reinforcement

Membranes reinforcement shall comply with SS 133 and SS 374 unless otherwise agreed.

Membrane reinforcement that can be used shall include:

Alkali-resistant polyester film with glass fibre matt

- (a) Alkali-resistant perforated fibre glass matt
- (b) Non-woven polyester fabric

3.7 Waterproofing Systems: Primers and Bonding Compounds

3.7.1 Primer

Primer shall be proprietary type, compatible with the membrane used and does not affect metal fittings, PVC and other plastics, and recommended for the intended purpose by the membrane manufacturer, to be submitted to the SO.

3.7.2 Bonding Compounds

Unless otherwise agreed, use products recommended by the membrane manufacturer for the conditions and type of surface.

3.8 Waterproofing Systems: Materials for Joints

3.8.1 Sealants for Joints

Sealant materials used for joints shall be approved silicone, polyurethane or polysulphide, complying with SS 637.

3.8.2 Sealants for Use in Water

Where there is permanent contact with water, sealants shall be silicone, polyurethane or polysulphide, to be submitted to the SO.

3.8.3 Sealants for Use in Traffic Loads

High modulus sealants shall be used in these conditions, and shall be submitted to the SO.

3.8.4 Sealing Strips

Sealing strips shall be mastic strips and impregnated or coated cellular strips, complying with SS 637.

3.8.5 Joint Fillers

Joint filler such as cellular plastics and rubbers shall comply with SS 637.

3.9 Surfacing Materials

3.9.1 Topping Screed

Topping screed shall be cement/sand and proprietary additives and achieve a fall of 1:80 unless otherwise indicated in the drawings. Provide galvanised steel mesh reinforcement when the screed is thicker than 50 mm.

3.9.2 Reinforced Concrete Topping

Unless otherwise specified, reinforced concrete topping shall be grade 40 concrete with coarse aggregate not exceeding 14mm, reinforced with steel reinforcement as indicated in the drawings.

For material requirement refer to structural specifications.

Submit suitable joints and joint filler material to the SO.

3.9.3 Surface Tiling

Refer to Section A02-40 "Wall Tiling" for general requirement of materials.

Refer to Section A14-030:Clause:3.1 for type of tiles selected for the project.

3.10 Drainage

For requirements of waste pipes, valves and fittings refer to the drawings and mechanical specifications.

4 WORKMANSHIP

4.1 Delivery, Storage and Handling

On delivery to Site, all materials shall be properly stacked in a dry and well-ventilated area, under cover and protected from the weather and moisture.

4.2 General Workmanship Requirements

4.2.1 Method of Works

Carry out the Works in accordance with the method of Works, as submitted to the SO. Ensure construction will achieve the design as set out in the approved shop and drawings.

4.2.2 Co-ordination and Setting Out

Co-ordinate the waterproofing works with all interfacing work packages and trades to ensure correct setting out and positioning of all penetrations, attachments, and other constituent materials and elements.

4.2.3 Handling and Hoisting

Handle and hoist assemblies carefully, at all stages to ensure that sections and finishes are not damaged, and in accordance with manufacturer's recommendations.

4.3 Preparation

4.3.1 Slope to Fall

Grade all substrate to a fall of 1:80 towards drainage outlets, either by tilting the RC structural base slab or by means of screeding. Refer to Section A07-010 "Floor Screeds and Hardeners" for general requirements on workmanship for screeding.

4.3.2 Render to Walls

Flush point mortar joints and render walls with cement/sand mix to extent of waterproofing application. Refer to Section A02-030: "Plasters and Renders" for general requirements on workmanship for rendering.

4.3.3 Surface Preparation

Prepare all horizontal and vertical surfaces, to which membranes shall be applied (including elevations, upstands, curbs, and protrusions), ensuring that the substrates shall be clean, dry, smooth, free from honeycombs, sharp protrusions, voids, laitance, dust, loose material, sand particles, paint, oil, incompatible curing agent or any other contaminants, unwanted particles, and other defects.

4.3.3.1 Moisture Content Test

Use a moisture meter to carry out a moisture content test to verify that the moisture content of the substrate is within the product specific tolerance, suitable for the application of waterproofing membrane.

4.3.4 Cracks

Seal all cracks and movement joints, with reinforcement and sealant, and allow to cure. Repair all structural cracks to SO's approval.

4.3.5 Chamfering of Corners

Provide fillet beads to chamfer all 90-degree corners (such as those formed by RC deck to wall, RC deck to curb etc.), reinforce, seal, and allow to dry or cure. Provide 20 mm x 20 mm triangular beads from sealants or mortar.

4.3.6 Priming

Apply primer to substrate, ensuring full coverage and allow to dry prior to application of membrane.

4.4 Application of Membranes

4.4.1 General Requirements

4.4.1.1 Extent of Waterproofing

Apply waterproofing membrane to the entire floor of the wet area and turn up every wall to a minimum height of 300 mm from the finished floor level. In bath and shower areas, apply waterproofing membrane to a height of at least 1800 mm from the finished floor level and width of 1 500 mm for all walls of the enclosure.

4.4.1.2 Dressing of Membrane

Dress membrane over penetrations and attachments, and down into floor outlets.

4.4.1.3 Perimeter of Membrane

Mechanically secure pressure seal at all edge conditions, changes of plane, curb flashings, upstands, etc.

Lay a strip of reinforced membrane at the edge of the horizontal plane and mechanically fasten.

Dress membrane over all perimeter profiles and bond to substrate and to secured perimeter reinforcing strip.

4.4.2 Application of Liquid Applied Membranes

Where liquid applied membranes consist of two formulations (one for horizontal and one for vertical application), determine the correct formulation prior to application.

For two components (two part) systems, ensure that the compounds are accurately measured and mixed for the time recommended by the membrane manufacturer.

4.4.2.1 Bituminous

Mix mechanically, the waterproofing compounds as necessary, to achieve a lump free and workable liquid for application.

Where required, apply a proprietary recommended primer.

Apply the bituminous liquid applied membrane onto all prepared and primed surfaces, using brush, roller, spray, or squeegee, in accordance with the following product specific requirements.

- (a) Minimum number of coats required
- (b) WFT per Coat
- (c) Drying time between coats
- (d) Minimum total DFT
- (e) Tile-over time (after final coat)

Where reinforcement is required, apply polyester reinforcement fabric over the membrane, making sure that there is no entrapment of air in between.

4.4.2.2 Flexible Non-Cementitious Liquid Applied Membrane

Mix mechanically, the waterproofing compounds as necessary, to achieve a lump free and workable liquid for application.

Where require, apply a proprietary recommended primer.

Apply the non-cementitious liquid applied membrane onto all prepared and primed surfaces to be waterproofed, using roller, spray, brush, trowel, or squeegee, in accordance with the following product specific requirements.

- (a) Minimum number of coats required

- (b) WFT per Coat
- (c) Drying time between coats
- (d) Minimum total DFT
- (e) Tile-over time (24 hours / 48 hours after final coat)

4.4.3 Application of Flexible Cementitious Membrane

Where the flexible cementitious membrane consists of two formulations (one for horizontal and one for vertical application), determine the correct formulation prior to application.

For two components (two part) systems, ensure that the components are accurately measured and mixed for the time recommended by the membrane manufacturer.

Mechanically mix the cementitious waterproofing components to the consistency required.

Pre-water the surfaces to which the membrane shall be applied.

Do not apply the membrane onto a hot substrate.

Apply the flexible cementitious membrane onto prepared and primed surfaces, from lowest point to the highest point, using brush, trowel, squeegee, roller or spray, in accordance with the following product specific requirements.

- (a) Minimum number of coats required
- (b) WFT per coat
- (c) Drying time between coats
- (d) Minimum total DFT
- (e) Tile-over time (24 hours / 48 hours after final coat)

Allow the applied flexible cementitious membrane surfaces to cure.

Protect the applied flexible cementitious membrane surfaces from rain, ponding of water, wind and direct sunlight, with plastic sheeting, during the curing period.

4.4.4 Surfacing

Where required, apply a 20 mm thick waterproof screed over the membrane.

Apply surfacing material over the waterproof screed.

Where tiles are laid directly onto the waterproof screed or membrane, use a compatible proprietary adhesive recommended by the membrane manufacturer.

Where the surfacing material is a RC topping slab or ballast materials, add a proprietary recommended slip sheet in between the membrane and surfacing material.

4.5 Waterproof Screed

Apply strictly to manufacturer's recommendations and accepted methods.

4.6 Protection

Ensure that from completion of the waterproofing works until practical completion:

- (a) the waterproofed area is not used as a working platform unless fully protected to the satisfaction of the SO
- (b) do not allow petroleum based solvents or other chemicals harmful to bitumen to come into contact with the waterproofed surface
- (c) protect the waterproofed areas from damage by subsequent building operations.

4.6.1 Wet Weather

Provide temporary covers and drainage as required to keep unfinished areas 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.

5 VERIFICATION AND SUBMISSION

5.1 Submissions

5.1.1 Technical Submissions

Include in construction program, event for submission of the following information:

- (a) Waterproofing system
- (b) Manufacturer, supplier and proprietary brand and technical details of the membrane being used
- (c) Composition of the waterproofing system and other associated components
- (d) Membrane applicator
- (e) Name
- (f) Information of contracts, current or completed over the last 5 years and details of Quality Control Procedures adopted

5.1.2 Work Submissions

5.1.2.1 Method Statements

Prior to commencing construction work, submit a detailed method statement to the SO. Include at least the following information:

- (a) Sequence of construction
- (b) Application of waterproofing system
- (c) Protection of the Works

5.1.2.2 Shop Drawings

Prepare shop drawings, particularly include the following:

- (a) Setting out plans, including the following information:
 - (i) Location of services and protrusions
 - (ii) Layout of membrane
 - (iii) Layout of surface finishes
- (b) Co-ordination Drawings shall show integration of the following items:
 - (i) Drainage and mechanical services system
 - (ii) Surface finishes
- (c) Typical sectional details of the following:
 - (i) Composition of the waterproofing system
 - (ii) Flashing at upstands
 - (iii) Flashing of services and protrusions
 - (iv) Termination of surfacing materials
 - (v) Dressing of waterproofing membrane at floor traps and wastes

Do not commence installation until shop and installation drawings have been reviewed and permission to proceed has been obtained from the SO.

5.1.3 Test Reports and Certificate Submissions

5.1.3.1 Material Certification

Provide the SO with certification from the manufacturer(s) of the following materials/components, certifying that the respective materials are of the correct grade, strength, size, finish, etc., and is in accordance with the relevant codes and standards specified.

(a) Waterproofing membrane

(b) Sealant materials

5.1.4 Quality Control Plan Submissions

Prepare and submit the quality control plan to the SO prior to starting work.

5.1.5 Maintenance Submissions

Submit the maintenance/replacement manual at the completion of construction.

Include the following information in the maintenance manual and logbook:

(a) Cleaning of drain outlets

5.1.6 Warranty

Submit the warranty upon completion of the Works.

5.2 Samples and Mock-ups

5.2.1 Samples

No item.

5.2.2 Mock-ups

Prepare 1 x 1 metre panel sample of each internal floor and wall waterproofing type, clearly showing compositional materials and components from structural slab to finished surface.

Include a sample of the floor-to-wall junction, the flashing around a 50 mm diameter pipe and the drain outlet.

Keep at least one panel of each respective sample on site, for use as a site quality standard for the remainder of the Works.

Refer to the Project Specific Data for additional mock-up requirement, if any.

Provide additional mock-ups for the project as follows:

Mock-up	Size of Panel (mm)	Due Date
.	.	.
.	.	.
.	.	.

5.3 Inspections

Prepare and submit an inspection plan to the SO.

Carry out inspections at the following stages, ensuring that the Work is carried out in a proper and orderly manner:

- (a) Preparation of the building substrate, ready for the application of the waterproofing membrane.
- (b) Application of the waterproofing membrane.
- (c) Commencement of any required testing, on or off site.

5.4 On-Site Tests

5.4.1 Test Plan

Prepare and submit test plan to the SO.

5.4.2 On-Site Water Test

Carry out on-site water tests at the following stages to verify serviceability and watertightness, in accordance with the membrane manufacturer's recommendations and specifications.

- (a) Upon completion of final coat of membrane.
- (b) Upon completion of surfacing material installation.

Do not conduct on-site water tests until the membrane is cured and set. Inform the SO 5 days prior to the tests being carried out.

Carry out the water tests highest point of the floor for 24 hours and the running of the shower head onto each of the tiled walls for 15 minutes.by blocking up the drain holes and flooding the floor to a depth of 25 mm above the

Any areas showing water penetration through the floor, signs of seepage or other defects, shall be made good. Submit a method statement and remedial measures to the SO. Retest the area after

(51) A16-010 CONVENTIONAL RAINWATER DRAINAGE SYSTEM

1 GENERAL

Read this Section with G01-010 "General Requirements" and all other contract documents.

1.1 Scope

This Section covers requirements for:

- (a) Conventional rainwater drainage system and associated drainage system for the conveyance of rainwater to surface drainage, rainwater harvesting tank, detention tank, etc., as shown on drawings.
- (b) Connection of overflow pipes from rainwater harvesting tanks to detention tanks and/or surface drainage system, including all associated fittings and accessories to complete the rainwater drainage system.

This Section does not cover the specification for siphonic rainwater drainage system and wind-driven rainwater drainage system that are appended under separate sections.

1.2 Related Sections

Read this Section in conjunction with the relevant requirements of the following sections:

A02-020	Painting and Coatings
A02-030	Plaster and Renders
A05-010	Metal Roof System
A05-020	Tile Roof System
A05-030	Concrete Roof System
A05-040	Glass Roof System
A06-010	Green Roof Planting
A06-020	Green Facade Planting
A14-010	Damp-proof Membranes
A14-020	Liquid-Applied Membrane System
A14-030	Cementitious System
A14-040	Thermal Barriers
A15-010	Hardscape Works
A15-020	Softscape Works

1.3 Standards, Codes, Regulations and Technical References

1.3.1 Standards and Codes

Unless otherwise agreed by the SO, ensure all of the Works comply with the relevant requirements of the standards and codes listed below or referenced in the body of the Specification. Alternative standards and codes may be proposed for approval by the SO, provided it can be demonstrated that the alternative standards and codes comply with the

requirements of the standards specified. All standards and codes quoted are the current version, unless specific year references are noted.

In the event that the standards or codes are partially superseded or have become obsolete, refer to the current edition or the approved substitution for the relevant clauses.

Singapore Standards	
SS 30	Manhole tops and surface-box tops
SS 141	Specification for unplasticised PVC pipe for cold water services and industrial uses
SS 174	Specification for joints and fittings for use with unplasticised PVC pressure pipes
SS 183	Concrete cylindrical pipes and fittings including manholes and street gullies
SS 213	Unplasticised PVC pipes and fittings for soil, waste and vent applications
SS 272	Specification for unplasticised PVC pipes and fittings below ground for drainlines and sewers
SS 525	Code of practice for drainage of roofs
SS 631	Specification for metal roofing system
SS 637	Code of practice for waterproofing of reinforced concrete buildings
Other Standards	
BS EN 545	Ductile iron pipes, fittings, accessories and their joints for water pipelines – Requirements and test methods
BS EN 598	Ductile iron pipes, fittings, accessories and their joints for sewerage applications – Requirements and test Methods
BS EN 607	Eaves gutters and fittings made of PVC-U – Definitions, requirements and testing
BS EN 612	Eaves gutters with bead stiffened fronts and rainwater pipes with seamed joints made of metal sheet
BS EN 681-1	Elastomeric seals – Material requirements for pipe joint seals used in water and drainage applications – Part 1: Vulcanized rubber
BS EN 681-2	Elastomeric seals – Material requirements for pipe joint seals used in water and drainage applications – Part 2: Thermoplastic elastomers

BS EN 877	Cast iron pipes and fittings, their joints and accessories for the evacuation of water from buildings – Requirements, test methods and quality assurance
BS EN 988	Zinc and zinc alloys. Specification for rolled flat products for building
BS EN 1401-1	Plastics piping systems for non-pressure underground drainage and sewerage. Unplasticized poly(vinyl chloride) (PVC-U) – Part 1: Specifications for pipes, Fittings and the System
BS EN 1462	Brackets for eaves gutters – Requirements and testing
BS EN 10088	Stainless Steels
BS EN 10255	Non-alloy steel tubes suitable for welding and threading – Technical delivery conditions
BS EN 10226	Pipe threads where pressure tight joints are made on the threads
BS EN 12056-3	Gravity drainage systems inside buildings – Part 1: Roof drainage, layout and calculation
BS EN 12200-1	Plastics rainwater piping systems for above ground external use. Unplasticized poly(vinyl chloride) (PVC-U) – Part 1: Specifications for pipes, fittings and the system
BS EN 13598-1	Plastics piping systems for non-pressure underground drainage and sewerage – Unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) – Part 1: Specifications for ancillary fittings including shallow chambers
BS EN ISO 1452-2	Plastics Piping Systems for Water Supply and for Buried and Above-Ground Drainage and Sewerage under Pressure. Unplasticized Poly (Vinyl Chloride) (PVC U). pipes
BS 437	Specification for cast iron drain pipes, fittings and their joints for socketed and socketless systems
BS 460	Cast iron rainwater goods – Specification
BS 476	Fire tests on building materials and structures
BS 1461	Hot dipped galvanised coatings on iron and steel articles
BS 3506	Specification for unplasticized PVC pipe for industrial uses

BS 4576-1	Specification for unplasticized polyvinyl chloride (PVC-U) rainwater goods and accessories - Part 1: Half-round gutters and pipes of circular cross section
BS 7874	Method of test for microbiological deterioration of elastomeric seals for joints in pipework and pipelines
AS 1530	Methods for fire tests on building materials, components and structures
JIS K 6739	Unplasticized poly(vinyl chloride) (PVC-U) pipe fittings for drain
JIS K 6741	Unplasticized poly(vinyl chloride) (PVC-U) pipes
JIS K 6742	Unplasticized poly(vinyl chloride) (PVC-U) pipes for water supply (Foreign Standard)
JIS K 6743	Unplasticized Poly(vinyl Chloride) (pvc-u) pipe fittings for water supply

1.3.2 Regulations

Code of Practice on Surface Water Drainage
Code of Practice on Environmental Health
Code of Practice for Fire Precautions in Buildings ("Fire Code")

1.3.3 Technical References

Guidelines on Mosquito Prevention in Domestic Rainwater Collection System for Non-Potable Uses
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1.4 Trade Preamble

1.4.1 Contractor's Submissions

The intended types of conventional rainwater drainage systems and locations are indicated in the drawings.

Engage qualified and experienced personnel/specialist to carry out and submit the following items for the SO's acceptance:

- (a) Hydraulic head and flowrate calculations and drawings for pipe size justification complete with PE's endorsement for competency in design calculation & pipe material selection for SO acceptance.
- (b) Shop drawings showing locations of rain water outlets, pipe hangers, pipe guides, pipe anchors, cleaning eyes, pipe bracing and equipment to which the piping connects.
- (c) Details showing interface between outlets and gutters, roof finishes and waterproofing.

- (d) Preparation and installation instructions and method statements.
- (e) Manufacturer's descriptive literature and product specification for specified products and rainwater outlets, including pipes, fittings, brackets and bracing required to complete all installation.

1.4.2 Co-ordination with Other Works

Co-ordinate the Works, particularly the interfaces with the following trades:

- (a) Metal roofing
- (b) Tiled roof
- (c) Green roof
- (d) RC walls, columns and slabs
- (e) Water proofing
- (f) Ceiling works
- (g) Built-in furniture, accessories, devices, etc.
- (h) Tiling works
- (i) Paintings and coatings

1.4.3 Provision of Spare Materials

No Item.

1.4.4 Quality Control Plan

Prepare and submit a quality control plan for the SO's review.

1.4.5 Warranty

Provide the following warranty against any defect in materials and workmanship, deterioration, leakage, failure of watertightness, lack of fitness:

Item of Works to be Warranted	Period of Warranty Required
Conventional Rainwater Drainage System	5 yrs from issuance of completion certificate

[Note: Warranty period for siphonic system should preferably be consistent with the warranty period for the waterproofing works]

1.4.6 Maintenance Manual

Prepare and submit an operation and maintenance/replacement manual covering all components and accessories, and system functioning requirements. Include precautions against removal/illegal alterations to the as-built system/materials and provide recommendations on cleaning of the roof and maintain the performance of the system.

Refer to Section G01-010:Clause:1.4.5 for details and maintenance intervals for this submission.

1.5 Definitions and Abbreviations

The following definitions and abbreviations apply within this Section.

1.5.1 Definitions

No item.

1.5.2 Abbreviations

1.5.2.1 RWDP

Rain Water Down Pipe

1.5.2.2 uPVC

unplasticised Polyvinyl Chloride

2 PERFORMANCE REQUIREMENTS

2.1 Contractor's Brief

When carrying out the proposals as set out in Section A16-010:Clause:1.4.1, take account of the following performance requirements.

2.1.1 Design Rates of Rainfall

(a) The direct open-to-sky catchment areas and wind-driven rain catchment on vertical surfaces shall be designed at a dimensional rainfall intensity as referred to under SS 525 to comply with SO's requirement.

(i) 165 mm/hr: 15 min duration in 10 years return period

(ii) 200 mm/hr: 15 min duration in 50 years return period

(iii) 330 mm/hr: 4 min duration in 100 years return period

- (b) The gravity drainage system's horizontal and vertical pipe flow shall be designed in accordance with tables 7, 8 and 9 of SS 525. Provide calculations for run-off rate in support of horizontal pipe sizing.

2.1.2 Acoustic Integrity

Sound insulation shall comply with acoustic consultants' requirements or as shown in drawings.

3 MATERIALS

3.1 types of Conventional Rainwater Drainage System

- (a) Rainwater pipework for gravity RWDP system shall be uPVC pipework complying with SS 213 and as shown in the Standards below.
- (b) uPVC pipework specification shall be in accordance with the following:

Table 1: Pipework (uPVC) specification

Type: uPVC		
Item	Requirements	Remarks
uPVC pipe - Nominal Bore 50 mm - 150 mm	BS EN ISO 1452, SS 141, SS 213, JIS K 6741 Class VU (AE & AW)	Above ground
.	BS EN ISO 1452, SS 272	Underground
.	BS EN ISO 1452, SS 141, JIS K 6741 Class VP(AW)	Heavy Duty (for cast in reinforced concrete)
Nominal Bore 200 mm and above	BS EN ISO 1452, SS 141, JIS K 6741 Class VU (AE & AW)	Above ground
.	BS EN 1401-1, SS 272	Underground
.	BS EN ISO 1452, SS 174, JIS K 6741, JIS K 6739	Heavy Duty
Pipework joints - 50 mm - 200 mm	BS EN ISO 1452, SS 141, JIS K 6743, JIS K 6739	Above ground
.	BS EN 1401-1, SS 272	Underground
.	BS EN ISO 1452, SS 174, JIS K 6743, JIS K 6739	Heavy Duty
250 mm and above	SS141, JIS K 6743, JIS K 6739	Above ground
.	BS EN 1401-1, SS 272	Underground
.	BS EN ISO 1452, SS 174, JIS K 6743, JIS K 6739	Heavy Duty

- (c) All built-in rainwater outlets to membrane waterproofing to concrete roofs shall be in cast iron, complete with body (sump), flashing clamp and dome as shown in drawings unless otherwise indicated.
- (d) All paved deck outlets draining into a piped rainwater discharge system shall be promenade deck drains with heel-proof grating as shown on drawings unless otherwise indicated.
- (e) Cast-iron pipework as indicated in drawings shall be with hubless connections and supported using proprietary fittings, clamps, hangers and related accessories.
- (f) Provide an overflow at balconies as a precaution against a blocked outlet. This can be an additional outlet, weir opening and spout outlet, **SUBJECT TO soâS APPROVAL** and must have at least the same capacity as the original outlet(s).
- (g) Gutters and outlets at or less than 15 m above ground level shall be provided with stainless steel Grade 316 leaf cover in accordance with NEA requirement.
- (h) The rainwater harvesting tank shall be mosquito-proof in accordance to the "Guidelines on Mosquito Prevention in Domestic Rainwater Collection System for Non-potable Uses" and display clearly at the points of use the label "Non-potable Use Only / Not for Drinking".
- (i) The rainwater harvesting system shall be designed with a bypass system to allow rainwater to be directly channelled into any drains or watercourses when required by PUB or other relevant authorities.

4 WORKMANSHIP

4.1 Installation of Conventional Rainwater Drainage System

4.1.1 General

All rainwater heads shall be cast in place in the concrete roof slab and set at the correct level relative to the roof falls and the membrane waterproofing finished surface. This may be executed in conjunction with the concrete casting or separately cast in at a later date, subject to the approval of the SO.

For cast iron rainwater heads, ensure that the body is firmly secured and set using non-shrink grout to fill voids. Where manufacturer's fixing accessories are used, ensure that installation is done in accordance with the manufacturer's recommendations. Co-ordinate with the roof membrane waterproofing installer to ensure that necessary and adequate space is provided for application of sealants and dressing in of membrane.

Ensure that the stem of the outlet is inserted inside the existing pipework and the seal (rubber/vinyl) at the base of the outlet ensures that the area is protected from water back-up.

4.1.2 Pipe Installation

Install piping parallel to columns and/or walls, clear of obstructions, preserving headroom specified in all vehicular traffic areas to comply with authorities' requirements and keeping passageways clear.

If structural difficulties or other work prevent running of pipes or setting of equipment at locations indicated in drawings, allow for necessary minor deviations. Inform the SO of these deviations and obtain approval from the SO prior to carrying out the work.

Cut pipes in a neat and workmanlike manner without damage to the pipes. Unless otherwise recommended by the manufacturer, cut with an accepted type of mechanical cutter. Use wheel cutters where practicable. Ream pipe ends to remove burrs.

As soon as pipes have been installed, cover openings to prevent extraneous materials causing obstructions. Leave covers in place until removal is necessary for completion of installation.

Attach supports only to structural framing members. Where supports are required between structural framing members, provide suitable intermediate metal framing.

Install piping with sufficient pitch to ensure adequate drainage.

Support piping independently from all equipment so that equipment is not stressed by piping weight or expansion.

All pipes shall be stored with closed ends, which shall not be opened until erection. Every precaution shall be taken to clean out piping before, during and after erection, and to prevent foreign material being left in the pipe.

Where pipes pass through a building expansion joint and/or are subjected to movement, approved flexible connections shall be provided to eliminate any stresses whatsoever which might be caused by such movement.

Where pipes are to be connected to existing fittings or drains that were installed by previous Contractor, the Contractor shall ensure that the pipes are compatible with the existing fittings. Joints shall be spigot and socket joints.

Install access pipe fitting with inspection opening and cleaning eyes along horizontal pipes near the bend and on the vertical pipe when it connects to the underground drainage pipe for cleaning and maintenance purposes.

All pipework shall be installed plumb, level or true to the gradient, and shall be neatly grouped with the minimum number of crossovers and adequate provision for venting, expansion, contraction and movement. Pipework shall be substantially supported. Adequate clearance shall be maintained from all other services and from the building structure.

Check all declared invert levels before laying any underground and embedded piping and shall notify the SO immediately of any discrepancies.

All underground and embedded pipework shall be protected by wrapping with hessian or other acceptable material and coated with bitumen paint.

When pipework is embedded into the concrete structure all pipework including joints shall be cleaned and tested for leakage prior to the pouring of concrete.

No welding is permitted on the pipework under any circumstances whatsoever.

4.1.3 Pipe Joints

All jointing of cast iron or uPVC pipes shall be carried out in compliance with respective codes of practice and performance compliance.

Use only hubless connections for cast iron pipes and fittings.

4.1.4 Pipe Hangers and Supports

Prior to fabricating necessary hangers and supports, including rods, angles, channels and plates, as well as any changes from indicated design, obtain the SO's acceptance. All members of the hanger and support system shall be fabricated from hot-dipped galvanised steel.

Components such as washers, bolts, nuts, etc., shall also be of hot-dipped galvanised steel.

Vertical piping shall be guided or supported in the centre of each riser, with approved steel brackets to prevent swaying, sagging, vibration and resonances. Avoid strains that cause lines to snake or buckle between supports or anchors.

Provide pipe hangers of the same size or nearest manufactured size available, as the pipe or tubing on which these pipe hangers shall be used.

Install a gasket between clamp and pipe of dissimilar material.

No pipe support and hangers shall be mounted on any drywall partitions.

No ramset nails shall be used for anchoring supports.

4.1.5 Type of Devices

Provide hangers and supports as illustrated in the drawings, or as required in accordance to the manufacturer's instruction.

Secure hangers from concrete work to metal inserts cast into / anchored to concrete. When these inserts are not available, make attachment by one of the following as directed by the SO:

- (a) Anchor bolts set in place with fast setting high strength grout.
- (b) Controlled energy type power actuated fasteners.
- (c) Furnish anchors and guides for all horizontal and vertical piping for proper control of thermal movement, to prevent perforation of expansion joints and to avoid overloading of hangers and supports.

4.1.6 Connection to External Drainage System

Excavation for pipe trenches shall not be less than 600 mm wider than the internal diameter of the pipes and the ground under pipe beds shall be carefully graded. Proper necessary shoring, planking or strutting shall be constructed and maintained to ensure that the trench does not collapse.

Surplus excavation soil shall be removed from Site.

All excavations shall be kept free from water at all times by pumping, bailing or temporary drainage.

In the event of the excavations being made deeper than necessary, fill the excavations to the proper level with lean concrete.

Allowance shall be made for removing all rock or construction debris encountered in the course of excavation with picks, wedges, levers and sledgehammers and compressor drills. Blasting shall not be allowed.

Where sleeves have been cast into the existing diaphragm walls, carry out any remedial works required to penetrate the walls if the sleeves have been misaligned. Waterproof the pipe penetrations through the wall to the satisfaction of the SO.

Fill with selected materials, free from lumps exceeding 75 mm in size and from stones, and compact in layers not exceeding 150 mm in depth to a level of 300 mm above the top of the pipes. The remainder of the trench shall be backfilled to the surrounding level with approved excavated material.

Leave trenches open for the inspection by the SO and the Local Authority. Do not cover up until the drains have been properly tested and approved.

4.2 Cleaning

Exercise every precaution to avoid introducing foreign matter into piping system. All piping and fittings shall be internally cleaned of oil, grease or dirt, prior to assembly into systems.

Following fabrication and erection, clean all piping 150 mm and smaller by flushing with clean water. Run to waste until thoroughly free of all dirt, oil and cuttings, etc. Generally, each size of pipe shall be flushed separately before being jointed with larger size piping.

Clean piping 200 mm and larger by pulling through fibre brush or swab for entire length of each pipe size. Brushes and swabs are to be slightly larger than the inside diameter of pipe being cleaned.

All cleaning operations shall be continuous throughout piping installation system, except at joints required for final joining of various sections of cleaned piping. After cleaning and until above final joints are made, end of sections of piping shall be adequately and tightly sealed off to prevent any dirt, water or other foreign matter from entering ends of pipe.

4.3 Delivery, Storage and Handling

All samples and mock-ups shall be reviewed to the satisfaction of the SO, prior to procurement and fabrication.

Submit purchase orders for verification by designated technical officer upon delivery of goods. Goods delivered to Site shall remain in seal and be in a position protected from the elements and potential damage.

Prepare surfaces and notify designated technical officer for inspection prior to assembly and installation.

5 VERIFICATION AND SUBMISSIONS

5.1 Submissions

5.1.1 Technical Submissions

Include in construction programme, events for submission of the following information:

- (a) Name of manufacturer(s) of all specified products, rainwater outlets including pipes, fittings, brackets and bracing required to complete all installation as specified in Section A16-010:Clause:1.4.1.
- (b) Technical data for all specified products, rainwater outlets including pipes, fittings, brackets and bracing required to complete all installation.
- (c) Details of quality control procedures adopted.

5.1.2 Work Submissions

Prepare and submit the following:

- (a) An installation strategy, setting out the sequence of work
- (b) Specimen of warranty
- (c) Shop drawings
- (d) Method statements

5.1.3 Test Reports and Certificate Submissions

5.1.3.1 Tests

No item.

5.1.3.2 Certification of Materials

Provide certification from the manufacturer of the materials/components as set out in Section A16-010:Clause:3.1 certifying that the respective material is of the correct grade, size, finish, etc., and is in accordance with the relevant codes and standards specified.

Submit FSSD certificate of conformity and SGBC green label certificates where appropriate.

5.1.4 Quality Control Plan Submissions

Prepare and submit the quality control plan to the SO prior to starting work.

5.1.5 Warranty

Submit the warranty upon completion of the Works.

5.1.6 Maintenance Submissions

No item.

5.2 Samples and Mock-ups

5.2.1 Samples

Submit samples of all materials and components for the system as specified in Section A16- 010:Clause 5.1.1 with correct finishes and sizes. All approved samples to be kept on site for record.

5.2.2 Mock-ups

No item.

5.3 Inspections

Allow for inspection at factory or off-site fabrication areas as directed by the SO. Inform the SO on completion of the installation and inspection before closing up.

5.4 On-Site Tests

5.4.1 Testing and Commissioning

Manufacturer's works test shall include all tests in accordance with the relevant British or Singapore Standards and in addition, any tests called for by the SO to ensure that the plant being supplied meets the requirements of the Specification.

For material/equipment not covered by any British Standard or specifically mentioned in this Specification, tests shall be agreed on with the SO.

Supply and install all materials, supplies, labour and power required for hydrostatically testing of all piping. Conduct preliminary tests and prove that work is satisfactory. Notify SO in ample time to be present for final testing of all piping.

Repair defects disclosed by tests or, if required by SO, replace defective work with new work without additional cost. Make tests in stages if so directed by SO, to facilitate work of others. Use of wicking in tightening leaking joints is not permitted.

5.4.2 Positive Pressure Tests

Internal rainwater pipes shall be tested with water to whatever pressure is likely to be exerted within the pipe in the event of a blockage.

Internal rainwater pipes shall be capable of withstanding a constant air pressure test of 38 mm water gauge for a period of not less than 3 mins, after equilibrium has been established, according to BS EN 12056-2. Any drop in pressure shall be investigated, remedial works undertaken and the system retested until no pressure drop is observed.

When the various installations have been completed and the preliminary commissioning checks carried out, set to work and regulate the system in the entire installation.