SCENTRE GROUP

GENERAL SPECIFICATION

MECHANICAL SERVICES

Owner and Operator of Westfield in Australia and New Zealand

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DOCUMENT INFORMATION

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PREFACE

This General Specification is intended as supplementary information to be read in conjunction with the Project Specification issued in the Contract Documents.

The Scope of Works relevant to the Contract is contained within the Project Specification(s) and this specification provides additional information as to requirements pertaining to that scope.

Items may be referenced within that are not within the Scope of Works.

CONTENTS

1 GENERAL REQUIREMENTS

1.1 GENERAL

General: This General Specification covers the general requirements of materials, workmanship, testing, maintenance and documentation for electrical services installations. Unless specified otherwise in other project specific document, these requirements will apply when they are relevant to the project.

1.2 STANDARDS

a) General:

I. Comply with the relevant Australian Standards including but not limiting to those referenced in this document.

II. If the Australian Standard referenced in this document is superseded or withdrawn, the superseding standard or other relevant standards shall apply.

III. Refer to the latest issue of the Australian Standard unless a particular issue is referenced in the BCA.

1.3 DESIGN AND COMPLIANCE WITH OHS

a) Services and equipment: Locate and arrange all services and equipment so that:

I. Failure of plant and equipment does not create a hazard for the building occupants.

II. Failure of plant and equipment causes minimum or no damage to the building, its finishes and contents.

III. Inspection and maintenance operations can be carried out with minimum inconvenience and disruption to building occupants or damage to the building structure or finishes.

IV. Services and equipment are readily accessible for inspection and maintenance and arranged so that inspection and maintenance can be carried out in a safe and efficient manner.

i. If parts of the plant require regular inspection and maintenance either locate plant so it is safely and readily accessible from floor level or provide permanent access platforms and ladders.

ii. Locate items of equipment that require inspection and maintenance above removable ceiling where possible. If this is not possible (for example above set plaster or other inaccessible ceilings) provide access panels. Arrange services and plant locations to reduce the number of access panels. Coordinate with other trades to use common access panels where feasible.

iii. Modify manufacturer's standard equipment when necessary to provide the plant access.

b) Fault level protection: To withstand the fault level of the incoming supply at the location of the equipment.

c) Energy efficiency: Equipment selection and design shall comply with Section J of the BCA .

d) Submission to authorities: If required, submit design and documentation to statutory authorities for approval. Provide evidence showing approval of the authorities.

1.4 MATERIALS AND WORMANSHIP

a) Materials: Provide new and high quality materials and components.

b) Workmanship: The standard of workmanship for all works shall conform to the industry best practice and shall be in accordance with the relevant standards, codes of practice.

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

   I. Factory finish: To manufacturer's standard for factory fabricated equipment. All ferrous metallic work which is exposed to elements shall be hot dip galvanised. Any damage to the factory finish shall be repaired at completion.

d) Locking system: Provide 'Lockwood Twin System' for all locking applications.

1.5 INSTALLATION

a) General: Install equipment and services plumb, fix securely and organise reticulation neatly. Provide for movement in both structure and services.

b) Install equipment in accordance with manufacturer's recommendation, and in such a way that the performance of the equipment shall not be adversely affected.

c) Arrangement:: Arrange services so that services running together are parallel with each other and with adjacent building elements. Under suspended ground floors, keep services at least 150 mm clear above ground surface, additional to insulation, and ensure access is not impeded.

d) Minimum clear head height in Car Park 2200mm, Disabled car space (directly over) 2500mm.

e) Lifting: Provide permanent fixtures attached to the equipment for lifting heavy items of equipment as recommended by the manufacturer.

f) System integration: Interconnect system elements so that the installation performs the designed functions.

g) Fixing:

   I. General: If equipment or services are not suitable for fixing to non-structural building elements, fix directly to structure and trim around holes or penetrations in non-structural building elements.

   II. Fasteners: Use proprietary fasteners capable of transmitting the loads imposed, and sufficient to ensure the rigidity of the assembly.

   III. Explosive-powered tools: Do not use explosive-powered tools.

h) Mounting: (caution heavy items will require structural engineers approval prior to installation)

   I. Wall/ceiling mount: Provide galvanised steel support from building structure.

   II. Roof mount:

      i. Roof mount - Metal: Unless equipment platform is provided by the Builder, provide galvanised steel support from roof structure.

      ii. Concrete roof: Fix equipment on concrete plinth.

i) Services connections:

   I. Statutory Authorities requirements: If the authorities elect to perform or supply part of the works, make the necessary arrangements. Install equipment supplied, but not installed, by the authorities.

   II. Connections: Connect to statutory authorities services or service points. Excavate to locate and expose connection points. On completion reinstate the surfaces and facilities which have been disturbed.

j) Concrete plinth:

   I. General: Provide concrete plinth for floor mounted equipment. Contractor to confirm size and location on a builders work drawing for review and coordination.

   II. Construction:

      i. General: Provide galvanised steel surround at least 75 mm high and 1.6 mm thick, fixed to floor with masonry anchors, fill with concrete.

ii. Reinforcement: Single layer of F62 fabric.

iii. Concrete: Grade N20.

iv. Finish: Steel float finish with the surround.

k) External application: Equipment and installation located outdoor shall be suitable for external application and shall be protected from the elements.

l) Cleaning: At completion, clean all cable tray, conduit, equipment and switchboards (internal and external). Remove all redundant material and rubbish from site.

1.6 BUILDING PENETRATIONS

a) General: Provide all necessary building penetrations details shop drawings including those formed in situ in concrete and block work structures to allow structural coordination. Seal all penetrations after installation of services in accordance with any applicable fire or acoustic rating.

b) Piping sleeves:

I. General: Provide metal sleeves formed from pipe sections for piping penetrations through building elements.

II. Sleeve diameter: Sufficient to provide an annular space around the pipe or pipe insulation of at least 12 mm.

III. Minimum sleeve thickness:

i. Metal: 1 mm.

ii. PVC: 3 mm.

IV. Sleeve terminations:

i. If cover plates are fitted: Flush with the building surface.

ii. If floor draining to floor waste: 50 mm above finished floor.

iii. In fire-rated and acoustic-rated building elements: 50 mm beyond finished building surface.

iv. Elsewhere: 5 mm beyond finished building surface.

V. Finish: Prime paint ferrous surfaces.

c) Cable sleeves: Provide UPVC sleeves formed from pipe sections, for penetration through ground floor slab and beams and external walls by cables not enclosed in conduit.

d) Penetrations:

I. Fire Resistance Level: Seal penetrations using a system to comply with BCA Spec A1.3, AS 1530.4 and AS 4072.1 to retain the design FRL of the building element.

II. Non-fire rated building elements: Seal penetrations around conduits and sleeves. Seal around cables within sleeves. If the building element is acoustic rated, maintain the rating.

III. Roof penetration: Provide leak-proof seal for roof penetration with under-flashing and over-flashing.

IV. Limitations: Do not penetrate or fix to the following without approval:

i. Structural building elements including external walls, fire walls, floor slabs and beams.

ii. Membrane elements including damp-proof course, waterproofing membranes and roof coverings.

V. Membranes: If approval is given to penetrate membranes, provide waterproof seal between the membrane and the penetrating component.

1.7 VIBRATION SUPPRESSION

a) General: Minimise the transmission of vibration and noise from rotating or reciprocating equipment to other building elements.

b) Flexible connection: Provide flexible connections to rotating machinery and assemblies containing rotating machinery.

   I. Isolate ducts by flexible connections.

   II. Isolate pipes by incorporating sufficient flexibility into the pipework or by use of proprietary flexible pipe connections installed so that no stress is placed on pipes due to end reaction.

c) Vibration isolation mountings:

d) Equipment requiring vibration isolation mountings: Except for external equipment that is not connected to the structure of any building, support rotating or reciprocating equipment on mountings as follows:

   I. Type:

      i. For static deflections < 15 mm: Single or double deflection neoprene in-shear mountings incorporating steel top and base plates and a tapped hole for bolting to equipment.

      ii. For static deflections ≥ 15 mm: Spring mountings.

   II. Selection of vibration isolation mountings: Select mountings to achieve 95% isolation efficiency at the normal operating speeds of the equipment.

e) Spring mountings: Use freestanding laterally stable springs with at least 12 mm clearance between springs and other members such as bolts and housing. Provide the following:

   I. Ratio of mean coil diameter to compressed length at the designated minimum static deflection: > 0.8:1.

   II. Minimum travel to solid of at lease 150% of the designated minimum static defection.

   III. Levelling bolts and lock nuts.

   IV. Neoprene acoustic isolation pads between base plate and support.

   V. Vertical resilient limit stops: To prevent spring extension when unloaded, to serve as blocking during erection, and which remain out of contact during normal operation.

   VI. Snubbing: Snub the springs to prevent bounce at start-up.

f) Installation: Set and adjust vibration isolation mounting supports to give adequate clearance for free movement of the supports.

1.8 NOISE CONTROL

a) General: Control noise levels at site boundaries and in occupied spaces by proper system design, equipment selection, and acoustic treatment to plant rooms and noise sources.

b) Environmental noise:

   I. General: Comply with the noise limit requirements of the authorities.

   II. Background noise: If there is no specific authorities' noise limit requirements, classify the site as noise area category R3 in accordance with Australian Standards

   III. Noise level at boundary: If there is no specific authorities' noise limit requirements, ensure that when equipment operates under normal conditions it will not raise the ambient noise level at the nearest boundary of the site by more than 5 dB when measured on the unweighted 'A' scale, and will be free of any disturbing tone or harmonic sound, at any time of day and night, 7 days a week.

   IV. Building interior noise: Ensure that the sound levels of different areas of the building interior will not exceed the recommended 'satisfactory' levels in accordance with Australian Standards when all equipment is operating under normal conditions.

1.9 SEISMIC RESTRAINT

a) General: Arrange all components, other than service items exempted in Australian Standards to resist seismic loads. Securely fix all plant and equipment to the building structure. Do not rely on gravity and/or friction to resist seismic forces.

b) Anti-vibration mounts: Use horizontally restrained type.

c) Components: Do not use components that will be damaged by earthquake conditions. Protect systems against the adverse effects of components such as mercury switches that, although not damaged by earthquake, may malfunction.

1.10 METAL WORK

a) General: Use metalwork capable of transmitting the loads imposed, and sufficient to ensure the rigidity of the assembly without causing deflection or distortion of finished surfaces. Construct to prevent rattle and resonance.

b) Edges and surfaces: Keep clean, neat and free from burrs and indentation. Remove sharp edges

1.11 WELDING AND BRAZING

a) General: Avoid on-site welding operation as far as possible. If unavoidable, all welding is to be carried out in accordance with the relevant Australian Standard for the metal material being welded

b) Brazing: Ensure brazed joints have sufficient lap to provide a mechanically sound joint.

1.12 SITE PAINTING

a) General: Paint all new surfaces of equipment, duct and pipes except surfaces of chromium, anodised aluminium, UPVC and stainless steel finish; non-metallic flexible materials and normally lubricated machine surfaces.

b) Exposed to view: 1 prime coat and 2 full gloss enamel finish coats.

c) Uninsulated ferrous pipes in concealed space: 1 prime coat.

d) Factory painted items: Repair damaged paint.

e) Low VOC emitting paints: Provide the following low odour/low environmental impact paint types with the following VOC limits:

   I. Primers and undercoats: < 5 g/litre.

   II. Low gloss white or light coloured latex paints: < 5 g/litre.

   III. Coloured low gloss latex paints: < 16 g/litre.

   IV. Gloss latex paints: < 90 g/litre.

f) Paint application: Apply first coat immediately after substrate preparation and before contamination of the substrate can occur. Ensure each coat of paint or clear finish is uniform in colour, gloss, thickness and texture, and free of runs, sags, blisters or other discontinuities.

g) Repair galvanising: If galvanised surfaces have been cut or welded after galvanising, prime the affected area using zinc rich organic binder.

h) Colour schedule:

Service	Conforming Colour	Service	Conforming Colour
Chilled water	Jade Green, G21	Fire Fighting	Signal red, R13
Condenser water	Jade Green, G21	Air Duct	Aqua Blue, B25
Hot water	Jade Green, G21	Air Handling Unit	Aqua Blue, B25
Waste, drain, etc	Black	Electrical	Orange, X15

Service	Conforming Colour	Service	Conforming Colour
Refrigerant	Golden Tan Brown, X53	Switchboard	Harbour Blue, B24
Steam	Silver-grey	Exposed Copper Pipe	Polished Lacquer

i) Underground metal piping

I. Corrosion protection: Provide corrosion protection for the following:

i. Underground ferrous piping.

ii. Underground non-ferrous metal piping in corrosive environments.

II. Protection methods: Select from the following:

i. Continuous wrapping using proprietary petroleum taping material.

ii. Impermeable flexible plastic coating.

iii. Sealed polyethylene sleeve

1.13 MARKING AND LABELLING

a) General: Mark services and equipment to provide a ready means of identification.

b) Piping: Identify throughout its length, including in concealed space.

c) Electrical:

I. Mark operable control devices, indicators, isolating switches to provide a ready means of identification.

II. Label cables. to indicate the origin and destination, cable number, cable cross sectional area and associated earth cable size.

d) Consistency: Label and mark equipment using a consistent scheme across all services elements of the project.

e) Text:: Provide marking and labelling text identical to the text and terminology used in Operating and Maintenance Manuals.

f) Labels and Notices:

Select from the following:

I. For indoor application: Engraved two-colour laminated plastic or proprietary pre-printed self-adhesive flexible plastic labels.

II. For outdoor application: Engraved and black filled lettering on stainless steel or brass, minimum thickness 1 mm.

g) Emergency functions: Code compliant Safety Signs required for operational environment

h) Colours: Generally in conformance with Australian Standards as appropriate, otherwise black lettering on white background except as follows:

I. Danger, warning labels: White lettering on red background.

II. Main switch and caution labels: Red lettering on white background.

i) Minimum lettering heights: Unless specified in the Australian Standard:

I. Equipment nameplates: 40 mm.

II. Warning notices: 7 mm.

III. Automatic controls and electrical equipment: 5 mm.

IV. Isolating switches: 5 mm.

V. Inside electrical enclosures: 3.5 mm.

VI. Other: 3 mm.

j) Fault current limiters: In assembly sections containing fault current limiter fuses provide caution notices fixed next to the fault current limiters, stating that replacement fuse links are to match as-installed fuse link ratings, make and characteristics. Provide separate label stating fault current limiting fuse ratings.

k) Externally controlled equipment: To prevent accidental contact with live parts, provide warning notices for equipment on assemblies not isolated by main switch or local main switch.

l) Stand-by power: Provide warning notices stating that assemblies may be energised from the stand-by supply at any time.

m) Custom-built assemblies: For insulation or shrouding requiring removal during normal assembly maintenance, provide danger notices with appropriate wording for replacement of insulation shrouding before re-energising assemblies.

n) Location: Locate notices so that they can be readily seen, next to, if impracticable, on busbar chamber covers of functional units, and behind the front cover of functional units. Provide circuit identification labels in the cabling chamber of each functional unit, located next to external terminations.

o) Schedule cards: Provide schedule cards with written text showing the following as-installed information.

p) Submain designation, rating and short-circuit protective device.

q) Equipment item numbers and current ratings, cable sizes and types and areas supplied.

r) Mounting: Mount schedule cards in a holder fixed to the inside of the assembly or cupboard door, next to the distribution circuit switches. Protect with hard plastic transparent covers, or laminated.

s) Fixing: Use mechanical fixing.

1.14 SUBMISSION BY CONTRACTOR

a) The Contractor must:

I. Design the Works, including the preparation of Design Schematic and Documents and reports

II. Prepare a complete Functional Design Brief of each system to demonstrate a full knowledge of the project. This Functional Design Brief will later become the front end of the O&M Manual, updated to As Built status.

III. Supply, install, test and commission the mechanical services, including all labour and materials that are necessary for a complete and working installation; and

IV. Maintain the Works during the Defects Liability Period.

b) The Contractor must warrant that the Works when completed:

I. Are fit for the stated purpose; and

II. Comply with all the requirements of the Contract.

1.14.1 TECHNICAL DATA

a) General: Carry out system design. Submit system design details and technical data for all items of plant and equipment selected before ordering equipment. The equipment schedules must contain all necessary technical data and calculations to clearly demonstrate compliance with Section J Energy Efficiency of the BCA.

b) Data to be submitted: Include at least the following:

I. System design:

i. Assumptions and design parameters.

ii. Engineering calculations, modeling.

II. Detailed BMS points schedule

III. Schedules of equipment selected with the following information::

i. Model name, designation and number.

ii. Capacity of all system elements.

iii. Country of origin and manufacture.

iv. Materials used in the construction.

v. Size, including required clearances for installation.

vi. Manufacturers' technical literature, type test report.

1.15 DESIGN DRAWINGS

1.15.1 GENERAL

General: Prepare and submit design development drawings that are based on the Scentre Group (or appointed Consultant) Concept Design information. The proposed designs submitted by the contactor are to be issued for review by Scentre. These drawings must clearly indicate the design philosophy, plant spatials, equipment sizes, interfaces with other services and building construction. Initial details must also include penetration requires and main service routes. The drawings will be required for initial coordination agreement between all other disciplines prior to producing Shop drawings

1.15.2 SHOP DRAWINGS

a) General: Prepare and submit shop drawings for the fabrication and installation of services and equipment. Shop drawings shall be dimensioned, with reference to building structure and other services. Shop drawing shall contain all necessary information for coordination and construction on site, including symbols and legends, details, sections and equipment schedules. These drawings are to be submitted to Scentre Groupfor review prior to construction.

b) Shop drawings: Prepare and submit the following shop drawings:

I. Drawings of work by the Builder including:

i. Equipment rooms and platforms.

ii. Shafts and risers.

iii. Access doors and panels.

iv. In situ penetrations and openings.

v. Penetrations and ceiling cut outs.

vi. Structural support for equipment with loads to be imposed on the structure during installation and operation.

vii. Fire resistance of building structures.

viii. Other Builder's works documented.

c) Drawings of work by other contractors.

d) Mechanical services drawings including:

I. Ductwork, pipework and equipment layouts and sections. (Mounting height above finished floor level to be noted)

II. Coordination with all other services.

III. Identify fire rated building elements.

IV. Ductwork, pipework insulation type and performance.

V. Refrigerant piping include slope of horizontal runs, oil traps, double risers and valving.

VI. Diffuser and grille reference numbers corresponding to commissioning test results.

VII. Riser layouts and sections.

VIII. Plant room layouts and sections.

IX. Locations of automatic control sensors, motors and valves.

X. Acoustic details.

XI. Conditioner construction details.

XII. Seismic restraint details.

XIII. Relevant performance data for each item of equipment including make, model, speed, capacity etc., as appropriate.

XIV. Piping and other schematic drawings including numbering of each valve to correspond to the valve tag notation.

XV. Automatic control details.

XVI. Switchboard details.

XVII. Wiring diagrams

1.15.3 WORK-AS-EXECUTED DRAWINGS

a) General: Submit work-as-executed drawings. Prepare work-as-executed drawings based on the shop drawings and include changes made during the construction and commissioning periods. The contractor is to maintain a set of drawings on site marked up with any alterations to his shop drawings during construction. These should be available for inspection at any time and as a record to assist him in his final work-as-executed drawing production.

b) Submit for review: Submit draft work-as-executed drawings for review.

c) Final submission:

I. Timing: Submit work-as-executed drawings prior to Completion.

II. Format: Submit work-as-executed drawing in:

i. Revit format; and

ii. Adobe .pdf files

d) Data Format

e) General: Shop drawings and work-as-executed drawings must be prepared using Revit 2009 format. Data in other compatible formats may be considered, but will only be accepted with prior agreement by the Project Manager.

f) General modelling guidelines:

I. Scentre Group will provide relevant Revit standards upon request for the Contractor to follow. If the Contractor elects to use other standards, the data shall be consistent, systematic and well organised. This applies to Revit worksets and object categories/sub-categories in particular.

II. The services drawing model shall share the same origin and coordinate system as the architectural model.

III. The services model must follow the same general data structure as the architectural model; typically the building is split into ‘zone models. The Project Manager may be accept a single model for a discipline or trade subject to agreement prior to commencement of documentation.

IV. Elements shall be modelled using correct element types and with minimal use of ‘generic’ models/in place families. For example, ducts are created as ducts, beams as beams and so on.

V. Shop drawing Revit phasing shall follow the architectural model, new construction, stage 2 etc.

1.15.4 OPERATION AND MAINTENANCE MANUAL (O & M MANUAL)

a) Format: A4 size loose leaf, in commercial quality, 4 ring binders with hardcover, each indexed, divided and titled. Identify each binder with printed title 'Operation and Maintenance Manual' to spine and on the cover. Identify title of project, volume number and date of issue on the cover.

b) Contents: Include the following:

I. Table of contents.

II. Directory: Names, addresses, and telephone and fax numbers of consultants, contractors, and names of responsible parties.

III. General description of installations.

c) Design Intent including the following:

I. A description of the energy efficiency features and strategies in relation to the design of the building, including an overview of the potential savings, as stated for economic and environmental impact.

II. Details on energy, water, indoor environment quality and waste targets and benchmarks for the building such as W/m2.

d) System description: Technical description of the systems installed. Identifying function, normal operating characteristics, and limiting conditions.

e) Design:

I. Design parameters, assumptions, standards referred to.

II. Print out of heat load calculation.

f) Equipment description:

I. Names, addresses, telephone and fax numbers of manufacturers and suppliers of items of equipment installed.

II. Schedule (system by system) of equipment, stating locations, duties, performance figures. Use unique item number cross-referenced to the work-as-executed drawings.

III. Manufacturer's technical literature for equipment installed.

g) Operating Procedures:

I. Manufacturer's literature as appropriates.

II. Safe starting up, running-in, operating and shutting-down procedures for systems installed. Include logical step-by-step sequence of instructions for each procedure.

III. Control sequences and flow diagrams for systems installed.

IV. Schedule of fixed and variable equipment settings established during commissioning.

h) Maintenance Procedures:

I. Maintenance procedures.

II. Detailed recommendations for preventive maintenance frequency and procedures.

III. Safe trouble-shooting, disassembly, repair and reassemble, cleaning, alignment and adjustment, balancing, and checking procedures. Provide logical step-by-step sequence of instructions for each procedure.

IV. Schedule of spares recommended to be held on site.

V. Instructions of use of tools and testing equipment.

VI. Emergency procedures including telephones numbers for emergency services and procedures for fault finding.

i) Certificates:
   I. Copies of manufacturer's warranties.
   II. Certificates from authorities and certifiers.
   III. Product certification.
   IV. Test and balancing reports.
   V. Certificates of compliance.

j) Drawings
   I. Work-as-executed drawings contained in plastic envelopes.
   II. Electrical circuit schedules.

k) Timing;
   I. Draft: Submit draft manual 8 weeks before Completion.
   II. Final copy: Submit final copy prior to Completion

l) Quantity: Submit 3 hard copies, and 1 copy of .pdf files on CD ROM.

1.16 LOG BOOK

a) General: Provide a log book for each of the following systems:
   I. Automatic smoke/heat venting systems.
   II. Air handling system.
   III. Chillers and refrigeration plants.
   IV. Water treatment systems.

b) Volume: Provide sufficient pages to receive entries for a period of not less than 24 months.

2 REFRIGERATION EQUIPMENT

2.1 GENERAL

a) Refrigerants: Do not use CFC and HCFC refrigerants. Use only HFC of zero ODP refrigerants.

b) Compressors:

I. General: Proprietary compressors of the following types.

i. Screw

ii. Centrifugal

iii. Reciprocating

II. Safety control: Provide electrical interlocks to protect against the following:

i. Compressor motor overload.

ii. Oil pressure failure on compressors.

iii. High and low pressure for compressors.

iv. Short cycling of compressors.

2.2 PACKAGED CHILLERS

2.2.1 GENERAL

a) General: Provide factory-designed and prefabricated assembly comprising compressors, condensers, evaporators, refrigeration piping, internal power circuits, motor starters, controls and other ancillary equipment.

b) Performance rating: In accordance with Australian Standards and ARI.

c) Energy efficiency ratio: Unless documented otherwise, comply with Section J of the BCA and Australian Standards, whichever is higher.

d) Comply with Proposed Future MEPS Levels as follows:

I. Single unit installation: Minimum COP and Minimum IPLV of Path B.

II. Multiple unit installation:

i. Chiller designated as ‘part load’ chiller: Minimum COP and Minimum IPLV of Path B.

ii. Chiller not designated as ‘part load’ chiller: Minimum COP and Minimum IPLV of Path A.

e) Multiple compressor units: Provide at least 2 independent refrigeration circuits.

f) Starters ≤ 60 kVA: Provide solid-state starters with soft start function, supplied and factory fitted by the chiller manufacturer.

g) Current limiter: Limit the maximum current drawn by the compressor motor by monitoring the 3 phases of supply power.

h) Demand limiting control: Provide capability to limit the chiller capacity during a programmable period of high tariff.

i) Casing of air cooled chillers: Constructed of welded steel base frame, galvanised steel structural profiles and panels with corrosion resistant finish of polyurethane paint. Provide weatherproof sheet metal enclosures for equipment requiring weather protection.

2.2.2 CAPACITY CONTROL

a) Operation: Provide for chillers to start unloaded and for subsequent loading and unloading.

b) Control system: Senses the leaving/return chilled water temperature and maintains it at the desired setting using the following methods as appropriate:

I. Loading and unloading compressor, for multi-compressor unit.

II. Modulation of the compressor slide valve.

III. Unloading ports.

IV. Modulating the inlet guide vanes.

V. Variable frequency drive.

VI. Cycling of condenser fans for air cooled units.

2.2.3 PURGE UNIT

a) General: For chillers that are below atmospheric pressure at any time, provide purge unit to minimise loss of refrigerant during purging cycle.

b) Operating efficiency: Emit less than 1 part of refrigerant per part of air as rated in accordance with the methods prescribed in ARI Standard 580.

c) Operation: Provide automatic control which allows unattended chiller independent operation.

d) Alarm: Provide purge units which automatically alarm if excessive purging is detected within a continually updated given time period. Interface with the BMS for remote alarm indication.

2.2.4 EMISSION ABATEMENT SYSTEM

a) General: For centrifugal chillers which, at any time, are below atmospheric pressure, provide a means of:

I. Preventing air infiltration and refrigerant loss.

II. Preventing the subsequent need for purging to atmosphere.

III. Pressurising the chiller for leak-testing purposes.

b) System: Refrigerant emission abatement systems permanently attached to chillers and automatically maintain positive pressure within the chiller vessel during non-operational periods, by referencing atmospheric pressure.

2.2.5 CONTROL PANEL

a) General: Provide a menu driven, microprocessor based control panel.

b) Monitoring and control functions: Include but not limited to the following:

I. System status.

II. Alarm indication.

III. Entering and leaving chilled water temperatures.

IV. Entering and leaving condenser water temperatures.

V. Chilled water temperature set point and reset.

VI. Percentage loading.

VII. Operating voltage and current.

VIII. Electrical current limit set point.

IX. Chillers diagnostics.

X. Hours run.

XI. Start counter.

c) Safety Controls: Provide manufacturer's standard safety control including but not limited to the following:

I. Chilled water low flow.

II. Condenser water low flow, for water cooled units.

III. Condenser fan motor overload, for air cooled units.

IV. Compressor motor overload.

V. Compressor motor high temperature.

VI. Oil pressure failure.

VII. Hi and low pressure for compressor.

VIII. Low chilled water temperature.

IX. Phase failure

X. Surge protection

d) Interface with BMS: Provide high level interface with BMS at the control panel based on BACnet protocol for remote control, monitoring and indication. Provide BACnet gateway if necessary.

2.2.6 INSTALLATION

a) Manufacturer's instructions: Install in accordance with instructions supplied by chiller manufacturer. Include completed manufacturer's check lists in commissioning data.

b) Piping: If marine water boxes are not provided, provide removable piping sections to allow tube cleaning.

c) Anti-corrosion treatment: Provide anti-corrosion treatment to the internal surface and end plates of the shell type condenser with cathodic protection, of either impressed current or sacrificial anodes. Comply with the recommendations of AS 2832.1 and incorporate facility for periodic testing. Design and install the cathodic protection system by a corrosion protection specialist.

I. Impressed current: To each output provide a continuously indicating ammeter, and a high/low current alarm light mounted on the facia panel of the power supply unit. House the power supply unit in an enclosure with transparent lockable cover.

II. Sacrificial anodes: Provide at least two 0.9 kg magnesium bobbins at each end of the vessel.

d) Relief device:

I. General: Provide relief valves for pressure vessels in series with a rupture disc.

II. Type: Spring loaded type relief valve capable of resetting within 10% of the rated relief pressure. Provide non-fragmenting metallic rupture disc for negative pressure systems.

III. Indication: Provide indication for verification of disc integrity.

IV. Installation: Pipe to a safe external location. Provide a stainless steel mesh screen over the outlet to prevent insects entering the vent pipe outlet.

2.3 CONDENSING

a) General: Provide factory-designed and prefabricated assembly comprising compressors, condensers (water-cooled or air-cooled), refrigeration piping, internal power circuits, motor starters, controls and other ancillary equipment.

b) Multiple compressor units: Provide at least 2 independent refrigeration circuits.

c) Electronic expansion valve: Provide electronic expansion valve for units of capacity exceeding 20 kW.

d) Starters ≤ 60 kVA: Provide solid-state starters with soft start function.

e) Enclosure – Air-cooled condensing unit:

I. General: Provide enclosures, materials and finishes that are weatherproof and corrosion-resistant, assembled and reinforced to prevent flexing and drumming. Provide mounting legs for fixing to the support structure.

II. Materials: Select from the following:

i. Metallic-coated steel ≥ 1.0 mm thick panels, fixed to ≥ 1.6 mm folded thick metallic-coated steel sheet frames and supports. Powder coat all interior and exterior surfaces as appropriate. Provide stainless steel fasteners.

ii. Aluminium ≥ 1.6 mm thick grade 5251 panels with ≥ 2.0 mm aluminium frames and supports. Provide stainless steel fasteners.

III. Drain: All parts free draining with no pockets in which condensation and/or rainwater may be retained.

IV. Capacity control: By either of:

i. Loading and unloading compressor, for multi-compressor unit.

ii. Solenoid valve.

iii. Variable frequency drive.

iv. Air-cooled units: Cycling of condenser fans.

V. Control panel:

i. General: Provide a menu driven, microprocessor based control panel for all necessary control and safety functions.

ii. Interface with BMS: Provide high level interface with BMS at the control panel based on BACnet protocol for remote control, monitoring and alarm indication.

f) Refrigerant charging valve: Provide.

2.4 REFRIGERANT STORAGE VESSELS

a) General: Provide refrigerant storage vessels for recovered refrigerant.

b) Capacity: Capable of holding the specified amount of refrigerant when 90% full at room temperature.

c) Construction: Welded steel construction complete with pressure relief, 'bulls eye' type sight glasses at operating level and maximum storage level, heavy duty swivel casters.

3 HEAT EXCHANGERS

3.1 COOLING TOWERS, CLOSED CIRCUIT COOLERS, EVAPORATE CONDENSERS AND HYBRID COOLERS

3.1.1 GENERAL

a) Type: Mechanical drafts counterflow type.

b) Type test and production tests:

   I. Drift loss: (0.002% maximum of circulated water flow rate). Submit manufacturer's published testing results.

   II. Thermal performance: Apply appropriate de-rating for installation location.

c) Document of evidence: Submit the following:

   I. Drift loss.

   II. Thermal performance.

d) Location: Ensure free air circulation at the air intakes and un-obstructed air discharge. Locate equipment in accordance with manufacturer's recommendations.

e) Materials: Standard - Fiberglass casing and water basin.

f) Nozzle: ABS or polypropylene.

g) Mechanical equipment support: Steel hot-dip galvanised.

h) Hardware: Stainless steel.

i) Fill and drift eliminators: Decay and ultraviolet light resistant rigid PVC-U with minimum temperature rating of 50 °C.

j) Fibreglass treatment: Coat fibreglass with ultraviolet light stabilised polyester on inside and outside surfaces.

k) Casing: Louvres and splash guards: Provide air inlet louvres and splash guards which are readily removable.

l) Air inlet screen: Provide air inlet screen to prevent the entry of birds.

m) Cell partitions: Divide cells using full height and width partitions which provide complete water vapour and air separation. Extend partitions downward to separate the cold water basin.

3.1.2 COLD WATER BASIN

a) General: Provide basins capable of supporting the weight of service personnel and the rated water content.

   I. Thickness: Minimum 6 mm.

   II. Capacity: Sufficient to contain the water overflow from the water suspended in the water distribution system and the fill without loss to overflow pipes when the water distribution system is stopped.

   III. Filling facilities: Provide a copper alloy ball float valve to AS 1910, with float position in accordance with AS 3500.1.

   IV. Separate quick fill facility: Provide.

b) Overflows: DN 50 minimum.

c) Sumps: Provide the following fittings:

   I. Outlet stainless steel strainer sufficient to prevent vortex forming at the water outlet.

   II. Anti-vortex plate if necessary.

   III. Drain outlet DN 50 minimum.

IV. Equaliser connections for multiple tower operation.

3.1.3 WATER DISTRIBUTION SYSTEM

a) Film-type fill: Wave formed sheets designed to ensure even water distribution to give maximum wetted surface area.

b) Drift eliminators: Provide drift eliminators located in the air flow downstream of the fill and water distribution system, so that full air flow passes through the eliminators.

c) Distribution system: Distribute water evenly through non-clog nozzles fitted to a spray tree arranged for complete wetting of the fill. Construct using UPVC branch pipes, readily removable from pipe header.

3.1.4 FANS

a) Type: Axial flow fan or centrifugal fan.

b) Balancing: Statically and dynamically balanced.

c) Drive: Direct drive or belt drive.

d) Fan shaft: Stainless steel.

e) Fan guard:

I. Axial flow fans: Provide a stainless steel mesh guard over the fan discharge.

II. Centrifugal fans: Provide stainless steel mesh guards over the fan inlets.

f) Fan motor:

I. Totally enclosed with IP 56 protection.

II. VSD for capacity control.

III. Motor exposed to moist air stream shall have:

i. Stainless steel shaft.

ii. Cable entry into conduit box from below.

3.1.5 ACCESS AND CLEANING PROVISIONS

a) General: Provide smooth inside surfaces.

b) Access doors and panels: Provide watertight and airtight access doors/panels in each cell above the highest water level in the cold water basin. For multiple cell towers, access to each cell must not be dependant on passage through another cell.

c) Ladders and working platform: Provide a fixed access ladder to AS 1657 for equipment requiring service and maintenance located $\geq$ 2.4 m above floor level. Provide working platform in compliance with the relevant health and safety regulation.

d) Waste Discharge

I. Control valves: Provide control valves for:

i. Bleed-off pipes.

ii. Basin outlets.

II. Dead legs: Arrange the cooling towers and piping so that all parts can be drained and flushed. Provide additional full way drain valves and flushing facilities so that balance/equalising lines between towers can be drained and flushed.

III. Discharge to tundish: Connect bleed-off, water basin drains and overflow to tundish separately. Use UPVC pipes. Install discharge pipes to allow flow inspection.

3.1.6 CLOSED CIRCUIT COOLERS AND EVAPORATIVE CONDENSERS

a) Coil sections: Design for low pressure drop. Provide headers and pipe connection stubs of the same material as the coil. Extend stubs at least 100 mm outside the enclosure through openings sealed air tight around the stubs with grommet. Provide air vent for closed circuit cooler.

b) Coil materials: Copper pipe with brazed joints.

c) Subcooling coil: For evaporative condensers provide a subcooling coil, with surface area at least 10% of that of the condensing coil. Locate the subcooling coil in the entering side of the condensing coil.

d) Water system: Distribute water evenly through non-clog nozzles fitted to spray tree arranged for complete wetting of the coil. Construct from UPVC branch pipes, readily removable from pipe headers. Ensure that pipe bends are covered by the spray. Connect pump discharge to spray tree headers by pipes sealed with grommet and electrolytically insulated at casing penetrations.

e) Spray pumps:

   I. General: Close-coupled centrifugal pump piped to the suction strainer and the water distribution system.

   II. Materials: Cast iron casing with zinc-free bronze impeller, stainless steel shaft.

   III. Motor: Totally enclosed with IP 56 protection.

   IV. Mounting: Vertically mounted with flood suction and free draining into the basin.

   V. Pump shaft power: Comply with Section J of the BCA.

3.1.7 HYBRID COOLERS

a) Type: Condenser water cooler consisting of an extended surface water cooling coil with automatically controlled evaporative pre-cooler on the coil air entering side, induced draft fans and casing.

b) Coil sections:

   I. Design for low pressure drop. Provide headers and pipe connection stubs of the same material as the coil. Extend stubs at least 100 mm outside the enclosure through openings sealed air tight around the stubs with grommet. Provide air vent.

c) Coil materials: Copper pipe with brazed joints.

d) Pre-cooler:

   I. Provide a pre-cooler consisting of non-metallic evaporative cooling pads, with stainless steel or plastic water distribution system and water circulation pump.

   II. Pre-cooling pads: Conform to the specification of fill.

e) Water system: Distribute water evenly through non-clog nozzles fitted to spray tree arranged for complete wetting of the coil. Construct from UPVC branch pipes, readily removable from pipe headers. Ensure that pipe bends are covered by the spray. Connect pump discharge to spray tree headers by pipes sealed with grommet and electrolytically insulated at casing penetrations.

f) Spray pumps:

   I. General: Close-coupled centrifugal pump piped to the suction strainer and the water distribution system.

   II. Materials: Cast iron casing with zinc-free bronze impeller, stainless steel shaft.

   III. Motor: Totally enclosed with IP 56 protection.

   IV. Mounting: Vertically mounted with flood suction and free draining into the basin.

3.2 AIR COOLED CONDENSERS

a) General

I. Type: Provide air cooled condensers comprising condensing coil, fan and associated piping and electrical connection, mounted within an enclosure.

II. Location: Ensure free air circulation at the air intakes and un-obstructed air discharge. Locate equipment in accordance with manufacturer's recommendations.

b) Enclosure

I. General: Provide enclosures, materials and finishes that are weatherproof and corrosion-resistant, assembled and reinforced to prevent flexing and drumming. Provide mounting legs for fixing to the support structure.

II. Materials: Select from the following:

i. Metallic-coated steel ≥ 1.0 mm thick panels, fixed to ≥ 1.6 mm folded thick metallic-coated steel sheet frames and supports. Powder coat all interior and exterior surfaces to AS 3715 or AS 4506 as appropriate. Provide stainless steel fasteners.

ii. Aluminium ≥ 1.6 mm thick grade 5251 panels with ≥ 2.0 mm aluminium frames and supports. Provide stainless steel fasteners.

c) Drain: All parts free draining with no pockets in which condensation and/or rainwater may be retained.

d) Backflow prevention: Provide internal baffles to prevent backflow of air through idle fans when multiple fans are sequentially switched.

e) Access panels: Hinged doors or lift-off panels with cam lock fasteners.

f) Condenser Fans

I. General: Provide statically and dynamically balanced axial flow fans, with metallic-coated steel fan guards.

II. Drive: Direct or belt driven.

III. Motor: Degree of protection ≥ IP 54.

IV. Vibration isolation: Provide each fan with at least four anti-vibration mountings, selected to give isolation efficiency not less than 95%.

g) Condenser Coil

I. Type: Non-sprayed.

II. Air pressure drop: ≤ 100 Pa.

III. Face velocity: ≤ 3.5 m/s.

IV. Fin pitch: ≤ 630 fins/m.

h) Materials:

I. For general application:

i. Frame: Aluminium alloy.

ii. Fins: Aluminium fins with proprietary coil corrosion protection coating.

II. For high atmospheric corrosivity application:

i. Frame: Heavy gauge brass.

ii. Fins: Copper fins electro-tinned after fabrication.

III. Tube material: Copper.

IV. Header material: Copper.

i) Proprietary coil corrosion protection coating:

   i. Type: Factory applied coating resistant to dilute acids, dilute alkalis, solvents, inorganic salts and salt laden air.

   ii. Application: Apply after coil fabrication.

   iii. Performance: When tested, show no sign of attack after 3000 hours in salt spray.

j) Subcooling coils: Provide a subcooling coil identical to the condensing coil, to achieve at least ≥ 5 K subcooling. Locate on the air entering side of, or next to, the condensing coil and in the same coil frame.

k) Control

   I. General: Provide a menu driven, microprocessor based control panel for all necessary control and safety functions.

   II. Interface with BMS: Provide low level Interface with the BMS at the mechanical services switchboard for remote control, equipment status and alarm indication.

3.3 WATER COOLED CONDENSERS

a) Type: Provide horizontal water cooled, mechanically cleanable refrigerant condensers with water flowing through the tubes, consisting of a shell containing a tube bundle, refrigerant and cooling water circuits and necessary valves and fittings.

b) Sub-cooling: Provide.

c) Pressure drop: Pressure drops of condenser water circuit shall not exceed 45 kPa at full load.

d) Refrigerant storage within the condenser: If the compressor is positive displacement type and fitted with suction and discharge valves, provide sufficient condenser volume to hold the full refrigerant charge on pump down.

e) Construction:

   I. Shells: Hot rolled low carbon steel plate with seams precision electric welded and ground smooth externally.

   II. Tube bundles: Unjoined seamless copper tube expanded into tube plates. Finish tubes flush with the outside edge of the tube sheet.

   III. Water boxes: Removable water box from cast or fabricated from mild steel. Provide marine water box for centrifugal chillers with removable cover plates that permit access to tubes without disturbing the attached water piping.

f) Accessories: Provide accessories including but not limited to the following:

   I. Refrigerant connections: Sealed after pressurising with dry nitrogen.

   II. Water connections.

   III. Drain connections.

   IV. Vent connections.

   V. Thermometer pockets.

g) Control

   I. General: Provide a menu driven, microprocessor based control panel for all necessary control and safety functions.

   II. Interface with BMS: Provide low level Interface with the BMS at the mechanical services switchboard for remote control, status and alarm indication.

3.4 WATER CHILLING EVAPORATORS

a) General: Provide horizontal water chilling evaporator consisting of a shell containing a tube bundle, refrigerant circuits, water drain and vent connections, insulation, and necessary valves and fittings.

b) Type: Flooded type for centrifugal chillers, and direct expansion type with electronic expansion valve for others.

c) Pressure drop: Pressure drops of chilled water circuit shall not exceed 45 kPa at full load.

d) Construction:

   I. Shells: Hot rolled low carbon steel plate with seams precision electric welded and ground smooth externally.

   II. Tube bundles: Unjoined seamless copper tube expanded into tube plates. Finish tubes flush with the outside edge of the tube sheet. Same as for Water Cooled Condensers.

   III. Water boxes: Removable water box from cast or fabricated from mild steel. Provide marine water box for centrifugal chillers with removable cover plates that permit access to tubes without disturbing the attached water piping.

e) Thermal insulation: Insulate the evaporator and other surfaces that operate below ambient temperature.

f) Accessories: Provide accessories including but not limited to the following:

   I. Refrigerant connections.

   II. Water connections.

   III. Drain connections.

   IV. Vent connections.

   V. Freeze-up protection.

3.5 AIR COILS-COOLING AND HEATING

a) Coil selection:

   I. Air pressure drop:

      i. Cooling coils: ≤ 150 Pa when wet.

      ii. Heating coils: ≤ 70 Pa.

   II. Face velocity:

      i. Cooling coils: ≤ 2.5 m/s.

      ii. Heating coils: ≤ 3.5 m/s.

   III. Fin pitch:

      i. Cooling coils: ≤ 480 fins/m.

      ii. Heating coils: ≤ 630 fins/m.

   IV. Water pressure drop:

      i. Cooling coils: ≤ 30 kPa.

      ii. Heating coils: ≤ 20 kPa.

b) Construction

   I. Materials:

      i. Frame: Aluminum alloy.

      ii. Fins: Aluminum fins with proprietary coil corrosion protection coating.

      iii. Tube material: Copper.

iv. Header material: Copper.

II. Proprietary coil corrosion protection coating:

i. Type: Factory applied coating resistant to dilute acids, dilute alkalis, solvents, inorganic salts and salt laden air.

ii. Application: Apply after coil fabrication.

iii. Performance: When tested, show no sign of attack after 3000 hours in salt spray.

c) Headers:

I. General:

i. Fluid flow: Ensure even cooling and heating fluid flow to pipe circuits.

ii. Vents: Provide vent plugs to top of headers.

iii. Drains: Provide drain plugs to bottom of headers, arrange to fully drain coils.

II. Piping connection: Provide inlet connections at the bottom of supply headers at the air-off face of coils, and outlet connections at the top of return headers at the air-on face of coils.

d) Coil Installation

I. Configuration: Install coils so that fluid and airflow directions are counter flow.

II. Supports: Support coils using either of the following:

i. The internal support frame of conditioners.

ii. Prefabricated, predrilled, hot dipped galvanised steel frames.

e) Dissimilar metals: Provide neoprene gaskets to separate the mating surfaces of dissimilar metals.

f) Heating coils in ductwork: Provide coils with flanged frames, for connection to ductwork. Support coil from above using drop rods. Provide a 600x600 access panel in the duct on the air inlet side.

g) Fin damage: Comb straight damaged fins.

h) Drip Trays

I. General: Provide drip trays for cooling coils.

II. Material: Stainless steel at least 0.8 mm thick.

III. Size: Extend at least 150 mm upstream and 300 mm downstream from the face of the coil, 100 mm deep minimum.

IV. Construction: Construct all internal corners and edges for easy cleaning. Grade to the bottom outlet to prevent pondage.

i) Stacked coils: Provide drip tray for each coil, run a drain pipe from the upper drip tray to the lower drip tray.

j) Drain: Drain the drip tray with min 32mm Ø pipe and discharge into the floor waste gully. Provide 80mm water seal in the drainage.

3.6 ELECTRIC DUCT HEATERS

a) General

I. Type: Finned type totally enclosed.

II. Surface temperature: ≤ 400 °C when tested in still air at 20 °C.

III. Arrangement: Provide uniform heat distribution across the air stream.

b) Construction

I. General: Sheathed in steel or nickel alloy, with brazed spiral steel fins.

II. Frames: Assemble elements in a galvanised steel frame with terminal connections contained in an enclosed terminal box.

III. Heating section: Install to allow access to the terminal box and removal of the assembly without disturbing other components.

c) Installation

I. General: Assemble and support the heater in steel casing extending along the air duct for not less than 250 mm on each side of the element.

II. Insulation: Internally insulate the casing with non-combustible materials with $F \leq 30$ W/m^2.K at 100 °C.

d) Safety Control

I. Provide the following:

i. Electrical interlock: Electrically interlocked with the supply air fan.

ii. High temperature cut out at 65 °C.

iii. Air supply failure cut out.

iv. Cut out the power supply to the element when the supply air fan is operating in smoke control mode.

3.7 WATER HEATING BOILERS

a) Type: Proprietary water heating boilers of the following type:

I. Water-tube.

II. Fire-tube.

III. Condenser boiler.

b) Performance:

I. General: Suitable for operation with returning water temperature of 60 °C and leaving water temperature of 85 °C.

II. Gross thermal efficiency: Comply with Section J of the BCA.

c) Burners

I. Type: Gas-fired burners.

II. Gas: LPG or natural gas at 3.0 to 6.9 kPa pressure.

III. Ignition: Electronic.

d) Instrument: Provide pressure and temperature gauges for heating water inlet and outlet.

e) Controls: Provide for automatic ignition, stopping and modulating burner control.

f) Accessories: Provide gas pilot, gas valve, and gas regulator.

g) Control Panel

I. General: Provide a menu driven, microprocessor based control panel.

II. Interface with BMS: Provide high level interface with BMS at the control panel based on BACnet protocol for remote control, monitoring and indication. Provide BACnet gateway if necessary.

h) Insulation: Insulate complete boiler shell using a minimum of 50 mm thick semi-rigid mineral wool or glass wool and sheath in 0.8 mm zinc-coated steel.

i) Sheathing finish: Air-drying enamel.

j) Marking

Provide the following details:

I. Model number.

II. Serial number.

III. Blowdown vessel: Provide a blowdown vessel complete with fittings in compliance with authority's requirements Output.

IV. Design and test pressure.

V. Burner details.

k) Installation

I. Fixing: Mount boilers on concrete plinths.

II. Boiler waste:

i. General: Connect the blowdown vessel to a tundish.

ii. Condenser boiler: Provide stainless steel condensate drain pipe.

III. General: Provide feed water and expansion tanks with capacity to accommodate the expansion of water contained within the boiler and the associated piping system.

IV. Location: To flood boilers and the associated piping system.

V. Piping: Do not fix valve between tank and boiler. Provide piping of adequate size.

l) Boiler Flue

I. General: Provide a separate flue to each boiler. For pressurised boilers, do not discharge multiple flues into a single flue.

II. Flue size: To boiler manufacturer's recommendation.

III. Material: Use:

i. Purpose-built 1.6 mm thick stainless steel construction.

ii. Proprietary modular pre-insulated stainless steel system.

IV. Construction: All welded construction with flanged removable section near the boiler for maintenance.

V. Lagging: Lag externally using calcium silicate insulation, sheathed with zinc-coated steel sheet.

VI. Flue outlets: Fit flue cowls to prevent down draft, at 3 m above roof.

3.8 PLATE HEAT EXCHANGER

a) General: Provide prefabricated plate heat exchangers with the following:

I. Corrugated metal plates gasketted together to form alternate channels for liquid flow.

II. Adjustable and extendable rails for compaction of the plates and for dismantling.

b) Construction:

I. Frame: Epoxy coated carbon steel end plates with stainless steel inserts where rails are connected.

II. Rails and plates: Grade 316L stainless steel.

III. Gaskets: Nitrile rubber.

4 PACKAGED AIR CONDITIONING UNITS

4.1 GENERAL

a) Packaged air conditioning units include the following:

   I. Single packaged air conditioning units.

   II. Split air conditioning units.

   III. Room air conditioning units.

b) Energy efficiency ratio: Comply with Section J of the BCA.

c) General: Provide packaged units, either one-piece package or split system, consisting of refrigerant condensers, compressors, supply air fan, cooling coil, air filter and associated piping and electrical connections, mounted within the same enclosure.

d) Equipment enclosures:

   I. External units: Manufactured for outdoor application with sloping roofs, louvres, rainhoods, birdscreens, reinforced seals and special paint finishes...

   II. Construction: Assembled and reinforced to prevent flexing and drumming. Provide for removal of major components.

   III. Access: Provide access for inspection and maintenance.

   IV. Insulation: Internally insulate the supply air chamber to prevent external surface condensation under operational conditions.

   V. Acoustic treatment: Provide acoustic treatment to meet the specified noise criteria.

e) Condensate trays

   I. General: Provide a tray under each cooling coil section, extending downstream to collect water carry over, and under components on which condensation can occur.

   II. Material: Corrosion-resistant.

   III. Insulation: Insulate trays to prevent condensation internally and on external surfaces of the unit enclosure under operational conditions.

   IV. Condensate drain: Connect condensate trays to nearest drain points using trapped minimum DN 20 drain lines.

   V. Reverse cycle units: Provide:

      i. Effective outdoor coil defrosting facility; and

      ii. Refrigerant reversing valves.

f) Electronic expansion valve: Provide electronic expansion valve for units of capacity exceeding 20 kW.

g) Control panel: Provide a menu driven, microprocessor based control panel.

Interface with BMS: Provide low level interface with BMS at the mechanical services switchboard for remote control, status and alarm indication.

5 AIR HANDLING EQUIPMENT

5.1 GENERAL

a) Construction - FCU:

I. Casings: Fabricate casings using galvanised steel sheet, 1.6 mm minimum thickness. Internally insulate the enclosure.

II. Duct connection: Provide spigot or flanged connections.

III. Pipe connections: Provide water pipe/refrigerant pipe connections outside the casing. Provide grommet for pipe penetrations.

b) Construction – AHU:

I. Factory fabricated unit: Modular design with fan section, coil section and filter section. Provide an air mixing section unless the air handling unit room is used as air mixing chamber. All sections shall be of same construction with double-skin sandwich panels of galvanised steel, extruded aluminum frames and galvanised steel channel base. Insulation shall be of non-PVC material of thickness to meet thermal resistance requirement and not less than 25 mm. Sections shall be assembled on site. Seal joints with non-hydroscopic sealants.

II. Built-up unit: The whole casing shall be constructed with sandwich panels of same material as for factory fabricated unit.

III. External units: External units shall be manufactured for outdoor application with sloping roofs, louvres, rainhoods, birdscreens, reinforced seals and special paint finishes.

IV. Maximum deflection of casing: Under maximum internal-external pressure difference, provide casings having the lesser of the following:

V. Maximum deflection consistent with correct operation and air tightness of the air handling unit.

c) Air leakage: The FCU and AHU shall be air tight. Seal all penetration through the casing with non-hardening mastic. Close the space between coil frame and filter holding frame and the casing with baffle plates and seal the gaps to make it air tight.

d) Condensation: Take all steps necessary to prevent condensation on the outside of units under any operating conditions including:

I. Insulate drain trays.

II. Eliminate cold bridging.

e) Access: Provide easy access to all equipment for inspection and cleaning, including both faces of each coil with suitably located access panels and doors.

f) Duct connections: Provide flanged connections.

g) Pipe connections: Provide water/refrigerant pipe connections outside the casing. Provide grommet or sleeves with cover plate for pipe penetration.

h) Finish: Chemically treat the outer panel surface pre-coat with prima, finish with polyurethane enamel paint.

i) Supply air fans: Provide centrifugal fans.

j) Dampers: Provide return air and outside air dampers for AHUs with integrated air mixing section.

k) Filter sections: Provide the following filter sections:

I. Air handling units $\leq$ 2000 l/s: Filter box for 100 mm pleated filters.

II. Air handling units $>$ 2000 l/s: Filter box for 50 mm panel or pleated pre-filter, and main bag filter of maximum 600mm depth.

l) Electrical

I. Switch: Provide supply air fan isolator on the external unit casing adjacent to the access door.

II. Lighting: Provide water resistant bulkhead lights in each section, controlled by external switch.

m) Penetrations for other services: Provide penetrations for sprinkler pipes, fire detector and BMS conduits. Seal penetrations around pipes and conduits.

5.2 FANS

5.2.1 CENTRIFUGAL FANS

a) General: Provide fans with a constant falling head v. quantity curve for stable operation.

b) Fans with variable speed control: Ventilation fans designed for variable speed operation shall be equipped with high efficiency electronically commutated (EC) motor compatible with BMS control using BACnet protocol.

c) Construction

I. Casing:

i. Construction: Welded steel scroll and side plates, reinforced to prevent flexing and drumming.

ii. Split type casing: Provide for fans with impellers ≥ 1200 mm diameter.

iii. Inlet bells: Removable, shaped for aerodynamically efficient air entry and close approach to impeller.

iv. Access panels: Provide inspection/access panels to casings of fans with impellers ≥ 650 mm diameter. Seal panels air tight using neoprene gaskets.

v. Outlets: Provide flanged outlets to casings of fans with impellers ≥ 250 mm diameter.

vi. Guards: Provide removable inlet and discharge guards for fans not connected to ductwork.

vii. Drains: Fix 25 NS drain point at base and stopped with non-ferrous screw plug for kitchen exhaust fans and fans exposed to weather.

II. Base:

i. General: Form from fully welded steel sections integral with or bolted to casings.

ii. Mounting brackets: Provide at least 4 height saving mounting brackets.

III. Impeller: Backward or forward inclined curved section, laminar or aerofoil type, statically and dynamically balanced. Select impeller for optimum fan efficiency.

IV. Bearing: Grease lubricated self-aligning ball or roller bearing sealed for life or fitted with lubrication lines extending through the casing.

V. Motor:

i. General: Provide electric motors compatible with requirements to give efficient fan units.

ii. Power rating: At least the power required by the fan when the airflow is increased by 10% above the specified design airflow against the corresponding increased system resistance.

iii. Maximum degree of protection:

(1) Installed indoor: IP51.

(2) Installed outdoor: IP54.

VI. Drive:

i. Type: Belt drive, or direct drive.

ii. Drive sizing: To suit a minimum 125% of motor power and capable of transmitting full starting torque without slip.

iii. Belt tension: Provide adjustment of belt drive tension by either movement of motor on slide rails or by pivoting support.

iv. Drive guards: Provide removable drive guards of open mesh or perforated zinc-coated steel, to totally enclose the drive and exposed shafts.

5.2.2 IN-LINE CENTRIFUGAL FANS

a) Characteristics: Provide fans with non-overloading power characteristics.

b) Casings: Rectangular or circular with spigots and flanges for duct mounting, with construction as follows:

I. Steel: Zinc-coated steel sheet, spot welded. Provide access panels for fan and motor removal.

II. Fibreglass or plastic: Moulded fibreglass or impact resistant plastic with integral support foot.

c) Impellers: Backward or forward curved blade, constructed from zinc-coated steel, aluminium or polypropylene, balanced statically and dynamically.

d) Motors: Direct mounted to impellers. Provide sealed for life bearings with minimum rating fatigue life of 8750 hours.

e) Electrical connection: Provide terminal boxes external to fan casings and wired to fan motors

5.2.3 AXIAL FLOW FANS

a) Characteristics: Provide fans with non-overloading characteristics.

b) Casing: Tubular, flanged at each end, constructed from mild steel, fully welded, hot dip galvanised after fabrication. Provide access panels securely bolted to casings and sealed with neoprene gaskets for maintenance.

c) Impellers:

I. Fans < 450 mm: Fixed pitch polypropylene impellers or zinc coated steel impellers.

II. Fans ≥ 450 mm: Adjustable pitch aluminium alloy aerofoil section impellers.

III. Smoke spill fans and kitchen exhaust fans: Adjustable pitch steel impellers.

d) Balancing: Balance impellers statically and dynamically.

e) Inlets and outlets not connected to ductwork:

I. Cones: Provide aerodynamically shaped cones.

II. Guards: Provide galvanised steel mesh guards.

f) Motors: Direct mount to impellers.

5.2.4 ROOF MOUNTED FANS

a) Types: Centrifugal, mixed flow, axial or propeller type.

b) Housing:

I. General: House fans in compact bases fitted with weathering skirts.

II. Material: UV stabilised ABS, polypropylene, glass fibre reinforced polyester or zinc-coated steel.

c) Vertical discharge:

I. General: Provide weatherproof galvanised steel back draft dampers where rain may enter when units are stopped.

II. Bird mesh: Where back draft dampers are not fitted, provide bird mesh guards.

d) Motors:

I. Direct mounted to impellers with minimum class 155 ~~insulation to AS 2768~~. Provide sealed for life bearing with minimum fatigue life of 8750 hours.

II. Provide terminal boxes external to fan casings and wired to fan motors.

5.2.5 WINDOW AND WALL MOUNTED FANS

a) Impeller: Propeller type.

b) Housing: Provide the following:

I. Isolating mounting.

II. Discharge cowls with bird mesh guards.

III. Back draft damper constructed from aluminium blade, closed by gravity.

5.3 FILTERS

5.3.1 AIR FILTERS

a) Air handling systems < 2000 l/s: Provide single stage air filters of the following:

I. Filter type: Type 1 pleated filter.

II. Class: Class A.

III. Performance rating: F5.

IV. Nominal module size: 305 mm x 610 mm, or 610 mm x 610 mm.

V. Depth: 100 mm.

VI. Rated airflow (610 mm x 610 mm module): 944 l/s.

b) Air handling system > 2000 l/s: Provide 2-stage air filters comprising the following:

I. Pre filter :

i. Filter type: Type 1 panel filter or pleated filter.

ii. Class: Class A or Class B.

iii. Performance rating: G3.

iv. Nominal module size: 305 mm x 610 mm, or 610 mm x 610 mm.

v. Depth: 50 mm.

vi. Rated airflow (610 mm x 610 mm module): 944 l/s.

II. Main filter :

i. Filter type: Type 1 extended surface bag filter.

ii. Class: Class A.

iii. Performance rating: F6.

iv. Nominal module size: 305 mm x 610 mm, or 610 mm x 610 mm.

v. Depth 610 mm – 660 mm

vi. Rated airflow: 944 l/s.

c) Pressure gauges:

I. Provide pressure gauge for AHUs complete with static pressure tips and fittings to measure air filters resistance in installations except where for air handling unit is monitored and controlled by BMS.

II. Type: 'Magnehelic' model 2000 – 750 Pa range.

III. Location: Install gauges at visible locations, protected from outside interference.

IV. Marking: Provide marking on the dial to indicate dirty filter condition.

5.3.2 GREASE FILTERS

a) Standard: To AS 1668.2

b) Construction: All-aluminium construction, honeycomb configuration.

c) Performance:

I. Initial resistance: 140 Pa maximum at 1.5 m/s face velocity.

II. Efficiency: 94% at 1.5 m/s face velocity.

d) Installation: Install grease filters at an angle ≥ 30° from the vertical.

5.4 UVC ULTRAVIOLET COIL CLEANING EMITTERS

a) General

I. Quality Assurance

i. UL Compliance: Comply with UL Standard 1995 as applicable to usage of UVC Emitters in HVAC Equipment.

ii. ISO Certification: Fixtures must be manufactured in a ISO 9001:2000 registered facility.

iii. Each component and product is to be inbound and outbound tested before shipment in accordance with ISO 9001:2000 test procedures.

II. Delivery, Storage and Handling:

i. Store UVC Emitters in a clean dry place and protect from weather and construction traffic. Handle UVC Emitters carefully to avoid damage to components, enclosures and finish. Leave factory-shipping covers in place until installation and only when called for in the installation instructions. Do not install damaged components; replace and return damaged components to equipment manufacturer.

ii. Comply with manufacturer's installation instructions placement, wiring and testing.

b) Emitters

I. Manufacturer Steril-Aire, Inc. Model SEN, SE or GTS Series or equal and approved.

II. Output Verification: Independent certified testing shall indicate that when Emitter first installed total output per one inch arc length shall not be less than 9 μW/cm2, measured at one meter, in a 2.8 m/s airstream of 10° C, and at end of manufactures tube warrantee period, or 9000 hours, whichever is longer, shall have output per one inch arc length not be less than 4.5 μW/cm2 measured at one meter, in a 2.8 m/s airstream of 10° C.

III. Dose On the Down Stream Coil Face At Extremities: The UVC dose at the extreme edges of the coil shall not be less than 750 μW/cm2 at the end of the 9000 hour period.

c) Warranty

I. Fixture and Emitter shall be 100% warranted to be free from factory defects for a period of 9000 hours.

II. The Power Supplies and Fixtures shall be warranted for 5-years.

III. The Coil shall be substantially free of Mould at the end of the manufacturer's Emitter warrantee period, or 9000 hours, whichever is longer.

d) Design Requirements

I. Irradiation **-** Emitters are to be installed downstream of the coil horizontally across the full face of the coil in sufficient quantity and in such an arrangement so as to provide an output as specified in Part 2.2 b & c and equal distribution of UVC energy on the coil and in the drain pan. To maintain energy efficiency, the UVC energy produced shall be of the lowest possible reflected and shadowed losses.

e) Equipment

I. Units shall be high output, HVAC-type, germicidal UVC light sources, factory assembled and tested. Components shall include a high efficiency electronic power source, Emitter sockets and Emitter tube, all constructed to withstand HVAC environments.

II. High efficiency electronic power sources shall be 115, 208/230 and 277 V, 50/60 Hz. They shall be UL listed to comply with UL Standard 1995 and capable of igniting each Emitter at temperatures from 1º - 70° C in airflow velocities common to HVAC systems. They shall be equipped with RF and line noise suppression.

III. Emitter tube shall be of the high output, hot cathode, T5 (15mm) diameter, and medium bi-pin type. They shall produce 95% of their energy at 254 nm and be capable of producing the specified output at airflow velocities common to HVAC systems and at temperatures of 1º - 70° C. **UVC Emitters shall produce no ozone or other secondary contamination**.

f) Installation

I. Coordinate with installation of HVAC equipment and install Emitters as indicated after such equipment is properly installed.

II. Provide an interlock switch on the access to the UVC Emitters to turn the lights off when the access is opened.

III. Provide a view port to enable the maintenance technician to view Emitters to determine that they are operating.

IV. If specified to include a stationary radiometer, install the radiometer and adjust and set in accordance with manufacturer recommendations.

V. If specified install an on/off indicator capable of informing BMS if there is an Emitter failure.

VI. Install provided Caution Labels on all accesses to the Emitters.

6 DUCTWORK

6.1 GENERAL

a) Material: Prime quality lock forming galvanized steel.

b) Rivets: Expanding solid end type, aluminium base alloy, and minimum size as follows:

   I. For sheet metal to sheet metal: 3 mm.

   II. For sheet metal to supports, brackets, and rolled steel angles: 4.8 mm.

c) Bolts, nuts, washers and drop rods: Zinc-plated steel. Provide washers under nuts and bolt heads.

d) Sealing: Seal all openings in the surface, joints and seams of ducts. Do not use duct tape as the primary duct sealing agent. For machine rolled flanges, use mastic at corners.

e) Outdoor application: Ductwork located outdoor shall be of watertight construction and shall be shielded from direct solar heat with a metal canopy over.

f) Arrangement: Arrange ductwork neatly. Provide access to ductwork components that require inspection, entry, maintenance and repairs where possible; arrange duct runs adjacent and parallel to each other and to building elements.

g) Spacing: Provide minimum clear spacing additional to duct insulation as follows:

   I. 25 mm between adjacent ducts.

   II. 25 mm between duct flanges or upper surfaces of duct and undersides of beams and slabs.

   III. 50 mm between ducts and electric cables.

   IV. 150 mm between ducts and ground below suspended floors.

h) Access: Provide access panels as required for cleaning of ductwork.

i) Cleaning: During installation progressively remove construction debris and foreign materials from inside ducts.

6.2 KITCHEN EXHAUST DUCTWORK

a) Standard: To AS 1668.

b) Ductwork. Do not cross-break.

c) Joints: Seal cross-joints and longitudinal joints using grease resistant sealant. Provide longitudinal joints of the Pittsburgh lock type.

d) Penetrations: Provide penetrations for sprinkler pipes. Seal penetrations around pipes.

e) Access panels: Provide accesses panels with waterproof, fire-resistant and grease resistant seals as follows:

   I. At accessible joints on the sides of ducts, at 3 m maximum centres.

   II. At duct junctions.

   III. At the bottom of kitchen exhaust-risers.

   IV. On each side of changes in direction.

   V. At sprinkler head locations.

f) Drains: Provide a 25 mm drain socket and plug at the lowest point of each run of ducting, and with a 25 mm grease arresting gutter at the bottom of vertical risers.

6.3 FIRE RESISTANT DUCTWORK

a) General: Submit test certificates.

b) Systems:

I. Sprayed fire resistant compound coating.

II. Composite fire resistant panels or ducting.

c) Fire-resistance level: Not less than the FRL of the structure separating the fire compartments.

6.4 FLEXIBLE DUCTS

a) General:

I. Use flexible ducts for connection between rigid metal ducts and air grilles only.

II. Isolate fans and conditioner casings from ductwork using airtight flexible connections.

b) Uninsulated flexible duct: Aluminised fabric clamped on a formed metal helix.

c) Insulated flexible duct: As for uninsulated flexible duct with flexible blanket insulation wrapped around duct and covered with an outer vapour barrier.

d) Maximum length: 5m. Two lengths of flexible ducts inter-connected with a rigid section are not acceptable.

e) Air velocity: ≤ 4 m/s.

f) Support: Support flexible duct from building structure, do not support flexible duct from suspended ceiling or other services.

g) Material: Heavy duty, waterproof.

h) Length: Provide sufficient slack to ensure free movement and vibration isolation under operating and static conditions.

i) Alignment: Align opening between connected equipment.

j) Fixing: Fix to attachment using zinc-coated steel strip. Seal joints. Do not paint flexible material.

k) Maintenance: Arrange to permit easy removal and replacement without disturbing ductwork or plant.

l) Restriction: Do not protrude connections or frames into the air stream.

6.5 VOLUME CONTROL DAMPERS

a) General: Provide volume control dampers complete with actuator as necessary for proper air balancing of the air distribution system and subsequent adjustment, which are free of rattles, fluttering or slack movement, and capable of adjustment over the necessary range without excessive self-generated noise or the need for special tools.

b) Type: Opposed action type. Do not use splitter type damper.

c) Face dimension:

I. Duct mounted: Duct size.

II. Wall mounted: 6 m/s maximum face velocity.

d) Construction

I. Frames: 2 mm minimum thickness aluminium folded to form channel sections at least 150 mm wide and welded at corners.

II. Blades:

i. Material: Aluminium, 2.4 mm minimum thickness, with neoprene or silicon rubber blade tip seals.

ii. Form: No sharp edges, sufficiently rigid to eliminate movement when locked.

iii. Maximum size: 1200 mm long x 175 mm wide.

III. Bearings:

i. Type: Oil impregnated sintered bronze ball bearings or engineering plastic sleeve bearings.

ii. Lubrication: Provide access for lubrication.

iii. Housings: Riveted to damper frames.

IV. Spindles:

i. Material: Bright zinc-coated steel.

ii. Minimum diameter:

(1) Blade lengths ≤ 600 mm: 10 mm.

(2) Blade lengths > 600 mm: 12 mm.

V. Linkage: Fix securely to blades so that the blades rotate equally and close tightly without slip.

e) Damper adjustment: Provide for adjusting the damper and locking it in position. Locate in an accessible position. Label the open and close positions clearly and permanently.

f) Non-return damper: Counterweight the assembly so that it offers minimum resistance to air flow, and closes by gravity.

6.6 FIRE AND SMOKE DAMPERS

a) Construction: Provide free cross section area at least 85% of the face area.

b) Activation:

I. Fire dampers: Fusible links.

II. Smoke dampers: Provide actuator controlled by fire alarm signals.

c) Access panels: Provide for maintenance of dampers, links and motors.

6.7 DAMPER ACTUATOR

a) Actuator: Provide LV electrical actuator for all volume control dampers which are designed for automatic control by the BMS/fire alarm and control system. Provide power supply from the mechanical switchboard.

b) Type: Electronic, incorporating a disengagement mechanism that permits manual operation in the event of power failure without disconnecting the actuator. Provide a position indicator on the actuator.

c) Position feedback: Provide position feedback for remote monitoring by BMS.

d) Protection: Minimum IP54 enclosure. If the actuator is located outdoors provide additional weather protection.

e) Overload and stall: Protect actuators against overload. Provide electronic or magnetic clutch type stall protection effective throughout the entire actuator stroke. Do not rely on end switches that require field adjustment.

f) Override: Provide an AUTO-OFF-MANUAL override switch to enable the position to be manually set.

g) Connection to damper: Provide non-slip connection to the damper shaft by means of toothed clamp or square or hexagonal holed link.

h) Motion: Power driven in both directions except where spring return is required.

i) Permanently mark normal operating position.

j) Spring return: Provide spring return for all dampers associated with air handling units.

k) Torque: The greater of the following:

I. 5 Nm/m^2 of damper area.

II. Sufficient to operate the damper smoothly and without overload through its entire travel, including tight shut-off.

l) Large dampers: Divide dampers into sections to limit the operating torque to ≤ 15 Nm per section. Provide an independent drive shaft for each section sized to withstand the operating torque.

6.8 ACCESS OPENINGS

a) General:Provide access openings as required for operation and maintenance of equipment.

b) Access Panels

I. Size: Minimum clear opening:

i. Personnel access: 450 mm x 600 mm

ii. Hand access: 200 mm x 300 mm

II. Type: Double panel, deep formed, zinc-coated steel construction, insulated to match the duct.

III. Cold bridging: Minimise.

IV. Frames: Provide rigid matching galvanised steel frames securely attached to the duct.

V. Seals: Silicon rubber or soft neoprene gaskets mechanically fixed to either the panel or the frame to ensure an airtight seal when latched in the closed position. For fire rated seals, use woven ceramic fibre material.

VI. Latches: Wedge type sash latches.

VII. Number of latches:

i. For personnel access: 4

ii. For hand access: 2

c) Access Doors

I. General: Provide access doors reinforced to minimise distortion, and hinged so that internal air pressure holds doors closed.

II. Minimum clear opening: 1350 mm high x 600 mm wide.

III. Door swing: Against air pressure.

IV. Frames: Rigid matching galvanised steel frames securely mounted.

V. Door hardware: Provide proprietary heavy duty clamping-type latches, hinges and handles which can be operated from both sides of the door.

VI. Seals: Silicon rubber or soft neoprene gaskets mechanically fixed to the door to ensure an airtight seal when latched closed. For fire rated seals, use woven ceramic fibre material.

VII. Insulation: To match surrounding ductwork/plenum.

6.9 AIR DISTRIBUTION DEVICES

a) General: Provide devices for efficient air distribution.

b) Quality: Provide proprietary air diffusers and grilles which are:

I. Free from distortion, bends, surface defects, irregular joint, exposed fastenings and operation vibration;

II. Mounted with secured and concealed fixings; and

III. Complete with flanges lining corners neatly mitred and buffed, with no joint gaps.

c) Material: Steel or aluminium.

d) Finish: Powder coated to selected colour.

e) Bar Grille and Linear Diffusers

I. Finished appearance: Continuous and unbroken irrespective of the purpose of the slot. Blank off slots not used for supply or return air. For long lengths, provide aligning devices where necessary.

II. Air flow deflection:

i. Bar grille: With angled blades for air flow deflection.

ii. Linear diffuser: Provide an adjusting device that can be operated through the slot to allow 180° deflection of air pattern.

f) Ceiling Diffusers

I. Type: Multi-bladed, removable-core 4-way blow configuration, fitted with a blanking plate for 1, 2, or 3-way blow, as appropriate.

II. Face size: Unless otherwise specified, 600 mm x 600 mm.

III. Reducer necks: If the outlet neck is smaller than the outlet necessary to suit the louvre face size, provide a reducer neck.

IV. Mounting:

i. For plastic board ceiling: Surface mounted

ii. For T-bar ceiling: Flush mounted

g) Circular Diffusers: adjustable multi-core diffusers allowing variation of discharge pattern from horizontal to vertical by rotation of the centre core.

h) Side Wall Registers

I. General: Double deflection type with horizontal front louvre blades and vertical rear blades at 19 mm maximum centres, capable of field adjustment of air flow over the range $\pm$ 45°.

II. Blades > 600 mm long: Support at mid point on a notched support bar.

i) Return Air and Exhaust Grilles

I. Egg crate type: 13 mm grid core cubing, clip-in removable core. Use for ceiling mounting, egg crate grilles not permitted for wall return.

II. Half chevron type: Fixed louvre set, pitched at 25 mm blade spacing, 50% minimum area, screw-fixed removable core. Use for mounting height $\leq$ 2 m.

j) Plenum Boxes

I. General: Provide for all supply air diffuser and grilles.

II. Support of plenum boxes: Independently from the soffit above.

III. Flexible duct connections: Provide round or oval spigots on plenum box.

IV. Internal insulation:

i. Insulation type: Semi-rigid mineral wool, 25 mm minimum thickness.

ii. Surface facing type: Factory applied perforated aluminium foil laminate, painted matt black.

k) Volume control damper: Provide opposite action type damper adjustable through the diffuser/grille face.

6.10 SOUND ATTENUATORS

a) Type: Rectangular or circular, with or without internal pod.

b) Fire hazard properties: Fire hazard properties of sound attenuator shall be not less than those of the ductwork attached to.

c) Case: Galvanised sheet steel case stiffened.

d) Insulation: Heavy density acoustic infill with tissue facing and covered by perforated metal sheathing.

e) Weatherproofing: Wrap insulation with polyester film, and seal edges using aluminium foil laminate tape for attenuators exposed to weather and attenuator used in kitchen exhaust system

6.11 BUILT-UP PLENUMS

a) Sheet Metal Construction

b) Panels: Zinc-coated steel panels, folded to 450 mm maximum width with 50 mm edges and 15 mm returns.

c) Frames: Galvanised steel angles or channels.

d) Joints: Welded, or fold and bolt together using galvanised nuts, bolts and washers. Seal joints airtight and water tight using silicon sealant.

e) Material thickness: 1.6 mm minimum. Provide 50 mm x 50 mm x 5 mm galvanised steel bracing angles.

f) Sandwich Panel Construction

   I. Panels: Prefabricated cool room panels consisting of a sheet of insulation bonded at high temperature to metal skin on both sides.

   II. Frames: Extruded aluminium sections.

   III. Insulation: Single layer non-PVC insulation approved by FM Global of thickness to suit fan pressure and panel span and not less than 50 mm.

   IV. Metal skin: 0.6 mm minimum thickness zinc-coated steel sheet, factory pre-painted.

   V. Joints: Provide aluminium extrusions internally and externally at panel junctions and between panels. Apply a continuous bead of silicone sealant along extrusions to form an airtight seal.

g) Penetrations: Provide flanged sleeves for pipes and conduits. Fill the void between the sleeve and the panel using a one-part polyurethane sealant. Frame duct penetrations using aluminium channels.

h) Access: Provide an access panel or door to each compartment.

7 WATER HANDLING EQUIPMENT

7.1 PUMPS

a) Design

I. General: Provide centrifugal pumps for chilled water, condenser water and heating water reticulation systems.

II. Standard: To AS 2417: Rotodynamic pumps.

b) Type: Select from the following:

I. Single stage, radially split, end-suction, back-pull-out pump.

II. Back-pull-out in-line circulation pump.

c) Speed: Pumps shall be compatible with variable frequency control.

d) Single operation: Provide pumps with constant falling head v. quantity curves for stable operation with duty nearest to the best efficiency point for the impeller diameter.

e) Parallel operation:

I. General: Provide pumps with stable and constant falling head v. quantity curves, with no instability when operating either singly or in parallel at the same shaft speed.

II. Maximum difference between the individual shut-off heads: 10% of that of the pump with the lowest shut off head.

f) Selection: The design flow rate of the selected pump shall not exceed 80% of the maximum rating shown in the manufacturer's catalogue.

g) Positive suction head: Provide positive suction head.

7.1.1 END-SUCTION CENTRIFUGAL PUMP

a) Casings: Cast iron Grade T 220, or bronze for in-line circulating pump.

b) Shafts: Stainless steel Grade 431 or bronze.

c) Impellers: Stainless steel Grade 431 or Grade 836B bronze.

d) Couplings:

I. General: Direct couple pumps and motors using flexible spacer couplings which are enclosed in coupling guards.

II. Closed-coupling is acceptable for pump motor ≤ 5 kW.

e) Bearings:

I. General: Provide at least 2 deep groove ball bearings, widely spaced and selected for a minimum rating fatigue life of 17,500 hours.

II. Lubrication: Provide either grease or oil lubrication. Seal bearings against ingress of dust and moisture, using lip seals. Allow for release of lubricant. Provide grease nipples for grease lubrication.

f) Shaft seals: Provide mechanical seals compatible with carbon elements rotating against a ceramic stationary face.

g) Motors:

I. General: Provide electric motors compatible with pump requirement, giving efficient, non-overloading pumping units.

II. Minimum power rating: At least the maximum power required by the pump when projecting the system resistance curve to the maximum impeller size.

III. Minimum degree of protection: IP 54.

h) Bases: Mount pumps and motors on bases sufficiently rigid to prevent distortion. Select from the following:

   I. Mild steel plate cold-formed bases; and

   II. Fabricated bases of fully welded rolled steel channel sections.

i) Drip trays: For chilled water pumps, provide grade 316 stainless steel drip trays between the pump and the base, to catch condensate from the pump body.

   I. Size: Extend beyond the pump suction by 100 mm minimum, and beyond insulated pump flanges.

   II. Drainage: Provide 25 mm diameter sockets for drainage.

   III. Sealant: Seal between trays and pumps using silicon sealant.

   IV. Thermal insulation.

j) General: Adjust mountings to level the units. Align pumps and motors.

   I. Removable connections: Provide flanges for removal of pump casings without disturbing piping.

   II. Suction connections: Provide demountable pipe sections between pumps and system isolating valves for removal of impellers.

   III. Mounting: Fix water pump on inertia base, supported by spring mount.

7.1.2 IN-LINE CIRCULATING PUMP

a) General: Canned rotor type, Comply with the requirements end suction centrifugal pump except as follows.

   I. Mounting: Suitable for mounting with the shaft vertical or horizontal.

   II. Radial bearings: Ceramic sleeve or ball bearing.

   III. Axial bearings: Carbon/ceramic sleeve or ball bearing.

   IV. Casing arrangement: Back pullout.

   V. Sealing: Seal motors and electrical connections to protect against ingress of condensation.

7.2 FEED WATER AND EXPANSION TANKS (ATMOSPHERIC PRESSURE)

a) General: Provide tanks for chilled water and heating water systems.

b) Capacity: Sufficient to accommodate system expansion without overflowing.

c) Safe trays: Required.

d) Material:

   I. Tanks: 0.7 mm corrugated or swagged copper.

   II. Cover: 0.7 mm copper.

   III. Safe trays: 0.7 mm copper.

e) Accessories: Provide float valve make-up, fast fill make-up, overflow, tank drain, tray drain and system connection.

f) Tank stands: Provide galvanised steel support stands with 25 mm thick hardwood deck bolted to the frame, to suit the size of the safe tray.

g) Location: Locate tanks above the highest point of system.

7.3 WATER TREATMENT SYSTEMS

a) General: Provide water treatment to control microbes, scale and corrosion in chilled water systems, condensing water systems, and heating water systems. Water treatment system shall comprise valves, sensors, storage vessels, pumps, controller, filter, chemicals, piping and wiring. Chemical free water treatment systems are preferred.

b) Performance:

I. General: Provide water treatment to control the following:

i. Condensing water systems: Scale formation, corrosion, sludge accumulation and microbiological growth including legionnaire species.

ii. Chilled water systems and heating water systems: Scale formation, corrosion and sludge accumulation.

II. Corrosion rates: Limit corrosion rates to:

i. Mild steel and iron: 150 μm/year.

ii. Copper: 12 μm/year.

III. Compatibility: Water treatment shall suit the fluid being treated and the as-installed system construction.

IV. Chemicals: Chemicals used for water treatment shall:

i. Be suitable for the purpose.

ii. Not adversely affect, nor adversely affected by, the materials with which they are in contact.

iii. Be of types readily available locally.

iv. Not contain chromates, chromium and phosphorous compounds.

v. Not require pre-treatment of wastewater prior to discharge to sewer. The use of organometallic algaecides including tributyl tin oxide is prohibited.

V. Authority's approval: Submit evidence of authority approval for the use of the chemicals.

VI. Marking:

i. Hazard identification: Identify piping and storage vessels containing hazardous materials.

ii. Safety signs: If hazardous chemicals are to be stored, provide safety signs to AS 1319.

VII. Initial treatment:

i. Detergent flushing: After hydrostatic testing has been completed, release the testing water and flush piping systems using non-foaming alkali detergent solution.

ii. Cleaning and flushing: Introduce cleaning chemicals to piping systems and circulate continuously for at least 24 hours, with control and manual valves open. Drain the system and clean the strainers. Flush with clean water until cleaning chemicals are removed.

iii. Drain piping system and charge with chemically treated water.

VIII. Test kits: Provide in the main plant room a test kit, housed in a suitable purpose made lockable cabinet, comprising the apparatus and materials necessary to perform the test recommended by the manufacturer

7.3.1 WATER TREATMENT FOR CONDENSER WATER SYSTEM

a) General: Provide water treatment for the cooling towers, comprising of chemical dosing equipment, bleeding system, filters, controllers, chemicals, pipework and other auxiliary equipment.

b) Biocide dosing:

I. System: Provide automatically controlled biocide treatment direct into each system.

II. Materials: Rotate the type of biocide regularly according to schedules prepared by a suitably qualified person.

c) Dosing pumps: Variable stroke positive displacement type, electrically direct driven, of capacity and performance suitable to the operating head and to the type and quantity of the material to be pumped. Provide pump stroke frequency control to permit variation of the pumping period. Provide an isolating valve on the suction line. Connect the discharge line directly to the water system.

d) Automatic bleed

I. Provide automatic total dissolved solids control by means of a conductivity control unit (probe) activating a solenoid bleed valve in the water bleed line, and also activating the dosing pump to provide chemical dosing proportional to the bleed rate. Wire the control unit so that it is inoperative when the water circulation pump is shut down. Provide a conductivity indicator and an isolating valve on the sampling line to the unit. Control the range of conductivity to 0 to 4000 ms/metre.

II. Solenoid valves: Diaphragm type sized to the expected bleed off rate. Provide an upstream strainer and an isolating/throttling valve.

III. Stand-by bleed: Provide an additional bleed line for manual bleeding with a throttling valve.

IV. Bleed off rate: Minimum 6 cycles (5 cycles for projects in SA and WA) of concentration.

V. Discharge: Discharge bleed off over a tundish.

e) Control panel:

I. General: Provide a water treatment control panel to control and monitor the performance of each water treatment system.

II. Type: The controller shall be of microprocessor based (industrial quality microprocessor) with non-volatile memory, designed for the particular water treatment programme used for the project.

III. Control: The controller, with probes, sensors, valves and other auxiliary equipment, shall automatically regulate chemical dosage and conductivity based on the demand of the water treatment system to maintain the set parameters for efficient water treatment.

IV. Monitoring: The controller shall continuously monitor the pH value, ORP, conductivity and water temperature of the water systems.

V. Data logging and storage: The controller shall provide logging of all measured parameters and dosages, and shall store the data internally for 30 days on 24/7 basis.

f) Interface with BMS: Provide high level interface with BMS at the control panel based on BACnet protocol for remote control, monitoring and indication. Provide BACnet gateway if necessary.

g) Filters:

I. General: Provide a proprietary filter system for each condensing water system, consisting of storage tanks, sand filter or high-efficiency cartridge, piping, valves, instrument timers and controls to provide automatic backwashing.

II. Backwash system: Complete with piping, valves, pressure gauges and ancillary devices to indicate the need for backwash.

III. Backwash cycle: Initiated by automatic timer with provision for manual over-ride.

h) Quantity: Supply sufficient quantities of chemicals to treat the water from the time of initial filling to the end of the Defects Liability Period.

i) Storage tanks: Low density polyethylene construction with lid, sized to ensure sufficient capacity between service visits.

7.3.2 WATER TREATMENT FOR CHILLED WATER AND HEATING WATER SYSTEM

a) General: For each individual system to be treated provide a separate chemical dosing system consisting of a by-pass slug-dose feeder vessel employing discharge flow to flush chemicals into the system.

b) Feeder vessels: Provide a storage tank capable of withstanding the maximum pump pressure. Provide a funnel, DN 15 piping and valves for adding chemicals, a vent line with valve, a DN 15 drain line with valve discharging to drain, and a DN 15 outlet line with valve.

c) Test loops:

   I. General: Provide loops in chilled water and heating water circulation systems containing corrosion coupons representing the respective metals in the system.

   II. Standard: To ASTM D 2688.

   III. Coupons: Suitable for changing every 3 months.

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8 PIPEWORK

8.1 GENERAL

a) Design pressure: Base design pressures on:

I. The maximum hydrostatic head at the location;

II. The pump shut-off head at the maximum impeller size; and

III. The minimum working pressure 1000 kPa.

8.2 REFRIGERATION PIPEWORK

a) Refrigeration Circuit: Conform to equipment manufacturer's recommendations for the refrigerant used. Provide refrigeration piping designed and installed so that the complete system meets the documented performance under the documented operating conditions.

b) Refrigerant pipe and fittings: Copper.

c) Design:

I. Suction lines: Size for pressure drop < 1.0 K saturated suction temperature at documented supply air flow, documented cooling coil entering conditions, documented condenser air entering condition and unit manufacturer's rated total capacity, saturated condensing temperature and saturated suction temperature under the above conditions.

II. Oil return: Size for oil return to compressor. Where velocity for oil return would result in the suction line pressure drop exceeding pressure drop limit, provide double suction risers. Prevent oil draining back on the off cycle.

III. Liquid lines: Size for pressure drop < 1.0 K saturated liquid temperature when handling the manufacturer's unit capacity under the operating temperatures stated in the schedules.

d) Accessories: Provide necessary refrigerant circuit accessories, including but not limited to the following:

I. Discharge mufflers (internal or external type).

II. Liquid line filter driers, full flow, with replaceable cartridge.

III. Isolation valves before filter drier.

IV. Liquid line solenoid valves.

V. Liquid line sight glass moisture indicators.

VI. Refrigerant charging valves.

VII. Suction, discharge and oil pressure indicators, either gauges or digital readout from transducers via microprocessors based control module, as appropriate.

VIII. Expansion devices.

IX. Flexible braided piping for vibration isolation.

e) Reverse cycle system: Provide refrigerant reversing valve and an effective outdoor coil defrost facility that prevents room temperature dropping more than 2 K during defrost.

f) Refrigerant and oil charge: Charge the refrigeration system with refrigerant and compatible lubricating oil.

g) Valves and Accessories

I. Isolating valves:

i. Screw capped angle valves: ≤ DN 15.

ii. Diaphragm valves: > DN 15.

iii. Packed and capped globe valves: > DN 15.

II. Expansion valves: Thermostatic expansion valves: No limitation.

III. Line valves

i. Valve bodies: Forged brass with flow indication.

ii. Diaphragm valves: Incorporate mounting feet-integral with valve body, with at least 2 fixing holes.

iii. Packed and capped globe valves: Back seating valves with renewable nylon or Teflon seats, packed spindle and removable gland cap.

IV. Solenoid valves: Replaceable solenoid coil without disturbing the valve body or the refrigerant piping.

V. Thermostatic/electronic expansion valves: Of sufficient size and range to allow for load variations. Provide valves individually adjusted to maintain satisfactory superheat at each suction header without excessive slop-over and with good shut-off at light loads. Clamp the thermal bulb to the suction pipe in the recommended position and cover with insulation.

h) Dryers: Provide casings designed to contain solid cored desiccant. Provide for minimum water capacity to ANSI/ARI 710 at maximum refrigerant flow, 13.8 kPa pressure drop, and standard temperature.

i) Strainers: Provide casings incorporating a mesh screen with welded seam and reinforced or capped ends.

j) Liquid receiver:

I. Criteria: If the entire refrigerant charge cannot be stored in less than 80% of the internal volume of the condenser, provide a liquid receiver.

II. Minimum size: To accommodate 125% of the refrigerant charge.

k) Accessories: Provide the following:

I. Plugged tapping.

II. Liquid level gauges.

l) Installation Layout: Install pipework in straight lines and uniform grades without sags. Locate condensers minimum 1.5 metres above compressors.

m) Grade:

I. Horizontal hot gas lines and suction lines at not less than 1 in 200 in the direction of gas flow.

II. Liquid condensate lines at 1: 50 or steeper down to liquid receivers or traps. Make reductions in pipe size in vertical legs only.

n) Flexibility: Incorporate at lease 3 changes in direction between the compressor and the first anchor point.

o) Oil circulation: Ensure positive oil return to compressor. Prevent oil draining back into the head of the compressor during the off cycle.

p) Crankcase equaliser lines: Provide crankcase equaliser line level, without pockets. Prevent gas locking using either isolating valves or refrigerant ball valves.

q) Instrumentation lines: Make instrumentation lines as short as possible, and provide anti-vibration loops and pulsation elimination devices.

r) Pipes exposed to elements: Enclose refrigerant pipes, which are exposed to elements in ventilated metal duct/trunking. Clamping/fixing of pipework with rubber sleeves to absorb vibration.

s) Refrigerant charging: Provide for charging and withdrawal of refrigerant.

8.3 WATER PIPEWORK

8.3.1 WATER PIPES

a) Pipe and Fittings Table:

APPLICATION	MATERIAL	PIPE SIZE (mm)	FINISH
CHILLED WATER	Seamless steel pipe	All sizes	Plain
	Seamless copper pipe	All sizes	Plain
	ABS	All sizes	Plain
CONDENSER WATER	Stainless steel pipe	All sizes	Plain
	ABS	All Sizes	Plain
HEATING WATER	Seamless steel pipe	All sizes	Hot dip galvanised internal and external
	Seamless copper pipe	All sizes	Plain
VENTS,DRAIN, OVERFLOW, ETC.	Copper pipe	All sizes	Plain

b) Fittings

Use manufactured bends, tees and reducers only. Provide long radius elbows or bends where practicable. Use swept branch connections. Use elbows or short radius bends where pipes are led up or along walls and then through to fixtures. Do not use mitred fittings.

c) Standard:

I. Copper pipes: hard drawn.

II. Steel pipes:

i. For closed circuit:

ii. For open circuit: Do not use steel pipe.

III. Stainless steel pipes: spiral butt welded from stainless steel sheet. Grade 316L.

IV. ABS pipes:

8.3.2 VALVES AND ACCESSORIES

a) General: Provide valves and accessories necessary for throttling, flow and temperature measurements and isolation purposes in water reticulation systems, either as individual components or as combined units.

b) Valve size: Generally at least the nominal pipe size, unless a smaller size is necessary for the intended purpose.

c) Working pressure rating: Minimum 1.4 MPa and to suit the system pressure requirements.

d) Working temperature rating: To suit the system requirements.

e) Insulated valves: Provide extended shafts or bodies to butterfly and ball valves to allow full thickness of insulation.

f) Connections: To suit piping system.

g) Hand wheels and handles: Removable, with the direction of closing marked permanently on hand wheels.

h) Copper alloy valves: Dezincification resistant and stamped accordingly.

i) Valve Table:

Function	Valve Type	Size Range (mm)
Isolation	Gate valve	All sizes
	Ball valve	≤ DN 50
	Butterfly valve	> DN 50
Throttling or balancing	Calibrated balancing valve	All sizes
	Automatic balancing valve	All sizes
Control valve – Mixing or diverting	Proprietary combined set of pressure control and control valves	All sizes
	Proprietary dynamic control valve	All sizes
Control valve – Isolation/shut-off control	Ball valve	≤ DN 50
	Butterfly valve	> DN 50
Non-return	Swing check	≤ DN 65
	Dual flap	> DN 65

j) Gate Valves

I. Description: Straight-through flow, solid wedge type, inside screw design, medium pattern.

II. Materials:

i. Body:

ii. ≤ DN 80: Bronze.

iii. > DN 80: Cast iron.

iv. Seats: Integral seat for bronze valves, replaceable bronze seats for cast iron valves.

k) Ball Valves

I. Description: Full bore pattern with handle parallel to the direction of flow when the valve is fully open.

II. Materials:

i. Body: Bronze.

ii. Ball: Hard chromed brass.

iii. Gland seal: Adjustable.

iv. Seat: PTFE.

l) Butterfly Valves

I. Description: Lug type.

II. Standard: To AS 4795.

III. Operation:

i. ≤ DN 150: Positive locating bar, parallel to the disk with notch plate.

ii. > DN 150: Geared operators.

IV. Materials:

i. Body: Cast aluminium or cast iron.

ii. Shaft: Stainless steel.

iii. Disk: Bronze generally, stainless steel for condenser water systems.

iv. Seat: Bonded EPDM.

m) Balancing Valve

I. Provide balancing valves for balancing and flow control.

II. Calibrated balancing valve:

i. Continuously adjustable graduated limit stop for precise setting of the maximum valve opening position, and pressure tapping across the variable orifice.

ii. Materials:

(1) Body: Copper alloy.

(2) Seat: PTFE.

n) Automatic balancing valve

I. Pre-settable valves that automatically control flow rate within ± 5% accuracy independent of pressure fluctuation in the system, with an internal spring loaded cartridge control mechanism and external tapping for pressure and temperature measurement.

II. Materials:

i. Body: To suit the piping and fluid.

ii. Cartridge: Passivated stainless steel or PTFE based thermoplastic materials.

o) Control Valves

I. General: Provide control valves for cooling and heating coils.

II. Type: Pressure independent control valves complete with actuator, either as a combination of pressure control valve and control valve, or a dynamic control valve.

III. Demand authority: Retain full authority through the control range.

IV. Characteristics: Select valves with the following characteristics:

i. 2-way valves - general: Equal percentage characteristics; linear or equal percentage characteristics for bypass control.

ii. 3-way valves – for load at end of each branch circuit: Linear characteristics.

iii. Isolation or shut-off control: Quick acting characteristic without causing water hammer.

p) Dynamic control valve: Proprietary valve combining flow regulation valve, differential pressure control valve and automatic modulation control valve in a 3-in-1 design. Flow can be preset at an external dial, and the pressure control cartridge can be removed for flushing through the valve before commissioning. The valve shall have integrated plug for connection of pressure/temperature gauge.

I. Valve pressure drop at design flow rate: Provide valves selected as follows:

i. Modulating control of heat exchange devices: Sufficient to achieve accurate control under all operating conditions. Select coil control valves for 100% to 150% of coil pressure drop at maximum flow.

ii. Open cooling tower bypass: ≥10 kPa but not more than the static head between the tower spray nozzle or distribution tray and the sump.

iii. Isolation and shut-valves: Full line size and selected for ≤ 5 kPa at maximum flow.

II. Rangeability: ≥ 40.

III. Material:

i. Body: Brass

ii. Shaft: Stainless steel.

iii. Cartridge: Stainless steel.

q) Control Valve Actuator

I. Type: Electronic, incorporating a disengagement mechanism that permits manual operation in the event of power failure without disconnecting the actuator. Provide a position indicator on the actuator.

II. Characteristic: Modulating; when de-energised, the actuator returns the controlled device to 'open'.

III. Power supply: 24V a.c.

IV. Control signal: 0-10 V d.c, 1 mA.

V. Position feedback: Provide position feedback for remote monitoring by BMS.

VI. Protection: Minimum IP54 enclosure. If the actuator is located outdoors provide additional weather protection.

VII. Overload and stall: Protect actuators against overload. Provide electronic or magnetic clutch type stall protection effective throughout the entire actuator stroke. Do not rely on end switches that require field adjustment.

VIII. Override: Provide an AUTO-OFF-MANUAL override switch to enable the position to be manually set.

r) Non-Return Valves

I. Non-return valves: Provide non-return valves at the discharge

II. Materials:

i. Body: Bronze or cast iron.

ii. Pin and spring: Stainless steel.

iii. Seat: Integral Nitrile rubber.

iv. Plates: Bronze or stainless steel.

s) Float Valves

I. Materials:

i. Body: Bronze.

ii. Needle and pins: Bronze.

iii. Float: Copper

iv. Linkage: Copper or stainless steel.

t) Strainers

I. General: Provide strainers as follows:

i. At the water pump return line.

ii. At the supply line of cooling/heating coils.

II. Pressure drop: 15 kPa maximum.

III. Materials:

i. Body: Bronze or cast iron.

ii. Screen: Stainless steel.

IV. Strainers > 65 mm diameter: Fit a 25 mm ball valve blow-down.

u) Automatic Air Vents

I. Description: Float operated.

II. Materials:

i. Body: Copper alloy.

ii. Float: Non metallic.

iii. Seat: Stainless steel.

v) Combined Air and Dirt Separator

I. General: Provide a combined air and dirt separator for chilled water and heating water reticulation system. Locate the separator in the return of the water pump. The separator shall automatically and continuously remove air and dirt from the system.

II. Construction: Heavy gauge steel cylindrical case complete with removable bottom and flanged inlet and outlet connections.

III. Accessories:

i. Automatic air release valve.

ii. Drain valve.

8.3.3 FEED AND EXPANSION TANK

a) Type: Open type or closed type with pressurisation unit.

b) Capacity: To suit the system.

c) Construction: Open type tank shall be manufactured from stainless steel or copper complete with safety tray, lid and float valve.

8.4 INSTRUMENTS

a) General: Provide instruments necessary for balancing, monitoring and measurement purposes.

b) Pressure Gauges

- Provision: Provide pressure gauge at inlet and outlet of water pump.
- Bourdon pipe type.
- Scale range: At least 130% maximum working pressure.
- Construction:

i. Case: Glass filled nylon. Minimum diameter 100 mm.

ii. Lens, dial: UV stabilized polycarbonate.

iii. Configuration: Direct mounting, bottom entry.

iv. Bourdon pipe material: Stainless steel for hot water systems. Phosphor bronze for other services.

c) Gauge plug: Provide pressure and temperature gauge plug at inlet and outlet of cooling and heating coil. Provide control cocks.

d) Thermometer

I. Provision: Provide thermometer at inlet and outlet of water pump.

II. Type: Mercury in steel dial thermometers.

III. Accuracy: ± 1% of full-scale deflection.

IV. Construction:

i. Case: Glass filled nylon. Minimum diameter 100 mm.

ii. Lens, dial: UV stabilised polycarbonate.

iii. Bulb: Grade 316 stainless steel.

iv. Configuration: Direct mounting, bottom entry.

e) Thermometer wells and pockets

I. General: Provide thermometer wells/pockets at inlet and outlet of cooling and heating coil.

II. Type: Construct for use with the sensing element. Use the same material as the pipe, weld or braze to pipe. Fill with conductive medium.

III. Size: Minimum 10 mm internal diameter, at least 75 mm into the pipe.

8.5 INSTALLATION

a) General: Before installations, remove loose scale, burrs, fins and obstructions.

b) Protection: During construction, prevent the entry of foreign matter into the piping system by temporarily sealing the open ends of pipes and valves, using purpose-made covers of pressed steel or rigid plastic.

c) Install pipes in straight lines at uniform grades with no sags. Arrange to prevent air locks. Provide sufficient unions, flanges and isolating valves to allow removal of piping and fittings for maintenance or replacement of plant.

d) ABS pipes .

e) Grading: Grade to rise in the direction of flow to points of air venting. Minimum grading: 1 in 200.

f) Arrangement: Arrange and support piping so that it remains free from vibrations whilst permitting necessary movements. Minimise the number of joints.

g) Spacing: Provide at least 25 mm clearance between pipes and between pipes and building elements, additional to insulation.

h) Dissimilar metals: Joint dissimilar metals using fittings of electrolytically compatible material.

i) Embedded piping: Do not embed piping in masonry or concrete structure elements.

j) Valves:

I. If practicable, install with the stem horizontal.

II. Non-return valves: Provide at least 6 pipe diameters of straight pipe on the upstream side.

III. Instruments: Install instruments vertically free from vibration. Provide gauge line connection cocks.

k) Accessibility: Provide access and clearance at fittings that require maintenance or servicing, including control valves and joints intended to permit pipe removal. Arrange piping so that it does not interfere with the removal or servicing of associated equipment or valves, or block access or ventilation openings.

l) Support Systems

I. General: Provide proprietary support systems of galvanised or zinc-coated steel construction.

II. Saddles: Do not use saddle type supports for pipes ≥ DN 25.

III. Vertical pipes: Provide anchors and guides to maintain long pipes in position, and supports to balance the mass of the pipe and its contents.

IV. Uninsulated pipes: Clamp piping supports directly to pipes.

V. Insulated pipes:

i. Spacers: Provide spacers at least as thick as the insulation between piping supports and pipes. Extend either side of the support by at least 20 mm.

ii. Spacer materials: Rigid insulation material of sufficient strength to support the piping, and suitable for temperature application.

iii. Vapour barriers: For cold pipes apply aluminium foil tape over the circumference of the spacer to form a vapour barrier.

iv. Metal sheathing: Provide a 0.55 mm thick zinc-coated steel band between the aluminium foil tape and the support for the full width of the spacer.

VI. Support spacing:

i. Steel pipes: To AS 4041 Table 3.28.2.

ii. Copper pipes: To AS 4809 Table 6.2.

iii. Other pipe: To AS/NZS 3500.1 Table 5.2.

VII. Anti-vibration mounting: Support all pipes in chiller plant rooms with anti-vibration mounting.

m) Flexibility

I. General: Provide pipe anchors offsets or expansion devices and pipe guides which accommodate expansion and contraction, and minimise the transmission of vibration and noise to building structures. Locate anchors and guides at equal distance at each side of expansion devices. Securely clamp anchors to bare pipes. If limitations in the strength of structures preclude the use of expansion devices and anchors, arrange piping to move in lateral and linear directions (e.g. at bends) while not deviating from gradients.

II. Flexible connections: Minimise the transmission of vibration and noise through the piping. Provide flexible connections between piping and vibrating sources, using:

i. Water piping: Reinforced rubber type with spherical shape and flanged ends for connection to major plant items, or proprietary flexible grooved coupling.

ii. Elsewhere: Flexible nylon hose.

n) Joints

I. General: Minimise the number of joints.

II. Steel pipes: Provide 'Victaulic' mechanical grooved coupling for pipes and fittings of 50 mm diameter and above; non-welding coupling system for pipes and fittings below 50 mm.

III. Copper pipes: Provide 'Victaulic' mechanical grooved coupling for pipes and fittings of 50 mm diameter and above.

IV. ABS pipes: Use solvent welding.

V. Demountable joints: Provide demountable joints:

i. At connections to mechanically cleanable heat transfer vessels and pumps; and

ii. At maintenance locations.

o) Drains

I. Water systems: Provide valved drains to the bottom of riser piping and as necessary to drain water completely from piping.

II. Drain size: Minimum DN 20. Match equipment drain size if larger.

III. Drain points: Pipe drains to discharge points via air breaks.

p) Air Release Vents

I. General: Provide air release vents at:

i. High points of the system;

ii. Sections of the piping in which air may collect; and

iii. Upstream from each item of equipment.

II. Material: Copper pipe.

III. Size: 15 mm minimum.

IV. Water systems: Provide automatic air vents.

9 INSULATIONS

9.1 GENERAL

a) General: Provide insulation to hot and cold piping, flues, exhaust pipes, tanks vessels, ductwork and plant.

b) Material: Insulation material shall be:

I. Of zero Ozone Depleting Potential (ODP) in manufacturing and composition;

II. Non-PVC material such mineral wool and glass wool.

III. FM Global listed.

IV. Delivered to site in packaging labelled FBS-1 BIO-SOLUBLE INSULATION including the following label.

c) Fire hazard indices for all materials:

I. Spread of flame index: 0.

II. Smoke developed index: ≤ 3.

9.2 DUCTWORK INSULATION

a) Extent of insulation: Insulate the following:

I. Air conditioning supply air ducts.

II. Air conditioning return air ducts, except those in the air conditioned space.

III. Air conditioning plenum chambers.

IV. Air handling units.

V. Ductwork and plenums requiring acoustic treatment.

b) Insulation systems:

Application	System	Form of Insulation	Min Thickness *	Outer Finish	Securing Method
S.A./R.A. duct – General	External Insulation	Matt	25 mm	Aluminium foil	Mechanical/ Adhesive
S.A./R.A. duct - Outdoor - Subject to mechanical damage - 6m from AHU - Inside AHU/plant room	Internal Insulation	Matt	25 mm	Perforated aluminium foil	mechanical
Factory fabricated AHU	Insulated sandwich panel		50 mm	Factory finish	Manufacturer standard

Application	System	Form of Insulation	Min Thickness *	Outer Finish	Securing Method
Built-up AHU & Plenum	Insulated sandwich panel		50 mm	Factory finish	Manufacturer standard
	Internal insulation		50 mm	Perforated steel sheet	Mechanical/ Adhesive
Acoustic treatment	Internal Insulation	Semi-rigid board	50 mm	Perforated aluminium foil	Mechanical/ Adhesive

* Insulation shall also satisfy the thermal resistance/conductance requirement of Section J of the BCA, and the acoustic performance specified.

c) Installation: Install insulation and finish using adhesives and sealants with a VOC content of less than 70 grams of VOC per litre.

d) Vapour barrier: Provide a system with vapour barrier of classification High.

e) Fixing: Mechanically secure insulation onto ductwork using pins and speed clips. Secure speed clips flush to the surface of insulation. Cut off excessive length of pins after insulation. Cover fixing pins and speed nuts on external insulation with aluminium foil laminate tape.

9.3 PIPEWORK INSULATION

a) General: Provide insulation to hot and cold piping, flues, exhaust pipes, tanks vessels and plant.

b) Insulation systems

Application	Nominal Pipe Size	Insulation		Outer Finish		Securing Material
		Form	Min. Thickness *	Indoor	Outdoor/ Inside plant room/ Subject to mechanical damage	
Cold pipework	< 100 mm	Rigid/semi-rigid sections	25 mm	Aluminium foil	Zinc-coated steel cladding	Adhesive
	≥ 100 mm		50 mm			
Hot pipework	< 100 mm	Rigid/semi-rigid sections	25 mm	Aluminium foil		
	≥ 100 mm		50 mm			
Cold & hot vessels, tanks	All size	Sheet	50 mm	Plain		
Refrigeration Pipework	All sizes	Tube	25 mm	Plain		
Condensate drain	All size	Tube	25 mm	Plain		

* Insulation shall also satisfy the thermal resistance/conductance requirement of Section J of the BCA.

c) Refrigeration Pipework

I. General: Insulate all refrigerant piping that may sweat. Apply insulation un-slit where possible. If slit, refix slit faces with adhesive applied to full area.

II. Type of insulation: Chemically blown closed cell nitrile rubber or polyethylene in tubular form.

III. Physical properties:

i. Maximum thermal conductivity: 0.04 W/mK at 0°C.

ii. Moisture absorption: Non-hygroscopic.

iii. Water vapour permeability: ≤ 0.065 ng/Pa.m.s.

iv. Fire hazard properties:

(1) Spread of flame index: 0.

(2) Smoke developed index: ≤ 3.

v. Thickness: 13 mm for pipes ≤ DN 20, 19 mm otherwise.

d) Cold Pipework

I. General: Insulate pipework carrying fluids at temperatures below ambient including:

i. Chilled water piping.

ii. Condensate piping.

iii. Cold vessels e.g. chilled water storage tank, evaporator vessel of water chiller.

iv. Associated valves and fittings.

II. Exception: Do not insulate chilled water pumps.

e) Hot Pipework

I. General: Insulate the following:

i. Steam, condensate, heating, warm and hot water piping.

ii. Piping hazardous to personnel, including blow down piping.

II. Exception: Do not insulate hot water pumps.

f) Installation

I. Install insulation and finish using adhesives and sealants with a VOC content of less than 70 grams of VOC per litre.

II. Vapour barrier: Provide a system with vapour barrier of classification High.

III. Pipes exposed to elements: Protect pipes, which are exposed to elements, with metal canopy.

IV. Cladding material:

i. Material: Metallic-coated sheet steel, 0.55 mm minimum thickness coating class Z275.

ii. Fixing: Select from the following:

(1) Clamp sheathing at 500 mm maximum centres with 12 x 0.55 mm metallic-coated sheet steel straps.

(2) Fix sheathing with screws or rivets at 150 mm maximum centres. Do not penetrate the vapour barrier. Protect the vapour barrier with reinforced cloth tape.

V. Weatherproof external joints and fixings with silicone sealant.

g) Serviceable items: Provide removable boxes or cover plates to equipment requiring maintenance. Provide proprietary toggle action catches for removable boxes. The following equipment requires maintenance:

I. Valves.

II. Strainers.

III. Flexible connections.

IV. Demountable joints.

V. Flow measuring devices.

10 ELECTRICAL INSTALLATION

10.1 GENERAL

a) Compliance: In addition to items noted following comply in all aspects with the Scentre General Specification for Electrical Services, such version as issued with the contract documents.

b) Isolation: Provide local isolation device for equipment which cannot be sighted from the control switchboard. The isolation device shall be lockable or housed in a securable enclosure.

10.2 SWITCHBOARDS

10.2.1 GENERAL

Provide proprietary switchboard assemblies, or custom-built assemblies that are type tested.

10.2.2 DESIGN

a) Service conditions: Normal service conditions.

b) Short-circuit capacity: Rate main circuit supply and function units as follows:

I. Back-up protective device not provided: Rated short-circuit current for one second.

II. Back-up protective device provided: Rated short-circuit current for the maximum opening time of the associated protective device.

c) Tested levels: Do not use equipment at fault levels higher than tested levels, unless provided with current-limiting back-up protection.

d) Separation:

I. Switchboard for essential services: Form 2B unless required to be Form 3B if ≥ 800A

II. Switchboards for chillers and switchboards that supply other switchboards: Form 2B.

III. Others: Form 1.

e) Degree of protection:

I. In plant rooms: IP 42.

II. Outdoor use: IP 56.

f) Segregation: Segregate BCA emergency equipment from non-emergency equipment by means of metal partitions designed to prevent the spread of a fault from non-emergency equipment to emergency equipment.

g) Selector switches: Provide 'ON-AUTO-OFF' selector switches mounted on the door/cover for electrical equipment. When the switch is in the 'AUTO' position the operation of the equipment will the controlled by the automatic control system or the BMS.

h) Spare capacity: Provide at least 25% spare capacity for load, and at least 25% spare capacity for space

i) Mounting:

I. Floor mounted: Assemblies generally.

II. Wall mounted: Front access assemblies with frontal area < 2 m^2.

10.2.3 CONSTRUCTION

a) General: Provide rigid, ventilated, insect-screened enclosures consisting of panels, doors giving the designated enclosure separation and degree of protection.

b) Compartments: Separate shipping sections, subsections, cable and busbar zones, functional unit modules and low voltage equipment compartments using vertical and horizontal steel partitions which suit the layout and form of separation.

c) Steel enclosures:

   I. General: Minimum 1.6 mm thick zinc-coated steel coating class Z200.

   II. Outdoor assemblies: Coating class Z450.

d) Insect proofing: Cover ventilation openings using non-combustible and non-corroding 1 mm mesh.

e) Connection:

   I. Indoor cable entries: Top or bottom.

   II. Outdoor cable entries: Bottom.

f) Equipment spacing: Provide sufficient thermal, mechanical and electrical clearance between equipment to ensure proper functioning.

g) Ventilation: Provide ventilation, natural ventilation or mechanical ventilation if necessary, to maintain design operating temperatures at full load.

h) Earth continuity: Effectively bond equipment and assembly cabinet metal frame to the protective earth conductor.

i) Cable entry: Provide cable entry facilities within assembly cable zones for incoming and outgoing power and control cabling. Provide sufficient clear space within each enclosure next to cable entries to allow incoming and outgoing cables and wiring to be neatly run and terminated, without undue bunching and sharp bends.

j) Cover plates and gland plates: 5 mm thick aluminium cover plate and gland plate to maintain the degree of protection.

k) Escutcheons (Hinged) to shield busbars.

l) Design to minimise EMF by collocating Neutral busbars with phase busbars. Limit EMF to 10 milligauss in regularly occupied areas.

m) Extent: Apply protective coatings to internal and external metal surfaces of assembly cabinets including covers, except to stainless steel, galvanised, electroplated, or anodised surfaces and to ventilation mesh covers.

n) Finish coats: Thermoset powder coating or two-pack liquid coating of AS/NZS 3750.13 primer and proprietary or epoxy acrylic full gloss spray finish to the factory finishes schedule.

o) Finish schedule:

   I. Assembly exterior:

      i. Non-essential section: Harbour blue, Ref. No. B24.

      ii. Essential section: Signal red, Ref. No. R13.

   II. Assembly interior: White.

p) Busbars

   I. General: Provide main circuit supply busbars within assemblies, extending from incoming supply terminals to the line side of protective equipment for outgoing functional units and for future functional units.

   II. Material: Hard-drawn high-conductivity electrolytic tough pitched copper alloy bars, designation 110.

   III. Temperature rise limits - active and neutral conductors: Maximum rated current temperature rise limits: 65 $\pm$ 1.5 °C by type test.

   IV. Maximum short-circuit withstand current temperature rise limits: 160 °C.

   V. Phase sequence: For main busbars and connections to switching devices, setout phase sequence for phases A, B and C, from left-to-right, top-to-bottom and back-to-front when viewed from the front of the assembly.

q) Colour coding:

I. General: Provide 25 mm minimum width colour bands permanently applied to busbars at 500 mm maximum intervals with at least 1 colour band for each busbar section within each compartment.

II. Active busbars: Red, white and blue respectively for the A, B and C-phase.

III. Neutral busbar: Black.

IV. MEN link: Green-yellow and black.

V. Protective earth busbar: Green-yellow.

VI. Restrictions: Do not use adhesive type colour bands.

r) Current carrying capacity:

I. Active conductors: Equal to maximum frame size rating of the functional unit. For multiple functional units, do not apply diversity factor. Take into account thermal stresses due to short circuit current, assuming magnetic material enclosures located indoors in well-ventilated rooms and 90 °C final temperature.

II. Neutral conductors: Same as the active conductors of the circuit.

III. Protective earth conductors: Size for at least 50% of the rated short circuit withstanding current for 100% of the time duration.

IV. Fault current limiters: Rate busbars connected to fault current limiters to 100% of the indicated fault current limiter circuit breaker frame size or fuse base rating.

s) Busbar links: For current transformers, provide removable busbar links ≤ 450 mm long.

t) Busbar insulation: Active and neutral busbars and joints: Heat shrink material.

10.2.4 WIRING

a) General: Provide power and control wiring from mechanical services switchboards to all electrical equipment, sensing devices and control devices including VCD and valve actuators.

b) Cable type:

I. Low voltage: 0.6/11 kV copper cables. Use V-90HT insulation where directly connected to active and neutral busbars.

II. Extra low voltage: Cable to suit the application.

c) Cable entries:

I. General: Neatly adapt one or more cable entry plates, if fitted, to accept incoming cable enclosure. Use the minimum number of entry plates to leave spare capacity for future cable entries. Do not run cables into the top of weatherproof assemblies.

II. Single core cables rated > 300 A. Pass separately through non-ferrous gland plates. Do not use metal saddles.

d) Cable Terminations:

I. Connection to circuits ≤ 6 mm^2: Provide DIN-type tunnel terminal blocks.

II. Connection to circuits > 6 mm^2: Provide stud type terminals ≥ 5 mm diameter, sized to continuously carry the load.

III. Tunnel terminals: Provide insulated sleeve ferrules to flexible cables terminated in tunnel terminals.

IV. Identification: Identify cables at both ends using neat ring-type ferrules.

V. Arrangement: Terminate internal wiring to one side of the terminal block, leaving the other side for outgoing circuits.

VI. Grouping: Provide separate terminal groups for final subcircuits and control wiring. Provide oversized barriers between each group of terminals having different voltages and terminal size.

VII. Facilities for interface with BMS: Provide dedicated termination blocks for connection and termination of BMS communication cables.

e) Control and indication circuits: Minimum size: 1 mm^2 with 32/0.2 stranding.

f) Control and indication circuits: Cable colours: Colour code wiring as follows:

I. A phase: Red.

II. B phase: White.

III. C phase: Blue.

IV. Neutral: Black.

V. Earthing: Green-yellow.

10.3 SWITCHGEAR AND CONTROL GEAR

10.3.1 GENERAL

a) Rated making capacity (peak): ≥ 2.1 x fault level (r.m.s) at assembly incoming terminals.

b) Utilisation category:

I. Circuits consisting of motors or other highly inductive loads: At least AC-23.

II. Other circuits: At least AC-22.

III. Fuses:

i. Distribution/general purpose: gG.

ii. Motors: gM.

c) Coordination: Select and adjust protective devices to discriminate under over-current and earth faults

10.3.2 SWITCHGEAR

a) Operation: Independent manual operation including positive ON/OFF indicator

b) Breaking range and utilisation category:

c) Operation: Independent manual operation including positive 'ON/OFF' indicator.

d) Locking: If specified, provide for padlocking in the 'OFF' position.

e) Control and Testing Switches

f) Degree of protection: At least the degree of protection of the assembly.

g) Push buttons

I. Type: Oil-tight, minimum 22 mm∅, or 22 mm x 22 mm.

II. Rated operational current: At least 4A at 240 V a.c.

III. Marking: Identify functions of each push-button. For latched 'STOP' or 'EMERGENCY STOP' push-buttons, state instructions for releasing latches.

h) Rotary switches:

I. Type: Oil-tight, minimum 22 mm∅, or 22 mm x 22 mm.

II. Rated operational current: At least 4A at 240 V a.c.

III. Marking: Identify functions of each push-button. For latched 'STOP' or 'EMERGENCY STOP' push-buttons, state instructions for releasing latches.

10.3.3 MOTOR STARTERS

a) Standard: To AS 60947, all parts.

b) Type:

I. General: Direct-on-line starter.

II. Power rating exceeding 75 kW: Electronic starter with soft starting.

c) Performance:

I. Rated duty: Intermittent class 12.

II. Utilisation category: AC-3.

III. Mechanical durability: ≥ 3 million cycles ~~to AS 60947.4.1.~~

IV. Electric durability: ≥ 1 million operations at AC-3 ~~to AS 60947.4.1~~.

d) Motor protection: Provide:

I. Over-current protection.

II. Single-phase protection.

III. Thermal protection.

10.3.4 VARIABLE SPEED DRIVE (VSD)

a) Standards: To AS 61000, AS 61800.2, AS 61800.3, AS 61000-3-12: Adjustable speed electrical power drive systems – General Requirements.

b) Type: Microprocessor controlled, solid-state electronic type, providing motor speed control of 3 phase squirrel cage induction motors by means of stepless variable frequency, variable voltage pulse width modulated (PWM) output. Specifically designed for mechanical services, having output voltage and frequency matching the quadratic load torque output of the centrifugal fan and pump.

c) Design: Provide the following:

I. Soft starting (initially start motors on low speed).

II. Adjustable maximum current limit.

III. Automatic reset/restart of system after removal of fault or power failure condition. If the number of reset/restart attempts is limited for safety and equipment protection, provide for safe shut down and manual restart in the event of an unsuccessful attempt at the reset/restart sequence.

IV. Ability to immediately restart a motor following momentary interruption of supply, even if the motor is rotating, or rotating in the reverse direction.

V. Protection: Provide protection against:

i. Instantaneous power failure.

ii. Instantaneous over current.

iii. Internal and external overload.

iv. Under and over voltage.

v. Over temperature of the controller.

vi. Earth fault.

vii. Contact with live parts without the removal of fixed covers or panels.

VI. Motor protection:

i. General: Provide automatic, electronic motor thermal overload protection facility wherein the tripping time is based on the motor's running frequency, actual motor current, operating time, and the rated current.

ii. Motors ≥ 22 kW: Provide PTC thermistor input to initiate motor shutdown under fault conditions.

d) Harmonics and EMC:

I. General: Provide integrated harmonic suppression filters to limit the harmonics to within the value prescribed by the electricity distributor for the motor load and environment.

II. Authorities: Comply with the requirements of the Australian Communications Authority.

e) Control: Provide facilities for local display and control, including the following:

I. Indication of run condition, motor speed or output frequency, input control parameters, output current and voltage, and alarm conditions.

II. Indication of power on, zero speed, enable, earth fault, short circuit, over current, under voltage, over temperature and remote trip.

III. Facilities for automatic/off/manual control.

IV. Local and remote analogue input, to control frequency output of controller when in manual or automatic mode.

V. High level interface with BMS: Provide high level interface at the mechanical services switchboard with the BMS for remote interrogation, control and monitoring the operation. High level interface shall be based on BACnet protocol. Provide BACnet gateway if necessary.

f) Installation: Switchboard mounted.

10.4 INSTRUMENTS

10.4.1 POWER METERS

a) General: Provide a power meter for each incoming submain at the mechanical switchboard for real-time local and remote (via BMS) monitoring.

b) Type: 3-phase communicating power meter complete with current transformers, local display and accessories.

c) Local display: Panel mounted multiple values displayed at the same time on an anti-glare back-light LCD screen.

d) Energy parameters to be monitored: Minimum data output of:

I. kWh.

II. kW and max. kW.

III. kVA and max. kVA.

IV. Voltages.

V. Currents.

VI. Phase power factors.

VII. Frequency.

VIII. THD currents.

e) High level interface with BMS: Provide high level interface based on MODBUS protocol at the mechanical services switchboard with the BMS for remote interrogation, control and monitoring..

10.4.2 ELECTRICITY SUBMETERS

a) General: Provide smart electricity submeters for real-time local reading, and with output and facility for interface with the BMS for remote monitoring.

b) Type: 3-phase or single phase electricity meter complete with current transformers and accessories.

c) Local display: LCD screen.

d) Energy parameters to be monitored: Minimum data output of:

I. kWh.

II. kW.

e) High level interface with BMS: Provide high level interface based on MODBUS protocol at the mechanical services switchboard with the BMS for remote interrogation, control and monitoring..

10.4.3 INDICATING LIGHTS

a) General: Provide the following indicating lights on every switchboard:

I. Mains supply 'ON': Red.

II. Mains supply 'OFF': Green.

III. System/equipment 'ON': Red.

IV. System/equipment 'OFF': Green.

V. System/equipment 'FAULT': Amber.

b) Type: 12 V or 24 V LED indicators in corrosion resistant bezel.

10.5 MARKING

a) 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.

b) Labels on assembly exteriors:

I. Manufacturer's name: Required.

II. Assemblies: Label with essential markings.

III. Designation labels: For other than main assemblies, provide designation label stating source of electrical supply. Identify separate sections of enclosures.

c) Assembly controls: Label controls and fault current limiters, including the following:

I. Circuit designation for main switches, main controls and submains controls; and

II. Fuse link size.

d) Labels on assembly interiors: General: Provide labels for equipment within assemblies. Locate so that it is clear which equipment is referred to, and lettering is not obscured by equipment or wiring.

e) Danger, warning and caution notices:

I. Fault current limiters: In assembly sections containing fault current limiter fuses provide caution notices fixed next to the fault current limiters, stating that replacement fuse links are to match as-installed fuse link ratings, make and characteristics. Provide separate label stating fault current limiting fuse ratings.

II. Externally controlled equipment: To prevent accidental contact with live parts, provide warning notices for equipment on assemblies not isolated by main switch or local main switch.

III. Stand-by power: Provide warning notices stating that assemblies may be energised from the stand-by supply at any time.

IV. Custom-built assemblies: For insulation or shrouding requiring removal during normal assembly maintenance, provide danger notices with appropriate wording for replacement of insulation shrouding before re-energising assemblies.

V. Positioning: Locate notices so that they can be readily seen, next to, if impracticable, on busbar chamber covers of functional units, and behind the front cover of functional units.

Provide circuit identification labels in the cabling chamber of each functional unit, located next to external terminations.

f) Schedule cards: Provide schedule cards with written text showing the following as-installed information.

I. Submain designation, rating and short-circuit protective device.

II. Equipment item numbers and current ratings, cable sizes and types and areas supplied.

III. Mounting: Mount schedule cards in a holder fixed to the inside of the assembly or cupboard door, next to the distribution circuit switches. Protect with hard plastic transparent covers, or laminated.

g) Single-line diagrams: Provide a single-line diagram adjacent to the main mechanical services switchboard, showing the complete power supply system(s) of mechanical services

I. Format: Non-fading print, at least B1 size, showing the as-installed situation.

II. Mounting: Enclose in a non-reflective glazed metal frame and wall mount close to assembly.

10.6 SPARE CABINET

a) General: Provide a spares cabinet with main name plate, labelled shelves and non-lockable door. Size the cabinet for storing racking handles, special tools, spare lamps, spare fuse links and other equipment necessary for satisfactory assembly operation.

b) Location: Adjacent to the main mechanical services switchboard.

c) Fixing: Wall mounted.

d) Finish: To match assembly.

e) Spare fuses: Provide 3 spare fuse links for each rating of fuse link on each assembly. Mount spares on clips.

f) Label: Label the cabinet 'SPARES CABINET'.

g) Accessories: Provide one set of racking tools for circuit breakers, and special installation, operation and servicing tools.

10.7 POWERFACTOR CORRECTION SYSTEM

10.7.1 GENERAL

a) Type: Automatic, solid state switched type for group correction at the main switchboard.

b) Power factor correction: To maintain the system power factor from 0.75 lagging to 100% under all load conditions. No leading power factor at any time.

c) Hunting: Provide positive means to prevent hunting around the set point.

d) Service conditions:

i. Over voltage, intermittent: 100%.

ii. Overcurrent, continuous: 30%.

iii. Overload: 135% of normal rating including voltage 2nd harmonics, 2.15 pu for 10 s between terminals.

iv. Ambient temperature: 5 °C to 50 °C.

e) Components: To be sized and selected to:

I. Limit the increase in incoming supply voltage total harmonic distortion to < 2.5%.

II. Limit the total harmonic distortion to < 4%.

III. Prevent interference with Supply Authority frequency injection systems.

f) Protection: Protect the capacitors and other electronic components against disturbances in the power supply system including high-energy surges.

g) Service life of all components: > 10 years.

10.7.2 CAPACITORS

a) Standard: To IEC 60831-1 and IEC 60831-2.

b) Type: Vacuum oil impregnated metallised polypropylene (MPP).

c) Automatic overpressure disconnection: Required.

d) Capacitance tolerance: Within -5% to +10%.

e) Construction: Cylindrical with single capacitor unit per can.

f) Dielectric rating: ≥ 500 V RMS at 50 Hz selected to accommodate the series reactor voltage.

g) Discharge resistance: Required.

h) Loss: < 0.5W/kVAR (low loss type).

i) Removal: Arranged to permit removal of faulty module while the remaining capacitors continue to function normally.

j) Surface temperature: Rated to achieve < 60°C.

k) Terminals: Tunnel or post type.

10.7.3 CONTACTORS

a) Type: Step-switching.

b) Utilisation category: for capacitor switching AC-6b.

c) Rating: For capacitor switching duty at ≥ 1.5 times the capacitor step full load current.

10.7.4 INDUCTORS

a) General: Provide detuning inductors for each capacitor stage to prevent resonance of centre point lower than 400 Hz.

b) Carrying capacity: ≥ 1.5 times the rated capacitor current at 50 Hz without saturating at 40°C ambient.

c) Cores: Insulated, laminated, high permeability silicon iron.

d) Flux density at rated current: < 0.85 tesla.

e) Inductance tolerance: Within ± 5% at rated current.

f) Losses: Very low loss design.

g) Mounting hardware: Non-ferrous.

h) Q factor: > 10.

i) Separate inductors for each capacitor step: Required.

j) Windings: High purity copper with Class F temperature rated insulation.

10.7.5 CONTROLLER

a) General: Provide a site-programmable, microprocessor controller with non-volatile programme and data memory for the following functions:

   I. Automatic cycling of use of capacitor steps: Required.

   II. Automatic isolation in the event of capacitor over temperature or over current: Required.

   III. Data interface for remote monitoring and data download: RS232.

IV. Local alarms for:
    i. Over temperature.
    ii. Over voltage.
V. Reactive power exceeding adjustable programmed levels.
VI. Local and remote display:
    i. Power factor.
    ii. Incoming supply load (amps, kW and kVAR).
    iii. Number of steps in use.
    iv. Percent harmonic current.
    v. Harmonic currents.
    vi. Stored data for ≥ 1 week in date/time format.
VII. Manual-off-auto selection: Required.
VIII. Interface with BMS system: Required.
IX. Time delay after restoration of power supply: ≥ 60 s before switching in the first stage.
X. Time delay between stages: Switching adjustable to be from 1 to 300 s.

b) High level interface with BMS: Provide facilities at the control panel for high level interface based on MODBUS protocol with the BMS for remote monitoring and indication.

10.7.6 INSTALLATION

a) Current transformer: Provide a 5 A secondary, 10 V.A, Class 1, PFC current sensing transformer installed in the relevant switchboard.

b) Protection: Provide protective devices to grade and discriminate with upstream devices. Individually protect each kVAR step.

c) Capacitors
    I. Insulation: Insulate all live parts.
    II. Layout: Arrange capacitors for easy removal and replacement.
    III. Mount capacitors in separate cubicle compartment, segregated from inductors, fuses and switchgear.
    IV. Ventilation: Separate capacitors by > 25 mm of air space.

d) Inductors: Mount inductors in separate cubicle compartment, segregated from capacitors, fuses and switchgear.

e) Cubicle
    I. Enclosure: Rigid sheet metal cubicle with front access, top and bottom cable entries, matching the enclosure of the main switchboard.
    II. Degree of protection: IP 54 to AS 1939.

f) Ventilation: Ventilate the PFC cabinet so internal temperature rise is < 5°C above ambient in each cabinet compartment. Provide mechanical ventilation with thermostatic control if necessary.

10.8 WIRING

10.8.1 GENERAL

Provide a wiring system appropriate for the purpose.

10.8.2 CABLES

a) Cable:
   I. Use multi-stranded copper cable generally.
   II. Minimum size:
      i. Power sub-circuits: 2.5 mm^2.
      ii. Sub-mains: 6 mm^2.
   III. Neutral conductor: Same size as active conductors.

b) Straight-through joints: Unless it is unavoidable due to length or difficult installation conditions, otherwise run cable without intermediate straight-through joints. Locate in accessible positions in junction boxes.

c) Tagging: Identify multi-core cables and trefoil groups at each end using stamped non-ferrous tags clipped around each cable or trefoil group.

d) Marking: Identify the origin of all wiring using legible indelible marking.

e) Conductor: Use multi-stranded copper cable generally except for MIMS.

f) Cable termination: Terminate copper conductors to equipment using compression-type lugs of the correct size for the conductor. Compress using the correct tool or use soldering.

10.9 CABLE MANAGEMENT SYSTEM

10.9.1 GENERAL

a) Provide cable management system comprising cable enclosures and cable supports for all electric cables

b) Segregation: General: Segregate cables in accordance with the relevant Australian Standards.

c) Protection: Protect cables.

d) De-rating of cables: Cables shall be grouped and spaced on cable ladders and cable trays in such a way that the de-rating factor of cables will be the lowest.

10.9.2 CONDUITS

a) Type: Metallic or non-PVC conduits, minimum 25 mm. Use metallic conduits wherever exposed to mechanical damage.

b) Set out: If exposed to view, install conduits in parallel runs with right angle changes of direction.

c) Draw-in boxes: Provide draw-in boxes at intervals not exceeding 30 m in straight runs, and at changes of level or direction.

d) Flexible conduit: Use for equipment and plant subjected to vibration. If necessary, use for adjustment or ease of maintenance. Provide the minimum possible length.

10.9.3 CABLE TRUNK

a) General: Provide purpose-made metallic cable trunk system comprising solid-wall trunk lengths, fittings, fixing devices and. Round off sharp edges and provide PVC bushes for cable entries into metallic ducting.

b) Covers: Provide purpose-made accessories and covers to match the duct system. Use screw-fixed covers or clip-on covers removable only with the use of tools.

c) Cable support: Except for horizontal runs where the covers are on top, support wiring using retaining clips at intervals of not more than 1m.

10.9.4 CABLE LADDER

a) General: Provide a complete metallic cable ladder system, complete with brackets, fixings and accessories. Fabricate brackets, racks and hangers using structural steel sections or other materials in sections of equivalent strength.

b) Construction:

I. General: Use 2 folded steel side rails with cable support rungs between the rails.

II. Material: Galvanised, heavy-duty steel.

III. Rung spacing: 300 mm maximum.

IV. Minimum width: 450 mm.

V. Rods: 10 mm minimum diameter.

c) Fixing to building structure:

I. General: Fix supports to the building structure or fabric using direct fixing, hangers or brackets.

II. Supports: Galvanised or zinc plated.

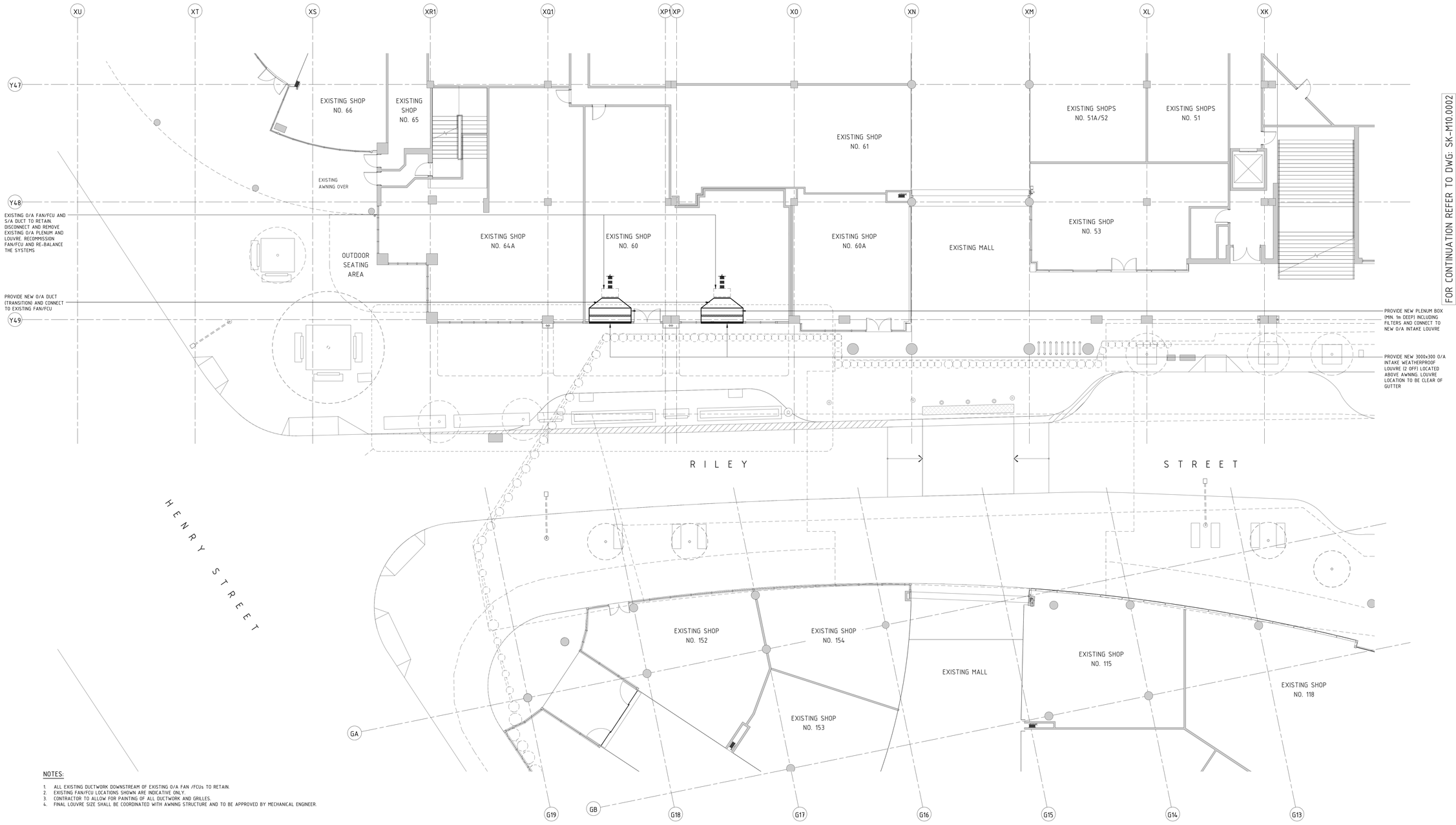
III. Spacing: Space supports at maximum intervals of 1.5 m.

d) Access: Provide a minimum of 150 mm free space above and 600 mm free space on one side of trays and ladders.

e) Cable fixing:

I. Provide slats or rails suitable for fixing cable ties, strapping or saddles

II. Cable protection: Provide rounded support surfaces under cables where they leave trays or ladders.



NOTES:

1. ALL EXISTING DUCTWORK DOWNSTREAM OF EXISTING O/A FAN /FCUs TO RETAIN.
2. EXISTING FAN/FCU LOCATIONS SHOWN ARE INDICATIVE ONLY.
3. CONTRACTOR TO ALLOW FOR PAINTING OF ALL DUCTWORK AND GRILLES.
4. FINAL LOUVRE SIZE SHALL BE COORDINATED WITH AWNING STRUCTURE AND TO BE APPROVED BY MECHANICAL ENGINEER.

01 FLOOR PLAN – SOUTH
RILEY STREET UPGARDE 1:100
CAD REF.:

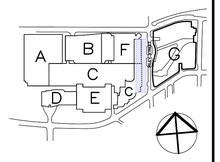
FOR CONTINUATION REFER TO DWG: SK-M10.0002

SCALE = 1:100

TENDER

Rev	Date	By	Chk	Description
A	15.11.2015	WN	GT	PRELIMINARY ISSUE
1	17.12.2015	WN	GT	ISSUED FOR TENDER
2	01.02.2016	WN	GT	REVISED ISSUE FOR TENDER
3	23.06.2016	WN	GT	REVISED ISSUE FOR TENDER
4	27.04.2017	WN	GT	REVISED ISSUE FOR TENDER

Key Plan



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Title
MECHANICAL SERVICES - RILEY STREET UPGRADE FLOOR PLAN SOUTH

Drawn By	Design By	Checked By
S.L.	W.N.	G.T.

Drawing Scale	CAD File	Plot Date
1:100	SK-M100001_CAD.dwg	27/04/201

Project No	Drawing No.	Revision
C57490	SK-M10.0001	4

SK-M10.0001[4]

Drawing to scale at A0

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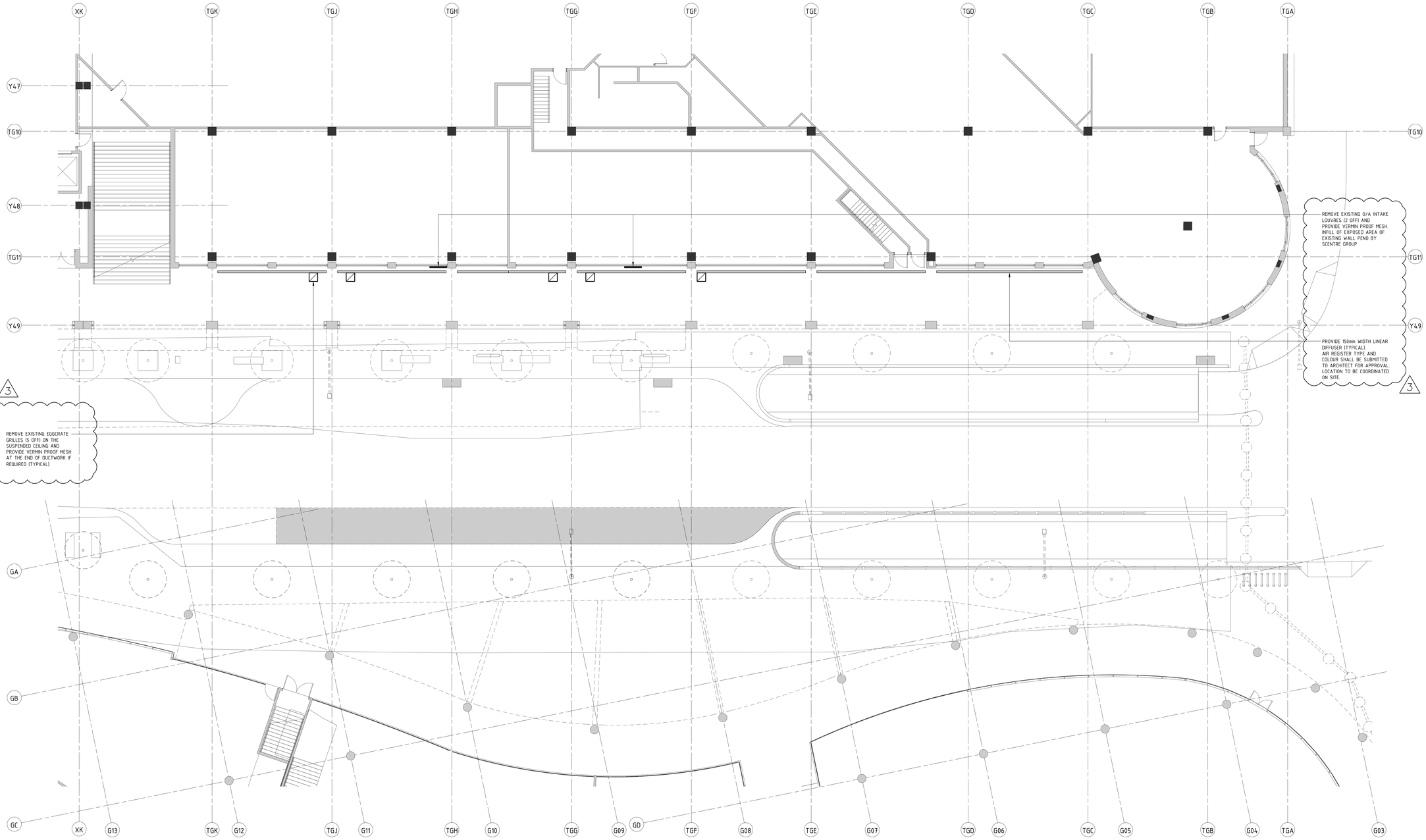

01 FLOOR PLAN – SOUTH
RILEY STREET UPGARDE 1:100
CAD REF.:

0 1m 2m 3m 5m 10m
SCALE = 1:100

Rev	Date	By	Chk	Description
3	23.06.2016	WN	GT	REVISED ISSUE FOR TENDER
2	01.02.2016	WN	GT	REVISED ISSUE FOR TENDER
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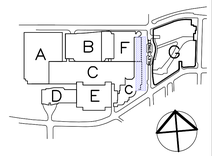
A	15.11.2015	WN	GT	PRELIMINARY ISSUE

Key Plan



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Title
MECHANICAL SERVICES - RILEY STREET UPGRADE FLOOR PLAN NORTH

Drawn By	Design By	Checked By
S.L.	W.N.	G.T.
Drawing Scale	CAD File	Plot Date
1:100	SK-M100002_CAD.dwg	28/06/2016
Project No	Drawing No.	Revision
C57490	SK-M10.0002	3

TENDER

Drawing to scale at A0

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