



UNOPS

UNITED NATIONS OFFICE FOR PROJECT SERVICES

PROJECT SPECIFICATION

**Project: Responsive Assistance for Priority Infrastructure Development (RAPID)
– Small and Minor Works –
John Garang Memorial University of Science and Technology, Bor, South Sudan**

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Project Schedules

1.2 Inspection Notification Schedule

Item for inspection
Earthwork- Excavation completed to contract levels of founding material.
Earthwork- Filling completed to contract levels.
Service Trenching- Service trenches excavated before laying the service.
Service Trenching- Services laid in trenches and ready for backfilling.
Pavers- Mortar bed- Substrate immediately before tiling.
Pavers- Mortar bed- Trial set-outs before execution
Pavers- Mortar bed- Control joints before sealing.
Pavers- Sand bed- Completed base preparation.
Pavers- Sand bed- Completed trial set-out for segmental paving.
Concrete- General- Base or subgrade before covering.
Concrete- General - Membrane or film underlay installed on the base.
Concrete- General - Completed formwork, and reinforcement, cores, fixings and embedded items fixed in place.
Concrete- General - Surfaces or elements to be concealed in the final work before covering.
Concrete- Commencement of concrete placing.
Precast Concrete- Formwork dimensions and stability.
Precast Concrete- Panel edge details and penetrations.
Precast Concrete- Connection materials, reinforcement and inserts in place.
Block Walling- Forms for blocks prior to casting blocks.
Block Walling- Completed blocks prior to use.
Block Walling- Damp-proof courses, in position.
Earth Block Walling- Built-in items, in position.
Brickwork- Set out of brickwork to lintels, arches and other architectural features.
Brickwork- Damp-proof courses, in position.
Brickwork- Lintels, in position.
Light Steelwork- Steel framing after erection before lining or cladding.
Steelwork Painting- Surfaces after preparation prior to application of first coating.
Steelwork Painting- Coating after application of final coat.
Light Timberwork- Timber framing after erection before lining or cladding.
Light Timberwork- Roof framing and connection to wall and ceiling structures.
Waterproofing- Background preparation completed.
Waterproofing- Before membranes are finished, covered up or concealed.
Roofing- Roof framing during construction.
Roofing- Those parts of the roofing, vapour barrier, insulation and roof plumbing installation which will be covered up or concealed.
Windows- Openings prepared to receive windows (where windows are to be installed in prepared openings).
Windows- Fabricated window assemblies delivered to the site, before installation.
Windows- Commencement of window installation.
Doors- Door frames standing in place before building in to brickwork.
Doors- Door frames installed before fixing trim.
Glazing- Glass products before they are installed.
Insulation- Insulation to roof space in areas which will be covered up or concealed.
Lining- wall face or framing before installation of linings.
Metalwork- Shop fabricated or assembled items ready for delivery to the site.

Metalwork- Site erected assemblies on completion of erection.
Plastering- Backgrounds immediately before applying base coats.
Plastering- Finish treatments before decoration.
Tiling- Floor preparation and set out of floor tiles before fixing.
Tiling- Wall preparation and set out of wall tiles before fixing.
Tiling- Control joints before sealing and grouting.
Painting- substrate immediately before application of paint finishes.
Mechanical Services- Equipment in place before connection and commissioning.
Water Services- Underground pipework prior to concealment.
Water Services- Above ground pipework prior to concealment.
Electrical Services- Underground electrical services conduits prior to concealment.
Electrical Services- Above ground electrical services conduits in walls prior to concealment.
Electrical Services- Switchboards prior to installation.

1.2 Warranty Schedule

Warranty	Form	Period
Termite treatment	Manufactures' warranty	10 years
Waterproofing	Manufactures' warranty	10 years

2.9 Paving Schedule

Paver Properties	Types		
	P1	P2	P3
Product name	Available market product('Boral Brick' or equivalent)		
Location	External paving/outdoor kitchen		
Work size	300mmx300mmx25mm		
Clay/ ceramic product	Clay product		
Colour	To be determined		
Surface finish	Non-slip		
Beddings: Sand bedding	Sand bedded		

3.1 Non reinforced concrete schedule

As per the structural notes, drawings and specifications

3.1 Reinforced concrete schedule

Properties	Types		
	25 N/mm2 concrete		
Location	All columns, beams, lintels, column		

	foundations		
Colour	Natural		
Tolerance class	B		

3.2 Concrete- Integral Finishes Schedule

Finish Properties	Types
Location	Concrete floors
Tolerance class	B
Integral finish	Broom finish

3.2 Concrete- Formed Surface Finishes Schedule

Surface Properties	Types
Location	All column Foundations, columns and beams
Surface finish type	Off form

3.5 Brickwork Construction Schedule

Brick/block work Type	First Class	Second Class
Location	None	All walls
Colour		To be confirmed
Mortar and colour		M300, grey
Built-in components		
Damp-proof course type		polythene 1000 gauge
Lintel type		Reinforced concrete as given

4.1 Liquid Waterproofing System Schedule

Properties	Types		
	LWS1	LWS2	LWS3
Location	Inside Hand wash troughs, shower & laundry area wall/floor		
Material type	Cementitious		
Method of application	Brush application		
Priming	As per manufacture spec.		
Number of coats	2		
Surface protection/finish	Plaster/tiles		

4.2 Corrugated Sheet Roofing Materials Schedule

Properties	Types		
	CSR1	CSR2	CSR3
Location	As shown in drawing		
Material	As shown in drawing		
Profile	As shown in drawing		
Thickness of base metal (mm)	As shown in drawing		
Finish	Pre-painted.		
Colour	To be decided by client		
Thermal insulation type	Double sided Sisalation		

4.2 Gutter and Downpipe Schedule

Item	Material and finish	Shape and size	Thickness and grade	Jointing method	Colour
Eaves gutters	Steel sheet, painted	As shown in drawing	As shown in drawing & to match with specification	As shown in drawing	To be determined
Box gutters	Steel sheet, painted	As shown in drawing	As shown in drawing & to match with specification	As shown in drawing	To be determined
Valley gutters	Steel sheet, painted	As shown in drawing	As shown in drawing & to match with specification	As shown in drawing	To be determined
Downpipes	Steel, painted	As shown in drawing	As shown in drawing & to match with specification	As shown in drawing	To be determined

4.3 Window Schedule

Properties	Types	
	W1	W2
Material	Steel frames to suit glassed & steel louver windows	- Steel frames to suit glassed & steel louver windows
Colour	On approval	On approval
Sash type	swing	swing
Colour	To be determined	To be determined
Glazing method	Silicone & EPDM gasket	Silicone & EPDM gasket

Properties	Types	
	W1	W2
Insect screens	To all open able window sashes	To all open able window sashes
Material and finish	Steel insect screen ,paint finish	Steel insect screen ,paint finish

4.3 Window Schedule

Properties	Types		
	W3	W4	FG1
Material	Steel frames to suit glassed & steel louver windows	Steel frames to suit glassed & steel louver windows	Steel frames to suit glassed windows
Colour	On approval	On approval	On approval
Glazing method	Silicone & EPDM gasket	Silicone & EPDM gasket	Silicone & EPDM gasket
Insect screens	To all open able window sashes	To all open able window sashes	To all open able window sashes
-Material and finish	Steel insect screen ,paint finish	Steel insect screen ,paint finish	Steel insect screen ,paint finish

4.3 Louvre Schedule

Properties	Types		
	L1	L2	L3
Location	As per drawings		
Adjustable or fixed	fixed		
Blade material	Steel		
Colour	To be determined		
Bird screens			
Material and finish	Steel insect screen		

4.3 Window Hardware Schedule

Hardware item	Description and finish	Use with window types
Hinges	Steel butt hinges	
Stays	Steel painted stays for each sash	
Pulls	Steel painted, fixed to side frame	
Catches	Adequate catches to be formed on the top and bottom window frame	
Locks	Steel painted 120mm barrel tower bolts on top and bottom	

Hardware item	Description and finish	Use with window types
	window sash frame	

4.4 Steel Doors Schedule

Properties	Types				
	DW1	D1	D2	D3	D4
Door thickness (mm)	25mm	25mm	25mm	25mm	25mm
Facing material	As per drawings	As per drawings	As per drawings	As per drawings	As per drawings
Finish	paint	paint	paint	paint	paint
Floor clearance	12mm	12mm	12mm	12mm	12mm
Hinges	To approval	To approval	To approval	To approval	To approval
Handles	Lever handle to approval	Lever handle to approval	Lever handle to approval	Lever handle to approval	Lever handle to approval
Locks	5 lever lock in cylinder to approval	5 lever lock in cylinder to approval	5 lever lock in cylinder to approval	5 lever lock in cylinder to approval	5 lever lock in cylinder to approval
Bolts	To approval	To approval	To approval	To approval	To approval
Hardware finish	To approval	To approval	To approval	To approval	To approval

4.7 Insulation Schedule

Properties	Types		
	IS1	IS2	IS3
Location	All ceiling building except roof eaves		

5.1 Sheet Lining Schedule

Properties	Types		
	SL1	SL2	SL3
Location	As per drawings	As per drawings	
Type	PVC ceiling	PVC lining	
Thickness (mm)	8mm	5mm	
Configuration	Exposed ceiling	Lining as shown in drawing	
Joint type	Flush	Parallel joints	
Fixing	Screw fixing	Screw fixing	
Battens: -Size (mm)	50mmx75mm& 50mmx50mm	50mmx120mm& 50mmx75mm	

Properties	Types		
-Spacing	As per drawings	As per drawings	

6.1 Plastering Schedule

Properties	Types		
	PL1	PL2	PL3
Location	Internal walls of block/brick work throughout	External and Internal faces of concrete beams, columns and walls including formed sills	
Background material	Brick/block wall	concrete	
Base coat(s)	CRM	CRS	
Finish coat	CRF	CRF	
Mix type or properties	Water based	Water based	

6.2 Cementitious Toppings Schedule

Properties	Types		
	CT1	CT2	CT3
Location	All floors within the buildings except tile & paving block areas		
Thickness	25mm		
Topping function	To provide easily cleanable floor finish		
Topping method	1:3 cement mortar mix		
Slip resistance	Rough		
Colour	Colour to be determined		

6.6 Interior Painting Schedule

Paint systems	Substrate types	Paint name	Colour name or code
Full gloss oil based	Exposed structural steel framing, door frames & any other steel items	Dulux or International paint	To be determined
Low gloss water based	Timber doors & any other timber items	Dulux or International paint	To be determined
Low gloss water based	Cement render to walls, chip board lining& cement sheet flush ceiling	Dulux or International paint	To be determined

Paint systems	Substrate types	Paint name	Colour name or code
	throughout		

6.6 Exterior Painting Schedule

Paint systems	Substrate types	Paint name	Colour name or code
Low gloss water based (weather-shield)	Cement render to walls	Dulux or International paint	To be determined
Full gloss oil based	Exposed structural steel framing, door frames & any other steel items	Dulux or International paint	To be determined
Full gloss water based	Timber doors & any other timber items	Dulux or International paint	To be determined

7.1 Fire Extinguishers Schedule

Properties	Types		
	FE1	FE2	FE3
Location	Kitchen & Dining	Dormitory	Library & ICT Centre
Number	3	2	2
Extinguisher type	9 litre H2O	9 litre H2O	1 No. 9 litre H2O 1 No. 4.5kg CO2

8.1 Water System Piping Schedule

System	Pipe material and nominal size	Grade or class	Jointing method	Bedding material
Cold water	Type 1000 PVC for underground pipes	DIN 8062, DIN 19534, ASTM 1785, BS 3505	solvent cement Weld	Compacted granular material
	WRW GI for header pipes	BS 1387 or ASTM A36	Threaded joint	N/A
Hot water	N/A			
Sanitary drainage	Type 600 PVC	DIN 8062, DIN 19534, ASTM 1785, BS 3505	solvent cement Weld	Compacted granular material

9.1 Electrical Systems Schedule

Refer to electrical services drawings for details.

PRELIMINARIES

1 GENERAL

1.1 PRE-CONSTRUCTION WORK

The Employers Representative and Contractor will carry out a joint condition-in survey using video or digital photographs to record the condition of the site upon handover to the Contractor. This will determine the state of the site that the Contractor must hand back upon completion of the works. The Contractor will carry out a detailed site set out survey for the works.

A Pre-Construction Meeting will be held between the Employers Representative and the Contractor to review the following information:

- Condition-in Survey
- Site Survey
- Work Method Statement
- Programme
- Schedule of Materials and Installed Equipment

If the Employers Representative approves the above documentation, then the Contractor will be issued with the Notice to Proceed. If the documentation is incomplete, the Contractor will have 3 calendar days to revise and resubmit the documentation for approval.

The contract period begins on the day the Notice to Proceed is issued.

The Contractor must mobilise on the project site within 7 calendar days of the date of issue of the Notice to Proceed.

Site restrictions

Site security limitations: Comply with any restrictions on site area, access or working times advised by the Employers Representative.

Access: Access on to and within the site, use of the site for temporary works and constructional plant, including working and storage areas, location of offices, workshops, sheds, roads and parking, is restricted to the areas shown on the drawings or as agreed with the Employers Representative.

Occupied areas of site or buildings

For the parts of the site designated as occupied areas in the **Occupied areas schedule**:

- Allow occupants to continue using the area for the required period.
- Make available safe access for occupants.
- Arrange work to minimise nuisance to occupants and ensure their safety.
- Protect occupants against weather, dust, dirt, water or other nuisance, by such means as temporary screens.

Protection of persons and property

Temporary works: Provide and maintain required barricades, guards, fencing, shoring, temporary roadways, footpaths, signs, lighting and traffic flagging.

Accessways, services: Do not obstruct or damage roadways and footpaths, drains and watercourses and other existing services in use on or adjacent to the site. Determine the location of such services. If damage occurs, immediately repair it at the Contractors cost.

Property: Do not damage property which is to remain on or adjacent to the site, including adjoining property encroaching onto the site. If damage occurs, immediately repair it at the Contractors cost.

Existing services

Attend to existing services as follows:

- If the service is to be continued, repair, divert or relocate as required.
- If the service is to be abandoned, cut and seal or disconnect, and make safe.

Submit proposals to the Employers Representative for action for existing services before starting this work. Minimise the number and duration of interruptions.

Adjoining property

Records: For properties described in the **Adjoining properties to be recorded schedule**:

- The Contractor is to inspect the properties with the Employers Representative and Employers and occupants of the properties, before start of work.
- Make detailed records of conditions existing within the properties, especially structural defects and other damage or defacement.
- Arrange for at least 2 copies of each record, including drawings, written descriptions, and photographs, to be endorsed by the owners and occupants, or their representatives, as evidence of conditions existing before commencement of work.

Submit one endorsed copy of each record to the Employers Representative. The Contractor is to keep the other endorsed copy.

1.2 CONSTRUCTION PLANT**Access**

Access route and site access point are as shown on the drawings or as agreed with the Employers Representative.

Use of existing services

Existing services may be used as temporary services for the performance of the contract subject to conditions stated in the **Existing services schedule**.

Contractors Facilities and Work Practices

The Contractor is required to provide adequate toilet and washroom facilities for his staff. These facilities shall be kept clean and serviceable at all times.

The Contractor is required to provide adequate first aid equipment on-site, failure of the Contractor to ensure the availability of first aid equipment on-site will result in an immediate 'stop work' order being issued. All costs and time delays resulting from any such 'stop work' order are entirely the Contractors responsibility.

A site office will be established by the Contractor at the work site. The location of the site office will be identified by the Employers Representative to the Contractor. The office will have a complete set of the contract documents.

The Contractor is to maintain a safe, healthy and tidy worksite at all times and all work activities are to be performed with protective and safety equipment appropriate for the task. The Contractor is entirely responsible for workplace safety and unsafe work practices will be identified and recommendations made for revised work methods as appropriate.

Project signboards

Provide project-specific signboards and the following:

- Location, size and wording as directed by Employers Representative.
- Maintain in good condition for duration of the work.
- Remove on completion.

Obtain approval before display of advertisements or provision of other signboards.

1.3 BUILDING THE WORKS**Surveys**

Setting out:

Set out the works from the dimensioned drawings

Check surveys:

Check the setout regularly on site

Final survey:

Confirm final setout of roads, services and buildings on the as constructed drawings after Substantial completion

Survey marks

Definition: The term "survey mark" means a survey peg, bench mark, reference mark, signal, alignment, level mark or any other mark used or intended to be used for the purpose of setting out, checking or measuring the work.

Care of survey marks: Preserve and maintain the survey marks in their true positions. If the survey marks are damaged, immediately advise the Employers Representative and rectify the damage.

Contractor's representative

The contractor must employ a suitably experienced Employers Representative as the Site Manager. This person must be on site during working hours, and fluent in English and technical terminology. The Contractor's Site Manager will have the authority to make all decisions concerning the project

Programme of work

The Contractor is to provide a construction programme which has the following information:

- Sequence of work.
- Allowance for holidays.
- Activity inter-relationships.
- Periods within which various stages or parts of the work are to be executed.

Time scale: Working days.

Update the programme weekly. Identify changes since the previous version, and show the estimated percentage of completion for each item of work.

Site meetings

Hold and attend weekly site meetings throughout the contract and ensure attendance of appropriate subcontractors, the Site Manager and Employers Representative. The meeting schedule may be modified by the Employers Representative.

The meeting will consider the following items:

- Technical issues.
- Commercial issues.
- Programme.
- Quality of work.

The Contractor is to keep minutes of site meetings. Within 3 working days after each meeting, submit to each party written copies of the minutes.

Items supplied by owner

Materials and other items identified in the **Items to be supplied schedule** will be supplied free of charge to the Contractor for installation in the execution of the works. Unload and take delivery of them, inspect them for defects and then take care of them. If defects are found, advise. Return unused items to the owner.

1.4 COMPLETION OF THE WORKS

Final cleaning

Before Substantial completion, clean throughout, including interior and exterior surfaces exposed to view. Clean carpeted and soft surfaces. Clean debris from the site, roofs, gutters, downpipes and drainage systems. Remove waste and surplus materials.

Reinstatement

Before substantial completion, clean and repair damage caused by installation or use of temporary work and restore existing facilities used during construction to original condition.

Adjoining property

At substantial completion, for properties described in the **Adjoining properties to be recorded schedule** inspect the properties with the Employers Representative and owners and occupants of the properties, recording any damage that has occurred since the pre-commencement inspection.

Post construction Works

The Contractor will provide the following documentation after all site construction has been completed:

- Warranty Statement
- Material Test Certificates
- As-Built Drawings

A condition-out survey will be conducted with the Contractor and Employers Representative at which damages caused by the Contractor will be identified. The Employers Representative will determine if the Contractor is to make repairs or if the damage will be deducted from the Contractor's final invoice.

Removal of plant

Within 10 working days after substantial completion, remove temporary works and construction plant no longer required. Remove the balance before the end of the defects liability period.

1.5 PAYMENT FOR THE WORKS**Anticipated progress claims schedule**

The Contractor is to submit a schedule of anticipated progress claims which will be made throughout the contract. Submit a revised schedule with each progress claim.

1.6 MISCELLANEOUS**Compliance with the law**

The Contractor is responsible for compliance with all requirements of authorities. The owner, before entering into the contract, has given the notices, paid the fees, and obtained the permits, approvals and other authorisations stated in the **Prior applications and approvals schedule**.

GENERAL REQUIREMENTS

1 GENERAL

1.1 CONTRACT DOCUMENTS

Drawings

Large scale drawings take precedence over small scale drawings. Written or calculable dimensions take precedence over scaled dimensions.

If there are any errors in dimensions, set out or size, immediately notify the Employers representative.

Bill Of Quantities

If there are any errors in description of items or omissions in the BOQ, immediately notify the Employers representative.

If there are any items which are unclear or are not available within the project programme, immediately notify the Employers representative.

Services diagrammatic layouts

Layouts of service lines, plant and equipment shown on the drawings are diagrammatic only, except where figured dimensions are provided or calculable.

Before commencing work:

- Obtain measurements and other necessary information.
- Coordinate the design and installation in conjunction with all trades.

Site Levels

Spot levels and identified levels on drawings take precedence over contour lines and ground profile lines.

1.2 INSPECTION

Inspection Notification Schedule

The Contractor is to notify the Employers representative when the items identified in the **Inspection notification schedule** are ready for inspection.

Notice

Minimum notice for inspections to be made on site is 24 hours for off site personnel, 4 hours for onsite personnel.

If notice of inspection is required in respect of parts of the works that are to be concealed, advise when the inspection can be made before concealment.

1.3 SUBMISSIONS

Samples

Submit nominated samples for approval of the Employers representative.

If it is intended to incorporate samples into the works, submit proposals for approval. Only incorporate samples in the works which have been approved. Do not incorporate other samples.

Keep endorsed samples in good condition on site, until practical completion.

Shop drawings

General: If required, submit dimensioned drawings showing details of the fabrication and installation of services and equipment, including relationship to building structure and other services, cable type and size, and marking details.

Diagrammatic layouts: Coordinate work shown diagrammatically in the contract documents, and submit dimensioned set-out drawings.

2 PRODUCTS

2.1 TESTS

Notice

Give notice of time and place of nominated tests.

Attendance

The Contractor is to carry out and attend all tests where nominated in this specification.

As a minimum, the Contractor will carry out the following tests:

- Flatness of the sub-base (allowed tolerance is ± 2 cm using the 4 Lm bar test), to be certified on site.
- Flatness of the base of foundations (allowed tolerance is ± 2 cm using the 4 Lm bar test), to be certified on site.
- Testing of the granulometric composition and strength of all aggregates to be used.
- Testing of all concrete in accordance with the regulations and methods as stated in Concrete section of the specification.
- Bricks shall have certified crush strength of greater than 105kg/cm².
- Upon completion of the electrical installation a test and measurement of the earth reading for the building is to be undertaken. The results of this test are to be certified by a properly qualified electrical employer's representative and the results are then to be presented to the Employers representative for acceptance.
- Full load testing and commissioning of all components of the electrical system is to be included for the various components of the electrical system. The electrical works will not be approved until the entire system has been successfully tested and signed off in the presence of a suitable qualified UNOPS Employer's representative.
- The Contractor will supply all necessary appliances and labour for testing of the complete water supply system at such time and as directed by the Employers representative. Such testing shall as a minimum require the pressurizing of the complete water supply system to a pressure of not less than 4.5bar. The pipe work and fittings shall retain this pressure for a minimum of 1 hour following the commencement of the test.
- All drains shall be hydraulically tested to a minimum of 1500 mm head and no drains shall be covered up until such test has been made and repeated as necessary until passed to the approval of the Employers representative. Access plugs and caps shall be removed, greased, refitted and made sound prior to the final testing.

2.2 MATERIALS AND COMPONENTS

Consistency

For the whole quantity of each material or product use the same manufacturer or source and provide consistent type, size, quality and appearance.

Manufacturers' or suppliers' recommendations

Proprietary items: Select, if no selection is given, and transport, deliver, store, handle, protect, finish, adjust, prepare for use, and provide manufactured items in accordance with the current written recommendations and instructions of the manufacturer or supplier.

Proprietary systems/assemblies: Assemble, install or fix in accordance with the current written recommendations and instructions of the manufacturer or supplier.

Project modifications: Advise of activities that supplement, or are contrary to, manufacturer's or suppliers' written recommendations and instructions.

Proprietary items

Identification of a proprietary item does not necessarily imply exclusive preference for the item so identified, but indicates the necessary properties of the item.

Alternatives: If alternatives are proposed, submit proposed alternatives and include samples, available technical information, reasons for proposed substitutions and cost. If necessary, provide an English

translation. State if provision of proposed alternatives will necessitate alteration to other parts of the works and advise consequent costs.

3 EXECUTION

3.1 COMPLETION

Warranties

Name the employer as warrantee in conformance with the **Warranty schedule**. Register with manufacturers as necessary. Retain copies delivered with components and equipment.

Commencement: Commence warranty periods at practical completion or at acceptance of installation, if acceptance is not concurrent with practical completion.

3.2 OPERATION AND MAINTENANCE MANUALS

General

General: Submit operation and maintenance manuals for installations.

Format – hard copy

These will be A4 size loose leaf, in commercial quality files with hard covers, each indexed, divided and titled. Include the following features:

- Cover: Identify each binder with typed or printed title “*OPERATION AND MAINTENANCE MANUAL*”, to spine. Identify title of project and date of issue.
- Drawings: Fold drawings to A4 size and accommodate them in the files so that they may be unfolded without being detached from the rings.
- Text: Manufacturers’ printed data, including associated diagrams, or typewritten, single-sided on paper, in clear concise English.

Number of copies: 3.

GRAVITY SEWER MAINS**10.00****10.01 General**

This section covers the requirements for constructing gravity sanitary sewers and service connections.

Non pressure sewer pipe shall be Ductile Iron pipe (DIP), unplasticised polyvinyl chloride (uPVC), Reinforced Concrete Pipe (RCP), Vitrified Clay pipe (VCP), or high density polyethylene pipe (HDPE).

Sewer construction shall conform to applicable local Standards for construction and testing of drains and sewers. In the absence of appropriate local Standards, International Standards shall apply. This reference to Standards shall apply throughout this specification.

10.02 Materials**10.02.1****Ductile iron**

DI pipe will be used for all branch sewers crossing roads or railways, for all inverted siphons at stream crossings, and in all above ground installations.

Pipes and fitting shall be cement lined and bituminous seal coated inside.

10.02.2**uPVC pipe and fittings**

BS EN 124

BS EN 681-2: 2000

BS EN 1277: 2003

BS EN 1401: 2009

uPVC pipes and fittings are intended for the use on all non pressure branch sewers less than 280mm in diameter.

Smooth wall uPVC pipe and fittings with locked-in gasket and integral bell system, pressure class 600 shall be used

The Contractor shall be responsible for the compatibility of fittings with the uPVC pipes offered.

The Contractor shall furnish copies of certificates of quality control tests carried out during manufacture of the pipes and fittings and shall if required by the Employers Representative undertake such additional tests as he considers necessary at the Contractor's expense.

Gasketed Saddles

Sewer saddles shall be moulded uPVC 'Tee' or 'Wye' with bolt on straps. The straps, bolts and nuts shall be of stainless steel.

Sewer saddles shall be gasketed and leak proof. The "O" ring material shall be of elastomeric material.

Couplings

uPVC coupling shall be injection moulded, slip over or similar type suitable for working pressure of 12 bars, unless otherwise specified.

Joint rings shall be of elastomeric material.

10.02.3

Reinforced concrete pipes

Reinforced concrete pipe shall be used for trunk sewers, and all sewers ranging from 300mm to 1000 mm in diameter.

The pipe interior shall be smooth and even, free from roughness, projections, indentations, offsets, irregularities of any kind. The concrete mass shall be dense and uniform. Concrete pipes shall be free from fracture, large or deep cracks, and surface roughness. The planes of the ends of the pipe shall be perpendicular to the longitudinal axis

Reinforced concrete pipes shall have a minimum nominal length of 2.0 m except as otherwise specified or required for special purposes such as curves, closures or built in pipes. The maximum nominal length shall be 6m.

Pipe joints shall be spigot and socket type with flexible water tight confined "O-ring" synthetic rubber gasket with neoprene elastomer. Joint details shall be submitted to the Employers Representative for review and approval before commencement of pipe manufacture.

All reinforced concrete pipe shall be spun and lined with 12.5 mm thick high alumina lining consisting of 12.5 mm of sulphate resistant type V Portland Cement (one part), Granite dust passing no. 100 BS sieve and 2 1/2 parts of fine aggregate with sufficient clean water to ensure maximum density.

Interior surfaces shall be covered with two coats of an approved bituminous coating. Coating shall be applied by the manufacturer at the plant.

10.02.4

High Density Polyethylene (HDPE) pipes

Corrugated PE pipes shall not be installed for sewers.

HDPE pipes will be used for branch sewers 280 mm in diameter or less installed in areas with high groundwater table or on steep slopes.

High density polyethylene pipes for non-pressure sewers shall be class PE100, pressure rated PN8.

All polyethylene pipes and fittings are to be joined by means of thermal fusion in accordance with the recommendations of the manufacturer. Gasketed jointing systems and couplers are not accepted.

10.03 Execution**10.03.1****Preparation**

Clean pipes and fittings of debris and water before installation. Inspect materials for defects before installing.

Remove defective materials from site.

10.03.2**Trenching and backfilling**

Do trenching and backfill work shall be carried out in accordance with Section 2.4 of the General Specification

Trench line and depth as well as condition of trench bottom require approval prior to placing bedding material and pipe.

Do not backfill trenches until pipe grade and alignment have been checked and accepted and infiltration and exfiltration test results are within the limits specified. If the pipe is backfilled for any reason prior to testing, the Contractor must accept responsibility to meet the tests or to re-excavate and repair the line at his expense.

10.03.3**Concrete bedding and encasement**

Do concrete work in accordance with Sections 3.1, 3.2 and 3.3

Pipe may be positioned on concrete blocks to facilitate placing of concrete. Rigidly anchor or weight pipe to prevent flotation when concrete is placed if necessary.

Do not backfill over concrete within 24 hours after placing.

10.03.4**Granular bedding**

Place granular bedding materials in accordance with details specified or directed.

Shape bed true to grade and to provide continuous, uniform bearing surface for barrel of pipe. Do not use blocks when bedding pipe.

Shape transverse depressions as required to within bell if bell and spigot pipe is used.

Compact full width of bed to at least 95% of corrected maximum dry density.

Fill excavation below bottom of manholes or structures with specified bedding material or common backfill according to standard drawings and specifications.

10.03.5**Installation**

Lay and join pipes in accordance with manufacturer's recommendations.

Handle pipes only with approved equipment. Do not use chains or cables passed through the pipe bore so that weight of pipe bears upon pipe ends.

Use laser-type instrument to control line and grade for sewers.

Lay pipes on prepared bed, true to line and grade, with pipe invert smooth and free of sags or high points. Ensure barrel of each pipe is in contact with shaped bed throughout its full length.

Commence laying at outlet and proceed in upstream direction with bell ends of pipe facing upgrade.

Check alignment between manholes as each portion is laid by means of a strong light shone through the pipe from manhole to manhole. If less than half the full pipe cross-section at the light source is visible at the other end, realign pipes at no additional cost.

Do not allow water to flow through pipe during construction.

Whenever work is suspended, install a removable watertight bulkhead at the open end of the last pipe laid to prevent entry of foreign materials.

Position and join pipes by approved methods. Do not use excavating equipment to force pipe sections together.

10.03.6 Joining**10.03.6.1****uPVC Pipe Joining:**

- Install gaskets as recommended by manufacturer.
- Support pipes with hand slings or crane as required in order to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
- Align pipes carefully before joining.
- Maintain pipe joints free from mud, silt, gravel and other foreign material.
- Avoid displacing gasket or contaminating with dirt or other foreign material. Remove disturbed or dirty gaskets; clean, lubricate and replace before joining is attempted. Use only manufacturers recommended lubricant.
- Complete each joint before laying next length of pipe.
- Minimize joint deflection after joint has been made to avoid joint damage.
- Apply sufficient pressure in making joints to ensure that joint is complete as outlined in manufacturer's recommendations.

- At rigid structures, install pipe joints not more than 600 mm from side of structure.

Make watertight connections to manholes or other structures. Provide details of proposed method of installing pipe stubs in structure walls to ensure a watertight joint. In the case of pre-cast manhole bases an integral joint gasket may be cast in the manhole wall to receive the pipe stub. In the case of cast-in-place manhole bases the exterior pipe surface in contact with the structure wall shall be roughened or treated to provide a bond with the concrete. Any grout used to be non-shrink type.

10.03.6.2

Concrete pipe joints:

- Pipe Interior: Circular pipes 700 mm in diameter and larger, and arch or elliptical pipe equivalent to 900 mm diameter or larger shall have interior gap between ends of adjacent pipes filled with mortar. Apply mortar a minimum 7 days after backfilling has been completed to allow pipe settlement to occur. Finish interior surface of joints smooth.
- Pipe Exterior: For bell and spigot pipe, mortar to be used for caulking outside of joints. Press and caulk mortar into place. Allow mortar to set minimum of one hour before backfilling.

Block pipes as directed when any stoppage of work occurs to prevent creep during down time.

Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes. Backfill to prevent flotation as required.

Cut pipes as required for special inserts, fittings or closure pieces in a neat manner, as recommended by pipe manufacturer, without damaging the pipe or its coating and to leave a smooth end at right angles to axis of pipe.

Make watertight connections to manholes or other structures. Provide details of proposed method of installing pipe stubs in structure walls to ensure a watertight joint. In the case of pre-cast manhole bases an integral joint gasket may be cast in the manhole wall to receive the pipe stub. In the case of cast-in-place manhole bases the exterior pipe surface in contact with the structure wall shall be roughened or treated to provide a bond with the concrete. Any grout used to be non-shrink type.

Where a pipe enters the manhole it shall be cradled with class B concrete half the diameter of the pipe to a joint in the pipe, distance 1.8 m from the manhole. Place non-shrink grout in the remaining space between the concrete cradle and the manhole wall filling the void between the pipe, the seal gasket and the manhole wall.

When placing sewers on steep slope of 20% or greater, they shall be anchored securely with concrete anchor blocks.

Where pipe enters a manhole with precast seal, and is bedded on undisturbed (not over-excavated) earth, the cradle is not necessary. The connection shall be sealed on the manhole exterior with a non-shrinking grout material and painted with a bituminous sealant.

Use prefabricated saddles or approved field connections for connecting pipes to existing sewer pipes. Joint of saddle to pipe shall be structurally sound and watertight.

Leave joints and fittings exposed for ex-filtration testing. Provide protection when required. If it is necessary to backfill sections of the sewer prior to testing, take full responsibility and bear all costs for any additional excavation and backfill to expose pipe, fittings or joints that may be necessary.

When the infiltration and ex-filtration test results are acceptable to Employers Representative, backfill the remainder of trench in accordance with Section 2.4.

Hand place granular material in uniform layers not exceeding 150 mm thick to minimum 300 mm over top of pipe. Dumping of material directly on top of pipe is not permitted.

Place layers uniformly and simultaneously on each side of pipe to prevent lateral displacement of pipe.

Compact each layer to at least 95% maximum density.

All exterior surfaces of concrete pipes that will remain exposed shall be coated by the pipe manufacturer with a minimum 650 microns dry thickness of a heavy duty, 100 percent solid coal-tar epoxy durable abrasion resistant and especially designed for production line application on moist concrete.

10.04 FIELD TESTING

10.04.1

General

After the gravity sewers have been laid and backfill has been placed to 600mm above the pipe, a light will be flashed between manholes, or if the manhole has not yet been constructed, between the location of manholes, by means of a flashlight or mirrored light, to determine whether the alignment of the main is true and whether any pipe has been displaced subsequent to laying. If alignment is correct and no other defects are disclosed, backfilling may be continued. If the test shows poor alignment of the main, misplaced pipes or other defects, such defects shall be remedied by the Contractor, as required by the Employers Representative, before the work of backfilling proceeds.

After backfilling has been done, the Contractor shall make tests to ascertain if joints are tight. Leaky or poor joints shall be repaired, or removed at once by the Contractor to the satisfaction of the Employers Representative.

No section of gravity sewer lines shall be tested for leakage before backfilling in that section has been completed. If this condition has been fulfilled, the sewer lines shall be tested for leakage between manholes as the work progresses.

The Contractor shall perform the tests and shall furnish all apparatus and materials including water required for the tests.

The tests will be witnessed by the Employers Representative.

10.04.2**Tests**

The following tests shall be made:

- All sewers shall be tested by making exfiltration or infiltration tests
- Smoke test shall be required in lieu of exfiltration or infiltration tests, or airtests, only where conditions are not appropriate for these tests. Smoke testing shall be done prior to the placement of any paving material. Repair or replace pipe, pipe joint or bedding found defective.

Perform infiltration or ex-filtration testing as soon as practicable after jointing and bedding are complete, and service connections have been installed.

Do infiltration and/or ex-filtration testing as directed. Perform tests in presence of Employers Representative. Give notice of tests in accordance with the Conditions of Contract.

Carry out tests on each section of sewer between successive manholes including service connections.

Install watertight bulkheads in suitable manner to isolate test section from rest of pipeline.

10.04.3**Filtration testing**

Ex-filtration test:

- Fill test section with water in such a manner as to allow displacement of air in line.
- Immediately prior to test period add water to pipeline until there is a head of 1 metre over interior crown of pipe measured at highest point of test section or water in manhole is 1500 mm above static ground water level, whichever is greater.
- Duration of ex-filtration test shall be one hour.
- Water loss at end of test period shall not exceed maximum allowable ex-filtration over any section of pipe between manholes.

Infiltration test:

- Conduct infiltration test in addition to ex-filtration test.
- Install a watertight plug at upstream end of pipeline test section.
- Discontinue pumping operations for at least 3 days before test measurements are to commence and during this time keep thoroughly wet at least one third of pipe invert perimeter.
- Prevent damage to pipe and bedding material due to flotation and erosion.
- Place a 90° V-notch weir, or other measuring device approved by the Employers Representative in invert of sewer at each manhole.
- Measure rate of flow over a minimum of 1 hour, with recorded flows for each 5 min interval.

Infiltration/ex-filtration shall not exceed 4.63 litres per millimetre of internal pipe diameter per kilometre per 24 hours which are the following limits in litres per hour per 100 m of pipe, including service connections.

Table 10.04.3 Gravity Sewer Pipe Maximum Allowable Leakage

Internal Pipe Diameter (mm)	Maximum Amount (litre/hr)
100	1.93
150	2.89
200	3.86
250	4.83
300	5.79
350	6.75
400	7.72
450	8.68
500	9.65
550	10.61
600	11.58
700	13.51
800	15.44
900	17.37

This allowance shall include leakage in manholes along the length of the line.

Repair and retest sewer line as required, until test results are within limits specified at no additional cost to the Contract. Repair visible leaks regardless of test results.

10.04.4

Television inspections:

- Prior to TV inspection remove foreign material from sewers and related appurtenances by flushing with water
- Television equipment shall consist of a self-contained colour camera and a monitoring unit connected by a 3 wire coaxial cable. The camera shall be small enough to ensure passage through a 150 mm sewer, shall be waterproof, and shall have a self-contained remotely controlled lighting system of varying the illumination of the interior of the sewer line for inspection and photographic purposes. Picture quality shall be such as to produce a continuous 600-line resolution picture showing the entire periphery of the pipe. All video must be in DVD format. An audio description of the inspection must also be provided. The monitor used shall be not less than a 13 inch colour monitor.
- Carry out inspection of installed sewers by television camera.
- If defective work is found by such inspections, repair sewer line and repeat television inspections as required until all defective work has been corrected, at no additional cost to the Employer.
- All DVD of television inspections are to be submitted to the Employers Representative as a permanent record.

A sewer section is defined as the length of pipe between successive manholes.

10.04.5 DEFLECTION TESTS

Deflection Test for PVC, HDPE, DI and Plastic pipes

- Carry out a deflection test on all sections of the sewer. The maximum allowable deflection under fully backfilled and compacted trench conditions shall not exceed 5% before 30 days and 7.5% after 30 days.
- Locations with excessive deflection shall be repaired and/or the pipe replaced at the Contractor's expense. The equipment used for the deflection test shall be that as recommended by the manufacturer, and may include an Electronic Deflectometer or a Rigid "Go-No-Go" Device. For the purpose of deflection measurement, the base inside diameters and the deflection mandrel dimensions are provided in the following table. To ensure accurate testing the lines shall be thoroughly cleaned. The 5% and 7.5% deflection mandrel against nominal size of pipe shall be in accordance with the relevant standards.
- For nominal sewer sizes not shown in above table the Mandrel dimensions shall be calculated as follows:

$$\text{Mandrel O.D.} = \frac{(100-Y)}{100} \times \text{Base I.D.}$$

Where Y = Deflection Limit in %

10.04.6 ADDITIONAL TV INSPECTION

Additional Television inspection of the sewers

The Contractor shall perform television inspection of sewers within 30 days of the expiry of the defects liability period to compare the condition of collection system before and after defects rectification. The Contractor shall remedy defects in compliance with the relevant clause of the Conditions of Contract. Emptying and cleaning of the facilities shall be done by the Contractor. The inspection procedure and the submittal requirements for additional television inspection shall be same as that of item (3) above.

10.05 Sewer Manholes

10.05.1

General

This section specifies requirements for constructing new manholes and service connection manholes.

10.05.2**Materials****Concrete and reinforcement**

Refer to Sections 3.1, 3.2 and 3.3 of the specification.

Concrete mix design to produce 30 MPa for pre-cast manholes, catch basins and ditch inlets and 25 MPa for cast-in place manholes. Maximum size aggregate shall be 40 mm except 28 mm for pre-cast units.

10.05.3 CONCRETE MANHOLES**Pre-cast manhole sections**

Walls of manholes shall be constructed of reinforced concrete ring sections with a minimum inside diameter of 900 mm. Riser sections shall have tongue and groove ends (tongue on top of section) and a minimum wall thickness of 125mm. Top sections shall be of eccentric cone or flat slab top design as indicated by the Contract drawings. Eccentric cones shall have the same minimum wall thickness and area of circumferential steel reinforcement as the round riser sections. Flat slab tops shall have a minimum thickness of 150 mm and shall be reinforced with steel in accordance with the appropriate design standard. Top sections shall have a top width of such design and dimensions as to properly support the required manhole frame and cover and the lower joint shall be of tongue and groove design.

Top sections of eccentric cones or flat tops shall have an offset opening of 750 mm for vertical ladder installation. Top sections shall have four (4) anchoring devices, equally spaced to receive 75 mm frame anchor bolts on flange B.C. pattern.

The entire exterior surface of all manholes shall be coated with two (2) coats of an approved bituminous coating, minimum 2.3 mm in thickness.

All sections shall contain factory installed lifting keys or lugs.

All sections shall be cured by the manufacturer not less than 7 days before transporting and date stamped with the casting date.

Reinforced concrete manhole bases

Pre-cast reinforced concrete bases shall normally be used in lieu of cast-in-place concrete bases.

The base, for either type, shall extend 150 mm beyond the outside face of the manhole wall and shall be at least 200 mm thick.

Cast-in-Place bases for up to 400 mm sewers shall have one mat of No. 4 deformed Grade 60 reinforcing steel on 300 mm centres placed midway in minimum 200 mm thick base.

Pre-cast bases shall have factory installed pipe seals.

Pre-poured flow lines in base will be approved only after inspection of a completed example.

Pre-cast Joints: to be made watertight using rubber ring gaskets.

10.05.4

Pre-cast grade rings

Pre-cast concrete grade rings of 50, 75, 100 and 150 mm height shall be manufactured in accordance with ASTM C-478.

Rings shall have pre-cast bolt holes matching cone or flat top sections and be of diameter to support full manhole frame.

Field moulding of grade rings will not be permitted.

10.05.5

Manhole steps

Ladder rungs/steps shall be of 19 mm dia (minimum), polypropylene coated galvanized steel.

Place all steps on 300 mm centres.

Portion of steps embedded in concrete shall be given a coat of heavy bodied bituminous paint.

10.05.6

Pipe opening seals

Pipe opening seals shall be cast integrally with manhole section, sized to fit pipe specified, and set at correct elevation and location.

10.05.7

Preformed plastic sealing compound

Sealing compound shall be of either bituminous or butyl rubber base.

Material shall be in rope form, supplied with a two-piece cover to prevent adhesion until use.

10.05.8

Water stops

Water stops shall be composed of virgin Polyvinyl chloride (PVC) or rubber with stainless steel bolts and nuts, sized for respective pipe.

10.05.9

Manhole frames and covers

Heavy duty ductile iron pre-locked circular manhole cover in hexagonal frame, suitable for road surfaces. Non-'rock' nylon cushion insert for stability under load.

Cover cast without perforations and complete with two 25 mm sealed keyways. Clear opening to be 600 minimum, or such larger size as required. Frame is 100 mm deep.

Provide a minimum of 18 lifting keys.

Frames shall contain four (4) 25 mm holes equally spaced to match manhole inserts for fastening.

All manhole covers shall bear the wording required by the Employer and described in the drawings.

10.05.10

Watertight manhole frame and cover

This item shall be same as specified above except that the cover shall have a neoprene gasket contained in a factory machined dovetail or rectangular groove in the bearing side of cover.

Cover shall have hold-down bolts and washers of stainless steel or bronze.

10.05.11

PE manholes

a) Manhole design

The PE manholes are made with concentric, eccentric and full open tops. Manholes in highway traffic areas require a reinforced concrete pad to distribute vehicle load to surrounding soil. The DI manhole cover complying with the relevant Standard shall be installed in such a way to transfer vertical loads directly to the ground all in accordance with manufacturers' recommendations. The manholes shall have PE coated metal runs or protected ladder attached firmly to the vertical wall. The benched bottom is required to facilitate undisturbed flow. The inlet, outlet, cleaning and vent pipes to PE manholes shall be attached around the circumference of the manhole. The extrusion welding is recommended for pipe connections. Welded gussets or ribs to inlet and out let pipes provide strong connection.

The proper anchoring of PE manhole against flotation and thermal expansions due to variation in Ground Water Table and ambient temperature should be carried out. The Contractor shall propose an appropriate anchoring option to the Employers Representative for approval.

b) Submittals

The Contractor shall submit test certificates, drawings, calculations of PE manhole designs, (ring compression, combined ring compression, buckling, axial strain, features and thickness of base) fabrication procedure etc to the Employers Representative for approval.

10.06 Manholes, Execution**10.06.1****Excavation and backfill**

Excavate and backfill is to be in accordance with Section 2.4 of the Specification.

The Employers Representative is to inspect and approve excavations before the installation of outfall structures, manholes, catch basins, valve chambers or ditch inlets.

Do not backfill any manhole or other structure for which a leakage test is required, prior to completion of testing and acceptance of test by the Employers Representative.

10.06.2**Concrete work**

Do concrete work in accordance with Sections 3.1, 3.2 and 3.3

10.06.3**Installation**

Construct units in accordance with details indicated, plumb and true to alignment and grade.

Complete units as pipe laying progresses. Maximum of three units behind point of pipe laying will be allowed.

Pump excavation free of standing water and remove soft and foreign material before placing base. Fill any excavation below level of bottom of specified bedding as outlined in Section 2.4

Cast base directly on undisturbed ground or set a pre-cast concrete base on 150 mm minimum of well compacted granular material.

(1) Bases for pre-cast units:

- (i) Make each successive joint watertight with approved rubber ring gaskets. Each lifting ring hole shall be grouted with non-shrink grout.
- (ii) Clean surplus grout and joint compounds from interior surface of unit as work progresses.
- (iii) Flow channels shall be placed after pipe placement.

(2) Bases for cast-in-place units:

- (i) Place stub outlets and bulkheads at elevations and in positions indicated.
- (ii) Bench to provide a smooth U-shaped channel. Side height of channel to be full diameter of sewer. Slope adjacent floor at 1 on 5. Curve channels smoothly. Slope invert to establish sewer grade.
- (iii) Apply two coats of cement rendering to manhole benching. Cement rendering shall consist of one part cement and two parts sand with

sufficient mixing water. Surface to be rendered shall be roughened before concrete has fully set, and immediately before rendering is applied, cleaned of all oil, grease, laitance or foreign matter. Keep surface moist. Roughen between coats. Work into surface and give last coat smooth, steel trowel finish.

- (iv) Flow channels shall be formed directly in the concrete of the manhole base and shall be smooth and accurately shaped to a semi-circular bottom conforming to the inside of the adjacent sewer sections. Changes in the direction of the sewer and entering branches shall have a true curve of as large a radius as the size of the manhole will permit.
 - Complete concrete placement around pipe openings, working well into water stop. Finish flush on outside.
 - All slopes (benches) outside flow channels shall be sloped gradually towards the invert.

(3) Manhole Sections

- (i) All pre-cast concrete ring sections and top sections shall fit together readily to permit effective jointing. Joints between adjacent sections of all manholes shall be made with two (2) strips of approved preformed joint sealing compound. All material squeezed out on inside shall be cut off.
- (ii) Adjoining riser and conical top sections shall be fitted together in such a manner as to assure true vertical alignment of manhole steps.

(4) Manhole Frame and Covers

- (i) Set manhole frame to proper elevation and to cross-section slope where required. Set in a bed of Portland cement and silica sand, and bring mortar up over frame.
- (ii) Where adjustment is required [maximum one 300 mm], use pre-cast concrete grade rings. Set in two (2) strips of preformed plastic sealing compound, taking care to align bolt holes. Paint exterior surface with two (2) coats bituminous paint. Recheck elevation due to possible sealant compression.
- (iii) Tighten down manhole frame using bolts long enough to reach insert in cone or flat top section.
- (iv) The Contractor shall be responsible to see that all such items as mentioned under this Section are adjusted to the new paving elevation to provide a smooth even transition from pavement to manhole cover.

Clean units of debris and foreign materials. Remove fins and sharp projections. Prevent debris from entering system.

(5) Drop Manholes

- (i) Drop connection shall be made where the invert of any inlet pipe is 600 mm or more higher than the invert out of the manhole.
- (ii) Pre-cast manhole sections shall have openings with integrally cast pipe seals to fit design elevations for new installations.
- (iii) Connection configuration to manhole shall be made in accordance with Standard Detail Drawings.

- (iv) Entire configuration of piping shall be encased in Class B concrete to a minimum thickness of 150 mm.
- (v) Paint entire surface of encasement, when dry, with an approved bituminous coating.

10.06.4**Infiltration and exfiltration test**

Install watertight plugs or seals on inlets and outlets of each new sanitary sewer manhole and fill manhole with water. Keep manhole full for 24 hours to allow maximum absorption. Leakage must not to exceed 0.3% per hour of volume of manhole.

If permissible leakage is exceeded:

- (i) By up to 0.03% per hour of the volume of the manhole defects may be corrected on site by the manufacturer's representative using injected polyurethane. Concrete mortar grouting is not acceptable. Repeat testing until acceptable.
- (ii) By more than 0.03% per hour of the volume of the manhole, the manhole must be replaced at the Contractor's expense.

In areas of high ground water the allowable infiltration shall not exceed 0.3% per hour of the volume of the manhole.

Test any water retaining structure or special manhole in accordance with this section.

DEMOLITION**1 GENERAL****1.1 INTERPRETATION****Demolished materials classes**

Salvaged for re-use: Demolished materials scheduled for re-use in the works.

Salvaged for disposal: Demolished materials scheduled for re-use elsewhere.

Demolished for re-use: Non-scheduled demolished materials proposed by contractor for re-use in the works.

Demolished for removal: Other demolished materials.

1.2 INSPECTION**Notice**

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

- Adjacent structures before commencement of demolition.
- Propping of structures prior to demolition works.
- Structure after stripping and removal of roof coverings and other external cladding.
- Underground structures after demolition above them.

2 PRODUCTS**2.1 DEMOLISHED MATERIALS****Demolished materials**

Ownership: Ownership of demolished materials is described in the **Demolished materials classes table**.

Demolished Materials Classes Table

Class	Ownership
Salvaged for reuse	Principal/Employer
Salvaged for disposal	Principal/Employer
Demolished for re-use	Principal/Employer
Demolished for removal	Contractor

Reuse: If it is proposed to reuse demolished materials in the works, submit proposals.

Salvage: Recover without damage materials to be salvaged, for reuse in conformance with the **Salvaged materials for reuse schedule** or for disposal in conformance with the **Salvaged materials for disposal schedule**.

Removal: Remove from the site demolished materials which are the property of the contractor. Do not burn or bury on site.

Transit: Prevent spillage of demolishing materials in transit.

3 EXECUTION**3.1 SUPPORT****Temporary support**

If temporary support is required, certification for its design and installation is required from a professional engineer engaged by the contractor.

Until permanent support is provided, provide temporary support for sections of existing buildings which are to be altered and which normally rely for support on work to be demolished.

Support excavations for demolition of underground structures. Provide supports to adjacent structures where necessary, sufficient to prevent damage resulting from the works.

Permanent supports

If permanent supports for adjacent structures are necessary and are not described, give notice and obtain instructions.

3.2 PROTECTION

Encroachment

Prevent the encroachment of demolished materials onto adjoining property, including public places.

Weather protection

If walls or roofs are opened for alterations and additions or the surfaces of adjoining buildings are exposed, provide temporary covers to prevent water penetration. Provide covers to protect existing plant and equipment and materials intended for re-use.

Dust protection

Provide dust-proof screens, bulkheads and covers to protect existing finishes and the immediate environment from dust and debris.

Security

If a wall or roof is opened for alterations and additions, provide security against unauthorised entry to the building.

3.3 DEMOLITION

Explosives

Do not use explosives in the demolition process.

3.4 HAZARDOUS MATERIALS

General

General: Hazardous materials that have already been identified are set out in the **Identified hazardous materials schedule**.

Hazardous materials

General: Give notice immediately hazardous materials or conditions are found, including the following:

- Asbestos or material containing asbestos.
- Flammable or explosive liquids or gases.
- Toxic, infective or contaminated materials.
- Radiation or radioactive materials.
- Noxious or explosive chemicals.
- Tanks or other containers which have been used for storage of explosive, toxic, infective or contaminated substances.

3.5 COMPLETION

Notice of completion

Give at least 3 working days' notice of completion of demolition so that adjacent structures may be inspected following completion of demolition.

Make good any damage arising out of demolition work. Obtain written acceptance from the owner of each adjoining property of completeness and standard of making good.

Temporary support

General: Clear away at completion of demolition.

PAVERS – SAND BED**1 GENERAL****1.1 INSPECTION****Notice**

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

- Completed base preparation.
- Completed trial set-out for segmental paving.

1.2 TOLERANCES**Tolerances**

Conform to the **Surface level tolerances table**:

Surface Level Tolerances Table

Item	Level tolerance	
	Absolute	Relative
Vehicular pavements	± 10 mm	10 mm
Footpaths	± 10 mm	5 mm

2 PRODUCTS**2.1 MATERIALS****Bedding sand**

Grading: All sand must pass through a sieve with 2.0mm apertures.

Moisture content: Uniform in moisture content with spread.

Deleterious material: Free of deleterious material, such as soluble salts which may cause efflorescence.

Joint filling sand

Grading: All sand must pass through a sieve with 1.0mm apertures.

Moisture content: The sand shall be dry when spread.

Deleterious material: Free of deleterious material, such as soluble salts which may cause efflorescence.

2.2 COMPONENTS**Concrete and clay segmental paving units**

Provide labelled samples of all pavers for approval of the Employers Representative prior to use. Ensure that the horizontal dimensions of each paver have a maximum variation of 3mm in 300mm. Any pavers outside this tolerance will be rejected and removed from the site. Ensure that all pavers are free from fault lines, cracked edges, surface flakes, mould marks or other defects before use.

Stone paving units

Provide labelled samples of all pavers for approval of the Employers Representative prior to use. Ensure that all stone pavers are free from fault lines, cracked edges, surface flakes or other defects before use.

3 EXECUTION

Refer to **Paving schedule** for details of pavers and bedding.

3.1 SUBGRADE PREPARATION

General

The subgrade shall be prepared in accordance with the *Earthwork* worksection.

3.2 SUBBASE AND BASE

General

The subbase and base shall be prepared in accordance with the *Pavement base and subbase* worksection.

3.3 BEDDING SAND

General

Preparation: Remove all loose material from the prepared base.

Spreading: Screed uncompacted sand over prepared base in a uniform manner to achieve a 30 mm thick layer. Maintain sand at a uniform loose density.

3.4 LAYING PAVING

General

Pattern: Paving units are to be laid on the screeded sand bedding to the nominated pattern shown on the drawings.

Joints: Paving units are to be laid with a 2 – 3 mm gap between adjoining units.

Cut courses: Do not use cut units with a plain dimension of less than 50 mm.

Control joints: Where paving units are to be placed over control joints in an underlying concrete base, a joint is to be provided in the pavers. The joint shall be 10 mm wide and filled with approved jointing material.

3.5 COMPACTION OF BEDDING

General

After laying of the paving units the sand bedding shall be fully compacted using a vibrating plate compactor.

Joint filling: All paving units are to be compacted to design levels prior to the commencement of joint filling.

3.6 JOINT FILLING

General

Spread dry sand over the paving units and fill the joints by brooming. Undertake one or more passes with the vibrating plate compactor and refill the joints with sand. Repeat the process until the joints are completely filled.

Timing: Fill joints on the same day that pavers are compacted.

3.7 PROTECTION OF THE WORK

General

Protection: All vehicular and pedestrian traffic shall be prevented from using the pavement until all compaction and joint filling is completed and all edge restraints are in place.

3.8 CLEANING

Cleaning

General: Leave pavements clean on completion.

SITE PREPARATION**1 GENERAL****1.1 AIMS****Responsibilities**

The aim of this worksection is to clear the site and put in place adequate environmental controls to allow the commencement of earthworks and/or building works.

1.2 SUBMISSIONS**Execution**

Submit the methods and equipment proposed for the earthworks, including the following:

- Dewatering and groundwater control and disposal of surface water.
- Control of erosion and contamination of the site, surrounding areas and drainage systems.
- Dust control.
- Noise control.

2 EXECUTION**2.1 TREES****Work near trees**

Keep the area within the dripline free of construction material and debris. Do not place bulk materials and harmful materials under or near trees. Do not place spoil from excavations against tree trunks. Prevent wind-blown materials such as cement from harming trees and plants.

Prevent damage to tree bark. Do not attach stays, guys and the like to trees.

If excavation is required near trees to be retained, give notice and obtain instructions. Open up excavations under tree canopies for as short a period as possible.

Use hand methods to locate, expose and cleanly remove the roots on the line of excavation. If it is necessary to excavate within the drip line, use hand methods such that root systems are preserved intact and undamaged.

Backfill to excavations around tree roots with backfill free from weed growth and harmful materials. Place the backfill layers, each of 300 mm maximum depth, compacted to a dry density similar to that of the original or surrounding soil. Do not backfill around tree trunks to a height greater than 300 mm above the original ground surface. Immediately after backfilling, thoroughly water the root zone surrounding the tree.

Water trees as necessary, including where roots are exposed at ambient temperature > 35°C.

2.2 EXISTING SERVICES**Marking**

Before commencing earthworks, locate and mark existing underground services in the areas which will be affected by the earthworks operations including clearing, excavating and trenching.

Excavation

Do not excavate by machine within 1 m of existing underground services.

2.3 ENVIRONMENTAL PROTECTION**Dust protection**

Provide dust-proof screens, bulkheads and covers to protect existing finishes and the immediate environment from dust and debris.

Dewatering

Keep groundworks free of water. Provide and maintain slopes and drains on excavations and embankments to ensure free drainage. Place construction, including fill, masonry, concrete and

services, on ground from which free water has been removed. Prevent water flow over freshly laid work.

2.4 SITE CLEARING

Extent

Clear only the following site areas:

- Areas to be occupied by works such as buildings, paving, excavation, regrading and landscaping.
- Other areas designated to be cleared.

Contractor's site areas: If not included within the areas specified above, clear generally only to the extent necessary for the performance of the works.

Clearing and grubbing

Remove everything on or above the site surface, including rubbish, scrap, grass, vegetable matter and organic debris, scrub, trees, timber, stumps, boulders and rubble.

Remove tree stumps and roots over 75 mm diameter to a minimum depth of 500 mm below subgrade under buildings, embankments or paving, or 300 mm below finished surface in unpaved areas. Holes remaining after grubbing shall be backfilled with sand material to prevent ponding of water. The material shall be compacted to the relative density of the existing adjacent ground material.

Old works: Remove old works, including slabs, foundations, pavings, drains and manholes found on the surface unless identified on the drawings to remain intact.

Topsoil

All topsoil shall be stripped over the area on which construction or grading takes place. This topsoil shall be carefully stockpiled to be reused for landscaping on completion of the building operations or otherwise disposed of as directed.

2.5 DISPOSAL OF MATERIALS

Disposal

General: Remove cleared and grubbed material from the site.

EARTHWORK

1 GENERAL

1.1 INTERPRETATION

Definitions

For the purposes of this worksection the definitions given below apply.

- Bad ground: Ground unsuitable for the purposes of the works, including fill liable to subsidence, ground containing cavities, faults or fissures, ground contaminated by harmful substances and ground which is or becomes soft, wet or unstable.
- Line of influence: A line extending downward and outward from the bottom edge of a footing, slab or pavement and defining the extent of foundation material having influence on the stability or support of the footings, slab or pavement.

1.2 RECORDS OF MEASUREMENT

Excavation and backfilling

Do not commence backfilling or place permanent works in the excavation until the following have been agreed and recorded:

- Depths of excavations related to the datum.
- Final plan dimensions of excavations.

Method of measurement: To be jointly agreed between the Employers representative and Contractors Site Manager unless otherwise agreed.

1.3 INSPECTION

Notice

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

- Excavation completed to contract levels or founding material.
- Filling completed to contract levels.

1.4 TOLERANCES

Tolerances

Finish the surface to the required level, grade and shape within the following tolerances:

- Under building slabs and loadbearing elements: + 0, -40 mm.
- Pavement subgrades; + 0, - 60 mm.
- Other ground surfaces: ± 50 mm, provided the area will drain and matches adjacent construction where required.

2 PRODUCTS

2.1 FILL MATERIALS

Fill material generally

Fill material is to be inorganic, non-perishable material.

Excluded materials:

- Organic soils.
- Materials contaminated through past site usage.
- Silts or silt-like materials.
- Fill containing wood, metal, plastic, boulders or other deleterious material.

Classifications for structural fill are based on the intended use of the fill, and defined as follows:

Class I structural fill - used as support for shallow foundations, paved areas, and slabs each with loadings of 3660 kgf/m² or more, for storage tanks, truck turnarounds, and base course and sub-base course for roadway pavements.

Class II structural fill - used as support for shallow foundations, paved areas, and slabs each with loadings of less than 3660 kgf/m² and for parking areas, backfill around foundations, for the construction of embankments, and for roadways pavement subgrades.

Class III non-structural fill - used in areas where installation of structures or equipment is not planned and in open areas where grading is only required to reach levels noted on the drawings.

Re-use of material recovered from excavation

Re-use excavated material elsewhere on site if approved by the Employers representative.

3 EXECUTION

3.1 REMOVAL OF TOPSOIL

General

Remove topsoil to all areas to be cut, areas to be filled, areas to be occupied by structures, pavements, embankments and the like.

Maximum depth: 100 mm.

Re-use of removed topsoil

Re-use removed topsoil elsewhere on site as directed by the Employers representative.

3.2 EXCAVATION

Extent

Excavate over the site to give correct levels for construction, pavements, filling and landscaping.

Excavate for footings, pits and shafts, to the required sizes and depths. Confirm that bearing capacity is adequate.

Proof rolling

Proof roll excavations for pavements, filling and non-spanning slabs on ground to determine the extent of any bad ground.

Disposal of excess excavated material

Remove excess excavated material from the site and dispose of legally.

3.3 BEARING SURFACES

General

Provide flat bearing surfaces for loadbearing elements including footings. Step to suit changes in levels. Make the steps to the appropriate courses if supporting masonry.

3.4 REINSTATEMENT OF EXCAVATION

General

Where excavation is deeper than the required depth, fill and consolidate to the correct depth.

3.5 SUPPORTING EXCAVATIONS

Provision of supports

Provide temporary supports to all excavations greater than 1.8m deep. Confirm type of supports and level of protection required with the Employers representative.

Removal of supports

Remove temporary supports progressively as backfilling proceeds.

3.6 ADJACENT STRUCTURES

Temporary supports

Provide supports to adjacent structures where necessary, sufficient to prevent damage arising from the works. This applies to all structures where the line of influence is interfered with by the proposed excavation works.

Lateral supports: Provide lateral support using shoring.

Vertical supports: Provide vertical support where necessary using piling or underpinning or both.

Permanent supports

If permanent supports for adjacent structures are necessary and are not described, give notice and obtain instructions.

3.7 PREPARATION FOR FILLING**General**

Prepare the ground surface before placing fill (including topsoil fill), ground slabs or load bearing elements. Shape to assist drainage. Compact the ground exposed after stripping or excavation.

3.8 PLACING FILL**General**

Layers: Place fill in maximum 15cm horizontal layers across the fill area.

Mix: Place fill in a uniform mixture.

Protection: Protect the works from damage due to compaction operations. Where necessary, limit the size of compaction equipment or compact by hand. Commence compacting each layer at the structure and proceed away from it.

3.9 COMPACTION REQUIREMENTS FOR FILL AND SUBGRADE**Density**

Compact the subgrade exposed by excavation to a minimum depth of 15cm. Compact each layer of fill to the required depth and density, as a systematic construction operation. Shape surfaces to provide drainage and prevent ponding.

Density of all layers of filling are to be approved by the Employers representative before subsequent layers are placed.

Maximum rock and lump size in layer after compaction: 2/3 compacted layer thickness.

Moisture content

Adjust the moisture content of fill during compaction in order to achieve the required density. Do not allow subgrade or fill layers to dry out after compaction before placing subsequent layers of fill. Do not over water filling to greater than moisture content of adjoining undisturbed ground.

SERVICE TRENCHING**1 GENERAL****1.1 INSPECTION****Notice**

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

- Service trenches excavated before laying the service.
- Services laid in trenches and ready for backfilling.

2 EXECUTION**2.1 EXCAVATING****Excavation**

Excavate for underground services, to required levels and grades. Generally make the trenches straight between inspection points and junctions, with vertical sides and uniform grades.

Trench widths

General: Keep trench widths to the minimum required for laying and bedding of the relevant service and construction of pits.

Trench depths

If excavation is necessary below the zone of influence of the underside of adjacent footings, give notice, and provide support for the footings as instructed.

Obstructions

Clear trenches of sharp projections. Cut back roots encountered in trenches to at least 600 mm clear of services. Remove other obstructions including stumps and boulders which may interfere with services or bedding.

Dewatering

Keep trenches free of water. Place bedding material, services and backfilling on firm ground free of surface water.

Excess excavation

If trench excavation exceeds the correct depth, reinstate to the correct depth and bearing value using compacted bedding material or sand stabilised with 1 part of cement to 20 parts of sand by weight.

2.2 BACKFILLING**General**

Backfill service trenches as soon as possible after the service has been laid and bedded, if possible on the same working day. Place the backfill in layers maximum 150 mm thick and compact to approval of Employers representative.

Backfill material

General fill with no stones greater than 25 mm occurring within 150 mm of the service, or other materials as required for particular services or locations.

Under roads and paved areas and within 4 m of building: Coarse sand, controlled low strength material or fine crushed rock.

In topsoil areas: Complete the backfilling with topsoil for at least the top 100 mm.

2.3 REINSTATEMENT OF SURFACES**General**

Reinstate existing surfaces removed or disturbed by trench excavations to match existing and adjacent work.

LANDSCAPE – WALLS AND FENCES

1 GENERAL

1.1 INSPECTION

Notice

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

- Setting out before commencement of construction.
- Filter fabric and subsurface drainage in place before backfilling.

2 PRODUCTS

2.1 TIMBER

Hardwood

All hardwood in timber fences is to be without any rot, significant knots, twists, or other defects which may affect its strength and to be as per Employers Representative's approval.

Preservative treatment: Provide only timbers with preservative treatment painted on the timbers surface where the timber is in the ground, or ensure that all timber is highly resistant to rot.

2.2 STEEL

Steel tubes and channels

All steel tubes and channels used for posts, rails, stays are to be painted or galvanised to ensure the maximum lifetime for the item without significant maintenance.

Wire

Chainwire, cable wire, tie wire and barbed wire are to be galvanised or other suitable metallic finish for maximum lifetime.

2.3 CONCRETE WALLS

General

Concrete walls and concrete foundations are to be constructed as shown on the drawings.

2.4 STONE WALLS

Walling stone

Natural stone: Stone of uniform quality, sound and free from defects liable to affect its strength, appearance or durability.

Field stone: Local weathered uncut random sized natural stones.

Quarried stone: Cut or uncut random or regular size stone.

2.5 CRIB WALLS

General

Type: Proprietary system of interlocking precast concrete units with selected backfill placed and compacted progressively to form a retaining wall.

2.6 GABION WALLS

General

Type: Proprietary system of rock filled wire baskets.

2.7 BRICK WALLS

General

Brick walls on stone or concrete foundations are to be constructed as shown on the drawings.

2.8 EARTH BLOCK WALLS

General

Earth block walls on stone or concrete foundations are to be constructed as shown on the drawings.

2.9 FILTER FABRIC

General

Type: Polymeric fabric formed from a plastic yarn composed of at least 85% by weight of propylene, ethylene, amide or vinylidenechloride and containing stabilisers or inhibitors to make the filaments resistant to deterioration due to ultraviolet light.

Protection

Provide heavy duty protective covering. Store clear of the ground and out of direct sunlight. During installation do not expose the filter fabric to sunlight for more than 14 days.

3 EXECUTION

3.1 GENERAL

Set out

General: Set out the wall and fence lines and mark the positions of posts, gates and bracing panels.

Clearing

Extent: Except trees or shrubs to be retained, clear vegetation within 1 m of the landscape walls. Grub out stumps and roots of removed trees or shrubs and trim the grass to ground level, but do not remove the topsoil.

Excavation

Excavate for foundations and footings.

Earth footings

Backfill with earth around posts, compacting firmly by hand or machine in 150 mm deep layers.

Concrete footings

In ground: Place mass concrete around posts and finish with a weathered top falling 25 mm from the post to ground level.

On slabs: Provide welded and drilled post flanges and fix with 3 masonry anchors per post.

Strip footings: Place mass concrete or reinforced concrete footings for walls. Refer to drawings for details.

3.2 GATES

Types

Gates are to be constructed with minimum 30 x 30mm steel tube frames for rigidity. Infill panels can be steel sheet, steel mesh, timber boards or other material as identified on the drawings.

Hardware

Provide the following:

- Drop bolt and ferrule to each leaf of double gates.
- Latch to one leaf of double gates.
- Provision for locking by padlock.
- Holding lugs for security bars to inside face of double gates with vehicle access.
- Minimum of 2 hinges for gates 1.2m high. 3 hinges for gates 1.2 to 2.1m high. 4 hinges for gates greater than 2.1m high.

Hand access

General: Where required, provide hand holes to give access from outside to reach locking provision.

3.3 TIMBER FENCING

Timber picket fence

Height (mm): As shown on drawings

Maximum post spacing: 2400 mm.

Member sizes (dressed):

- Posts: 90 x 90 mm.
- Rails: 70 x 40 mm.
- Pickets: 70 x 19 mm.

Picket spacing: 125 mm maximum.

Footing type: Earth.

Footing size: 200 mm diameter x 600 mm depth.

Installation

General: Mortice posts, taper splice rails and nail twice in mortices. Set pickets and palings clear of the ground.

Picket fence: Nail twice to each rail.

3.4 CHAINWIRE BARRIERS

Fence dimensions

Maximum post spacing: 3000 mm.

Component sizes

Intermediate posts: 42.4 mm diameter, 2.6 mm wall thickness.

End, corner and gate posts: 60.3 mm diameter, 2.9 mm wall thickness.

Chainwire: 3.15 mm diameter wire woven to form uniform mesh.

- Mesh generally: 50 mm.

Tie wire: 2 mm diameter.

Post and rail barriers:

- Rails and gooseneck stay: 33.7 mm diameter, 2.6 mm wall thickness.

Railless barriers:

- Struts: 42.4 mm diameter, 2.6 mm wall thickness.
- Cable wires:
 - . Two strands: 3.15 mm diameter wire.
 - . One strand: 4 mm helicoil wire.

Security barriers:

- Chainwire selvages: Twisted and barbed.
- Barbed wire to security fencing post extensions: Barbs at 95 mm maximum centres.

Installation

Posts: Do not splice members except in posts when splice is embedded at least 150 mm into concrete. Fit tightly fitting steel caps to posts, except where fixed to overhead structure.

Chainwire: Lace chainwire to end and gate posts. Tie chainwire twice around members at 250 mm maximum intervals. Twist ends twice and cut off neatly.

Cable wire: Tension cable wire(s) to support chainwire after at least 24 hour curing of concrete footings.

Footing type: Concrete.

- Footing size:
 - . Intermediate and end posts: 225 mm diameter x 600 mm depth.
 - . Corner posts and gate: 225 mm diameter x 900 mm depth.

Post and rail barriers:

- Rails: Connect rail(s) to posts using bolted split pipe fittings and purpose-made caps and brackets with rail apertures.
- Continuous rail type fences: Join the rails together in long lengths using purpose-made sleeves or socketed connections, and pass them through the apertures of caps and brackets on intermediate posts.

Railless barriers:

- Struts: Provide struts at ends, corners and gates.

Security barriers:

- Security fencing: Strain barbed wire between post extensions.

Gates

Frame tubes: 33.7 mm diameter, 2 mm wall thickness.

Chainwire: Match fence.

Maximum width: 3600 mm.

Security barriers:

- Barbed wire security gate extension supports: 26.9 mm diameter, 2 mm wall thickness.
- Barbed wire: Match fence.

3.5 STONE WALLS

Construction

Select the stones for their locations and lay them in the wall with the minimum of stonecutting.

Footings: Select the largest, flattest and most regular stones for footings, and set them in concrete blinding in accordance with drawings.

Copings: Select stones of reasonably uniform size and finish the top of the wall to a level line or cap with precast concrete sections.

Retaining walls

Construction: Where dry stone walls act as retaining walls, construct the stonework to be free draining through the wall. Batter back the wall face 50 – 70 mm for every 300 mm in height. Cap the top of the wall. Backfill progressively, with a layer at least 300 mm thick of porous material, such as coarse aggregate or crushed rock in the size range 20 – 40 mm. Install filter fabric to stop movement of silt into porous material.

Minimum thickness: 450 mm.

Where stone walls are mortared, batter back the wall face 50 – 70 mm for every 300 mm in height. Cap the top of the wall. Backfill progressively, with a layer at least 300 mm thick of porous material, such as coarse aggregate or crushed rock in the size range 20 – 40 mm. Install filter fabric to stop movement of silt into porous material. Install a slotted pipe drain at the bottom of the wall backfill to ensure all water is drained away from the wall face.

Minimum thickness: 450 mm.

3.6 CRIB WALLS

Construction

Construct walls in conformance with the manufacturer's written requirements or specific design included in the drawings.

3.7 GABION WALLS

Assembly

Construction: Assemble the baskets and join them together by wiring along edges both horizontally and vertically before placing the rock fill. Fix the top of the basket by wiring to both the sides and the diaphragms.

3.8 BRICK, EARTH BLOCK WALLS

Construction

Construct walls in conformance with the specific design included in the drawings. Construction of brickwork and earth blockwork to be in accordance with the relevant specification sections.

LANDSCAPE – SOILS AND PLANTING

1 GENERAL

1.1 SUBMISSIONS

Suppliers

Obtain statements from suppliers of plant materials, giving the following:

- Particulars of the supplier's experience in the required type of work.
- Lead times for delivery of the material to the site.

1.2 INSPECTION

Notice

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

- lawns prepared before seeding
- plant holes excavated and prepared for planting
- setout of gravel paths prepared for filling

2 PRODUCTS

2.1 TOPSOIL

Source

Import topsoil unless the topsoil type can be provided from material recovered from the site.

Additives

Use additives to raise topsoil to the required standard approved by the Employers Representative.

2.2 COMPOST AND FERTILISER

Compost

Provide well rotted vegetative material or animal manure, free from harmful chemicals, grass and weed growth.

Fertiliser

Provide proprietary fertilisers, delivered to the site in sealed bags marked to show manufacturer or vendor, weight, fertiliser type, recommended uses and application rates.

2.3 GRAVEL PATHS

Provide paths constructed with consolidated small gravel chippings and concrete edging pavers where shown on plans.

3 EXECUTION

3.1 PREPARATION

Vegetative spoil

Remove vegetative spoil from site. Do not burn.

3.2 ROCKWORK

Rock work

General: Place rocks while ground formation work is being carried out. Provide site rock, otherwise provide imported rock. Bury rock two thirds by volume, with weathered faces exposed. Protect the weathered faces from damage.

Site rock: Stockpile for future placement and accessibility for lifting. Dispose of other rock off site.

Imported rock: Provide rock which has been selected before delivery.

3.3 SUBSOIL

Ripping

Rip parallel to the final contours wherever possible. Do not rip when the subsoil is wet or plastic. Do not rip within the dripline of trees and shrubs to be retained.

Ripping depths: Rip the subsoil to the following typical depths:

- Compacted subsoil: 300 mm.
- Heavily compacted clay subsoil: 450 mm.

Planting beds

Excavated: Excavate to bring the subsoil to at least 300 mm below finished design levels. Shape the subsoil to fall to subsoil drains where applicable. Break up the subsoil to a further depth of 100 mm.

Unexcavated: Remove weeds, roots, builder's rubbish and other debris. Bring the planting bed to 75 mm below finished design levels.

Cultivation

Minimum depth: 100 mm.

Services and roots: Do not disturb services or tree roots; if necessary cultivate these areas by hand.

Cultivation: Thoroughly mix in materials required to be incorporated into the subsoil. Cultivate manually within 300 mm of paths or structures. Remove stones exceeding 50 mm, and weeds, rubbish or other deleterious material brought to the surface during cultivation. Trim the surface to design levels after cultivation.

Additives

Apply additives after ripping or cultivation and incorporate into the upper 100 mm layer of the subsoil. Refer to the **Soil additives schedule**.

3.4 TOPSOIL

Placing topsoil

Spread the topsoil on the prepared subsoil and grade evenly. Ensure that grassed areas may be finished flush with adjacent hard surfaces such as kerbs, paths and mowing strips.

Contamination: Where diesel oil, cement or other toxic material has been spilt on the subsoil or topsoil, excavate the contaminated soil, dispose of it off the site, and replace it with site soil or imported topsoil.

Finishing: Feather edges into adjoining undisturbed ground.

Consolidation

Compact lightly and uniformly in 150 mm layers. Produce a finished topsoil surface which has the following characteristics:

- Smooth and free from stones or lumps of soil.
- Graded evenly into adjoining ground surfaces.
- Ready for planting.

Topsoil depths

Spread topsoil to the following typical depths:

- Excavated planting areas: If using organic mulch, 200 mm.
- Irrigated grassed areas generally: 150 mm.
- Non-irrigated grass areas: 100 mm.

Surplus topsoil

Spread surplus topsoil on designated areas on site, if any; otherwise, dispose off site.

Designated areas to be determined by the Employers Representative.

3.5 GRASS SEEDING

Preparation

Prepare the areas to be sown. Spread the fertiliser evenly over the cultivated bed within 48 hours before sowing, and rake lightly into the surface. If a prepared area becomes compacted from any cause before sowing can begin, rework the ground surface before sowing.

Sowing

Do not sow if frost is likely before the plant has reached an established state, or in periods of extreme heat, cold or wet, or when wind velocities exceed 8 km/h. Provide even distribution. Lightly rake the surface to cover the seed.

Rolling

Roll the seed bed immediately after sowing.

Roller weight (maximum):

- Clay and packing (heavy) soils: 90 kg/m width.
- Sandy and light soils: 300 kg/m width.

Watering

Before germination: Water the seeded area with a fine spray until the topsoil is moistened to its full depth. Continue watering until germination to keep the surface damp and the topsoil moist but not waterlogged.

After germination: Water to maintain a healthy condition, progressively hardened off to the natural climatic conditions.

Germination

Maintain sown areas until healthy grass covers the whole of the seeded area.

Reseeding: If germination has not been attained within one month, reseed the sown areas.

Weeding

Remove weeds that occur in sown areas. Where necessary spray with a selective weedkiller for broad leaved weeds. Do not spray grass seeded areas within 3 months of germination.

Protection

Protect the newly sown areas against traffic until well established. Protection method to be approved by the Employers representative.

Mowing

Mow to maintain the grass height within the required range. Do not remove more than one third of the grass height at any one time. Carry out the last mowing within 7 days before the end of the planting establishment period. Remove grass clippings from the site after each mowing.

3.6 PLANTS

Plants

Characteristics: Provide plants with the following characteristics:

- Large healthy root systems.
- Vigorous, well established, free from disease and pests.
- Suitable for planting in the natural climatic conditions prevailing at the site.

Replacement: Replace damaged or failed plants with plants of the same type and size.

Plant containers

Supply plants in weed-free containers of the required size.

Open rooted stock: If trees are to be supplied as open rooted stock, ensure this is appropriate to the species, variety, size, and time of year for planting.

Refer to the **Plant Schedule**.

Labelling

Label at least one plant of each species or variety in a batch with a durable, readable tag.

Storage

Deliver plant material to the site on a day to day basis, and plant immediately after delivery.

3.7 PLANTING

Individual plantings in grassed areas

Excavate a hole to twice the diameter of the root ball and at least 100 mm deeper than the root ball. Break up the base of the hole to a further depth of 100 mm, and loosen compacted sides of the hole to prevent confinement of root growth.

Locations

If it appears necessary to vary plant locations and spacings to avoid service lines, or to cover the area uniformly, or for other reasons, obtain directions from the Employers Representative.

Planting conditions

Do not plant in unsuitable weather conditions such as extreme heat, cold, wind or rain. In other than sandy soils, suspend excavation when the soil is wet, or during frost periods.

Watering

Thoroughly water the plants before planting, immediately after planting, and as required to maintain growth rates free of stress.

Placing

Remove the plant from the container with minimum disturbance to the root ball, ensure that the root ball is moist and place it in its final position, in the centre of the hole.

Fertilising

In planting beds and individual plantings, place fertiliser pellets around the plants at the time of planting.

Watering basins for plants in grass

Except in irrigated grassed areas and normally moist areas, construct a watering basin around the base of each individual plant, consisting of a raised ring of soil capable of holding at least 10 L.

3.8 STAKES AND TIES

Stakes

Use Hardwood stakes, straight, free from knots or twists, pointed at one end.

Drive stakes into the ground at least one third of their length, avoiding damage to the root system.

Stake sizes:

- For plants ≥ 2.5 m high: Three 50 x 50 x 2400 mm stakes per plant.
- For plants 1 – 2.5 m high: Two 50 x 50 x 1800 mm stakes per plant.

Ties

Provide ties fixed securely to the stakes, one tie at half the height of the main stem, others as necessary to stabilise the plant.

Tie types for plants < 2.5 m high: 50 mm sack webbing stapled to the stake.

3.9 GRAVEL PATHS

Pavement

Use small size gravel in layers not exceeding 150mm thick to form paths where shown on drawings. Colour and type of gravel to approval of Employers representative. Retain sides of path with either:

- Precast decorative concrete paving edge strips, colour to approval of Employers Representative.
- Concrete kerbs

3.10 PLANTING ESTABLISHMENT

Period

The planting establishment period commences at the date of substantial completion and finishes at the date of final certificate.

Existing planting and grass

Where existing grass or planting is within the landscape contract area, maintain it as for the corresponding classifications of new grass or planting.

Recurrent works

Throughout the planting establishment period, carry out maintenance work including, watering, mowing, weeding, rubbish removal, reseeding, staking and tying, replanting, cultivating, and keeping the site neat and tidy.

pavers – mortar bed**1 GENERAL****1.1 INSPECTION****Notice**

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

- Substrate immediately before tiling.
- Trial set-outs before execution.
- Control joints before sealing.

1.2 SUBMISSIONS**Samples**

Submit labelled samples of pavers, grout and sealants, illustrating the range of variation in colour and finish.

1.3 TOLERANCES**Completed paving**

Conform to the **Surface level tolerances table**:

Surface Level Tolerances Table

Item	Level tolerance	
	Absolute	Relative
Vehicular pavements- mortar	± 5 mm	5 mm
Footpaths- mortar	± 10 mm	<10 mm

2 PRODUCTS**2.1 MORTAR****Materials**

Cement shall conform to the requirements of ASTM specification C-150 Type 1 or similar approved standard for normal Portland cement.

- White cement: Iron salts content \leq 1%.
- Off-white cement: Iron salts content \leq 2.5%.

Lime: Confirm source of Lime with Employers Representative to ensure highest quality Lime is used in the mortar. Protect from damage on site and store minimum 300mm above ground in waterproof storage facility.

Sand: Fine aggregate with a low clay content selected for grading, sharp and free from efflorescing salts. River or pit sand should be sharp, angular, hard, clean uncoated particles free from clay and organic impurities.

Water: Water to be used for the mixing of mortar should be clean and free from oil, acid, alkali, salts, organic materials or other substances that are harmful to the mortar mix.

Measurement of volume: Measure binders and sand by volume using buckets or boxes. Do not allow sand to bulk by absorption of water.

Bedding mortar

Proportioning: Standard and ratio of mix for all mortar shall be M-400 (1:3), M-300 (1:4), M-250 (1:5) and M-200 (1:6). Provide minimum water.

2.2 GROUT

Type

Cement based proprietary grout: Mix with water. Fine sand may be added as a filler in wider joints.

Portland cement based grout: Mix with fine sand. Provide minimum water consistent with workability.

- For joints < 3 mm: 1 cement:2 sand.
- For joints \geq 3 mm: 1 cement:3 sand.

Pigments

Pigments for coloured grout: Provide colourfast fillers compatible with the grout material. For cement-based grouts, provide lime-proof natural or synthetic metallic oxides compatible with cement.

Water

General: To be clean and free from any deleterious matter.

2.3 PAVERS

Concrete and clay segmental paving units

Provide labelled samples of all pavers for approval of the Employers Representative prior to use.

Ensure that the horizontal dimensions of each paver have a maximum variation of 3mm in 300mm.

Any pavers outside this tolerance will be rejected and removed from the site. Ensure that all pavers are free from fault lines, cracked edges, surface flakes, mould marks or other defects before use.

Stone paving units

Provide labelled samples of all pavers for approval of the Employers Representative prior to use.

Ensure that all stone pavers are free from fault lines, cracked edges, surface flakes or other defects before use.

3 EXECUTION

3.1 SUBSTRATES

Drying and shrinkage

Before paving, allow at least the following times to elapse (for initial drying out and shrinkage) for these substrates:

- Concrete slabs: 42 days.
- Toppings on slabs: A further 21 days.

3.2 PREPARATION

Trial set-out

Prepare a trial paving set-out to each area as follows to:

- Maximise the size of equal margins of cut pavers.
- Locate movement joints.
- Note minor variations in joint widths to eliminate cut tiles at margins.

Ambient temperature

General: If the ambient temperature is < 5 or > 35°C, do not lay pavers.

Substrates

Ensure substrates are as follows:

- Clean and free of any deposit or finish which may impair adhesion or location of pavers.
- Excessive projections are hacked off and voids and hollows are filled with a cement:sand mix not stronger than the substrate nor weaker than the bedding.

Absorbent substrates: If suction is excessive, control it by dampening but avoid over-wetting and do not apply mortar bedding to substrates showing surface moisture.

Dense concrete: If not sufficiently rough to provide a mechanical key, roughen by scabbling or the like to remove 3 mm of the surface and expose the aggregate; then apply a bonding treatment.

Fixtures

Before paving ensure that fixtures interrupting the surface are accurately positioned in their designed or optimum locations relative to the paving layout.

3.3 PAVING GENERALLY

Variations

If necessary, distribute variations in hue, colour, or pattern uniformly, by mixing pavers or paving batches before laying.

Paving joints

Joint widths: Set out pavers to give uniform joint widths of $6 < 12$ mm.

Margins

Provide whole or purpose-made pavers at margins where practicable, otherwise set out to give equal margins of cut pavers. If margins less than half paver width are unavoidable, locate the cut pavers where they are least conspicuous.

Protection

Traffic: Keep pedestrian and vehicular traffic off paving until the bedding has set and attained its working strength.

Cleaning: Keep the work clean as it proceeds and protect finished work from damage.

Refer to **Paving schedule** for details of pavers, bedding and grout.

3.4 MORTAR BEDDING

Preparation of pavers

Suction: Soak porous pavers in water for half an hour and then drain until the surface water has disappeared.

Bedding

Use bedding methods and materials which are appropriate to the paver, the substrate, the conditions of service, and which leave the paver firmly and solidly bedded in the bedding material and adhered to the substrate. Form falls integral with the substrate.

Mortar beds

Either lightly dust the screeded bed surface with dry cement and trowel level until the cement is damp, or spread a thin slurry of neat cement, or cement-based thin bed adhesive, on to the tile back. Do not provide mortar after initial set has occurred.

Nominal thickness of 20mm for mortar bed unless noted otherwise on drawings.

3.5 MOVEMENT JOINTS

General

Provide movement joints in the following locations:

- Location:
 - . Over structural (isolation, contraction, expansion) joints.
 - . At internal corners.
 - . Around the perimeter at abutments.
 - . At junctions between different substrates.
 - . To divide large paved areas into bays, maximum 5 m wide, maximum 16 m^2 .
 - . At abutments with the building structural frame and over supporting walls or beams where flexing of the substrate is anticipated.
- Depth of joint: Right through to the substrate.
- Sealant width: 6 – 25 mm.
- Depth of elastomeric sealant: One half the joint width, or 6 mm, whichever is the greater.

Movement joint materials

Divider strip: A proprietary expansion joint consisting of a neoprene filler sandwiched between plates with lugs or ribs for mechanical keying. Set flush with the finished surface.

Proprietary slide plate divider strip: An arrangement of interlocking metal plates grouted into pockets formed in the concrete joint edges.

Sealant: Two-pack self-levelling non-hardening mould resistant, one-part silicone or polyurethane sealant applied over a backing rod. Finish flush with the tile surface.

Backing rod: Compressible closed cell polyethylene foam with a bond-breaking surface.

3.6 GROUTED AND CAULKED JOINTS**Grouted joints**

Commence grouting as soon as practicable after bedding has set. Clean out joints as necessary before grouting.

Face grouting: Fill the joints solid and tool flush. Clean off surplus grout. Wash down when the grout has set. When grout is dry, polish the surface with a clean cloth.

3.7 COMPLETION**Cleaning**

Completion: Leave pavements clean on completion.

CONCRETE - GENERAL

1 GENERAL

1.1 INSPECTION

Notice

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

- Base or subgrade before covering.
- Membrane or film underlay installed on the base.
- Completed formwork, and reinforcement, cores, fixings and embedded items fixed in place.
- Surfaces or elements to be concealed in the final work before covering.
- Commencement of concrete placing.

1.2 SUBMISSIONS

Products – proposals

Curing compounds: If it is proposed to use a liquid membrane-forming curing compound submit certified test results for water retention.

Curing by the covering sheet method: Submit details of the proposed covering material.

Repair materials: Submit proposals for epoxy resin/grout and elastomeric sealant.

1.3 TESTS

General

Perform tests of the type and frequency necessary to adequately control the materials and processes used in the construction of the works and in conformance with the **Concrete tests table**.

Compliance assessment tests

Timing: Obtain materials samples at the time of delivery to the site.

Location: Sample from selected sample sites within designated uniform test lots, consisting of an area placed, or compacted or both in one day. Test lots must be uniform in terms of material properties and density.

Specimen type: A set of compression test specimens shall consist of four 200 x 200 x 200 mm cubes, each cube being one specimen.

The specimens within each set shall be tested at the following ages in conformance with the **Concrete tests table**.

- One at 7 days for information.
- Two at 28 days. The 28 day strength shall be taken as the average of the two specimens. If one specimen in this test shows evidence of improper sampling, molding or testing, it shall be discarded. The remaining specimen shall be considered the test result. Should both specimens show the specified defects, the entire test shall be discarded.
- The fourth shall be retained as a spare to be tested as required.

Discharge slump tests

Carry out slump tests at approximately one quarter and three quarter points of the load during discharge.

Working slump: 80mm

Maximum slump: 110 mm. Note concrete with slump greater than this value will be rejected and removed from the site at the contractors cost.

Flexural strength assessment of concrete

Acceptance criterion: The average strength of any set of 3 consecutive project samples must not exceed the specified maximum value.

Concrete Tests Table

Samples	ASTM C172
Curing	ASTM C31
Testing	ASTM C39
Slump Determination	ASTM C143
Air Content	ASTM C231 or C173

2 EXECUTION

2.1 PRODUCTS

Reinforcement

All reinforcing shall be supported and wired together to prevent displacement by construction loads, or the placing of concrete, beyond the tolerances specified in ACI 301. Any tack or spot welding of reinforcement shall not be performed without approval from the Employers Representative.

Reinforcement shall be free of loose rust and of any other coating which may adversely affect the bond.

Splices in bar reinforcement shall be located and lapped as shown on the design drawings. Bars in lapped splices shall be in contact unless otherwise shown on the design drawings. Additional splices, if required, shall be made only at locations, and in a manner approved by the Employers Representative. Welded splices shall not be used. All lap splices in bar reinforcement shall be fully in compliance with ACI 318-02.

Welded wire fabric used in concrete paving shall have lapped splices made so that the overlap between the outermost cross wires of each fabric sheet is at least 50 mm.

Unless specifically indicated on the design drawings, splicing by means of proprietary mechanical splices shall not be used.

Concrete spacers, metal or plastic bar spacers i.e. chairs, shall be used for obtaining proper spacing of reinforcement from the bottom and sides of formwork.

Dowels

Provide each dowel in one piece, straight, cut accurately to length with ends square and free from burrs. Fix in locations as shown on the design drawings.

Formwork

Construct formwork with timber or steel elements to support the concrete for full duration of critical curing period. Construct in a durable manner with sufficient props and fixings to ensure that the formwork remains in position at all times.

Aggregate

Aggregate size:

- For fixed form placement: < 40 mm.
- For slip form placement: To be a size compatible with the paving machine.

Washing: Wash aggregate as necessary or as directed to remove significant dust or achieve requirements for soluble salt content or concrete drying shrinkage.

Aggregate Sieve Table

Sieve size		Percent by weight passing
mm	in	
Coarse Sieves		
25	1	90-100
19	3/4	40-85
12.5	1/2	10-40

9.5	3/8	0-15
Fine Sieves		
4.75	No. 4	95-100
2.36	No. 8	80-100
1.18	No. 16	50-85
600 µm	No. 30	25-60
300 µm	No. 50	5-30
150 µm	No. 100	0-10

Cement

Cement shall conform to the requirements of ASTM specification C-150 Type 1 or similar approved standard for normal Portland cement.

Cement shall be free from any hardened lumps and foreign matter. It shall have a minimum of 90% of particles by weight passing the 75-micron sieve, an initial setting time in excess of 30 minutes and a final setting time of less than 7 hours.

Cement shall be stored in a waterproof shaded area. The cement stacks shall be placed at a minimum distance of 300mm from the walls. The damp proof floor shall be constructed by raising it minimum 300mm above the ground.

Curing products

Curing compounds: Obtain approval from the Employers Representative for all curing compounds prior to use.

Covering sheet materials: To be opaque polyethylene film, or burlap-polyethylene sheet, or equivalent material.

Concrete

Ready-mixed concrete shall comply with M-150 (1:2:4) for non-reinforced mass concrete and M-200 (1:1.5:3) for reinforced concrete and the requirements of these standards.

On site batch mixed concrete shall have characteristics and proportions of concrete ingredients which conform to those specified in M-150 (1:2:4) and M-200 (1:1.5:3).

Admixtures: Introduce in solution in a portion of the mixing water. Ensure a uniform distribution of the admixture in the batch within the mixing period.

Mixing time: Measure the mixing time after solid materials are in the mixer, provided that mixing water is introduced before a quarter of the mixing time has elapsed. Increase mixing time if necessary to obtain the required uniformity and consistence of concrete. Do not overmix such that additions of water are needed.

Transport: Transport and discharge the concrete without segregation.

Elapsed delivery time: Discharge truck mixed concrete within a time (t hours) determined as follows, where T is the temperature of the concrete in degrees Celsius:

$$t = 2 - 0.05T.$$

2.2 POLYMERIC FILM UNDERLAY**Location**

Provide a vapour barrier under slabs on ground including integral ground beams and footings.

Installation

Lay over the base, lap joints at least 200 mm and seal the laps and penetrations with waterproof adhesive tape. Face the laps away from the direction of concrete pour. Patch or seal punctures or tears before pouring concrete. Cut back as required after concrete has gained strength and forms have been removed.

Base preparation

According to base type, as follows:

- Concrete working base: Remove projections above the plane surface, and loose material.

- Graded prepared subgrade: Blind with sufficient sand to create a smooth surface free from hard projections. Wet the sand just before laying the underlay.

3 EXECUTION

3.1 PLACING- GENERAL

Cold weather

Subbase: Ensure that the subbase surface is free of frost.

Cold weather concreting shall be in accordance with the following:

- The guidelines of ACI 306R shall be followed when the Forecasted Mean Daily Temperature drops below 4°C for three consecutive days. The minimum concrete temperature when delivered at the site shall be in accordance with the **Minimum cold weather temperature table**.
- If water or aggregate is heated above 38°C, the water shall be combined with the aggregate in the mixer before cement is added. Cement shall not be mixed with water or with mixtures of water and aggregate having a temperature greater than 38°C.
- Concrete shall only be poured when the ambient temperature is rising.
- All concrete shall be insulated from freezing for the greater of following:
 - 3 days
 - Until the concrete reaches an in-place compressive strength of 35 kg/cm²,
- All materials shall be free from frost.
- Accelerating admixtures shall not be used without approval from the Employers Representative.

Maintain the concrete at a temperature of at least 10°C for at least 24 hours after placing.

Admixtures

General: Do not add calcium chloride, salts, chemicals or other material to the mix to lower the freezing point of the concrete.

Minimum Cold Weather Temperature Table

Air Temperature °C	Minimum Concrete Temperature °C	
	For Sections With Smallest Dimension Less Than 300 mm	For Sections With Smallest Dimension 300 mm Or Greater
-1 to 4	16	13
-18 to -1	18	16
Below -18	21	18

Hot weather

Avoid premature stiffening of the mix and reduce water absorption and evaporation losses. If the temperature of the surrounding air is higher than 32°C:

- Mix, transport, place and compact the concrete as rapidly as possible, and cover with an impervious membrane or hessian kept wet until moist curing begins.
- Hold the concrete to a temperature < 32°C when placed.

Hot weather concreting shall be in accordance with the following:

- Concrete temperatures shall be kept within desirable limits using methods recommended in ACI 305R.
- For mass concrete, i.e., concrete sections having a minimum dimension of 750mm or greater, the maximum acceptable concrete temperature is 21°C at time of discharge.
- For other concrete structures, the maximum acceptable concrete temperature is 32°C at time of discharge.

d. If ice is used as part of the mixing water, mixing should be continued until the ice is completely melted.

e. Retempering shall not increase the water content above that in the mix design.

Placing in fixed forms

Place concrete uniformly over the width of the slab and so that the face is generally vertical and normal to the direction of placing. Hand spread concrete using shovels, not rakes.

Compact concrete using internal mechanical vibration of sufficient amplitude to produce noticeable vibrations at 300 mm radius. Insert vibrators into the concrete to the depth which will provide the best compaction, but not deeper than 50 mm above the surface of the subbase, and for a duration sufficient to produce satisfactory compaction, but not longer than 30 seconds in any one location.

Elapsed delivery time

General: Ensure that the elapsed time between the wetting of the mix and the discharge of the mix at the site is in conformance with the **Elapsed delivery time table**. Do not discharge below 10°C or above 32°C.

Elapsed Delivery Time Table

Concrete temperature at time of discharge (°C)	Maximum elapsed time (hours)
10 – 24	2.00
24 – 27	1.50
27 – 30	1.00
30 – 32	0.75

Finishing

Immediately after placement and spreading and compaction of the plastic concrete, start finishing operations to achieve finish shown on the drawings.

Curing

Protect fresh concrete from premature drying and from excessively hot or cold temperatures. Maintain the concrete at a reasonably constant temperature with minimum moisture loss for the curing period.

- Temperature: Maintain the concrete at a temperature > 5°C for at least 7 days.

Curing compound method: Spray the entire surface including edges using a mechanical sprayer, at a uniform application rate of at least 0.35 L/m². Respray defective areas within 30 minutes. Respray within 3 hours after heavy rain. Apply as a continuous coating without visible breaks or pinholes.

Covering sheet method: Immediately after finishing operations cover concrete using damp hessian or cotton mats overlapped at least 150 mm and anchored against displacement by wind or other interference. Keep the mats continuously damp until covered by the covering sheet material. Repair tears and the like immediately.

- Joint sawing: Sheet materials may be removed for the minimum distance and period to permit joint sawing, provided the concrete is kept moist by other means.

Moist curing method: Immediately after finishing operations keep the concrete surface continuously damp by spraying constantly with water, fog, or mist, using suitable spraying equipment.

Minimum curing time: 7 days.

3.2 CORES, FIXINGS AND EMBEDDED ITEMS

Adjoining elements

For adjoining elements to be fixed to or supported on the concrete, provide for the required fixings. If required, provide for temporary support of adjoining elements during construction of the concrete.

Protection

Grease threads. Protect embedded items against damage.

Compatibility: Ensure inserts, fixings and embedded items are compatible with each other, with the reinforcement and with the concrete mix to be used.

Corrosion: If in external or exposed locations, galvanize anchor bolts and embedded fixings.

Structural integrity

Fix cores and embedded items to prevent movement during concrete placing. In locating cores, fixings and embedded items, reposition but do not cut reinforcement, and maintain cover to reinforcement.

Tolerances

Maximum deviation from correct positions:

- Cores and embedded items generally: 10 mm.
- Other fixing bolts: 3 mm.

3.3 COMPACTION**Compaction**

Methods: Use immersion and screed vibrators accompanied by hand methods as appropriate to remove air bubbles and to fully compact the mix.

Vibrators: Do not allow vibrators to come into contact with partially hardened concrete, reinforcement or items including pipes and conduits embedded in concrete. Do not use vibrators to move concrete along the forms. Avoid over-vibration that may cause segregation.

Placing

Use placing methods which avoid segregation and loss of concrete, and which minimise plastic settlement. Maintain a generally vertical and plastic concrete edge at faces of a pour.

Layers: Place concrete in layers ≤ 300 mm thick, such that each succeeding layer is compacted before previous layer has taken initial set.

Rain

General: Do not expose concrete to rain before it has been placed and set.

Vertical elements

In vertical elements, limit the free fall of concrete to 1500 mm per 100 mm element thickness, up to a maximum free fall of 3000 mm, using enclosed vertical chutes or access hatches in forms.

3.4 CONSTRUCTION JOINTS**Location**

Do not relocate or eliminate construction joints, or make construction joints not shown on the drawings. If emergency construction joints are made necessary by unforeseen interruptions to the concrete pour, submit a report on the action taken.

Joint preparation

Roughen and clean the hardened concrete joint surface. Remove loose or soft material, free water, and foreign matter. Dampen the surface just before placing the fresh concrete and coat with a neat cement slurry.

3.5 EXPANSION JOINTS**Joint filling**

Joint filling: Fill with jointing materials. Finish visible jointing material neatly flush with adjoining surfaces.

Preparation: Before filling, dry and clean the joint surfaces, and prime.

Watertightness: Apply the jointing material so that joints subject to ingress of water are made watertight.

CONCRETE- FINISHES

1 GENERAL**1.1 TOLERANCES****General**

Unformed surfaces: Confirm conformance with the **Tolerance classes table** for the class of finish nominated using a straight edge placed anywhere on the surface in any direction.

Tolerances Class Table

Class	Measurement	Maximum deviation (mm)
A	3 m straight edge	3
B	3 m straight edge	6
C	600 mm straight edge	6

2 PRODUCTS**2.1 MATERIALS****Surface hardeners, sealers and protectors**

Supply: If required by the project documentation, provide proprietary products in accordance with the manufacturer's written requirements.

3 EXECUTION**3.1 SURFACE MODIFIERS****General**

Application: Apply to clean surfaces in accordance with the manufacturer's requirements.

3.2 UNFORMED SURFACES**General**

Screed and level slab surfaces to finished levels, to tolerance class C.

Finishing methods

Broom finish: After floating draw a broom or hessian belt across the surface to produce a coarse even-textured slip-resistant transverse-scored surface.

Machine floated finish: After screeding and when the concrete has stiffened sufficiently, work the slab surface using a machine float. Hand float in locations inaccessible to the machine float. Cut and fill to tolerance class B and refloat immediately to a uniform, smooth texture.

Scored or scratch finish: After screeding, give the surface a coarse scored texture using a stiff brush or rake drawn across the surface before final set.

Steel trowelled finish: After machine floating, use power trowels to produce a smooth surface relatively free from defects. Then, when the surface has hardened sufficiently, use steel hand trowels to produce the final finish free of trowel marks and defects, and uniform in texture and appearance, to tolerance class A.

Wood float finish: After screeding, machine produce the final finish using a wood float, to tolerance class B.

Polished finishes

Water blast: After steel trowelling, water blast the cured surface to provide texture or to form patterns without exposing the coarse aggregate using medium pressure water jets. Ensure that aggregate is not removed to a depth greater than 10mm.

Applied finish: To a steel trowel finished surface, apply a proprietary liquid or dry shake material in accordance with the manufacturer's written requirements.

Burnished finish: Continue steel trowelling until the concrete surface attains a polished or glossy appearance.

Surface finishes

General: Provide surface finishes in conformance with the **Concrete-integral finishes schedule**.

3.3 FORMED SURFACES**General**

Provide formed concrete finishes in conformance with the **Concrete-formed surface finishes schedule**.

Damage: Do not damage concrete works through premature removal of formwork.

Curing

General: If forms are stripped when concrete is at an age less than the minimum curing period, commence curing exposed faces as soon as the stripping is completed.

Finishing methods

If exposed formed concrete elements are to have a finish other than off the form, provide details of proposed procedures. If not identified otherwise, all formed surfaces will be off form finish.

Exposed aggregate finish: Remove the vertical face forms while the concrete is green but set. Wet the surface and scrub using stiff fibre or wire brushes, using clean water freely, until the surface film of mortar is mechanically removed, and the aggregate uniformly exposed. Do not use acid etching. Rinse the surface with clean water.

Floated finishes:

- Sand floated finish: Remove the forms while the concrete is green. Wet the surface and rub using a wood float. Rub fine sand into the surface until a uniform colour and texture are produced.
- Grout floated finish: Remove the forms while the concrete is green. Dampen the surface and spread a slurry, using hessian pads or sponge rubber floats. Remove surplus slurry and work until a uniform colour and texture are produced.

Surface repairs

Surface repair method: Before commencing repairs, submit proposals to the Engineer for approval.

PRECAST CONCRETE

1 GENERAL

1.1 DEFINITIONS

Definitions

For the purposes of this worksection the following definition applies:

- Precast units: Concrete elements manufactured in other than their final position including elements manufactured on site but excluding tilt-up panels.

1.2 INSPECTION

Notice

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

- Formwork dimensions and stability.
- Panel edge details and penetrations.
- Connection materials, reinforcement and inserts in place.

1.3 SUBMISSIONS

Subcontractors

Submit name and contact details of proposed manufacturer of precast concrete units.

Design

Veneered fabrication: If veneered fabrication is proposed submit proposals to the Employers Representative.

Contractor design: Provide verification by a professional engineer of compliance of the design with project documents.

Shop drawings

Submit shop drawings of precast units showing the proposed details for their design, manufacture, assembly, transport and installation, including the following:

- Project title and manufacturer's name.
- Shape or profile drawings (submit these before fabrication of moulds and tooling).
- Concrete mix and type of cement if special-class concrete.
- Veneer details, if applicable.
- Surface finish class and surface treatment, if applicable.
- Curing and protection methods.
- Marking plan.
- Equipment and methods for handling, transport and installation, including lifting inserts and pick-up points.
- Calculated maximum loadings on lifting and bracing inserts and attachments.
- Evidence of load capacity of lifting and bracing inserts and attachments in the form of test reports or calculations.

Lifting

Early lifting: If it is proposed to lift the units by their designated lifting points before 28 day strength has been achieved, submit evidence to demonstrate that the unit has adequate strength to carry its own weight without damage or residual cracking or deflection on removal of the lifting device.

Attachments for handling purposes: If it is proposed to locate lifting attachments, holes and other temporary fixings for handling purposes on visible faces of units, submit proposals.

Lifting units: If it is proposed to lift or support units at other than specified points, submit proposals.

1.4 PROTOTYPES

General

Provide prototypes in accordance with the **Precast concrete prototypes schedule**.

Maintain prototypes on site, undamaged and protected from discolouration for comparison with manufactured precast units.

Test panels

Make separate test panels for surface finish, colour, or both, in conformance with the **Precast concrete prototypes schedule**.

2 PRODUCTS

2.1 PRECAST UNITS

Marking

Identification: Identify units by marks which are as follows:

- Remain legible until after the unit has been fixed in place.
- Are not visible in the completed structure.
- Show the date of casting.
- Show the correct orientation of the unit.
- On other than units manufactured as a standard product, indicate the locations within the structure in accordance with the marking plan.

Tolerances

Fixings and embedded items in precast units: To be maximum of 5mm from design location unless agreed otherwise with the Employers Representative.

Lifting devices

Capacity: Design each lifting device for a working load at least 1.65 times the maximum calculated static load at that point and an ultimate load ≥ 4 times the maximum static load.

Attachments

Sealing: Recess lifting attachments such as ferrules, or other types of cast-in fixings, and provide plugs for sealing.

2.2 VENEERED CONSTRUCTION

General

Use a method which ensures that delamination of the veneer will not occur. Obtain approval from the Employers Representative prior to construction commencing.

3 EXECUTION

3.1 HANDLING

Precautions

Lift or support units only at designated or other approved points. Use handling methods which do not overstress, warp or damage the units. Protect the units against staining, discolouration and other damage until they are installed in their final location.

Attachments

Remove temporary attachments after erection. Seal or otherwise make good residual recesses.

3.2 INSTALLATION

General

Fixing: Fix the units securely and accurately in their final positions.

Ancillaries: Provide components and materials, including fasteners, braces, shims, jointing strips, sealant, flashings, grout and mortar, necessary for the installation of the units.

BRICKWORK**1 GENERAL****1.1 INSPECTION****Notice**

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

- Set out of brickwork to lintels, arches and other architectural features.
- Damp-proof courses, in position.
- Lintels, in position.

2 PRODUCTS**2.1 MATERIALS****First Class Bricks**

First Class Bricks shall be made from good brick earth free from saline deposits, and shall be sand molded. They shall be thoroughly burnt by coal without being vitrified, of uniform and good color, shall be regular and uniform in size, shape and texture with sharp square edges and parallel faces. They must emit a clear metallic ringing sound when struck one against another. They shall be free from flaws, cracks, chips, stones, and nodules of lime or canker. A First Class Brick shall not absorb more than 1/6th of its weight of water after being soaked for one hour.

Second Class Bricks

Second Class Bricks shall be as well burnt as First Class or may be slightly over burnt but not vitrified, and must give a clear ringing sound when struck one against another. Slight irregularities in size, shape or color are acceptable provided irregular or uneven courses do not result. Second Class Bricks may have slight chips or flaws but must be free from lime or canker nodules. They shall not absorb more than 1/4th of their weight of water after being soaked for one hour.

General

Machine made pressed bricks shall be standard commercial products. The Employers Representative prior to use in the Works shall approve the use of machine made pressed bricks.

Bricks not meeting the above requirements shall not be used in brickwork.

First and Second Class Bricks should have the following dimensions after burning: 250mm x 120mm x 70mm. The unit weight of First and Second Class Bricks shall not be less than 1100 kg/m³.

The crushing strength of bricks shall be tested in a laboratory. The average crushing strength of First and Second Class Bricks shall not be less than 17MPa (N/mm²).

At the start of the works samples of the bricks shall be tested for crushing strength and water absorption, and brickwork shall only commence when the Employers Representative has approved the bricks. The Contractor may then only change the source of supply of bricks after samples from the new supplier have similarly been tested and approved.

Mortar materials

Cement shall conform to the requirements of ASTM specification C-150 Type 1 or similar approved standard for normal Portland cement.

- White cement: Iron salts content \leq 1%.
- Off-white cement: Iron salts content \leq 2.5%.

Lime: Confirm source of Lime with Employers Representative to ensure highest quality Lime is used in the mortar. Protect from damage on site and store minimum 300mm above ground in waterproof storage facility.

Sand: Fine aggregate with a low clay content selected for grading, sharp and free from efflorescing salts. River or pit sand should be sharp, angular, hard, clean uncoated particles free from clay and organic impurities.

Water: Water to be used for the mixing of mortar should be clean and free from oil, acid, alkali, salts, organic materials or other substances that are harmful to the mortar mix.

Measurement of volume: Measure binders and sand by volume using buckets or boxes. Do not allow sand to bulk by absorption of water.

Mortar

Proportioning: Standard and ratio of mix for all mortar shall be M-400 (1:3), M-300 (1:4), M-250 (1:5) and M-200 (1:6). Provide minimum water.

2.2 COMPONENTS

Nailing blocks

Solid timber, or hollow timber box filled with earthen mortar. Timber unseasoned or thoroughly pre-wetted.

Steel components, including reinforcement

All steel components to be galvanised for maximum durability after incorporation into the structure.

Window and Door lintels

Lintels: Use steel, concrete or timber lintels in accordance with the manufacturers' technical literature or conform to the **Steel angle and T-lintels table**.

Steel Angle and T-lintels Table

Maximum span (mm)	Wall height above ≤ 600 mm			Wall height above > 600 mm, ≤ 1800 mm		
	Angle lintel size	T-Lintel dimensions: H x W x T (mm)	Bearing min. (mm)	Angle lintel size	T-Lintel dimensions: H x W x T (mm)	Bearing min. (mm)
1000	Two 75 x 50 x 5 Unequal angles	81 x 150 x 6	100	Two 125 x 75 x 8 Unequal angles	136 x 150 x 6	200
2000	Two 100 x 75 x 6 Unequal angles	136 x 150 x 6	150	Two 150 x 90 x 8 Unequal angles	156 x 150 x 6	200
2400	Two 125 x 75 x 8 Unequal angles	156 x 150 x 6	150	Two 150 x 90 x 10 Unequal angles	160 x 150 x 10	250
2800	Two 150 x 90 x 8 Unequal angles	158 x 150 x 8	200	Two 150 x 100 x 10 Unequal angles	210 x 200 x 10	300
3000	Two 150 x 90 x 10 Unequal angles	160 x 150 x 10	200	Two 150 x 100 x 12 Unequal angles	210 x 200 x 10	300

Timber lintels

Size: Width of the wall and in conformance with the **Timber lintels height table**.

Grade: Best quality of imported Russian timber or suitable approved local timber.

Bearing: 300 mm (minimum).

Timber Lintels Height Table

Maximum span (mm)	Lintel height (mm)
1200	150
1800	150
2400	200
3000	250

Timber fixing plates

Size: 200 x 50 mm (minimum).

Holding-down bolts

Type: 10 mm diameter threaded rod.

Termination: Horizontal 5 x 100 x 200 mm steel plate, weld-fixed, or with nuts.

Depth of embedment:

- Length (minimum): 450 mm.

3 EXECUTION

Refer to **Brickwork construction schedule** for details of brickwork and mortar types.

3.1 GENERAL

General

Construction of masonry brickwork shall not commence until the Employers Representative has accepted the footings on which it is to be placed.

Brickwork shall be built plumb, curved or battered as shown on the Drawings or as may be required, by skilled masons and properly supervised workmen. Bricks shall be clean and if necessary, they shall be scrubbed. Bricks shall be soaked in water for at least one hour before use.

Unless otherwise specified bricks shall be laid in English Bond, with frogs downward. All horizontal joints shall be parallel and level. Vertical joints in alternate courses shall come directly over one another. Joint thickness shall be 6mm and shall in no case exceed 8mm. The height of four courses including 4 bed joints shall rise 300mm. Set out brickwork with joints of uniform width and minimise cutting of masonry units.

Walls shall always be carried up regularly along their entire length unless otherwise directed by the Employers Representative.

Mortar mix

Mortar mixing shall be done in a mechanical mixer unless the Employers Representative specifically permits hand mixing. If hand-mixing is done, the operation shall be carried out on a clean watertight platform and cement & sand shall be first mixed dry in the required proportion to obtain a uniform color and then the mortar shall be mixed for at least two minutes after addition of water.

Cement Mortar shall be mixed in such quantities as can be used in the work within 30 minutes. Mortar, which has taken initial set, shall not be used, nor shall it be re-mixed with fresh mortar.

Preparing lime putty:

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

Mortar proportions (cement:lime:sand):As defined on the drawings.

Sand stockpile: Ensure sand is dry and stored undercover to avoid errors in volume batching during the mixing process.

Protection from contamination

Protect masonry materials and components from ground moisture and contamination.

Building in

Embedded items: Build in fixing blocks, brackets, lintels and accessories as the construction proceeds.

Steel door frames: Fill the backs of jambs and heads solid with mortar as the work proceeds.

Joining to existing

If jointing to existing work is required, provide a straight joint. Do not tooth new masonry into existing work.

Chasing

Chasing of brickwork shall be to the **Brickwork chasing table** and subject to the following limitations:

- Parallel chases on opposite faces of a wall shall not be closer than 600 mm to each other.

Brickwork Chasing Table

Brick thickness (mm)	Depth of chase (maximum mm)
More than 250 thick	35
250 thick	25

Brick thickness (mm)	Depth of chase (maximum mm)
100 thick non load bearing walls only	20

Joint finish

Lay brickwork on a full bed of mortar. Fill perpends solid.

Finish:

- Externally: Tool to give a dense water-shedding finish for face brickwork or rake not more than 10mm to give a key for render finish.
- Internally: If wall is to be plastered, rake not more than 10 mm to give a key.

Temporary support

If the final stability of the brickwork or blockwork is dependent on structural elements to be constructed after the brickwork, provide proposals for temporary support or bracing for the approval of the Employers Representative.

3.2 FACEWORK**Cleaning**

General: Clean progressively as the work proceeds to remove mortar smears, stains and discolouration.

Colour mixing

Evenly distribute the colour range of units and prevent colour concentrations and "banding" unless specifically identified as a feature of the brickwork.

3.3 DAMP-PROOF COURSES**Damp-proof courses**

Material: Embossed Polythene sheeting. Install sheeting at base of all walls to stop moisture rising up wall structures.

Location

Provide damp-proof courses as follows:

- Walls built off slabs on ground: In the bottom course of the wall on top of the slab.
- Walls adjoining infill floor slabs: In the course above the slab. Project 40 mm and dress down over the membrane turned up against the wall.

Installation

Lay in long lengths. Lap full width at angles and intersections and at least 150 mm at joints. Step as necessary, but not exceeding 2 courses per step. Sandwich damp-proof courses between mortar.

3.4 CONTROL OF MOVEMENT**Joints**

Provide joints as follows:

- Expansion joints for brickwork:
 - . Maximum length of continuous wall face: 8 m.
 - . Closest joint location to external corner: 2.5m
 - . Maximum vertical spacing: 8 m.
 - . Width of control joint: $\geq 10 \text{ mm} \leq 20 \text{ mm}$.
 - . Width of horizontal joint: $\geq 15 \text{ mm} \leq 20 \text{ mm}$.

Filler material: Provide compatible sealant and bond breaking backing materials which are non-staining to masonry.

- Bond breaking materials: To be non-adhesive to sealant, or faced with a non-adhering material.
- Foamed materials: To be closed-cell or impregnated, not water-absorbing.

Joint filling:

- Installation: Clean the joints thoroughly and insert an easily compressible backing material before sealing.

- Sealant depth: Fill the joints with a gun-applied flexible sealant for a depth of at least two-thirds the joint width.

Refer to the **Brickwork construction schedule** and drawings for details of locations, types and extent of built in components. Preferably show on the drawings.

STONework**1 GENERAL****1.1 INSPECTION****Notice**

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

- The prepared stone sample range.
- Lintels in position.
- Damp proof courses in position.

1.2 TOLERANCES**Dimensions of stone units**

Maximum deviation from required dimensions:

- Loadbearing stone in cut blocks: ± 4 mm.
- Other stone used in foundations or not exposed to view: No size requirement unless noted otherwise in this worksection .

2 PRODUCTS**2.1 NATURAL STONE****Stone types**

Sandstone defects: Minor shale laminates and minor concentrations of carbonaceous material (tea leaves) are acceptable in visible faces. Neither defect is acceptable in carved or moulded work.

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

Stone selection

Grading: Select stone of the designated quality grade.

Matching: Within each grade, select stone for the best match of colour and pattern.

Source of stone supply

Ensure the stone quarry or supplier can provide all stone required for the project without the need to find alternative supplies.

2.2 MORTAR**Mortar materials**

Cement shall conform to the requirements of ASTM specification C-150 Type 1 or similar approved standard for normal Portland cement.

- White cement: Iron salts content $\leq 1\%$.
- Off-white cement: Iron salts content $\leq 2.5\%$.

Lime: Confirm source of Lime with Employers representative to ensure highest quality Lime is used in the mortar. Protect from damage on site and store minimum 300mm above ground in waterproof storage facility.

Sand: Fine aggregate with a low clay content selected for grading, sharp and free from efflorescing salts. River or pit sand should be sharp, angular, hard, clean uncoated particles free from clay and organic impurities.

Water: Water to be used for the mixing of mortar should be clean and free from oil, acid, alkali, salts, organic materials or other substances that are harmful to the mortar mix.

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

Measurement of volume: Measure binders and sand by volume using buckets or boxes. Do not allow sand to bulk by absorption of water.

Mortar

Standard and ratio of mix for all mortar shall be M-400 (1:3), M-300 (1:4), M-250 (1:5) and M-200 (1:6). Provide minimum water.

Mortar mix

Mortar mixing shall be done in a mechanical mixer unless the Employers representative specifically permits hand mixing. If hand-mixing is done, the operation shall be carried out on a clean watertight platform and cement & sand shall be first mixed dry in the required proportion to obtain a uniform color and then the mortar shall be mixed for at least two minutes after addition of water.

Cement Mortar shall be mixed in such quantities as can be used in the work within 30 minutes. Mortar, which has taken initial set, shall not be used, nor shall it be re-mixed with fresh mortar.

Preparing lime putty:

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

Mortar proportions (cement:lime:sand): As defined on the drawings.

Sand stockpile: Ensure sand is dry and stored undercover to avoid errors in volume batching during the mixing process.

3 EXECUTION

Refer to **Stonework construction schedule** for details of stonework and mortar types.

3.1 WORKMANSHIP GENERALLY

Cutting

Perform the necessary cutting and shaping of stone to designated profiles including weathering, jointing, chasing, forming grooves. Make the bed, face and back joints of the stone square and true where dimensioned stone is required.

Carving and moulding

Achieve a clean sharp finish. Carry out all work identified on the drawings to the approval of the Employers representative.

3.2 LAYING UNITS

Bedding

Remove dust and foreign material from the bedding surfaces. Water the face of the stone units so that full strength joints are achieved. Where possible, bed and joint the stone in one operation. Lay each stone on a full bed of mortar. Solidly fill and grout vertical joints as the work proceeds. Point up joints around flashings as necessary.

Natural bed

Lay loadbearing sedimentary stone with its natural bed at 90 degrees to the load, except for the following:

- Cladding panels: In non-loadbearing cladding panels, form each panel with its natural bed at right angles to the face.

Temporary support

Provide support as necessary to the stone while the mortar is curing, using bracing, joint spacers, or both.

Bracing and joint spacers: Non-damaging and non-staining softwood wedges soaked in water. Do not allow metal pinch bars to bear directly on the stone.

Raking and toothing

Raise advanced work no more than 1.5 m above the general level, and rake back. Do not tooth stonework for subsequent additions except where toothing is shown on the drawings.

Bonding

Bond the masonry so as to provide stability and monolithic structural action to the stonework assembly.

3.3 STONE FOUNDATIONS**Stone footings**

Construct the footing course entirely of through stones, and if stepping is necessary, overlap the stepped courses at least 300 mm.

Subfloor stone foundation walls

Minimum foundation wall thicknesses:

- Supporting masonry walls 100 mm thick: 300 mm.
- Supporting masonry walls 250 mm thick: 450 mm.
- Supporting masonry walls 370 mm thick: 600 mm.

Stone sizes:

- Maximum height: 350 mm.
- Minimum height: Generally 175 mm; through stones 300 mm.

Bond pattern: Provide through stones as follows:

- All stones in top and bottom courses.
- Elsewhere as header units.

Slab bearings: Provide continuous bearing at least 100 mm wide to the edge of suspended slabs.

3.4 DAMP-PROOF COURSES**Material**

Material: Embossed Polyethylene sheeting. Install sheeting at base of all walls to stop moisture rising up wall structures.

Location

Provide damp-proof courses as follows:

- Walls built off slabs on ground: In the bottom course of the wall on top of the slab.
- Walls adjoining infill floor slabs: In the course above the slab. Project 40 mm and dress down over the membrane turned up against the wall.

Installation

Lay in long lengths. Lap full width at angles and intersections and at least 150 mm at joints. Step as necessary, but not exceeding 2 courses per step. Sandwich damp-proof courses between mortar.

3.5 JOINTING AND POINTING**Joints**

Size (mm): Not less than 3mm or more than 5mm for dimensioned stonework. Size may vary for non dimensioned stonework from 10mm to 30mm. Joint size should not exceed this without approval of the Employers representative.

Jointing material: Mortar with a strength less than the stonework. Lime putty where identified on drawings for special dimensioned stonework.

Pointing material: Coloured mortar or mortar as above, refer to Schedule or drawings. Lime putty where identified on drawings for special dimensioned stonework.

3.6 SEALANT JOINTING**Preparation for jointing**

Immediately before jointing remove loose particles from the joint, using brushes or compressed air.

Taping

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

Jointing materials

Use recommended jointing and pointing materials which are compatible with each other and with the contact surfaces and non staining to finished surfaces.

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

Sealant colour: Refer to Schedule or drawings.

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

Sealant application

Apply the sealant to dry joint surfaces. Do not apply the sealant in unsuitable weather conditions (e.g. when the ambient temperature is outside the range 5 – 50°C) or outside the recommended working time for the material or the primer.

Joint finish

General: Produce a smooth, slightly concave surface using a tool designed for the purpose.

3.7 COMPLETION**Cleaning**

Cleaning: Leave the stonework clean on completion.

Refer to the **Stonework construction schedule** and drawings for details of locations, types and extent of built in components.

LIGHT STEELWORK

1 GENERAL

1.1 INSPECTION

Notice

Give notice so that inspection may be made of steel framing erected before lining or cladding.

1.2 SUBMISSIONS

Design

The Contractor is to confirm that all proposed member sizes are available for the project in accordance with the drawings and BOQ. If selected sizes are not available, seek alternatives and obtain approval from the Employer's representative.

2 EXECUTION

2.1 CONSTRUCTION GENERALLY

Fabrication

Length: Cut members accurately to length so that they fit firmly against abutting members.

Service holes: Form holes by drilling or punching if needed.

- Bushes: Provide plastic bushes or grommets to site cut holes.
- Swarf: Remove swarf and other debris from cold-formed steel framing immediately.

Site work: Do not fabricate on site where welded connections are required.

Fastening

Select from the following:

- Bolting.
- Self-drilling, self-tapping screws.
- Blind rivets.

Welding

Burning: Avoid procedures that result in greater than localised "burning" of the sheets or framing members. Protect other adjoining materials from damage during welding activities.

Other workers: Protect other workers on site from welding flash, sparks and other potential injuries during welding activities.

Prefabricated frames

Protect frames from damage or distortion during storage, transport and erection.

Unseasoned timber

Do not fix in contact with framing without fully painting the timber and/or the steel to avoid future rusting of the steel.

Earthing

Permanent earthing: Required.

Temporary earthing: Provide temporary earthing during erection until the permanent earthing is installed.

Protection

Coatings which have been damaged by welding or other causes shall be restored. Thoroughly clean affected areas to base metal and coat with zinc rich organic primer.

2.2 TRUSSES

Fabrication

Factory assemble trusses and transport to site where possible. Obtain approval from the Employer's representative if it is required to fabricate trusses on site.

Marking

Permanently mark each truss to show:

- Manufacturer.
- Tag or number.
- Location.
- Support points.

Installation

Fix to support structures, plumb to within $H/200$, where H is the height at the apex.

2.3 COMPLETION**Cleaning**

On completion of framing remove debris from any gaps between members.

STEELWORK PAINTING

1 GENERAL

1.1 INSPECTION

Notice

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

- Surfaces after preparation prior to application of first coating.
- Coating after application of final coat.

1.2 SAMPLES

Painting and coating colour

Submit a sample of the finished product for each different coating system.

Size of each sample: 200 x 200 mm.

2 PRODUCTS

2.1 GENERAL

General

All protective coatings must be handled, stored, mixed and applied strictly in accordance with the manufacturer's instructions and Product Data Sheets.

3 EXECUTION

3.1 PROTECTION

Surroundings

Provide protection of the surroundings to the coating works and ensure that no abrasive, overspray or paint waste debris is released either to air, ground or to any watercourse. Repair or clean damage as appropriate.

Contamination

Ensure protection of sensitive items during surface preparation and coating works. Do not permit surface preparation debris to contaminate coated surfaces which are not yet dry, nor cause damage to any other services or equipment.

Stacking and handling

Do not stack, handle or transport coated items until the coating has sufficiently cured so as to resist handling actions.

Stack and handle all steelwork using fabric slings or padded chains, used in a manner that ensures that no damage is caused to the coating system. Adopt soft packaging, carpet strips or other deformable materials between all steel items. Do not permit steel to steel contact in any situation.

Water ponding: Stack coated items so that water ponding does not or cannot occur whilst the items are in storage, transport or "lay down".

Repair of coating damage

If damage occurs repair so as to ensure that the full corrosion protection ability of the system is reinstated.

3.2 SURFACE PREPARATION

General

Coatings shall be applied only to properly prepared and cleaned surfaces.

Surface preparation

Ensure all surfaces are free from oil, grease, dirt, bird droppings or any other contaminants, particularly soluble contaminants.

Surface defects: Remove or correct other surface defects, including cracks, laminations, deep pitting, undercutting, weld spatter, slag, burrs, fins and sharp edges.

Remove all weld spatter by grinding or chipping.

Priming

Prime coat all surfaces with zinc rich primer on the same day as the completion of surface preparation works. In every case, the specified surface preparation standard, in both cleanliness and profile, shall be evident at the time that the primer coating is applied.

3.3 COATING APPLICATION**General**

Apply the coatings in accordance with the **Interior and Exterior painting schedules..**

Final surface preparation or coating application

Limits: If the following climatic/substrate conditions are present do not apply coating:

- The ambient air temperature is below 5°C or above 40°C.
- The substrate temperature is below 10°C or above 35°C.
- The surface to be coated is wet or damp.

Defects: Apply materials so as to produce an even coating free from film defects.

Detail: Stripe coat all welds, bolt holes, sharp edges and difficult to spray areas by brushing in with the prime coat and intermediate coat material prior to the full coating application.

Subsequent coats

Ensure that before any subsequent coating layer is applied, the surface condition of the preceding coat is complete and correct in all respects, including its cleanliness and freedom from defects.

Correct any defects before the next coating layer is applied.

LIGHT TIMBERWORK**1 GENERAL****1.1 INSPECTION****Notice**

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

- Timber framing after erection before lining or cladding.
- Roof framing and connection to wall and ceiling structures.

1.2 SUBMISSIONS**Design**

The Contractor is to confirm that all proposed member sizes are available for the project in accordance with the drawings and BOQ. If selected sizes are not available, seek alternatives and obtain approval from the Employers representative.

2 PRODUCTS**2.1 TIMBER****Timber grades**

Structural timbers:

- Appearance grade if exposed to view in the finished work:
Use best quality timber free from twists, knots, splits and other visual or physical defects.
- Structural grade if concealed in the building:
Lower quality timber with some visual defects are acceptable but with minimal physical defects.

2.2 SHEET PRODUCTS**Structural plywood panels**

All structural plywood panels used for construction purposes are to be approved by the Employers representative. Refer to drawings and BOQ for details of locations and sizes. All structural plywood is to be tested before use to the satisfaction of the Employers representative to ensure that it will be suitable for the proposed use.

Use branded or certified plywood products where possible.

Hardboard or fibreboard panels

All hardboard or fibreboard panels used for construction purposes are to be approved by the Employers representative. Refer to drawings and BOQ for details of locations and sizes. All material is to be tested before use to the satisfaction of the Employers representative to ensure that it will be suitable for the proposed use.

Use branded or certified products where possible.

2.3 COMPONENTS**Steel post bases**

Minimum dimensions:

- Stirrup: 75 mm wide x 6 mm thick.
- Dowel: 20 mm diameter heavy tube.

Location: To timber posts supported off concrete slabs or footings.

Finish: Galvanize after fabrication.

Fasteners

Material:

Use best quality steel bolts, washers and nuts for bolted connections. Washers to be used both sides of timber to avoid crushing of the timber at the connection point.

Use best quality screws to avoid damage to screw heads during tightening process.

Use best quality bright steel nails for internal work protected from the weather and galvanised nails for external fixings exposed to the weather.

Lightweight alloy bolts and screws will not be permitted.

Installation: Pre drill holes in hardwood timber to avoid splitting the timber.

Do not split or otherwise damage the timber or fastener by hammering bolts or screws into the timber.

3 EXECUTION

3.1 GENERAL

Protection from weather

General: Provide temporary protection for members until permanent covering is in place.

3.2 FLOOR FRAMING

Bearers and joists

Levelling: Level bearers and joists by packing for the full width of the member.

Joints: Locate joints only over supports:

- Minimum bearing of bearers: 50 mm.
- Minimum bearing of joists: 30 mm.

Fixing: Secure bearers and joists to supports to provide restraint against lateral movement.

Joist restraint: If joist timber is unseasoned, the span ≥ 3000 mm, provide solid blocking between each joist in rows at 1800 mm centres and at the ends of the joists over the supports.

Members: Provide bearers and joists where shown on the drawings and in the BOQ.

Flooring

Provide flooring of structural plywood where shown on the drawings and in the BOQ.

3.3 ROOF AND CEILING FRAMING

Wall plates

Fix timber wall plates to top of masonry walls with either straps or bolts, or provide fixings cast into the ring beam as required.

Ceiling framing

Construct timber framed ceilings where shown on drawings with battens fixed to underside of trusses or ceiling joists as required.

Additional support

Provide a frame member behind every joint in fibre cement sheeting or plywood lining to ensure that the lining is fully supported.

Roof cladding boards

Provide roof cladding boards minimum of 20mm thick to full extent of roof structure to support flat metal sheet roofing where shown on drawings. Securely fix to structure and ensure that the top surface is as smooth as possible to avoid damage to the roof sheeting.

3.4 TRUSSES

Installation

Support: Support trusses on bottom chord at two points only, unless designed for additional support.

Plumb: Within $H/200$, where H is the height.

Vertical movement: Over internal walls provide at least 10 mm vertical clearance and use bracing methods which allow for vertical movements.

Construction: Construct trusses strictly in accordance with the drawings. If variations are proposed due to construction fabrication or installation issues, obtain approval from the Employers representative before changing the design.

3.5 COMPLETION

Tightening

Tighten bolts, screws and other fixings so that joints and anchorages are secure at all times.

Clean up

Remove all shavings, discarded chips and pieces of timber from the structure during construction and clean up all working areas prior to Completion.

WATERPROOFING

1 GENERAL

1.1 INTERPRETATIONS

Definitions

For the purposes of this worksection the definitions given below apply.

- Substrates: The surfaces on which membrane systems are laid.
- Bitumen: A viscous material comprising complex hydrocarbons which is soluble in carbon disulphide, softens when it is heated, is waterproof and has good powers of adhesion. It is produced as a refined by-product of oil.
- Bond breakers: Layers which prevent membranes from bonding to the backgrounds.
- Membranes: Impervious barriers to liquid water which may be:
 - . Liquid applied: Membranes applied in liquid or gel form and air cured to form a seamless film.
 - . Sheet applied: Membranes applied in sheet form with joints lapped and bonded.
- Membrane systems: Combinations of membranes, flashings, drainage and accessories which form waterproof barriers and which may be:
 - . Loose-laid.
 - . Bonded to backgrounds fully or partially.

1.2 INSPECTION

Notice

Give sufficient notice so that inspection may be made as follows:

- Background preparation completed.
- Before membranes are finished, covered up or concealed.

2 PRODUCTS

2.1 MEMBRANES

Membrane systems

To be proprietary membrane systems where possible having certification from an international testing organisation.

Internal roof outlets for membrane roof

Proprietary funnel shaped sump cast into the roof slab, set flush with membrane, with a flat removable grating and provision (e.g. clamp ring) for sealing the membrane into the base of the outlet.

3 EXECUTION

Refer to **Single layer, Multi layer and Liquid waterproofing system schedules** for details of systems.

3.1 PREPARATION

General

Prepare backgrounds as follows:

- Fill all cracks in backgrounds wider than 1.5 mm with a filler compatible with the membrane system.
- Fill voids and hollows in concrete backgrounds with a concrete mix not stronger than the background.
- Remove excessive projections.
- Remove deleterious and loose material.
- Leave the surface free of contaminates, clean and dust free.

Moisture content

Concrete backgrounds: Cure for > 21 days.

Falls

Verify that falls in backgrounds are > 1:100.

Joints and fillets

Internal corners: Provide 45° fillets.

External corners: Round or arris edges.

Movement control joints: Prepare all background joints to suit the membrane system.

Priming

If required, prime the backgrounds with compatible primers to ensure adhesion of membrane systems.

3.2 APPLICATION**Protection**

Protect membrane from damage during installation.

Drains

Prevent moisture from tracking under the membranes at drainage locations.

Drains and cages: Provide grates or cages, to prevent blockage from debris.

Overflows: Turn the membranes into the overflow to prevent moisture from tracking behind the membrane.

Sheet joints

Bituminous sheet membranes:

- Side laps > 50 mm.
- End laps > 100 mm.

Synthetic rubber membranes:

- Factory-vulcanized laps > 40 mm.
- Field side laps > 50 mm for side laps.
- Field end-laps > 100 mm for end laps.

Curing of liquid applied systems

To the manufacturers' instructions.

Movement control joints

Locate over movement control joints in the substructure.

Fillets and bond breakers: Provide of sufficient dimension to allow the membrane to accommodate the movement.

Bonded membranes: Carry movement joints in the substrate through the surface finish.

Membrane terminations

Edge protection: Provide upturns above the maximum water level expected from the exposure conditions of rainfall intensity and wind.

- Minimum height of 200mm for all upturns above membrane level unless noted otherwise on the drawings.
- Anchoring: Secure sheet membranes along the top edge.
- Edge protection: Protect edges of the membrane.
- Waterproofing above terminations: Waterproof the structure above the termination to prevent moisture entry behind the membrane using cappings, waterproof membranes or waterproof coatings.

Membrane vertical penetrations

- Pipes, ducts, and vents: Provide separate sleeves for all pipes, ducts, and vents and have them fixed to the substrate. Minimum height of 200mm for all sleeves above membrane level unless noted otherwise on the drawings.

Overlaying finishes on membranes

Compatibility: If a membrane is to be overlayed with another system such as tiles, pavers, ballast, insulation, soil, and the like, provide an overlaying system that is compatible with and not cause damage to the membrane.

Ensure that no damage is caused to the membrane during the laying of the overlay material. If any damage occurs immediately stop work and repair the damage before proceeding with the overlay process.

Bonded or partially bonded systems: If the topping or bedding mortar requires to be bonded to the membrane, provide sufficient movement joints in the topping or bedding mortar to reduce the movement over the membrane.

ROOFING

1 GENERAL

1.1 INSPECTION

Notice

Give sufficient notice so that inspection may be made of:

- Roof framing during construction.
- Those parts of the roofing, vapour barrier, insulation and roof plumbing installation which will be covered up or concealed.

1.2 SUBMISSIONS

Samples

Submit samples of the following showing the range of variation available:

- Corrugated and flat metal roof sheeting
- Roof cappings, flashings, gutters, downpipes

2 PRODUCTS

2.1 MATERIALS AND COMPONENTS

Fasteners

Self-drilling screws: Corrosion resistant screws to approval of Employers representative.

Nuts and bolts: Corrosion resistant fastenings to approval of Employers representative.

Fastenings to timber battens or purlins: Provide fastenings just long enough to penetrate the thickness of the timber without piercing the underside.

2.2 CORRUGATED METAL ROOFING AND CLADDING

General

Provide a proprietary system of preformed corrugated sheets and all purpose-made accessories required to complete the installation to roof framing or wall framing. Refer to **Corrugated sheet roofing materials schedule** for details.

2.3 FLAT SHEET METAL ROOFING AND CLADDING

General

Provide a system of flat metal sheets and all purpose-made accessories required to complete the installation to roof framing or wall framing. Refer to **Flat sheet roofing materials schedule** for details.

2.4 GLAZED ROOFING AND SKYLIGHTS

General

Provide a proprietary overhead glazing system fixed to glazing bars or directly to the roof framing. Provide all purpose-made accessories required to complete the installation. Refer to **Glazed roofing materials and skylight schedule** for details.

2.5 ROOF VENTILATORS

General

Provide proprietary roof mounted ventilators and all purpose-made accessories required to complete the installation where shown on the drawings to ventilate the roof space.

Provide fabricated ventilators in walls as shown on the drawings to ventilate the roof space.

Refer to **Roof ventilators schedule** for details.

3 EXECUTION

3.1 INSTALLATION

Protection

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

If it is necessary to repair minor damage to metal roofing, do so immediately after the damage has occurred. The Contractor is take care to not damage other surfaces during the repair works.

Thermal movement

Provide for thermal movement in the roof installation and the structure, including movement in joints and fastenings.

3.2 SHEET METAL ROOFING AND CLADDING

Roofing sheet installation

Fixings: Provide all fixings required to fix the roof sheeting to the framing so that the entire roof covering is waterproof and secure. All loose edges are to be fixed down to ensure that they cannot get loose in high winds.

Expansion joints: refer to drawings for locations of expansion joints in roofs and details of construction.

Ridges and eaves

Treat ends of sheets as follows:

- Project sheets 50 mm into gutters.
- Close off ribs of ribbed sheeting at bottom of sheets using mechanical means or with purpose-made end caps.
- Turn pans of ribbed sheeting up at tops and down into gutters by mechanical means.
- Provide pre-cut notched eaves flashings and bird proofing wire mesh where necessary.

Ridge and eaves capping

Finish off along ridge and side eaves edges with purpose-made ridge capping and eaves cappings.

End laps

Where end laps are unavoidable in roof sheeting, and the sheet profile is not suitable for interlocking or contact end laps, construct a stepped type lap. Refer to details on drawings as required.

Length of lap (mm): Laps to ends of sheets should not be less than 150mm and sealed with a continuous line of silicone sealant between the sheets of roofing.

Curved corrugated sheet

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

K-Span roofing where identified on the drawings is to be strictly controlled during the installation process to ensure that the completed work is of a high standard.

Cladding sheet installation

Fixings: Provide all fixings required to fix the wall cladding sheeting to the framing so that the entire wall is waterproof and secure. All loose edges are to be fixed to ensure that they cannot get loose in high winds.

Expansion joints: refer to drawings for locations of expansion joints in walls and details of construction.

Flashings: Flashings are required at the top, sides and bottom of all metal wall cladding to ensure that the wall is waterproof in all weather conditions.

Metal separation

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

- Applying an anti-corrosion, low moisture transmission coating to contact surfaces.
- Inserting a separation layer.

3.3 GLAZED ROOFING AND SKYLIGHTS

Installation

Fixing: Fix all glazed roof panels and skylights in accordance with the drawings.

Flashings: Flashings are required at the top, sides and bottom of all glazed roof panels and skylights to ensure that the roof is waterproof in all weather conditions.

3.4 ROOF VENTILATORS

Installation

Fixing: Fix roof ventilators in accordance with the manufacturer's construction details or in accordance with the drawings for fabricated ventilators.

3.5 ROOF PLUMBING

Refer to the **Gutter and downpipe schedule** for details.

General

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

Jointing sheet metal rainwater goods

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

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

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

Jointing system: Refer to the **Gutter and downpipe schedule** for specific jointing details for each type of element.

Flashings and cappings

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

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

Wall abutments: Provide overflashings where roofs abut walls, stepped to the roof slope in brickwork.

- In masonry: Build cover flashing at least 100mm into the wall at least 250mm above the roof level. Provide base flashing on roof and provide at least 100mm vertical overlap.
- In concrete: Turn cover flashing at least 30 mm into sawcut grooves at least 250mm above the roof level, wedge at 200 mm centres with compatible material and render over top of flashing. Provide base flashing on roof and provide at least 100mm vertical overlap.

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

- Secure with a clamping ring.
- Provide a proprietary flexible clamping shoe with attached metal surround flashing.

Gutters

Prefabricate gutters to the required shape where possible. Form stop ends, bends and returns. Provide overflows to prevent back-flooding.

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

Support: Steel straps as shown on drawings or as approved by the Employers representative.

Lining: Timber boards or plywood as shown on drawings or as approved by the Employers representative.

Valley gutters: Profile to suit the valley boarding. Nail or screw to the valley boarding at the top end to prevent the gutter creeping downwards.

Gratings and guards: Provide removable gratings over rainwater heads and sumps:

- Type: Wire mesh cages reinforced with steel bars where required due to size and expected snow loads. Refer to drawings for details.

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

- Type: Refer to drawings for details.

Downpipes

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

Access cover: Provide a removable watertight access cover at the foot of each downpipe stack if the downpipe is connected to rainwater drains.

Downpipe support: Provide supports and fixings for downpipes.

3.6 ROOF MOUNTED EQUIPMENT ACCESS**Walkway**

Product: Provide proprietary walkway system to locations as shown on drawings. Provide fabricated system constructed as shown on drawings. Fabricate in accordance with metalwork section of the specification.

Installation: Install proprietary systems in accordance with manufacturer's details and as identified on drawings.

3.7 COMPLETION**Roof Inspection**

The Contractor is to closely inspect the entire roof covering and metal cladding to walls at completion of the works.

Make good any defects or damage to the sheeting, cappings or flashings. Remove all loose metal and other rubbish, spare nails, screws, filings and other debris.

Clean down the roof, gutters, and downpipe outlets to ensure that it is good condition ready for occupation.

WINDOWS AND WINDOW HARDWARE**1 GENERAL****1.1 INTERPRETATION****Definitions**

For the purposes of this worksection windows also includes louvres, either vertical or horizontal, set into frames.

1.2 INSPECTION**Notice**

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

- Openings prepared to receive windows (where windows are to be installed in prepared openings).
- Fabricated window assemblies delivered to the site, before installation.
- Commencement of window installation.

2 PRODUCTS**2.1 LOUVRE ASSEMBLIES****General**

Provide louver blades mounted in a surround frame and able to withstand the wind pressure for that location without failure or permanent distortion of blades, and without blade flutter.

Adjustable louvres

Provide louver blades clipped into holders which pivot, linked together in banks, each bank operated by an operating handle incorporating a latching device, or by a locking bar.

Screens

Provide metallic coated steel wire mesh screens behind louvres to prevent the entry of birds, rodents and wind blown leaves and papers.

2.2 INSECT SCREENS**Aluminium framed screens**

Provide insect screens with mesh frame channel. Provide an extended frame section where necessary to adapt to window opening gear.

- Mesh: Fix the mesh into the frame channel with a continuous resilient gasket, so that the mesh is taut and without distortion.

Fixed screens

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

Hinged screens

Hinge at the side to give access to opening sash.

Sliding screens

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

- Hardware: Nylon slide runners and finger pull handle.

2.3 SECURITY WINDOW GRILLES**General**

Provide security grilles in accordance with the drawings or proprietary metal security grille screens, fixed to the building structure with tamper resistant fastenings.

2.4 WINDOW HARDWARE

Hardware

Provide hardware of sufficient strength and quality to perform its function, appropriate to the intended conditions of use and climate and fabricated with fixed parts firmly joined.

3 EXECUTION

3.1 INSTALLATION

General

Install windows so that the frames:

- Are plumb, level and straight within acceptable building tolerances.
- Are fixed or anchored to the building structure to resist the wind loading.
- Will not carry any building loads, including loads caused by structural deflection.
- Allow for thermal movement.

Flashing and weathering

Install moulds, sealant and cement pointing as required so that water is prevented from penetrating the building between the window frame and the building structure.

Fixing and fasteners

Materials: Use materials compatible with the item being fixed and of sufficient strength, size and quality to perform their function.

Concealed fixings: Provide a corrosion resistant finish.

Exposed fixings: Match exposed fixings to the material being fixed.

Support: Provide appropriate back support (for example blocking and backing plates) for hardware fixings.

Window fastener spacing (nominal): 600 mm.

Window fasteners: Conceal fasteners where possible.

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

Prepared masonry openings: If fixing timber windows into existing prepared openings with fastenings through the frame face, make the fastener heads finish below the surface and fill the hole for a smooth surface finish.

Joints

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

Operation

Ensure moving parts operate freely and smoothly, without binding or sticking and are lubricated.

Supply

Deliver window hardware items, ready for installation, in individual complete sets for each window.

- In a separate dust and moisture proof package labelled for the specific window.
- Including the necessary templates, fixings and fixing instructions.

Refer to the drawings and **Window, Louvre and Security grille/shutter schedules** for details of windows. Refer to the **Window hardware schedule** for details of window hardware.

3.2 COMPLETION

Cleaning

The Contractor is to clean all frames, glass, hardware at completion. Any damage to frames, or broken glass is to be repaired or replaced to the satisfaction of the Employers representative.

Adjustment

Leave the hardware properly adjusted with working parts in working order and lubricated where appropriate.

DOORS AND DOOR HARDWARE

1 GENERAL

1.1 INTERPRETATION

Definitions

For the purposes of this worksection the definitions given below apply.

- Door frame: Includes door trims.
- Doorset: An assembly comprising a door or doors and supporting frame, guides and tracks including the hardware and accessories necessary for operation.
 - . Fire-doorset: A doorset which retains its strength and limits the spread of fire.
 - . Smoke-doorset: A doorset which restricts the movement of smoke.
- Flush door: A door leaf having two flat faces which entirely cover and conceal its structure. It includes doors with cellular and particleboard cores.
- Joinery door: A door leaf having stiles and rails, framed together. A joinery door may also incorporate glazed panels.
 - . Louvred door: A joinery door in which the panel spaces are filled in with louvre blades.

1.2 INSPECTION

Notice

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

- Door frames standing in place before building in to brickwork.
- Door frames installed before fixing trim.

1.3 SUBMISSIONS

Samples

Submit samples of all hardware items for approval by the Employers representative before use in the works.

Subcontractors

Automatic sliding door assemblies: Submit names and contact details of proposed supplier and installer.

Product warranties

Automatic sliding door assemblies: Submit a warranty from the supplier and installer for the system and its installation, for a period of at least twelve months from the date of completion.

Hardware: Submit the warranties offered by the manufacturer for the hardware items provided in the works.

Keys

Key codes: Submit the lock manufacturer's record of the key coding system showing each lock type, number and type of key supplied, key number for re-ordering, and name of supplier.

Keys: For locks keyed to differ and locks keyed alike, verify quantities against key records, and deliver all keys and records to the Employers representative at completion.

2 PRODUCTS

2.1 FRAMES

Aluminium frames

To be assembled from aluminium sections, including necessary accessories such as buffers, strike plates, fixing ties or brackets, and suitable for fixing specified hardware.

Timber frames

To be constructed with best quality timber. Obtain approval from the Employers representative for the timber selection before use. Construct as shown on the drawings and ensure that all joints are securely made to avoid distortion of the frame in use.

Steel frames

To be folded from metallic-coated steel sheet sections, joints to be continuously welded, including necessary accessories such as buffers, strike plates, spreaders, fixing ties or brackets, and suitable for fixing specified hardware.

Finish: Grind the welds smooth, prepare and paint the welded joints with primer. Then prime the entire frame.

Hardware and accessories: Provide for fixing hardware including hinges and closers, using 4 mm backplates inside the frame. Screw fix the hinges into the back plates.

Base metal thickness:

- General: ≥ 1.1 mm.
- Fire rated doorsets: ≥ 1.4 mm.
- Security doorsets: ≥ 1.6 mm.

2.2 DOORS**Flush doors**

Cellular core flush doors:

- Provide a subframe of 25 mm minimum width timber around openings for louvres and glazing.
- Provide additional material to take hardware and fastenings.
- Cut outs: If openings are required in flush doors (e.g. for louvres or glazing) make the cut outs not closer than 120 mm to the edges of the doors.

Solid core flush doors:

- Core of timber strips laid edge to edge, fully glued to each other and to facings each side of no less than two sheets of timber veneer.
- Single thickness of moisture resistant general purpose particleboard.

Refer to drawings and **Flush doors schedule** for details.

Joinery doors

Fabricate joinery doors as shown on the drawings and in the **Joinery doors schedule**.

PVC doors

Fabricate PVC doors as shown on the drawings and in the **PVC doors schedule**.

Construction

Form rebates to suit standard rebated door hardware.

Louvre grilles: Construct by inserting the louvre blades into a louvre frame, and fix the frame into the door.

Double doors

Provide rebated meeting stiles unless the doors open in both directions. Chamfer square edged doors to prevent binding between the leaves.

2.3 DOORSETS**Automatic sliding door assemblies**

Provide auto sliding door assemblies in accordance with the **Automatic door schedule**.

Toughened glass door assemblies

Provide toughened glass door assemblies with matching concealed hinges and patch fittings as appropriate. Ensure that all glass edges are protected during installation and polish on completion.

Fire-resistant doorsets

Provide fire resistant doors and frames as matched sets for door openings required to have a fire rating. Refer to the **Fire and smoke resistant doorsets schedule** for details.

Provide copies of test certificates from recognised authorities proving the performance of the doorsets.

Smoke-resistant doorsets

Provide smoke resistant doors and frames as matched sets for door openings required to have a smoke stopping capability. Refer to the **Fire and smoke resistant doorsets schedule** for details.

Provide copies of test certificates from recognised authorities proving the performance of the doorsets or seals to frames.

Security screen doorsets

Provide security screen doorsets in accordance with the **Security screen doors schedule**.

2.4 ANCILLARY MATERIALS**Nylon brush seals**

To be dense nylon bristles locked into galvanized steel strips and fixed in a groove in the edge of the door or in purpose-made anodised aluminium holders fixed to the door

Pile weather strips

To be polypropylene or equivalent pile and backing, low friction silicone treated, ultra-violet stabilised.

Door Seals

To be proprietary items as identified in Schedules and to approval of Employers representative.

2.5 HINGES**Butt hinge sizes**

Refer to **Hinge table A** and **Hinge table B** in which length (l) is the dimension along the knuckles, and width (w) is the dimension across both hinge leaves when opened flat.

- Steel, stainless steel, brass, bronze butt hinges for timber doors in timber or steel frames: To **Hinge table A**.
- Aluminium hinges for aluminium doors, or for doors of other materials in aluminium frames: To **Hinge table B**.

Hinge materials

Aluminium hinges: High tensile aluminium with fixed stainless steel pins in nylon bushes, and with nylon washers to each knuckle joint.

Doors fitted with closers: Provide low friction bearing hinges.

Hinge pins

Exterior or security doors opening out: Provide fixed pin hinges.

Hinge Table A

Nominal hinge size l x w x t (mm)	Door leaves not exceeding any of the following		
	Mass (kg)	Width (mm)	Thickness (mm)
70 x 50 x 1.6	16	620	30
85 x 60 x 1.6	20	820	35
100 x 75 x 1.6	30	920	40
100 x 75 x 2.5	50	920	50
100 x 75 x 3.2	70	1020	50
125 x 100 x 3.2	80	1220	50

Hinge Table B

Nominal hinge size l x w x t (mm)	Door leaf not exceeding mass (kg)	Minimum construction	
		Knuckles	Screws/hinge leaf
100 x 70 x 3	30	3	3
100 x 80 x 3.5	50	5	4

Number of hinges

Provide 3 hinges for doors up to 2200 mm high, and 4 for door leaves between 2200 mm and 3000 mm high.

Wide throw

If necessary, provide wide throw hinges to stop doors binding on obstacles such as nibs or deep reveals.

2.6 DOOR HANGING SYSTEMS**General**

Provide sliding door tracks in conformance with the schedules.

2.7 LOCKS AND LATCHES**General Door Hardware**

Provide hardware of sufficient strength and quality to perform its function, appropriate to the intended conditions of use and climate and fabricated with fixed parts firmly joined.

Bolts

Provide bolts including barrel bolts and tower bolts with associated hardware, including lock plates, ferrules or floor sockets.

Furniture

Provide lock and latch furniture suitable for use with the lock or latch to which it is installed with the corresponding level of performance.

Strike plates

Use strike plates provided with the locks or latches.

Fire rated door closers

Provide closers tested and certified for use as components of fire door assemblies.

Door Controllers Performance

Provide door controllers, including door closers, floor or head spring pivots which are suitable for the door type, size, weight and swings required and the operating conditions, including wind pressure.

3 EXECUTION**3.1 FRAMES****General**

Install doors so that the frames:

- Are plumb, level and straight within acceptable building tolerances.
- Are fixed or anchored to the building structure to resist the wind loading.
- Will not carry any building loads, including loads caused by structural deflection.
- Allow for thermal movement.

Flashing and weatherings

Install moulds, sealant and cement pointing as required so that water is prevented from penetrating the building between the door frame and the building structure.

Aluminium frames

Building in to masonry: Screw galvanized steel brackets twice to jambs and build in.

Fixing to masonry openings: Use proprietary expansion anchors and screw through jambs at each fixing.

Frame fixing

Brackets: Metallic-coated steel:

- Width: ≥ 25 mm.
- Thickness: ≥ 1.5 mm.

Jamb fixing centres: ≤ 600 mm.

Fixing and fasteners

Materials: Use materials compatible with the item being fixed and of sufficient strength, size and quality to perform their function.

Concealed fixings: Provide a corrosion resistant finish.

Exposed fixings: Match exposed fixings to the material being fixed.

Support: Provide appropriate back support (for example blocking and backing plates) for hardware fixings.

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

Prepared masonry openings: If fixing timber door frames into existing prepared openings with fastenings through the frame face, make the fastener heads finish below the surface and fill the hole for a smooth surface finish.

Joints

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

Operation

Ensure moving parts operate freely and smoothly, without binding or sticking and are lubricated.

Supply

Deliver door hardware items, ready for installation, in individual complete sets for each door.

- In a separate dust and moisture proof package labelled for the specific door.
- Including the necessary templates, fixings and fixing instructions.

Refer to the drawings and **Flush doors, Joinery doors, PVC doors, Security screen doors, Fire and smoke resistant doorset** and **Automatic door schedules** for details of frames, doors and hardware.

3.2 COMPLETION

Cleaning

The Contractor is to clean all frames, doors, glass, hardware at completion. Any damage to frames and doors, or broken glass is to be repaired or replaced to the satisfaction of the Employers representative.

Adjustment

Leave the hardware properly adjusted with working parts in working order and lubricated where appropriate.

GLAZING**1 GENERAL****1.1 INSPECTION****Notice**

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

- Glass products before they are installed.

2 PRODUCTS**2.1 GLASS****Glass and glazing materials**

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

Glazing plastics: Free from surface abrasions, and warranted by the manufacturer for 10 years against yellowing or other colour change, loss of strength and impact resistance, and general deterioration.

Refer to **Annealed glasses**, **Processed glasses** and **Fabricated glass units schedules** for specific details for the works.

2.2 GLAZING MATERIALS**General**

Glazing materials (including putty, glazing compounds, sealants, gaskets, glazing tapes, spacers, setting blocks): Appropriate for the conditions of application and the required performance.

Jointing materials

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

Pile weather strips

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

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

Extruded gaskets and seals

Type: Non cellular (solid) seals to exclude water from glass/frame junctions.

Material:

- Rubber products to be neoprene, ethylene propylene diene monomer (EPDM) or silicone rubber.
- Flexible polyvinyl chloride (PVC)

Priming

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

Movement joints

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

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

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

Glazing films

Supply films identified in the schedules to approval of the Employers representative. All films are to be proprietary products installed strictly in accordance with the manufacturers instructions.

2.3 MIRRORS

Refer to **Mirrors schedule** for details.

Reflective surface

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

3 EXECUTION ---

3.1 GLASS PROCESSING

General

Perform required processes on glass, including cutting, obscuring, silvering and bending. Form necessary holes, including for fixings, equipment, access holes and speaking holes. Process exposed glass edges to a finish that will reduce the risk of injury.

3.2 INSTALLATION

General

Install the glass so that:

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

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

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

External timber framed glazing: Glaze with putty. Do not dry bead into timber frames.

3.3 FIXING MIRRORS

Screw fixing

Direct to wall plugs with dome-headed chromium-plated screws in each corner and at 900 mm maximum centres around perimeter. Provide polyethylene sleeves and washers to prevent contact between screw and glass. Do not over-tension the screws.

Frame fixing

Proprietary aluminium frames to mirror perimeter, corners mitred. Attach the frame to the wall with concealed screw fixings. Frames and finish to approval of the Employers representative.

Bead fixing

Rebated timber beads to mirror perimeter, corners mitred. Screw fix the beads to the substrate.

3.4 GLAZED SHOWER SCREENS

Type

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

Water shedding

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

Sliding assemblies

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

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

3.5 COMPLETION

Cleaning

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

INSULATION AND VAPOUR BARRIERS

1 GENERAL

1.1 INTERPRETATION**Definitions**

General: For the purposes of this worksection the definitions given below apply.

- Sarking-type material: Flexible reflective foil membrane material normally used for waterproofing, vapour proofing or thermal reflectance.
- Mineral wool (including glasswool and rockwool): Entangled mat of fibrous non-crystalline material derived from inorganic oxides or minerals, rock, slag or glass, processed at high temperatures from a molten state.
- Vapour barrier: A material or system that adequately impedes the transmission of water vapour.

1.2 INSPECTION**Notice**

Give sufficient notice so that inspection may be made of the insulation to roof space in areas which will be covered up or concealed.

2 PRODUCTS

2.1 MATERIALS AND COMPONENTS**Bulk insulation**

Mineral wool blankets and cut pieces: Provided in bulk rolls for laying over roof structures or on roof slabs and batts to suit ceiling member spacing.

Polystyrene (extruded rigid cellular sheets): Provided in modular panels for fixing to walls and roof slabs.

Reflective insulation: Provided in bulk foil rolls for laying over roof structures and foil batts to suit ceiling member spacing.

Sarking-type material

Sarking: Reflective foil fixed as a membrane to reduce liquid water transfer in walls or roof structures but allow water vapour to move through the building envelope.

Vapour barrier: Reflective foil sealed as a membrane to stop all liquid water and water vapour transfer.

Fasteners and supports

Metallic-coated steel.

3 EXECUTION

3.1 GENERAL**Bulk insulation**

Batts: Fit tightly between framing members. If support is not otherwise provided, fix over wire mesh stapled to the framing and stretch tight.

Reflective foil laminate

To timber: Metallic-coated flat head nails or staples at 300 mm maximum centres.

To steel or aluminium: Double sided pressure sensitive tape.

Overlap (minimum): 150 mm and adhesive fix.

Roof sarking locations

Location: Provide sarking under metal sheet roofs. Fix over timber supports and run rolls across roof plane. Overlap each layer of foil so that any water will run down the slope and discharge into the gutter without dripping into the roof space.

3.2 ROOF INSULATION

General

Location: The whole of the ceiling area, except the following:

- Eaves, overhangs, roof lights, vents and openings.
- Roofs to outbuildings, garages, and semi-enclosed spaces such as verandahs, porches.

Installation

Refer to the drawings and **Insulation schedule** for details of insulation requirements for the works.

LINING

1 GENERAL

1.1 INSPECTION

Notice

Inspection: Give sufficient notice so that inspection may be made of the wall face or framing before installation of linings.

1.2 SUBMISSIONS

Samples

Plasterboard: Submit two 300x300mm samples of each type.

Fibre cement sheet: Submit two 300x300mm samples of each type.

Accessories: Submit samples of accessories, fasteners, trims and cornices.

1.3 TOLERANCES

Surface

Flatness, twist and bow: ≤ 3.0 mm deviation from a 1.5 m straightedge placed in any position.

2 PRODUCTS

2.1 MATERIALS AND COMPONENTS

Plasterboard

Plasterboard sheet lining is to be sheet material, size, type and thickness in accordance with the **Sheet lining schedule**, to the approval of the Employers representative.

Fibre cement

Fibre cement sheet lining is to be sheet material, size, type and thickness in accordance with the **Sheet lining schedule**, to the approval of the Employers representative.

Fasteners

Steel nails: Hot dip galvanized.

Screws: Coated steel cross head screws.

Adhesives

For plasterboard: Epoxy grout adhesive as supplied by the plasterboard sheet manufacturers.

For cement sheet: Mastic adhesive.

Sealants

Fire rated sealant: Non-hardening sealant compatible with the materials to be sealed and having a fire rating equal to that of the partition it seals.

Acoustic sealant: Non-hardening sealant compatible with the materials to be sealed and having a specific gravity of not less than 1.5 gm/cubic centimetre and of 100% polyurethane mastic.

3 EXECUTION

3.1 CONSTRUCTION GENERALLY

Conditions

Do not commence lining work until such time as the building or zone in question is enclosed and weathertight and all wet trades have been completed.

Substrates or framing

Before fixing linings check and, if necessary, adjust the alignment of wall faces or framing. Make good any damaged areas that may affect the fixing of the lining. Ensure that there are no projections from the face of the wall structure that may affect the installation of the lining material.

Ceiling linings

Do not install ceilings until at least 14 days after the timber roof structure is fully loaded where this is used for support of the ceiling.

Accessories and trim

Provide accessories and trim necessary to complete the installation.

Adhesives

Provide adhesives of types appropriate to their purpose, and apply them so that they transmit the loads imposed, without causing discolouration of finished surfaces.

3.2 PLASTERBOARD LINING**Supports**

Install timber battens or galvanized steel channels as follows:

- Where framing member spacing exceeds the recommended spacing.
- Where direct fixing of the plasterboard is not possible due to the arrangement or alignment of the framing or wall face.

Installation

Gypsum plasterboard: Install strictly in accordance with manufacturers recommendations.

Framed construction: Screw or nail or combine with adhesive.

Masonry construction: Fix using adhesive direct to masonry.

Suspended ceilings: Fix using screw or screw and adhesive to ceiling members.

To steel channels: Fix using screw or screw and adhesive.

Multiple sheet layers

Application: Fire rated and acoustic rated walls.

Joints: Fill and flush up all joints and fixings in each layer and caulk up perimeters and penetrations before commencing succeeding layers. Stagger all sheet joints by minimum 200 mm.

Joints

Flush joints: Provide recessed edge sheets and finish flush using perforated paper reinforcing tape.

Butt joints: Make joints over framing members or otherwise provide back blocking.

External corner joints: Make joints over metallic-coated steel corner beads.

Control joints: Install purpose-made metallic-coated control joint beads at not more than 12 m centres in walls and ceilings and to coincide with structural movement joints.

3.3 FIBRE CEMENT LINING**Supports**

Install timber battens or galvanized steel channels as follows:

- Where framing member spacing exceeds the recommended spacing.
- Where direct fixing of the fibre cement is not possible due to the arrangement or alignment of the framing or substrate.

Installation

Run sheets across the framing members. In flush jointed applications, stagger end joints in a brick pattern and locate them on framing members, away from the corners of large openings. Provide supports at edges and joints.

Timber framed construction: Nail only or combined with adhesive.

Steel framed construction: Screw only or combined with adhesive.

Masonry construction: Fix using adhesive direct to masonry.

Suspended flush ceilings: Fix using screw or screw and adhesive to ceiling members or support frame.

Ceilings and soffits: Provide battens where fixing to underside of rafters, roof trusses and purlins.

Multiple sheet layers

Application: Fire rated and acoustic rated walls.

Joints: Fill and flush up all joints and fixings in each layer and caulk up perimeters and penetrations before commencing succeeding layers. Stagger all sheet joints by minimum 200 mm.

Joints

Flush joints: Provide recessed edge sheets and finish flush using perforated paper reinforcing tape.

- Movement joints in walls: Position a stud parallel to the joint on each side.
- Movement joints in ceilings and soffits: Provide movement joints to divide ceilings into bays not larger than 10.8 x 7.2 m and soffit linings into bays not larger than 4.2 x 4.2 m or 5.4 x 3.6 m.
Provide framing parallel to the joint on each side. Do not fix the lining to abutting building surfaces.

External corner joints: Make joints over metallic-coated steel corner beads.

Control joints: Provide purpose-made metallic-coated control joint beads at ≤ 7.2 m centres in walls and ceilings and to coincide with structural movement joints.

3.4 CEILING ACCESS**General**

Location: Provide personnel access ways to each separate ceiling space.

Size (mm): Minimum of 600 x 600 mm

Material: Match adjacent ceiling lining.

Type: Plain cover supported on all sides by timber trim fixed to underside of ceiling.

3.5 CORNICES**General**

Plasterboard cornice: Install plasterboard trims to the junctions between wall surfaces and ceilings as shown on the drawings.

Timber cornices: Install timber trims to the junctions between wall surfaces and ceilings as shown on the drawings.

3.6 COMPLETION**General**

Ensure that all surfaces are protected, dry and free from damage before paint finishes are to be applied. All plasterboard and fibre cement surfaces must dry for at least 7 days before painting is commenced.

PARTITIONS – SYSTEMS

1 GENERAL

1.1 INTERPRETATION**Definitions**

For the purposes of this worksection the definitions given below apply.

- Partition – fully demountable: A partition system in which any component may be demounted without damage, using only small hand tools, and subsequently reassembled without cutting, trimming or refinishing.
- Partition – semi demountable: A partition system in which the major components are designed to be removed and reused but panels or linings, which are likely to be damaged during removal, are not.
- Partition – non demountable: A partition system in which major components, such as panels or linings, are likely to be damaged during removal and may require cutting, trimming or structural repair before reuse.
- Cool room panel system: A partition system fabricated to suit specific thermal conditions in which the insulated panels are designed to be removed and reused but panels or trims are likely to be damaged during removal.

1.2 INSPECTION**Notice**

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

- Installation of framing / fixings before they are enclosed.

1.3 SUBMISSIONS**Samples**

Submit samples as follows:

- A sample, at least 300 x 300mm, of each panel type.
- Floor and ceiling fixings and adjustments.
- Samples at least 100 mm long of each structural section, including posts, sills, transoms, door frames, ceiling channels and metal channel headrails, and each moulding, cover strip and bead.
- Skirting, skirting duct, skirting duct stop ends, returns and removable covers.

1.4 TOLERANCES**General**

Deviation (from true grid lines and planes): up to 3 mm maximum in a 1500mm length.

Misalignment (of adjoining surfaces at grid junctions): 3 mm maximum.

Flatness, twist and bow: Maximum 3 mm deviation from a 1500mm straightedge placed in any position.

2 PRODUCTS

2.1 PARTITIONS**General**

Provide proprietary non-load-bearing partition wall framing and lining comprising cold formed steel or extruded aluminium members, or both, in conformance with the **Partition schedule**.

Building movements

Provide clearances or movement joints so that partitions are not damaged by structural building movements such as long term slab deflection. Where fire resistance or acoustic properties are specified provide a resilient foam or mastic seal having properties equal to those required for the partition.

Control joints

General: Provide for control joints in sheet finishes where required by the structural frame.

3 EXECUTION

3.1 PREPARATION**General**

Prepare the base to receive the partitions. Ensure that all surfaces are flat without lumps or hollows that could affect the performance of the partition system.

Set out

Set out the partitions so that the partition grid, as expressed in panel joints and centrelines of frame members, coincides with the ceiling grid and the building grid, if applicable.

3.2 ERECTION**Partition erection**

Install the partitions so they:

- Are plumb, level, on their correct alignments, and firmly fixed.
- Have adequate top support by fixing the top plate to the ceiling structure or slab soffit, or are stabilised by lapping and fastening intersecting or butting plates together.
- Have bottom plates fixed at 600 mm maximum centres generally, and 100 mm maximum from ends.

Install coolroom panel systems to manufacturers recommendations and standard details where feasible. Ensure that all seal strips, cover strips, accessories, fixings needed to satisfactorily carry out the installation are provided and installed to the approval of the Employers representative.

Fixing

Conceal fixings. For demountable items provide fixings capable of being repeatedly removed and replaced without damage to finishes.

Fixing to masonry: Provide masonry anchors of expansion or chemical grout type. Do not provide explosive-driven fastenings.

Fixing to suspended ceilings: Provide adequate top support to the partition without damage to the ceiling components.

Protection

Protect existing work from damage during the installation and make good any damage. Provide temporary coverings if necessary.

Sound properties

Preserve the sound reduction properties of partitions by sealing flanking sound transmission paths during installation, including junctions between partitions and other building surfaces, air gaps around doorsets, recesses, such as pelmets and blind boxes and cut-outs for services. Avoid cut-outs next to or back-to-back with each other.

Sealing methods: Use appropriate sealing methods, such as durable resilient gaskets or closed cell foam strips. Provide solid resilient materials in preference to foamed materials whenever possible.

Support

Provide additional support in the form of framing for fixing hardware, fixtures and fittings.

3.3 SERVICES**Services access**

Conceal associated building services, either within cavities in the partition structure, or within ducted skirtings supplied as part of the partition system, or both. Provide removable or demountable components of the partition system, for access to services concealed within partition cavities.

ROOM DIVIDERS

1 GENERAL

1.1 INSPECTION**Notice**

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

- Overhead tracks installed before dividers/door panels are hung and ceiling installed.

1.2 SUBMISSIONS**Samples**

Submit 2 samples of each of the following where applicable:

- Sections proposed to be used for frames, louvres and slats.
- Colour range samples of facings and prefinished production material.
- Manufacturer's standard door furniture items.

1.3 TOLERANCES**Tolerances**

Deviation (from true grid lines and planes): up to 3 mm maximum in a 1500mm length.

Misalignment (of adjoining surfaces at grid junctions): 3 mm maximum.

Flatness, twist and bow: Maximum 3 mm deviation from a 1500mm straightedge placed in any position.

2 EXECUTION

2.1 COMPLETION**Maintenance manual**

Submit manufacturer's published recommendations for service use.

Cleaning

Temporary coating: On or before completion of the works, or before joining up to other surfaces, remove all traces of temporary coatings used as a means of protection.

3 SELECTIONS

Refer to the **Folding doors, accordion doors and operable walls schedules** for details of room dividers for the works.

SUSPENDED CEILINGS

1 GENERAL

1.1 INSPECTION

Notice

Give sufficient notice so that inspection may be made of the framing preparation and setout of suspended ceilings before installation of panels.

1.2 SUBMISSIONS

Samples

Submit samples as follows:

- Ceiling material: Sheet, panel, tile, with insulation
- Methods: Methods of jointing, fixing, height adjustment.
- Suspension: Sections proposed for suspension system, including wall angles and trim.

2 PRODUCTS

2.1 LININGS

Fibrous plaster tiles

All imported fibrous plaster tiles with hard cast plaster face for decorative ceiling sections.

Plasterboard panels

All imported glass fibre reinforced gypsum plasterboard panels or tiles to approval of the Employers representative. Refer to the **Suspended ceiling schedule**.

Suspension system

Refer to the **Suspended ceiling schedule**.

3 EXECUTION

3.1 INSTALLATION

Ceiling grid

Set out the ceiling grid so that panel joints and centrelines of visible suspension members coincide with grid lines shown on the drawings. If not otherwise shown, set out so that opposite margins are equal.

Pattern and texture: Set out patterned or heavily textured materials to give consistency in direction of pattern or texture.

Special sized panels: Provide special sized purpose-made panels to fill non-standard margins, openings and penetrations.

Cut tile edges

General: Conceal, or finish to match prefinished edges.

Lighting

Fit lights within the ceiling grid system to ensure that distortion, overloading or excessive vertical deflection is prevented. Support lights on the ceiling primary grid members.

Proprietary systems

Provide suspended ceilings as complete proprietary systems, each fabricated by one manufacturer and installed by a specialist installer of demonstrated capacity.

Protection

Protect existing work from damage during the installation.

Stability

Install the ceilings level; and fix so that under normal conditions there is no looseness or rattling of ceiling components.

3.2 SUPPORTS**Bracing**

General: Provide bracing to prevent lateral movement and to resist any imposed horizontal seismic force.

External suspended ceilings

Support external suspended ceilings on rigid members capable of carrying the imposed loads. Install members to minimise any eccentricity, and ensure that the upward and downward wind loads are carried through to the supporting structure.

Movement joints

Install the ceiling with control joints to correspond in location and direction to those in the structural frame.

Finishes

Repair damaged finishes by replacement or refinishing of the item. All repairs are to be completed so no sign of the damage is visible in the completed work.

Support members

Grid members: If required, notch grid members at the junction with the perimeter trim to ensure the panels lie flat on the perimeter trim.

Services: Do not suspend from services (e.g. pipework or ductwork) unless the service has been designed to accept the ceiling load. In locations where services obstruct the ceiling supports, provide bridging and suspension on each side of the services.

Spacing: Space the support members as required by the loads on the system and the type of ceiling, and allow for the installation of services and accessories, including ductwork, light fittings and diffusers. Provide additional support or suspension members for the fixing of such items.

Suspension system

Height adjustment: Provide height adjustment by means of a length adjustment device at each suspension point, permitting length variation of at least 50 mm.

3.3 PANELS**General**

Fitting: Fit panels accurately and neatly, free from air leakage and staining.

Panel lock clips: If panels are exposed to wind loads or if required for security, insert locking clips at the junction of rails and panels.

Accessories and trim

Provide accessories and trim necessary to complete the installation.

Plasterboard trim: Provide purpose-made corner beads, casing beads and stop beads.

Metal Trim: Provide trims at junctions with other building elements and surfaces, such as walls, beams and penetrations, consistent with the style, materials and finishes of the ceiling system generally.

Service penetrations

Provide openings for, and fit the ceiling system up to, all services elements such as light fittings, ventilation outlets, detectors, sprinklers and loudspeakers.

3.4 ACCESS PANELS**Finish**

Match the ceiling panels in appearance and performance and mark the panel for easy identification.

3.5 COMPLETION**Spares**

Supply spare matching tiles and accessories of each type for future replacement purposes. Store the spare materials on site where directed.

JOINERY

1 GENERAL**1.1 TOLERANCES****Responsibilities**

Fabricate and install joinery items. Items to be undamaged, plumb, level, straight and free of distortion and to the **Tolerances table**.

Tolerances Table

Property	Tolerance criteria
Plumb and level	2 mm in 800 mm
Offsets in flush adjoining surfaces	< 1 mm
Alignment of adjoining doors	< 1.5 mm

1.2 INSPECTION**Notice**

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

- Shop fabricated or assembled items ready for delivery to the site.
- Site erected assemblies on completion of erection.

1.3 SUBMISSIONS**Samples**

Submit samples to the **Sample table** for approval by the Employers representative.

Sample Table

Description	No. of samples
Each type of board to be used complete with finish and edge stripping	2
Typical item of hardware indicating each finish	2
Stone benchtop indicating range of colours	2
Timber balustrade section	1
The finish to all stainless steel items	2
Complete timber bench cupboard door, including hardware	1
Complete drawer front, including hardware	1

2 PRODUCTS**2.1 JOINERY MATERIALS AND COMPONENTS****Joinery timber**

All joinery timber shall be to approval of the Employers representative.

Plywood

All plywood shall be to approval of the Employers representative.

Decorative overlays

Timber veneer or laminate to approval of the Employers representative.

Thickness (minimum):

- For horizontal surfaces fixed to a continuous background: 1.2 mm minimum.

- For vertical surfaces fixed to a continuous background: 0.8 mm.
- For edge strips: 0.8 mm.

Stone facings

Provide stone slabs to benchtops within the visual range of the approved samples.

Timber veneers

Provide veneers falling within the visual range of the approved samples.

2.2 JOINERY ITEMS**General**

Provide materials noted on drawings as follows:

- Joinery components and their location, indicative construction details, trims, materials, dimensions and thicknesses, and finishes shall be as detailed.
- All dimensions noted on drawings shall be confirmed on site before construction of the joinery.
- Finishes selections and hardware are noted in the **Joinery fixtures schedule**.

2.3 KITCHEN ASSEMBLIES**Plinths**

Material: Construct from exterior grade general purpose plywood unless already in place as a concrete plinth.

Thickness: 16 mm.

Fabrication: Form up with front and back members and full height cross members at not more than 900 mm centres.

Finish: Decorative laminated sheet or ceramic/ stone tile finish.

Installation: Fix to floor and secure to wall to provide level platform for carcasses.

Carcasses

Material: Select from the following:

- Melamine overlaid high moisture resistant particleboard.
- Approved solid timber sections.

Thickness: 16 mm minimum.

Joints: Select from the following:

- Proprietary mechanical connections.
- Screws and glue.

Shelves: Support on battens or fix directly into grooves in side walls of joinery units.

Finish: Decorative laminated sheet or solid timber finish.

Fasteners: Conceal with finish.

Installation: Secure to walls at not more than 600 mm centres.

Drawer fronts and doors

Material: Refer to the drawings for specific details of joinery or select from the following:

- Melamine overlaid high moisture resistant particleboard.
- Approved solid timber sections with or without inset glass panels.
- Metal grille or sheet metal panels fixed over timber frames

Thickness: 16 mm minimum.

Maximum door size: 2400 mm high, 900 mm wide, 1.5 m² on face.

Finish: Decorative laminated sheet, solid timber finish or paint.

Drawer backs, sides and bottoms

Material: Select from the following:

- Melamine overlaid high moisture resistant particleboard.
- Approved solid timber sections.

Thickness: 12 mm minimum.

Finish: Decorative laminated sheet or solid timber finish.

Laminated benchtops

Material: High moisture resistant particleboard.

Benchtop thickness: 33 mm.

Finish: Decorative laminated sheet.

Exposed edges: Extend laminate over shaped nosing, finishing > 50 mm back on underside or provide solid timber edge trim.

Installation: Fix to carcass at least twice per 600 mm length of benchtop.

Joint sealing: Clamp with proprietary mechanical connectors to ensure high quality connection between benchtop sections. Ensure joints in benchtops are clear of sinks to avoid water damage to joint.

Stone or concrete benchtops

Material:

- Thickness is to be minimum of 40mm unless noted otherwise on the drawings.
- Concrete benchtops may have a polished finish or be covered with ceramic tiles.

Splashback:

Material is identical to benchtop unless noted otherwise in the **Joinery fixtures schedule**.

- Thickness is to be 16mm for high moisture resistant particleboard with laminate finish.
- Thickness is to be 20mm minimum for stone.
- Thickness is to be 40mm minimum for concrete. Alternatively use ceramic tile splashback for concrete benchtops.
- Waterproof silicone sealant is to be used as a continuous seal between the benchtop and splashback.

Drawer and door hardware

Hinges, drawer runners, door handles and locks are to be to the approval of the Employers representative.

2.4 TIMBER BALUSTRADES

Provide materials for the approval of the Employers representative before installation. Ensure all dimensions are checked on site before construction starts. Refer to BOQ and drawings for extent of work.

3 EXECUTION**3.1 JOINERY****General**

Joints: Provide materials in single lengths whenever possible. If joints are necessary make them over supports.

Framing: Frame and trim where necessary for openings, including those required by other trades.

Accessories and trim

Provide accessories and trim necessary to complete the installation.

Fasteners

Visibility: Do not provide visible fixings except in the following locations:

- Inside cupboards and drawer units.
- Inside open units.

Visible fixings: Where fastenings are unavoidable on visible joinery faces, sink the heads below the surface and fill the sinking flush with a material compatible with the surface finish. In surfaces which are to have clear or tinted timber finish provide matching wood plugs showing face (not end) grain. In surfaces which are to have laminate finish provide proprietary screws and caps finished to match.

Fixings: Screws with washers into timber or steel framing, or masonry anchors to brickwork.

Adhesives

Provide adhesives to transmit the loads imposed and to ensure the rigidity of the assembly, without causing discolouration of finished surfaces.

Finishing

Edge strips: Finish exposed edges of sheets with edge strips which match sheet faces or use solid timber trims as noted on the drawings.

Matching: For surfaces which are to have clear or tinted finish, arrange adjacent timber pieces to match the grain and colour.

Hygiene requirements: To all food handling areas and voids at the backs of units to all areas, seal all carcass junctions with walls and floors, and to cable entries, with silicone sealant for vermin proofing. Apply water resistant sealants around all plumbing fixtures and ensure the sealants are fit for purpose.

3.2 DELIVERY AND STORAGE**General**

Deliver joinery units to site in unbroken wrapping or containers so that its moisture content is not adversely affected. Do not store in areas of wet plaster. Keep storage to a minimum by delivering items only when required for installation.

Examine joinery units for completeness and repair defects before installing in place.

Background

Clean all background surfaces that will be permanently concealed behind joinery before installing in place.

3.3 TIMBER BALUSTRADES**General**

Provide a balustrade to the stair and landing, consisting of posts, handrail, infill panels, and associated mouldings as noted in the BOQ and drawings.

3.4 COMPLETION**Cleaning**

Temporary coatings: On or before completion of the works, or before joining up to other surfaces, remove all traces of temporary coatings used as a means of protection.

General: Remove all dust, marks and rubbish from all surfaces and internal spaces. Clean and polish all surfaces such as solid timber, anodised or painted metals, glass, stone, concrete, ceramic tiles and laminates.

Refer to the **Joinery fixtures schedule** for locations, type and finishes of joinery items.

METALWORK**1 GENERAL****1.1 INSPECTION****Notice**

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

- Shop fabricated or assembled items ready for delivery to the site.
- Site erected assemblies on completion of erection.

1.2 SUBMISSIONS**Samples**

Submit samples to the **Sample table** for approval by the Employers representative.

Sample Table

Description	No. of samples
Each type of metal item to be purchased	2
Typical joints of welded or fabricated items	2
Finished sample of each type of painted or anodised metalwork indicating range within colour specified and finish	2
The finish to all stainless steel items	2

Manufacturer's data: Submit manufacturer's published product data and details for purchased items.

Stainless steel: For each batch of stainless steel supplied to the works, submit the certificate of compliance specified for the applicable standard.

2 PRODUCTS**2.1 MATERIALS AND COMPONENTS****Metals**

Performance: Provide metals suited to their required function, finish and method of fabrication, in sections of strength and stiffness adequate for their purpose.

Rivets

Use blind rivets where available in the required metal.

Masonry anchors

Proprietary types comprising screws or bolts in self-expanding sockets.

Masonry plugs

Screws in purpose-made resilient plastic sockets or fixed to timber plugs built into the wall surface.

3 EXECUTION**3.1 CONSTRUCTION GENERALLY****Metals**

Provide metals so that they transmit the loads imposed and ensure the rigidity of the assembly without causing deflection or distortion of finished surfaces.

Fasteners

Materials: Provide fasteners in materials of mechanical strength and corrosion resistance at least equal to that of the lowest resistant metal joined.

To copper and copper alloys: Provide copper or copper-alloy fixing devices only.

To aluminium and aluminium alloys: Provide aluminium alloy or stainless steel fixing devices only.

To stainless steel: Provide appropriate stainless steel materials only.

Fabrication

Workshop: Fabricate and pre-assemble items in the workshop wherever practicable.

Edges and surfaces: Keep clean, neat and free from burrs and indentations. Remove sharp edges without excessive radiusing.

Tube bends: Form bends in tube without visibly deforming the cross section.

Colour finished work: Match colours of sheets, extrusions and heads of fasteners.

Thermal movement: Accommodate thermal movement in joints and fastenings.

Fabrication tolerances

Structural work generally: ± 2 mm from design dimensions.

Joints

Fit joints to an accuracy appropriate to the class of work. Finish visible joints made by welding, brazing or soldering using grinding, buffing or other methods appropriate to the class of work, before further treatment.

Self-finished metals: Free of surface colour variations, after jointing.

Joints: Fit accurately to a hairline where feasible.

Marking

Provide suitable and sufficient marks or other means for identifying each member of site-erected assemblies, and for their correct setting out, location, erection and connection.

Splicing

Provide structural members in single lengths where possible. Obtain approval of the Employers representative for locations of joints where splices in metalwork cannot be avoided.

3.2 WELDING AND BRAZING

General

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

Brazing

General: Ensure brazed joints have sufficient lap to provide a mechanically sound joint. Do not use butt joints relying on the filler metal fillet only.

3.3 STAINLESS STEEL FABRICATION

Welding stainless steel

All tube, angle or thick plate material is to be welded unless noted otherwise on the drawings. Ensure that welds do not discolour the final surface finish in the welding process.

Riveting

Riveting may be used only to join stainless steel sheet or strip less than 1 mm thick. Drill (not punch) the rivet hole, and drive the rivet cold. On completion, clean and passivate the riveted assembly.

Soldering

Do not solder stainless steel.

3.4 METAL FIXTURES

General

Provide metal fixtures where noted on drawings and in the **Metal fixtures schedule** as follows:

- Components such as toilet roll holders, towel rails, soap dishes and their location, indicative construction details, trims, materials, dimensions and thicknesses, and finishes shall be as detailed or described in the schedule.
- All dimensions noted on drawings shall be confirmed on site.

3.5 PIPE HANDRAILS, STAIRS, LADDERS AND BALUSTRADES

Assembly

Material: Refer to drawings and BOQ for details of member sizes and assembly of components.

Fabrication

Method: Welding.

Joints: Produce smooth unbroken surfaces at joints. Make end-to-end joints over an internal sleeve.

Bends: Make changes of direction in rails by evenly curved pipe bends.

Free ends: Seal the free ends of pipes with fabricated or purpose-made end caps.

Fixing to structure

Provide fabricated predrilled or purpose-made brackets or post bases, and attach the pipework to the building structure with fixings, including bolts into masonry anchors, and coach screws or bolts into timber, of metal compatible with the pipework.

Galvanizing

If possible, complete fabrication before galvanizing; otherwise apply a zinc-rich primer to affected joint surfaces.

Painting

If possible, complete fabrication before painting; otherwise apply paint to affected joint surfaces after fixing on site. Make good all damaged painted surfaces before completion of the building works. Paint finish in accordance with the **Exterior and Interior painting schedules**.

3.6 CORNER GUARDS AND VEHICLE GUARDS**Corner Guards**

Where corners of the structure are required to be protected from mechanical damage, provide metal corner guards as follows and as identified on the drawings or in the BOQ:

- Consisting of angle sections or sections fabricated from metal sheet bent to the radius or angle of the corner.
- Fitting close to adjoining surface finishes.
- Solidly grouted up at the back to eliminate voids.
- Securely fixed by a method which does not cause distortion in the guard surface, and consists of either concealed built in lugs, or flush countersunk head fixings into masonry anchors.
- Paint finish in accordance with the **Exterior and Interior painting schedules**.

Vehicle Guards

Where external features such as lamp posts, fire hose reels or pedestrian walkways are required to be protected from vehicle damage, provide metal guards as follows and as identified on the drawings and in the BOQ:

- Consisting of steel pipe posts set in deep concrete pads with welded end caps or bent to form a rail and two posts.
- Steel barrier rails securely bolted to the posts.
- Heavy duty protection posts will be large diameter steel pipe posts filled with concrete.
- Paint finish in accordance with the **Exterior and Interior painting schedules**.

3.7 WATER STORAGE TANKS AND STANDS**Water Tanks**

Fabricate metal water storage tanks to sizes shown on drawings and as identified in the BOQ. Allow for all reinforcement of tank walls, floors, and around fixtures projecting from the tank.

Bolt together prefabricated plastic or metal water storage tanks to sizes shown on drawings and as identified in the BOQ.

Fabricate metal tank stands for the water storage tanks as identified on the drawings and in the BOQ.

Refer to the **Metal fixtures schedule** for details.

Paint finish in accordance with the **Exterior and Interior painting schedules**.

3.8 COMPLETION**Maintenance manual**

General: Submit manufacturer's published recommendations for service use.

Cleaning

Temporary coatings: On or before completion of the works, or before joining up to other surfaces, remove all traces of temporary coatings used as a means of protection.

STAINLESS STEEL BENCHING**1 GENERAL****1.1 INSPECTION****Notice**

Give sufficient notice so that inspection may be made of the units when fabrication is complete, before delivery.

1.2 SUBMISSIONS**Samples**

Submit samples to the **Sample table** for approval by the Employers representative.

Sample Table

Description	No. of samples
Typical joints of welded or fabricated items	2
The finish to all stainless steel items	2

Stainless steel: For each batch of stainless steel supplied to the works, submit the certificate of compliance specified for the applicable standard.

Site welding

General: If site welding is proposed, submit details indicating location and process.

2 PRODUCTS**2.1 MATERIALS****Stainless steel**

Plate, sheet, strip, bar and pipe: To ASTM standards.

Type: 304.

Stainless steel sheet

Surface finish: Fine brushed finish not including to underside of shelves, and door backs and drawer backs.

Thickness: 1.2 mm minimum.

Particleboard

Use moisture resistant particleboard minimum thickness 12mm to splashback and 25mm to benchtop as substrate for support of flat sheet.

Plywood

Use external grade structural plywood minimum thickness 12mm to splashback and 25mm to benchtop as substrate for support of flat sheet.

2.2 COMPONENTS**Fasteners**

Material: Stainless steel.

Dimensional system: Metric.

Bolt and screw heads: Polished, pan type or countersunk.

Hardware

Material: Stainless steel.

Handles: Stainless steel unless noted otherwise.

Sealants

Type: Neutral cure one-part silicone.

Performance: Flexible. Resistant to growth of mould, bacteria and fungi. Colourfast.

Adhesive

Type: Spray contact adhesive.

3 EXECUTION

3.1 FABRICATION GENERALLY**Stainless steel welding**

Process: Gas tungsten arc welding.

Weld type: Butt.

Surface finish: Grade I, 120 grit.

Welding materials: Compatible with metal being welded.

Weld quality: Free from imperfections such as cracks and pits. Grind and polish to give required surface finish. Continuous exposed welds.

Joints: Strength at least that of parent metal. Free from crevices and folds.

Joint position: At corners and edges as far as possible. Minimise joints in flat panels.

Protection

Provide temporary self-adhesive plastic film to stainless steel surfaces.

Hardware fixing

Drill and tap, or weld fix.

Finishing grain direction

Benches and shelves: Lengthwise.

Bowls: Horizontal to sides, parallel to bench grain to bottom. Mitre at bottom corners.

Abutting surfaces: Parallel where possible.

3.2 BENCH TOPS FABRICATION**Bench tops**

Material: Stainless steel sheet.

Thickness: 2 mm.

Refer to drawings for details of bench construction and nominal overall sizes. Confirm all dimensions on site before fabricating bench units.

Exposed corners: Radius exposed corners at least 5 mm, including back vertical corners of upstands.

Internal back vertical corners: Fuse only from behind.

Wet bench perimeter: Except at wall flashing, provide a raised bead, with a fascia.

Dry bench perimeter: Except at wall flashing, provide a fascia.

Fascia

Fascia height: 30mm unless noted otherwise.

Fascia return: Full depth of bench top unless noted otherwise.

Drainer

Drainer falls to sinks: 1:50, 450 mm long.

Drainer surface: Plain.

Wall splashback

Type: Integral.

Height above bench: 300mm unless noted otherwise.

Ends: Return for full width of bench top.

Fixing to support frame

Type: Screw fix benchtop to support frame through welded lugs on front and back frames at 600mm centres into plywood or particleboard substrate. Provide star washers under screwheads.

If no substrate is used, weld benchtop to frame on welded lugs on front and back frames at maximum 300mm centres.

3.3 BOWL FABRICATION

Bowls

Type: Deep drawn stainless steel.

Thickness:

- Capacity < 75 L: 1.6 mm.
- Capacity ≥ 75 L: 2 mm.

Internal radii: 25 mm minimum.

Minimum depth: 250 mm.

Wastes:

- Size (minimum): 50mm diameter.
- Position: Centred in single bowls, adjacent in double bowls.
- Plug: Heavy-duty commercial.

Fall to waste (minimum):

- Capacity < 75 L: 10 mm.
- Capacity ≥ 75 L: 25 mm.

3.4 FRAME FABRICATION

Bench top support frame

Support: Provide sufficient support so that no load is placed on the waste pipe or water connections.

- Design deflection (maximum): 3 mm.

Members: 31.8 x 31.8 x 1.6 mm stainless steel pipe. Seal ends.

Extent: Perimeter and at sides of bowls, with additional members spaced as follows:

- 1.6 mm sheet: 350 mm maximum centres.
- 2 mm sheet: 500 mm maximum centres.

Maximum unsupported area: 0.3 m².

If 25mm plywood or particleboard substrate is used, the benchtop can be supported on front and back rails only, with additional members at 1200mm maximum centres.

Connections: Welded.

Bench legs

Members: 31.8 x 31.8 x 1.6 mm stainless steel pipe. Seal ends.

Fixing to bench top support frame: Weld all around at junctions.

Spacing: 1200 mm maximum.

Fixing to walls: Predrilled 100 x 50 x 2 mm stainless steel plate welded to legs at 600 mm high.

Feet: Nylon or chrome-plated aluminium, adjustable vertically ± 25 mm. Threaded section must not protrude from leg.

3.5 SHELVING FABRICATION

Under bench shelving

Material: Stainless steel.

Thickness: 1.6 mm.

Shelf support: 30 x 30 x 5 mm stainless steel angles.

- Extent: Perimeter, with additional angles spaced to give a maximum unsupported area of 0.3 m².

Connections: Welded.

Fixing of support to legs: Welded.

If 25mm plywood or particleboard substrate is used, the shelf can be supported on front and back rails only, with additional members at 1200mm maximum centres.

Fixing of shelf to support: as for benchtop support.

Over bench shelving

Material: Stainless steel.

Thickness: 1.6 mm.

Shelf support: 25.4 x 25.4 x 1.6 mm stainless steel pipe brackets minimum 300mm high above the shelf level. Seal ends.

- Spacing: 900 mm maximum with 25mm substrate or shelf fabricated with 30 x 30 x 5 mm stainless steel angles, 600mm with 12mm substrate.
- Fixing to wall: Two 50 x 50 x 5 mm stainless steel plates, fixed with at least two M8 bolts. Weld to top and bottom of the support brackets.

Fixing of shelf to support: Screw fix minimum of 3 times through tube into side of shelf or shelf angles. Seal between shelf and support.

3.6 DRAWERS FABRICATION**Drawers**

Material: Stainless steel.

Thickness: 1.2 mm.

Construction: Welded.

Frames: Removable, and interchangeable with other drawer frames. Provide extension-type drawer slide mechanism and front panel. Provide rubber stops at rear.

Front panel: 20 mm thick double pan construction.

Housing: Back and 2 sides, of a neat external appearance.

Runners: Incline to rear so drawers roll closed. Provide stop so drawer cannot be pulled out accidentally.

Locks: Chrome-plated brass.

3.7 INSTALLATION GENERALLY**Welding**

Preference should be given to any other fixing method other than site welding. Obtain approval from the Employers representative for any proposed site welding.

Sealing

Gaps < 5 mm wide: Apply sealant at the following locations:

- Butt joints between benches.
- Between benches, including flashings, and walls.
- Spaces and gaps under benches.

Gaps \geq 5 mm wide: Close with stainless steel infill panels.

Floor fixing

8 mm diameter stainless steel dowels, sealed to floor with silicone sealant.

3.8 COMPLETION**Protection**

General: Temporary self-adhesive plastic film: Remove from stainless steel surfaces.

PLASTERING

1 GENERAL

1.1 INTERPRETATION

Abbreviations

For the purpose to this worksection the abbreviations given below apply.

- CRF: Cement render – finish.
- CRM: Cement render – medium.
- CRS: Cement render – stronger.
- CRW: Cement render – weaker.
- LF: Lime felting render- weaker.
- GPF: Gypsum plaster – finish.

1.2 INSPECTION

Notice

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

- Backgrounds immediately before applying base coats.
- Finish treatments before decoration.

2 PRODUCTS

2.1 MATERIALS AND COMPONENTS

Accessories

Beads: To be metal proprietary sections manufactured to be fixed to backgrounds and/or embedded in the plaster to form and protect plaster edges and junctions.

Aggregates

Sand: To be fine, sharp, well-graded sand with a low clay content and free from efflorescing salts.

Bonding products

To be proprietary products manufactured for bonding cement-based plaster to solid backgrounds.

Cement

Cement shall conform to the requirements of ASTM specification C-150 Type 1 or similar approved standard for normal Portland cement.

Colouring products

To be proprietary products manufactured for colouring cement plaster.

Integral pigment proportion: 5% by mass of cement.

Curing products

To be proprietary products manufactured for use with the plaster system.

Gypsum plaster

To be a proprietary product containing calcium sulfate hemihydrate with additives to modify setting.

Lime

Confirm source of Lime with Employers representative to ensure highest quality Lime is used in the mortar. Protect from damage on site and store minimum 300mm above ground in waterproof storage facility.

Preparing lime putty:

- Using hydrated lime: Add lime to water in a clean container and stir to a thick creamy consistency. Leave undisturbed for at least 16 hours. Remove excess water and protect from drying out.
- Using quicklime: Run to putty as soon as possible after receipt of quicklime. Partly fill clean container with water, add lime to half the height of the water, then stir and hoe ensuring that no lime

remains exposed above the water. Continue stirring and hoeing for at least 5 minutes after all reaction has ceased, then sieve into a maturing bin. Leave undisturbed for at least 14 days. Protect from drying out.

Mixes

Select a mix ratio to suit the application in conformity to the **Mixes table**.

Measurement: Measure binders and sand by volume using buckets or boxes. Do not allow sand to bulk by absorption of water.

Plaster mixing: Machine mix for greater than 3 minutes and less than 6 minutes.

Strength of successive coats: Ensure successive coats are no richer in binder than the coat to which they are applied.

Mixes Table

Mix type		Application	Upper and lower limits of proportions by volume			
			Gypsum	Cement	Lime	Sand
Cement render coats in: - Single or multi-coat systems with integral finishing treatments - Base coats in multi-coat systems with cement or gypsum finishes	CRS	Dense and smooth concrete and masonry Thrown finishing treatments Tiled finishes Gypsum finishes Cement finishes	- -	1 1	0 0.5	3 4.5
	CRM	Clay or concrete masonry	- -	1 1	0.5	4.5 6
	CRW	Lightweight concrete masonry and other weak backgrounds	- -	1 1		6 9
Cement finish coats	CRF	Cement render base coats	- -	1 1	1	1.5 2
Lime felting finish coats	LF	Cement render base coats			1	3
Gypsum finish coats	GPF	Cement render base coats	3 1	- -	1 1	- 1

Movement control joint products

To be proprietary products manufactured for use with the plastering system and to accommodate the anticipated movement of the backgrounds and/or the plaster.

Water

To be clean and free from any deleterious matter.

Refer to the **Plastering schedule** for details of plastering and locations.

3 EXECUTION

3.1 PREPARATION

Substrates

Ensure substrates have:

- Any deposit or finish which may impair adhesion of plaster cleaned off.
- If solid or continuous, excessive projections hacked off and voids and hollows filled with plaster stronger than the first coat and not weaker than the background.

Absorbent substrates: If suction is excessive, control it by dampening but avoid over-wetting and do not plaster backgrounds showing surface moisture.

Dense concrete: If not sufficiently rough to provide a mechanical key, roughen by scratching or hacking to remove 2 mm of the surface and expose the aggregate then apply a bonding treatment.

Painted surfaces: Remove paint and hack the surface at close intervals.

Untrue substrates: If the substrate is not sufficiently true to ensure conformity with the thickness limits for the plaster system or has excessively uneven suction resulting from variations in the composition of the background, apply additional coats.

Beads

Location: Fix beads as follows:

- Angle beads: At all external corners.
- Drip beads: At all lower terminations of external plaster.
- Mechanical fixing to background: at 300 mm centres.
- Movement control beads: At all movement control joints.
- Stop beads: At all terminations of plaster and junctions with other materials or plaster systems.

Bonding treatment

If bonding treatment is required, throw a wet mix onto the background as follows:

- Cement plaster: 1 part cement to 2 parts sand.
- Gypsum plaster: 1 part gypsum to 2 parts sand.

Curing: Keep continuously moist for 5 days and allow to dry before applying plaster coats.

Thickness: From greater than 3mm but less than 6 mm.

Embedded items

If there are water pipes and other embedded items, sheath them to permit thermal movement. Ensure embedded items will have a suitable level of corrosion resistance prior to embedment.

3.2 APPLICATION

Plastering

General: Provide plaster finishes as follows:

- Resistant to impacts expected in use.
- Free of irregularities.
- Consistent in texture and finish.
- Firmly bonded to substrates for the expected life of the application.
- As a suitable substrate for the nominated final finish.

Base coats: Scratch-comb each base coat in two directions when it has stiffened.

Finishing treatments

Plain:

- Bag: To be a finish mainly free from sand by rubbing the finish coat with a Hessian pad when it has set firm.
- Carborundum stone: To be a smooth finish free from sand by, rubbing the finish coat with a fine carborundum stone when it has set hard.
- Steel trowel: To be a smooth dense surface by steel trowelling which is not glass-like and is free from shrinkage cracks and crazing.
- Wood or plastic float: To be an even surface by wood or plastic floating the finish coat on application.

Incidental work

Return plaster into reveals, beads, sills, recesses and niches. Plaster faces, ends, and soffits of projections in the background, such as string courses, sills, and other wall features. Trim around openings. Plaster exposed inside of built-in cupboards.

Joining up

If joining up is required, ensure joints will not be visible in the finished work after decoration.

Movement control joints

Provide movement control joints in the finish to coincide with movement joints in the background. Ensure that the joint in the background is not bridged during plastering.

- Depth: Extend the joint right through the plaster and reinforcement to the background.
- Width: 3 mm, or the same width as the background joint, whichever is greater.

Damp-proof courses: Do not continue plaster across damp-proof courses.

V-joints: Provide V-joints, cut right through the plaster to the background, at the following locations:

- Abutments with metal door frames.
- Abutments with other finishes.
- Junctions between different backgrounds.

Plaster thickness

Conform to the **Plaster thickness table**.

Plaster Thickness Table

Plaster	Application	Upper limit of thickness (mm)			
		Single coat systems	Multi-coat systems		
			Base coat(s)	Finish coat	System
Cement render base coats and cement or gypsum finish coats	On smooth dense concrete	12	10	4	13
	On clay and concrete brickwork and other backgrounds	15	13	4	16

Temperature

If the ambient temperature is less than 10°C or more than 30°C ensure that the temperature of mixes, backgrounds and reinforcement are, at the time of application, greater than 5°C or less than 35°C.

3.3 TOLERANCES

General

Conform to the **Tolerances table**.

Tolerances Table

Property	Tolerance criteria: Permitted deviation (mm)
Features ¹ : Verticality in 2000 mm	3
Features: Horizontality in 2000 mm	3
Soffits: Horizontality in 2000 mm	5
Walls: Verticality in 2000 mm	5
Walls: Flatness ² in 2000 mm	4
¹ Features: Conspicuous horizontal or vertical lines including external corners, parapets, reveals, heads, sills, movement control joints and mouldings.	
² Flatness: Measured under a straightedge laid in any direction on a plane surface.	

3.4 COMPLETION

Curing

General: Prevent premature or uneven drying out and protect from the sun and wind.

Keeping moist: If a proprietary curing agent is not used, keep the plaster moist as follows:

- Base coats and single coat systems: Keep continuously moist for 2 days and allow to dry for 5 days before applying further plaster coats.
- Finish coats: Keep continuously moist for 2 days.

CEMENTITIOUS TOPPINGS

1 GENERAL

1.1 INTERPRETATIONS

Abbreviations

For the purposes of this worksection the abbreviations given below apply.

- BCS: Bonded – cement and sand.
- BFC: Bonded – fine concrete.
- FFC: Floating – fine concrete.
- MGR: Monolithic – granolithic.
- SFC: Separated – fine concrete.

1.2 TOLERANCES

General

Thickness:

- Thickness < 15 mm: ± 2 mm.
- Thickness $\geq 15 < 30$ mm: ± 5 mm.
- Thickness ≥ 30 mm: ± 10 mm.

Flatness: Measured under a 3000 mm straightedge laid in any direction on a plane surface:

- Grade A: < 3 mm.
- Grade B: $\geq 3 < 5$ mm.
- Grade C: $\geq 5 < 10$ mm.

2 PRODUCTS

2.1 PRODUCTS

Admixtures

Introduce in solution in a portion of the mixing water. Ensure a uniform distribution of the admixture in the batch within the mixing period.

Aggregates

Coarse aggregate: To be nominal single size.

Fine aggregate: To be fine, sharp, well-graded sand with a low clay content and free from efflorescing salts.

Bonding products

To be proprietary products manufactured for bonding cement-based toppings to concrete backgrounds.

Cement

Cement shall conform to the requirements of ASTM specification C-150 Type 1 or similar approved standard for normal Portland cement.

Colouring products

To be proprietary products manufactured for colouring cement toppings.

Integral pigment proportion: 5% by mass of cement.

Coloured chips

To be marble chips of selected colour or proprietary products manufactured for distribution in cement toppings.

Concrete

On site batch mixed concrete shall have characteristics and proportions of concrete ingredients which conform to those specified in M-150 (1:2:4).

Curing products

To be proprietary products manufactured for use with cement-based toppings and with the floor finish to be laid on the toppings.

Mixes

Provide concrete as follows or select mix proportions to the **Mixes table**.

- Air entrainment: $\leq 3\%$.
- Nominal coarse aggregate size: $\leq 0.3 \times$ topping thickness.
- Slump: 80 mm.

Water quantity: Use the minimum necessary to achieve full compaction and prevent excessive water being brought to the surface during compaction.

Mixes Table

Mix type		Thickness (mm)	Upper and lower limits of proportion by mass (mm)		
			Cement	Fine aggregate	Coarse aggregate
Bonded – cement and sand	BCS	35	1 1	3 4.5	0 0
Bonded – fine concrete	BFC	40	1 1	3 3	1 2
Floating – fine concrete	FFC	100	1 1	3 3	1 2
Monolithic – granolithic	MGR	Floors and treads: 25 Risers and skirtings: 13	1	2	1
Separated – fine concrete	SFC	70	1 1	3 3	1 2

Movement control joint products

Provide products manufactured for use with cement based toppings and accommodate the anticipated movement of the backgrounds and/or the toppings.

Sealing products

Provide proprietary products manufactured for the sealing of movement joints in cement-based toppings.

Slip-resistance products

Provide proprietary products manufactured to improve the wet-slip resistance of toppings.

- Silicon carbide granules:
 - . Granule size: $\geq 300 < 600 \mu\text{m}$.
 - . Colour: Black.

Surface treatment products

Provide proprietary products manufactured for use with cement- based toppings to change the characteristics of the surface of the finished topping.

Reinforcement

All reinforcing shall be supported and wired together to prevent displacement by construction loads, or the placing of concrete, beyond the tolerances specified in ACI 301. Any tack or spot welding of reinforcement shall not be performed without approval from the Employers representative.

Reinforcement shall be free of loose rust and of any other coating which may adversely affect the bond.

Water

General: To be clean and free from any deleterious matter.

Refer to the **Cementitious toppings schedule** for details of toppings and locations.

3 EXECUTION

3.1 PREPARATION

Backgrounds

Ensure backgrounds have:

- Any deposit which may impair adhesion of monolithic or bonded toppings cleaned off.
- Excessive projections hacked off and voids and hollows filled with a mix not stronger than the background nor weaker than the topping.
- Hardened concrete roughened by scratching or hacking to remove 2 mm of the surface and expose the aggregate.

Bonded toppings

Before laying topping wash the subfloor with water and use a bonding product or treat as follows:

- Keep wet for ≥ 2 hours.
- Remove surplus water and brush on neat cement or a clean slurry of cement and water.
- Place the topping while the slurry is wet.

3.2 APPLICATION

Laying

Spread the mix and compact and level the surface to finished levels.

Monolithic toppings: Lay while concrete subfloor is plastic and surface water is no longer visible.

Toppings over 50 mm thick:

- Lay in two layers of equal thickness.
- Place a layer of reinforcement between the layers of toppings. Lap reinforcement 100 mm and tie. Do not create four way laps.

Floating and trowelling

Machine float finish:

- After levelling, consolidate the surface using a machine float.
- Cut and fill and refloat immediately to a uniform, smooth, granular texture.
- Hand float in locations inaccessible to the machine float.

Flatness: Grade B.

Steel trowel finish: After machine floating finish as follows:

- When the surface has hardened sufficiently, use steel hand trowels to produce the final consolidated finish free of trowel marks and uniform in texture and appearance.

Flatness: Grade A.

Wood float finish: After machine floating finish as follows:

- Use wood or plastic hand floats to produce the final consolidated finish free of float marks and uniform in texture and appearance.

Flatness: Grade A.

Floor finish dividers

Finish cementitious toppings at junctions with differing floor finishes with a corrosion resistant metal dividing strip suitable fixed to the background, with top edge flush to the finished floor. If changes of floor finish occur at doorways make the junction directly below the closed door.

Monolithic toppings

Coved skirtings: Form coves in the topping material, and finish the top to a neatly struck line. Mitre internal and external angles. 10 mm radius to top of skirting. 25mm radius to junction between floor and skirting.

Movement control joints

Provide movement control joints to divide toppings into bays as follows

- Form in situ using square edge steel forms and trowelling a 3 mm radius to edges.
- Form a groove, extending at least one quarter the depth of the section, either by using a grooving tool, by sawing, or by inserting a premoulded strip.
- Install a movement control joint product.

Bay sizes:

- Area: $\leq 15 \text{ m}^2$.
- Length to width ratio: $\leq 1:1.5$.

Joints in background: Provide movement control joints in toppings to coincide with joints in the background.

Slip-resistance treatment

Stair treads: Form two grooves and fill with a silicon carbide two-part resin.

- Dimensions: 10 mm deep, 15 mm wide, length \geq width of tread less 100 mm.
- Position:
 - . First groove: Centre 35 mm from tread nose.
 - . Second groove: Centre 60 mm from step nose.

Plane surfaces: Apply silicon carbide granules after floating and before the topping surface has set, and trowel into the surface so that the granules remain exposed.

- Application rate: 1 kg/m^2 evenly distributed.

Surface colouring

Apply the colouring product or coloured marble chips after floating and before the topping surface has set and trowel into the surface so that it is even in colour distribution.

Temperature

If the ambient temperature is less than 10°C or more than 30°C ensure that the temperature of mixes, backgrounds and reinforcement are, at the time of application, greater than 5°C or less than 35°C .

3.3 COMPLETION

Curing

General: Prevent premature or uneven drying out and protect from the sun and wind.

Curing: Use a curing product or, as soon as it has set sufficiently, keep the toppings moist by covering with polyethylene film for seven days.

TILING

1 GENERAL**1.1 INSPECTION****Notice**

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

- Floor preparation and set out of floor tiles before fixing.
- Wall preparation and set out of wall tiles before fixing.
- Control joints before sealing and grouting.

1.2 SUBMISSIONS**Samples**

Submit labelled samples of tiles, including fittings, accessories, grout and sealants, illustrating the range of variation in colour and finish.

1.3 INTERPRETATIONS**Definitions**

For the purposes of this worksection the definitions given below apply.

- Substrates: The surfaces on which tiles are bedded.
- Bedding: Mixtures of materials which are applied to substrates in a plastic state and dry and cure to adhere tiles to substrates.
 - . Adhesive bedding: Tiling adhered by adhesives.
 - . Mortar bedding: Tiling adhered in a cementitious mortar bed.
- Pavers: Slabs made from clays, stone, precast concrete and/or other inorganic raw materials generally over 20 mm thick used as coverings for floors and supported over continuous substrates.
- Tiles: Thin slabs made from clays and/or other inorganic raw materials used generally as coverings for floors and walls and adhered to continuous supporting substrates.
 - . Natural stone: Tiles cut from natural stone.
 - . Industrial cast: Tile products of reconstituted stone. Also known as manufactured stone.
 - . Cementitious: Manufactured cement based pre-finished tiles.
 - . Terrazzo – cementitious: Manufactured cementitious terrazzo tiles formed in a suitable machine to give sufficient compaction and density to the finished surface, and moisture cured before grinding and honed at the place of manufacture. Thickness usually 35 mm.
- Wet areas: Areas within buildings with water supply and drainage systems.

1.4 TOLERANCES**Completed tiling**

Conform to the **Tolerances table**.

Tolerances Table

Property	Tolerance criteria
Alignment: Deviation of the finished tiles from a 3 m straight edge laid against any joints	< 4 mm
Flatness: Deviation of any plane surface under a 3 m straight edge laid in any direction on an area of uniform grade	< 4 mm

2 PRODUCTS

2.1 TILES AND ACCESSORIES

Provide tiles and accessories to the **Wall tiling** and **Floor tiling schedules**.

Tiles

Coves, nosings and skirtings: To be matching stop-end and internal and external angle tiles moulded for that purpose.

Exposed edges: To be purpose-made border tiles with the exposed edge glazed to match the tile face. If such tiles are not available, round edge with grout.

2.2 ADHESIVES

Type

General: Provide adhesives to the **Wall tiling schedule** and to the **Floor tiling schedule** and compatible with the materials and surfaces to be adhered.

Prohibited uses: Do not provide the following combinations:

- Cement-based adhesives on wood, metal, painted or glazed surfaces, gypsum-based plaster.
- Organic solvent-based adhesives on painted surfaces.
- Organic PVC-based adhesives and organic natural rubber latex adhesives in damp or wet conditions.
- PVA (polyvinyl acetate) based adhesives in wet areas or externally.

2.3 MORTAR

Materials

Cement: Cement shall conform to the requirements of ASTM specification C-150 Type 1 or similar approved standard for normal Portland cement.

- White cement: Iron salts content $\leq 1\%$.
- Off-white cement: Iron salts content $\leq 2.5\%$.

Lime: Confirm source of Lime with Employers representative to ensure highest quality Lime is used in the mortar. Protect from damage on site and store minimum 300mm above ground in waterproof storage facility.

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

Measurement of volume: Measure binders and sand by volume using buckets or boxes. Do not allow sand to bulk by absorption of water.

Bedding mortar

Proportioning: Select proportions from the range 1:3 – 1:4 cement:sand to obtain satisfactory adhesion. Provide minimum water.

Terra cotta tiles: Use proprietary polymer modified mortar.

Water

General: To be clean and free from any deleterious matter.

2.4 GROUT

Type

Cement based proprietary grout: Mix with water. Fine sand may be added as a filler in wider joints.

Terra cotta tiles: Use proprietary polymer modified grout.

Portland cement based grout: Mix with fine sand. Provide minimum water consistent with workability.

- For joints < 3 mm: 1 cement:2 sand.
- For joints ≥ 3 mm: 1 cement:3 sand.

Pigments

Pigments for coloured grout: Provide colourfast fillers compatible with the grout material. For cement-based grouts, provide lime-proof natural or synthetic metallic oxides compatible with cement.

3 EXECUTION

Provide tiling systems to walls, floors and other substrates as follows:

- Consistent in colour and finish.
- Firmly bonded to substrates for the expected life of the installation.
- Resistant to expected impacts in use.
- Set out with joints accurately aligned in both directions and wall tiling joints level and plumb.
- To direct all water flowing from supply points to drainage outlets without leakage to the substrate or adjacent areas.

3.1 SUBSTRATES

Drying and shrinkage

Before tiling, allow at least the following times to elapse (for initial drying out and shrinkage) for these substrates:

- Concrete slabs: 42 days.
- Concrete blockwork: 28 days.
- Toppings on slabs and rendering on blockwork: A further 21 days.

3.2 PREPARATION

Ambient temperature

If the ambient temperature is less than 5 or more than 35°C, do not lay tiles.

Substrates

Ensure substrates are as follows:

- Clean and free of any deposit or finish which may impair adhesion or location of tiles.
- If solid or continuous, excessive projections are hacked off and voids and hollows are filled with a cement:sand mix not stronger than the substrate nor weaker than the bedding.

Absorbent substrates: If suction is excessive, control it by dampening but avoid over-wetting and do not apply mortar bedding to substrates showing surface moisture.

Dense concrete: If not sufficiently rough to provide a mechanical key, roughen by scratching or hacking to remove 3 mm of the surface and expose the aggregate; then apply a bonding treatment.

3.3 TILING GENERALLY

Sequence

General: Fix wall tiles before floor tiles.

Cutting and laying

Cutting: Cut tiles neatly to fit around fixtures and fittings, and at margins where necessary. Drill holes without damaging tile faces. Rub edges smooth without chipping.

Laying: Return tiles into sills and openings. Butt up to returns, frames, fittings, and other finishes.

Variations

Distribute variations in hue, colour, or pattern uniformly, by mixing tiles or tile batches before laying.

Protection

Floor tiles: Keep traffic off floor tiles until the bedding has set and attained its working strength.

Cleaning: Keep the work clean as it proceeds and protect finished work from damage.

3.4 SETTING OUT

Tile joints

Set out tiles to give uniform joint widths within the following limits:

- Ceramic floor tiles: 4 to 6 mm.
- Quarry floor tiles: 6 to 12 mm.
- Terrazzo and stone pavers to floor: 2 to 3 mm.
- Large and/or irregular floor tiles: 6 to 12 mm.
- Mounted mosaics: To match mounting pattern.
- Ceramic wall tiles: 3 to 5 mm.

- Terrazzo and stone wall panels: 2 to 3 mm.

Margins

Provide whole or purpose-made tiles at margins where practicable, otherwise set out to give equal margins of cut tiles. If margins less than half tile width are unavoidable, locate the cut tiles where they are least conspicuous.

Fixtures

If possible position tiles so that holes for fixtures and other penetrations occur at the intersection of horizontal and vertical joints or on the centre lines of tiles. Continue tiling fully behind fixtures which are not built in to the tiling surface. Before tiling ensure that fixtures interrupting the tile surfaces are accurately positioned in their designed or optimum locations relative to the tile layout.

3.5 FALLS AND LEVELS**Grading**

Grade floor tiling to even and correct falls to floor wastes and elsewhere as required. Make level junctions with walls. Where falls are not required lay level.

Fall, general: 1:100 minimum.

Fall, in shower areas: 1:60 minimum.

3.6 BEDDING**Preparation of tiles**

Adhesive bedding: Fix tiles dry; do not soak.

Mortar bedding: Soak porous tiles in water for half an hour and then drain until the surface water has disappeared.

Terra cotta tiles: Use pre sealed tiles or apply a breathable sealer and lay dry. If a final sealed finish is selected, use a compatible laying sealer.

Bedding

Use bedding methods and materials which are appropriate to the tile, the substrate, the conditions of service, and which leave the tile firmly and solidly bedded in the bedding material and adhered to the substrate. Form falls integral with the substrate.

Thin adhesive beds

Provide only if the substrate deviation is less than 3 mm when tested with a 3 m straight edge. Cover the entire tile back with adhesive when the tile is bedded.

Thickness: 1.5 – 3 mm.

Thick adhesive beds

Provide on substrates with deviations up to 6 mm when tested with a 3 m straight edge, and with tiles having deep keys.

Nominal thickness: 6 mm.

Adhesive bedding application

Apply adhesive by notched trowel to walls and floors and direct to tiles if required, to provide evenly distributed coverage after laying.

Wall tile spacers: Do not use spacer types that inhibit the distribution of adhesive.

Curing: Allow the adhesive to cure for the period nominated by the manufacturer prior to grouting or allowing foot traffic.

Mortar beds

For floor tiles: Either lightly dust the screeded bed surface with dry cement and trowel level until the cement is damp, or spread a thin slurry of neat cement, or cement-based thin bed adhesive, on to the tile back. Do not provide mortar after initial set has occurred.

- Nominal thickness: 20 to 40 mm.

3.7 MOVEMENT JOINTS**General**

Provide movement joints to the **Tile movement joints schedule** and as follows:

- Location:
 - . Over structural (isolation, contraction, expansion) joints.

- . Close to external corners in large tiled areas.
- . Around the perimeter of the floor.
- . At junctions between different substrates.
- . To divide large tiled areas into bays, maximum 5 m wide, maximum 16 m².
- . At abutments with the building structural frame and over supporting walls or beams where flexing of the substrate is anticipated.
- Depth of joint: Right through to the substrate.
- Sealant width: 6 – 10 mm.
- Depth of elastomeric sealant: One half the joint width, or 6 mm, whichever is the greater.

Movement joint materials

Divider strip: A proprietary expansion joint consisting of a neoprene filler sandwiched between plates with lugs or ribs for mechanical keying. Set flush with the finished surface.

Sealant: Two-pack self-levelling non-hardening mould resistant, one-part silicone or polyurethane sealant applied over a backing rod. Finish flush with the tile surface.

Backing rod: Compressible closed cell polyethylene foam with a bond-breaking surface.

3.8 GROUTED AND CAULKED JOINTS**Grouted joints**

Commence grouting as soon as practicable after bedding has set. Clean out joints as necessary before grouting.

Face grouting: Fill the joints solid and tool flush. Clean off surplus grout. Wash down when the grout has set. When grout is dry, polish the surface with a clean cloth.

Edges of tiles: Grout exposed edge joints.

Mosaic tiles

Grouting mosaics: If paper faced mosaics are to be bedded in cement mortar, pre-grout the sheeted mosaics from the back before fixing. After fixing, rub grout into the surface of the joints to fill any voids left from pre-grouting. Clean off surplus grout. When grout has set, wash down. If necessary use a proprietary cement remover.

Sealant joints

Provide joints filled with sealant and finished flush with the tile surface as follows:

- Where tiling is cut around sanitary fixtures.
- Around fixtures interrupting the tile surface, for example pipes, brackets, bolts and nibs.
- At junctions with elements such as window and door frames and built-in cupboards.

Width: 5 mm.

Depth: Equal to the tile thickness.

3.9 JOINT ACCESSORIES**Floor finish dividers**

Finish tiled floors at junctions with differing floor finishes with a corrosion resistant metal dividing strip suitably fixed to the substrate, with top edge flush with the finished floor. Where changes of floor finish occur at doorways make the junction directly below the closed door.

3.10 COMPLETION**Cementitious terrazzo tiled surfaces**

In situ grind and polish the completed installation with equipment nominated by the tile supplier.

Spare tiles

Supply spare matching tiles and accessories of each type for future replacement purposes. Store the spare materials on site where directed by the Employers representative.

Quantity: At least 1% of the quantity installed.

Cleaning

Clean tiled surfaces using an appropriate tile cleaning agent, and polish.

VINYL FINISHES

1 GENERAL

1.1 INSPECTION

Notice

Give sufficient notice so that inspection may be made of the substrate immediately before fixing vinyl finishes.

1.2 SUBMISSIONS

Samples

Range: Submit labelled samples of vinyl finishes illustrating the range of colour, pattern or texture as seen in the finished work.

Minimum size per sample:

- Sheet: 450 x 450 mm.
- Linear accessories (coving, skirting, stair nosing, protection strips, and the like): A piece 300 mm long.

Welded joints: Submit a sample joint 300 mm long.

Identification

Labelling: Label each sample, giving brand, product name, and manufacturer's code reference

2 PRODUCTS

2.1 MARKING

Identification

Deliver materials to the site in the manufacturer's containers legibly marked to show the following:

- Manufacturer's identification.
- Product brand name.
- Product type.
- Dimensions and quantity.
- Handling and installation instructions.

2.2 SHEETS AND TILES

Edges of sheets and tiles

Ensure edges are firm, unchipped, machine-cut accurately to size and square to the face, and that tile edges are square to each other.

Polyvinyl chloride (PVC)

Resilient floor covering, jute or polyester felt backing: To BS EN 650.

Resilient floor covering, with foam layer: To BS EN 651.

Refer to the **Vinyl sheet and tile schedule** for details.

3 EXECUTION

3.1 PREPARATION

Substrates

Ensure substrates conform to the **Substrate tolerance table** and are as follows:

- Clean and free of any deposit or finish which may impair adhesion or location and functioning of movement joints.

Substrate Tolerance Table

Property	Length of straight edge laid in any direction	Max. deviation under the straight edge
Flatness	3000 mm	4 mm
Projections	100 mm	1 mm

Cleaning concrete surfaces: Mechanically remove the following surface treatments:

- Sealers and hardeners.
- Curing compounds.

Concrete substrate correction: Remove projections and fill voids and hollows with a levelling compound compatible with the adhesive.

Moisture content: Do not commence installation unless the following periods have elapsed:

- Concrete slabs: 42 days.
- Toppings on slabs: A further 21 days.

Working environment

Do not start work before the building is enclosed, wet work is complete and dry, and good lighting is available. Protect adjoining surfaces.

3.2 SHEET AND TILE INSTALLATION

Sheet set out

Set out sheets to give the minimum number of joints. Run sheet joints parallel with the long sides of floor areas, vertically on walls.

Tile set out

Set out tiles from the centre of the area. Wherever possible cut tiles at margins only, to give a cut dimension of at least 100 mm x full tile width. Match edges and align patterns. Arrange the material so that variation in appearance is minimised.

Joints

Non-welded: Butt edges together to form tight neat joints showing no visible open seam.

Junctions

Scribe neatly up to returns, edges, fixtures and fittings. Finish flush with adjoining surfaces.

Rolling

Where rolling is required, roll the finish in 2 directions before the adhesive sets, using a 70 kg multi-wheeled roller.

Cleaning

Keep the surface clean as the work proceeds.

3.3 VINYL SHEETING

Welded joints

Heat welding: After fixing, groove the seams using a grooving tool and weld the joints with matching filler rod and using a hot air welding gun. When the weld rod has cooled, trim off flush.

Cold welding: Apply seaming compound 100 mm wide to the substrate centrally under the seam. Roll the seam until the compound is forced up into the joint. Clean off flush using a damp cloth.

Epoxy jointing: Join seams with epoxy adhesive.

3.4 STAIRS

Vinyl

Preformed: Provide purpose-made vinyl stair finish combining riser, nosing and tread in the one element. Lay each step consecutively with the joint at the bottom of each riser.

Formed in situ: Fit the sheet vinyl to each tread, and to the riser above, in one piece, coved in the angle. Accurately scribe, cut and fit to stair nosings and perimeters.

Stair nosings

Aluminium: Purpose-made extruded anti-slip aluminium nosing.

Vinyl: Purpose-made moulded anti-slip section, matching the stair finish.

Refer to the **Stair vinyl finishes schedule**.

3.5 JOINTS AND ACCESSORIES

Refer to the **Vinyl finishes joint and accessories schedule** for details.

Junctions

Finish junctions flush with adjoining surfaces. Where changes of floor finish occur at doorways locate the joint on the centreline of the closed door leaf.

Cover strips

Provide edge cover strips at junctions with different floor finishes and to exposed edges.

Metal cover strip: Extruded tapered strip 25 mm wide, of the same thickness as the sheet or tile. Fix with masonry anchors at 200 mm maximum centres.

UPVC cover strip: Feather-edge strip matching the floor finish, fixed with contact adhesive.

Movement joints

Location: Provide movement joints as follows:

- Over structural (isolation, contraction, expansion) joints.
- At junctions between different substrates.

Depth of joint: Right through to the substrate.

Sealant width: 6 – 10 mm.

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

Vinyl skirting

Feather edge: Moulded PVC skirting section.

Flat skirting: Flat PVC skirting section.

Fixing: Fix to walls with contact adhesive.

Minimum height: 100 mm.

Coves and nosings

Coved skirtings: Carry the flooring material up over a profiled coving section to form skirting, weld all joints. Minimum radius of 20mm to coving.

3.6 COMPLETION

Protection

Keep traffic off floors until bonding has set or for 24 hours after laying, whichever period is the longer. Do not allow water in contact with the finish for 7 days.

Reinstatement: Repair or replace faulty or damaged work. If the work cannot be repaired satisfactorily, replace the whole area affected.

Spare materials

General: Supply spare matching covering materials and accessories of each type for future replacement purposes. Store the spare materials on site where directed.

Quantity: At least 1% of the quantity installed.

Cleaning

Clean the finished surface. Buff and polish. Before handover, mop and leave the finished surface clean and undamaged on completion.

Refer to the **Vinyl sheet and tile schedule** for details and locations of vinyl finishes.

PAINTING

1 GENERAL

1.1 INSPECTION

Notice

Give sufficient notice so that inspection may be made of the substrate immediately before application of paint finishes.

1.2 SUBMISSIONS

Clear finish coated samples

Submit pieces of timber or timber veneer matching the timber to be used in the works, prepared and coated in accordance with the paint system.

Opaque coated samples

Provide approx 600x600mm samples on representative substrates of each paint system showing surface preparation, colour, gloss level and texture.

2 PRODUCTS

2.1 PAINTS

Combinations

Do not combine paints from different manufacturers in a paint system.

Clear timber finish systems: Provide only the combinations of putty, stain and sealer recommended by the manufacturer of the top coats.

Delivery

Deliver paints to the site in the manufacturer's labelled and unopened containers.

Tinting

Provide only products which are colour tinted by the manufacturer or supplier.

Putty

Non-timber substrates: Oil-based or polymeric based.

Timber finishes: Lacquer or water based only.

3 EXECUTION

3.1 PREPARATION

Order of work

Other trades: Before painting, complete the work of other trades as far as practicable within the area to be painted, except for installation of fittings and laying flooring materials.

Clear finishes: Complete clear timber finishes before commencing opaque paint finishes in the same area.

Protection

Fixtures: Remove door furniture, switch plates, light fittings and other fixtures before starting to paint, and refix in position undamaged on completion of the installation.

Adjacent surfaces: Protect adjacent finished surfaces liable to damage from painting operations.

Under no circumstances is the painter allowed to get paint on any surface which is not to be painted. The painter is required to protect all surfaces other than the one which is to be painted immediately, with coverings. These include, but are not limited to: drop cloths, masking tape, plastic sheeting, and paper. No paint may be allowed on glass, stone, floors, stone walls, suspended ceilings, windows or any other surface which is not mean to be painted.

“Wet paint” warning

Place notices conspicuously and do not remove them until paint is dry.

Restoration

Clean off marks, paint spots and stains progressively and restore damaged surfaces to their original condition. Touch up damaged decorative paintwork or misses only with the paint batch used in the original application.

Substrate preparation

Prepare substrates to receive the painting systems.

Cleaning: Clean down the substrate surface. Do not cause undue damage to the substrate or damage to, or contamination of, the surroundings.

Filling: Fill cracks and holes with fillers, sealants, putties or grouting cements as appropriate for the finishing system and substrate, and sand smooth.

Clear finish: Provide filler tinted to match the substrate.

Clear timber finish systems: Prepare the surface so that its attributes will show through the clear finish without blemishes, by methods which may involve the following:

- Removal of discolourations, including staining by oil, grease and nailheads.
- Puttying.

3.2 PAINTING

Provide coating systems to substrates as follows and as scheduled:

- Consistent in colour, gloss level, texture and thickness.
- Free of runs, sags, blisters, or other discontinuities.
- Fully adhered.
- Resistant to expected impacts in use.
- Resistant to environmental degradation within the manufacturer's stated life span.

Number of coats

Unless specified as one coat or two coat systems, each paint system consists of at least 3 coats comprising priming coat and 2 top coats.

Drying

Ensure that the moisture content of the substrate is at or below the recommended maximum level for the type of paint and the substrate material.

Paint application

Apply the first coat immediately after substrate preparation and before contamination of the substrate can occur. Apply subsequent coats after the manufacturer's recommended drying period has elapsed.

Priming before fixing

Apply one coat of wood primer (2 coats to end grain) to the back of the following before fixing in position:

- Timber door and window frames.
- Bottoms of external doors.
- Associated trims and glazing beads.

Spraying

If the paint application is by spraying, use conventional or airless equipment which does the following:

- Satisfactorily atomises the paint being applied.
- Does not require the paint to be thinned beyond the maximum amount recommended by the manufacturer.
- Does not introduce oil, water or other contaminants into the applied paint.

Sanding

Clear finishes: Sand the sealer using the finest possible abrasive and avoid cutting through the colour. Take special care with round surfaces and edges.

Repair of galvanizing

For galvanized surfaces which have been subsequently welded, prime the affected area.

4 SELECTIONS

4.1 PAINT SYSTEMS

Paint system description

Choose from the following paint systems and substrates and paint in accordance with manufacturers recommendations and **Interior** and **Exterior painting schedules**:

Paint Systems:

Flat water based: Interior
Low gloss water based: Interior
Flat or low gloss water based: Exterior
Semi-gloss water based: Interior
Semi-gloss water based: Exterior
Gloss water based: Interior
Gloss water based: Exterior
Semi-gloss, oil based: Interior
Full gloss, oil based: Interior
Full gloss, oil based: Exterior
Texture finish, water based: Interior
Texture finish, water based: Exterior
Varnish clear: Interior
Varnish clear: Exterior
Varnish tinted: Interior
Opaque timber finish, water based: Exterior
Clear or tinted timber finish, oil based: Interior
Clear or tinted timber finish, oil based: Exterior
Paving paint - Semi gloss oil based
Roofing paint, oil based
Low flame spread specialised coating

Substrate Types:

Existing paintwork (oil based)
Existing paintwork (water based)
Concrete
Cement render
Fibre cement
Brickwork
Stonework
Set plaster
Glass reinforced gypsum plaster
Plasterboard (paper faced)
Iron and steel
Aluminium
Metallic-coated steel
Oil-based air-drying primed metal
Organic or inorganic zinc primed metal
Timber
Particleboard
UPVC

Colour selection

As nominated in the **Interior** and **Exterior painting schedules**.

MECHANICAL SERVICES**1 GENERAL****1.1 Aims****Airconditioning load calculations**

Calculate the cooling and heating loads using one of the following:

- Manual methods: AIRAH DA9, ASHRAE or Carrier.
- Electronic methods: ACADS-BSG Camel, Carrier E20 or Trane Trace.

Design

General: Provide systems designed in conformance with the following unless specific items of equipment are identified in the schedules.

Outside design conditions: Use outdoor design conditions listed in AIRAH DA9, Table 1 or Table 1A for the location geographically closest to the site and Comfort Conditions.

Inside design conditions:

- Summer: 25°C dry bulb, 50% relative humidity
- Winter: 20°C dry bulb.

Zoning: Divide the systems into temperature controlled zones to suit the proposed uses of the facility and heat loss/gain conditions.

Fresh air: Supply fresh air to spaces with airconditioning systems via the air handling systems as applicable.

Windows, walls, floors and roofs: Refer to drawings for construction and insulation.

Lighting load: Refer to drawings for lighting layout and details.

Supply air: To each airconditioned space $\geq 4.5 \text{ L/s/m}^2$ at all times the plant is operational.

Ambient noise emitted: Lower than the level that can be heard within a habitable room in any neighbouring premises, regardless of whether any door or window to that room is open.

Fire separation: Refer to drawings.

Heating: Use reverse cycle plant to provide heating.

Duct design: Size ductwork as follows:

- Rigid sheet metal duct: $\leq 6 \text{ m/s}$ and $\leq 1.2 \text{ Pa/m}$.
- Flexible duct: $\leq 4.0 \text{ m/s}$.

1.2 SUBMISSIONS**General**

Before starting work, submit the following for approval from the Employers representative:

- Outside design conditions, corresponding geographic location and source of data.
- Calculated total and sensible cooling capacities and heating capacity.
- Name of calculation method used.
- Makes and model numbers of proposed equipment.
- Any assumptions on which the calculations are based.
- Details of any departures from this specification.
- Details of fire provisions.
- A drawing of the proposed duct, pipe and equipment layout. Show proposed zoning and methods of heating.

1.3 INSPECTION**Notice**

Give sufficient notice so that inspection may be made of the equipment in place before connection and commissioning.

2 PRODUCTS

Refer to **Non-ducted** and **Ducted air conditioning system schedules** for details.

2.1 AIRCONDITIONING EQUIPMENT

Standards

Ducted airconditioners: To appropriate international standards from country of origin.

Non-ducted airconditioners: To appropriate international standards from country of origin.

Equipment

Performance: Provide equipment as follows:

- Is made by a manufacturer with a demonstrated ability to provide spare parts and service promptly to the site.
- Will operate within the specified range of outdoor design conditions under the calculated loads without excessive head pressure or icing.

Reverse cycle units: Provide an effective outdoor coil defrost facility that prevents room temperature dropping more than 3°C during defrost.

Cabinet: Aluminium, powder coated steel or moulded ABS plastic with metallic-coated steel or stainless steel fasteners. Insulate and vapour seal cabinet and drain trays to prevent external condensation under all operating conditions.

Drain trays: Aluminium, stainless steel or plastic to collect all moisture inside indoor and outdoor units.

Filters: Washable panel type.

Coils: Copper tube with aluminium plate fins.

Controls

Provide the following functions:

- Temperature control for each zone located to accurately sense zone temperature.
- Fan speed selection for multi and variable speed fans.

2.2 ELECTRIC DUCT HEATERS

General

Standard: To appropriate international standards from country of origin.

Elements: Sheathed in steel or nickel alloy.

Frames: Assemble elements in a galvanized steel frame with terminal connections contained in an enclosed terminal box.

Heating section: Install to allow access to the terminal box and removal of the assembly without disturbing other components.

Refer to **Power accessories schedule**.

2.3 GRILLES AND DIFFUSERS

Refer to **Air grills schedule** for details.

General

Size and locate diffusers to provide even air distribution and temperatures without draughts.

Ceiling diffusers: Provide at least one per airconditioned room and at least one per 12 m².

Construction:

- Variable volume diffusers: Powder coated pressed steel.
- All others: Powder coated aluminium.

Dampers: Provide a damper to each diffuser and grille. If connected by flexible duct, locate the damper at the duct spigot unless a damper in this position is inaccessible.

Supply diffusers and grilles

Louvre ceiling diffusers: Multi-bladed, removable core 4-way blow configuration, fitted with a matt black blanking plate for 1, 2, or 3-way blow, as appropriate. If the outlet neck is smaller than the outlet necessary to suit the louvre face size, provide a matt black reducer neck.

Side wall registers: Double deflection type with horizontal front louvre blades and vertical rear blades at 19 mm maximum centres, capable of field adjustment of air throw over the range $\pm 45^\circ$. Support blades > 600 mm long at mid point on a notched support bar.

Return or exhaust grilles – indoor

Ceiling and wall louvre type: Half chevron louvres at 25 mm maximum centres.

Egg crate type (ceiling use only): Elements at 90° to each other, and at 15 mm maximum centres.

Door grilles: Full chevron, 50% minimum free area. Frame to suit door thickness.

External intake and discharge louvres

General: Refer to *Windows* worksection.

2.4 FANS

Refer to **Power accessories schedule** for details.

General

Guards: Provide galvanized steel or bronze mesh guards.

Steel components: Corrosion protect by zinc plating or better.

Motors in air stream: Direct mount to impellers. Provide terminal boxes external to fan casings and wired to fan motors.

Motor minimum degree of protection: IP55.

Bearings: Provide sealed for life or grease packed bearings.

Balancing: Dynamically balance impellers.

Connections: Provide flexible duct connections at fan.

Centrifugal and mixed-flow in-line fans

Casings: Rectangular or circular manufactured from metallic-coated steel sheet, fibreglass or plastic with spigot or flanges for duct mounting.

Impellers: Backward or forward curved blades, constructed from metallic-coated steel, aluminium or polypropylene. Provide fans with non-overloading power characteristics.

Propeller fans

Mounting: Mount on contoured diaphragm plate.

Impellers: Aluminium or UV stabilised ABS or polypropylene.

Window or wall mounted fans

Propeller type: Complete with isolating mountings, discharge cowls or louvres, birdmesh guards and backdraft shutters.

Roof mounted fans

Type: Centrifugal, mixed flow or propeller. Comply with the respective clauses above.

Housing: House fans in compact bases fitted with weathering skirts and manufactured from zinc-coated steel or UV stabilised plastic or composite.

Finish:

- Metallic-coated steel: UV stabilised powder coat to match roof colour.
- Other materials: Manufacturer's standard colour.

Vertical discharge fans: Provide weatherproof galvanized steel, plastic or aluminium backdraft dampers where the weather may enter when units are stopped.

Birdmesh: Where backdraft dampers are not fitted, provide birdmesh guards.

3 EXECUTION

3.1 DUCTWORK**Rigid duct**

Material: Metallic-coated sheet steel.

Flexible duct

Material: Alumidised fabric clamped on formed metal helix with insulation blanket wrapped around duct and covered with an outer vapour barrier.

Installation: Install flexible duct as straight as possible with minimum number of bends. Maximise bend radius. Check for and rectify any crushed flexible duct.

Support: Limit sag to < 40 mm/m.

Duct insulation

Insulate ducts to reduce heat gain and prevent condensation. Provide continuous vapour barrier around ducts carrying conditioned air. Insulate flexible connections on ducts carrying air below ambient temperature.

Cleaning

Clean interior of ductwork progressively during installation.

3.2 REFRIGERATION PIPEWORK

General

Conform to equipment manufacturer's recommendations for the refrigerant used.

Deemed to comply: Split system manufacturer's standard pre-charged piping kit.

Pipe insulation

Insulate all refrigerant and drain piping that may sweat with chemically blown closed cell nitrile rubber in tubular form to ASTM C534. Apply to manufacturer's recommendations. Protect insulation from sunlight and mechanical damage.

Insulation thickness: 13 mm for pipes < DN 20, 19 mm otherwise.

Condensate drains

Provide trapped \geq DN 20 condensate drains from each indoor coil and safety tray. Provide drains from each reverse cycle outdoor coil unless casing freely drains to a roof or other location where condensate will not cause damage or pond.

3.3 UNIT INSTALLATION

General

Supply all components and install to manufacturer's recommendations.

Outdoor equipment: Provide clearance around units for condenser air flow and maintenance access. Ensure discharge air does not short-circuit to condenser intake.

Equipment at ground level: Mount on 100 mm high concrete plinth or equivalent impervious material.

Duct connections: Provide internal or external flexible duct connections at indoor unit.

Vibration isolation

Suspended units: Provide \geq 4 metal spring or rubber-in-shear isolation mountings with \geq 25 mm static deflection and 98% isolation efficiency.

Floor mounted units: Provide neoprene waffle pads. Bolt in place.

Safety trays

If leaks or condensation from equipment could cause nuisance or damage to the building or its contents, provide a galvanized steel safety tray under the equipment.

3.4 COMPLETION

Commissioning

Commission the systems to manufacturer's recommendations. Check ductwork for leaks. Test all safety controls by simulating fault.

Air quantities: Balance systems to accord with design air quantities.

Tolerance on air quantities: +10%, -0%.

Check list: Submit signed commissioning check list on completion.

Cleaning

Clean filters, outdoor coils, grilles and diffusers on completion.

Operating and maintenance instructions

Provide written operating and maintenance instructions containing:

- Contractor's contact details for service calls.
- Manufacturer's maintenance and operation literature.
- Manufacturer's warranty certificates if the manufacturer's warranty period is greater than the defects liability period.

- Description of day to day operation.
- Schedule of recommended maintenance.

Record drawing: Provide a drawing of the system as installed.

3.5 MAINTENANCE

General

Provide corrective maintenance on the installation.

Maintenance period: 6 months from the date of commissioning of the systems or the duration of the Defects Liability Period if greater than 6 months.

Warranty: Warrant the installation for the whole of the maintenance period.

Corrective maintenance: Attend site and undertake corrective maintenance within 24 hours of receipt of verbal or written advice.

Maintenance reports: Provide a signed maintenance report setting out the work done and any measured values after each visit.

WATER SERVICES

1 GENERAL

1.1 AIMS

Responsibilities

Provide water services systems subject to the site and other constraints below:

- Cold water services: Connect the cold water supply system to the water source with a stop valve at the connection point. Provide the water source if required to suit the particular conditions as defined on the drawings. Provide the cold water installation to the draw-off points or connections to other services.
- Hot water services: Provide the hot water installation from the cold water connection points to the draw-off points or connections to other services.
- Hose reel system: Provide the hose reel system where defined on the drawings and in the BOQ.
- Sanitary plumbing and drainage: Provide the plumbing and drainage system where defined on the drawings and in the BOQ.
- Stormwater: Provide the stormwater system where defined on the drawings and in the BOQ.
- Subsoil drainage: Provide the subsoil drainage system where defined on the drawings and in the BOQ.

1.2 INSPECTION

Notice

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

- Underground pipework prior to concealment.
- Above ground pipework prior to concealment.

1.3 SUBMISSIONS

Execution details

Before starting the respective portions of the installation, submit the following for approval from the Employers representative:

- Embedded services: Proposed method for embedding services in concrete walls or floors or chasing into concrete or masonry walls.
- Fixing of services: Typical details of locations, types and methods of fixing of services to structure.
- Inaccessible services: If services will be enclosed and not accessible after completion, submit proposals for location of service runs and fittings.
- Proposals for location of exposed piping.

Samples

Provide samples listed in the **Water services samples schedule**.

2 EXECUTION

Refer to the **Water system piping schedule** for details of all pipe types.

2.1 INSTALLATION GENERALLY

Accessories

Provide the accessories and fittings necessary for the proper functioning of the systems, including taps, valves, outlets, pressure and temperature control devices, strainers, gauges and pumps.

Isolating valves: provide valves so that isolation of parts of the system in the event of leaks or maintenance causes a minimum of inconvenience to building occupants.

Arrangement

Services and equipment: Locate and arrange so that:

- Failure of plant and equipment (including leaks) does not create a hazard for the building occupants and causes a minimum or no damage to the building, its finishes and contents.
- maintenance operations can be carried out in a safe and efficient manner, with a minimum of inconvenience and disruption to building occupants and without damaging adjacent structures, fixtures or finishes.

Embedded pipes

Do not embed pipes that operate under pressure in concrete or surfacing material of a building without prior written approval. If embedding is approved:

- Install in continuous lengths without fittings wherever possible.
- Do not lay across joints between adjoining sections of concrete through which reinforcement does not extend.
- Pressure test and rectify leaks before the concrete is poured.

Penetrations and fixing

Limitations: Do not penetrate or fix to the following without prior approval:

- Structural building elements including external walls, fire walls, fire doors and access panels, other tested and rated assemblies or elements, floor slabs and beams.
- Membrane elements including damp-proof courses, waterproofing membranes and roof coverings.

Fire rated building elements: Seal penetrations with a system that maintains the fire rating of the element.

Membranes: If approval is given to penetrate membranes, provide a waterproof seal to the approval of the Employers representative between the membrane and the penetrating component.

Piping

Install piping in straight lines, plumb and to uniform grades. Arrange and support the piping so that it remains free from vibration and water hammer, while permitting movement in both structure and services. Keep the number of joints to a minimum. Prevent direct contact between incompatible metals.

Concealment: If practicable, conceal piping and fittings requiring maintenance or servicing so that they are accessible within non-habitable enclosed spaces such as roof spaces, subfloor spaces and ducts. Provide at least 25 mm clearance between adjacent pipelines (measured from the piping insulation where applicable).

Cover plates: Where exposed piping emerges from wall, floor or ceiling finishes, provide cover plates of stainless steel or non-ferrous metal finished to match the piping.

Pipe support materials: To be the same as the piping or galvanized or non-ferrous metals, with bonded PVC or glass fibre woven tape sleeves where needed to separate dissimilar metals.

Pits

Location: Install below-ground water meters, control valves and gas regulators in concrete access pits with removable pit covers.

Internal dimensions: To give 300 mm clear space all around the fittings in the pit.

Concrete: Grade M-200, 100 mm thick, with reinforcement fabric.

Pit covers: To be minimum of 5mm thick steel covers with finger holes for easy removal.

Installation: Grade floor to a point on one side and drain to the stormwater drainage system. Carry the pit walls up to 50 mm above finished ground level. Cast in the pit cover frame flush with the top.

Trowel the top smooth.

Valve boxes

Location: Install underground isolating valves in concrete access pits with removable pit covers.

Identification: Mark the box covers with the name of the service.

2.2 INSTALLATION OF FIXTURES**General**

Accessories: Use manufacturer's brackets and accessories where these are available and suitable for the mounting substrate.

Protection: Deliver fixtures to site protected from damage under site conditions by coatings, coverings and packaging. Remove only sufficient protection to permit installation.

Installation

Connections: Connect to each fixture supply and waste services. Install plumb and level.

Cutting and fitting: If it is necessary to cut and/or fit substrate to install an item carry out this before the surface is finished or painted. Remove items when required for painting and protect until re-installed. Reinstall when painting and finishing is complete. Cap or plug the open ends of pipes.

Substrate and fixings: Before installation make sure that the substrate to which the fixtures are to be installed is adequate. In solid walls confirm adequacy of the material at fixing locations.

2.3 PAINTING, FINISHES AND MARKING**Exceptions**

Do not paint chromium or nickel plating, anodised aluminium, glass reinforced plastic, stainless steel, non-metallic flexible materials and normally lubricated machined surfaces.

Finishes

Finish exposed piping, including fittings and supports, as follows:

- In internal locations such as toilet and kitchen areas: Chrome plate copper piping with bright finish.
- Externally and steel piping and iron fittings internally: Paint.
- In concealed but accessible spaces (including cupboards and non-habitable enclosed spaces): Leave copper and plastic unpainted except for identification marking. Prime steel piping and iron fittings.

Valves: Finish valves to match connected piping.

Marking and labelling

Mark services and equipment to provide a ready means of identification.

- Locations exposed to weather: Provide durable materials.
- Pipes, conduits and ducts: Identify and label.

Consistency: Label and mark equipment using a consistent scheme across all services elements of the project.

2.4 HOT AND COLD WATER SERVICES**Fittings and accessories**

Provide the fittings necessary for the proper functioning of the water supply system, including taps, valves, backflow prevention devices, temperature control devices, strainers.

Line strainers

Type: Low resistance, Y-form bronze bodied type, with screen of dezincification resistant brass, stainless steel or monel.

Screen perforations: 0.8 mm maximum.

Piping insulation

Application: Fit insulation tightly to piping surfaces without gaps. Minimise number of joints. Insulate fittings for the same thermal resistance as the piping insulation. Install the insulation on unions and other items requiring service so that it is readily removable. Provide supports formed to fit around the insulation so the insulation thickness is reduced by < 10%.

Material: Select from the following:

- Polyester in moulded tubular sections faced with factory bonded aluminium foil laminate or integral polyester scrim.
- Polyolefin foam: Cross linked closed cell polyolefin foam faced with factory bonded aluminium foil laminate.

Tapware

Provide the tapware in accordance with the **Sanitary fixtures schedule**.

Metal heads and handles: Provide brass fittings or suitably bush to prevent electrolysis and growth.

Plastic heads and handles: Provide break-resistant fittings of a compact nature, to prevent fracture and exposure of jagged or rough edges.

Tap positions: Locate hot tap to the left of or above, the cold tap.

Thermostatic mixing valves

Water temperature regulated by a single hand control, capable of delivering water at the temperature of either of the supply systems and at any temperature in between and suitable for controlling single or multiple outlets, as appropriate. Refer to the **Sanitary fixtures schedule**.

Controls: Incorporate the following:

- A temperature sensitive automatic control which maintains temperature at the pre-selected setting and rapidly shuts down the flow if either supply system fails or if the normal discharge water temperature is exceeded.

2.5 WATER HEATERS**Standard electric systems**

Provide standard electrical water boilers as identified in the BOQ to locations identified on the drawings. Refer to the **Water heater schedule**.

Solar water systems

Provide a proprietary automatic water heater comprising solar collector and storage container, with or without supplementary heating unit and including connections, controls and necessary fittings.

2.6 HOSE REELS**General**

Provide hose reels with swivel hose guides in accordance with the **Fire hose reels schedule**.

2.7 STORMWATER**Cleaning**

During construction, use temporary covers to openings and keep the system free of debris.

Downpipe connections

Turn up underground drainage pipelines to finish 50 mm above finished ground or pavement level.

Access Pits

Cover levels: Locate the top of covers or gratings, including frames as follows:

- In paved areas: Flush with the paving surface.
- In landscaped areas: 25 mm above finished surface.

Stormwater drains

Provide stormwater drains to connect downpipes, surface drains, subsoil drains and drainage pits to the outlet point or discharge point.

Downpipe connections: Turn up underground drainage pipelines with bends to meet the downpipe, finishing 50 mm (nominal) above finished ground or pavement level. Seal joints between downpipes and drains. Alternatively, terminate downpipe minimum of 100mm above adjacent ground level and discharge water to surface run off area. Allow for scour protection to bottom of downpipe.

Lined surface drains-grated trenches

Provide precast or cast in situ concrete lined trenches with painted or galvanized steel gratings.

2.8 SUBSOIL DRAINS**General**

Provide subsoil drains to intercept groundwater seepage and prevent water build-up behind walls and under floors and pavements. Connect subsoil drains to surface drains or to the stormwater drainage system as applicable.

Connection: Connect subsoil drains to the stormwater drainage system.

Filters: UV resistant geotextile material with a permeability ≥ 10 times that of the native soil and capable of retaining particles of 0.25 mm size. Securely fit or join the sock at each joint.

Subsoil drains: Provide proprietary perforated plastic pipe.

2.9 SANITARY PLUMBING AND DRAINAGE**Vent pipes**

Staying to roof: If fixings for stays penetrate the roof covering, seal the penetrations and make watertight.

Terminations: Provide bird-proof vent cowls of the same material and colour as the vent pipe.

Sanitary fixtures

Provide sanitary fixtures in the **Sanitary fixtures schedule** complete with all accessories necessary for correct installation and use.

2.10 COMPLETION**Testing**

Hydrostatic tests: Do not install insulation until the piping has been tested. Pressure test cold and hot water services to ensure that all pipework is free from leaks. Include pipe joints, valve seats, tap washers and strainers. Repair as necessary, replace if damaged and retest.

Completion

Hot and cold water services: On completion, flush pipelines using water and leave them clean.

Stormwater and wastewater services: On completion, flush the system using water and leave clean.

Charging

On completion of installation, commissioning, and testing, fill the hot and cold water systems with water, turn on control and isolating valves and the energy supply and leave the water supply system in full operational condition.

Operation and maintenance manuals

Provide written operating and maintenance instructions containing:

- Contractor's contact details for service calls.
- Manufacturer's maintenance and operation literature.
- Description of day-to-day operation.

Record drawings

Provide a drawing of the system as installed. Show dimensions, types and location of the services in relation to permanent site features and other underground services. Include all changes made during commissioning and the maintenance period.

Diagrams: Include diagrammatic drawings of each system.

Services below ground: Where pipes and fittings are below ground show the depth and dimensioned references that will allow the future location of the service for maintenance or expansion.

ELECTRICAL SERVICES**1 GENERAL****1.1 AIMS****Responsibilities**

Provide electrical systems in conformance with the **Electrical systems schedule**.

Qualification

Use only persons appropriately experienced and qualified to undertake the electrical design and construction work on the systems documented.

Performance

Carry out verification tests and measurements to show compliance with the specification.

Rates for installation work

Rates for installation of cabling, light fittings, sockets, switches and all other electrical components are to include allowance for fixings, connection, chasing of wiring and any other works required for the installation of the electrical system to a fully operational and safe working condition.

1.2 Inspection**Notice**

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

- Underground electrical services conduits prior to concealment.
- Above ground electrical services conduits in walls prior to concealment.
- Switchboards prior to installation.

Inspection and testing on completion

To verify that the requirements of this specification have been met, all electrical installations and any alterations, additions or repairs to an existing electrical installation, after completion and before being energised shall be:

- Inspected as far as is practicable
- Tested

Precautions shall be taken to insure the safety of persons and to avoid damage to property and the electrical installation equipment during inspection and testing.

NOTE: if requires, the contractor is responsible to provide temporary power generator in order to undertake all needed testing.

A visual inspection shall be made when work on an electrical installation has been completed in order to verify that the work complies with the requirements of this specification. The visual inspection shall be carried out before, or in association with testing and shall where practicable be made before the relevant part of the electrical installation is placed in service. Visual inspections shall be carried out prior to the completion of the installation where that part of the electrical installation will be covered by following works.

The following items provide a guide to the matters to be checked during the visual inspection to assess that the relevant requirements of this specification have been met.

General:

- Protection against direct contact with live parts e.g. Insulation and enclosure.
- Protection against indirect contact with exposed conductive parts, e.g. Double insulation or isolating transformers.
- Protection against hazardous part, e.g. Enclosure, guarding or screening of flammable materials, hot surfaces and parts that may cause physical injury.
- Protection against spread of fire, e.g. Penetration of fire barriers.
- General condition of the electrical equipment, e.g. Signs of damage that could impair safe operation, disconnection of unused electrical equipment.

Consumers Mains:

- Current carrying capacity.
- Voltage drop.
- Underground installation conditions, e.g. Enclosure, depth of burial and mechanical protection.
- Aerial installation conditions.
- Connection of wiring.
- Protection against external influences.

Switchboards:

- Location, e.g. Access and egress.
- Protective devices, e.g. Overload and residual current rating, fault current rating.
- Isolating devices, e.g. Main switches.
- Connecting devices, e.g. Neutral bars, earth bars and live links.
- Connection and fixing of wiring and switchgear.
- Identification and labelling of electrical equipment.
- Protection against external influences.

Wiring systems:

- Conductor size, e.g. Current-carrying capacity and voltage drop.
- Identification of cable cores.
- Adequate support and fixing.
- Connections and enclosures.
- Particular installation conditions, e.g. Underground, aerial and emergency systems.
- Segregation from other services and electrical installations.
- Protection against external influences, e.g. Enclosure.

Electrical equipment:

- Isolation and switching devices for protection against injury from mechanical movement devices and motors.
- Isolation and switching devices for protection against thermal effects, e.g. Motors, room heaters and water heaters.
- Switching devices for particular electrical equipment, e.g. Socket outlets and cooking appliances.
- Particular installation conditions, e.g. Locations affected by water, explosive atmospheres, extra low voltage and high voltage.
- Compliance with required standard.
- Connection, support and fixing.
- Protection against external influences.

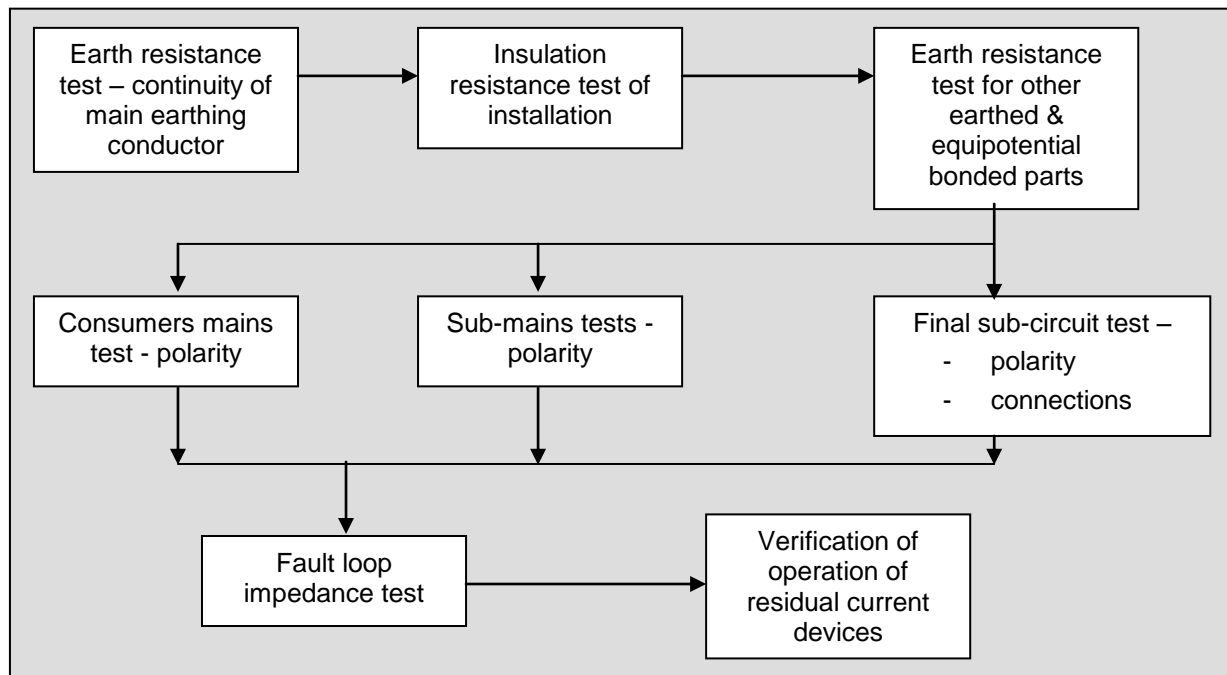
Earthing:

- Multiple earth neutral (MEN) connection.
- Earth electrode.
- Earthing conductors, e.g. Size and identification.
- Equipotential bonding conductors, e.g. Size and identification.
- Connections, joints and terminations.
- Protection against external influences.
- Connection to earthing arrangements for other systems.
- Creation of earthed situation that may require earthing of additional electrical equipment.

Testing:

After completion of, or in association with the visual inspection tests, testing shall be carried out on the electrical installation to verify that it complies with the requirements of this specification and that it is suitable for the use intended.

Sequence of tests as noted:



2 EXECUTION

2.1 GENERAL

General

Arrangement: Arrange services so that services running together are parallel with each other and with adjacent building elements.

Installation: Install equipment and services plumb, fix securely and organise reticulated services neatly. Allow for movement in both structure and services.

Lifting: Provide heavy items of equipment with permanent fixtures for lifting as recommended by the manufacturer.

Suspended ground floors: Keep all parts of services under suspended ground floors > 150 mm clear of the ground surface. Make sure services do not impede access.

Samples

Samples: Provide samples of all accessories and light fittings for the approval of the Employers representative prior to use in the project.

Installation of accessories

General: Install accessories in conformance with the **Installation of accessories table**.

Flush mounting: Provide flush mounted accessories except in plant rooms.

Mounting heights: To on-site direction

Restricted location: Do not install wall boxes across junctions of wall finishes.

Surface mounting: Proprietary mounting blocks.

Installation Of Accessories Table

Wall construction	Installation and concealed cabling facilities
Rendered brickwork partition	Flush wall box with conduit chased into wall
Double sided face brick partition	Vertically mounted flush wall box with conduit concealed in cut bricks
Concrete wall or slab	Flush wall box or flush mounted outlet with thermoplastic insulated cables in conduit integral with slab. Do not chase into concrete walls without obtaining approval from the Employers representative.

Installation of ceiling mounted appliances

Connections: Provide flush mounted outlets on the ceiling next to support brackets.

Fixing: Provide support brackets fixed through ceiling to the building structure. Brace appliances that have excessive bending moments, are heavy or vibrate, to prevent horizontal movement.

Electrical installations

- All cabling and wiring is to be installed in approved PVC conduit or within a metal cable tray for horizontal runs within the ceiling. there will be no exceptions. Any cabling installed otherwise will be removed and replaced correctly at the contractor's expense. All below ceiling level electrical circuits are to be installed in surface mounted conduits.
- International standard connectors (chocolate block) for the wiring and cabling are to be used for all connections, no other method is acceptable.
- All IP ratings given refer to Ingress Protection (IP) Codes to AS1939.

NOTE: Simple twisting of wires as a means of connecting wires and cables with protective electrical tape is not acceptable.

Earthing/Grounding

- All installed electrical fixtures and fittings are to be earthed to the main earth system for the facility, there are no exceptions to this requirement.
- All protective earthing conductors should be incorporated in the same wiring enclosure as the associated live conductors or in the adjacent vicinity.
- Where a 'clean' earth is specified for a particular item of electrical equipment, the manufacturer of the electrical equipment shall be consulted in order to confirm the necessary arrangements.
- Precautions shall be taken against the risk of damage to the earthing arrangement and other metallic part of the electrical installation through electrolysis or galvanic action.
- The size of an earthing conductor shall be such that it meets the requirements of the IEC regulations and is in accordance with the Earth conductor size table.

Earth Conductor Size Table

Nominal size of live conductor (mm ²)	Nominal size of copper earthing conductor (mm ²)	
	With copper live conductors	With aluminium live conductors
1	1*	-
1.5	1.5*	-
2.5	2.5	-
4	2.5	-
6	2.5	2.5
10	4	2.5
16	6	4
25	6	6
35	10	6
50	16	10
70	25	10
95	25	16
120	35	25
150	50	25
185	70	35
240	95	50
300	120	70
400	120	95
500	120	95
630	120	120

* These earthing conductors may be used only where incorporated in a multicore cable or flexible cord.

2.2 LOW VOLTAGE POWER SYSTEMS

General

Provide a complete operational low voltage power system, comprising the following and to the **Electrical supply mains** and **Electrical switchboard design schedules**:

- Supply from mains power
- Metering.
- Consumers mains and switchboard.
- Submains and sub boards.
- Final subcircuits.

Submissions

Technical data: Submit documentation to fully describe the proposed installation. As a minimum provide:

- Submain cable routes and support or enclosure method.
- Switchboard cupboard layouts including risers.

Accessories

Provide the following and to the **Power accessories** and **Lighting control and fittings schedules**:

- General power outlets.
- Isolating switches.
- Three phase outlets.
- Ceiling mounted sweep fans
- Duct heaters
- Wall, window or roof mounted exhaust fans
- Light switches
- Light fittings
- Emergency lighting and exit signs
- Other equipment as identified in the Schedule

Junction and terminal boxes

Shall be manufactured from PVC and rated to IP56. They shall come complete with a rigid PVC cover attached by means of screws.

Switches

All switches are to be manufactured in compliance with international standards IP24. rate is to include allowance for installation of switches recessed into the wall. Switches are to be installed in locations as shown on the drawings.

Wiring systems

Selection: Provide wiring systems appropriate to the installation conditions and the function of the load. All wiring quality to be approved by the Employers representative before installation commences.

Power cables

Copper cable generally, multi-stranded except for MIMS. All cabling is to be manufactured to international standard (BS 5467 or BS 6500) and meet all appropriate safety and performance requirements.

Minimum size:

- Lighting subcircuits: 1.5 mm².
- Power subcircuits: 2.5 mm².
- Submains: 6 mm².

Voltage drop: Install final subcircuit cables within the voltage drop parameters dictated by the route length and load.

Dummy load tests

Where electrical tests are required and the actual load is not available, provide a dummy load equal to at least 75% of the design load.

2.3 SWITCHBOARDS

General

Provide proprietary switchboards to the following and to the **Electrical switchboard design schedule**:

- Main switchboard.
- Distribution boards.

Distribution boards shall be constructed from steel with a lockable door. Doors shall be sealed to meet a rating of IP56. All cable entry and exit points shall be constructed using suitable sized, proprietary PVC cable glands.

Statutory authority's equipment

Refer to local supply authority service rules to determine their requirements. Install equipment supplied by the statutory authority, and provide wiring to complete the installation.

Cable entries

Single core cables rated > 300 A: Arrange to minimise eddy currents.

Construction

Fixing: Before making interpanel connections, fix assemblies and metering equipment enclosures into position, level and plumb.

Cable entries: Neatly adapt one or more cable entry plates, if fitted, to accept incoming cable enclosure. Provide the minimum number of entry plates to leave spare capacity for future cable entries. Do not run cables into the top of weatherproof assemblies.

Single core cables rated > 300 A: Pass separately through non-ferrous gland plates. Do not provide metal saddles.

Cable enclosures: Continue cable enclosures to or into assemblies and fit cable entry plates so that the IP rating of the assembly and the fire rating of the cable are maintained.

Cable supports: Support or tie mains and submains cables within 200 mm of terminations.

2.4 SWITCHBOARD COMPONENTS

Switch-isolator and combination fuse-switch units

Rated current: To suit unit installed in enclosure.

Rated fault capacity: Provide units selected for short-circuit making capacity that is at least the fault level at assembly incoming terminals.

Breaking capacity: At least the rated full load current.

Rated duty: Uninterrupted in non-ventilated enclosure.

Operation: Independent manual operation including positive 'ON/OFF' indicator.

Locking: Provide for padlocking in the 'OFF' position.

Handles: Removable only when switch is in open position.

Fuse links: Isolated when switch contacts are open.

Moulded case and miniature circuit breakers

Moulded case breakers to International Standards.

Miniature circuit breakers to International Standards

Fault capacity > 10 kA circuit breakers to approval of Employers representative

Fault capacity < 10 kA, current rating < 100 A: Miniature overcurrent circuit breakers

Mounting: Mount circuit breakers so that the 'ON/OFF' and current rating indications are clearly visible with covers or escutcheons in position. Align operating toggles of each circuit breaker in the same plane.

Clip tray chassis: For miniature overcurrent circuit breakers provide clip tray assemblies capable of accepting single, double, or triple circuit breakers, and related busbars. Provide moulded clip-on pole fillers for unused portions.

Residual current devices

Integral type: Incorporate earth leakage in circuit breaker protection operation.

Maximum tripping current: 30 mA.

Fuses with enclosed fuse links

Standards: To International Standards

Fault level: Provide fuses suitable for the fault level at the assembly, and which discriminate with other protective equipment.

Let-through energy and peak cut-off current: To suit protected equipment.

Fuse-holders: Mount fuse-holders so that fuse carriers may be withdrawn directly towards the operator and away from live parts. Provide fixed insulation which shrouds live metal when the fuse carrier is withdrawn.

Barriers: Provide barriers on both sides of each fuse link, preventing inadvertent electrical contact between phases by the insertion of screwdriver.

Fuse links: Enclosed, high rupturing capacity type mounted in a fuse carrier. If necessary for safe removal and insertion of the fuse carrier, provide extraction handles. Mount on clips within the spares cabinet.

Identification: Clearly indicate manufacturer or distributor.

Contactors

Standard: To International Standards.

Rated operational current: Full load current of the load controlled.

Minimum rating: 16 A.

Mounting: Mount with sufficient clearance to allow full access for maintenance, removal and replacement of coils and contacts, without the need to disconnect wiring or remove other equipment.

Interconnection: Do not connect contactors in series or parallel to achieve ratings.

2.5 LIGHTING

General

Provide a complete operational lighting system, tested and commissioned.

Proprietary equipment: Provide only proprietary lights, fittings and accessories.

Modifications and refurbishing: Carry out to the original manufacturer's standards.

Lamps

Lamps: Provide all lights complete with lamps and accessories.

Verify operation: Install lamps in all lights and verify correct operation before completion

Low voltage lamps: Provide lamps strictly in accordance with the light manufacturer's recommendation.

Dichroic lamps: Provide dichroic lamps with integral reflector which match the design specification.

Lighting control system

Provide the following and to the **Schedules**:

- Lighting switches.
- Dimmers.
- Automatic control systems.
- External light fittings.
- Internal light fittings.

Documentation: Provide complete technical and operational documentation for the lighting control system where installed.

Installation

Supports: Mount lights on proprietary supports by means of battens, trims or packing material to suit location.

Completion

Verify the operation of all lights.

2.6 EMERGENCY EVACUATION LIGHTING

General

Provide a complete operational emergency evacuation lighting system, tested and commissioned to International Standards.

Single-point system lights

Visual indicator lights: Provide a red indicator, readily visible when the light is in its operating location, which indicates that the battery is being charged.

Inverter system: Provide protection of the inverter system against damage in the event of failure, removal or replacement of the lamp, while in normal operation.

Local test switches: Provide a momentary action test switch, accessible from below the ceiling, on each fitting to temporarily disconnect the mains supply and connect the battery to the lamp.

Common test switches: Provide a common test switch on the distribution board which disconnects main supply to the lights and tests for discharge performance, after testing, this switch must automatically revert to normal operating mode.

Batteries

Type: Lead-acid or nickel-cadmium batteries capable of operating each lamp at its rated output continuously at least 2 hours during completion tests and 1.5 hours during subsequent tests.

Battery life: At least 3 years when operating under normal conditions at an ambient temperature of 25°C and subjected to charging and discharging at 6 monthly intervals.

Marking: Indelibly mark each battery with its date of manufacture.

Power supply to single-point systems

Provide an unswitched active supply to each fitting and exit sign, originating from the test switch control panel.

2.7 TELECOMMUNICATION CABLING**General**

Provide a complete operational telecommunications cabling system, tested and commissioned to International Standards. Provide accommodation for telecommunications cabling infrastructure complying with relevant clearance requirements from power cable distribution systems.

Include the following and to the **Telecommunication equipment schedule**:

- Building distributor.
- Backbone cabling.
- Floor distributors.
- Consolidation points.
- Equipment racks and patch cords.
- Horizontal cabling.
- Telecommunications outlets.
- Fly leads.

Equipment racks

Type: 19 inch rack.

Free standing racks: Provide adjustable feet.

Modular connector patch panels

Terminations: Terminate directly to the modular connector.

Patch cords: Terminate cord ends with appropriate registered jacks.

Optical fibre termination panels

Break out trays: Provide fibre optic cable break out trays at each group of fibre optic cable terminations.

Loom cables: Neatly loom cables and lay stripped cables into the break out tray.

Secure cables: Ensure that cables are secured by the sheath and that there is no stress on the fibre optic cores.

Patch cords

Provide terminated patch cords for 60% of the total incoming and outgoing ports used.

Records

Record book: Provide a record book at each cross connect.

Records in pencil: Complete the records in pencil for each termination and jumper, providing origin and destination and type of service.

Location: Secure log books in each distribution frame records holder.

Cable separation

Low voltage cables: Separate telecommunications cables not enclosed in conduits or ducts from low voltage services by at least 150 mm.

Electromagnetic interference (EMI): Provide clearance to minimise the effect of EMI where communications cables are installed parallel and adjacent to power cables carrying loads in excess of 200 A.

Installation

Crossover: Install cables neatly and without crossovers between cables.

Loom size: Loom cables into groups not exceeding 50 cables, and hold looms in place using reusable cable ties at least 20 mm wide. Do not exert compressive force on the cables when installing cable straps.

Telecommunications outlets

Outlets: Provide RJ45 8 way modular jacks except where documented otherwise.

Pinouts: The pinouts vary with the application. Determine required pinouts before making cable terminations.

Fly leads

Provide minimum 2000mm long fly leads to 50% of the outlets installed.

Earthing system

Communication earth system (CES): Provide a communications earth terminal (CET) associated with the local protective earth (PE) system adjacent to each electrical distribution board.

2.8 AUTOMATIC FIRE DETECTION**General**

Provide a fully operational system, tested and commissioned in accordance with International Standards.

Base station monitoring system connection

Connection: Connect the installation to the fire alarm monitoring base station via telecommunication carrier lines where identified in the **Fire detection equipment schedule**.

Installation wiring

Conductor size: > 1.5 mm² TPI 220 V rated, with red and white insulation.

Sheathing: Red.

Fire indicator panels

Provide metal cubicle-type enclosures to locations identified on drawings.

Detectors

Provide the following detector types as indicated on the drawings:

- Point type heat detectors.
- Duct sampling units.
- Integral heat detector/alarm units.
- Point type smoke detectors.
- Integral smoke detector/alarm units.

Self-indicating detectors

Provide a light emitting diode mounted in a clearly visible position, which illuminates whenever detector operation causes an alarm condition to register on the fire indicator panel. Provide self-indicating devices which, if faulty, will not render the detector inoperative under fire conditions.

Mounting positions of light emitting diodes:

- Visible detectors: On the outside of the detector or its base.
- Detectors concealed above ceilings: On the underside of the ceiling immediately below the detector.
- Detectors in other concealed spaces: On a visible panel close to the entry to the concealed space housing the detector.

Installation

Install detectors so they can be easily inspected and tested in situ, and readily withdrawn for service.

Control facilities

Provide ancillary control device circuits and connections for automatically controlling and releasing magnetic door holders to operate the relevant fire doors under fire alarm conditions.

Fire fan control and indication panels

Provide fire detection and alarm signals for the fire fan control panel to be incorporated by mechanical services.

2.9 ACCESS CONTROL**General**

Provide a complete operational access control system, tested and commissioned in accordance with International Standards as applicable. Refer to the **Access control equipment schedule**.

Processors or panels

Capacity: Provide separate entry/exit control modules for each designated door.

Users: Program the system to match the number of authorised users with unique access codes.

Time zones: At least 3 per day, with provision for weekends and public holidays.

Door control devices

Provide electric strikes, electric locks, drop bolts, or similar devices to suit door construction and hardware.

Fail-safe: Connect door control devices in a fail-safe mode to permit exit in the event of power failure.

Authorised products: Provide equipment approved for use by the Employers representative.

Double leaf doors (solid frame): Provide an electric strike or lock on the fixed leaf, connected to the door frame by concealed flexible wiring.

Activation

Provide keypads, card readers or other activation devices, and locate next to entry points.

External: Provide weatherproof (IP56) hoods or housings for external units.

Mounting height: 1200 mm from floor level.

Vehicle control

Vehicle access control: Provide a vehicle access control system combining connection to vehicular doors and boom gates, and interconnection to the main access control system.

Exit Loop detection: Provide a buried loop detection system adjacent to the exit point to activate boom gates or vehicular doors on approach by a vehicle. Connect so that doors or gates close after a pre-set time.

Interlock: Provide a photo electric beam safety interlock.

Interlock function: To prevent door or gate from closing until the vehicle has cleared the exit point.

Push-buttons and readers: Where practicable, provide direct wall mounting for push-buttons or readers; otherwise provide a mounting bollard and extension arm.

Mounting height: 1000 mm from floor level.

Reed switches: Provide heavy duty reed switches on both sides of vehicle doors, which generate a door closed indication at the control panel.

Intercom

Base station: Provide an intercom base station at each external entry point, interconnected with the individual local stations. Include speakers and microphones.

Construction: Wall mounted flush stainless steel panel.

Weatherproofing: IP56.

Dial: Digital push-button type.

Schedule: Provide a weatherproof (IP56) schedule holder and card identifying individual local stations. Locate next to the intercom panel.

Local station: Provide wall mounted intercom local stations, interconnected with the base stations and external entry points.

Type: Surface mounted, removable handset type.

Operation: Provide an audible tone device to indicate that the individual station is being called, and a press-to-talk switch so that the local station can communicate with the base station only when the switch is held down.

Door control: Provide integral momentary action door release switches to operate the door release or opening mechanisms at each external entry point.

2.10 LABELLING**General**

Provide labels including control and circuit equipment ratings, functional units, notices for operational and maintenance personnel, incoming and outgoing circuit rating, sizes and origin of supply and kW ratings of motor starters.

Identifying labels

Provide labels fixed to access panels, doors, covers and escutcheon panels and internal equipment, indicating the relevant information and componentry.

Single-line diagrams

Custom-built assemblies: Provide single-line diagrams.

Format: Non-fading print, at least A3 size, showing the situation as installed.

Mounting: Enclose in a folder and fix close to assembly.

Marking cables

Identify the origin of all wiring by means of legible indelible marking.

Identification labels: Provide durable labels fitted to each core and sheath, permanently marked with numbers, letters or both to suit the connection diagrams.

Telecommunications cabling

Label telecommunications cables. cross connects and outlets.

Labels: Label cables to indicate the origin and destination of the cable. Label outlets to show the origin of the cross connect, the workstation or outlet number, and the port designation.

Location marking

Accurately mark the location of underground cables with route markers consisting of a marker plate set flush in a concrete base.

Location: Place markers at each joint, route junction, change of direction, termination and building entry point and in straight runs at intervals of not more than 100 m.

Concrete bases: 200 mm diameter x 200 mm deep, minimum.

Direction marking: Show the direction of the cable run by means of direction arrows on the marker plate. Indicate distance to the next marker.

Plates: Brass, minimum size 75 x 75 x 1 mm thick.

Plate fixing: Waterproof adhesive and 4 brass or stainless steel countersunk screws.

Marker height: Set the marker plate flush with paved surfaces, and 25 mm above other surfaces.

Labelling – minimum lettering heights

Main assembly designation: 25 mm.

Distribution assembly designations: 15 mm.

Small proprietary distribution boards: 10 mm.

Main switches: 10 mm.

Outgoing functional units: 8 mm.

Identifying labels (on outside of cabinet rear covers): 4 mm.

Danger, warning and caution notices: 10 mm for main heading, 5 mm for remainder.

Other labels including equipment labels within cabinets: 3 mm.

Label colours

Generally black lettering on white background except as follows:

- Main switch and caution labels: Red lettering on white background.
- Danger, warning labels: White lettering on red background.

Fixing

General: Fix labels securely.

Fixing methods: Use screws and double-sided adhesive. Fixed in extruded aluminium sections attached to panels with rivets or countersunk screws.

Permanent fixing: Fix labels permanently in place.

Refer to drawings, BOQ and Electrical **schedules** for details and locations of all fixtures, fittings and cabling.

GENERATING SETS**1 GENERAL****1.1 AIMS****General**

Provide proprietary packaged stand-by generating set(s) incorporating the following:

- Engine cooling system.
- Combustion air system.
- Exhaust system.
- Liquid fuel system.
- Acoustic enclosure.
- Control system.
- Connection to low voltage power system.

1.2 INTERPRETATIONS**Definitions**

Net continuous rated output (or prime rating): Net continuous electrical output available at alternator terminals, not including the electrical power consumed by the generating set's dependent and essential auxiliaries.

Net short-time rated output (or stand-by rating): Net electrical output available from the generating set for 1 hour in every 12 hours at net continuous rated output, not including electrical power consumed by the generating set's dependent and essential auxiliaries.

Start response time: Total elapsed time from receipt of start signal to final connection to load.

1.3 INSPECTION**Notice**

Give sufficient notice so that inspection may be made of each completed generating set and associated systems before connection to electrical services.

1.4 SUBMISSIONS

Refer to the **Generator set performance schedule** for details before providing technical data and drawings for any generator.

Technical data

Submit technical data including the following:

- Technical description and specifications of each generating set, including output curves for base load and stand-by conditions, alternator and engine data, automatic voltage regulator, synchronising and load sharing modules and auxiliaries.
- Net continuous rated output.
- Net short-time rated output.
- Voltage regulation grade.
- Generating set efficiency at 50%, 75% and 100% load.
- Evidence that the engine type has previously passed cold starting tests at the minimum ambient site temperature.

Shop drawings

Submit shop drawings indicating the following:

- Location and size of fuel tanks.
- Physical size of generating set base and clearances for maintenance.
- Location and estimated size of control and distribution boards.
- Maximum mass and overall dimensions of each separable assembly.

- Access clearances for operational maintenance and dismantling.
- Control diagrams.
- Details of control panels
- Details of foundations and anti-vibration mountings.

2 PRODUCTS

2.1 GENERAL

Multiple generating sets

For multiple generating sets operating in parallel, provide generating sets of the same make and type.

Mounting

Mount the engine and alternator units on a common structural steel frame to support the generating set assembly and the engine local control board.

Coupling

Directly couple the engine and generator shafts with a self-aligning type coupling, capable of transmitting the engine maximum output torque under operating conditions, including starting and overload.

2.2 ALTERNATORS

General

Voltage waveform: Sinusoidal, with total wave form deviation not exceeding 10%.

Excitation: Provide self-regulated brushless type exciters.

Overspeed: Withstand a speed of 1.2 times unit rated speed for both alternator and engine.

Alternator underspeed withstand: Normal operation at net continuous rated output at a speed of 0.95 times unit rated speed, without overheating.

Number of poles: 4.

Enclosure classification: IP21, with screened ventilation openings.

Anti-condensation heaters

Provide at least 2 anti-condensation heaters within the winding enclosure.

Rating: Rate heaters to maintain the windings and insulation at least 6°C above ambient temperature when the alternator is at rest and one heater is in service.

Location: Locate a heater at each end of alternator windings in a position which allows heat transfer to the winding insulation by convection, without exceeding maximum allowable insulation temperature. Do not fix heaters to windings.

Terminations: Connect heaters to separate identified terminals within a separate accessories terminal box which is connected to a permanent supply.

Connection diagram: Provide a connection diagram for the heaters. Locate within the terminal box.

Winding thermistors

Provide thermistors to alternator stator windings.

Thermistor type: Positive temperature coefficient.

Thermistor temperatures:

- Engine shutdown: 160°C.
- Winding temperature high pre-alarm: 140°C.

Terminal boxes

Construction: Provide metal terminal boxes. Size to allow the current transformers, power and control cables and cable lugs to be neatly installed and terminated with necessary clearances between live parts and the box, and without placing undue strain on termination points.

Supply cable terminal box: Provide removable lid and side covers.

Terminals: Provide star connected windings. Bring both ends of each winding out to separate terminals. Establish a neutral terminal.

Sealing: Provide neoprene or bonded cork gaskets between terminal boxes and their frames and covers.

2.3 ENGINES

General

Sizing: When sizing the engine, take into account the nature of connected loads including auxiliaries, harmonics and transient operation.

Bearings: Provide front and rear main bearings, so that crankshaft alignment is not affected by dismantling of the alternator.

Governing

Provide electronic or mechanically controlled governors which enable engines to operate continuously at 1480 r/min from no-load to the maximum rated electrical load connected to the alternator. Provide filters which ensure that harmonics or switching spikes generated by the load do not interfere with the operation of the governor, overspeed or underspeed cut out devices.

2.4 FUEL STORAGE

General

Provide daily fuel tank capacity and bulk storage capacity to the capacities identified in the **Generator set fuel tanks schedule**.

2.5 CONTROLS

General

Provide automatic and manual modes, or manual modes only, depending on generator set capacity to start and shut down generating sets in the selected sequence and, if operating in parallel, share the load in proportion to their rated kW capacities.

Manual sequence control

Provide controls to manually synchronise and shut-down each generating set. Include emergency stop, meters, selector switches, check synchroniser and status indicating lights.

Automatic start control

Provide for the following:

- When a "start" signal is received, generating sets start automatically, come on-line and, when synchronised, connect to the load.
- Connection of alternators for sequential control of load sharing/shedding.
- Shutdown of alternate machines.

Automatic engine shutdown

Provide for generating sets to run to suit the load demand until receipt of the mains "restored" signal is received. At this point the automatic sequenced engine shutdown signal must be activated after an adjustable time delay of 0 – 30 min.

Emergency and fault shutdown

Provide a shutdown control system which disconnects the alternators, and shuts down engines upon the occurrence of fault conditions.

Provide for the following conditions to register as audible and visible alarms and to cause each generating set main circuit breaker to open immediately and each generating set to immediately shutdown:

- Emergency stop push-button: Pressed.
- Generating set: Over voltage.
- Generating set: Over current.
- Engine: Overspeed.
- Engine oil pressure: Low.
- Daily fuel tank: Low.
- Jacket water temperature: High.

Automatic synchronising

Provide synchronising modules which automatically synchronise each incoming alternator supply frequency and phase angle to the live busbars.

Emergency stop push-buttons

Generating sets < 2 m long: Provide one push-button per generating set.

Other generating sets: Provide 2 push-buttons per generating set. Locate one on each side or locate one of the push-buttons in the engine local control board.

Type: 40 mm diameter red, palm operated type mounted in a metal wall box. Wire to disconnect the generator and immediately shut down the engine when the controls are in the automatic or manual mode.

2.6 CONTROL PANELS

General

Provide control panels, switchgear and controlgear assemblies required to enable the safe operation of the generating set and the interconnections with the low voltage supply service.

Engine local control board

For each generating set, provide the following minimum level of information and equipment:

- Key operated local engine start/stop control.
- Controls for auto/off/manual/load test.
- Emergency manual shutdown.
- Speed indicator, kW meter, frequency meter, ammeter, and hours run meter.
- Indicator showing generating set under local control.
- Oil pressure indicator.
- Coolant temperature indicator.
- Automatic voltage regulator consisting of the following:
 - . Switch to select manual or automatic voltage control.
 - . Solid-state type automatic voltage regulator.
- Under and overvoltage sensing.
- Over and underspeed sensors.

2.7 BATTERIES AND CHARGERS

General

Provide separate batteries and charger systems for the following:

- Engine start.
- Control and alarm functions.

Chargers – control and alarm batteries

Select the charger to suit the batteries supplied.

2.8 STARTING

Electric starting

Provide starter motors, batteries and chargers, and associated control equipment to automatically start each engine.

Wiring: Wire starter motors so that starter motor solenoid contacts are on the active side and field windings are at earth potential when the motor is de-energised. Provide an interlock, connected directly to the engine, to prevent the starter motor operating when the engine is running.

Starting batteries

Locate in proprietary battery holders attached to the generating set, or on purpose-built stands next to the set and constructed of timber or other corrosion resistant material. Isolate batteries from vibration.

Capacity: Sufficient to crank the engine for 3 successive attempted starts, repeated at 5 min intervals.

Isolator: Provide a lockable isolator to prevent accidental starting.

Starting batteries chargers

Mains power: Connect chargers to the mains power to ensure that power is maintained to the charger under all supply conditions.

2.9 ACOUSTIC ENCLOSURES

General

Provide weatherproof acoustic enclosures to surround generating sets, including inlet and outlet sound attenuators.

Sound pressure level limit

85 dB (A) at 12 locations 1 m from the enclosure exterior surface, at 1.5 m above floor level, measured with the generating set operating at constant maximum rated full load output, with doors closed and service penetrations sealed.

Doors

Provide doors of same material as the enclosure. Provide door stays to each door.

Ventilation

Provide ventilation to the enclosure so that:

- With generating sets running at full rated output the enclosure temperature rise does not exceed 10°C.
- Hazardous concentrations of toxic or explosive fumes and gases are prevented.

3 EXECUTION

3.1 GENERAL**Plinths**

Provide reinforced concrete plinths for floor mounted equipment, sized to suit equipment footprints.

Resilient mounts

Provide at least 6 resilient mounting blocks between the frame and the plinth.

Drip trays

Provide removable drip trays under those parts of the assembly where fuel or lubricant leakage may occur. Provide overflow outlet pipes taken to a point where a receptacle can be fitted under the pipe outlet.

Capacity: At least 1.5 times the oil capacity of the engine sump.

Material: 1.6 mm galvanized steel with brazed joints and rolled edges.

3.2 ENGINE COOLING**General**

Provide a cooling system consisting of radiators, fans and pumps.

Cooling air ductwork: Connect the cooling air outlet to generator room cooling air outlet.

3.3 ENGINE AIR INTAKE**General**

Filters: Provide dry type air intake filters of sufficient capacity to permit continuous engine operation for 200 hours before filter servicing becomes necessary.

Fans: Provide a fan selected for the installed system air pressure drop. Include power absorbed by the fan under site operating conditions when calculating generator output.

3.4 EXHAUST SYSTEM**General**

Provide exhaust piping from the engine complete with silencers, piping, ductwork, supports and expansion devices.

Weatherproofing

Provide weatherproof flashing, sleeves and acoustic seals where the exhaust system penetrates the roof or external walls.

3.5 FUEL SYSTEM**Stop valves**

Provide stop valves on the inlet to, and outlets from, the daily service tank.

3.6 COMPLETION**Completion tests**

For each generating set carry out the following:

- Check tightness of connections and securing devices.

- Verify correctness of operation of protection devices and systems including sensor settings. Simulate actual conditions as far as possible, in order to test responses to faults imposed.
- Cold start with the engine having been at rest for the previous 24 hours.
- Continuous operational trial consisting of:
 - . 4 hours at 100% rated power.
 - . 1 hour at 110% rated power.
 - . 30 min at 75% rated power.
 - . 30 min at 50% rated power.
- Record fuel consumption for each step of the continuous trial.
- Continuous operational trial: During the trial, measure the following at maximum intervals of 30 minutes:
 - . Generator kW and kVAr output.
 - . Generator output voltage.
 - . Generator output current.
 - . Generator output frequency.
 - . Oil pressure and water temperature.

Synchronisation and load sharing tests: For generating sets running in parallel perform tests to verify automatic synchronisation and load sharing including the following:

- Sequence start and shutdown of each generating set.
- Parallel operation of generating sets.
- Synchronising of generating sets.
- Operation of controls, switchgear and auxiliaries.

Temporary test loads

Provide test loads including power and control wiring, ancillary equipment and test instruments to achieve the kW, kvar and necessary load steps.
