Auckland City Rail Link

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MOTT MACDONALD
Jasmax
ARUP

CONSTRUCTION CONTRACT 1 BRITOMART STATION
Mechanical, Fire and Hydraulics Specification

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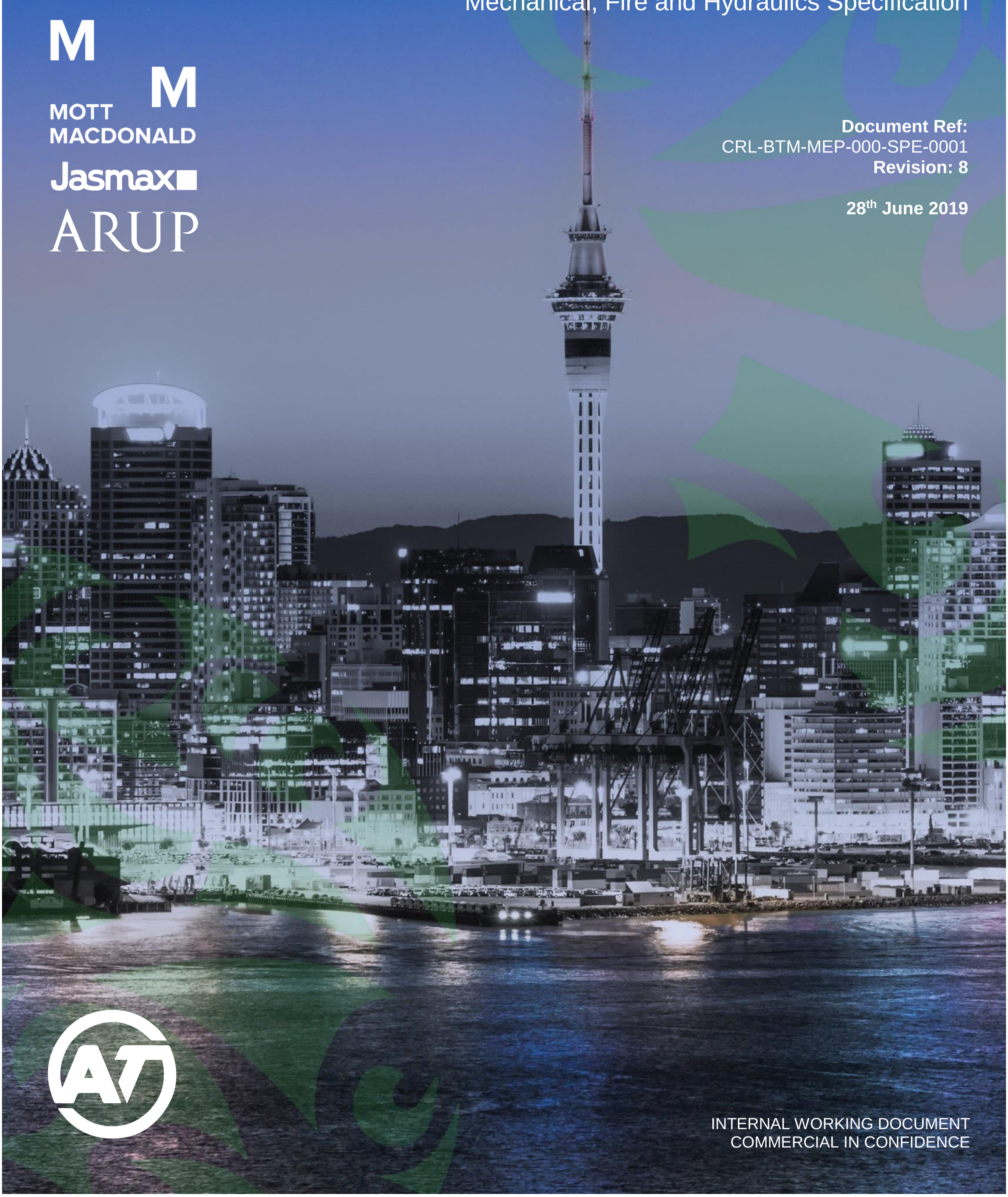

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Approval			
Author signature		Approver signature	
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Title	Technical Director	Title	C1 Package Manager

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Appendices

1 Preliminaries

1.1 GENERALLY

This part of the specification shall be read in conjunction with the general conditions of contract, preliminary clauses and technical clauses included in the main specification.

The Contractor when entering into the conditions of this contract shall be fully aware and in acceptance of the full responsibility for the planning design development, coordination, workshop documentation, supply, installation, testing, commissioning, quality assurance, certification and maintenance during defects liability period for the provision of the complete new mechanical, fire and hydraulic services systems required in the station.

The specification is indicative and a guideline for the scope of works required. It shall be the full responsibility of the Contractor to allow for full compliance of all required mechanical, fire and hydraulic services systems in the station, inclusive of all necessary and required system components, equipment, plant, accessories and interface with other building services systems in accordance with all relevant New Zealand Standards and Authority requirements.

1.2 DEFINITIONS

The following terms shall represent the relevant parties in this specification.

“Client/Principal”	City Rail Link (CRL)/Auckland Transport (AT)
“Engineers Rep”	herein after referred to, as the ER shall be the person as nominated by the Client or as nominated in the main building contract.
“PTA”	Principal Technical Adviser to AT. Includes a number of integrated companies that provide design and advice to AT. Companies include: Aurecon, Mott MacDonald, Jasmax, Grimshaw and Arup
“PTA Architect”	Jasmax
“PTA MEP Engineer”	Mott MacDonald New Zealand
“Building Contractor”	Downer, Soletache Bachy
“MFH Contractor”	Contractor carrying out the Mechanical, Fire and Hydraulic services installation under this specification. Referred to as the MFH Contractor or Contractor.
“ESC Contractor”	Contractor carrying out the Electrical, Communications and Security services installation under this specification.
"Approved"	shall mean approved in writing by the ER or by Regulation or Ruling by Local Authority.
"Or equal"	shall mean a material, product of component nominated by the Contractor, which is equivalent in performance and quality to and of cost not exceeding that specified. The reference ‘or equal’ shall be taken in all cases to be the same as the reference ‘or equal in all respects to”. The acceptance of what constitutes as being of equal type and quality shall be at the sole discretion of the ER or Client.

2 General

2.1 INTRODUCTION

This specification has been prepared based on the instructions from Auckland Transport (AT) as part of the design for Britomart Station works associated with the City Rail Link (CRL) project. Mott MacDonald was commissioned as part the Principal Technical Advisor (PTA) team to produce the design for the Building Services aspects of the design.

This specification covers the work encompassing the following Mechanical, Fire and Hydraulic Services (MFH);

- Mechanical Services (Heating Ventilation and Air Conditioning);
- Fire Services (Sprinklers and Hydrants)
- Fire Detection Services (Smoke Detection, Heat Detection, VESDA)
- Hydraulic Services (Sanitary, Storm, Potable Water)

All works shall be in accordance with the P&G sections of the main contract – refer to all other relevant documents.

This document details the requirements for the detailed design (where required), construction design, supply, delivery, shop drawings, installation, testing, commissioning (staged as required to suit the overall works), maintenance and guarantee of the new engineering services for the overall project.

2.2 PROJECT OVERVIEW

This specification includes works for the upgrade and integration of the existing Britomart Station and CPO building for the proposed new CRL passenger rail link.

This specification covers works required for the enabling, temporary and permanent works at Britomart Station, CPO building, and associated ancillary buildings. Staging of works and works required for staging purposes shall be the responsibility of the contractor.

Works include:

- Demolition of existing services
- Diversions and relocation of services
- Temporary services
- Permanent services
- Provision for base build retail services

The Construction Contract 1 at Britomart Station will require extensive civil works within the CPO building. The most northerly line (Platform 1) and the most southerly line (Platform 5) will be extended West under the CPO and then southward under Albert Street. During the construction period the station will need to remain operational with minimal adverse impacts on rail customers.

The extent of works generally covers the following areas at the western end of the station (excluding the alighting platforms):

- B2 platform level
- B1 Station Level
- B1 Concourse level

- CPO Underpass
- CPO ground and upper floors
- CPO glass house
- Station Plaza West
- Integration into existing east end systems

2.2.1 Preliminary and Generals

Refer to the Main Contract documentation for Preliminaries and General.

2.2.2 Britomart Station – Continuous Operation

Britomart station shall remain operational throughout the demolition, temporary and permanent works. The contractor shall allow for all staging and phasing of the works to ensure continuous operation of the station is maintained.

The temporary phasing of the project is described in more detail in the following document (CRL-SYW-ENG-000-RPT-0008). Refer to Section 6.2 Passenger and Pedestrian Analysis, in particular table 6-2.

The hours of operation for normal working hours and Engineering hours shall be as described in the main contract.

2.2.3 CRL Design Documents

The contactor shall make reference to the following CRL documents, specifications and reports as part of these works;

Report/Specification No.	Description
Mechanical, Fire and Hydraulics Specification	CRL-BTM-MEP-000-SPE-0001
Electrical and Communication Specification	CRL-BTM-MEP-000-SPE-0002
Vertical Transportation Specification	CRL-BTM-VER-000-SPE-0001
SCADA Controls Specification	CRL-BTM-BMS-000-SPE-0001
Building Management Systems Specification	CRL-BTM-BMS-000-SPE-0002
Architectural Temporary Works Specification	CRL-BTM-ARC-000-SPE-0001
Architectural Permanent Works Specification	CRL-BTM-ARC-000-SPE-0001
Structural/Civils Works Specification	CRL-BTM-STR-000-SPE-0001
FIRE ENGINEERING BRIEF AND REPORTS	
Fire Engineering Brief	CRL-SYW-FIR-000-MAN-0007
Fire Engineering Report	CRL-BTM-FIR-000-RPT-0011
DETAILED DESIGN REPORTS – Temporary Works	
Overview and Assurance – Vol 1	CRL-BTM-ENG-000-RPT-0010
Structural – Vol 2	CRL-BTM-STR-000-RPT-0051
Architectural – Vol 3	CRL-BTM-ARC-000-RPT-0019
MEP and Rail Services – Vol 4	CRL-BTM-MEP-000-RPT-0024
DETAILED DESIGN REPORTS – Permanent Works	
Overview and Assurance – Vol 1	CRL-BTM-ENG-000-RPT-0011
Civil and Structural – Vol 2	CRL-BTM-CIV-000-RPT-0022

Architectural – Vol 3	CRL-BTM-ARC-000-RPT-0020
MEP and Rail Services – Vol 4	CRL-BTM-MEP-000-RPT-0025
DESIGN MANUALS	
Draft Design Manual Volume 1, Part 1 - General	CRL-SYW-ENG-000-MAN-0001
Draft Design Manual Volume 1, Part 2 – Civil Infrastructure and Structures	CRL-SYW-CIV-000-MAN-0002
Draft Design Manual Volume 1, Part 3 – Mechanical and Electrical Systems	CRL-SYW-MEP-000-MAN-0003
Draft Design Manual Volume 1, Part 4 – Rail Systems	CRL-SYW-ARC-000-MAN-0005
Draft Design Manual Volume 1, Part 5 - Architecture and Planning	
Draft Design Manual Volume 1, Part 6 - Passenger Analysis	CRL-SYW-TPP-000-MAN-0006
Draft Design Manual Volume 1, Part 7 – Fire Engineering Brief	CRL-SYW-FIR-000-MAN-0007
HUMAN FACTORS AND PED ANALYSIS	
Passenger and Pedestrian Analysis (Temporary)	CRL-BTM-TPP-000-RPT-0008
Passenger and Pedestrian Analysis (Permanent)	CRL-BTM-TPP-000-RPT-0009
Human Factors Technical Note	CRL-BTM-HMF-000-ENN-0001
RAMS AND FMECA	
FMECA Report	CRL-BTM-SSA-000-RPT-0006
Safety and RAMS Requirement Specification	ATCRL-PRW-SSA-SPE-000193

2.3 WORKS REQUIRED BY THIS SPECIFICATION

This specification is provided as a combined document that covers the following services;

- Mechanical
- Fire
- Hydraulics

This specification, accompanying drawings and documents shall be referred to in their entirety. For discipline specific requirements the following sections shall be reviewed in conjunction.

2.3.1 Mechanical

Section 1, 2, 3 and 6 including the Station Controls Specification (CRL-BTM-BMS-000-SPE-0001) and Building Management System Specification (CRL-BTM-BMS-000-SPE-0002) and all Appendices.

2.3.2 Fire

Section 1, 2, 4 and 7 including the Station Controls Specification (CRL-BTM-BMS-000-SPE-0001) and Building Management System Specification (CRL-BTM-BMS-000-SPE-0002) and all Appendices.

2.3.3 Hydraulics

Section 1, 2, 5 and 8 including the Station Controls Specification (CRL-BTM-BMS-000-SPE-0001) and Building Management System Specification (CRL-BTM-BMS-000-SPE-0002) and all Appendices.

2.4 SCOPE OF WORK – MFH SYSTEMS

2.4.1 General Scope for MFH Systems

The MFH services work covered by these documents includes, but not be limited to, the final design co-ordination, manufacture, supply, installation, testing, commissioning and subsequent maintenance for the stipulated period of the work specified herein and shown on the accompanying drawings.

Provide all manufactured items, materials, labour, cartage, tools, plant, appliances and fixings necessary for the proper execution of the works, together with all minor and incidental works.

The whole of the works shall comply with all the latest relevant Regulations and to all Local Authority requirements. The cost of any materials or equipment required to meet such regulations and requirements shall be included in the Tender whether specially shown or described in the documents or not.

All materials and equipment shall be the best of their respective kinds, complying with the relevant Standards and Local Codes of Practice. All materials and equipment shall be new and shall be delivered to the site with the maker's label intact.

The general scope for all Mechanical, Fire and Hydraulics systems includes;

- Demolition of existing services not required for station operation
- Diversion of services during temporary and permanent works
- Services diversions required to enable the CPO building to be safely isolated and reinstatement at the end of the works;
- Staging of all works necessary for enabling, temporary and permanent works
- Provision of all services for temporary works
- Provision of all services for permanent works
- Provision of MFH services for the Rail Systems rooms but not installed. MFH services will be blanked and capped off external to the rooms to allow provision of a future fitout.
- Provision of base build retail services (described herein)
- Provision of enclosures, fixings and all supports;
- Design and installation of all seismic restraints to comply with NZS 4219
- Isolation and decommissioning of services to the temporary accommodation facilities;
- Isolation and decommissioning of services not required to remain or be provided for the permanent works;
- Integration of temporary and permanent systems into the station east end (i.e. Station Controls, Fire etc)
- Reinstatement of the station fire integrity where identified and impacted by the Works
- Co-ordination of services with other trades
- Submission of shop drawings and samples for approval
- Spare parts
- Sectional Testing & Commissioning of all installed services to provide fully functioning MFH systems
- Final Testing and Commissioning of all installed services to provide fully functioning MFH systems

- Training
- Update existing Operating & maintenance manuals (Temporary and Permanent)
- New Operating & maintenance manuals (Temporary and Permanent)
- Warranties on all works and materials
- As built drawings and documentation

2.4.2 Future Rail Systems works

At the completion the works various rail systems rooms are not required to be operational. The running tunnels will be isolated from the station and the fitout of the rail systems rooms will take place at a 'future' date. This is due to the 'future' CRL project connecting Britomart with Mt Eden via Aotea and Karangahape Road Stations. These stations and running tunnels will form 'future' works.

These rooms include;

- Overhead Line Room (OHLE)
- Tunnel LV Room
- Tunnel Comms nodes (x2)
- Signalling Equipment Room (SER)
- Platform Screen Doors Room (PSD)

The C1 design allows for the provision of shell only services to these rooms. Refer Memo CRL-BTM-MEP-000-MEM-0429 for proposed works.

2.4.3 Mechanical

The scope of the contract Mechanical works as detailed within this specification and associated drawings shall include, but not be limited to, the design, supply, installation, testing, commissioning, defect liability, warranty/guarantee and planned preventative maintenance of the following:

2.4.3.1 Demolition Works

- Removal of all redundant heating, ventilation and air conditioning systems – refer to all relevant demolition drawings.
- Make safe all redundant electrical and control systems after the removal of all cabling / cable trays / distribution boards, etc – refer to all relevant demolition drawings.
- Modification of the existing systems proposed to continue to operate throughout the "temporary works" and "permanent works" lifecycle of the overall project.

2.4.3.2 Temporary Works

Omitted for clarity. Refer to Revision 7 of this specification for requirements relating to Temporary Works.

2.4.3.3 Permanent Works

Supply and installation of all new heating ventilation and air conditioning systems – refer to all relevant permanent works drawings. Systems include:

- All works installed as part of the Temporary Accommodation buildings shall be isolated, decommissioned and removed as part of the Works. The reinstatement of the plaza will be carried out by others

- Chilled water fan coil units serving the equipment rooms namely all the UPS/battery rooms and low voltage switchrooms. These rooms shall include duty / standby 2 pipe ducted chilled water fan coil units. Units shall be controlled as duty / standby via the BMS control system.
- Chilled water close control units serving the Computer Equipment Room (CER). This room shall include duty / standby plant controlled via the onboard control system, whilst being monitored by the BMS.
- Chilled water fan coil units serving the kitchenette, office areas, sick bay, customer services office, cashroom and excess fare room. A combination of ducted fan coil units, console type floor standing units, high wall and ceiling cassette units shall be utilised. All units shall be controlled via the BMS control system.
- Central plant compromising three air cooled chillers with integrated primary duty/standby pumps, buffer vessel, duty / standby secondary chilled water pumps, pipework system and associated electrical / controls work. The controls shall be proprietary to the chiller systems with a high level interface to the BMS for monitoring purposes.
- Exhaust air ventilation system serving all UPS rooms. The exhaust system shall be capable of providing emergency ventilation to some of the rooms when required, if a failure of the duty and standby air conditioning systems occurs. Duty / standby ventilation fans are included as part of this system.
- Exhaust air ventilation system serving all sump rooms. Duty / standby ventilation fans are included as part of this system.
- Emergency ventilation system for the CER room.
- Supply air and exhaust air ventilation for the lift motor room at level B2 plus auxiliary rooms at this level. The ventilation system is sized for the upgrade/fitout of the SER / auxiliary rooms.
- Replacement of the DX based air conditioning system serving the lift motor room (part of the temporary works) with an equivalent sized chilled water fan coil unit connected to the new central plant.
- Removal of HVAC systems from the decanted Excess Fare Kiosk (north to south side)
- Provision of HVAC systems for the Rail System rooms, blanked and capped off external to the room for a 'future' fitout
- Outside air ventilation plus exhaust ventilation to the majority of the BOH areas. An air handling unit with a heat recovery wheel shall be utilised to minimise energy usage in relation to the heating of the spaces.
- New toilet exhaust system's at level B1 and ground floor of the CPO building. The new ducted systems shall connect to the existing duct risers / fans that terminate on the roof of the CPO building. Work includes providing a condition report on the two ventilation systems, internal cleaning of the existing duct risers and measuring / recording the existing air flow rates from the ventilation systems.
- Modification to the existing CPO ground floor exhaust ventilation systems to provide vertical discharges in lieu of the existing side discharges to the south side system. Work includes providing a condition report on the four ventilation systems, internal cleaning of the existing duct risers and measuring / recording the existing air flow rates from all of the four existing ventilation systems.
- Electric heaters serving the customer service / ticketing areas, ground level staff kitchenette, public baby change areas as well as the staff toilets / lockers area.
- Outside air ventilation systems temporary accommodation for AT staff (level L0 and L1 located east of the existing glasshouse and CPO building).
- Replacement of the outside air ventilation system serving the existing lift motor room.

- Testing and re-commissioning of the Britomart Station Fans in accordance with the Fire Engineering Report
- Coordination and interfacing with the fire protection signals (duct mounted smoke detection, local smoke detection and general fire alarm).
- New leak detection systems for 'wet services and cooling units (ie: leak detection zones LD1, LD2, LD3 and LD4 as well as all equipment room FCU's additional drain trays and CER close control units).
- All Electrical for Mechanical works required for the above mentioned systems. All HVAC systems shall be supplied power from five new Mechanical Services switchboards (MCP-1, MCC-B1.W, MCC-B1.S, MCC-L0.N and MCC-Roof). Two power supplies to each mechanical board is generally provided (with exception of MCC-L0.N) with automatic transfer switches at each board to automatically changeover when either of the one supplies are compromised. UPS power supplies are provided to the emergency ventilation for the UPS rooms and the CER emergency ventilation.
- All Electrical for Hydraulics works (including Controls/MCC's) required.
- Automatic Controls for mechanical and hydraulic equipment (BMS, SCADA interfacing etc)
- Training of the client representative(s) at the various sectional completion stages plus at the conclusion of the final practical completion.
- Sectional and Final Testing and Commissioning for all works
- Provision of temporary works operation and maintenance manuals including all relevant as-built drawings at the sectional completion stage of the temporary works.
- Provision of all relevant training of the client representatives at the sectional completion stage of the temporary works.

2.4.4 Fire

The fire services work covered by these documents includes, but not be limited to, the final detailed design, co-ordination, manufacture, supply, installation, testing, commissioning and subsequent maintenance for the stipulated period of the work specified herein and shown on the accompanying drawings.

Provide all manufactured items, materials, labour, cartage, tools, plant, appliances and fixings necessary for the proper execution of the works, together with all minor and incidental works.

The extent of the fire sprinkler work covered in this Specification and as shown on the drawings consists of the following:

2.4.4.1 Demolition Works

- Removal of all redundant fire systems – refer to all relevant demolition drawings.
- Make safe all redundant fire and control systems after the removal of all pipework, cabling / cable trays / etc – refer to all relevant demolition drawings.
- Modification of the existing systems proposed to continue to operate throughout the "temporary works" and "permanent works" lifecycle of the overall project.

2.4.4.2 Temporary Works (Plaza)

Omitted for clarity. Refer to Revision 7 of this specification for requirements relating to Temporary Works.

2.4.4.3 Temporary Works (B2 Level)

Omitted for clarity. Refer to Revision 7 of this specification for requirements relating to Temporary Works.

2.4.4.4 Permanent Works

- All works installed as part of the Temporary Accommodation buildings shall be isolated, decommissioned and removed as part of the Works. The reinstatement of the plaza will be carried out by others
- Maintain existing fire protection and detection systems in all other areas of the station not affected by these works
- Design, supply and install Sprinkler and detection systems for CPO ground staff areas
- Modifications to existing Sprinkler and VESDA systems in CPO ground ceiling (i.e retail provision, any non-compliances identified during inspections)
- Design, supply and install new VESDA panels for CPO ground ceiling and reconnect existing VESDA pipes to them
- Design, supply and install minimum fire protection and detection for retail areas to suit building code
- Retain existing CPO fire hydrants – south and north side
- Isolate and remove Optical Heat Detection System in the glass house
- Design, supply and installation of Sprinklers as per Fire Engineering requirements
- Design, supply and install new detectors, manual call points etc
- Design, supply and install CPO Fire Alarm Panel and integration into existing main FAP at East end
- Provision of fire protection systems for the Rail System rooms
- Design, supply and installation of the duct mounted smoke detection systems required for the two outside air ventilation systems being installed by the Mechanical Services contractor. Included as part of the fire protection works is relay contact adjacent to each detection device for the mechanical/BMS system to pick up the signal.
- Design, supply and installation of the local smoke detection systems (smoke detector each side of wall/door) required for the two passive air intake system being installed by the Mechanical Services contractor. Included as part of the fire protection works is relay contact adjacent to each detection device for the mechanical/BMS system to pick up the signal.
- Retail areas – design, supply and install minimum fire provision as per building code
- Supply and installation of new Fire Extinguishers
- Modifications to DBA1/ZCP to suit Sprinkler system
- Modifications to existing west end Mimic Panel to reflect permanent works
- Design, supply and install new Mimic panel at Intervention/Evacuation exit (north CPO ground)
- Design, supply and install new gas suppression systems for CER and SER rooms
- Modifications to existing main FAP at east end
- Removal of Fire protection systems from the decanted Excess Fare Kiosk (north to south side)
- All Electrical for Fire works (including controls) required for the above mentioned systems
- Sectional and final Testing and Commissioning for all works

2.4.5 Hydraulics

The scope of the contract Hydraulics works as detailed within this specification and associated drawings shall include, but not be limited to, the design, supply, installation, testing and commissioning of the following:

2.4.5.1 Demolition Works

- Removal of all redundant hydraulics systems – refer to all relevant demolition drawings.
- Make safe all redundant hydraulic systems after the removal of all pipework, cabling / cable trays / etc – refer to all relevant demolition drawings.
- Modification of the existing systems proposed to continue to operate throughout the "temporary works" and "permanent works" lifecycle of the overall project.

2.4.5.2 Temporary Works (Plaza)

Omitted for clarity. Refer to Revision 7 of this specification for requirements relating to Temporary Works.

2.4.5.3 Temporary Works (B2 Level)

Omitted for clarity. Refer to Revision 7 of this specification for requirements relating to Temporary Works..

2.4.5.4 Permanent Works

- All works installed as part of the Temporary Accommodation buildings shall will be isolated, decommissioned and removed as part of the Works. The reinstatement of the plaza will be carried out by others
- Reinstate existing CPO water systems (all levels)
- Reinstate existing CPO sanitary drainage
- Reinstate existing CPO Stormwater drainage
- Supply and install Foul water drainage
- Supply and install Stormwater drainage
- Supply and install Fire water drainage systems
- Supply and install foul water packaged pump sets including controls at B1 Level
- Supply and install foul water packaged pump sets including controls at B2 Level
- Supply and install main sump pump sets (fire/incidental water) including controls at B2 Level
- Supply and install domestic hot and cold water systems including water storage
- Rodding, cleaning flushing existing sub-platform drainage systems
- Retail provision - metered cold water supplies
- Retail provision - drainage and floor gully connections
- Removal of water and drainage systems from the decanted Excess Fare Kiosk (north to south side)
- Design, Supply and install Water Treatment tanks for main sump discharge (future provision)
- Sectional and final Testing and Commissioning for all works.

2.5 SUSTAINABILITY

The project's sustainability objectives are set out in the main contract. The Contractor shall be aware of their requirements to contribute to the achievement of these objectives.

The project is targeting an 'Excellent' rating against the Infrastructure Sustainability rating tool from the Infrastructure Sustainability Council of Australia. The Contractor shall be aware of their requirements to contribute to the achievement of this rating.

- Energy efficiency: any substitutions proposed by the Contractor will need to achieve equivalent or better performance in terms of energy demand.
- Water efficiency any substitutions proposed by the Contractor will need to achieve equivalent or better performance in terms of water use.
- Zero waste to landfill: The Contractor shall be cognisant of this target when procuring goods and services in relation to the project.

The Contractor shall refer to the following information as part of these works:

Report/Specification No.	Description
CRL Infrastructure Sustainability Management Plan	CRL-EWG-SUS-AT-PLN-003680

2.6 WORK BY OTHER TRADES

Refer to the Technical General section for the following specific works by other trades;

- Mechanical (section 3 & 6)
- Fire (section 4 & 7)
- Hydraulics (section 5 & 8)

2.7 BUILDERS WORKS IN CONJUNCTION (BWIC)

The Main Contractor shall provide all the BWIC with this specification. This shall include, but not limited to;

- Cutting, forming or drilling through walls, floors or ceilings to allow services to pass.
- Ensuring structural integrity is not compromised.
- Chasing block and brickwork for conduits or pipes.
- Lifting and replacing floors.
- Asbestos removal.
- Plant moving services.
- Sealing holes.
- Reinstating fire, thermal or acoustic separation.
- Constructing plinths.
- Making good plaster and other finishes

2.7.1 BWIC for Mechanical Works

- All cutting, patching, trimming and making good of the building structure for the installation of pipework, ductwork and the like, provided the installation takes place in accordance with the building programme.
- Provision of plinths or structural platforms on the roof areas or in plant rooms to support mechanical equipment. The mechanical services contractor shall advise the builder of their requirements (via “builders work” shop drawings)
- Provision of timber walkways across roof to access mechanical services roof mounted plant. Raised walkways / stair sections are required to pass over ductwork in roof areas with restricted access.
- Provide approved under flashing and upstands on ductwork and pipework penetrating roofs or external walls.
- Clear openings throughout the building structure for the passage of ductwork, pipework, cables and related systems. These shall be documented by the Mechanical Services contractor via “builders work” shop drawings. Penetrations missed out because of the Mechanical Services Contractor’s failure to provide details in time shall be performed by the Building Contractor(s) at the Mechanical Services Contractor’s expense.
- Provide service access panels in ceilings and walls as identified by the Mechanical Services Contractor.
- Provision and installation of external weatherproof louvres provided by the Mechanical Services Contractor.
- Enclosing and acoustic screens for external plant.
- Platforms stairs, ladders and walkways providing permanent access to plant and complying with AS1657 Fixed platforms, walkways, stairways and ladders unless otherwise noted
- Lifting eyes for equipment.
- Installation of door grilles provided by the Mechanical Services Contractor.
- Provision of a 25 mm undercut on doors as indicated on the mechanical services drawings.
- Chasing of and reinstatement of concrete floors, walls, and columns where necessary to provide access for cabling to sensors etc.
- Access for the installation of equipment and provision of power, drainage and water supply for installation, testing and commissioning purposes.
- Cutting, installation, and removal of ceiling tiles during installation and commissioning.
- Fire proofing (using approved methods) of the gaps between the mechanical services and the penetrations through fire rated structures, including reinstating the fire integrity of existing penetrations where affected by the Works.

2.7.2 BWIC for Fire Works

The Main Contractor shall provide:

- Supply of master key or keys to the Fire Brigade to allow emergency access to the building and all items of fire protection equipment.
- Access openings where required for testing, inspection and maintenance.
- All cuttings, patching, framing-up, furring-in and making good etc associated with the building structure for the passage of pipes, conduits, fire services control panels, etc. Details shall be supplied by the Fire Contractor.

- The forming of major penetration openings in the building for all items required for the work of this Fire Contractor after such items have been located by dimension drawings and placed in final position by this Fire Contractor.
- Clear openings through the building structure for passage of pipes and conduits etc to the Fire Contractor's details.
- Provision of penetration and making good for the fully recessing of the Fire Alarm Panels/Mimic panels.
- Fire proofing (using approved methods) of the gaps between the fire services and the penetrations through fire rated structures, including reinstating the fire integrity of existing penetrations where affected by the Works.
- Primary structural supports for plant.
- Fire hydrant cupboards and necessary signs.

2.7.3 BWIC for Hydraulic Works

The Main Contractor shall provide:

- Temporary drainage and water supply for use during construction;
- Temporary electrical supply for use during construction;
- Foundation pads for water storage tanks.
- Provision of building and structure penetrations including provision and removal of formwork, or provision of framing, and making good at locations as required by Hydraulics sub-contractor, with under-flashing for pipes, conduits, flues and the like through external walls and roofs.
- All cutting, patching, trimming and making good of the building structure for the installation of pipework and the like, provided the installation takes place in accordance with the building programme.
- Cut all holes in finished surfaces, timber, cupboards, false ceilings, vanity units, shelves, etc., as required by the Hydraulics Contractor.
- Bollards and mechanical protection to pipework, stacks and equipment.
- Supply and installation of waterproof membranes in all wet areas.
- All roof work, roof flashing, gutters and roof penetrations being made watertight.
- Set out of building grids to allow set out of core holes
- Supply and install all roof/parapet/balcony overflows.
- All in-situ concrete sumps and grated drains (grates that form part of the structural slab.)
- All concrete plinths and support structure (for pumps, hot water plant etc.). Metal forms are to be used for all concrete plinths to the dimensions supplied by the Hydraulics Contractor.
- Cupboards, meter enclosures.
- Fire proofing (using approved methods) of the gaps between the hydraulic services and the penetrations through fire rated structures, including reinstating the fire integrity of existing penetrations where affected by the Works.
- Primary structural supports for plant.
- Platforms stairs, ladders and walkways providing permanent access to plant and complying with AS1657 Fixed platforms, walkways, stairways and ladders unless otherwise noted
- Trip protection in the form of stairs or ramps and head protection where services cross walkways.

- Lifting eyes for equipment.
- Building in circular sleeves for penetrations, holding bolts, cast in fixings, conduit, puddle flanges and similar items at locations shown on the Hydraulics Contractor's drawings.
- Concrete upstands, pits, bunds and kerbs.
- Cutting and making good of chases for wiring, conduits, wall boxes and the like. Where chases exceed 80mm wide, provide expanded mesh over the full width and length of the chase.
- Boxing in of exposed piping and cables.
- Access panels/hatches in the ceilings, shafts, walls, floors and bulkheads for access to hydraulics services.
- Removal, relocation and replacement of ceiling tiles and grids for access for the installation and commissioning of hydraulics services.
- Trenching for services installations including cutting, excavation, shoring, backfilling and making good of surface, but excluding services, bedding and initial cover.

2.7.4 BWIC for Controls Works

The Main Contractor shall provide:

- Cut away all penetrations through walls, floors and partitions as detailed in drawings provided by the Controls Specialist Contractor, via the Appointed Person, together with all the necessary making good after such work.
- Provide all scaffolding and working platforms required by the Controls Specialist Contractor including setting up and taking down of such items.
- Provide concrete plinths for all motor control centres to drawings provided by the Controls Specialist Contractor.
- Fire proofing (using approved methods) of the gaps between the control services and the penetrations through fire rated structures, including reinstating the fire integrity of existing penetrations where affected by the Works.

2.8 TENDER REQUIREMENTS

2.8.1 Tender Quantities

The information detailed in the Schedules and drawings are to be used for Tender purposes only.

2.8.2 Tender Submissions/Returns

Where equipment or components have been specified as part of this specification the Tenderer shall include these as part of their submission or provide an equal equivalent for consideration by the ER.

The project is targeting an '<u>Excellent</u>' rating against the Infrastructure Sustainability (IS) rating tool from the Infrastructure Sustainability Council of Australia (ISCA). The Tenderer shall be aware of their requirements to contribute to the achievement of this rating.

The Tenderer shall provide manufactures/ products that satisfy the performance requirements indicated in the Technical sections of the specification and also provide at least 3 alternative product selections that 'exceed' the energy performance benchmarks indicated below and indicated in the Technical sections of this specification.

Where no manufacture/ product has been indicated or specified then the Tenderer shall include a proposed manufacture/ product for approval by the ER.

The tenderer shall:

- Return with his Tender a completed schedule of system details;
- Specify the make and model of all equipment being proposed;
- Include for at least 3 alternative product selections indicating energy benchmarks and costs for comparison by the ER
- Include within the Tender a description of any discrepancies between the Tenderer's standard system and the technical and performance requirements of this Specification. If the Tenderer does not highlight these discrepancies then it shall be deemed that the Tender complies fully with the Specification;
- Include in the tender for all electrical and electronic equipment proposed to have Electro Magnetic Compatibility (EMC) CE certification and approval.
- Include in the Tender all costs associated with the warranty requirements of attending any call by the end of the next working day;
- Include in the Tender all costs associated with warranty visits to maintain particular items that are more frequent than monthly;
- Include what the Tenderer sees as the main Health and Safety issues associated with this specific aspect of the project and their proposals for managing them.

2.8.3 Energy Benchmarks and Product Selections

The project is targeting an 'Excellent' rating against the Infrastructure Sustainability rating tool from the Infrastructure Sustainability Council of Australia. The Tenderer shall be aware of their requirements to contribute to the achievement of this rating.

The Tenderer shall as a minimum provide products/equipment that satisfies the minimum energy performance requirements indicated in the tables below and in the Technical sections of the specification.

These are based on the Government 'Guidelines for energy efficient HVAC plant' that is issued as guidance under section 175 of the Building Act 2004.

2.8.3.1 ISCA Energy and Carbon Monitoring and Reduction

As part of contributing to achieving an 'Excellent' IS rating a reduction of Greenhouse Gas emissions by 10-20% below a business as usual footprint is required. An improved energy efficiency performance will contribute to a reduction in greenhouse gas emissions and hence contribute to achieving an "Excellent" IS rating.

Mechanical

- Minimum energy efficiency ratio (EER) for cooling systems.

Type	65kWr to 95kWr EER	95kWr to 1255kWr EER
Packaged air conditioners	2.7	2.8
Split and multi-split air conditioners	2.7	2.8
Variable refrigerant flow systems	2.6	2.7

Type	Full Load	Part Load
Air cooled more than 125kWr but not more than 525kWr	2.2	3.0
Air cooled more than 525kWr	2.5	3.1

- Maximum specific fan power (SFP) in air distribution systems

System type	SFP (W/(l/s))
Central balanced mechanical ventilation system with heating and cooling	1.6
Central balanced mechanical ventilation system with heating only	1.5
All other central balanced mechanical ventilation systems	1.1
Zonal supply system where fan is remote from zone, such as ceiling void or roof mounted units	1.1
Zonal extract system where fan is remote from zone	0.5
Zonal supply and extract ventilation units, such as ceiling void or roof mounted units serving single room or zone with heating and heat recovery	1.9
Local balanced supply and extract ventilation system such as wall/roof units serving single area with heat recovery	1.6
Local supply or extract ventilation units such as window/wall/roof units serving single area (e.g. toilet extract)	0.3
Other local ventilation supply and extract units	0.5
Fan assisted terminal VAV unit	1.1
Fan coil unit	0.5

- Extending specific fan power (SFP) in air distribution systems for additional components

Component	SFP (W/(l/s))
Additional return filter for heat recovery	+0.1
HEPA filter	+1.0
Heat recovery – thermal wheel system	+0.3
Heat recovery – other systems	+0.3
Humidifier/dehumidifier (air conditioning system)	+0.1

- Heat Recovery Efficiencies

Component	Efficiency %
Thermal Wheel	65

- Pumps

Component	
Where water is circulated by pumping at greater than 2l/s;	
Be designed so that the total of the motor shaft power does not exceed	3W/m2 for a building of not more than 500m2 floor area adjusted by 330 W/(l/s) for each increase of 1 (l/s/m2) in water flow rate above 10 (l/s)/1,000m2
Except where the pump is required to run at full speed for safe or efficient operation, have the pump capable of varying its speed when it is	Operating for more than 3,500 hours per year Is more than 11kw of motor shaft power

Hydraulics

As part of contributing to achieving an 'Excellent' IS rating a reduction in water use by 5-20% below a business as usual footprint is required. Low water-use fittings will contribute to a reduction in water use and hence contribute to achieving an "Excellent" IS rating.

- The following minimum WELS ratings are required for all fixtures and fittings within the building

Component	WELS
Showers	3 WELS, <9L/min flow rate, with "Shower timer – Standard Model" or equal
Toilets/WC	4 WELS, 4.5L/3L dual flush, average <3.5L/flush
Urinals	0.8L/ flush with individual smart flush controllers
Hose Taps	6 WELS, <4.5L/min flow rate (to be installed with flow restrictors)
Cleaners Sink	4 WELS, <7.5L/min flow rate
Hand Basins	6 WELS, <4.5L/min flow rate
Dishwashers	5 WELS
Kitchen Sinks	6 WELS, <4.5L/min flow rate

2.8.3.2 Product Selections

The contractor shall submit at least 3 alternative products/equipment that 'better' the minimum energy performance requirements. This shall be included as part of the tender returns.

The equipment selections shall indicate the following;

- Energy efficiency rating (EER/SFP/%)
- Product/Equipment Cost ($)

Equipment selections and cost comparisons shall be provided for the following major pieces of equipment.

Mechanical

Type
Chillers
Close Control Units/Packaged Air Conditioners
Fan Coil Units
Variable refrigerant flow systems
Air Handling Units (including heat recovery)
Exhaust Fans
Pumps (chilled water primary/secondary)

2.8.4 Description of Excluded Work

The Tenderer shall, with his Tender, clearly describe any work necessary for the proper completion of the works not included for in his Tender and which he may require to be executed and paid for by others; any such work not specifically stated and described shall be deemed to have been included in his Tender.

2.8.5 Trade Name References

Any reference in this Specification to trade names or to a particular manufactured product should not be interpreted to mean that the particular article or product is the only one to be supplied or used. The reference is given as an indication of the quality, class, type and finish of the items to be used and as information to Tenderers on the amount to be allowed for the items concerned.

Alternative offers will receive serious consideration but only on that basis. A conforming offer must be made with alternatives and the price variation applicable included as an option to the conforming tender. Where alternatives are offered, full details of the variation must be set out. This must include both benefits and disadvantages to enable a fair assessment to be made.

If tenderers are in doubt as to the suitability of any alternative, it is recommended that they discuss the matter with the Engineer prior to the expenditure of time and effort.

Articles or products of equal type and quality produced by the other manufacturers **must** be submitted by the Contractor to the ER for approval at the tender stage. Failure to submit alternatives at the tender stage of the project may result in any subsequent submission being rejected simply on a 'time bar' decision.

The reference 'equal to' shall be taken in all cases to be the same as the reference 'equal in all respects to". The acceptance of what constitutes as being of equal type and quality shall be at the sole discretion of the ER or Client.

2.9 PREFERRED MANUFACTURERS

The following product manufactures are considered acceptable for use for the project. Alternative manufactures not included on the list must be submitted by the Tenderer/Contractor to the ER for approval at the tender stage.

2.9.1.1 Mechanical

Equipment	Manufacturer
Air Handling Unit	Cooke Industries
Fans	Fantech FlaktWoods (Alaskon) Pacific HVAC
Chillers	Trane Clivet (Cooke Industries) Airedale (Eurotech) York
Close Control Units	Stulz Airedale (Eurotech) Emerson
Refrigerant Systems (VRF/VRV/DX)	Mitsubishi Electric Daikin
Fan Coil Units	Temperzone Clima Solutions
Attenuators/Silencers	NAP Silentflo (Cooke Industries) Fantech Noise Control Services (NCS)
Grilles/Diffusers	Holyoake
Pumps:	Grundfos Flygt (Xylem) Wilo
Variable Speed Drives (VSD)	ABB Danfoss Emerson PDL
Electric Heaters	Avon Electric Dimplex
Radiant Panels	Avon Electric Energotech EEPL (Energy Efficient Products)
Fire/Smoke Dampers	Holyoake

2.9.1.2

2.9.1.3 Fire

Equipment	Manufacturer
Gas Suppression Agent	ProInert

2.9.1.4 Hydraulics

Equipment	Manufacturer
Pumps	Grundfos Flygt (Xylem) KSB ABS Gorman Rupp
Packaged Pumps	Saniboy Grundfos Flygt (Xylem)
Variable Speed Drives (VSD)	ABB, Danfoss, Emerson, Schneider
Hot Water Cylinders	Rheem

2.10 QUALITY ASSURANCE

The Contractor shall establish Quality Management procedures in conjunction with the Building Contractor to ensure that the installations, equipment, materials and workmanship conform to the standards required in the Main Contract Documents.

2.11 SPECIALISTS TO THE PROJECT

The contractor is required to retain the following Specialists for the duration of the project. This shall include the Demolition, Temporary and Permanent works stages through to practical completion.

2.11.1 Building Services Coordination Engineer

The Building Services Coordination Engineer shall be responsible for the overall coordination of all trade works (main and sub). The Coordination Engineer shall have a minimum of 15years experience in similar roles preferably within the rail environment working on large complex rail projects. The MEP Coordination Engineers responsibilities shall include the coordination of the following disciplines (but not limited to);

- Mechanical (HVAC)
- Electrical
- Fire (wet and dry)
- Hydraulics (drainage and potable)
- Communications (PA/CCTV/PHP/PIDs etc)

- IT/DATA

Overall responsibilities include;

- Manage the overall coordination of subcontractor's equipment submissions
- Manage the main contractors (and all applicable subcontractors) specific design requirements such as the building services seismic design, verification of fan/pump system pressure drops, controls, etc.
- Coordinating wall penetrations
- RFI (services) tracking
- Shop drawings submissions
- Sub-contractor coordination
- Revit "construction design"
- Work programming (including continuously updating)
- Methodology (including updates once reviewed)
- Shutdowns/cut ins into existing systems
- Staged "sectional handovers"
- Staged commissioning
- Final as-built / O&M manual production

2.11.2 Structural Engineer (Seismic Restraints)

A Chartered Engineer (Structural) experienced in seismic fixings of plant to complete the design and observation of all equipment installations. The Contractor is to make allowance for the Chartered Engineer to provide a Producer Statement PS1 (Design) and PS4 (Construction Review) prior to Practical Completion.

2.11.3 Commissioning Engineer

The contractor shall appoint specialist Commissioning Engineers for the project to carry out all aspects of testing and commissioning. This shall include sectional testing and commissioning and final testing and commissioning stages. The Commissioning Engineer (s) shall have a minimum of 15years experience.

- Review of Design Drawings at construction issue to check for dampers, valves, sensors etc.
- Review of contractors shop drawings for access, commissioning etc.
- Inspection on site of first fix for access.
- Static completion works
- Proving operation from static completion to fully functioning works
- Pre-commissioning review of sectional and completed systems and review of results.

If applicable the Commissioning Engineer will oversee and co-ordinate the testing and commissioning of the Control Specialist Contractor's work.

2.12 SITE CONDITIONS/VISIT THE SITE

Contractors should visit the site to gain knowledge of the accessibility and of conditions affecting labour, carriage, unloading and storage of materials.

Contractors shall satisfy themselves as to the staging, scaffolding, tools, storage, accommodation etc., required for the proper execution of the Contract, with respect to the Main Contract and site conditions.

2.13 TAG AND TRACE WORKS & AS-BUILT INFORMATION

Tag and trace works were carried out at the west end of station during July – August 2015. The information provided to the design team was based on as-built information (dating back to 2003) which was updated as far as practicable to reflect the current installation.

The T&T works generally covered the western end of the station and where practicable identified existing services and service routes. Due to the complexities and extent of services the T&T works were unable to fully identify all services. This was due to inaccessible spaces, services cast in slab and untidy installations.

The accuracy and validity of any T&T information shall be verified by the Contractor prior to the commencement of any works on site.

In conjunction with the T&T works the design has been based on available as-built information dating from 2003 and a REVIT model produced from point cloud data and as-built structural data. There will be areas in the station that are not accurately modelled and the Contractor shall carry out his own due diligence surveys to verify the accuracy of this information.

Any claims by the Contractor arising from lack of knowledge of the above mentioned conditions, will be disallowed.

The contractor shall refer to the following Tag and Trace information as part of these works;

Report/Specification No.	Description
Mechanical Services Tag and Trace Information	CRL-BTM-MEP-000-DOC-0001
Electrical Services Tag and Trace Information	CRL-BTM-MEP-000-DOC-0002
Plumbing Services Tag and Trace Information	CRL-BTM-MEP-000-DOC-0003
Fire Services Tag and Trace Information	CRL-BTM-FIR-000-DOC-0001
CCTV and Security Services Tag and Trace Information	CRL-BTM-COM-000-DOC-0001
PA and Public Help Point Tag and Trace Information	CRL-BTM-COM-000-DOC-0002
Incoming Telecommunications Services Tag and Trace Information	CRL-BTM-COM-000-DOC-0003
Drainage Services Tag and Trace Information	CRL-BTM-DRN-000-DOC-0001
SCADA Services Tag and Trace Information	CRL-BTM-BMS-000-DOC-0001
IT/DATA Systems Tag and Trace Information	CRL-BTM-ITM-000-DOC-0001

2.14 CO-ORDINATION

The Contractor shall co-ordinate his work with other trades on the buildings in such a manner as not to interfere with other work being carried out on the building.

In locations where equipment must be installed along with other work being installed under other contracts, the Contractor shall co-operate with the other Contractor's concerned and see that all equipment is installed to the best advantage.

Any cutting etc, required to the building structure as a result of this Contractor's failing to co-ordinate with the program shall be arranged at this Contractor's expense.

The main contractor shall employ a specific “Building Services” Coordination Engineer to undertake overall responsibility of the building services coordination process. The coordinator shall have a minimum of 15years experience in similar roles preferably within the rail environment. They will need to undertake;

- Manage the overall coordination of subcontractor’s equipment submissions
- RFI (services) tracking
- Shop drawings submissions
- Sub-contractor coordination
- Revit “construction design”
- Work programming (including continuously updating)
- Methodology (including updates once reviewed)
- Shutdowns/cut ins into existing systems
- Staged “sectional handovers”
- Staged commissioning
- Final as-built / O&M manual production

2.15 EXISTING SERVICES

The Contractor shall be completely satisfied that all existing services required to be connected are those to which the documents indicate, and that they are of the size and level shown on the drawings. No additional claims will be accepted for rectifying works that have been incorrectly connected as a result of failing to confirm the documented information at site prior to commencing this work.

All existing services to be connected to, other than Authority Services, shall be cleaned, flushed out and tested to an equivalent standard of all new works, and to the satisfaction of the ER prior to their connection.

The Contractor shall not close down any existing services without giving at least 48 hours notification to the ER or without written approval to do so. After notification to the ER that the service is redundant, the Contractor may proceed to cap off, or seal the service off in the correct manner, as is required by the Authorities and the ER.

The Contractor will be responsible for checking with all Authorities and the ER concerning the location of any existing services on the site.

The Contractor shall allow to seal off all existing services that may become redundant during the progress of the Project. All such services shall be sealed off at the relevant Authority supply main, and removed where practicable.

Include a detailed maintenance schedule in the equipment manuals for the servicing of each system.

2.15.1 Redundant Services

The contractor shall arrange for the full isolation, disconnection and removal of any MFH services that are;

- Identified as existing redundant station services not required as part of these works
- Existing redundant services left in place from previous installations

The contractor shall ensure all redundant wiring, pipework, ductwork etc is fully isolated and stripped back to its source and made safe. Any recyclable materials i.e. copper, steel shall be offered back to the client for the disposal of.

2.15.2 Site Hazards and Past Installation Works

The Tag and Trace works carried out during July – August 2015 identified various hazards in certain locations at the west end of the station.

The below report highlights some of the hazards and past installation practices carried out at the station. This is not an exhaustive list but an overview of the typical standard of installation that has been undertaken in the past.

The contractor shall make themselves familiar with the report contents, site hazards and past installation works.

Report/Specification No.	Description
MEPF/Comms Hazard Identification Report	CRL-BTM-HSE-000-RPT-0001

2.16 ASBESTOS

Prior to the commencement of any works, the contractor must request and read any available information on asbestos and any other relevant documentation relating to all areas where work is being carried out or used for access.

Test results from 2002 and also records of reports and tests through to 2005 are available through the main contract. In general these reports were carried out by Nikau and Dowdell & Associates;

- Summary Sheet of the reports (Test results and report comments)
- Visual representation of reports and results for CPO
- Reports of CPO – records from Dowdell & Associates

2.17 CERTIFICATION OF WORKS

At the completion of the works and prior to the submission for final payment the Contractor shall make all necessary applications, pay all fees, obtain and issue to the ER Certificates indicating that the works comply with the current regulations and requirements of the relevant Authority.

Wherever applicable the relevant Authority shall issue the Certificate. Where this is not standard practice the Contractor shall provide a Certificate or Letter of Certification which will guarantee that the works comply with the relevant Authorities regulations, requirements and conditions.

2.18 CODES AND STANDARDS

The Contractor shall comply with relevant standards / codes associated within the project.

The Contractor must take full responsibility for the safety and appoint his/her own authorised competent persons.

Refer to the Technical General section for the relevant codes and Regulations;

- Mechanical (section 3 & 6)
- Fire (section 4 & 7)
- Hydraulics (section 5 & 8)

Where some doubts exist as to the appropriate standard, the decision shall be made by the ER before commencement of any work on or off the site. If a doubt exists as to whether a section of the design is able to comply with the relevant authorities regulations the ER shall be notified prior to the commencement of any work. No consideration of claim for redundant work shall be given if the ER is not notified.

2.19 AUTHORITIES

The whole of the work shall be carried out by or under the full supervision of a fully licensed contractor in accordance with the drawings and specification, and to the satisfaction of the ER and to the current Standards and Regulations of any authority having jurisdiction over the works.

The Contractor shall submit evidence that:

- Requirements of authorities relating to the work under the contract have been ascertained prior to the commencement of the services installation.
- Fees to authorities, if any, have been paid and all types of approvals obtained.
- Certificates of compliance with regard to the extent of the installation. Such certificates have to be obtained on completion of the installation.
- All fittings, pipes, accessories and the like used in the works shall bear approval marks where and as required by the regulatory authorities.
- Test certificates for all essential service fittings. Be provided prior to completion.

2.20 DRAWINGS

Drawings show the approximate route of the various services in setting out; they shall be read in conjunction with all construction drawings for this Project. Make sure allowance for all necessary diversions from the straight line, rise and fall and adjustment and positions of equipment as may be required for the proper execution of the works. No additional money shall be payable to the Contractor for any of these diversions.

It shall be understood that the drawings accompanying this specification are intended to show the general arrangement and the intent of the work to be done and that it is the tenderer's responsibility to provide a complete and fully functioning system complying in all respects to those codes (as amended) and authorities. All materials and items shall be installed in accordance with the manufacturer’s recommendations unless noted otherwise in this specification or tender drawings.

The Contractor shall be responsible for checking all dimensions and levels indicated against site restrictions and ensure that the proposed layout is practical before commencing work. The drawings shall not be used for scaling of dimensions.

The Contractor shall refer to the architectural dimensioned drawings for setout of fixtures.

The Contractor is to ensure that all the plant offered can be accommodated within the available spaces and is to include for taking all necessary dimensions on site and prepare;

- Working/Workshop drawings for approval prior to installation commencing
- Manufactures drawings
- Builders works drawings
- Record Drawings
- Work As Executed Drawings

No variation to the contract price will be accepted for any such items not included in the tender.

2.20.1 Discrepancies in Drawings

In the event of discrepancies appearing on the drawings, or between the Drawings, Specification, Preliminaries, and Tender Documents, the Contractor shall refer the matter to the client for interpretation. No variation in the Tender price will be considered due to the Contractor's failure to remark such errors, or to having incorrectly interpreted any part of the Specification or Drawings.

2.20.2 REVIT

The MEP REVIT model (LOD300) was issued to the contractor to develop LOD400.

2.20.3 Working/Workshop Drawings

Produce and submit to the ER for inspection, comprehensive working/workshop drawings, with notes and/or specifications for such parts of the works as are necessary, or specified in the Contract, or as set out below.

These drawings shall be submitted following detailed co-ordination with other trades.

Submission of the drawings shall be both as CAD files and PDF files and shall be submitted electronically either via the project document management system or by CD Disk or USB stick.

Such drawings shall be submitted as described to the Building Contractor to allow sufficient time for examination, production and supply so as not to delay progress of the works.

Shop drawings shall take account of site dimensions, actual dimensions and access requirements for installation and servicing of the particular brands and models of equipment supplied, and shall co-ordinate with the building structure, finishes and other services in accordance with the design details and general arrangements shown on the design drawings and shall comply with Statutory Authorities and shall show sufficient information to enable the Building Contractor and the ER to check that the equipment can be installed, operated adjusted and maintained in the manner for which the system was designed.

The Contractor shall prepare shop drawings from the latest available information. Wherever possible consultation with the Building Contractor and ER should continue during shop drawing preparation. This will ensure the quickest possible handling when shop drawings are formally submitted to the Building Contractor and generally reduce the incidence of re-submitted drawings.

The Sub-Contract works shall include:

- The execution of the Sub-Contract works inclusive of full design and co-ordination with the intent of the Sub-Contract.
- Provision of shop drawings which take account of full design of required systems, site dimensions, actual dimensions and access requirements for installation and maintenance of the particular brands and models of equipment supplied, and which co-ordinate the locations of all pipes, conduits, equipment etc. with other trades.
- Provision of detailed drawings to the Building Contractor showing work associated with the Sub-Contract to be carried out by other trades.

Shop drawings shall have all building details such as columns, stairways, floors, lifts, etc. numbered in accordance with the Architectural drawings. Services and plant shall be identified by numbering in a manner approved by the Building Contractor and ER.

Shop drawings shall:

- Be drawn to the following scales - 1:1, 1:5, 1:10, 1:20 for components and 1:50, 1:100 for locations, except for wiring diagrams which need not be to scale.
- Be drawn on preferred metric sized drawing sheets.
- Be dimensioned in metric measurements.
- Be prepared by competent draftsperson (freehand drawings will NOT be accepted).
- Be amended as necessary and incorporated within the as-installed drawing set.
- Be co-ordinated with the building construction and all other services, so that the position of sprinkler heads, EWIS speakers and smoke detectors etc are coordinated with other services to achieve a consistent and symmetrical pattern to the ceiling.
- Include but not be limited to all necessary plant, equipment, accessories and construction details.
- Plans, sections and details shall be provided.
- Be submitted to the relevant inspecting authority where required prior to submission to the Engineer.
- Be submitted to comply with the construction programme within sufficient time to permit modifications to be made without delaying the works if such are deemed necessary by the Engineer and to provide the Engineer with not less than seven (7) working days to make his comments.

2.20.4 Examination of Shop Drawings

Forward the shop drawings and a copy of data and Specifications in time to allow inspection, manufacture, supply and installation so as not to delay the works.

The Building Contractor, ER and Engineer shall examine and return such drawings, indicating approval or otherwise of the work shown for use on or in connection with the Sub-Contract. Where amendments are required to such drawings, the amendments shall be made and re-submitted promptly, without variation.

If the drawings are "Accepted" or "Accepted with Notes" then the Building Contractor, ER and Engineer are satisfied that the arrangement and requirements are generally in accordance with those specified under this Contract and shown on the drawings, subject to any amendments shown thereon. However, dimensions, co-ordination with associated plant and site conditions, compliance with statutory regulations and compliance with specified requirements whether or not shown on the drawings remain the responsibility of the Contractor under this Contract work. Examination of the shop drawings shall not diminish the Contractor's responsibility for ensuring that they provide fully coordinated and functioning services.

Pay for all alterations of the work due to any discrepancies, errors or omissions in the prints of drawings or other information supplied, whether such prints of drawings or information have been inspected or not provided that such discrepancies, errors or omissions are not due to inaccurate or incomplete information given by the Building Contractor or ER.

Arrange the work in co-operation with other trades so that all work is installed to the best advantage. Where equipment is installed without due regard to other trades, the work of relocation of such equipment shall be performed by the Contractor at no extra cost to the contract.

2.20.5 Manufactures Drawings

As soon as practicable, and in any event to allow adequate time for Engineer's comments and to comply with the requirements of the Contract programme, the Contractor shall provide to the Engineer for comment duplicate copies of Manufacturing Drawings for all items of plant and equipment listed in the schedules attached to this document.

In addition, the Contractor shall submit to the Engineer with these drawings all relevant pump curves, fan curves, details of noise criteria, weights, electrical loadings, etc., and electrical connection diagrams.

Manufacture of relevant items of plant and equipment shall not commence until the Engineers comments on the relevant Manufacturing Drawing has been obtained.

The Engineer reserves the right to amend, or add to the drawings as may be necessary or expedient.

2.20.6 Builder’s Work Drawings

As soon as practicable, and in any event to allow adequate time for Engineer's comments and to comply with the requirements of the Contract programme, the Contractor shall provide to the Engineer for comment duplicate copies of fully dimensioned drawings to an approved scale, of builders work requirements in connection with this Contract. Drawings shall show details of;

- Access doors and panels.
- Conduits to be cast in slabs.
- All penetrations
- Duct and pipe supports
- Holding down bolts and other anchorage and/or fixings required complete with loads to be imposed on the structure during installation and operation.
- Openings, penetrations and block-outs.
- Pipe sleeves.
- Plinths, kerbs and bases.
- Required external openings.

The Contractor shall provide to the Engineer full particulars of loadings including moments, and dimensions and positions of foundations and plinths, and/or fixings necessary for the support and accommodation of all equipment to be supplied under this Contract, so that adequate provision may be made. Builders work drawings shall be fully dimensioned showing location of holding down bolts, details of anti-vibration mountings, etc.

All dimensions affecting accommodation and installation of the plant, and equipment supplied under this Contract, and points at which services other than those covered under this Contract are required shall be clearly indicated on drawings to be submitted to the Engineer by the Contractor.

The Contractor shall be responsible for any discrepancies, errors or omissions in the above mentioned drawings whether these drawings have been comment on by the Engineer or not. Comments given by the Engineer to any drawing shall in no way relieve the Contractor from his liability to complete the works in accordance with this document or exonerate him from any of his guarantee.

The Engineer reserves the right to amend, or add to the Drawings as may be necessary or expedient.

2.20.7 Progress Drawings

The Contractor shall keep on site one full set of white prints of the Working Drawings showing the progress of all work in connection with this Contract.

These drawings, which shall be maintained in clean condition, shall be kept up to date on a weekly basis, and all pipe lines, duct runs, positions of equipment and apparatus, including all modifications and/or variations, shall be clearly recorded by the Contractor on the drawings as they are installed.

The Contractor shall make the above drawings available at any time for inspection by the Architect/Engineer.

The Contractor shall provide to the Engineer, for the Employers use, duplicate copies of the Progress Drawings no later than two weeks prior to the Date of Practical Completion.

2.20.8 Record Drawings

The Contractor shall keep available at all times on site, a copy of design drawings marked up in colour and dated to indicate the extent and chronological order of all work tested and approved by local authorities. The Contractor shall also keep available at all times on site a copy of all local authority test certificates.

2.20.9 Work as Executed Drawings

One month prior to practical completion of the works provide a complete and accurate set of CAD drawings showing the installed position of all services, equipment, valves and sundry pipework included in this specification. Drawings shall be prepared by a competent draftsman on approved reproducible material. The minimum size scale shall be at least equivalent to those used on the contract document. The invert depths and location of all pipes and valves shall be accurately plotted and indicated by measurements and be signed off by a registered surveyor

Preliminary copies of the documents shall be submitted for inspection by the Engineer, who will indicate that they are suitable or alternatively mark where they require modification.
After approval, provide three (3) A3 size hard copy sets of CAD drawings for inclusion into the Operations and Maintenance Manuals and one (1) set of CAD drawings in AutoCAD release 2014 or later format on CD or USB stick.

All changes in between practical completion and the initial issue of the “Approved for Construction” drawings are to be allowed by the Contractor.

The WAE Drawings shall be prepared by a competent draftsman on approved reproducible material. The minimum size scale shall be at least equivalent to those used on the contract document. The invert depths and location of all pipes and valves shall be accurately plotted and indicated by measurements that are to be provided by a registered surveyor. A copy of the plans marked up and signed off by a registered surveyor shall be submitted prior to the commencement of the preparation of the work as executed drawings.

2.21 SEISMIC DESIGN AND INSTALLATION

2.21.1 General

This section covers the general seismic restraint requirements for suspended engineering systems, both vibration and non-vibration isolated and/or related suspended equipment. Further Seismic design requirements are indicated in the relevant Technical Sections;

- Mechanical (section 3 & 6)
- Fire (section 4 & 7)

- Hydraulics (section 5 & 8)

The contractor shall retain the services of a Chartered Engineer (Structural) experienced in seismic fixings of plant to complete the design and observation of all equipment installations. The Contractor is to make allowance for the Chartered Engineer to provide a Producer Statement PS1 (Design) and PS4 (Construction Review) prior to Practical Completion.

All hangers' supports, equipment etc. for the mechanical installation are required to be designed and installed to safely resist earthquake forces without compromising the continuing operation of the installation.

All equipment, ductwork, pipework, etc. shall be provided with restraints to resist seismic forces in addition to the normal fixing and supports as provided by the Contractor.

The Contractor shall allow for the costs of complying with this section of the specification. Special attention shall be given to the design of flexibly mounted equipment restraints, which shall allow freedom for vibration control, together with the appropriate earthquake protection.

This clause shall apply to complete assemblies, and subassemblies. All installed plant and equipment (including proprietary plant, pipework and other components) shall be designed by the Contractor to withstand, without exceeding working stresses:

- A horizontal earthquake-induced force acting through the centre of gravity equal to its weight multiplied by a seismic factor as stated in the "Seismic Requirements for Mechanical and Electrical Services".
- Maximum gravity loads under expected operating conditions (including allowances for temperature movement, fluid pressure surges and the like).
- Wind loads induced by the application of the maximum 3-second gust expected every 50 years, multiplied by the appropriate factors as detailed in NZS 4203

Co-ordinate with the main building Contractor and all their Contractors, the Architect and Structural engineer in respect of the design and installation of seismic restraints to NZS4219

Considering the nature of the building, where services are exposed, seismic restraints and supports will be required that complement rather than dominate the architecture of the building.

Prior to fabrication of seismic restraints and supports the shop drawings are to be submitted to the Architect for their review and final approval.

2.21.2 Standards

To comply with this clause the installation is to be analysed and the detail design done in accordance with the provisions in the following Standards:

- NZS 4219:2009 'Seismic Performance of Engineering Systems in Buildings'.
- AS/NZS 1170 'Loadings Code' and be detailed in accordance with the appropriate material codes.

2.21.3 Seismic Requirements

The following table provides the design parameters for the temporary accommodation works and permanent works.

Table 1: Britomart - Seismic design for non-structural components

Design Parameters	SLS	ULS
Design working life	100 year	100 year
Importance Level	**3**	**3**

Return Period	1/25	1/2500
Return Period Factor	0.25	1.8
Soil	Type E	Type E
Z	0.13	0.13

2.21.4 Quality Assurance

The Contractor is required to retain a Chartered Engineer (Structural) experienced in seismic fixings of plant to complete the design and observation of all equipment installations. The Contractor is to make allowance for the Chartered Engineer to provide a Producer Statement PS1 (Design) and PS4 (Construction Review) prior to Practical Completion.

Seismic restraint designer shall layout and identify seismic restraint locations. The layout and identification of seismic locations shall comply with New Zealand Standard NZS 4219:2009, Seismic Performance of Engineering Systems in Buildings. Engineered seismic restraint submittal and shop drawings shall be (signed & sealed) by a chartered New Zealand Structural Engineer and shall be submitted to the designer of record for review and acceptance prior to installation.

Seismic design submittal shall include Quality Assurance guidelines for use by reviewing authorities during inspection.

The project specific seismic restraint submittal shall include the design of both the seismic restraints and vertical (gravity) supports of the system(s) at seismic restraint locations.

Seismic restraint and vertical support design information shall dictate the following:

- Seismic restraints: Brace arm material/size/type and load rating, anchorage, allowable spacing (transverse/longitudinal), brace installation angles and allowable tolerances, means for positive attachment to utilities at longitudinal/transverse locations, means for reinforcing vertical support rods (as required) at restraint locations.
- Vertical (Gravity) Supports: Vertical support spacing, type, size, and anchorage.
- After installation of the seismic restraints, but prior to inspection by local territory authorities, contractor shall submit to the designer of record for review and acceptance As Built Record Drawings accurately identifying all actual installed system layouts and seismic restraint locations.

2.21.5 Products

All seismic restraint bracketry and seismic anchorage connections to be those furnished by ISAT (International Seismic Application Technology) or approved equivalent.

2.22 PAINTING AND FINISHES

2.22.1 General

- Finishes for all products shall be as detailed on the Architect’s drawings.
- If exposed to view (including in plant rooms) paint new services and equipment.
- Surfaces painted or finished off-site: Conform to Metals and pre-finishes.
- Exceptions: Do not paint chromium or nickel plating, anodised aluminium, GRP, stainless steel, non-metallic flexible materials and normally lubricated machined surfaces. Surfaces with finishes applied off-site need not be re-painted on-site provided the corrosion resistance of the finish is not less than that of the respective finish in the On-site paint systems table.

- All paint finishes on steel work including MCC's shall be no thicker than 0.4mm and the sheet metal shall be equal to or greater than 0.4mm.
- Material Group Numbers shall be in accordance with Appendix A of C/VM2 and tested to either ISO 5660 part 1 and part 2 or ISO 9705, Or in lieu of testing as defined in Table A1 of Appendix A of C/VM2.

2.22.2 Standard

General: Conform to the recommendations of AS/NZS 2311 Sections 3, 6 and 7 or AS/NZS 2312 Sections 5, 8 and 10, as applicable.

Specifications: Conform to the On-site paint systems table.

ON-SITE PAINT SYSTEMS TABLE:

- Substrate 1st coat 2nd and 3rd coat
- Aluminium APAS-0035/3 APAS-0015/1
- Concrete APAS-0280/1 APAS-0015/1
- Copper APAS-2921 APAS-0024/1
- GRP APAS-2971 APAS-0015/1
- Iron and steelAPAS-0032 APAS-0015/1
- Organic or inorganic zinc primed metal APAS-0016/1 APAS-0015/1
- Timber APAS-0181 APAS-0015/1
- Metallic-coated steel APAS-0134 APAS-0015/1

2.22.3 Oil and petrol resistant finishes

- General: If the finished surface may be subject to oil and/or petrol provide APAS-0024/1 for the 2nd and 3rd coats in the On-site paint systems table.

2.22.4 Paint application

- Coats: Apply the 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.

2.22.5 Combinations

- Do not combine paints from different manufacturers in a paint system.
- Protection
- Remove fixtures before starting to paint and re-fix in position undamaged on completion.

2.23 MARKING AND LABELLING

2.23.1 General

Mark services and equipment to provide a ready means of identification. Further marking and labelling is indicated in the relevant Technical Sections;

- Mechanical (section 3 & 6)

- Fire (section 4 & 7)
- Hydraulics (section 5 & 8)

2.23.1.1 General

Locations exposed to weather: Provide durable materials.

- Consistency: Label and mark equipment using a consistent scheme across all services elements of the project.
- Operating and maintenance manuals: Provide marking and labelling text identical to the text and terminology used in operating and maintenance manuals.
- Accessories: Label isolating switches and outlets to identify circuit origin.
- Label text: To correspond to terminology and identifying number of the respective item as shown on the record drawings and documents.

Operable devices: Mark to provide a ready means of identification. Include the following:

- Controls.
- Indicators, gauges, meters and the like.
- Isolating switches.
- Outlets.

2.23.2 Labels and notices

All labelling shall be to the following requirements:

- For indoor applications only, engraved two-colour laminated plastic (Traffolyte)
- Proprietary pre-printed self-adhesive flexible plastic labels: Black lettering on white background except as follows:
- Danger, warning labels: White lettering on red background.
- Main switch and caution labels: Red lettering on white background.
- Colours in conformance with AS 1345
- For external applications: Stainless steel or brass ≥ 1 mm thick with black filled engraved lettering.
- Emergency functions: To AS 1319
- Signs for electrical hazards to NZBC F8/AS1
- If labels exceed 1.5mm thickness, radius or bevel the edges.
- Fix labels securely using screws, rivets or proprietary self-adhesive labels.
- Locate labels so that they are easily seen and are either attached to, below or next to the item being marked.
- To correspond to terminology and identifying number of the respective item as shown on the record drawings and documents.
- If labels are mounted in extruded aluminium sections, use rivets or countersunk screws to fix the extrusions.
- Use aluminium or monel rivets for aluminium labels.

2.23.2.1 Label locations

Locate labels so that they are easily seen and are either attached to, below or next to the item being marked.

2.23.2.2 Lettering heights

- Danger, warning and caution notices: ≥ 10 mm for main heading, ≥ 5 mm for remainder.
- Equipment labels within cabinets: ≥ 3.5 mm.
- Identifying labels on outside of cabinets: ≥ 5 mm.
- Isolating switches: ≥ 5 mm.
- Switchboards, main assembly designation: ≥ 25 mm.
- Switchboards, outgoing functional units: ≥ 8 mm.
- Switchboards, sub assembly designations: ≥ 15 mm.
- Other locations: ≥ 3 mm.

2.24 CONTRACTORS RESPONSIBILITY IN RESPECT TO SPECIALIST EQUIPMENT

Where specialist equipment forms part of the works the Project Manager may have had earlier contact with manufacturers in order to obtain information. The Contractor must not assume that manufacturers are aware of the requirements as set out in this Specification and it is the Contractor's responsibility to ensure that manufacturers are given full details of Tender Requirements when seeking quotations.

2.25 SETTING OUT

The set out of all equipment shall be so arranged in conjunction with the ER and other trades concerned. All pipework shall be made and positioned in a neat, workmanlike manner and a first class finish obtained.

2.26 PLACING OF ORDERS

The Contractor shall ensure that orders for materials shall be placed with the manufacturer and/or supplier as soon as possible to ensure delivery of the items specified and to obviate any delay or change of specified articles due to this neglect.

2.27 PROVISION OF MATERIALS

Except where otherwise noted, the Contractor shall provide all necessary fixtures and appliances, fittings, tools and all other incidental materials and accessories necessary for the satisfactory installation, testing and completion of the works, all to the satisfaction of the client.

All materials shall be new and the best of their respective kinds and generally the whole of the work shall be carried out in a neat and tidy manner and a first class finish obtained.

Allow for building in such other fittings and accessories as required or supplied with the fixtures.
The Contractor is to allow for submitting a materials and sample schedule to the ER a minimum of four (4) weeks prior to the placement of the order of the sample in question.

2.28 OBVIOUS WORK

The nature and spirit of the Specification and Drawings is to provide for the work herein enumerated and shown on the tender documents to be fully understood that the Contractor, on accepting the contract, agreed to furnish everything necessary for such construction notwithstanding any omission in the Specification and Drawings.

2.29 BUILDING PENETRATIONS

Set out core holes and sleeves in floors, walls, beams and columns and obtain approval of the set out prior to placing concrete.

Where pipes pass through walls, floors, beams or columns, provide purpose-made metal with 12mm clearance all round pipes, packed with gunned silicone rubber joint sealer (self-extinguishing grade).

Pipes passing through walls below ground level shall be provided with a water stop puddle flange.

Penetrations for metal pipes in fire rated walls, ceilings or floors shall incorporate galvanised mild steel sleeves, overall diameter not less than 40mm larger than the penetrating pipe. Seal with a fire stop material/fire prevention, to comply with AS 1530 Part 4.

Approved fire collars shall be provided wherever a fire rated wall, ceiling or floor is penetrated by a pipe or fitting. The rating of the fire collar is to be the same fire rating of the wall, ceiling or floor penetrated, to comply to AS 1530 Part 4.

Contractor to provide fire rating certification for all installed hydraulic services, such as fire stop collars, sealants, materials and the like, to maintain the integrity of the fire compartments. Certification shall be provided by an independent party.

Where cold water lines emerge from wall, floor or ceiling surfaces, provide cover plates or non-ferrous metal, finished to match the pipe, or of stainless steel as follows:

Pipe Diameter:	Cover plate diameter (nominal):
Up to 20mm	100mm
Up to 50mm	150mm
Larger than 50mm	100mm larger than pipe

2.30 PLANT AND EQUIPMENT ACCESS

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

- Failure of plant and equipment (including leaks) does not create a hazard for the building occupants.
- Failure of plant and equipment (including leaks) cause a minimum or no damage to the building, its finishes and contents.
- Inspection and maintenance operations can be arranged to minimise inconvenience and disruption to building occupants or damage to the building structure or finishes.
- Locate and arrange all services and equipment so that:
- Inspection and maintenance operations can be arranged to minimise inconvenience and disruption to building occupants or damage to the building structure or finishes.
- 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. Include the following:
- Conform to AS/NZS 2865 and OSH Guidelines for the provision of facilities and general safety in the construction industry.

- If parts of the plant require regular inspection and maintenance either locate plant so it is safely accessible from floor level or provide permanent access platforms and ladders.
- In false ceilings locate items of equipment that require inspection and maintenance above tiled ceilings where possible. If this is not possible (for example if 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.
- Modify manufacturer's standard equipment when necessary to provide the plant access in the contract documents.

2.31 PROTECTION

The Contractor shall be entirely responsible for all apparatus, equipment and appurtenances furnished by him or his Contractors in connection with this work and special care shall be taken to protect all parts thereof in such a manner as may be necessary or as directed. This protection shall include covers, crating, sheds, stores or other means to protect the apparatus, equipment and materials from the weather and to prevent dirt, grit, plaster or other foreign substances from entering the working parts of machinery or equipment.

Special care shall be taken to keep all open ends of pipes, ducts, flues, etc. closed while in storage or during course of installation.

The Contractor shall protect all parts of the building and the work of other Contractors from damage which may be caused by the Contractor's workmen. The Contractor shall be responsible for making good any such damage.

2.32 ELECTRICAL WORK

All equipment supplied and work carried out under the contract shall comply with the requirements of the latest appropriate NZ/AS 3000 Electrical Installations.
The electrical installation shall be carried out in accordance with the requirements of the Local Supply Authority.

All items of equipment shall be of first grade with regard to design and manufacture and shall be completely satisfactory for operation, control, safety and maintenance under all conditions of service.

Uniformity of type and manufacture of switch gear, control gear, fittings and accessories shall be preserved throughout the whole of the installation, refer to the Electrical for the type of fittings, wiring, conduits, control gear, etc.

2.33 STATION CONTROLS REQUIREMENTS

2.33.1 General

Refer to the separate Controls Specifications (CRL-BTM-BMS-000-SPE-0001/0002) for details of;

- Building Management Systems (BMS)
- Electrical Management Systems (EMS)
- SCADA Systems
- Control Integration and Interfacing

2.34 MANUFACTURER'S DIRECTIONS

Manufactured articles, materials and equipment are to be supplied, installed, connected, erected, used, cleaned and commissioned in strict conformity with manufacturer's printed directions unless otherwise specified. In any case, the Contractor is to obtain from the Supplier agreement that the product as used or specified is being used or specified in accordance with the manufacturer's requirements and practice. Retain manufacturer's directions for such articles on site for the Proprietor's reference.

2.35 SPARE PARTS AND SPECIAL TOOLS

2.35.1 Tools

At least 8 weeks before the date for practical completion, submit a schedule of tools, portable instruments and spare parts necessary for maintenance of the installation. For each item state the recommended quantity and the manufacturer's current price. Include the following in the prices:

- Checking receipt, marking and numbering in accordance with the spare parts schedule.
- Packaging and delivery to site.
- Referencing equipment schedules in the operation and maintenance manuals.
- Suitable means of identifying, storing and securing the tools and instruments. Include instructions for use.
- Painting, greasing and packing to prevent deterioration during storage.

Referencing equipment schedules in the operation and maintenance manuals.

Provide suitable means of identifying, storing and securing the tools and instruments. Include instructions for use.

2.35.2 Spares

General: Provide spare parts listed in the appropriate work sections.

Replacement: Replace spare parts consumed during the maintenance period.

2.36 CAPPING OFF

During the construction, leave all unfinished work in safe condition and protect the works against damage or loss through any cause whatsoever, and seal off open ends of equipment in such a manner as to prevent the entry of foreign matter into the lines until the works have been handed over on completion.

2.37 WORKMANSHIP

All equipment to be installed in a neat and tidy manner and comply with the latest relevant regulations, all local requirements and this specification.

2.38 CLEANING OF SERVICES

After installation and prior to testing all services shall be thoroughly cleaned and flushed out. All systems shall be checked for any foreign matter and cleaned.

On completion of all work, all tools, supplies, unused materials and waste materials shall be removed and the work left in a clean and tidy condition.

2.39 FIRE STOPPING / FIRE STOP COLLARS

All pipes passing through any fire rated element shall be treated to achieve a fire rating of not less than the fire rating of the element that the service is passing through. Where any non-metallic services (eg HDPE, uPVC, XPE, PE, etc) pass through any fire rated element they shall be surrounded by a sealant of intumescent material capable of completely sealing the pipe penetration under fire conditions.

The Contractor shall provide an independently approved certification of all systems and/or methods of treatment proposed provided prior to the ordering of any materials. Certification must be for the situation that is proposed to be used. Generic certifications will not be accepted.

It is noted that where an independently approved certification of the proposed fire rating of the penetration cannot be provided for a proposed material, the Contractor shall be required to use an alternative material at no additional cost.

At the end of the project, a detailed schedule shall be provided giving the penetration number, location, services details, methods of treatment, the fire test report numbers and the fire resistance levels expected to be achieved. Provide detailed work as executed drawings showing the location of all penetrations treated. The schedule and drawings are to be included in the Operating and Maintenance Manual.

The Contractor shall arrange for all inspections required by the relevant authorities at suitable stages of the contract to enable the inspecting authority to ascertain that the treatment methods are being installed to their requirements and complies with the test reports.

2.39.1 Labelling Of Fire Rated Services Penetrations

All service penetrations to fire cells and fire separation systems are required to comply with all the designed fire integrity of the specified systems. Label all fire rated service penetrations to AS 4072.1 using the Certified Identification System provided by CID International Ltd.

Each fire stopping installation to have a permanently fixed tag or Label containing the following information:

- Manufacturer's name
- Name and address of installer
- Date of installation

Refer to CID International Ltd at www.cidcert.com to record all service penetrations.

2.40 PVC MATERIALS

Typically no PVC based products shall be used for pipe work or conduits which may be exposed to fire for both public and back of house areas.

PVC products (pipework, conduits) are <u>not</u> permitted for use for any of the permanent works or any below ground works associated with the temporary works.

All cabling for the project (both temporary and permanent works) shall be Low Smoke Zero Halogen (LSOH) type. No PVC cabling shall be used.

2.41 TESTING AND COMMISSIONING

The Contractor shall test and commission the works in accordance with all relevant standards and general good practice and provide completion and test certificates.

The Contractor shall not connect the works to the utility supplies until all inspections and approvals, which the relevant supply authorities deem necessary, have been carried out and certified.

Discipline specific testing and commissioning is referred to in the relevant Technical Sections;

- Mechanical (section 3 & 6)

- Fire (section 4 & 7)
- Hydraulics (section 5 & 8)

2.41.1 General

The Contractor shall include for the complete testing and commissioning of the installations which must be to the complete satisfaction of the Engineer.

Britomart station shall remain operational throughout the demolition, temporary and permanent works. The contractor shall allow for all staging and phasing of the works to ensure continuous operation of the station is maintained.

Sectional testing and commissioning shall be carried out during all phases of the works and include any systems that are ‘taken out of service’ that then require reinstating to ensure the safe operation and continuity of the station is not compromised.

The Contractor shall arrange for the commissioning of the installations to be carried out by a Specialist Firm of Commissioning Engineers.

All testing and commissioning shall be in accordance with the recommendations as detailed in the relevant standards and codes.

The Engineer or his appointed representative shall have access at all reasonable times to such parts of the Contractor's works as may be necessary for the purpose of inspection, examining and testing of materials, workmanship and performance of plant.

Except where stated in the specification or in the contract documents the Contractor shall provide all labour, materials, power, fuel and test equipment for carrying out the tests specified. Tests shall be on the site and/or off site as applicable to the test specified.

The Contractor shall ensure that all test equipment utilised by himself or his representatives for carrying out the tests is adequately maintained and calibrated, and carefully handled and transported.

The Contractor shall give the Engineer a minimum of seven days’ notice of his intention to carry out tests. All tests will be witnessed by the Engineer or his representative.

The Contractor shall allow for carrying out the testing and commissioning of the installation in sub-sections as may be necessary for technical purpose or to suit the construction programme.

The Contractor shall arrange for a full demonstration of the installation in the presence of the Engineer and the Principal’s nominated representative.

All plant, including standby equipment, shall be tested to ensure that it is operating in accordance with the specified conditions, and also that it is functioning in accordance with the control and interlocking sequences specified.

The adjusting and balancing of the systems shall as far as possible be done without the building being occupied or the systems being subjected to a full climatic cycle. Final adjustment and balancing to meet a full climatic cycle shall take place during the Defects Liability Period.

The Contractor shall commission the plant in accordance with NZ and CIBSE commissioning codes and leave the installation ready for full service.

2.41.2 Shutting Down/Linking into Existing Services

The Contractor shall follow this procedure when the work involves "shutting down" or "linking into" any existing building services at the site.

1. The Contractor shall advise the AT (through the Project Manager) of the required date, start time and duration for the shutdown. This advice shall be a minimum of 14 days before the required shutdown time.
2. AT (through the Project Manager) shall confirm to the Contractor if the required date, start time and duration for the shutdown is acceptable or advise an alternative.

- Steps 1 & 2 (as listed above) to be repeated until agreement is reached.

The Contractor shall then confirm in writing, the agreed date, start time and duration for the shutdown.

2.41.3 Commissioning Engineer

The contractor shall appoint Commissioning Engineers for the project including;

- Review of Design Drawings at construction issue to check for dampers, valves, sensors etc.
- Review of contractors shop drawings for access, commissioning etc.
- Inspection on site of first fix for access.
- Static completion works
- Proving operation from static completion to fully functioning
- Pre-commissioning review of sectional and completed systems and review of results.

2.41.4 Commissioning Plan and Staging of Works

The testing and commissioning of the works shall be carried out at various 'sectional' stages during the Demolition, Temporary and Permanent works with final system commissioning carried out prior to building handover.

2.41.5 Commissioning Dossier and Commissioning

Within an agreed time frame with the client the Contractor shall provide for the agreement and approval of the Engineer, a comprehensive commissioning dossier giving full details of all tests (sectional and final) to be carried out and the proposed method of recording of test information in respect of the plant and installations to be installed in the Contract.

2.41.5.1 Sectional Commissioning

Sectional testing and commissioning shall be carried out on any systems that are '<u>taken out of service</u>' that then require '<u>bringing back into use</u>' to ensure the safe operation and continuity of the station is not compromised. This includes any systems that;

- Impacts the day to day operation of the statio
- Impacts any Critical Life Safety systems
- Impacts any Critical Systems
- Impacts any Essential Life Safety Systems
- Impacts any Essential Systems

The contractor shall review the Pedestrian and Analysis Report and use this document as a baseline to understanding the various staging and phasing of the temporary and permanent works.

Report	Description
Passenger and Pedestrian Analysis	CRL-SYW-ENG-000-RPT-0008

Stage 1 - Testing

The Engineer or his representative will witness in conjunction with the Contractor all tests which are necessary to bring particular section of works up to a standard of "static" completion.

The Engineer or his representative will sign and obtain the signature of the Contractor on a test clearance certificate, which shall clearly indicate the test carried out, the date of the test and the result.

Sectional testing shall be carried out on any systems that are ‘taken out of service’ that then require ‘bringing back into use’ to ensure the safe operation and continuity of the station is not compromised.

Sectional testing shall be carried out on the following systems (not exhaustive);

Mechanical

- Works to the Station Supply Air Systems
- Testing / condition reports required on plant that will be reused for the contract – toilet exhaust fans (2off) – located on the roof of the CPO building
- Testing / condition reports required on plant that will be reused for the contract – CPO ground floor exhaust ventilation fans (4off) – located on the roof of the CPO building
- Testing / condition reports required on plant that will be reused for the contract – Platform level supply air fan systems (8off)

Fire

- Any works to hydrant systems
- Any works to sprinkler systems
- Any works to detection and alarm systems

Hydraulics

- Any works to Fire Hose Reel systems
- Any works to station Pumping systems

Stage 2 - Commissioning

The proving of the engineering systems from the "static" completion stage to a fully operating one shall be carried out by the Contractor's Specialist Contractor.

The proving of the systems shall include all the system balancing and recording of test data and set points to ensure the station operation is not compromised at the end of the intermediate stage.

Immediately prior to the ‘bringing back into use’ of the Employer's representative shall attend site, and together with the Engineer or his representative and the Contractor, he shall witness the sectional acceptance testing of all engineering services.

It is intended that spot checks be taken on the installation being proposed for ‘bringing back in use’, and compared with the test data obtained during Commissioning. In the event that the spot checks are inconsistent with the test data, the element in question shall be checked in its entirety.

Sectional commissioning shall be carried out on all systems described in Stage 1 following systems;

2.41.5.2 Final Commissioning

Stage 1 - Testing

The Engineer or his representative will witness in conjunction with the Contractor all tests which are necessary to bring the completed installation work up to a standard of "static" completion.

The Engineer or his representative will sign and obtain the signature of the Contractor on a test clearance certificate, which shall clearly indicate the test carried out, the date of the test and the result.

Stage 2 - Commissioning

The proving of the engineering systems from the "static" completion stage to a fully operating one shall be carried out by the Contractor's Specialist Contractor.

The proving of the systems shall include all the system balancing and recording of test data and set points.

Stage 3 – Final Commissioning

Immediately prior to handover of the completed building the Employer's representative shall attend site, and together with the Engineer or his representative and the Contractor, he shall witness final acceptance testing of all engineering services.

It is intended that spot checks be taken on the installation being proposed for handover, and compared with the test data obtained under Stage 2 Commissioning. In the event that the spot checks are inconsistent with the test data, the element in question shall be checked in its entirety.

2.42 PRACTICAL COMPLETION

A notice of Practical completion will only be granted when the following minimum requirements are completed:

- All testing and commissioning has been carried out and accepted
- Producer Statements PS3 (Construction including all seismic support installation works).
- Producer Statement PS1 and PS4 from the seismic specialist in relation to all the design and inspection of the seismic supports for all works covered by this specification.
- Electrical Certificate of Completion
- Local Territorial Authority certificates of acceptance and sign off
- Setting to work and test results completed
- Draft A3 As-Built drawings inserted in the Operating & Maintenance Instruction manual
- Guarantees
- Draft Maintenance Log book

This date shall be the date from which the guarantee, warranty and defects liability periods shall operate.

This notice will not be issued until the systems have been property commissioned and until the Contractor has supplied operating and maintenance instructions.

2.43 GUARANTEES

The Contractor shall obtain all guarantees, certificates, etc for the work specified to be guaranteed or certified satisfactorily completed and lodge same with the ER on completion of the Agreement. Guarantees shall apply to all existing equipment, that is to remain in the completed development and all new equipment etc, for the full guarantee period.

2.44 OPERATION AND MAINTENANCE MANUALS

Britomart Station has an existing set of Operating and Maintenance Manuals (O&M). The intention is to maintain the existing set of O&M's and provide a new set of O&M's for the temporary and permanent works.

2.44.1 Existing Station Operating & Maintenance Manuals

The contractor shall review and update all relevant sections in the existing O&M manuals that have been affected by the works at the west end of the station and integration into the east end. This shall apply to the following disciplines;

- Mechanical
- Fire
- Hydraulics
- SCADA

This shall include any systems that have been isolated, diverted, modified, removed, made good or new provided. Cross referencing shall be provided between the existing O&M and new O&M.

The existing O&M manuals shall be update for both temporary and permanent works.

2.44.2 New Station Operating & Maintenance Manuals

All new works carried out at the west end of the station shall include for new Operating and Maintenance manuals.

New O&M manuals shall be provided for both temporary and permanent works.

The format of all Operation and Maintenance Manuals shall:

Facilitate the rapid detection of the cause of all faults and the recommended course of action for repairs,

Provide a simple and clear system for the safe and efficient operation and maintenance of the system throughout its design life.

Equipment manuals shall comprise a plastic covered ring binder(s) with the project title, Client's name, Contractors name, Architect's name and Engineer's name embossed on the cover. The manuals are to contain all necessary information required for the safe and economic operation of the services, and shall include:

- Index
- General description of the installation, and a technical description and mode of operation of the systems installed. Identify function, normal operating characteristics and limiting conditions.
- Technical description of the systems installed, written to ensure that the principal's staff fully understand the scope and facilities provided. Identify function, normal operating characteristics, and limiting conditions
- Operation procedures for; safe starting up, running in, operating and shutting down - Include logical step-by-step sequence of instructions for each procedure.
- Control sequences and flow diagrams for systems. Schedules of fixed and variable equipment settings
- Preventive Maintenance Procedures (with illustrations)
- Corrective Maintenance Procedures (with illustrations)

- Repair Procedures (with illustrations)
- Test Procedures
- Illustrated Parts List (including a list of recommended spares holding)
- Special Tools and Test Equipment
- Final shop drawings/as-built drawings, and other final shop drawing documents. Include site and underground services. For alterations include existing services.
- Statutory Certificates as appropriate
- Manufacturers' technical literature for equipment installed, assembled specifically for the project, excluding irrelevant matter. Mark each product data sheet to clearly identify specific products and component parts used in the installation, and data applicable to the installation.
- Commissioning Data.

Equipment manuals shall comprise a plastic covered ring binder(s) with the project title, Client's name, Contractors name, Architect's

2.45 TRAINING

2.45.1 General

Provide training and instruction to the appropriate staff on;

- Maintenance of the installation
- Operation of the installation
- Seasonal requirements
- Use of the Maintenance and Operations Manual

Conduct training, in an agreed format, by agreed persons, at agreed locations and time and to agreed owner's representatives.

Duration: Instruction to be available for the whole of the commissioning and running-in periods. Format: Conduct training at agreed times, at system or equipment location. Also provide seminar instruction to cover all major components.

Operation and maintenance manuals: Use items and procedures listed in the final draft operation and maintenance manuals as the basis for instruction. Review contents in detail with the principal's staff.

2.45.2 Demonstrators

Use only qualified manufacturer's representatives who are knowledgeable about the installations. Explain and demonstrate to the principal's staff the purpose, function, operation and maintenance of the installations.

2.46 PREVENTIVE MAINTENANCE AND DEFECTS LIABILITY

The Preventative Maintenance and Defects Liability Period shall extend for a period of twelve (12) calendar months from the date of Practical Completion. During the maintenance and defects liability period the Contract Plant shall be under the possession and control of the Owner but the Contractor may be in attendance for maintenance.

During the Maintenance Period the Contractor shall:

- Carry out all maintenance and reporting as required by the New Zealand Building Code Handbook Compliance Schedules.
- Carry out all routine maintenance work necessitated by statutory regulations and as required by normal good trade practice.
- Comprehensively inspect, test and adjust where necessary all controls, indications and alarms for at weekly intervals, or as necessary.
- Correct any defects which may occur promptly and on a twenty four (24) hours a day, seven (7) days a week basis.

The Contractor shall provide an approved logbook kept by the Project Manager in which are recorded details of the inspection functions and all defects found and remedial actions taken. Each time an inspection is made, it shall be recorded with the name of the Building Services Contractor's inspector and details of inspections carried out and shall be signed by the Owner's representative on completion of the inspection.

All new works to be maintained by the contractor during the defects liability period. All existing equipment to be maintained by the maintenance contractor.

2.46.1 Call Out Services

A necessary element of services to be provided by the Contractor is the provision of a 24 hour, 7-day Call Out service to attend in the event of specific alarm notifications and unexpected situations or events where Contractor expertise is necessary.

There are three priority levels and associated response expectations for Call Out services and the Contractor is expected to constantly maintain a current 'Call Out' Response Plan for each:

2.46.1.1 Critical

Alarm notifications or events which are either life threatening or causing significant distress to AT. These require an immediate and absolute priority action response by the Contractor using authorised Contractor representative(s) and their attendance within 30 minutes at the scene or origin of the notification or event, subject to accessibility and normal personal safety procedures.

2.46.1.2 Emergency

Alarm notifications or events which potentially may escalate to become life threatening or cause significant distress to AT. These require an immediate response by the Contractor such that appropriate authorised Contractor representative(s) are in attendance within 240 minutes at the scene or origin of the notification or event, subject to access and normal personal safety procedures.

2.46.1.3 Routine

Alarm notifications or events which will not escalate within a 24-hour time frame to become life threatening or cause significant distress to AT. These require an initial response by the appropriate authorised Contractor representative(s) within 12 hours and their attendance at the scene or origin of the notification or event as promptly as is necessary to verify that the alarm cause or event cannot escalate to Emergency status, or implement immediate actions to ensure that this cannot occur.

Every Call Out shall be initially be treated as Critical until it is confirmed that it can be downgraded to Emergency or, in turn downgraded to Routine.

2.46.2 Defects Liability

The Contractor shall be responsible for the rectification of all defects in the work due to faulty materials and/or workmanship for the duration of the twelve (12) month defects liability period commencing from the date of practical completion. Such defects shall be made good immediately on receipt by the Contractor on advice from the ER.

Any defects discovered during the defects liability period which are due to default or negligence by the Contractor in the performance or observance of any of his obligations, shall extend the period to enable such defects to be made good by the Contractor and to allow the whole work after being made good in every way, to be proved satisfactory.

2.46.3 Expiration of Defects Liability Period

On expiration of defects liability period the Contractor is to produce certification for all services essential services installed by the Contractor as required by the BCA.

2.47 WARRANTIES

All plant, equipment and materials supplied under this contract shall be covered by a minimum of twelve (12) months warranty against faulty manufacture, workmanship and/or materials. The contractor shall also provide the client with any extended warranty period options over 12 months that the equipment manufacture may offer.

The Contractor shall be responsible for the rectification and/or replacement of any portion of the installation which fails during the warranty period.

The warranty period shall commence as from the date of practical completion or replacement, as applicable but extension of the period shall be made in respect of replaced portions only.

2.48 SCHEDULE OF RATES

The Contractor is to supply a detailed Schedule of Rates as per the main contract.

3 Scope - Mechanical

3.1 GENERAL

The Mechanical Contractor shall allow for;

- Provision of coordinated installation/working drawings, fabrication drawings and record drawings – the Contractor's installation/working drawings shall be developed from the design drawings and include for any post tender changes to the layout that do not alter the design intent of the engineering services. Multi service coordination details shall be provided where necessary to demonstrate the installation intent for main services distribution and congested areas, clearly indicating access for maintenance.
- Detailed design and locations for all brackets and supports. The arrangement and locations of each type, including structural loadings must be issued to the Engineer prior to installation for review and comment.
- Condition survey, testing and re-commissioning of the Britomart Station Fans in accordance with the Fire Engineering report
- Equipment component design and selection to comply with the engineering specification and performance.
- Regardless of any specified tender values for pump or fan flow and pressure the contractor shall make calculations before ordering plant to verify the actual required flow and pressure based on the contractors proposed installation details.
- Duct platforms, access covers and gratings, ladders and additional structural steelwork where required and detailed in the sub-contract documentation.
- Provision of fire stopping and fire rating of selected fittings and equipment, to maintain the building's fire compartmentation at all services penetrations.
- Supply and install all electrical and control connections from the Mechanical and Hydraulic control panels to all equipment where required. This shall include for all costs for all wiring from the Mechanical and Hydraulics control panels to the individual items of equipment, pumps, fans, cooling units, chiller plant etc and including all termination of the power to the items of equipment;
- Provision of drain points at all low points and vent points at all high pints with installed pipework gradients.
- Provision of thermal expansion accommodation and anchorage, including selection and installation of bellows or bends.
- Access locations for valves and dampers (balancing and fire/smoke).
- Attenuator design and selection to satisfy the particular and performance requirements of the specification, including spatial allowances shown on tender drawings.
- Acoustic design (and modification where necessary) of equipment to meet with the noise levels specified. All levels to be achieved with all plant and equipment operating at full design duty.
- Anti-vibration and seismic mountings to suit the particular application of the mounting arrangement.
- Seismic design including installation works to meet the requirements of NZS4219.
- Selection and final installed location of fluid regulation devices to comply with the relevant manufacturers recommendations.
- Final system water capacities and chemical additives.

- Details of electrical wiring diagrams of all equipment supplied by the Contractor showing all interconnections between equipment to enable the necessary wiring to be undertaken.
- Automatic controls detailed design to comply with the performance, functional and operational requirements of the Engineering Specification. The Contractor shall be responsible for ensuring the compatibility of the plant and equipment with the specified function. Where interfaces (relays or other devices or modifications to hardware or software) are required the design and installation shall be the Contractor's responsibility.
- Size and installation arrangement of automatic control panels to suit the detailed requirement of the particular agreed manufacturers controls equipment and cable entry/exit accommodation such that cable entry is possible in the selected location, doors are not sanitaryed by other plant equipment, services or the building structure and safe operating and maintenance clearances are provided in all access positions when installed on site.
- Final actual locations of control sensors detectors and thermostats.
- Detailed design and sizing of refrigerant pipework associated with air conditioning/heat pump/refrigeration equipment.
- Confirmation that the refrigeration volumes within all the proposed design (and subsequent installation work) is compliant with AS/NZS1677.2.
- Provision of all builders work including production of drawings and installation details.
- The coordination of services with the building fabric and structure, including but not limited to structures, civil works, electrical, plumbing/drainage, fire protection/emergency egress, ICT, telephone, security/access controls, finishes and coordination with all other Contractors and the provision and production of manufacturer's details, fabrication details and drawings and coordinated installation drawings. All of the above information shall be submitted for review and comment prior to plant being ordered or works carried out. The Contractor's installation/working drawings shall be developed from the design drawings and include for any post tender changes to the layout that do not alter the design intent of the engineering services.
- Seismic restraint and certification of MFH equipment – provide PS1 and PS4 from their CPEng structural engineer / seismic specialist.
- Submission of required construction drawings and information on materials and equipment for the project manager's review.
- A new building management system (BMS) via a front-end PC shall be provided to manage and control the building HVAC/PH/Fire plant for the permanent works at the west end of the station. The BMS shall be capable of graphically monitoring and controlling the facility environment, schedule and modify equipment operations, run reports on various systems, collect and view trend information and expandability.
- Design, supply and install all control cabling/wiring including final connections and all sub-network cabling and containment between MCC's, outstations, controllers and system interface units etc for mechanical and hydraulic systems.
- Front end PCs for BMS (location to be advised by AT)
- Interfaces at each MCC (and/or outstation) for local/site wide interrogation of the system and alarm indication;
- Integration via PC/laptop complete with all operating software & graphics for local interrogation of the systems;
- System hardware, software, reports and system configurations as necessary;
- BMS and DDC controllers and development of control strategy software as required;
- Frequency Invertors for fans and pumps;

- Motor Control Centres (MCC) and interface panels (outstations) as scheduled incorporating power and control sections as necessary and including delivery, offloading and positioning for mechanical and hydraulic systems.
- All associated mechanical and hydraulic field control devices including detectors, sensors, transducers, switches, thermostats, control valves, valve actuators, damper actuators, energy flow meters, etc.
- Labelling and identification of all plant, equipment, controls, terminations, cabling, control panels etc in accordance with recognised standards and Mechanical and Electrical specifications, and any other documentation forming part of the contract.
- All duct mounting flanges, Pitot pressure tappings brackets, clamping, bushes, couplings, linkage kits, locknuts, gaskets and any other special fittings to be fitted to ductwork or AHU as appropriate for sensors, actuators and any other instruments.
- Installation of all associated field control devices with the exception of ductwork mounted equipment and pipe work mounted sensors and valves. These items to be free-issued to the relevant services contractor for fitting.
- Emergency power off buttons to all plant rooms.
- Control cabling between MCC's/interface panels, plant and equipment including secondary containment systems.
- Local power isolation devices incorporating early break/late make (EBLM) auxiliary contacts as necessary for all plant and final connections between isolators and plant.
- Screened controls cabling, in line with manufacturers recommendations, from MCC's/outstations to field control devices including containment and final connections.
- Final connections and cabling from fire alarm interface units and smoke ventilation system as necessary and all hard wired control interlock sensors to MCC's and DDC controls as necessary
- Equipotential and supplementary earth bonding associated with the Controls System wiring installations.
- Provision of a commissioning plan and commissioning dossier
- Provision of sectional testing and commissioning as defined in the discipline specific specification and herein
- Commissioning of the completed installation.
- Off and on site testing and witnessing of Controls software/graphics and MCC's.
- Provide final test certificates, as installed drawings, documentation and description of operation
- Liaison with commissioning engineers and attendance at systems commissioning including electrical commissioning tests and life safety systems tests where interfacing occurs.
- Provision of enclosures, fixings and all supports;
- Isolation and decommissioning of services to the temporary accommodation facilities;
- Isolation and decommissioning of services not required to remain or be provided for the permanent works;
- Co-ordination of services with other trades
- Submission of shop drawings and samples for approval
- Testing & Commissioning of all installed services to provide fully functioning Controls systems
- Training

- Operating & maintenance manuals
- Warranties on all works and materials
- As built drawings and documentation

Preparation of detailed method statements and programmes for the execution of the works, including refurbishment works. This programme shall include testing and commissioning which is coordinated with other contractors and allow adequate time and notice for observation by the project manager.

3.2 ASSOCIATED WORK AND INTERFACES

This section outlines the work associated with the contract which is to be provided by the Mechanical Contractor and other interfacing trade contractors. The Mechanical Contactor shall co-ordinate and interface the Mechanical services works with the associated works contractors.

This applies to the temporary and Permanent works.

3.2.1 Mechanical for Fire Services

The Mechanical Contractor shall include for the following as part of the works:

- Cutting openings and sealing airtight of all penetrations for sprinkler heads and pipes through sheet metal walls of ducts and conditioners.
- Final connection of fire trip wiring and relay from FAP to each mechanical switchboard/MCC. Fire trip wiring and relay from FAP to mechanical switchboard by Fire Services Sub-Contractor
- Provision of access panels in air conditioning equipment where required for access to sprinkler heads.
- Final connection of the smoke detection alarms to stop relevant mechanical services plant or shut motorised fire dampers as required plus provision of the alarm to the BMS.

3.2.2 Mechanical for Hydraulic Services

The Mechanical Contractor shall include for the following as part of the works:

- Liaise with Hydraulics Contractor to confirm final locations of trapped tundishes and duties.
- Liaise with Hydraulics Contractor to confirm final locations of floor wastes in plantrooms.
- Extend condensate drains from mechanical equipment to trapped tundishes provided by the Hydraulics Contractor. The Mechanical Contractor is to ensure that air gaps to AS/NZS3500 are provided between condensate lines and the tundish mouth. To comply with AS/NZS3500 that tundishes must be in a visible location.
- Work with the Hydraulics Contractor to ensure no conflict occurs between proposed hydraulic services works and mechanical services equipment, pipes and duct runs.
- Liaise with Hydraulics Contractor to confirm final locations of domestic cold water supply take-offs.
- Extend cold water service to mechanical equipment from control valves provided by the Hydraulics Contractor.
- Supply and install backflow prevention devices to mechanical services equipment connected to potable water supplies.
- Be responsible for connecting the air conditioning units condensate connection to the condensate drainage point. Detailed coordination between the mechanical services and hydraulic services subcontractors is required.

- Provide secure storage of all control devices including, but not limited to, control valves, pressure sensors, pressure switches, flow switches, tank switches, contents transmitters, etc, free issued by the BMS Specialist Contractor for installation into the hydraulic systems.
- Liaise with the hydraulic contractor to agree suitable locations for all sensors, valves, actuators etc. Provide hydraulic installation drawings for submission showing agreed locations of sensing devices, valve and damper actuators etc. complete with their tag references. Drawings in electronic format of the hydraulic installation to be provided by the Hydraulic Contractor.
- The submission of the completed control valve schedule for information/comment prior to ordering any equipment.
- Supply free issue to site of all valve bodies, actuators, sensors, flow measurement devices, sensor pockets, hydraulic tube connections, brackets, clamping bushes, couplings, lock-nuts, gaskets, orifice plates/carrier rings and any special fittings for fitting to pipework.
- Liaison necessary, for the purpose of obtaining suitable differential pressure measuring signal values across orifice plates, static pressure values, differential pressure index points etc for the selection of differential pressure sensors and switches in pressure and flow proving applications.
- Supply free issue to site of all float switches, level controllers and contents transmitters for fitting into storage tanks/sump chambers.
- Liaison necessary to ensure all required controls signals from plant, listed in this Specification, are provided and are compatible with the control system.
- Provision of all Hydraulic Control Centres and interface panels (outstations) incorporating BMS/control and power sections;
- Provision of all power and control cabling from MCC(s) and/or outstations to all field devices and connections to BMS Network.
- Liaison necessary to ensure all required BMS signals from plant, listed in this Specification, are provided and are compatible with the BMS.
- Allow for all costs for all wiring from the hydraulics services boards to individual items of hydraulics services equipment including termination of the power to the items of equipment, including:
  - Lockable isolating switches or control panels for hot water circulating pumps and packaged pump stations.
  - Motorised valves.
  - Pumps.
- Terminate all power supplies from isolators to Hydraulics services equipment
- Obtaining certified electrical information/wiring diagrams of equipment fed from motor control centres or interfaced with the control system enabling the production of wiring diagrams and the sizing of switchgear and power wiring in accordance with an agreed programme.
- Liaise with the BMS Specialist Contractor to agree suitable locations for sensors, valves, actuators, flow measuring devices, etc.
- Provide the BMS Specialist Contractor with CAD drawings in electronic format of the hydraulic installation.
- Provide the BMS Specialist Contractor with information for the purpose of sizing control valves including medium, system static pressure, pump head, flow rates, coil pressure drops, and any other relevant data.
- Where orifice plates are installed in pipework for flow proving, provide the BMS Specialist Contractor with information for the purpose of selecting differential pressure switches/sensors including medium, system static pressure and the measuring signal differential pressure value at the maximum design flow rate.

- Fit all flow measuring devices into pipework in accordance with the manufacturer's installation instructions provided by the BMS Specialist Contractor.
- Supply and fit binder type test points adjacent to each port of the two-port and three-port control valves; isolating valves and binder type test points either side of differential pressure switches/sensors across pump sets for water flow switches, with an oversize branch connection bushed down.
- Provide independent means of validating the calibration of all flow measurement devices e.g. orifice plates and binder type test points in pipework.
- Fit all storage tank float switches, level controllers and contents transmitters in accordance with the manufacturer's installation instructions provided by the BMS Specialist Contractor. Provide and fit any stool pieces, isolation valves etc. required for calibration purposes.
- Liaise with the BMS Specialist Contractor to ensure all controls interface requirements/signals associated with hydraulic plant are provided and are compatible.
- Provide attendance during commissioning of the control system.
- Give four weeks prior written notice to the BMS Specialist Contractor for site attendance for commencement of the supervisory service and for testing and commissioning.
- Provide and install, adjacent to each motor control centre/controls enclosure, a relay box comprising relays with volt free change-over contacts suitable for interfacing hydraulic plant with the building fire detection system as detailed in the Contract Documents.
- Provide any wiring and terminations between the fire panel and relay boxes. Wiring and terminations between volt free contacts in each relay box and the associated motor control centre shall be by the BMS Specialist Contractor.
- Liaise with the BMS Specialist Contractor to ensure full compliance with this Specification.

3.2.3 Mechanical for BMS Controls

The Mechanical Contractor shall include for the following as part of the works:

- Provide secure storage of all control devices including, but not limited to, control valves, pressure sensors, pressure switches, flow switches, tank switches, contents transmitters, etc, free issued by the BMS Specialist Contractor for installation into the mechanical and hydraulic systems.
- Liaise with the BMS Specialist Contractor to agree suitable locations for sensors, valves, actuators, flow measuring devices, etc for mechanical and hydraulic systems.
- Provide the BMS Specialist Contractor with CAD drawings in electronic format of the mechanical installation.
- Provide the BMS Specialist Contractor with information for the purpose of sizing control valves including medium, system static pressure, pump head, flow rates, coil pressure drops, and any other relevant data.
- Where orifice plates are installed in pipework for flow proving, provide the BMS Specialist Contractor with information for the purpose of selecting differential pressure switches/sensors including medium, system static pressure and the measuring signal differential pressure value at the maximum design flow rate.
- Fit all valve bodies, pockets, hydraulic tube connections, duct mounting flanges, brackets, clamping bushes, couplings, lock-nuts, gaskets, orifice plates/carrier rings and any special fittings for pipework, air handling units and builder's work ducts, supplied by the BMS Specialist Contractor.
- Fit all flow measuring devices into pipework/ductwork in accordance with the manufacturer's installation instructions provided by the BMS Specialist Contractor.

- Supply and fit binder type test points adjacent to all pipework thermostats, temperature sensors and each port of the two-port and three-port control valves; isolating valves and binder type test points either side of differential pressure switches/sensors across pump sets; access panels where control and sensing devices are not removable from ductwork; welded bosses or screwed tees for water flow switches, with an oversize branch connection bushed down.
- Provide independent means of validating the calibration of all flow measurement devices e.g. orifice plates and binder type test points in pipework, test holes in ductwork for a pitot traverse.
- Fit all storage tank float switches, level controllers and contents transmitters in accordance with the manufacturer's installation instructions provided by the Controls Specialist Contractor. Provide and fit any stool pieces, isolation valves etc. required for calibration purposes.
- Install all averaging element temperature sensors supplied by the BMS Specialist Contractor and include for supplying and fitting all necessary clips, hangers and supports for serpentining the elements across the ducts. The elements shall be clipped every 200mm and the supports and hangers shall be adequate to prevent vibration of the element.
- Mount and fit universal joints, actuator cranks and damper actuators, supplied by the Controls Specialist Contractor, and supply, fit and connect linkages between actuators and dampers. Mount and fix all dampers and their frames into prescribed openings.
- Liaise with the BMS Specialist Contractor to ensure all control interface requirements/signals associated with mechanical plant are provided and are compatible.
- Make provision for the AHU manufacturer to supply and fit sectional light switches and internal bulkhead lights and install associated wiring and containment.
- Provide attendance during commissioning of the control system.
- Give four weeks prior written notice to the BMS Specialist Contractor for site attendance for commencement of the supervisory service and for testing and commissioning.

3.3 WORKS BY OTHERS

As part of the works, the contractor shall be required to liaise with the main contractor as well as all other sub-contractors and separate contractors to ensure that the programme of works, safety requirements and coordination/interfaces are maintained.

The supply and installation of the following items is not included and is to be carried out by others;

3.4 SUSTAINABILITY

The project's sustainability objectives are set out in the main contract. The Contractor shall be aware of their requirements to contribute to the achievement of these objectives.

The project is targeting an 'Excellent' rating against the Infrastructure Sustainability rating tool from the Infrastructure Sustainability Council of Australia. The Contractor shall be aware of their requirements to contribute to the achievement of this rating.

3.5 EXISTING SYSTEMS

3.5.1 Station West (Level B1 and B2)

Floor mounted supply air displacement diffusers (perforated metal cylinders) are located at platform level and provide ventilation to the platform areas. Supply air fans are located in the level B1 plant rooms and deliver outside air via under platform plenums to the diffusers.

Staff accommodation ventilation and cooling systems are located at platform level and serve the back of house accommodation areas. The outdoor units are located in the supply air intake plenum at level B1.

The staff accommodation area outdoor supply and exhaust air routes are located beneath the platform level in a builder's plenum air duct.

The station platform supply air intake is via external louvers located beside the transformer rooms and fire intervention stairs at street level near the entrance to the glasshouse.

3.5.2 CPO Building (Level B1 Concourse and Ground Level)

Public toilets located at level B1 concourse are provided with mechanical extract fans located on the roof of CPO building. Make up air is provided by a combination of transfer ducts and mechanical supply air originating from the Queen Street underpass.

Based on the as-built documentation, there are two supply air fans located in the subfloor area beside the public toilets at level B1. Originally these supply air fans were supplying ducted air to a coffee shop and a former information kiosk via floor mounted supply air grilles with outdoor supply air originating from the Queen Street underpass. However the floor grille openings have been sealed off.

A raised timber floor forms the middle part of the ground level waiting area. A number of rectangular perforated metal displacement diffusers, similar to the metal cylinders at platform level, are located on the top of the raised floor. It is understood from discussions with the station manager that these rectangular diffusers are not supplying outdoor air to the space as the fans are no longer in operation.

The ground level CPO is served by a mechanical exhaust system consisting of ceiling mounted extract grilles connected by ductwork to extract fans located on the CPO roof. Make up air is provided from the station, glass house and external doors.

3.6 BRITOMART STATION FANS

3.6.1 Overview

No physical changes to the Britomart fans and equipment are planned as part of the CRL Contract 1 Works, with the exception of the replacement of the power supply for the Station Supply Fans. Systems at the East end of Britomart and within the Britomart tunnels will be physically unaffected.

However, the contractor shall be responsible for implementing changes to the operational modes of the fans, in accordance with the Fire Engineering Report. These are required in response to a number of changes to the station that will occur during the Contract 1 Works:

- Permanent closure of the Queen Street Underpass
- Closure of air paths through CPO during the Accommodation Works
- New penetrations in the Glasshouse façade and changes to the Glasshouse louvre open area during the Accommodation Works
- Termination of diesel service operation in Britomart Station, leading to a decreased risk of large fires occurring at platform level.

3.6.2 Scope

The contractor shall allow for the following;

- Condition survey check of <u>all</u> existing fans and equipment (fans, ductwork, attenuators, louvres etc), sensors, switches and components exposed to the airstream. This shall include Supply, Exhaust, Transfer and Jet fans and report outlining component condition and recommendations.
- All necessary changes to the SCADA system modes in terms of ventilation response for Temporary and Permanent Works, including any changes required at sub-stages within the Temporary Works;
- Testing and re-commissioning of the ventilation systems for Temporary and Permanent Works

Note: Modifications to the ventilation strategy to deal with fire incidents in the Britomart Tunnels are not within the scope of the Construction Contract 1 Works. A separate works programme is currently underway to modify the tunnel ventilation arrangements in the Britomart Tunnels. Specifically, this is reviewing the possibility of decommission some or all of the existing jet fans located in these tunnels.

However, the aerodynamic changes to Britomart West may influence the tunnel ventilation performance in the Britomart Tunnels. The contractor shall make suitable allowance to assess the impact on the Britomart Tunnel system. Re-commissioning and testing of the ventilation modes for tunnel fires will also be required, following the implementation of changes at Britomart West.

3.6.3 Current Fan Usage

The current usage of the various fan sets at Britomart was reviewed on 27 August 2015 by interrogation of the SCADA system. The current ventilation modes are summarised below.

<u>Mode Table</u>: Current Ventilation Responses at Britomart

Mode	Ventilation Strategy	Station Supply Fans	Station Transfer Fans	Station Exhaust Fans	Britomart Place	West Tunnel Jet Fans	Tangihua Street Exhaust Fans	East Tunnel Jet Fans
0	Normal[1]	Normal	Normal	Normal	Normal	Normal	Normal	Normal
1	Fire at Station Platforms[2]	Off	Off	Exhaust[3]	Exhaust	4 fans to east	Off	Off

2	Fire Britomart to Tangihua	Supply[3]	Off	Off	Off	Off	Exhaust	Off
3	Fire Tangihua to East Portal	Supply	Off	Off	Off	Off	Exhaust	Off
4	Fire in Transition Station to Britomart	Supply	Off	Off	Exhaust	Off	Exhaust	Off
5	Fire in East End B1 Public	Supply	Off	Off	Off	Off	Off	Off
6	Fire in East End B1 Back of House	Normal	Normal	Normal	Normal	Normal	Normal	Normal
7	Fire in West End B2 Back of House	Normal	Normal	Normal	Normal	Normal	Normal	Normal
8	Fire in CPO B1	Off	Off	Off	Off	Off	Off	Off
9	Fire in CPO Ground	Off	Off	Off	Off	Off	Off	Off
10	Fire in CPO Upper Levels	Off	Off	Off	Off	Off	Off	Off

Notes:

1. Normal mode is currently setup as:

- Supply fans at 7.5% capacity in total (2 out of 8 fans operating at 30% capacity each)
- Transfer fans operating at 30% capacity
- All remaining fans OFF including OTE and jet fans
- Jet fans only in operation when diesel train present and a couple of hours after diesel train departure. All controlled manually via SCADA.

2. This mode is for a Fire at Station Platforms east of the smoke curtain. Scenario with Fire at Station Platforms west of smoke curtains not setup in SCADA system.
3. Supply and exhaust indicate that all fans are operating at 100% capacity.

3.6.4 Temporary Accommodation Works

Omitted for clarity. Refer to Revision 7 of this specification for requirements relating to Temporary Works.

3.6.5 Permanent Works

Following completion of the Contract 1 works, the glasshouse will be returned to its existing state; the louvres will be reset to their current open areas and the temporary door penetrations will be reclosed. The CPO will reopen and the Temporary Accommodation at Britomart Plaza will be deconstructed and removed.

The mode Table below gives the required ventilation modes for the Permanent Works, with changes from the Temporary Works highlighted.

Mode Table: Ventilation Responses Post-Contract 1 Works (highlighting indicates mode change)

Mode	Ventilation Strategy	Station Supply Fans	Station Transfer Fans	Station Exhaust Fans	Britomart Place	West Tunnel Jet Fans	Tangihua Street Exhaust Fans	East Tunnel Jet Fans

0	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
1	Fire at Station Platforms	Off	Off	Exhaust 350 m^3/s	Off	Off	Off	Off
2	Fire Britomart to Tangihua	Supply	Off	Off	Off	Off	Exhaust	Off
3	Fire Tangihua to East Portal	Supply	Off	Off	Off	Off	Exhaust	Off
4	Fire in Transition Station to Britomart	Supply	Off	Off	Exhaust	Off	Exhaust	Off
5	Fire in East End B1 Public	Supply	Off	Off	Off	Off	Off	Off
6	Fire in East End B1 Back of House	Normal	Normal	Normal	Normal	Normal	Normal	Normal
7	Fire in West End B2 Back of House	Normal	Normal	Normal	Normal	Normal	Normal	Normal
8	Fire in West End B1 Back of House/Public Toilets	Normal	Normal	Normal	Normal	Normal	Normal	Normal
9	Fire in CPO Ground	Off	Off	Off	Off	Off	Off	Off
10	Fire in CPO Upper Levels	Off	Off	Off	Off	Off	Off	Off
~~11~~	~~Fire in Glasshouse~~	~~Off~~	~~Off~~	~~Off~~	~~Off~~	~~Off~~	~~Off~~	~~Off~~
~~12~~	~~Fire in Temporary Accommodation~~	~~Off~~	~~Off~~	~~Off~~	~~Off~~	~~Off~~	~~Off~~	~~Off~~

3.6.5.1 Mode 0: Normal Operations

The supply air fans will remain available for use in normal operations to supply fresh air to platform level. The utilisation of these fans is expected to be lower than the current levels because diesel trains will no longer operate in Britomart Station from the start of the Contract 1 Works onwards. However, these fans are rated to provide make-up air for tunnel fire scenarios. The B1 Concourse back of house rooms will be supplied via a dedicated HVAC system.

3.6.5.2 Mode 1: Fire Station Platforms

The ventilation response for a platform fire will be modified following the reinstatement of the CPO and existing free area in the Glasshouse. The use of the Britomart Place and Tangihua Street Fans are no longer required.

3.6.5.3 Mode 8: Fire in B1 Back of House/ Public Toilets

For fires in the new back of house areas and public toilets at B1 west, all fans will remain on 'normal' mode (i.e. in keeping with other back of house areas, modes 6-7).

3.6.5.4 Mode 9-10: Fire in CPO

With the reopening of the CPO, the alarms and VESDA smoke detection in this building will be reinstated. The existing detection and ventilation modes will be re-established, which halt the station ventilation system upon detection of fire in the CPO area.

3.6.5.5 Modes 11-12: Fires in Glasshouse and Temporary Accommodation

For the permanent configuration, the Temporary Accommodation will be dismantled and the linear heat detection installed in the Glasshouse for the Temporary Accommodation Works will be removed. Accordingly these modes will be no longer relevant and are to be deleted from the SCADA system.

3.6.6 Commissioning and Testing

Following changes to the system, the contractor shall recommission the Britomart ventilation system and SCADA controls to ensure that appropriate flow rates are achieved by fans and that the operational modes are activated by the appropriate fire alarm signals.

Fans are to be tested and commissioned to the highest flow rate required of them (generally in fire mode).

Fan Set	Rated Flow Rate	Rated Static Pressure Drop	Notes
Station Supply Fans	22.9 m^3/s per fan	1020 Pa	To be commissioned to the flow rate required for Britomart Tunnels fire response
Station Transfer Fans	18 m^3/s per fan	690 Pa	Currently only required to run at 30% of capacity (5.4 m^3/s per fan) for Normal mode.
Station Exhaust Fans	87.5 m^3/s per fan	980 Pa	Rated for fire mode to achieve 350 m^3/s from four fans
Britomart Place Fans	90 m^3/s per fan	1000 Pa	Rated for fire mode to achieve 180 m^3/s total flow rate from 2 fans
Tunnel Jet Fans	See Tunnels Strategy		Not required for Station Fire Strategy. Refer to requirements of Tunnels Fire Strategy for required flow rate at commission.
Tangihua Street Exhaust Fans	60 m^3/s per fan	900 Pa	To achieve 180 m^3/s total flow rate from 3 fans

1. Following installation of the Temporary Accommodation Plaza Works, the SCADA and ventilation system will require re-commissioning and testing. In particular:

- The SCADA response to new fire alarm signals in Temporary Accommodation and Glasshouse
- The revised SCADA response for a fire alarm at platform level
- Air flow rates delivered by fan sets responsible for responding to station fire incidents
- Air flow rates at key locations in the station and tunnels for all fire modes (e.g. longitudinal tunnel flow rates, flow rates in vertical transport routes)

2. Following installation of the Temporary Accommodation B2 Works and the closure of the CPO building, the SCADA and ventilation system will require re-commissioning and testing. In particular:

- The SCADA response to fire alarm signals from the CPO (existing systems will be modified and some shut off for this phase)
- The SCADA response to any new fire alarm signals in Temporary Accommodation
- Air flow rates at key locations in the station and tunnels for all fire modes (e.g. longitudinal tunnel flow rates, flow rates in vertical transport routes)

3. Following the completion of the Permanent Works the following aspects will require testing and commissioning:

- The SCADA response to new fire alarm signals from the CPO (B1, Ground Level and Upper Floors)
- The revised SCADA response for a fire alarm at platform level
- Air flow rates delivered by fan sets responsible for responding to station fire incidents
- Air flow rates at key locations in the station and tunnels for all fire modes (e.g. longitudinal tunnel flow rates, flow rates in vertical transport routes)

4. Following any changes to the Tunnel Ventilation Strategy for Britomart Tunnels, additional testing and commissioning may be necessary. This is beyond the scope of this specification.

3.7 DESIGN CRITERIA

The listed design criteria are re

lated to Britomart Plaza works only. Britomart Level B2 and permanent works design criteria are to be confirmed.

3.7.1 External Ambient Design Conditions

Season	Design Ambient Temperature (Auckland) Atmospheric conditions 1% NIWA
Winter	3ºC
Summer	27ºC DB / 22ºC WB

3.7.2 Internal Design Temperatures

Zone	Winter Design Conditions	Summer Design Conditions
Occupied Rooms	Min 21ºC	Max 23ºC
Sick Bay	Min 21ºC	N/C
Comms Rooms	Min 15ºC	Max 25ºC
AT Staff Lockers	Min 21ºC	N/C
Accessible & Staff WCs	Min 15ºC	N/C
Switchroom / UPS Room	Min 15ºC	Max 25ºC
Rubbish Room	N/C	N/C
Public WCs	N/C	N/C

- Humidity control via cooling coil performance only. No active humidity control is provided.
- Internal temperature measured at the temperature sensor.
- The specified room conditions shall also be maintained under all partial loads.

3.7.3 Ventilation

Zone	Outdoor Air	Mechanical Exhaust	Infiltration
Occupied Rooms	10 l/s per person	N/A	1.0 ACH
Sick Bay	10 l/s per person	N/A	1.0 ACH
Comms Rooms	20 l/s	N/A	0.5 ACH
AT Staff Lockers	N/A	12 ACH	1.0 ACH
Accessible & Staff WCs	N/A	10 l/s.m^2 floor or 25 l/s per fixture	1.0 ACH
Switchroom / UPS Room	N/A	100 l/s to Comms Cupboard	0.5 ACH
Rubbish Room	N/A	12 ACH	0.5 ACH
Public WCs	N/A	10 l/s.m^2 floor or 25 l/s per fixture	1.0 ACH

3.8 TEMPORARY ACCOMMODATION WORKS

Omitted for clarity. Refer to Revision 7 of this specification for requirements relating to Temporary Works.

3.9 PERMANENT WORKS

3.9.1 Works Installed as part of Temporary Works Plaza

All mechanical works installed as part of the Temporary Accommodation Plaza buildings will be isolated, decommissioned and removed as part of the Works. However there are services that are still required to serve the permanent works. The contractor shall allow for the staging and phasing of these works.

3.9.2 Plaza Reinstatement (external to Glasshouse)

Once all the mechanical systems associated with the Temporary Accommodation Plaza buildings have been removed the reinstatement of all Plaza mechanical systems will be carried out by others.

3.9.3 Leak Detection Systems

The contractor shall provide leak detection systems to cover the following areas that have 'wet' services installed;

- B1 concourse void (between transfer slab and floor level) – identified as LD1 on drawings.
- MEP service trench (external to glasshouse below street level) – identified as LD2 on drawings.
- CPO services trench south (below CPO ground floor) – identified as LD3 on drawings.
- CPO services trench north (below CPO ground floor) – identified as LD4 on drawings.

The various 'wet' services installed include;

- Hydraulic pipes (drainage and potable services)
- Chilled Water pipework
- Sprinkler pipework
- Hydrant pipework

These areas are confined spaces. Access into these spaces will be infrequent and require proper access and controls procedures in place. Leak detection is provided to inform station staff of any leaks from pipework installed in these spaces reducing the need for regular inspections.

The leak detection shall be installed directly below the pipework at floor level.

Leak detection shall also be provided within the external condensate drain trays of the cooling units (both duty and standby) located in the following locations;

- CER
- UPS rooms
- LV Switch rooms

Leak detection will not be required in the staff areas (i.e. Kitchens, Ticketing area)

3.9.4 Rail System Rooms

The following Rail Systems Rooms will form part of a 'future' fitout;

- Overhead Line Room (OHLE)
- Tunnel LV Room
- Tunnel Comms nodes (x2)
- Signalling Equipment Room (SER)
- Platform Screen Doors Room (PSD)

The C1 design allows for the provision of shell only services to these rooms. Refer Memo CRL-BTM-MEP-000-MEM-0429 for proposed works.

3.9.5 Heating

The majority of the BOH rooms are equipment rooms that generally require year round cooling. However electric heaters shall be provided within the fan coil units serving the rooms, to ensure that minimum temperatures are maintained within the rooms served when the equipment heat load being generated is insufficient – such as when equipment is in an idle or standby state.

Electric heating shall also be provided within the main outside air supply, to ensure that a minimum supply air temperature is delivered to the occupied rooms. The electric heating is incorporated into the main heat recovery air handling unit (AHU).

The kitchen, sick bay and offices shall be provided with electric heater batteries integral within the cooling units. The public baby change areas as well as staff toilets shall be served by either wall mounted or ceiling mounted electric radiant heaters.

Electric radiant heaters shall also be provided for the ticketing, customer service areas and staff kitchenette at CPO ground level.

3.9.6 Ventilation

3.9.6.1 Outdoor Air Supply

The staff areas, equipment and plant rooms at B1 level shall be served by a general AHU comprising pre-heat coil, panel and bag filters and supply air fan / exhaust air fan units. A heat recovery shall be included within the AHU to provide heating (via the heat wheel) when conditions suit. The air shall not be centrally cooled by the AHU but supplied at conditions subject to the ambient outside air temperature plus the effect of the heat wheel / pre-heat coil. Space for future cooling coil shall be allowed for within the AHU.

The outside air supply to the kitchen/staff room shall be controlled locally via air quality sensors in the space plus a motorised damper within the outside air duct branch that shall modulate based on the demand for outside air in the space.

The B2 level areas will be served by duct mounted supply air fan (SAF), in-duct pre-heat coil and pleated filter bank. The areas covered by this system include the lift motor room, future SER area and ancillary rooms.

The outdoor air intake for these two items of plant shall be from the concourse area (level B1) in the Glasshouse for the AHU and platform area under the Glasshouse for B2 level spaces.

The supply air shall be delivered to the various areas via insulated distribution ducts routed via the corridors & combined services risers (where required).

The outside air supply / ventilation plant shall shut down on fire alarm. Upon the clearance of the fire condition, the plant shall return to its normal scheduled operation.

Three small ducted outside air systems shall be installed within the ground floor area of the CPO building. These systems shall deliver outside air to the enclosed office areas of the ticketing area, cash room and the excess fare office. The ticketing / cash room and office outside air system shall include filters plus a small inline electric duct heater to temper the air during colder ambient conditions. The outside air intakes shall be directly from the CPO area which is treated as “ambient air” due to the operation of the main existing systems that operate continuously during normal occupancy.

3.9.6.2 General Exhaust System

The B1 level general areas, some plant rooms and larger stores shall be served by the general extract system (associated with the heat recovery AHU). This air shall be exhausted to atmosphere at the CPO roof level.

This general exhaust systems shall shut down on fire alarm as part of the AHU.

The exhaust points have been located to avoid any potential recirculation of air with other systems.

3.9.6.3 CPO Ground Exhaust Systems

The existing mechanical exhaust system serving the CPO ground level with four fans located on the roof of CPO building shall remain. As part of the permanent works, the two south side fans final horizontal discharge arrangement shall be replaced with 90 degree bends and associated vertical discharge ducts and roof cowls.

The contractor shall provide a condition report on the existing fans and associated ducting/electrical supplies/controls to ascertain if the condition of the plant is satisfactory for continual use.

These fans shall remain under their existing controls.

3.9.6.4 WC Exhaust Systems

The new toilet areas shall be served by partially reusing the existing ventilation systems. The two existing duct vertical duct risers (from level 1 through to the roof of the CPO) and roof mounted toilet exhaust fans shall be reused. New exhaust air ducting on levels B1 and the ground floor shall be configured to exhaust air from the ablutions areas (both the public and staff area toilets) and connect into the existing risers. Make up air to these spaces shall be drawn from adjacent areas including the common public concourse.

The contractor shall provide a condition report on the fans and associated ducting/electrical supplies/controls to ascertain if the condition of plant is satisfactory for continual use.

The new BMS control system shall allow for digital inputs and associated hardware/software to enable the fans status to be monitored. Start/stop signals for operating the fans shall also be provided.

The toilet exhaust systems will shut down on fire alarm and shall automatically return to normal operation when the fire signal is cleared.

3.9.6.5 UPS/Battery Rooms Exhaust System

The dedicated duty / standby UPS extract system shall serve all the UPS/battery rooms to ensure the concentration of liberated hydrogen remains below the explosive limits defined in BS EN 50272-2 for Valve Regulated Lead Acid Batteries, discharging directly to atmosphere at CPO roof level.

The extract fans shall be duty/standby UPS backed bifurcated fans (i.e. the motor assemblies positioned outside of the airstream) to minimise the likelihood of explosion. The fan shall also be used in an emergency operation mode whenever both of the duty / standby air conditioning systems (fan coil units) serving the UPS/battery rooms fail or during total A & B power failure. Upon failure of the room air conditioning the temperature shall rise. Once the temperature exceeds the high temperature limit the associated motorised air intake damper plus exhaust air dampers for the room shall fully open. The “duty” exhaust air fan shall ramp up to operate at 100% speed to provide passive cooling via convective means from this room. This discharge shall be into the ‘up’ tunnel. Refer CRL-BTEM-MEP-000-MEM-0467.

The final roof level exhaust point shall be located to avoid any potential recirculation of air with other systems.

3.9.6.6 Sump Exhaust System

A dedicated duty / standby extract system shall be installed for all the main sump rooms.

The extract fans shall be duty/standby bifurcated fans (i.e. the motor assemblies positioned outside of the airstream) to minimise the likelihood of explosion, discharging directly to atmosphere at CPO roof level.

The final roof level exhaust point shall be located to avoid any potential recirculation of air with other systems.

3.9.6.7 Miscellaneous Exhaust

The Computer Equipment Room (CER) is provided with gas suppression as part of the Fire Protection Services. Pressure relief is required from these spaces via pressure relief dampers (supplied and installed by the Fire Protection Services).

An emergency exhaust air fan shall be provided for the CER room. The fan shall only operate in an “emergency mode” whenever both of the duty / standby air conditioning systems (close control units) serving the CER fail or during total A & B power failure. Upon failure of the room air conditioning, the emergency ventilation fan shall begin to operate in conjunction with the motorised air intake damper plus exhaust air damper for the room which shall both fully open. The exhaust fan and associated dampers shall also operate when the room temperature exceeds the high temperature limit.

3.9.7 Cooling

Cooling to the staff areas and equipment rooms shall be provided by a secondary chilled water circuit connected to packaged roof mounted air-cooled chillers. All equipment rooms that are equipped with mechanical cooling are configured with duty / standby plant to minimise downtime upon equipment failure or maintenance.

3.9.7.1 Chilled Water Plant

The air-cooled chillers shall be configured based on an N+1 arrangement (two duty / one standby). They are to be located on the CPO roof.

Each chiller shall include integral primary chilled water pumps. Supply and return header arrangement plus buffer vessel and duty / standby secondary chilled water pumps reticulate the chilled water through to the various fan coil units and close control units. The secondary chilled water circulation quantity is varied depending on the demand of the terminal units.

The chillers shall be controlled by their integral control system with a high level interface (via BACnet) to the main BMS / control system.

The chillers and pumps will be designed with redundancy N-1 (duty/standby).

The secondary chilled water pipework, pump sets, low loss headers, dosing, system pressurisation, filtration, buffer tank, etc. shall be located at the CPO roof.

3.9.7.2 CER Cooling

Close temperature control of the CER shall be provided by Close Control Units (CCUs) operating as duty/standby (N+1) configuration using chilled water.

The CCUs and all associated chilled water pipes, valves and controls shall located in dedicated FCU rooms adjacent to the respective CER room. This room has independent access from adjacent spaces (i.e. not via the equipment room). The FCU room is sized to allow for sufficient space for operative access and maintenance requirements. No chilled water pipes or condensate shall pass through or be contained within the CER room.

Floor gullies have been provided within the dedicated FCU room for the discharge of the condensate drains from the CCUs and drain down of the units.

Typically the CCU units shall be floor mounted up-flow configuration with top plenum boxes / supply air ducting. Motorised dampers shall be fitted to the supply air discharge of each unit to prevent potential air recirculation issues. The duty unit shall automatically open the motorised damper as part of its operation. Return air shall be delivered back to the CCU's through openings within the wall between the FCU room and the actual CER room. An outside air supply shall be delivered directly to the room for mixing with the return air. Each CCU will have an integral strainer, isolation valves & 2-port pressure independent control valve. Conditioned air shall be supplied to the equipment room via supply air grilles in the high-level supply air ducting.

No humidity control is required for the CER room.

The CCUs come complete with integrated controls that facilitate automation and optimisation of the system controls. A high-level interface shall be included between the integral controls and the main BMS / control system.

3.9.7.3 Equipment Room and Staff Area Cooling

Wall, floor or ceiling mounted chilled water fan coil units (FCUs) shall be provided for the remaining equipment rooms and staff areas. FCUs for the UPS rooms and MSB rooms shall be provided with N+1 redundancy. No redundancy shall be provided for non-essential equipment rooms and staff areas.

In the staff areas, the indoor units will maintain comfortable internal temperatures throughout the year. These units shall be provided with simple user interfaces.

Secondary chilled water flow and return pipework including valve assemblies deliver chilled water to each comfort cooling unit. Secondary drain trays shall be provided for each of the essential room FCU's.

3.9.7.4 Emergency Cooling to Critical Rooms

In the event of a total electrical power loss to the station (i.e. failure of both "A" & "B" Transformers) the following rooms that are critical to the operation of the railway and station systems shall be emergency ventilated by UPS backed up exhaust fans:

- UPS rooms (Note: the fan capacity is sufficient to ventilate three of the five UPS rooms). A controlled shutdown of electrical equipment is required to ensure that only three of the UPS rooms are active.
- CER room

These rooms shall be designed to operate at a maximum operating temperature for a period of time defined by the UPS autonomy period.

When failure of the power supplies occur the associated CCU or FCU's (both duty and standby) shall stop operating due to lack of power. The air intakes and exhaust outlets associated with each room shall automatically fully open whilst the exhaust fans ramp up to full speed. The main BOH corridor air intake shall open via its motorised damper. At this stage the station will be manned – the supervised opening of the doors between the FOH and BOH can also be undertaken to assist in providing more air intake area for the make-up air path.

3.9.8 CPO Roof Level, Upper Floors and Service Risers

3.9.8.1 CPO Roof Level

The following items of equipment shall be located on the CPO roof level:

- General exhaust discharge point (from AHU located in the B1 level).
- UPS/Battery exhaust discharge point
- Sump exhaust discharge point
- Toilet exhaust discharge points (existing duct and louvres reused)
- Chiller Plant including associated pumping, buffer tank, etc.
- Toilet exhaust fans
- CPO exhaust fans (existing fans reused with modification to the south side discharge – change from horizontal to vertical).

3.9.8.2 CPO Upper Levels

The existing HVAC systems serving the CPO upper level floors that were isolated/made safe during the permanent works shall be reinstated (ie: re-connected and made operational).

During the works all the existing CPO external equipment / plant as well as outside air intakes, exhaust air discharges shall be temporary sealed to minimise construction dust / debris entering the systems such as condenser coils and ductwork.

3.9.8.3 CPO Service Risers

The new ductwork and pipework shall rise through the existing service risers between B1 Concourse and the CPO roof level. Fire rating of these risers is in the vertical plane apart from at the base of the risers (high level B1).

Some reconfiguration of the existing riser services is required to accommodate the new services.

3.9.8.4 CPO Exhaust Fans

The existing CPO exhaust fans located at roof level shall be retained. The two (2) fans located on the south side shall be modified to discharge vertically through the roof. The exhausts shall be terminate in the horizontal with a bell mouth piece and mesh screen.

3.9.9 Hydraulics

3.9.9.1 Public WC Sumps

Two (2) duty/standby foul water sump pumps shall be provided at B1 Concourse Level – supplied and installed by the Hydraulic Contractor. The mechanical contractor shall design, supply and install the MCC panels including all power and control requirements and integration with the BMS and SCADA.

Pump Designation	Locations	MCC Panel No.
PMP-P-01/02	B1.059 Sump (Female)	MCC-HYD-03
PMP-P-03/04	B1.109 Sump (Male)	MCC-HYD-04

The foul water sumps shall include or allow for the following;

- Pump Control panels (MCC-HYD-03 & MCC-HYD-04)
- Level switches / floats / ultrasonic level indicators

- High level alarms and interfacing with the BMS/SCADA

3.9.9.2 Main Sump

Two (2) duty/standby sump pumps shall be provided at B2 Level in a dedicated sump room – supplied and installed by the Hydraulic Contractor. The mechanical contractor shall design, supply and install the MCC panels including all power and control requirements and integration with the BMS and SCADA.

Pump Designation	Locations	MCC Panel No.
PMP-P-05/06	B2.001 Sump	MCC-HYD-05
PMP-P-07/08		

The foul water sumps shall include or allow for the following;

- Pump Control panel (MCC-HYD-05)
- Level switches / floats / ultrasonic level indicators
- High level alarms and interfacing with the BMS/SCADA

3.9.10 Electrical for Mechanical/Hydraulic Supplies

Generally the mechanical and hydraulics services equipment for the permanent works shall be provided from two power sources known as A and B by the main electrical contractor. The majority of the mechanical and hydraulics services switchboards shall be equipped with an automatic transfer switch (ATS) which shall swap from supply A onto supply B (or vice versa) when one of the monitored power streams indicates an issue.

Three of the main mechanical services switchboards shall be provided with a UPS backed up power supply. This power supply shall be used to specifically serve the UPS room emergency ventilation fans (plus associated dampers), the CER room emergency ventilation fan (plus associated dampers and future SER room emergency ventilation fan (plus associated dampers).

3.9.11 Controls

Mechanical and Hydraulic systems will be monitored and controlled through a Building Management System (BMS). In the final CRL configuration the BMS will act as an intermediary control platform between the Station Management System SCADA (SMS-SCADA) and mechanical systems. In the interim, integration of the new BMS into the existing station SCADA system shall be required for the permanent works.

Mechanical Control Centres (MCC) and outstations will be provided at a local level to provide the necessary control (i.e. start/stop sequencing, time clock control, etc.) and fault monitoring of all HVAC and hydraulic plant. High level interfaces between the chillers and close control units and the BMS shall be provided. The BMS shall also provide the control / monitoring of the following auxiliary / other systems:

4 Scope - Fire

4.1 GENERAL

The Fire Contractor shall provide all details necessary for the carrying out of the work in sufficient time to enable other contractors to carry out the work and shall complete the respective portions in sufficient time to permit making good within the construction programme.

The Fire Contractor shall:

- Be fully responsible for the final detail design, planning design development, co-ordination, workshop documentation, supply, installation, testing, commissioning, quality assurance, certification and maintenance during defects liability period for the provision of the complete new fire services systems required for the Works.
- The specification is indicative and a guideline only, and it shall be the full responsibility of the Fire Services Contractor to allow for full compliance of all required fire services systems for the Works, inclusive of the full design, all necessary and required system components, equipment, plant, accessories and interface with other building services systems in accordance with all relevant New Zealand, Building Code and Authority requirements.
- Provision of coordinated installation/working drawings, fabrication drawings and record drawings – the Contractor's installation/working drawings shall be developed from the design drawings and include for any post tender changes to the layout that do not alter the design intent of the engineering services. Multi service coordination details shall be provided where necessary to demonstrate the installation intent for main services distribution and congested areas, clearly indicating access for maintenance.
- Liaise with the Electrical contractor with respect to final power requirements including loads and supply locations for all Fire services systems.
- Allow for all costs for all wiring from the fire services panels to individual items of fire services equipment including termination of the power.
- Supply the connection from the panels to the equipment where required. The Fire Contractor is to allow for all costs for all wiring from the fire panels to the individual items of equipment including all termination of the power to the items of equipment.
- Be responsible for contacting the Electrical Contractor to confirm where they require the power supply to be terminated as well as for confirming the power requirements for each item of fire plant.

4.2 DESIGN

The Fire Services Contractor shall take full responsibility for the fully complying detail design of each fire services system specified herein.

Design, workshop drawings and calculations must be submitted to the Engineer and Authorities for approval as necessary.

The Fire Services Contractor shall allow to review the architectural drawings and shall make all necessary allowances for the complete fire services installations as required to satisfy New Zealand, Building Code and Authority requirements.

The Fire protection drawings are diagrammatic and indicative only, and have been provided as a guide to assist with tender price purposes only.

4.3 ASSOCIATED WORK AND INTERFACES

This section outlines the work associated with the contract which is to be provided by the Fire Contractor and other interfacing trade contractors. The Fire Contactor shall co-ordinate and interface the Fire services works with the associated works contractors.

This applies to the Construction Contract 1 (Temporary and Permanent).

4.3.1 Fire for Hydraulics Works

The Fire Protection Contractor shall:

- Coordinate with the Hydraulics Contractor to ensure that drainage of the fire services is piped to the relevant drainage point in accordance with the relevant codes and standards.
- Work with the Hydraulics Contractor to ensure no conflict occurs between proposed hydraulic services works and fire protection services equipment, cables and pipework.
- Provide incoming fire water supply interfaces including gauge lines.
- Supply and install sprinkler test drains and drain down points to drain points provided by the Hydraulics Contractor.

4.3.2 Fire for Mechanical Works

The Fire Protection Contractor shall:

- Provide a fire interface panel located adjacent to the fire alarm panel within the Fire Control Room.
- Motorised damper control panel (including all required indication lamps/mimic panel – in general accordance with AS1668) and wiring between the panel and dampers to facilitate the control of all motorised fire dampers. Panel to be located at B1 level adjacent to the Fire Alarm Panel.
- Provision of fire signals as specified for the mechanical services systems.
- Provision of hard wired connections between the FAP and MCC panels (Mechanical and Hydraulics)
- Attendance during fire interface testing and demonstration to the Engineer and Territorial Authorities.

4.3.3 Fire for Controls Works

The Fire Protection Contractor shall;

- Provide and install, adjacent to each motor control centre/controls enclosure, a relay box comprising relays with volt free change-over contacts suitable for interfacing mechanical plant with the building fire detection system as detailed in the Contract Documents.
- Provide Wiring and terminations between the fire panel and relay boxes. Wiring and terminations between volt free contacts in each relay box and the associated motor control centre shall be by the Controls Specialist Contractor.
- Liaise with the Controls Specialist Contractor to ensure full compliance with this Specification.

4.4 WORKS BY OTHERS

As part of the works, the contractor shall be required to liaise with the main contractor as well as all other sub-contractors and separate contractors to ensure that the programme of works, safety requirements and coordination/interfaces are maintained.

4.5 SUSTAINABILITY

The project's sustainability objectives are set out in the main contract. The Contractor shall be aware of their requirements to contribute to the achievement of these objectives.

The project is targeting an 'Excellent' rating against the Infrastructure Sustainability rating tool from the Infrastructure Sustainability Council of Australia. The Contractor shall be aware of their requirements to contribute to the achievement of this rating.

4.6 EXISTING SYSTEMS

4.6.1 Station West and CPO Building (Level B1, B2 and Ground Level)

The incoming fire main and hydrant inlet is located in the sprinkler control valve room (west end - external to the glass house). This comprises:

- 100 diameter sprinkler system connects to the town utility mains and includes a single way fire service inlet;
- 150 diameter hydrant supply including a three way inlet for the hydrants.

The 100 dia sprinkler system serves the B2 level, B1 levels and CPO ground floor. The sprinkler pipework routes through the Transdev accommodation area and penetrates into the CPO building on both the north and south sides of the station.

The hydrant supply serves twin hydrant outlets at the B2 level, B1 level and CPO ground floor evacuation stair located on the north and south of the station. The hydrants located in the CPO ground floor evacuation stairs are on the north and south side of the CPO connect to the CPO upper levels.

There are automatic motorised smoke curtains located below the plenums at the end of the platform on the west side with linear detection cabling directly above the tracks. This comprises a main central curtain with two smaller north and south curtains. The control panel (ZCP) for these curtains is located at B2 level north.

The CPO building is covered by a VESDA and sprinkler system. The VESDA displays are located in the CPO switch rooms at B1 level (north and south side).

Manual call points are located throughout the area.

- Various control and fire panels are located at the west end of the station:
- DB1A (Sprinkler Valve Room GL107 – ground level south)
- ZCP (Smoke Curtain Zone Control Panel – B2 platform north)
- CPO Sub Fire Alarm Control Panel (CPO ground)
- Fire Alarm Mimic Panel (Sprinkler Valve Room GL107 – ground level south)

A gas flood system is provided at Tangihua Street.

4.6.2 Foam Suppression System

The trackway foam suppression system has now been decommissioned. Some elements of this system are still present in the station. However, no works to this system are proposed as part of the Construction Contract 1 Contract.

4.6.3 Smoke Curtains

There is currently an 'open' fire consent that is under development for this system. No works are proposed as part of the Construction Contract 1 Contract except that the smoke curtains must remain in place and deploy according to the existing strategy/consent upon either actuation of the above track heat detection system or manually via the station control centre.

4.6.4 Above Track Heat Detection System

No works are proposed as part of the Construction Contract 1 Contract except where necessary to maintain these systems operation during construction. The activation of the above track heat detection system must activate the ventilation system according to the Construction Contract 1 response mode described in the Mechanical Section.

4.7 TEMPORARY ACCOMMODATION WORKS - PLAZA

Omitted for clarity. Refer to Revision 7 of this specification for requirements relating to Temporary Works.

4.8 TEMPORARY ACCOMMODATION WORKS – B2 LEVEL

Omitted for clarity. Refer to Revision 7 of this specification for requirements relating to Temporary Works.

4.9 PERMANENT WORKS

4.9.1 Existing Fire Protection and Detection Systems

Any existing fire protection and detection systems not impacted by the works shall be maintained in operation.

4.9.2 Works Installed as part of Temporary Works

All fire protection and detection systems installed as part of the Temporary Plaza Accommodation buildings will be isolated, decommissioned and removed as part of the Works. However there are services that are still required to serve the permanent works. The contractor shall allow for the staging and phasing of these works.

4.9.2.1 Plaza Reinstatement

Once all the fire protection and detection systems are removed from the temporary accommodation, the reinstatement of all Plaza fire systems will be carried out by the Urban Realm works.

4.9.2.2 Rail System Rooms

Memo CRL-BTM-MEP-000-0429 describes the C1 scope for the future Rail Systems Rooms, located within the B2 back-of-house area. These rooms shall not be fully constructed as part of the C1 works. Instead, a space for these rooms shall be created with 2-hour fire resistance rated compartmentation to adjacent areas. In terms of fire detection and protection:

- Automatic fire detection is provided shall be provided in the future Rail Systems space
- The future Rail Systems space may be unsprinklered for the interim period before it is fully fitted out
- The space shall be kept free of fire load (i.e. not used storage) in the interim before it is fully fitted out
- The access/evacuation corridor shall be provided with automatic sprinkler protection.

4.9.3 Fire Protection

The existing automatic sprinkler systems shall be modified to comply with the requirements of NZS 4541 Automatic fire sprinkler systems.

Fire detection and alarm systems shall be designed for these works and integrated into the new Station West Fire Alarm Panel. This shall then be integrated back into the main station fire alarm station. These shall comply with NZS 4512:2010 Fire Detection and Alarm Systems in Buildings and the Fire Engineering Report (CRL-BTM-FIR-000-RPT-0011). The table below summarises the room requirements based on the FER drawings. The Fire Contractor shall be responsible for ensuring the fire protection complies with the FER requirements.

Permanent Works Protection

Level	ID	Name	Detection	Sprinklers	Gaseous Suppression
B2	1	Sump Pump Control Room	X		
	108	Room		X	
	109	OHLE	X		
	110	Lift Room		X	
	112	Police Box		X	
	113	Stair		Note 1	

	114	Platform Managers Room		X	
	115	MSB-1	X		
	117	MSB-1-1	X		
	118	Drivers Rest Area		X	
	119	Female Toilet		X	
	120	Existing Stair		Note 1	
	121	Room		X	
	128	Unallocated (future Rail Systems Rooms)	X		
	129	Corridor		X	
	130	Fire Intervention Stair		Note 1	
	132	Corridor		X	
	135	Electrical DB	X		
	136	Escalator Step Storage		X	
	137	Unallocated		X	
	138	Cleaners Room		X	
	141	Communications Room	X		
B1	103	Room		Note 5	
	104	Room		X	
	105	Plenum		X	
	106	Room		X	
	107	Room		X	
	108	Room		X	
	109	Stair		Note 1	
	110	Room		X	
	111	Room		X	
	112	Room		X	
	113	Room		X	
	114	Room		X	
	115	Stair		Note 1	
	1	Female WC		X	
	2	Escalator Step Storage		X	
	3	Riser		Note 2	
	4	Comms	X		
	5	Riser		Note 2	
	6	Male WC		X	
	7	Corridor		X	
	8	3rd Party Utilities	X		
	9	Lobby		X	
	10	Accessible WC		X	
	11	Baby Change		X	
	12	Baby Change		X	
	13	Lobby		X	
	14	Accessible WC		X	

	17	HVAC		X	
	18	Riser		Note 2	
	19	Sump	X		
	20	CER			X
	21	FCU		X	
	22	Gas		X	
	23	Storage		X	
	24	Kitchen		X	
	29	Corridor		X	
	30	Corridor		X	
	31	Sick Bay		X	
	32	Office		X	
	33	Female Change		X	
	34	Male Change		X	
	40	MSB	X		
	41	Cleaners Store - Dry		X	
	42	Cleaners Store - Wet		X	
	43	UPS	X		
	44	UPS	X		
	45	UPS	X		
	46	UPS	X		
	47	UPS	X		
	50	HVAC		X	
	51	Sump Pump Access Room		X	
	52	Services Duct		X	
	53	LV2	X		
	54	LV1	X		
	55	MSB	X		
	56	COM	X		
	57	3rd Party Utilities	X		
	58	Corridor		X	
	59	Sump	X		
	60	Riser		Note 2	
	63	Stair		Note 1	
GL	104	Transformer	X		
	105	Transformer	X		
	106	Air Intake	Note 3		
	107	Brigade Inlet	X		
	108	Stair		Note 1	
	109	Air Intake	Note 3		
	110	Water Skylight Pump	X		
G	2	CPO Gateline - Paid	X	X	
	6	Vestibule	X	X	
	10	Excess Fare Window	X	X	

	11	CPD	X	X	
	12	MSB	X		
	13	MSB	X		
	14	MSB	X		
	15	Corridor	X	X	
	20	Lobby	X	X	
	21	Retail	X	X	
	22	Retail	X	X	
	23	Retail	X	X	
	25	Retail	X	X	
	26	Ticketing	X	X	
	27	Customer Service	X	X	
	28	Cash Room	X	X	
	29	Corridor	X	X	
	30	Staff Kitchenette	X	X	
	31	Staff WC	X	X	
	32	Corridor	X	X	
	33	Office CSC	X	X	
	34	Lobby	X	X	
	35	Fire Intervention Stair		Note 1	
	111	Glass Bridge - Paid	Note 4		
	112	Glass Bridge - Unpaid	Note 4		
1	12	Electrical Cupboard	Out of Scope		
	13	Electrical Lobby			
	14	Electrical Room			
	15	Stair			
	16	HV Riser			
	19	Electrical Cupboard			
	21	Stair			
	22	HV Riser			
2	12	Electrical Cupboard	Out of Scope		
	13	Services Riser			
	15	Stair			
	16	HV Riser			
	19	Electrical Cupboard			
	20	Service Riser			
	21	Stair			
	22	HV Riser			
3	12	Electrical Cupboard	Out of Scope		
	13	Services Riser			
	15	Stair			
	16	HV Riser			

	19	Electrical Cupboard	
	20	Service Riser	
	21	Stair	
	22	HV Riser	
4	5	Plant Room	Out of Scope
	6	Open Plant Room	
	7	Plant Room	
	13	Open Plant Room	
	14	Open Plant Room	

Notes:
1. No sprinklers necessary if requirements of AS/NZ 4541 Section 207(f). Existing CPO stairs are sprinkler protected based on as-builts
2. Protection required per AS/NZ 4541 Section 511.3
3. Smoke detection required on supply side of make-up/supply fans if not currently provided
4. Linear heat detection being incorporated into glass house, to be removed post-works
5. Sprinkler protection zoned to provide waterflow indication for area.

Other Areas:
- Voids/concealed spaces per AS/NZ 4541 Section 511.2 except as permitted by Section 207; (heat) detection to be provided per NZS 4512 except as permitted per 405.2.2
- Under escalators as per AS/NZ 4541 Section 511.6

4.9.4 CPO Building

4.9.4.1 VESDA

The PTA design team could not obtain access to the existing ceiling void space therefore the contractor shall carry out an inspection of the CPO ground floor in-ceiling services to determine the condition of the existing VESDA network. The design intention is that the existing VESDA protection for the CPO ground floor shall be isolated and protected for reinstatement at the end of the Works. This shall include the existing capillary tubes, detectors etc at high level in the CPO ground level.

Any parts of the VESDA network discovered to be degraded or sub-standard shall be replaced as part of these works.

The existing VESDA protection for the CPO ground floor shall be reinstated at the end of the Works. This shall include modification of existing capillary tubes, detectors etc at high level at CPO ground level and the design, supply and installation of new VESDA panels, capillary tubes etc located at the B1 Concourse level.

The new VESDA panels shall connect to the existing east end fire alarm panel. Include for the integration into the existing FAP at the east end. This shall include new VESDA displays at the east end FAP.

Provide new VESDA indicator panels at the existing FAP at the east end and integration into the existing main FAP and SCADA.

4.9.4.2 Sprinklers (CPO Levels 1 – 3)

The existing sprinkler systems for the CPO building (Levels 1 – 3) shall be tested and re-commissioned at the end of the Works. This shall include existing flow switches, monitoring valves etc and integration into fire alarm systems.

The CPO upper levels (levels 1 – 3) and lift lobby monitoring valves shall be integrated into the existing DBA1 located in the Sprinkler Valve room (GL.107). Flow switches for these levels shall be integrated into the new CPO building Sub Fire Alarm Panel located at the B1 Concourse level.

The contractor shall allow for all diversion works required to maintain the sprinkler system operational.

4.9.4.3 Sprinklers (CPO Ground Floor)

The existing sprinkler protection for the CPO ground floor shall be isolated and reinstated at the end of the Works. This shall include the modification of existing sprinkler layout to suit the new retail areas. This shall include new flow switches, monitoring valves etc and integration into fire alarm systems. Any part of the sprinkler network discovered to be degraded or substandard shall be replaced as part of these works.

Flexible connections onto sprinkler heads may be considered for sprinkler bracing if required. This shall be checked with the seismic restraint Engineer and SI prior to works.

The CPO Ground floor monitoring valves shall be integrated into the existing DBA1 located in the Sprinkler Valve room (GL.107). Flow switches for the CPO ground level shall be integrated into the new CPO Building Sub - Fire Alarm Panel located at the B1 Concourse level.

4.9.4.4 Hydrants

The existing hydrants serving the CPO building (south and north side) shall remain in operation throughout the Works. The contractor shall allow for all diversion works required to maintain the hydrant system operational.

4.9.4.5 Detection

The existing detection systems for the CPO building (Levels 1 – 3) shall be tested and re-commissioned at the end of the Works. This shall be integrated into the new CPO Fire Alarm Panel located at the B1 Concourse level.

4.9.4.6 CPO Fire Alarm Panel

Supply and install a new CPO Fire Alarm Panel for the existing CPO building (Levels 1 – 3) including CPO ground lift lobby. The new CPO FAP shall integrate into the existing station FAP at the east end.

4.9.4.7 Testing and Commissioning

All fire protection systems serving the CPO building (Ground, Level 1-3) shall be tested and commissioned at the end of Construction Contract 1.

4.9.5 Fibreoptic Heat Detection

The Fibreoptic Heat Detection System installed in the temporary works for the glass house shall be isolated and removed for the permanent works, at the conclusion of the construction activities

4.9.6 Gas Suppression

Design, supply and install new Gas Flood Systems in accordance with AS ISO14520 for the following rooms:

- CER (B1 Concourse Level)

The Gas Flood System for the CER room shall be based on a **ProInert** System and come complete with the following items of equipment;

4.9.6.1 Alarm Hardware

- Zone Control Panel
- Local Control Station
- Warning signage to suit
- Evacuation sounders to suit
- Point type photoelectric smoke detectors to suit
- VESDA VLQ

4.9.6.2 Extinguishing Agent

- Cylinders (ProInert)
- Valve Assembly, pressure switches, manifolds and actuators to suit

4.9.6.3 General

- Pipework
- Agent nozzles
- DC power supply
- Pressure relief dampers to suit
- All necessary labour and materials

Each room will be fitted out with at least two (2) smoke detectors. If a fire is sensed by one of these smoke detectors then a "Stage 1" alarm will be generated for that room.

A Stage 1 alarm initiates the following Gas Flood System responses:

- The Stage 1 alarm is reported back to the central Fire Control Panel via the CPO FAP
- Ventilation system to the room shuts down
- An audible Alarm is sounded internal to the room
- Alarm is indicated on the LED Mimic Panels

If the second smoke detector for a room senses a fire then a "Stage 2" alarm will be generated for that room.

A Stage 2 alarm initiates the following Gas Flood System responses:

- The Stage 2 alarm is reported back to the central Fire Control Panel
- The audible Alarm continues to be sounded internal to the room
- Alarm is indicated on the LED Mimic Panels
- Evacuate Room signs are illuminated
- The Gas Flood System is automatically discharged by the local extinguishant gas control system into the room after a 30 second delay

4.9.7 Fire Extinguishers

Supply and install Fire Extinguishers as per the Fire Engineering report.

4.9.8 Detection Systems

Detection systems shall be provided for the permanent works. These shall comply with NZS 4512:2010 Fire Detection and Alarm Systems in Buildings and the Fire Engineering Report.

4.9.9 Sprinkler Valve Room (GL.107)

The existing sprinkler valve room at the west end shall be modified to suit the permanent works. This work is described in more detail in memo CRL-BTM-MEP-000-SPE-0001 and subject to contractor staging. In summary, the modifications shall include:

- Install the new tunnel hydrant inlet point, located adjacent to the existing station hydrant inlet point and station sprinkler inlet point, in room GL.107.
- The existing refuse store (GL.110) will be retained, unmodified.
- The existing louvred doors to GL.107 on the north side shall be retained, providing access to all breeching inlets.
- A new access door will be provided on the south wall of the sprinkler valve room GL.107. This can be accessed off Galway Street, via the existing intervention door located on the south face of the building. Following practical completion of the C1 works, this intervention stair (GL.108) will become a maintenance access point only.
- Access to both the breeching inlets and the sprinkler valve room will require the use of the fire service key (no change from current procedure).
- Updated signage will be provided in accordance with NZS 4510 and NZS 4541. Signage will show clearly which inlet point is for the station hydrant system and which inlet is for the tunnel hydrant system.

4.9.9.1 Pressurised Sprinkler Assembly

The existing pressurised sprinkler assembly (jockey pump, valves, gauges etc) shall be retested and commissioned to current codes. The contractor shall replace any fittings found to be substandard.

4.9.9.2 DBA1

The existing DBA1 shall be modified to suit the integration with any new and existing monitoring valves required as part of the permanent works.

4.9.10 Sprinklers

The existing sprinkler systems shall be modified to suit the permanent works. New sprinkler pipework shall be connected to the existing sprinkler network to serve the permanent works. This shall include all pipework, heads, flow switches, monitoring valves etc.

The CPO Ground floor monitoring valves shall be integrated into the existing DBA1 located in the Sprinkler Valve room (GL.107). Flow switches for the CPO ground level, B1 Concourse Level and B2 level shall be integrated into the new CPO Building Sub - Fire Alarm Panel located at the B1 Concourse level.

The sprinkler network associated with the temporary accommodation buildings shall be decommissioned and removed.

The contractor shall also upgrade all Fire sprinkler block plans around the station to incorporate all the modifications and upgrades etc.

The contractor shall check and re-design zone isolation valves and flow switches where required.

4.9.11 Station Hydrants

6 no new station hydrant outlets shall be installed in the following locations;

- B2 Level (2 no either side of escalators)
- B2 Level (Intervention stair)
- B1 Concourse Level (Public area)
- B1 Concourse Level (Back of House)
- B1 Concourse Level (Evacuation stair connecting to Intervention stair)

The fire hydrant system shall be installed in the stations to comply with NZS 4510:2008 “Fire Hydrant Systems for Buildings”.

Way finding lines shall be provided on the floor in the back of house areas to show fire hydrant locations and paths to exit. These will be indicated on drawings at the FAP and mimic panels.

4.9.12 Tunnel Hydrants

A new fire tunnel hydrant inlet with three 70mm male instantaneous hose connections conforming to NZS 4510:2008 Fire Hydrant Systems for Buildings and SNZ PAS 4505 shall be installed in the existing Sprinkler Valve room (GL 107) that will interface with the station systems at B2 platform level or at the headwall.

The tunnel hydrant system shall terminate and be isolated at the tunnel head wall and each section of the fire hydrant system is provided with redundancy through dual feed to the outlets from two locations and through cross-connection at the cross passage locations.

The contractor shall allow for the installation of pressure reducing valves in the hydrant main to regulate the downstream pressure and ensure that the hydrants cannot be over pressurised.

The ‘future’ CRL tunnel works will connect to the isolated tunnel hydrant section.

4.9.13 Fire Mimic Panels

4.9.13.1 General

Way finding lines shall be provided on the floor in the back of house areas to show fire hydrant locations and paths to exit. These will be indicated on drawings at the FAP and mimic panels.

4.9.13.2 Existing Fire Mimic Panel

The existing fire mimic panel located at the Sprinkler Valve Room (CPO ground west) shall be modified to suit the permanent works.

4.9.13.3 New Replica Fire Mimic Panel

In conjunction with the existing a new fire mimic panel shall be provided external to the CPO building on the north side. This panel shall replicate the layout and functionality of the mimic panel at the Sprinkler Valve Room (CPO ground west).

4.9.14 CPO Building Sub Fire Alarm Panel

Supply and install a new CPO Building Sub - Fire Alarm Panel for the existing CPO Ground Floor, B1 Concourse level and B2 Level. The new CPO building Sub FAP shall integrate into the existing station FAP at the east end.

Way finding lines shall be provided on the floor in the back of house areas to show fire hydrant locations and paths to exit. These will be indicated on drawings at the FAP and mimic panels.

4.9.15 Main Station Fire Alarm Panel (MCR East End)

The existing station FAP shall be modified to enable the permanent works to be fully integrated into the existing FAP. These works shall include the integration of;

- New CPO Sub-FAP
- Existing west end mimic panel
- New west end repeater mimic panel
- New VESDA systems for CPO Ground Floor
- New gas suppression systems
- Existing DBA1
- Fire control signals for the SCADA system

4.9.16 Retail Areas

All fixed retail areas shall be provided with minimum fire provisions as required by the NZ Building Code.

4.9.17 Fire Dampers

Motorised fire dampers shall be integrated into a damper control panel and connected to the CPO FAP for activation during a fire event. The dampers shall also be connected to the BMS control system.

5 Scope - Hydraulics

5.1 GENERAL

The Hydraulics Contractor shall provide all details necessary for the carrying out of the work in sufficient time to enable other contractors to carry out the work and shall complete the respective portions in sufficient time to permit making good within the construction programme.

The Hydraulics Contractor shall:

- Provision of coordinated installation/working drawings, fabrication drawings and record drawings – the Contractor's installation/working drawings shall be developed from the design drawings and include for any post tender changes to the layout that do not alter the design intent of the engineering services. Multi service coordination details shall be provided where necessary to demonstrate the installation intent for main services distribution and congested areas, clearly indicating access for maintenance.
- Liaise with the Mechanical contractor with respect to final power requirements including loads and supply locations for all hydraulics services systems.
- Liaise with the mechanical contractor on the supply and install of the electrical connections from the Hydraulics control panels to the equipment where required. This shall include for all wiring from the Hydraulic control panels to the individual items of equipment, pumps, hot water plant etc and including all termination of the power to the items of equipment;
- Provide cold water supply for make-up to expansion tanks, dosing pots and pressurisation vessels, with valved termination within 3m of the equipment for connection to mechanical plant by the Mechanical Contractor.
- General purpose cold water hose cocks in plant rooms.
- Provide tundish wastes (with access/visibility as per AS/NZS3500) where shown connected to sewer to receive condensate and for draining down and overflow from equipment.
- Provide trapped tundishes and grated floor wastes connected to sewer, in locations agreed with the Mechanical contractor, to receive condensate and for draining down and overflow from equipment.
- Coordinate the location of the required controls connection points with the Mechanical and BMS Specialist Contractor
- Liaise with the mechanical contractor over the Hydraulic Control Panel (HCP) or MCC, control panels and individual items of hydraulics equipment, all terminal strips, wiring access, control relays, interposing relays, voltage free contacts, transducers, power sources, interconnection facilities addressable devices and the like, all suitably sized and labelled to provide the required interface to the controls system.
- Provide access to Hydraulic Service plant and equipment for the BMS Specialist Contractor

5.2 ASSOCIATED WORK AND INTERFACES

This section outlines the work associated with the contract which is to be provided by the Hydraulics Contractor and other interfacing trade contractors. The Hydraulics Contactor shall co-ordinate and interface the Hydraulic services works with the associated works contractors.

5.2.1 Hydraulics for Mechanical Works

The Hydraulics Contractor shall provide the following to the Mechanical Contractor;

- Provide tundish wastes and / or connections upstream of traps (with access/visibility as per AS/NZS3500) where required connected to sewer to receive condensate and for draining down and overflow from equipment.
- Provide trapped tundishes and grated floor wastes connected to sewer, in locations agreed with the Mechanical contractor, to receive condensate and for draining down and overflow from equipment.
- Provision of condensate drainage points for the air conditioning units
- Provision of valved water connections to supply the chilled water make up.
- Details of all hydraulic equipment requiring a BMS connections

5.2.2 Hydraulics for Fire Works

The Hydraulics Contractor shall provide the following to the Fire Contractor;

- Provide drainage connections to any fire service pipework
- Liaise with the Fire Contractor for any tundish locations and advise on drainage points for any test drains
- Pressure gauges on both suction and discharge of pumps for performance testing of hydrant systems including any test certificates

5.2.3 Hydraulics for Controls Works

The Hydraulics Contractor shall;

- Liaise with the Mechanical and BMS Specialist Contractor to agree suitable locations for sensors, valves, actuators, flow measuring devices, etc.
- Provide the Mechanical and BMS Specialist Contractor with CAD drawings in electronic format of the hydraulic installation.
- Provide the Mechanical and BMS Specialist Contractor with information for the purpose of sizing control valves including medium, system static pressure, pump head, flow rates, coil pressure drops, and any other relevant data.
- Liaise with the Mechanical and BMS Specialist Contractor to ensure full compliance with this Specification.

5.3 WORKS BY OTHERS

As part of the works, the contractor shall be required to liaise with the main contractor as well as all other sub-contractors and separate contractors to ensure that the programme of works, safety requirements and coordination/interfaces are maintained.

5.4 SUSTAINABILITY

The project's sustainability objectives are set out in the main contract. The Contractor shall be aware of their requirements to contribute to the achievement of these objectives.

The project is targeting an 'Excellent' rating against the Infrastructure Sustainability rating tool from the Infrastructure Sustainability Council of Australia. The Contractor shall be aware of their requirements to contribute to the achievement of this rating.

5.5 EXISTING SYSTEMS

5.5.1 Potable Water

Two (2) no. potable cold water main supplies for the west side of the station are provided from incoming water mains at the south east corner of the CPO building (CPO Level B1 Switch room - south side).

These supplies serve the following:

- CPO Ground Floor
- CPO Upper floors
- Transdev staff accommodation
- B1 Concourse public toilets
- Ground level water skylight fountain feature
- Irrigation system for internal waterfall (currently isolated)
- Fire hose reels throughout station west and east

5.5.2 Hot Water

Hot water is provided by a mixture of instantaneous and hot water storage cylinders.

5.5.3 Cold Water Storage

There are no cold water storage tanks.

5.5.4 Sanitary Drainage

Sanitary and surface water drainage is collected in sumps located on level B1 concourse and B2 and pumped into the existing utility network on Tyler and Galway Street.

5.5.5 CPO Drainage

CPO upper floor drainage connects to the utility network at Tyler and Galway Street.

5.6 TEMPORARY ACCOMMODATION WORKS – PLAZA

Omitted for clarity. Refer to Revision 7 of this specification for requirements relating to Temporary Works.

5.7 TEMPORARY ACCOMMODATION WORKS – B2 LEVEL

Omitted for clarity. Refer to Revision 7 of this specification for requirements relating to Temporary Works.

5.8 PERMANENT WORKS

5.8.1 Asset Design Life

The maintainable design life of elements within the hydraulics system is detailed in Table 5-1 below.

Table 5-1 Hydraulic services design life requirements

Element	Design Life (Years)	Operating Requirements (hours per day – 365 days a year)
Drainage Assets (unless otherwise stated)	60	24
Pipes and Chambers made from Hydrocarbon based materials e.g HPPE	40	24
Pipes and chambers made from non-hydrocarbon based materials e.g concrete, masonry etc	100	24
Chamber covers and gratings	20	24

The design life for each element of the system shall be based on the expected environmental conditions and the installation method used.

Unless otherwise specified, all equipment shall be designed for a minimum maintainable design life of 25 years, operating 365 days a year, 24 hours per day.

5.8.2 Works Installed as part of Temporary Works

All water and drainage systems installed as part of the plaza temporary accommodation buildings will be isolated, decommissioned and removed as part of the Works. However, there are services that are still required to serve the permanent works. The contractor shall allow for the staging and phasing of these works.

The B2 level works will be retained in operation at C1 Practical Completion.

5.8.3 Plaza Reinstatement (external to Glasshouse)

Once all the water and drainage systems associated with the Temporary Accommodation buildings have been removed the reinstatement of all Plaza drainage systems (foul/surface water, water treatment) will be carried out under instruction by CRL.

5.8.4 Rail System Rooms

The following Rail Systems Rooms will form part of a ‘future’ fitout;

- Overhead Line Room (OHLE)
- Tunnel LV Room
- Tunnel Comms nodes (x2)
- Signalling Equipment Room (SER)
- Platform Screen Doors Room (PSD)

The C1 design allows for the provision of shell only services to these rooms. Refer Memo CRL-BTM-MEP-000-MEM-0429 for proposed works.

5.8.5 Potable Water

Two (2) Cold Water Mains (CWM) will be provided for the permanent works. These include:

1. Permanent CWM for station services including the CPO ground level (separate branch for all retail areas)
2. Permanent CWM for the CPO building Upper Levels 1 - 3 and roof

5.8.6 Station CWM Supply

The existing incoming CWM is located near the South CPO riser (feed from Galway Street). The incoming water supply will be fitted with water meters (Pulsed type), isolation valves and double check valves at the points of entry if not already provided. The CWM will route in the new MEP services trench located external to the glasshouse.

Internal CWS pipework distribution to be in copper and feed the;

- Staff accommodation areas including kitchenettes
- Public Male and Female toilets
- Male and Female showers/WC's
- CPO retail areas (will require a metered cold-water supply as a basic 'base build' type layout)
- Drinking fountain
- "quick fill" connections to equipment within the Chiller plant room (CPO roof level)

The existing irrigation waterfall features for the north and south walls will not be reinstated.

Hose union bib-taps will be provided in the main sump room and any cleaners rooms. In all cases a label will be provided within these rooms to warn that the water supply is not of drinking water quality and shall not be consumed.

5.8.6.1 Retail Areas

The CPO retail areas will connected off the Station CWM supply. CWS pipework distribution to be routed in copper pipe.

5.8.7 CPO Building Levels 1 - 3 and Roof CWM Supply

The existing incoming CPO CWMs is located near the South CPO riser (feed from Galway Street). The incoming water supply will be modified to suit the permanent works. The CWM will route in the new MEP services trench located external to the glasshouse.

The CWM pipework will feed the;

- CPO building upper levels 1- 3 and roof

The CWM will branch off at high level in the CPO ground floor to connect to the existing CWM serving the CPO Levels 1 – 3 and roof. The CWM supply routes through the existing south and north CPO risers.

5.8.8 Hot Water

Provide a complete domestic hot water generation and distribution system to serve all associated domestic appliances and sanitary ware throughout the building, and as follows:

- Wash Hand Basins
- Kitchen Sinks

- Cleaner's sinks
- Showers

Hot water for the station will be provided by electric hot water cylinders. Refer Table 5-2 below.

Table 5-2 Hot Water Provision

Type	Locations	Capacity
HWC-P-01	B1.017 HVAC	315 litres
HWC-P-02	B1.017 HVAC	315 litres
HWC-P-03	B1.023 Storage	180 litres
HWC-P-04	B1.041 Cleaners Store - Dry	180 litres
HWC-P-05	B2.138 Cleaners Room	180 litres

HWS pipework distribution shall be Copper.

Pressure and temperature relief lines from the water heaters shall discharge into the floor drain / stub stack in accordance with general code of practice.

Self-regulating trace heating tape shall be provided to the hot water flow pipework if the distribution routes are in excess of 6m from the heater to the outlet. This shall be provided to maintain the design temperature of the water at the point of use.

Pressure and temperature relief lines from the water heaters shall discharge into the floor drain / stub stack in accordance with general code of practice.

Self-regulating trace heating tape shall be provided to the hot water flow pipework if the distribution routes are in excess of 6m from the heater to the outlet. This shall be provided to maintain the design temperature of the water at the point of use.

Thermostatic mixing valves will be installed on all wash basins/sinks.

HWS pipework distribution shall be Copper.

The public toilets and staff area will be provided with heavy duty type hot water cylinders (HWC-P-01/02 and 03) and include for hot water return circulating pumps.

The following temperatures shall be applied to prevent Legionella's and minimise the risk of scalding.

5.8.8.1 Water Storage

- 60°C Hot Water Cylinder storage

5.8.8.2 Delivery Temperatures

Locations	Delivery Temperature
Public Male Toilet	45°C
Public Female Toilet	45°C
Staff and Public Accessible Toilets	45°C
Staff Toilets Wash Basins	50°C
Staff Mess Rooms (kitchens/wash basins)	50°C

The delivery temperatures shall be controlled by thermostatic mixing valve (TMV) set to the desired temperature. Wash hand basin temperature to be tested with a calibrated thermometer to ensure water temperature does not exceed peak temperature.

Domestic Hot Water Cylinders (HWC) shall be sized to provide sufficient hot water to each location and shall be fitted with factory fitted safety valves, and temperature cut outs. The safety discharges shall be collected via a tundish and discharge to waste. All HWC's shall be installed in strict accordance with manufacturer's instructions.

All hot water distribution pipework shall be insulated to within 1m of the outlet point.

In most cases, the hot water distribution pipework service shall be trace heated with heat maintenance tape to ensure that the system does not suffer from significant heat loss, and ultimately water wastage.

The contractor should ensure that electrolytic action between dissimilar metals does not occur within the system. All pipework shall be insulated with compliant insulation and a continuous vapour barrier shall be maintained.

5.8.9 Sanitary Drainage

5.8.9.1 CPO Roof Level

The contractor shall include for the drainage works to the following areas:

- CPO Roof – new Chiller plant

A new foul water drain shall be provided in the new chiller plant room at roof level. The drain shall route through the south riser and connect to foul water drainage into the new sumps at B1 Concourse level (south side).

5.8.9.2 CPO Levels 1 - 3

The contractor shall include for the drainage works to the following areas:

- CPO levels 1 - 3

New foul water drainage works shall connect to the existing vertical stacks at high level in the CPO Level 1ground floor. The CPO levels 1 – 3 drainage shall gravity drain and connect to the utility network.

The system shall be installed in such a manner that it requires the minimum of routine maintenance. The system shall vent to atmosphere wherever possible via existing vent pipes.

Offsets in the wet parts of the system shall be avoided; however any pipework offsets which are required shall be accomplished by the use of long radius fittings swept at 45 degrees in the direction of flow. Anti-siphon pipework shall be provided wherever deemed necessary by regulation and to aid system performance.

Full bore access fittings shall be provided at all junctions and offsets and at every floor level on the vertical stacks.

Rodding eyes shall be provided at the upstream end of all soil and waste floats and branches. (Rodding eyes on soil floats shall be extended above sanitary appliance flood level).

5.8.9.3 CPO Ground Level

The contractor shall include for the above ground drainage works to the following areas:

- CPO Ground Floor Staff areas

- CPO Ground Floor retail areas
- CPO ground floor WC

The above ground foul water drainage works shall comprise all pipework and fittings necessary to convey by gravity all foul and waste discharges from the fittings / connections and all sanitary fittings to the new male and female foul sumps.

The system shall be installed in such a manner that it requires the minimum of routine maintenance. The system shall vent to atmosphere wherever possible and shall pass vertically through the building prior to connection to the sump drainage system.

Offsets in the wet parts of the system shall be avoided; however any pipework offsets which are required shall be accomplished by the use of long radius fittings swept at 45 degrees in the direction of flow. Anti-siphon pipework shall be provided wherever deemed necessary by regulation and to aid system performance.

Full bore access fittings shall be provided at all junctions and offsets and at every floor level on the vertical stacks.

Rodding eyes shall be provided at the upstream end of all soil and waste floats and branches. (Rodding eyes on soil floats shall be extended above sanitary appliance flood level).

Floor waste gully traps shall be charged either by hot water relief vent, wash hand basins or a mechanical trap priming device. In all case the charge pipe shall be a maximum of 10m.

Condensate drainage from mechanical items of plant and equipment shall be routed within the plantroom to discharge over a gully or connect to a fitting trap. Under no circumstances shall condensate drainage be directly connected to the foul water drainage system. A separate connection to the foul drainage shall be provided.

5.8.9.4 Below Ground

The contractor shall include for below ground drainage works to the following areas:

- B1 Concourse Level
- B2 Level

The below ground foul water drainage works shall comprise all pipework and fittings necessary to convey by gravity all foul and waste discharges from the fittings / connections and all sanitary fittings, mess room appliances and plant / communal area gullies in station areas to separate foul pumped systems.

The two (2) packaged pumps sets installed as part of the B2 level temporary works shall be retained.

Pump Designation	Locations	MCC Panel No.	Status
PMP-T-01/02	B2.140 Plantroom	MCC-HYD-01	Retain
PMP-T-09/010	B2 North Platform	MCC-HYD-08	Retain

5.8.9.5 MEP Trenches (South and North)

One new duty only surface water sump pumps shall be provided for the MEP south trench.

New gravity drained pipework shall be provided from the MEP north trenches to the main sump between the running tunnels at B2 level.

Pump Designation	Locations	MCC Panel No.
PMP-P-09	MEP Service Trench – South	MCC-HYD-02

5.8.9.6 Public WC Sumps

Two (2) new duty/standby foul water sump pumps shall be provided at B1 Concourse Level. These shall be located near to the male and female public toilets.

Pump Designation	Locations	MCC Panel No.
PMP-P-01/02	B1.059 Sump (Female)	MCC-HYD-03
PMP-P-03/04	B1.109 Sump (Male)	MCC-HYD-04

The foul water sumps shall include or allow for the following;

- Duty and standby pumps
- Pumps have anti-clogging facility which ensures that the solids do not come into contact with the pump. The pump therefore stays clean and is more efficient and economical.
- The solids are flushed out of the collecting chamber at the beginning of the pumping cycle and the rest of the clean sewage flushes the chamber clean and prevents clogging of the non-return valve.
- The sump chamber shall be gas and odour tight.
- Dedicated vent pipe routed direct to atmosphere.
- Isolating valves
- Non-return valves (check valves as spring loaded to prevent water hammer)
- Pump Control panels (MCC-HYD-03 & MCC-HYD-04)
- Level switches / floats / ultrasonic level indicators
- Guide rails and lifting chains
- High level alarms and interfacing with the BMS/SCADA

The foul (and surface water) drainage collected in sumps shall be pumped into the existing utility network on Tyler and Galway Street.

5.8.9.7 B2 Main Sump

The Main Sump room is located at B2 level between the running tunnels with access from B1 Concourse level. The Main Sump shall deal with a variety of flows from the Albert Street Tunnels and Britomart Station West, including:

- fire water
- ground water
- wash water
- other incidental water.

Pump Designation	Type	Locations	MCC Panel No.
PMP-P-05/06	Incidental water pumps	B2 Main sump	MCC-HYD-05
PMP-P-07/08	Fire Water pumps	B2 Main sump	MCC-HYD-05

At C1 practical completion, no tunnel hydrants will be installed in the running tunnels. The fitout of tunnel services will be carried out at a later date. As such, the smaller sump pumps (PMP-P-05/06) to deal with minor fire events shall be installed as part of the C1 Permanent Works. However, the larger sump pumps (PMP-P-07/08) to deal with major tunnel fire events will not be installed initially.

The contractor shall allow for the following as part of these works:

- Duty and standby pumps PMP-P-05/06
- Space provision only (but not installation) of the Fire Water sump pumps (PMP-P-07/08)
- Integration into Pump Control Panel (MCC-HYD-05)
- Rising main from sump level to B1 Concourse level
- Valves
- Level indicators
- Ventilation pipework

The sumps shall include or allow for the following:

- Pumps to have anti-clogging facility which ensures that the solids do not come into contact with the pump. The pump therefore stays clean and is more efficient and economical.
- The sump chamber shall be gas and odour tight.
- Dedicated vent pipe routed to the sump room located directly above the Main Sump. The sump room shall be mechanically ventilated as detailed in the Mechanical Scope (Section 2.4.3)
- Isolating valves
- Non-return valves (check valves as spring loaded to prevent water hammer)
- Pump Control panel (MCC-HYD-05)
- Level switches / floats / ultrasonic level indicators
- Guide rails and lifting chains
- High level alarms and interfacing with the BMS/SCADA
- Discharge to Stormwater Utility, via water treatment device and water quality monitoring
- Connection for off-site disposal via tanker (sucker-truck)
- A future connection to wastewater utility (to be isolated until it is required and suitable wastewater consents are confirmed).

The MCC panel (MCC-HYD-05) shall control the discharge of both B2 Main sump pump sets.

PMP-P-05 and PMP-P-06 shall have the following functionality:

- Under normal operation or a minor fire event, these shall discharge water from the main sump to a water treatment system in Lower Queen Street for discharge to the stormwater network.
- These pumps may be used to facilitate off-site disposal via tanker (connection to sucker-truck).
- These pumps may be used in future to discharge to wastewater utility (following confirmation of suitable consents).

PMP-P-07 and PMP-P-08 shall be installed by others, post-C1 practical completion. The pumps will be used to discharge water from a Major Fire Event directly to the stormwater network. C1 works must allow space provision and for a future connection to these pumps.

5.8.9.8 B1 Station Maintenance Store

One new duty only pump shall be provided for the station maintenance room.

Pump Designation	Locations	MCC Panel No.
PMP-P-10	B1.041 station maintenance	MCC-HYD-04

5.8.10 Surface Water Drainage

Surface water (non-foul) from the temporary above ground structures, roofs and station mat-wells will be drained by gravity and connected into the local utility sewer network.

Above ground surface water drainage (rainwater pipes/gutters) shall be specified as part of the Architectural package.

5.8.10.1 MEP Trenches (North)

New gravity drained pipework shall be provided from the MEP north trench to the main sump between the running tunnels at B2 level.

5.8.11 CPO Drainage

The CPO upper levels surface water and connections to the existing utility networks shall be maintained throughout the Works.

5.8.12 Station Ground Water

Station ground water includes track water, surface water, seepage from walls, platforms and sub platform areas, escalator and lifts is drained to an existing cavity sump located in the sub-platform level. The cavity sump gravity discharges to a main sump further down towards the centre of the station.

The existing cavity drains on the perimeter walls will need to be modified to suit the running tunnels.

The sub-platform cavity drainage including gully traps in the B2 back of house areas shall be cleaned and rodded. Cleaning and rodding shall be carried out to all cavity drainage in the western end of the station and include the main cavity drain that connects to the platform sump at the middle of the station.

5.8.13 CPO Retail Drainage

Provide capped/blanked off drainage connection and floor gully sized at 100mm for ‘future’ connection to all CPO retail units. Drainage connection(s) to be connected;

- Direct to the utility network

Or

- Sump chambers at B1 Concourse level

Location to be confirmed on site.

5.8.14 Skylight Water Feature

Removed by CRL instruction.

5.8.15 Water Treatment

Water treatment systems associated with the CRL running tunnels are subject to resource consent requirements. The contractor shall allow for the provision for the design, supply and installation of water treatment for the following systems;

- Fire Water

- Ground Water
- Wash Water
- Foul Water
- Storm Water
- General use water

5.8.15.1 Water Treatment for B2 Main Sump

A water treatment device is to be installed at the west end of the station (directly below Queen Street). This shall treat water from the B2 Main Sump before discharging to the Stormwater Utility. Pumps PMP-P-05/06 within the Main B2 Sump will feed water to the treatment device.

Space allowance has also been made within the B2 Main Sump for the fire incident pumps P-07/08. Once installed, these shall discharge directly to the Stormwater Utility, bypassing the water treatment device.

At C1 Practical Completion, no tunnel hydrants will be installed in the running tunnels. The fitout of tunnel services will be carried out at a later date.

The Contractor shall allow for the following as part of these works:

- Water Treatment Device: Stormwater360 Stormfilter.
- Pumps PMP-P-05/06 within the B2 Main Sump
- Space provision only (but not installation) of pumps PMP-P-07/08 within the B2 Main Sump
- Pipework including fittings, flanges, flexible joints, flushing points, supports, mounts and brackets
- Level switches/sensors
- Valves and actuators
- Scheduled ancillary equipment
- Equipment rails
- Manholes and chambers
- Water treatment monitoring equipment
- All fixtures and fittings required to complete the installation of equipment including, but not limited to, all pipework, valves and actuators, instrumentation and equipment
- Testing of all installations and provisions of records as specified.

The treatment device will be installed below street level at the north-west end of Britomart station with manhole access from street level. The treatment device is a Stormwater 360 Stormfilter. It will be preinstalled in a concrete base rise manhole (1500mm riser on base) with access cover and lid. The contractor is to provide additional manhole risers over and above the base riser, to rise the manhole to the required surface level.

The contractor shall make reference to all existing design data.

5.8.15.1 Water Quality Monitoring for B2 Main Sump

The Resource Consent requires that the influent and effluent flows from the B2 main sump are monitored to test and record the water quality to ensure it meets the consent conditions for discharge to the stormwater network.

For influent sampling, sampling equipment shall be installed at the B2 West End Platform level to monitor the influent from the B2 main sump. Influent sampling will be achieved by tapping to the sewer rising main, diverting flows to a small sampling vessel. To ensure a fresh sample is available at any time, the small vessel has a drain with motorised valve installed. This valve will open briefly during each pump start, emptying the vessel. This allows fresh liquid to enter the vessel.

For effluent sampling, a monitoring manhole will be installed downstream of water treatment system. A weir shall be installed within the monitoring manhole to collect samples of the treated effluent. The weir will ensure a small volume of water is always available within the chamber. The water within the weir will flush during each treatment cycle ensuring a fresh sample is available at any time.

Refer to CRL-BTM-MEP-000-PLN-0001 (Britomart Water Treatment Draft Monitoring Plan) for further details.

6 Technical – Mechanical

6.1 CODES AND STANDARDS

The Contractor shall comply with relevant standards / codes associated within the project.

The Contractor must take full responsibility for the safety and appoint his/her own authorised competent persons.

New Zealand	
NZBC	New Zealand Building Code & New Zealand Building Act
HSE Act	Health in Safety and Employment Act
NZ	Electricity Act and Amendments.
NZ	Electricity Safety Regulations (2010).
NZS 3501	Specification for copper tubes for water, gas and sanitation
NZS 4203	General structural design and design loadings for buildings.
NZS 4219	Specification for seismic resistance of engineering systems in buildings
NZS 4303	Ventilation for acceptable indoor air quality
NZS 4442	Welded steel pipes and fittings for water, sewage and medium pressure gas
NZS 4711	Qualification tests for metal-arc welders
NZS 5261	Gas Installation
NZS 5807	Code of practice for industrial identification by Colour, Wording or other coding
NZS 7643	Code of practice for the installation of un-plasticised PVC pipe systems

Australia/NZ	
AS 1324	Air filters for use in general ventilation and air conditioning
AS 1668: Part 1:	The use of mechanical ventilation and air conditioning in buildings – fire and smoke control.
AS 1668: Part 2:	The use of mechanical ventilation and air conditioning in buildings – ventilation design for indoor air contaminant control
AS 4041	Pressure Piping.
AS 4254	Ductwork for air handling systems in buildings
ASME B31.5	Refrigeration Piping and Heat Transfer Components.
AS/NZS 1170	Structural Design Action Set
AS/NZS 1200	Pressure Equipment
AS/NZS 1571	Copper – Seamless tubes for air conditioning and refrigeration
AS/NZS 1677	Refrigeration Systems
AS/NZS 2642	Polybutylene pipe systems
AS/NZS 3000	Electrical Installations (2005)
AS/NZS 3666-1-3	Air handling and water systems of buildings. Microbial Control
AS/NZS 4331	Metallic Flanges
AS/NZS 4680	Hot dip galvanized (zinc) coatings on fabricated ferrous articles

Europe	

BS 10	Specification for flanges and bolting for pipes, valves and fittings.
BS 21	Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions)
BS 143 & 1256	Malleable cast iron and cast copper alloy threaded pipe fittings.
BS 1387	Specification for screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads
BS 1560-3.2	Circular flanges for pipes, valves and fittings (class-designated). Steel, cast iron and copper alloy flanges. Specification for cast iron flanges.
BS EN 1759	Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, class-designated. Copper, steel flanges
BS 2971	Class II arc welding of carbon steel pipework for carrying fluids
BS 3790	Specification for belt drives. Endless wedge belts, endless V-belts, banded wedge belts, banded V-belts and their corresponding pulleys
BS 3974-1	Specification for pipe supports. Pipe hangers, slider and roller type supports
BS 4677	Arc welding of austenitic stainless steel pipework for carrying fluids
BS EN 10253-1	Butt-welding pipe fittings. Wrought carbon steel for general use and without specific inspection requirements.

International	
SMACNA	HVAC duct construction standards (1985)

6.2 AIR CONDITIONING UNITS

6.2.1 General

This section is applicable to the detail design, supply, fixing and testing of:

- One piece and split, direct expansion (DX), packaged air-conditioning plant < 7.5kW
- One piece and split, direct expansion (DX), packaged air-conditioning plant > 7.5kW
- It includes air cooled and water cooled types, conventional comfort plant and close control computer type plant.

6.2.1.1 System Design

Refrigeration systems to AS/NZS 1677.2.

Microbial control to AS/NZS 3666.1.

Ductwork to SMACNA and insulation to AS 4254.

Air filter performance and construction to AS 1324.1.

Non-ducted air-conditioners tested to AS/NZS 3823.1.1, Standard test condition T1.

Ducted air-conditioners tested to AS/NZS 3823.1.2, Standard test condition T1.

Filters, Type 1 to AS 1324.1 with Class and Performance rating as documented but not less than:

- Test Dust No. 1 to AS 1324.2: 20% efficiency.
- Test Dust No. 4 to AS 1324.2: 85% arrestance.

6.2.1.2 Labelling

Required to AS/NZS 3823.2 and NZS 5807.

Show the type of refrigerant at the charging point and on indicator panels.

6.2.1.3 Operating Conditions

Provide equipment that operates within an ambient temperature range from -5°C - 40°C without excessive head pressure, unstable operation or icing.

6.2.1.4 Material And Finishes

To be metallic-coated steel: Base and legs ≥ 1.6mm with ≥ 1.0mm panels or aluminium: Base and legs ≥ 2.0mm with ≥ 1.6mm panels.

For outdoor equipment finishes, powder coat all metallic-coated steel interior and exterior surfaces to AS 3715 or AS 4506 as appropriate.

Indoor equipment finish to manufacturer's standard finish.

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

6.2.1.5 Access

Provide access to the interior of the unit for routine inspection and maintenance and for removal of major components. Provide doors and panels with handles and captive fasteners and, where they are for access to the conditioned air stream, provide soft gaskets ensuring an airtight seal. Provide weatherproof doors and panels on outdoor enclosures. Do not use self-tapping screws on removable panels.

As a minimum, provide access to the following:

- Condensate tray (underside of access panel to be within 300mm of tray).
- Supply fan motor and drive.
- Compressor section.
- Condenser section.
- Filter section.

Access panel fasteners:

- Units < 1000 L/s: Metal thread screws or camlock fasteners.
- Units ≥ 1000 L/s: Camlock fasteners.

Handles: Provide handles to permit easy and safe removal and replacement of panels.

- < 450mm diagonal panel dimension: 1 handle.
- ≥ 450mm diagonal panel dimension: 2 handles.

6.2.1.6 Insulation

Insulate enclosures to prevent external surface condensation under all operating conditions. Fix insulation to panels with waterproof adhesive applied to at least 50% of the panel area.

Material properties:

- Thermal conductivity: ≤ 0.035 W/m.K.
- Thickness: ≥ 25mm.
- Facing: Reinforced aluminium foil.
- Moisture absorption: Non-hygroscopic.

- Fire hazard properties: To NZBC C/AS1

6.2.1.7 Condensate Trays

Provide a tray under each cooling coil extending downstream of coil to collect water carry over and under any other components on which condensation may occur. Grade trays and sumps to the outlet to prevent water retention. Provide radiused corners and arrange to facilitate cleaning.

Fabricate wetted parts from aluminium to AS/NZS 1734 or stainless steel sheet grade 304L.

6.2.1.8 Protection

Metallic coated steel mesh protection to outdoor fans and exposed faces of outdoor coils.

6.2.2 Products

6.2.2.1 Split Systems

Supply only indoor and outdoor units of split systems designed and rated by the manufacturer to operate together.

Provide packaged outdoor condensing units consisting of refrigerant condensers, compressors and associated piping and electrical connections, mounted within the condenser enclosure.

Provide indoor units consisting of coils, piping, supply air fan, accessories and electrical connections, mounted within an insulated enclosure.

Split system heat pumps shall meet the requirements of AS/NZS 3823.1.1 and AS/NZS 3823.1.2 with minimum energy performance standards (MEPS) in accordance with AS/NZS 3823.2.

Comfort cooling units shall achieve minimum energy efficiency ratio (EER) as set out in the following table.

Type	Cooling unit full load EER
Packaged air conditioners	2.6
Split and multi-split air conditioners	2.6
Variable refrigerant flow systems	2.6

The completed installation works shall comply with the requirements of AS/NZS1677.2.

Provide effective outdoor coil defrost facility that prevents room temperature dropping more than 2°C during defrost.

6.2.3 Supply fan

6.2.3.1 Performance

Select fans and fan motors so the air flow can be increased ≥ 5% above the documented design air flow rate, against the corresponding increased system resistance by fan speed change alone and without unstable operation.

Fans with multi-speed motors, select for required duty at second highest speed.

6.2.3.2 Construction

Forward curved impellers to have metallic-coated steel blades and wheel.

Backward inclined impellers, backward inclined, steel or extruded aluminium, aerofoil or single thickness blades, and non-overloading power characteristic.

Casings, to be metallic-coated steel sheet, riveted or spot-welded with joints sealed. Provide 1.2mm minimum thickness scroll and 2mm minimum thickness side plates.

Bases to be formed from pressed metallic-coated steel sheets, bolted to casings. Provide at least 4 brackets for mounting.

Inlet bells, shaped for aerodynamically efficient air entry and small clearance from impeller.

Shafts, steel treated with solvent removable petroleum based protective coating.

Bearings self-aligning sealed for life ball or roller type.

Brush and prime spot welds with zinc-rich organic primer to AS/NZS 3750.9.

6.2.3.3 Drive

Direct or belt drive as documented.

Direct drive to be Multi speed or electronic variable speed.

Belt drive to suit a minimum 125% of motor power and capable of transmitting the full starting torque without slip. Provide adjustable motor pulley. Provide pulleys with shaft keys or taper lock bushes.

6.2.4 Condenser fans

6.2.4.1 Type

Propeller fan, direct drive with single thickness fixed pitch aluminium or UV protected polypropylene blades.

Aerofoil axial flow fan, direct drive with adjustable pitch aerofoil section blades of UV protected GRP or polypropylene, or aluminium.

Centrifugal fan:

- Drive: Direct or belt driven as documented.
- Impeller: Forward curved or backward inclined as documented.
- Construction: Conform to Package air-conditioner supply fan.
- Belt drive: If belt drive is documented conform to Package air-conditioner supply fan.

If multiple fans operate in sequence for capacity control, provide baffles in the condenser to prevent air short circuiting through idle fans.

Provide easily removable powder coat finished metallic coated steel guards over condenser fans.

Power consumption to be $\leq$ 0.015 kW/kW total heat rejected by the condenser.

6.2.4.2 Fan Motors

Power rating of supply fans shall be at least the power required by the fan when the air flow is increased by 10% above the design air flow rate stated in the schedules, against the corresponding increased system resistance as installed.

Single phase motors: $\leq$ 0.37 kW only.

Speed: < 25 rev/s.

Sealed for life ball bearings.

Minimum degree of protection:

- Supply fans: IP54.

- Condenser fans: IP55.

Insulation to AS 1359.101:

- Single phase motors: Minimum Class B.
- Three phase motors: Minimum Class F.

6.2.5 Anti-corrosion protection

Corrosion protection is required for all supply and condenser fans:

- Powder coating system to the inside and outside of the fan scroll and wheel or impeller to AS 3715 or AS 4506 as appropriate.
- Shaft, Stainless steel grade 316.
- Drain, provide 2 - DN 20 drain connections. Pipe to waste conforming to Condensate drains.

6.2.6 Compressors

Welded or accessible hermetic steel enclosure with ≥ 3 mounting feet. Provide the following:

- Mounting: Vibration isolating mountings.
- Service valves: Packed and capped, back-seating refrigerant suction valve.
- Charging connections: Schrader type connections for evacuation and refrigerant charging.

Provide integral positive temperature coefficient type crankcase heaters if required for safe compressor operation.

Provide reverse rotation protection to scroll compressors.

6.2.7 Air Cooled Condensing Units

General: Provide packaged condensing units consisting of air cooled refrigerant condenser, liquid receiver, compressor, hot gas muffler and associated piping, controls, and electrical connections, mounted within an acoustic casing on a fabricated steel base frame.

Selection: Match with evaporator and refrigerant circuit.

Construction: Weather proof and corrosion resistant.

Condenser Fans:	Outdoor -	Low noise aerofoil axial type
	Indoor -	Aerofoil axial or centrifugal to suit external air resistance.

Maximum 24 r/s sec with automatic head pressure control for low ambient temperature operation. Fit outdoor air cooled condenser fans with fan guards

Condenser Coils: Copper tube, with epoxy coated aluminium fins.

Multiple compressor units: Provide separate control and electrical circuits for each refrigerant circuit.

Pressure cut-outs: Provide a manual reset high pressure and an auto reset low pressure cut-out for each compressor.

Provide head pressure controls to enable units to run reliably in cold weather.

Short cycle timer function: To limit compressor starts. Fit pump down cycle.

Controls: Facility for remote on/off control, fault indication. A separate labelled terminal strip shall be provided for BMS interface.

Provide zinc-coated steel sheathing or proprietary ducting over exposed piping.

6.2.8 Variable Refrigerant Flow Systems

Variable Refrigerant Flow (VRF) systems allow multiple fan coil units to be attached to a single condensing unit, using a single refrigerant piping loop. VRF systems shall have the following features:

The VRF system shall incorporate the following features:

- Heat recovery units allow for simultaneous cooling and heating from one system (where specified)
- Up to 40 indoor units can be operated from a single outdoor unit using a variable-speed compressor system with multiple capacity steps (See table below)
- Oil and system management system to allow piping lengths of up to 160m, with a total networked length of up to 900m liquid line.
- Fully compatible with LonWorks® and BACnet® gateways

6.2.9 Computer Room Air Conditioning Units

Provide complete packaged units consisting of air coils, supply air fan, filters, electric heater, control panel and electrical wiring and components, mounted in an enclosure. Comply with the requirements for the respective package air-conditioner components except where modified by other requirements stated in this section.

Provide units designed for high sensible heat ratio applications and for continuous operation

For chilled water units provide coils and all related components.

6.2.9.1 Computer Room Controls

Provide stand alone, microprocessor-based controls with return air temperature and humidity sensors and adjustable set points.

Provide continuously charged battery back-up to the microprocessor.

Provide for operation of heating and cooling simultaneously only when in dehumidification mode.

Provide indication of operating status of equipment in the unit.

Alarms to have a silence switch.

Water cooled units to have condenser water flow switch.

Provide high level interface to building management systems to allow operating parameters and values to be monitored by those systems.

6.2.9.2 Computer Room Water Detection System

Provide water detection sensing elements underneath the floor, and alarm/display panel.

6.2.9.3 Computer Room Filters

Provide integral high efficiency filters with performance to AS 1324.1:

- Filter performance rating G4 (50mm thick pleated).
- Filter type, Type 1.
- Filter class, Class A.

6.2.9.4 Computer Room Base For Suspended Floors

Units installed on suspended floors: Provide fabricated steel stand to support the unit independently of the suspended floor.

6.2.10 Coils

6.2.10.1 Coil Design

Coil face velocity ≤ 2.5 m/s.

Fin pitch ≤ 550 fins/m.

Cooling coil air pressure drop ≤ 150 Pa when wet.

6.2.10.2 Coil Construction

Tubes, copper to AS/NZS 1571 or AS/NZS 1572 designation C12200.

Fins, aluminium alloy plate fins ≥ 0.12mm thick to AS 2848.1, designation 3003 or 8011.

Coil frames:

- Aluminium alloy to AS 2848.1, designation 5005.
- Metallic-coated steel sheet coating class Z275.

Condenser coil, to provide at least 5 K sub-cooling.

6.2.10.3 Coil Access

Arrange coils and casing so that both sides of coils are easily accessible for inspection and cleaning.

6.2.10.4 Anti-corrosion Coil Treatment

- Provide proprietary coil corrosion protection coating as follows:
- Factory applied coating resistant to dilute acids, dilute alkalis, solvents, inorganic salts and salt laden air.
- Apply after coil fabrication.
- When tested to ASTM B117, show no sign of attack after 3000 hours in salt spray.

6.2.11 Refrigeration System

6.2.11.1 Components

Refrigerant: R407C or R410A.

Copper pipe to AS/NZS 1571.

Insulate pipes that operate below ambient temperature with elastomeric foam ≥ 10mm thick.

Provide separate refrigeration circuit for each compressor.

Refrigerant expansion device:

- < 20 kW total capacity: Eliminator or similar, non-capillary expansion device, thermostatic expansion valve or electronic expansion valve.
- ≥ 20 kW total capacity: Thermostatic expansion valve or electronic expansion valve.

Provide each refrigeration circuit with a sight glass-moisture indicator, filter dryer and manual reset high pressure and auto reset low pressure cutouts. Provide a suction accumulator if compressor is liable to damage by liquid slugs.

Provide refrigerant reversing valve and an effective outdoor coil defrost facility that prevents room temperature dropping more than 2 K during defrost.

6.2.12 Controls and Electrical

Provide factory wired control panel for each unit containing the following:

- Plug-in relays.
- Terminal strips numbered to correspond to wiring diagram.
- Starter and overload protection for each motor.
- Provide each compressor and each 3-phase motor with short circuit protection by either;
- Circuit breaker with interrupting capacity selected to suit the anticipated short circuit current or
- Starter contactor with manual reset thermal or magnetic overload.
- Provide automatic lead/lag changeover for units (where required) – Closed control units..
- Provide automatic lead/lag changeover for units with multiple compressors.
- Short cycle timer function to limit compressor starts.
- Separate control and electrical circuit for each compressor.
- Circuit breaker short circuit protection for each crankcase heater (if fitted) and control circuit.
- Phase failure protection on motors ≥ 5.5 kW.
- Terminals for remote indication of run and fault conditions.
- Permanent, weatherproof, wiring diagram fixed on or next to the control panel.

Safety controls, arrange so that operation of one item does not shut down other items that are not directly dependent on its operation.

Provide system isolator for each system.

If documented, provide electronic condenser fan speed control to maintain minimum condenser head pressure at all operating ambient conditions.

If documented, provide solenoid valve and automatic pump-down control.

6.2.13 Built-up Plenums

6.2.13.1 Plenum Casing

Metallic-coated steel panels, folded to 450mm maximum width with 50mm edges and 15mm returns. Weld, or fold and bolt together using galvanized nuts, bolts and washers. Seal joints airtight and water tight with silicone sealant.

Material thickness, 1.6mm minimum. Provide 50 x 50 x 5mm galvanized steel bracing angles.

6.2.13.2 Plenum Access

Provide at least one air tight and gasketed access door or access panel conforming to the Ductwork work section. Access door to be large enough to permit removal of components inside.

6.2.13.3 Plenum Casing Insulation

Semi-rigid or batt form insulation refer to Insulation worksection.

Insulation facing:

- Facing in filter access section of units ≥ 1000 L/s: Apply to all sides ceiling and floor 0.55mm thick perforated metallic-coated steel sheet with perforations of 2.5mm diameter providing 10% open area.

- Facing in other locations: Factory applied perforated aluminium foil laminate conforming to the Internal - Laminate faced clause in the Ductwork insulation work section.

Installation of perforated steel facing:

- Supports, 0.55mm metallic-coated steel Z sections sized to suit insulation thickness.
- Space supports at 600mm maximum centres with the lowest at 150mm above the floor and with section flanges on the facing side turning down. Fix supports to sheet metal housings with rivets with heads on the outside and to masonry housings with expanding masonry anchors. Overlap facing 25mm minimum at all joints and fix to supports with rivets at 150mm maximum centres. Trim edges at openings with Z sections.
- In cold deck chambers prevent cold bridging between housing panels and support sections.
- Perimeter, trim with 40 x 40 x 0.55mm angles riveted to facing at 300mm maximum centres.
- Floor, provide Z section supports sufficient to support the weight of a person without deforming the perforated steel facing. Space at ≤ 200mm centres.

6.2.14 Execution

6.2.14.1 Refrigeration Piping

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.

6.2.14.2 Refrigeration Piping Design

Suction lines to be sized 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.

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.

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

6.2.14.3 Refrigeration Piping Layout

Install pipework in straight lines and uniform grades without sags. Grade horizontal hot gas lines and suction lines at not less than 1 in 200 in the direction of gas flow.

All refrigeration and condensate piping shall be concealed within the building structure unless otherwise stated.

6.2.14.4 Refrigeration Pipe Support

Provide hangers, brackets, saddles, clips, and support system components, incorporating provisions for adjustment of spacing, alignment, grading and load distribution. Support pipework from associated equipment or building structure. Support valves, strainers and major line fittings so that no load is placed on adjacent tubes or transmitted to them during operation and maintenance.

Proprietary supports metallic-coated steel channel section with clamps and hangers sized match external diameter of pipe being supported.

For vertical pipes, provide anchors and guides to maintain long pipes in position, and supports to balance the mass of the pipe and its contents.

Do not provide saddle type supports for pipes ≥ DN 25.

Uninsulated pipes, clamp piping supports directly to pipes.

Insulated pipe support:

- Provide spacers at least as thick as the insulation between piping supports and pipes. Extend either side of the support by at least 20mm.
- Spacer material, rigid insulation material of sufficient strength to support the piping and suitable for the temperature application.
- For cold pipes apply aluminium foil tape over the circumference of the spacer to form a vapour barrier.
- Provide a 0.55mm thick metallic-coated steel band between the aluminium foil tape and the support, for the full width of the spacer.

Nominal pipe size, DN	Maximum spacing (m)	
	Horizontal	Vertical
10	1	2
≥ 15, ≤ 20	1.5	2.5
25	2	3
32	2.5	3
40	2.5	4
50	3	4
65	3	4

6.2.14.5 Refrigeration Pipes

Provide copper tubes as follows:

- ≤ DN 20: To AS 1571/122-O.
- > DN 20: To AS 1571/122-H. Use annealed copper only for pulled bends.
- Pipe wall thickness:
- Pipes ≤ DN 50: To AS 1432 Type B.
- Pipes > DN 50: 1.6mm, minimum.
- Deemed to comply for split systems under 7.5 kW cooling capacity: Split system manufacturer's standard pre-charged piping kit.

6.2.14.6 Refrigeration Piping Bends

Form pulled bends without flattening or wrinkling with an inside radius ≥ 3 pipe diameters using the correct tool size for the pipe diameter.

6.2.14.7 Refrigeration Pipe Fittings

Copper alloy fittings to AS 3688, dezincification resistant, welded, brazed or compression type only.

Preformed refrigerant capillary line tees, bushes, couplings and elbows. Wherever possible make reductions at elbows, tees, line devices or equipment connections with reducing fittings, otherwise provide reducing bushes or reducing couplings.

Compression fittings, flareless twin ferrule, torque free, mechanical grip fittings which can be gauged using a precision ground and hardened metal gap inspection gauge.

6.2.14.8 Refrigeration Piping Brazed Joints

Provide preformed capillary fittings or form capillary unions by expanding one pipe end. Prevent flux and brazing alloy from entering pipes. Use dry nitrogen to purge air from pipes before brazing. During brazing, maintain a flow of dry nitrogen through pipes to prevent oxidation.

Brazing alloy to AS/NZS 1167.1 Table 2 alloy B4 15% min silver content.

Brazing alloy for jointing dissimilar metals to AS/NZS 1167.1 Table 1 alloy A18 or an alloy with an equivalent silver content (minimum 34%) and impurity levels.

6.2.14.9 Refrigeration Piping Sleeves

Provide pipe sleeves where pipes pass through building elements.

6.2.14.10 Refrigeration Piping Valves

Provide valves of the type and in the location recommended by SAA HB 40.1. Make provision for charging and withdrawal of refrigerant. If a gauge is not permanently connected (for example commissioning connections), seal the outlet of the isolating valve with a flared seal cap nut.

Service valves to be backseating type with gasketed cap.

Solenoid line valves to be solenoid coil and valve parts replaceable without disturbing valve body or refrigerant piping.

6.2.14.11 Refrigeration Pipe Insulation

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

Thickness, 19mm for pipes ≤ DN 20, 25mm otherwise.

Use chemically blown closed cell nitrile rubber or polyethylene in tubular form.

Physical properties:

- Maximum thermal conductivity 0.04 W/mK at 0°C.
- Moisture absorption, Non-hygroscopic.
- Water vapour permeability ≤ 0.065 ng/Pa.m.s.
- Fire hazard properties:
- Spread of flame index: 0.
- Smoke developed index: ≤ 3.

Use only an adhesive jointing or jointing system supplied by the insulation manufacturer.

Leak test piping before insulating joints, fittings and valves.

6.2.15 Condensate Drains

Provide drain lines with uniform and continuous fall to connect condensate trays to the nearest building drain point. Provide drains from:

- Each indoor coil.

- Each outdoor coil unless casing freely drains to a roof or other location where condensate and/or rain water will not cause damage or pond.
- Each safety tray – applicable to the air conditioning units serving the switchboard room of the temporary works
- Other moisture and rainwater collecting areas.
- Material:
- Copper: To AS 1432 Type B.
- PVC-u: To AS/NZS 1477, installed to AS/NZS 2032.

Size to be the greater of unit drain connection size and DN 20.

Pipe support spacing to AS/NZS 3500.1 Table 5.2.

Seal drain pipes where they penetrate casing.

Drain traps to equipment with enclosed condensate trays.

Terminate drains to enable visual inspection of condensate flow.

Traps to withstand > 2 times fan static pressure and constructed from either:

- Transparent, kink resistant hose.
- PVC-u trap with removable caps and a visible air break.

Check that the condensate tray falls comply with AS/NZS 3666.1 and in particular that trays and sumps are graded to the outlet to prevent moisture retention. Test drains by pouring a measured quantity of water into upstream end.

All condensate piping shall be concealed within the building structure unless otherwise stated.

Where appropriate falls cannot be achieved within the building structure provide a condensate pump with water leak detection and fault alarm.

6.2.16 Safety Tray

6.2.16.1 Safety Tray Location

Provide a safety tray under packaged unit and indoor unit of split systems if leaks or condensation from these could cause nuisance or damage to the building or its contents.

If reverse cycle outdoor units do not have drain connections, locate safety tray below unit and pipe drain to waste.

6.2.16.2 Safety Tray Construction

Galvanized steel sheet, 1.2mm thick folded and stiffened, edges turned over and with all joints sealed. Sides ≥ 50mm high.

Extend tray 150mm beyond unit casing and any components that may leak or drip condensation.

Provide fall in tray and provide drain at lowest point. Run drain to visible waste.

6.2.17 Unit Installation

Supply all necessary components, including but not limited to:

- Means of attachment to the structure.
- Anti-vibration mounting.

- Appropriate flexible connections.
- Trim and sealing around openings.
- Electrical connections.
- Drainage connections.
- Field connection of refrigerant lines in split systems.

Install units level, plumb and to manufacturer's recommendations.

Bolt units in place with minimum 4 anchors or suspension rods.

6.2.17.1 Outdoor Equipment

Provide clearance around outdoor units for condenser air flow and maintenance access, to manufacturer's requirements. Ensure discharge air does not short-circuit to condenser intake.

For equipment at ground level, ensure they are mounted on 100mm level concrete plinth or equivalent impervious material.

For vibration isolation of suspended units, provide (4 metal spring or rubber-in - shear isolation mountings with (25mm static deflection and 98% isolation efficiency. For floor mounted units, provide neoprene waffle pads. Bolt in place.

If leaks or condensation from equipment could cause nuisance or damage to the building or its contents provide a galvanized steel safety tray under the equipment.

Provide clearance around units for condenser air flow and maintenance access. Make sure discharge air does not short-circuit to condenser intake.

If located on grassed or similar permeable surfaces provide concrete plinths under outdoor equipment.

6.2.17.2 Unit Duct Connections

Provide internal or external flexible supply duct connection. Comply with the Flexible connections clause in the ductwork section.

For return, outside air and condenser duct connections, provide external flexible duct connection.

6.2.17.3 Unit Vibration Isolation

Provide to each assembly at least four mountings, located to give uniform deflection under the applied load.

Isolation efficiency: ≥ 90%.

Suspended units:

- Suspended from lightweight structures: Metal spring or rubber-in-shear isolation mountings with ≥ 25mm static deflection. Provide each mounting with a levelling screw and locknut.
- Suspended from heavyweight structure: Double deflection neoprene or rubber in shear mountings, with static deflection ≥ 15mm.

Floor mounted units: Neoprene waffle pads.

6.3 AIR FILTERS

6.3.1 Quality

6.3.1.1 Standards

Performance and construction: To AS 1324.1.

Microbial control: To AS/NZS 3666.1 as required by the BCA and the recommendations of SAA/SNZ HB 32.

Testing: To AS 1324:2, Methods of test or ASHRAE 52.2-1999.

Fire and smoke control: To AS/NZS 1668:1, Fire and smoke control in multi-compartment buildings.

Function: To AS 1668:2, Mechanical ventilation for acceptable indoor air quality.

Flame spread index: Zero to AS/NZS 1530:3 Simultaneous determination of ignitability, flame propagation, heat release and smoke release.

6.3.1.2 Type Tests

Particulate filters: For each type of filter, submit evidence of filter type tests conducted by a Registered testing authority within the past 5 years.

- Standards:
- Other particulate filters: To AS 1324.2.

The term Registered testing authority is defined in General requirements. It includes both Australian organisations registered by NATA and an organisation outside Australia recognised by NATA through a mutual recognition agreement.

AS 1324.1 clause 5.4.4 requires testing by accredited testing laboratories at clause 5.4.4.

Filter size for test: 610 x 610 mm face dimension.

6.3.2 Construction

Medium: Provide filter medium free of oil or adhesive impregnation. Glass fibre shall only be used in wet laid paper construction. Filter media assembly shall comprise heat welded and adhesive scaled seams. Sewn seams and stitching construction will be rejected. Filter media shall be fully supported rigid to airflow and turbulence movement effects. Filter pockets or media arrangements that sag or flex will be rejected.

Filter cells: 610 x 610 maximum dimension. Provide standard sizes throughout project based on the 610 x 610 full size manual module i.e. 610 x 305 and 305 x 305 for half and quarter modules.

Filter media dependant on frame systems comprising wire support frames or baskets will be rejected and shall not be offered. Side access filter module mounting shall comprise filter holding frames inserting to an airtight track mechanism. U channel slides for filters will be rejected.

Filter module holding frames: Provide universal type stainless steel or aluminium frames for filters, with plug on neoprene compressible airtight seal to prevent air bypassing the filters. Provide NATA test report for filter module holding frame by-pass leakage. Leakage shall not exceed 0.5% of nominal airflow at 375Pa. Self adhesive polyurethane foam seals will be rejected.

Filter removal: provide filter module retaining clips of the helical wound spring type. Filters shall be replaceable without tools. Folded wire type clips (e.g. P clips) will be rejected.

Steel frames will be rejected.

Frames must stop air by-passing the filter media.

For filters of the same type provide filters from only one manufacturer.

Filter media must:

- Not support microbial growth and be resistant to fungal and vermin attack.
- That does not shed fibres in service.

6.3.3 Disposable Panel Filters

6.3.3.1 Disposable Flat Panel Filters, 25mm Deep

Classification: Type 1, Class B/A replaceable media (washable not accepted) with cardboard frame panel.

Select for effective face velocity: 1.8 m/s maximum.

Performance rating G2 to AS 1324:1, Application performance and construction.

Average arrestance to AS 1324.2 Methods of test for test dust no.4 at 2.5m/s effective face velocity: 70%

Dust holding capacity of 610 x 610 cell at 125 Pa final resistance: 140 g/m2of no.4 dust.

6.3.3.2 Vee Form Pleated Filters 50 mm Deep

Classification: Type 1, Class A Disposable non-woven media on wire support or wet laid glass paper to cardboard frame.

Select for effective face velocity 1.8 m/s maximum.

Disposable Panel Filters Performance Requirements

Rating		G4 / F4	F5	F7
Average arrestance	(%)	>90	>95	>98
Minimum efficiency	(%)	>20	>30	>60
Average efficiency	(%)	>35	>50	>80
Dust holding	(g)	400	300	350
Test velocity	(m/s)	1.8	1.8	1.8
Final pressure	(pa)	150	150	150

6.3.4 Extended Surface Disposable Filters

Type 2, Class A extended surface wet laid glass paper rigid media to plastic box housing or synthetic media pockets to header frame (700mm deep).

Select for effective face velocity 1.8 m/s maximum of filter module.

Extended Surface Disposable Filters Performance Requirements

Rating		G4 / F4	F5	F7
Average arrestance	(%)	>98	>99	>99
Minimum efficiency	(%)	50	70	85
Average efficiency	(%)	>80	>90	>95
Dust holding	(g)	500	400	300
Test velocity	(m/s)	3.2	3.2	3.2
Final pressure	(pa)	250	250	250

6.3.5 Installation

6.3.5.1 Attachment

Rigidly attach filter frames to the air handling plant casing.

Ensure that there are no leaks between the filter holding frame and the casing or through the casing insulation lining. Seal individual filter frame units to each other. Seal filter connections to adjoining equipment, panelling or supporting framing. Do not use adhesive tapes for sealing.

6.3.5.2 Cell Frames

Install filters so that they are accessible for maintenance and do not accumulate moisture. Provide moisture eliminators at outdoor air intakes where required.

6.3.5.3 Blanking Plates

Close gaps where the dimensions of the filter plenum do not match those of the framing based on use of 610 x 610 and 610 x 305 filter frames installed to the maximum space available and to the target face velocity maximum of 1.8m/s.

Plates material: 0.8mm (minimum) aluminium, or grade 304 stainless steel sheet.

6.3.5.4 Bracing

Provide structural stiffeners to filter holding frames to support the weight of the filters and limit the deflection of filter bank under air pressure operating conditions twice the maximum final pressure nominated.

6.3.5.5 Filter Access

Filter platforms: Provide access platforms for filters extending >2.4m above floor. Platform standard: To AS 1657 Fixed platforms walkways, stairways and ladders. Ensure that platforms and ladders do not obstruct filter access or airflow to filters.

Access: Facilitate replacement and maintenance in accordance with AS 3666, Air handling and water systems for buildings - microbial control. Provide ductwork and conditioner access doors.

6.3.6 Filter Differential Pressure Gauges

Function: Indicate differential pressure across each filter bank.

Differential pressure gauge unit: Include pipework, termination and fittings necessary for correct operation and maintenance.

Indicator scale: 0 to 250 Pa in 5 Pa divisions.

Type: Dwyer Magnehelic series 2000 or similar

Location: Outside unit casing in a readily readable location. Extend pressure tubes to upstream and downstream plenums.

Commissioning: Mark gauge to indicate air resistance of clean and dirty filters. Mark dirty pressure drop with the words “replace media”.

6.4 AIR GRILLES

6.4.1 General

This section is applicable to the detail design, supply, fixing and testing of:

- fixed and adjustable diffusers used in air conditioning systems
- weatherproof or exterior louvers used in air conditioning systems

6.4.2 Samples

Submit a sample of each type of air grille and diffuser. Include plenum box and blanking plates.

Submit type test data as follows: Air diffusion equipment, acoustic performance to ISO 5135, ANSI/ASHRAE 70 or ARI 890.

6.4.3 Manufacture

Provide proprietary grilles:

- Free from distortion, bends, surface defects, irregular joints, exposed fastenings and operation vibration.
- Mounted with secure and concealed fixings.
- With flange corners neatly mitred, butted and buffed, with no joint gaps.

Material to be steel or aluminium.

Exposed surfaces to be powder coated to nominated colour.

Finish visible internal elements to be matt black enamel.

Provide concealed fixings which allow removal without damage to surrounds or grilles.

6.4.4 Diffuser Performance

6.4.4.1 Air Distribution During Cooling

Select air diffusers for air conditioned spaces for Air Diffusion Performance Index (ADPI) □80.

Determination: Method of Testing for Room Air Diffusion, ANSI/ASHRAE 113, Method of testing for room air diffusion.

Conditions:

- Constant volume systems - full cooling
- Variable volume systems - maximum air flow at minimum supply air temperature and also minimum air flow at coincident supply air temperature.

Allow for room design air temperature and design supply air temperature.

Select ceiling mounted diffusers for variable volume cooling duty with horizontal air pattern to avoid dumping of cold air at 30% of design maximum air flow.

6.4.4.2 Air Distribution During Heating

Select perimeter registers for heating to ensure that the throw from overhead diffusers reaches to floor during heating cycle, to minimise stratification and ensure that supply air does not short circuit to high level returns.

6.4.4.3 Noise Levels

Select registers, diffusers and grilles to meet the noise levels required for the space with allowances for the characteristics of the space and contributions from other registers and other mechanical and electrical noise sources.

Noise and vibration levels are required to perform to the specified space sound level requirements and shall include diffuser balancing device and as installed condition allowances. Excessive air turbulence generating sound exceeding the space sound level requirements shall be rectified.

For continuous slot diffusers noise levels shall apply to 3.6m length of diffuser.

Refer to Noise and Vibration Section and Acoustic consultant's report.

6.4.5 Volume control dampers

6.4.5.1 Dampers Controlling A Single Diffuser And Grille Attached To Rigid Or Flexible Duct

Provide a damper as follows:

- If the duct spigot is located above a tiled or otherwise accessible ceiling: Provide a butterfly damper in the rigid duct spigot.
- If the duct spigot is not located above a tiled or otherwise accessible ceiling: Provide an opposed blade damper behind the face of the diffuser or grille.

6.4.5.2 Butterfly Dampers

Single-Blade Round Dampers with external locking quadrant indicating butterfly damper position. Locate at Dampers controlling a single diffuser and grille attached to rigid or flexible circular duct.

6.4.5.3 Stream Splitter Dampers

Duct mounted ganged, multi-blade, stream splitter type.
Location:

- At rigid duct take-offs to outlets within rectangular ducts.
- Location: To Dampers controlling a single diffuser and grille attached to flexible duct.
- Behind duct mounted registers.

6.4.5.4 Opposed Blade Dampers

Multi-blade type with blades linked for ganged operation. If located at the air grille diffuser or register provide adjustment accessible through the grille face. If visible through grille paint the damper matt black.
Location:

- At the end of duct spigot take-offs.
- Location: To Dampers controlling a single diffuser and grille attached to flexible duct.
- Behind supply diffusers and registers attached to flexible duct if the spigot at the rigid duct is not accessible through the ceiling.
- Behind return and exhaust air grilles connected to ducts.

6.4.6 Air grille types

6.4.6.1 Louvre Ceiling Diffusers

Provide either:

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

- Multi-bladed, removable core 1-, 2-, 3- or 4-way blow configuration.

If the outlet neck is smaller than the outlet necessary to suit the louver face size, provide a reducer neck.

Provide a frame style to suit the type of ceiling, and ceiling grid mounting requirements.

If the diffuser is connected to a flexible duct, provide a cushion head box. Seal the cushion head box to the diffuser.

6.4.6.2 Side Wall Registers

Double deflection type with horizontal front louver blades and vertical rear blades at 19mm nominal centres, capable of field adjustment of air throw over the range ± 45°.

Extruded aluminium with mitred corners and aerofoil section blades which rotate in non metallic bearings in the support frame. Hold blades firmly so they do not rattle or flutter.

Provide a removable core (support frame and blades).

Blades > 600mm long, support at mid-point on a notched support bar.

Provide a stream splitter or opposed blade type damper behind each register, to provide even air flow across the register face.

6.4.6.3 Weatherproof Louvre Grilles

All main weatherproof louvres shall be supplied and installed by the main contractor. Refer to the architectural documentation for details.

Some of the internal louvres (in wall between the FOH and BOH areas) are to be supplied by the Mechanical contractor and installed by the main contractor. Refer to the equipment schedules for details.

6.4.6.4 Return Or Exhaust Grilles - Indoor

Extruded aluminium with fixed horizontal blades set into a fixed support frame with mitred corners. Fit blades tightly into the frame to prevent rattling or movement. Brace and stiffen to produce a rigid assembly.
Pressure drop (10Pa at the documented air flow).

Blades:

- Half chevron type: Blades at nominal 45° angle on a nominal 25mm pitch.
- Inverted V chevron type: Blades at nominal 25mm pitch. Provide a telescopic frame with clip-on pattern surround frames on both sides.
- Light proof grilles: Inverted V chevron type but with double inverted V chevron blades and blade pitch selected to stop light penetration.

Air volume control, if the grille is connected to a duct, provide an opposed blade damper behind the grille core, key operated without removing the grille core.

6.4.6.5 Mesh Grilles

Light duty type: Fabricate from 1.5mm thick galvanized steel or bronze wire at 12mm centres fixed into a folded metallic-coated steel or aluminium frame.

Heavy duty type: Fabricate from 3mm thick galvanized steel or bronze wire at 20mm centres, welded into a 3mm thick galvanized steel frame.

If bronze mesh is provided on external grilles, provide a bronze frame.

6.4.6.6 Egg Crate Return Or Exhaust Grilles

Nominal 12 x 12mm square, 12mm deep egg crate type aluminium core fixed in an extruded aluminium frame with mitred corners. Fit core tightly into the frame to prevent rattling or movement.

Free Area: ≥ 90% of nominal face area.

Air volume control, if the grille is connected to a duct, provide an opposed blade damper behind the grille core, key operated without removing the grille core.

6.4.6.7 Semi Light Proof Egg Crate Return Or Exhaust Grilles

As for Egg crate return or exhaust grilles but with a 9.5 x 12.5 x 12.5mm core set at 35°.

6.4.7 Installation

6.4.7.1 Protection

Leave protective wrappings in place until final mounting.

6.4.7.2 Mounting

Provide a matching escutcheon to close gaps between the grille and its surrounds. Provide grilles with flanges to cover penetrations and irregularities in surrounds.

For tiled ceilings locate grilles and diffusers to minimise cut tiles. Otherwise, locate grille symmetrically in the tile.

Install square to the tile grid.

6.4.7.3 Fixing

Provide concealed fixings and allow removal without damage to surrounds or outlets.

Provide foam type gaskets under outlet flanges or flanged supports.

6.4.7.4 Plenum And Cushion Head Boxes

Provide side entry plenum or cushion head boxes to diffusers and grilles connected to flexible or semi rigid ductwork.

Design to achieve even air flow across the face of the diffuser or grille.

To consist of prime quality lockforming galvanized steel, to AS 1397 Grade G2 or G3 with Z275 coating.

Conform to the Insulation of ductwork accessories clause in the 7632 DUCTWORK INSULATION section.

Paint interior of plenum box matt black if visible through grilles.

Flexible duct connections to be round or oval spigots on plenum boxes.

For louver ceiling and slot diffusers support the plenum either:

- From above and independently of the ceiling.
- From the ceiling main Tees provided the load is less than the ceiling system manufacturer's maximum.

6.5 AIR HANDLING AND FAN COIL UNITS

6.5.1 General

This section is applicable to the detail design, supply, fixing and testing of:

- Air handling plant: Proprietary and non-proprietary pre-assembled plant and prefabricated and site erected plant and plenums. Includes room fan coil units and air handling units.
- Room fan coil unit (FCU): A unit having a supply air flow < 400 L/s and consisting of casing housing coils and a direct drive fan designed for mounting exposed within a room. The casing may also house filters and other items. Includes manufacturer's variations within a range of this type of unit mounted concealed with or without connected ducts.
- Air handling unit (AHU): A unit having a supply air flow not less than 400 L/s and consisting of a casing housing a fan and coils. The casing may also house filters, dampers and other items. Includes larger sizes of units sometimes referred to as fan coil units.
- Packaged air handling unit: A proprietary AHU manufactured off site, factory assembled and type-tested.
- Built-up air handling plant: A custom made AHU, erected on-site on a building floor using standard panels and proprietary components.

6.5.1.1 Standards

To AS 4254.

Microbial control To AS/NZS 3666.1, AS/NZS 3666.2 and the recommendations of SAA/SNZ HB 32.

6.5.1.2 Submissions

Submit certified reports, calculations and other details to demonstrate that the documented performance will be achieved with the equipment offered.

AHUs: To ANSI/ARI 430, Central station air handling units.

FCUs: Testing to ANSI/ASHRAE 79 Methods of testing for rating room fan-coil air conditioners.

6.5.1.3 Performance

The maximum specific fan power in air distribution systems shall meet the requirements set out in the following table.

System type	SFP (W/(l/s))
Central balanced mechanical ventilation system with heating and cooling	1.6
Central balanced mechanical ventilation system with heating only	1.5
All other central balanced mechanical ventilation systems	1.1
Zonal supply system where fan is remote from zone, such as ceiling void or roof mounted units	1.1
Zonal extract system where fan is remote from zone	0.5
Zonal supply and extract ventilation units, such as ceiling void or roof mounted units serving single room or zone with heating and heat recovery	1.9
Local balanced supply and extract ventilation system such as wall/roof units serving single area with heat recovery	1.6
Local supply or extract ventilation units such as window/wall/roof units serving single area (e.g. toilet extract)	0.3
Other local ventilation supply and extract units	0.5
Fan assisted terminal VAV unit	1.1

Fan coil unit	0.5

Extending specific fan power for additional components is permitted as per the following table.

Component	SFP (W/(l/s))
Additional return filter for heat recovery	+0.1
HEPA filter	+1.0
Heat recovery – thermal wheel system	+0.3
Heat recovery – other systems	+0.3
Humidifier/dehumidifier (air conditioning system)	+0.1

Heat Recovery Efficiencies

Component	Efficiency %
Thermal Wheel	65

6.5.2 Quality

6.5.2.1 Construction

Finish to be not less than the standard achieved with the paint system for metallic-coated steel.

6.5.2.2 Condensation Control

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

- Insulate drain trays.
- Eliminate cold bridging.

6.5.2.3 Condensate Drains

Copper to AS 1432 Type B.

PVC-U to AS/NZS 1477, installed to AS/NZS 2032.

Support spacing and slope: To AS/NZS 3500.2.

Where there is a risk of condensation forming on condensate drains, piping to be insulated with 12mm thick elastomeric type insulation.

Condensation drains shall be piped (to drain) from the additional drain trays located underneath the equipment room fan coil units.

6.5.2.4 Coil Access

Arrange coils so that both faces of each coil are easily accessible for inspection and cleaning. Provide suitably located access panels and doors.

6.5.2.5 Air leakage

Make sure that, under maximum system operating pressure, there are no air leaks that can be felt or detected using a smoke pencil.

Close the space between the coil frames, fans and filters and the surrounding structure or equipment, with baffle plates.

Fabricate baffle plates from:

- Metallic-coated steel sheet: Coating class Z275.
- Aluminium: AS/NZS 1734 Grade A – 3003-H14.
- Stainless steel: Grade 304L.
- Sandwich panel material complying with Casings and plenums - Sandwich panel.

Seal gaps between coils and surrounding structure or equipment.

6.5.2.6 Sealants

To AS 4254 clause 2.2. Do not use sealants that foster microbial growth.

6.5.3 Fan Coil Units

Provide packaged fan coil units with components as scheduled including fans, cooling coils and drain pans, heating coils or electric heaters, panel filters, air mixing plenums with outside air and return air dampers all mounted with a thermally and acoustically insulated casing. Components to comply with related sections of this specification.

6.5.3.1 FCU Casings

Provide the unit with an enclosure consisting of panels, grilles, louvers and the like, fabricated from machine-folded sheet metal, reinforced where necessary with stiffening channels or angles, capable of supporting and retaining the components of the assembly without excessive noise and vibration. Provide adequate drainage.

Provide removable prefinished 1.2mm metallic-coated steel cabinet with extruded aluminium supply grille for units exposed to view.

Provide 1.2mm galvanized steel casing for units located above ceilings or otherwise concealed.

Provide access panels with quick release, captive fasteners. Do not use self-tapping screws.

Close the space between the coil frames, fans and filters and the surrounding structure or equipment, with baffle plates. Seal gaps between coils and surrounding structure or equipment.

Support coils using the internal support frame of the unit.

Provide neoprene gaskets to separate the mating surfaces of dissimilar metals. Provide non-metallic top hat washers in enlarged holes under nuts and bolts connecting dissimilar metals.

6.5.3.2 FCU Condensate Trays

Provide condensate tray or trays to collect all condensation occurring inside the unit.

Material, aluminium to AS/NZS 1734 or stainless steel sheet grade 304L. No plastics tray component shall be used.

All fan coil units serving the lift motor rooms, UPS rooms, LV rooms (ie equipment rooms) shall include an additional drain tray underneath the complete unit and valve assembly. The drain tray shall fall to one corner and be piped to connect to the main condensate drainage pipe from the respective fan coil unit. Point type leak detection shall be included in the tray to alarm to the BMS / SCADA when water is detected.

6.5.3.3 FCU Supply Fans

Select for quiet operation with long life bearings and resilient mounts.

Direct driven plug fan with EC motor for variable speed control as specified under automatic control. Mount on detachable mounting plate with extended cables to facilitate maintenance.

6.5.3.4 FCU Insulation

Insulate and vapour seal to prevent condensation on the outside of unit. R-value ≥ 0.4 m².K/W.

To have factory applied perforated aluminium foil laminate.

6.5.4 Air Handling Units

Provide factory assembled or built-up air handling units as scheduled. Provide components as scheduled including supply fans, cooling and heating coils, electric heaters, air filters, air mixing plenums with outside air and return air dampers all mounted within thermally and acoustically insulated casings.

6.5.4.1 Layout

All plant to be accessible for inspection, adjustment, maintenance and removal from one side of each air handling unit. Hand the units to suit their locations.

Provide 300mm separation between heating and cooling coils in series. All coils to be removable.

For blow through units fit perforated plates downstream of fans to equalise air flow across coils.

Provide insulated drain pans graded to outlet and extending beyond cooling coils and chilled water connections.

A structural steel channel base shall support the complete unit.

Units over 1.0m high shall be “walk in” and have trafficable insulated solid sheet metal floors.

6.5.4.2 Casings and Plenums

Standard

Construct casings and plenums to SMACNA HVAC Duct Construction Standards Metal and Flexible, Chapter 6.

Pressure Classification

Select pressure class greater than the maximum operating pressure in each section of air handling unit (AHU) or plenum.

Pressure classes for casings and plenums on discharge side of supply fans shall exceed close off (stall) pressure of associated supply fan.

Pressure Classes:

- Discharge side of constant volume supply fans: Pressure class 750 Pa minimum seal Class A.
- Discharge side of variable volume supply fans: Pressure class 1000Pa minimum, seal Class A.
- Exhaust plenums and suction side of supply fans: Pressure class 500 Pa, seal Class B.

Construction

Provide single skin casings or plenums of folded zincanneal sheets, braced by galvanised steel sections. Provide 50mm minimum thermal and acoustic internal insulation with perforated foil laminate facing as for internally insulated ductwork. Refer to Insulation, Thermal and Acoustic section.

ALTERNATIVELY

Provide double skin casings or plenums comprising folded zincanneal steel braced by galvanised steel sections, incorporating a solid outer casing, 50mm minimum thermal and acoustic insulation, and perforated sheetmetal inner casing. Refer to Insulation Thermal and Acoustic Section. Provide thermal barriers between framing and fasteners and exterior panels to prevent thermal bridging and condensation.

ALTERNATIVELY

Fabricate casings or plenums from sandwich panels consisting of 50mm thick cellular polystyrene sheet to AS 1366.3 Rigid cellular polystyrene - moulded Class M between two 0.6mm thick factory prepainted zincanneal sheets with an insulated supporting framework of galvanised steel or extruded aluminium members.

Penetrations Through Cellular Polystyrene Panels

Pipes, conduits: Provide flanged sleeves. Fill the void between the sleeve and the panel using a one-part polyurethane sealant.

Ducts: Frame penetrations using aluminium channels.

Access Doors and Panels

Provide access to all internal equipment including fans, motors, filters, coils, heaters and valves.

Fans

Units less than 7500L/s capacity to have direct drive plug fans. Bearings to be removable from the sides of units without removing the fan shaft.

Units greater than 7500L/s capacity to have belt driven backward inclined DIDW centrifugal fans with aerofoil blades and motors mounted on common base within the units with anti-vibration spring mounts and flexible discharge connections between fans and casings. Belt drives to be synchronous type. V-belt drives will not be accepted.

Coil Installation

Coil Support: n/a – for the air handling unit.

Air handling units shall be provided with sufficient space in the units to incorporate a chilled water coil at a later date.

Condensate Drainage

Standard: To AS 3666, Air handling and water systems of buildings - microbial control.

Condensate trays: Provide graded trays beneath heat wheels, cooling coils (future), extending beyond headers and valves and 300mm downstream to collect water carryover.

Provide a separate tray beneath each coil of multiple coil banks.

Material: Tray stainless steel, 1.6mm copper, or epoxy coated galvanised steel. Piping: copper

Insulation: Insulate underside of trays and internal drain piping with 25mm of rigid, non-hygroscopic cellular foam insulation to prevent condensation. Insulation to have a spread of flame index zero and smoke developed index three when tested to AS 1530.3, Simultaneous determination of ignitability, flame propagation, heat release and smoke release. Maximum water vapour transmittance to be 580mg/m2s to AS 2498.5 Methods of testing rigid cellular plastics - determination of water vapour transmission rate.

Drain Piping: In multiple coils units, inter-connect drain pans. Terminate down pipes a minimum of 25mm below the rim of the lower pan. Down pipes shall be a minimum DN 38.

Extend drain piping outside the air handling unit and seal the pipe penetration in the casing.

Drain pipe sizes:

- Single coils DN 25 minimum
- Multiple coils DN 38 minimum.

Filter and Damper Section

Provide accessible filter plenum of adequate size with filter holding frames and blanking panels. Fit opposed blade outside and return air dampers to mixing plenums, controlled manually or automatically as required.

6.5.4.3 Motorised dampers

Side seals: Aluminium or stainless steel.

Blade type: Aerofoil.

Blade tip seals: Neoprene or silicone rubber.

Leakage: ≤ 25 L/s.m2 at 1.5 kPa pressure differential.

Bearings: Provide sealed-for-life ball bearings only.

Mounting: Motorised dampers shall be located in the connecting ductwork. Dampers shall be sufficiently rigid to prevent flexing or distortion of the frame or ductwork during operation. Install damper motors and operating mechanisms where they are easily accessible for inspection, maintenance and adjustment.

Operation: If two sets of dampers are connected to a single motor, provide linkages that allow each damper to be adjusted without affecting the other.

Hot and cold deck dampers on common shaft: Adjust so that they close to achieve leakage rate above at both ends of stroke.

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.

Fire Dampers: Motorised dampers are to be modulating type with spring return for shut down on a GFA.

6.5.4.4 Casings and plenums – sheet metal

Construction: Metallic-coated steel panels, folded to 450 mm maximum width with 50 mm edges and 15 mm returns.

Joints: Weld, or fold and bolt together using galvanized nuts, bolts and washers. Seal joints airtight and water tight with silicone sealant.

Material thickness: 1.6 mm minimum. Provide 50 x 50 x 5 mm galvanized steel bracing angles.

Insulation: Comply with the CASING INSULATION clause.

6.5.4.5 Casings and plenums – interlocking decking panels

General: Construct from interlocking long span roof or wall panels with a closed rib profile for sealing.

Material: Metallic-coated steel ≥ 0.4 mm base metal thickness.

Frames: Select from the following:

- Folded 1.6 mm metallic-coated steel corner angles, top and bottom channels and trims.

- Welded from hot rolled angle and rectangular hollow sections.

Sealing: Seal all joints including joints between panels with mastic.

Deemed-to-satisfy finish: Panel manufacturer’s standard factory applied gloss enamel.

Doors and access panels:

- Construction: Comply with the Ductwork worksection. Select from the following:
- Construction as documented for casing.
- Proprietary pre-insulated doors and access panels.

6.5.4.6 Casings and plenums – sandwich panel

Construction

Prefabricated twin stressed-skin sandwich panels consisting of a sheet of insulation bonded to metal skin on both sides. Bond at high temperature and pressure using thermosetting adhesive. Stress both skins equally in the finished panels to result in stable performance under varying temperature and humidity conditions.

Metal skin: ≥ 0.55 mm base metal thickness factory prepainted metallic-coated steel sheet.

Fire hazard properties: Conform to Ductwork insulation and AS 4254.2 clause 2.7.1 (a).

Insulation: Single layer rigid cellular polyurethane to AS 1366.1 Use insulation in continuous form without voids and free of line faults through or across the sheet.

Blowing **agents**

General: Do not provide materials that use the following:

- CFC or HCFC as blowing agents in the manufacturing process.
- A blowing agent with a global warming potential ≥ 140.

6.5.4.7 Joints

General: Provide aluminium extrusions internally and externally at panel junctions and between panels and building structures. Apply a continuous bead of mastic along extrusions to form an airtight seal.

6.5.4.8 Coils

General: Install coils in aluminium slide rails to permit removal. Support cooling coils independently of condensate tray.

6.5.4.9 Penetrations

Pipes, conduits: Provide flanged plastic sleeves. Fill the void between the sleeve and the panel with a one-part polyurethane sealant. Provide a plastic flange to the sleeve on the outside of the panel, and vapour seal to the panel.

Ducts: Frame penetrations with aluminium channels.

6.5.4.10 Factory assembled units

Frame: Extruded aluminium sections. Side panels attached to frames by quarter turn clips to permit removal. Construct the insulated framework to stand alone with all panels removed.

Base: Rigid heavy gauge galvanized steel designed to support the unit without deflection during lifting and transportation.

6.5.4.11 Site erected units

Panel thickness:

- Wall: ≥ 75 mm.
- Ceiling: ≥ 75 mm.
- Door: ≥ 50 mm.

Structural adequacy: Certify that the units are structurally adequate to safely withstand the applied loads and pressure differentials without leakage or excessive deformation.

The design of the ceiling and walls may require structural engineering advice depending on application, span, loads and pressure differentials. These panels are not normally designed to be trafficable.

Panel jointing: Cut and join the panels accurately without voids. Profile the panel edges to receive the required splines and joiner moulds.

Longitudinal joints: For longitudinal joints between wall and ceiling panels select from the following:

- Site formed butt joint: Use a continuous length of a double web aluminium extrusion to join both the inner and outer panel skins to the insulation. Provide a centre location spline for ease of location.
- Factory fabricated joint: Form onto each side of the inner and outer sheet skin, to create a close fitting slide joint with ≥ 15 mm overlap. Vapour seal the external skin with mastic held in close contact with the skin to form a continuous vapour barrier.

Corner joints: Make wall to ceiling and wall to wall corner joints with checked joints. Make the check depth half the wall thickness. Join the outer skins of both the wall panel and ceiling panel at the intersection of the corner and vapour seal with mastic. Cover the internal and external corners with continuous lengths of aluminium angle riveted to the skins.

Sealing: Seal all joints and penetrations air, water and vapour tight. Before making each joint apply mastic continuously to the entire length of the external skin. Apply clear sealer to the outside of the joint to create a smooth finish. Form a continuous air and vapour seal on the outside of the conditioner by sealing the wall and ceiling butt and corner joints and penetrations. Seal the wall panels to the floor slab. Use mastic to seal concealed joints and clear sealant for exposed joints.

6.5.5 Installation

6.5.5.1 Storage

Protect equipment on site from damage and the entry of water or foreign matter.

6.5.5.2 Access And Removal

Keep adjacent equipment and ductwork clear of air handling units. Provide flanges or spigots for connection to adjacent equipment and ductwork.

Install piping to coils to allow access to equipment, and to minimise disturbance to piping when coils are removed. Arrange piping and isolating valves to minimise drain-down if coil is removed.

Arrange air handling units and adjacent equipment to permit safe removal of coils, fans and fan shafts without disturbing other adjacent items or building.

6.5.5.3 Vibration

Provide either internal or external flexible duct connections at fan.

Either mount fans and motors on vibration isolation within the unit or mount the whole unit on vibration isolating mounts.

6.5.5.4 Supports And Fixings

Suspended units ≥ 4 hangers.

Floor mounted units, fix in position at ≥ 4 points to prevent horizontal or vertical movement.

Do not restrict effectiveness of vibration isolation.

6.5.5.5 Protection

Prevent ingress of foreign matter and moisture during transport and storage.

Prevent damage to fins, piping and connections during transport, storage and installation.

Comb damaged fins straight.

6.5.5.6 FCU Connections

Provide isolating valves and unions at each unit so the fan coil assembly can be easily removed and replaced. Conceal piping to units exposed within rooms.

Make all electrical connections to the unit through a terminal strip or multi-pin plug arranged to facilitate easy removal of the fan coil unit.

Provide flexible duct connections at unit.

6.5.5.7 Access Panels

Provide access panels for the following:

- Inspection and cleaning upstream and downstream sides of coils.
- Filter removal and replacement.

Match the associated unit casing construction and insulation. Provide silicone rubber or soft neoprene gaskets. Provide minimum 2 wedge type sash latches and a handle on each panel.

6.5.5.8 Piping

Pipe connections to unit by, unions on pipes ≤ DN 50 and flanges on pipes > DN 50.

Prevent stress on coils by independently supporting piping to coils.

Install piping to coils to allow access to equipment, and to minimise disturbance to piping when coils are removed. Arrange piping and isolating valves to minimise drain-down if coil is removed.

Provide drain lines to connect condensate trays to the nearest building drain point. Discharge outside the air handling unit, to allow visual inspection of condensate flow. Provide traps to condensate drains enclosed within equipment.

Traps to be copper pipework. Provide means to clean and remove the trap.
Trap depth to withstand > 2 times the fan static pressure.

Provide drains from:

- Each cooling coil.
- Future cooling coil (for main air handling unit)
- Heat exchange wheel (for main air handling unit)
- Each safety tray.
- Other moisture collecting areas.

Size of drain, greater of unit drain connection size and DN 20.

Provide drains with uniform and continuous fall (10mm/m).

Seal drain pipes to casing with rubber grommets.

Test drains by pouring a measured quantity of water

6.6 CHILLERS

6.6.1 Standards

Chiller performance rating: To AS/NZS 4776.1.1.

Chiller testing: To AS/NZS 4776.1.2.

Microbial control: To AS/NZS 3666.1 as required by the BCA and the recommendations of SAA/SNZ HB 32.

Refrigeration systems: To AS/NZS 1677.2 and the recommendations of SAA HB 40.1.

Pressure vessels: To AS 1210.

6.6.2 Definitions

ASERCOM: Association of European Refrigeration Compressor and Controls Manufacturers.

COP: Coefficient of performance to AS/NZS 4776.1.1.

IPLV: Integrated part-load value to AS/NZS 4776.1.1.

NPLV: Non-standard part-load value to AS/NZS 4776.1.1.

MEPS: Minimum energy performance standard to AS/NZS 4776.2.

6.6.3 Performance

Chillers shall achieve minimum energy efficiency ratio (EER) as set out in the following table.

Type	Full load EER
Vapour compression cycle chillers, air cooled ≤ 750kW	2.55
Vapour compression cycle chillers, air cooled > 750kW	2.65

6.6.4 Submissions

Submit manufacturer's certification of the following for each chiller:

- Testing to AS/NZS 4776.1.2:
- Ratings to AS/NZS 4776.1.1 clause 6.3.
- If documented, NPLV.

Provide the following product data:

- Manufacturer's rated performance data for the chillers offered.
- Weights including loading diagrams.
- Details of facilities and services required for the chillers offered but not documented.
- Details of accessories and features provided with the chillers offered but not documented.
- Electrical requirements for the chillers.
- Wiring diagrams.

- Evidence of conformance to AS/NZS 1677.2 and AS 1210.
- Certified sound power levels.

6.6.5 Structure / Enclosure

Provide weatherproof sheet metal enclosures for equipment requiring weather protection.

Provide integrated lifting facilities on the chiller to permit easy removal of the water box covers.

6.6.6 Scroll compressors

Provide a proprietary compressor and motor assembly, in common enclosure to UL 984.

Performance: To AHRI 540 or ASERCOM.

Provide the following:

- Suction and discharge service valves are often not supplied for smaller units – delete if not required.
- Packed and capped backseating refrigerant suction and discharge service valves.
- Access fittings for evacuation and refrigerant charging.
- Fine mesh suction filters.
- Reverse rotation protection.

Hermetic motors: Fully sealed, suction gas cooled type with internal over-temperature protection.

Crankcase heaters: Provide integral positive temperature coefficient type crankcase heaters to operate during off cycles of the compressor if required for safe compressor operation.

Enclosures: Welded steel enclosure with at least 3 mounting feet, with vibration isolating mountings. Internally spring mount the compressor.

Chillers to include as a minimum one variable spped compressor (invertor type or digital) to provide stable continuous part load capacity of a minimum 23%.

6.6.7 Shell and tube liquid coolers

Provide horizontal shell liquid coolers consisting of a shell containing a tube bundle, refrigerant circuits, water drain and vent connections, insulation, and necessary valves and fittings.

Performance rating: Rate to AHRI 480.

6.6.7.1 Direct expansion type

Operation: Refrigerant liquid evaporates within the tubes.

Refrigerant system: Arrange refrigerant circuits to prevent oil logging at the lowest operating refrigerant velocity.

Water baffles: Provide polypropylene or mild steel water baffles securely fixed to the tube bundle or welded to the shell, and incorporate pass partitions complementary to the water baffles so that the cooling effect is distributed equally between all operating tubes.

6.6.7.2 Flooded type

Operation: Refrigerant liquid evaporates around the tubes.

Refrigerant system: Submerge the tube bundle in liquid refrigerant and incorporate provision for complete separation of liquid droplets from leaving vapour. Do not place the tube bundle in the 20% of the refrigerant volume closest to the refrigerant outlet.

Water boxes: Provide removable water boxes.

Marine water boxes: If documented, provide marine water boxes with removable cover plates that permit access to tubes without disturbing the attached water piping.

6.6.7.3 Construction

Shells: Hot rolled low carbon steel plate to AS 1548 with seams precision electric welded and ground smooth externally.

Tube bundles: Unjoined seamless copper tube to AS 1569 expanded into tube plates. Finish tubes flush with the outside edge of the tube sheet. If necessary, provide intermediate tube supports along the length of the shell, to prevent sagging of the tubes. Prevent tube from vibrating against supports. Arrange to permit replacement of individual tubes.

Tube plate material:

Type 316 stainless steel to ASTM A240/A240M.

- Hot rolled carbon steel to AS 1548 with factory applied ceramic coating resistant to corrosion and erosion under chiller operating conditions.
- Water boxes: Select from cast or fabricated from mild steel.

Water box corrosion protection: Finish all wetted surfaces with factory applied coating as documented, resistant to corrosion and erosion under chiller operating conditions.

6.6.7.4 Accessories

Water flow and return connections: Flanged to AS 2129 Table E or mechanical grooved joint.

Shipping protection: Fit blank companion flanges, bolts and gaskets or removable plugs or caps.

Drain connections: Minimum DN 20 screwed connection with valve at the lowest point of both water boxes. Arrange to permit complete drainage of water from the liquid cooler.

Vent connections: Minimum DN 10 screwed connection with valve. Extend valve clear of insulation.

Freeze-up protection: Provide threaded connections with removable plugs for the insertion of a separate well to hold the sensing bulb of a freeze-up protection safety cut-out.

Thermometer pockets: Provide at water inlet and outlet.

Water side pressure drop test sockets: Factory test and stamp cooler shell, or provide metal tag, stating pressure drop at design water flow. Provide pressure drop test sockets at inlet and outlet located to measure the same pressure drop as measured at the factory.

6.6.8 Plate evaporators

Provide single pass, counterflow, brazed plate heat exchangers, constructed from type 316 stainless steel to ASTM A240/A240M.

6.6.9 Liquid cooler insulation

Insulate the liquid cooler and other surfaces that operate below ambient temperature.

Material: Elastomeric foam.

Minimum total R value: 1.8 m^2.K/W (approx. 65mm).

6.6.10 Shell and tube condensers

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.

Performance rating: Rate to AHRI 450.

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.

Refrigerant storage within the condenser is not applicable to large chillers (e.g. centrifugal) that do not have suction and discharge valves. On small reciprocating chillers, automatic pump down (initiated by solenoid valve closure and terminated by automatically resetting low pressure cut-out) can reduce the risk of liquid slugs entering the compressor on start up.

6.6.10.1 Construction

Shells: Hot rolled low carbon steel plate to AS 1548 with seams precision electric welded and ground smooth externally.

Tube bundles: Integral finned or enhanced seamless copper tubes to AS 1569 expanded into tube plates. If necessary, provide intermediate tube supports along the length of the shell, to prevent sagging of the tubes. Prevent tubes from vibrating against supports. Arrange to permit replacement of individual tubes.

Tube plate material:

- Type 316 stainless steel to ASTM A240/A240M.
- Hot rolled low carbon steel plate to AS 1548. Finish all wetted surfaces with factory applied coating as documented, resistant to corrosion and erosion under chiller operating conditions.

Fixing: Fix rigidly to suitable supports.

6.6.10.2 Water boxes

Provide removable water boxes.

Marine water boxes: If documented, provide marine water boxes with removable cover plates that permit access to tubes without disturbing the attached water piping.

Material: Select from cast or fabricated from mild steel.

Water box corrosion protection: Finish all wetted surfaces with factory applied coating as documented, resistant to corrosion and erosion under chiller operating conditions.

Sacrificial anodes:

- Provide sacrificial anodes conforming to AS 2832.4 and AS 2239 in the condenser water boxes to protect all ferrous metals.
- Anode material: magnesium.
- Arrange for easy inspection of anode condition, and removal and replacement of spent anodes.

6.6.10.3 Accessories

Water flow and return connections: Flanged to AS 2129 Table E or mechanical grooved joint.

Shipping protection: Fit blank companion flanges, bolts and gaskets or removable plugs or caps

Drain connections: Minimum DN 20 screwed connection with valve at the lowest point of both water boxes. Arrange to permit complete drainage of water from the condenser.

Vent connections: Minimum DN 15 screwed connection with valve.

Thermometer pockets: Provide at water inlet and outlet.

Water side pressure drop test sockets: Factory test and stamp condenser shell, or provide metal tag, stating pressure drop at design water flow. Provide pressure drop test sockets at inlet and outlet located to measure the same pressure drop as measured at the factory.

6.6.11 Air cooled condensers

6.6.11.1 General

Type: Provide air cooled condensers consisting of condensing coil, fans and associated piping and electrical connections, mounted within an enclosure.

Performance rating: Rate to AHRI 460.

Coil mechanical protection: Provide protection against mechanical damage during transport and installation.

Coil grilles: Provide corrosion protected grilles to prevent birds and foreign matter entering the coils.

6.6.11.2 Equipment enclosures

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.

Materials: Select from the following:

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

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

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

Access panels: Hinged doors or lift-off panels with camlock fasteners.

6.6.11.3 Condensing coils

Type: Plate fin.
Fin pitch: ≤ 630 fins/m.

Fin material: Aluminium condenser fins coated with aluminium impregnated polyurethane coating sprayed 15 –30 μm thick (standard of acceptance: Blygold).

Frames: Aluminium alloy to AS 2848.1, designation 5005, or metallic-coated steel sheet coating class Z275.

Tube material: Copper to AS/NZS 1571 or AS 1572 designation C12200.

Header material: Copper to AS 1432 or AS/NZS 1571.

Installation: Attach to the frame and provide baffle plates between coil frames and condenser enclosure, to prevent air bypass.

Subcooling coils: Provide a subcooling coil identical to the condensing coil, to achieve the designated degree of subcooling. Locate on the air entering side of, or next to, the condensing coil and in the same coil frame.

Subcooling coils: Delete if not required, may be integral with main coil.

Subcooling: ≥ 5 K.

6.6.11.4 Condenser fans

Provide statically and dynamically balanced fans, with metallic-coated steel fan guards.

Impellers: Keyed to drive shafts by means of taper-lock fixing devices or taper keys.

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

Draw through fans: Provide fans and motor insulation selected for the temperature of the air leaving the coil.

Axial / Propeller fans: Direct driven, high efficiency, with aluminium, ultraviolet light resistant polypropylene or glass fibre blades.

Casings and impellers: Metallic-coated steel.

Shafts: Treat shafts with a solvent removable petroleum based protective coating designed for machinery shafts and parts.

Motors:

- Degree of protection: ≥ IP54.
- Finish: Air drying enamel or powder coat.

Fan corrosion protection:

Casing and impeller: Powdercoated finish.

Fan shaft: Type 316 stainless steel to ASTM A240/A240M.

Fan casing: Drain to waste with two 20 mm PVC-U drains.

6.6.11.5 Control panel

Degree of protection: ≥ IP44.

6.6.12 Refrigeration system

Design refrigeration systems for minimum refrigerant leakage potential to AS/NZS 1677.2 and SAA HB 40.1.

6.6.12.1 Accessories

Provide necessary refrigerant circuit accessories, including the following:

- Discharge muffler (internal or external type).
- Liquid line filter drier.
- Liquid line sight glass moisture indicator.

- Suction, discharge and oil pressure indication, either gauges or digital readout from transducers via the microprocessor based control module, as appropriate.
- Isolation valves both sides of the filter drier.
- Liquid line solenoid valves.
- Refrigerant charging valve.

Chillers with multiple compressors: Provide at least 2 independent refrigeration circuits.

6.6.13 Control system

Menu driven, stand alone, microprocessor based module.

Common alarm: Provide for a common alarm signal to be connected into a remote monitoring system.

BMS interface: Provide high and low level interfaces to enable a building management system to interrogate the control panel, or reset the chiller set points.

6.6.14 Indication

6.6.14.1 Scroll chillers

Provide indication of the following:

- System on.
- Fault requiring manual reset
- High and low pressure on each circuit.
- Oil pressure failure on each refrigeration circuit.
- Compressor contactor overload on each compressor.
- Number of capacity steps active.

Accessories: Lead/lag function and on/off control for multiple compressor chillers.

6.6.15 Safety controls

6.6.15.1 General

Provide electrical interlocks to protect against the following:

- Chilled water low flow.
- Condenser water low flow, for water cooled units.
- Condenser fan motor overload, for air cooled units.
- Compressor motor overload.
- Oil pressure failure on refrigeration compressors.
- High and low pressure for compressors.
- Short cycling of compressors.
- Low chilled water temperature.
- Motor high temperature.
- For motors ≥ 5.5 kW: phase failure, single phase, phase rotation and under voltage protection.

6.6.16 Capacity control

6.6.16.1 Scroll chillers

Chillers to include as a minimum one variable spped compressor (invertor type or digital) to provide stable continuous part load capacity of a minimum 23%.

Operation: Provide for chillers to start on the base step of capacity and for subsequent loading and unloading to be by the capacity controller.

Capacity controller: Provide a capacity controller which senses the return chilled water temperature and maintains it at the desired setting, and with the following characteristics:

- Electronic sensing of chilled water temperature, with adjustable set point.
- Full recycle to the start (fully unloaded) position on power failure or fault condition of the compressor, and suspension from operation until the respective run contactor has closed and the compressor has started in the unloaded state.
- For multiple compressors:
- Make sure faults in compressors do not prevent the step switch from loading other compressors.
- Back-stepping facility on the controller, to prevent short cycling of the lag compressor.

6.6.16.2 Air cooled chillers

Provide fan cycling for head pressure control.

6.6.17 Refrigerant Leak Detection, Monitoring and Recovery

Provide refrigerant leak detection to the chiller plant room.

Provide a refrigerant recovery system with an automated pump-down system. This system is to have sufficient capacity to capture, isolate and store 95% (by weight) of the maximum refrigerant charge. Once the refrigerant is extracted from the chillers into the storage vessels modulating isolation valves are to separate the stored refrigerant from the chiller vessel.

The refrigerant recovery system is to operate when refrigerant levels are detected above 50ppm (final level to be confirmed with the chiller manufacturer) within the plantroom. Prior to operation of the automated pump down system the chilled water system is to safely shutdown.

6.6.18 Marking

Show the following:

- Manufacturer's name.
- Model number.
- Serial number.
- Refrigerant type.
- Refrigerant charge.
- Water side pressure drop and design water flow rates.
- Rating plates

6.6.19 Off-site testing

Verify that chiller controls meet performance requirements. Verify the marked set points of instruments, gauges and switches, by measurement of the controlled medium. Record and rectify deviations.

Safety alarm circuits tests: Simulate each unsafe condition alarm.

Pressure tests: To AS/NZS 1677.2.

Pressurising: After testing, dehydrate, pressurise using dry nitrogen to ≥ 7 kPa, and seal.

6.6.20 Installation

6.6.20.1 General

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

Report any damage or loss of refrigerant holding charge.

6.6.20.2 Piping

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

6.6.20.3 Refrigerant pressure relief

Standard: To AS/NZS 1677.2.

If the chiller is installed inside a building, pipe refrigerant pressure relief devices to a safe location outside the building and as follows:

- Discharge point: To ANSI/ASHRAE 15.
- Material: Copper vent line from the pressure relief devices to atmosphere.
- Design: Take into account refrigerant volume, relief valve discharge rate and length of pipe.
- Flexibility: Provide a flexible piping connection at the safety relief valve and support pipework so no load is exerted on the valve assembly.
- Dirt leg: Install a dirt leg and sampling valve at the base of the vent pipe.
- Vermin protection: Provide a stainless steel mesh screen over the outlet to prevent insects entering the vent pipe outlet.

6.6.20.4 Safety provisions

Ventilation: To AS/NZS 1677.2.

Machinery room alarms: To AS/NZS 1677.1 and AS/NZS 1677.2.

Alarm system: Provide vapour activated alarms to AS/NZS 1677.2.

Refrigerant sensors: Conform to the Automatic controls worksection.

6.6.21 Commissioning

6.6.21.1 Operational check

Check operation of the chiller system including auxiliary equipment and control systems. After starting up, adjust and calibrate the chiller system.

Test each safety control and facility by simulating the unsafe condition that the control is intended to protect against.

6.6.21.2 Commissioning

Commission the chiller system under the supervision of the equipment manufacturer's representative. Complete the manufacturer's commissioning check list and include a copy, signed by the manufacturer's representative, in the maintenance manuals.

6.7 DUCTWORK

6.7.1 General

This section relates to the detail design, supply, fixing and testing of:

- ductwork fabricated from galvanised steel, stainless steel and aluminium
- ductwork ancillaries such as flexible duct, dampers, fabricated hoods and canopies

No flexible ductwork shall be used for the Mechanical Services installation work associated with the permanent works.

Flexible ductwork can be used for the Mechanical Services installation work associated with the temporary works where shown on the drawings.

6.7.1.1 Design

Ductwork to AS 4254.

Proprietary and non-standard systems to conform to functional criteria in AS 4254.

Microbial control to AS/NZS 3666.1 and the recommendations of SAA/SNZ HB 32.

6.7.1.2 Performance

Construct ductwork to minimise noise generation. Ensure that ductwork interiors are smooth and free from projections. Minimise resistance to airflow.

6.7.1.3 Fire Hazard Properties

Submit evidence of conformance with the following:

- All internal surfaces of ducting achieving Group 1 or 2 (in sprinklered areas) and 1S (non-sprinklered areas of the building) - to ISO9705:1993.
- All external surfaces of the ducting achieving Group 1, 2 or 3 (to ISO9705:1993).
- Facing materials when tested to NZS/AS 1530.2 Flammability index: $\leq$ 5.
- Assembled duct systems to pass the UL 181 burning test.
- Fire protection of duct systems FRL to AS 1530.4.

6.7.1.4 Fire And Smoke Dampers

Submit test certificates showing compliance as follows:

- Fire and smoke dampers to AS 1682.1 for air leakage.
- Fire dampers to AS 1530.4 for FRL.

For positions where dampers cannot be installed to close in the direction of the air flow, submit proposed installation details.

6.7.1.5 Motorised fire dampers

Motorised fire dampers shall be installed where ductwork penetrates fire rated elements as shown on the drawings. Motorised fire dampers shall comply with AS1682-1 and 2, be independently tested in accordance with AS1530.4, and be suitable for either vertical or horizontal mounting.

Motorised fire dampers shall be Holyoake Series HFS or equal.

Installation shall be in accordance with the manufacturers written recommendations. They shall open or shut based on the 'Fire Safety' clause with 240V, 50 Hz electric non-spring return actuators and blade closed limit switch. Feedback of their position shall be relayed to the BMS / SCADA system.

Fixings and duct connections shall be arranged so that neither the operation of the damper nor its ability to stop the spread of is impeded. Automatic as well as remote resetting shall be included.

6.7.1.6 Combination fire dampers / motorised dampers

Fire dampers shall be Holyoake IBD range used in conjunction with motorised dampers (Holyoake HCD-150 or equal). High temperature seals and bearings shall be included within the HCD components of the assembly. The dampers shall be normally closed. Upon fire signal, they shall open to a predetermined maximum position (maximum set during commissioning). They shall be held shut with 240V, 50 Hz electric spring return actuator to open (or close) to predetermined limit switch upon power failure. Feedback of their position shall be relayed to the BMS / SCADA system.

Fixings and duct connections shall be arranged so that neither the operation of the damper nor its ability to stop the spread of is impeded.

6.7.1.7 Access Panels

Access panels shall be provided at every change in direction and within 10m centres on straight runs. Provide details of sizes for proposal.

6.7.1.8 Rigid Ductwork

Submit test data establishing conformance of the assembled duct system with AS 4254 clause 2.1.2 with respect to AS/NZS 1530.3 and UL181 burning test.

6.7.1.9 Sealants And Tapes

Submit type-test certificates showing conformance with the following standards:

- Sealants to AS/NZS 1530.3.
- Tapes to AS 4254 clause 2.2.1.

6.7.1.10 Internally Insulated Ducts

Drawings show clear internal airway dimension of ducts. Increase dimensions of ductwork to accommodate lining thickness.

6.7.2 Products

6.7.2.1 Corrosion Resistance

Conform to the Corrosion resistance table for the Corrosivity category from AS/NZS 2312. Alternatively, provide proprietary products with metallic and/or organic coatings of equivalent or higher corrosion resistance.

CORROSION RESISTANCE TABLE

Corrosivity category	Situation	Fire, smoke and motorised dampers	Ductwork
C2: Low	Internal	Metallic-coated sheet Z275/AZ150	Metallic-coated sheet Z275/AZ150
C3: Medium	External	Stainless 316	Metallic-coated sheet Z275/AZ150

External situation includes:

- Ductwork outside the building.
- Fire, smoke and motorised dampers in ductwork outside the building.
- Fire, smoke and motorised dampers located in the discharge air path within 3m of the point of discharge from the building.
- Fire, smoke and motorised dampers located in the outside air or mixed air/recycle air path up to the filters.

6.7.2.2 Adhesive Duct Tapes

To AS 4254 clause 2.2.1. And mark label 'Compliant with AS 4254' at least every 200mm.

Adhesive, non-toxic, high tack, synthetic pressure-sensitive type.

Liner, silicone coated paper.

Backing, aluminium foil laminate.

6.7.2.3 Sheet Metal Ductwork

Galvanized steel duct and mild steel components < 3mm thick: Prime quality lockforming galvanized steel, to AS 1397 Grade G2 or G3 with Z275 coating.

Thickness To AS 2338.

Components for stainless steel and aluminium ductwork, use only materials with corrosion resistance not less than that of the duct wall material.

Sheet **Metal Duct Fasteners**

Rivets to be expanding solid end type, aluminium base alloy for galvanized duct, stainless steel for stainless steel duct, minimum size as follows:

- For sheet metal to sheet metal: 3mm.
- For sheet metal to supports, brackets and rolled steel angles: 4.8mm.

Self tapping screws to be zinc-plated for galvanized duct, stainless steel for stainless steel duct.

Self drilling and tapping screws to be zinc-plated for galvanized duct, stainless steel for stainless steel duct. Provide only if base material into which they screw is thicker than 1.5mm and they are unlikely to be removed or replaced.

Bolts, nuts, washers and drop rods to be zinc-plated steel, service condition number 2 for galvanized duct, stainless steel for stainless steel duct. Parts on stainless steel duct not in contact with air stream or corrosive conditions may be zinc-plated as for galvanized duct. Provide washers under nuts and bolt heads.

Sheet Metal Duct Sealing

Seal all openings in the surface, joints and seams of ducts in accordance with AS 4254 clause 2.2.1 and the Duct seal class table.

Duct seal class not lower than Class C to AS 4254 Table 2.2.1 regardless of duct pressure or location.

Use only sealants that:

- Do not foster microbial growth.
- Have a smoke developed index ≥ 3 and a spread of flame index ≤ 0 when tested to AS/NZS 1530.3.
- Will maintain their sealing performance for the life of the duct system.
- Bond to the surface of application without primers.
- Are resistant to oils, refrigerants and water after curing.
- Are non-toxic.
- Have high elastomeric properties over the range of operating temperatures after curing.
- Are suitable for application by gun or hand tools.
- Low VOC properties

Do not use duct tape as the primary duct sealing agent. Use only as a secondary sealant on joints sealed by other means such as mastic, liquids or gaskets. Do not use duct tapes for non-sealant purposes.

Machine rolled flanges, use mastic at corners.

Sheet Metal Duct Seal Class Table (Seal class to AS 4254 table 2.2.1)

Duct location	Supply ducts (Static pressure classification Pa) ≤ 500	Supply ducts (Static pressure classification Pa) > 500	Exhaust ducts	Return ducts
Outdoors	A	A	A	A
Unconditioned spaces	B	A	B	B
Conditioned spaces (concealed ductwork)	C	B	B	B
Conditioned spaces (exposed ductwork) - Office-type spaces	A	A	B	B
- Factory-type spaces	C	B	B	B

Fittings

Acoustic turning vanes and splitters:

- Install in all bends and elbows.
- Double thickness perforated vanes acoustically lined with 96 kg/m3 mineral wool with scrim encapsulation.

Heavy Gauge Ductwork

Extent: Provide heavy gauge rectangular ductwork to limit noise breakout.

Include discharge ducting from VAV supply fans for 10m from the fans and all supply ducts within plantrooms.

Construction: 1.2mm zinc coated steel. Provide acoustic lining. Support heavy gauge ductwork from resilient spring and neoprene hangers.

Provide circular high pressure ducts of standard gauge in lieu of rectangular heavy gauge where space permits.

Ductwork Exposed to View

Provide exposed ductwork well finished, straight and true, and free of visible defects.

Painting to be as per the architectural specification.

Transverse Joint

Rectangular duct - use drive slip or slip on proprietary flanges.

Circular or oval duct - use internal beaded sleeves.

Match spacing of transverse joints on adjacent exposed ducts.

Hangers

Top connected rod hangers with local internal duct reinforcement. Seal around rods. Do not use trapeze hangers. Ensure hangers are evenly spaced.

External Ductwork

Install ductwork exposed to weather to shed rainwater. Cross-break tops to prevent ponding.

Provide transverse joints with recessed flanges with hat sections for the flat and sides of any external surface.

Seal all joints of exposed ductwork, access doors, equipment connections and the like.

Internally insulate all external supply and return air ducts to achieve a minimum thermal insulation as required by the insulation section.

Provide galvanised brackets, hangers, nuts, bolts and other components.

All externally located ductwork shall be fully painted.

6.7.2.4 Flexible Ductwork

Flexible ductwork shall only be used in the above ground temporary works portion of the project. Uninsulated flexible duct to be aluminised fabric clamped on a formed metal helix. Do not use adhesives.

Insulated flexible duct, as for uninsulated flexible duct with flexible blanket insulation wrapped around duct and covered with an outer vapour barrier.

Insulation thickness to the Flexible duct schedule.

Insulation material as per the insulation section.

6.7.2.5 Semi rigid Ductwork

Semi-rigid ductwork is acceptable for use in the permanent works portion of the project providing the following conditions are met:

- Maximum of 1m length
- Used as the final section of ductwork before the connection to the air terminal/diffuser/grille.

Semi rigid ductwork shall be Holyoake Spiro-set or approved equivalent.

6.7.2.6 Flexible Connections

Isolate fans and conditioner casings from ductwork, by means of airtight flexible connections.

Materials to be heavy duty, waterproof.

Provide sufficient slack to ensure free movement and vibration isolation under operating and static conditions.

Align openings of connected equipment.

Fix to attachments with metallic-coated steel strip. Seal joints. Do not paint flexible material.

To achieve the FRL of the attached duct when tested to AS 1530.4.

For maintenance, allow easy removal and replacement without disturbing ductwork or plant.

Do not protrude connections or frames into the air stream where this would be detrimental to the air flow.

6.7.2.7 Dampers

Provide balancing dampers at each branch duct or tee:

- Splitter type, use only for supply branches up to 600mm wide and with velocity in main < 10 m/s. Do not use on return or exhaust ducts.
- Opposed blade dampers, use for any size supply and for all return and exhaust ducts. Locate in each branch.

Volume Control Dampers

Provide dampers 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.

Face dimensions to duct size.

Connections mating angle flanged cross joints.

Frames, 1.6mm minimum thickness metallic-coated steel or 2mm minimum thickness aluminium folded to form channel sections at least 150mm wide and welded at corners.

Dampers required to provide tight shut-off, comply with the Motorised dampers clause.

Dampers in smoke-spill systems to be metallic-coated steel or stainless steel blades and frames.

Volume Control Damper Blades

Metallic-coated steel, aluminium or stainless steel. With no sharp edges. Sufficiently rigid to eliminate movement when locked.

Minimum thickness:

Metallic-coated sheet steel and stainless steel:

- Single thickness blades 1.6mm.
- Double thickness blades 1.2mm.

Aluminium:

- Single thickness blades 2.4mm.
- Double thickness blades 1.8mm.

Maximum length 600mm. If necessary provide intermediate mullions.

Single blade dampers:

- For single thickness blades, 600mm maximum length, 600mm maximum width or 600mm maximum diameter.
- For single thickness blades with 6mm minimum edge breaks, 600mm maximum length x 175mm minimum width.

Multi-blade dampers, for single thickness blades with 6mm minimum edge breaks, allow 1200mm maximum length 175mm minimum width.

Volume Control Damper Bearings

Oil impregnated sintered bronze bearings, sealed-for-life ball bearings or engineering plastic sleeve bearings. If the operating temperature is > 50°C, do not provide nylon.

Provide access for lubrication.

Housings, rivet to damper frames.

Volume Control Damper Spindles

Stainless steel in stainless steel dampers, zinc-plated steel or stainless steel otherwise.

Securely fix to damper blades.

Minimum diameter:

- Blade lengths ≤ 600mm: 10mm.
- Blade lengths >600, ≤ 1200mm: 12mm.

Volume Control Damper Linkages

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

Volume Control Damper Adjustment

Provide for adjusting the damper and locking it in position. Locate in an accessible position. Label the open and closed positions clearly and permanently.

Splitter Dampers

Fabricate to AS 4254 Figure 2.3 (H) with a minimum length 1.5 times the width of the larger branch.

Use only on supply ducts and only if duct velocity is less than 10 m/s. Provide volume control dampers otherwise.

Push rods, 5mm diameter on 600mm centres with screw locking bushes to fix position.

Motorised Dampers

Comply with Volume control dampers and the following:

- Side seals, aluminium or stainless steel.
- Blade type: Aerofoil.
- Blade tip seals, neoprene or silicone rubber.
- Leakage ≤ 25 L/s.m² at 1.5 kPa pressure differential.
- Sealed-for-life ball bearings only.
- Drive shafts, keyed, square or hexagonal.

- Bearings: Provide sealed-for-life ball bearings only.
- Mounting: Sufficiently rigid to prevent flexing or distortion of the frame or ductwork during operation. Install damper motors and operating mechanisms where they are easily accessible for inspection, maintenance and adjustment.

Operation: If two sets of dampers are connected to a single motor, provide linkages that allow each damper to be adjusted without affecting the other.

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.

Motorised Damper Control Characteristics

Linear flow characteristics relative to damper motor drive shaft rotation.

Type:

- Outdoor air/return air mixing dampers, parallel blade type with air streams directed towards each other.
- Face and bypass dampers, parallel blade type with air streams directed towards each other.
- Other modulating dampers opposed blade type.
- Two position shutoff dampers parallel or opposed blade type.

Non Return Dampers

Comply with Volume control dampers. Spring assist or counterweight the assembly so that it:

- Offers minimum resistance to air flow.
- Closes by gravity.

Fire And Smoke Dampers

To AS 1682.2.

Provide free cross section area at least 85% of the face area. Provide oversize damper and enlarge duct both sides of damper if necessary to achieve this.

Fire And Smoke Damper Links

Mechanical fire dampers, to have frangible bulb or fusible links.

Smoke dampers to have fusible links activated by either local heat or a low power external electrical impulse.

Install or mount for easy replacement.

Fire And Smoke Damper Access Panels

Provide for maintenance / testing of dampers and replacement of links.

6.7.2.8 Access

Access Doors Location

Provide an access door in each section of air handling units where access is required for maintenance, inspection or removal of components. Removable panels may be used instead of doors where access is required only for removal of coils.

Access Panels Location

Provide access panels in the following locations:

- Next to each component located inside the duct requiring regular inspection and maintenance including, but not limited to:
  - Fire and smoke dampers.
  - Smoke detectors.
  - Motorised dampers.
  - Filters.
  - On the air entering side of electric duct heaters.
  - On the air entering side of duct mounted heating coils.
- In air handling units where unit size is insufficient to fit an access door.
- Where specified in Kitchen exhaust.
- In the vicinity of moisture producing equipment, to AS 3666.1 clause 2.11.3.
- In other locations documented.

Access Panel Sizes

Minimum clear opening:

- Personnel access: 450 x 600mm.
- Hand access: 200 x 300mm.

Access Panel Construction

Double panel type, deep formed, zinc-coated steel construction, insulated to match the duct, or filled with at least 25mm mineral wool insulation.

Arrange to prevent cold bridging and condensation on cold surfaces.

Provide rigid matching galvanized steel frames securely attached to the duct. Do not protrude any part of the panel or frame into the air stream.

Silicone rubber or soft neoprene gaskets mechanically fixed to either the panel or the frame to ensure an airtight seal against the operating pressure when latched in the closed position. For fire rated seals, provide woven ceramic fibre material.

Wedge type sash latches.

Number of latches:

- 4 for personnel access.
- 2 for hand access.

Provide a 'D' handle on access panels for personnel access.

Access Door Construction

Provide rigid, reinforced access doors. Thickness: 50mm.

Construction: Provide either:

- Sandwich panel: As specified for wall and ceiling panels. Form door edging with a heavy gauge aluminium extrusion with double web seal to both skins. Mitre corner and firmly secure to panel with countersunk head screws.
- Folded two-piece press formed or machine folded from ≥ 1.6mm zinc coated steel.

Minimum clear opening 1350mm high x 600mm or larger to permit safe removal of equipment inside the section.

Door swing against air pressure.

- Doors on the inlet side of the fan to open outwards
- Doors on the discharge side of the fan to open inwards.

Arrange to prevent cold bridging and condensation on cold surfaces.

Jamb, stiles and head, rigid matching ≥ 2.5mm zinc coated steel, or ≥ 3.0mm PVC or fibreglass securely mounted.

Door hardware:

- Catches ≥ 2 heavy duty proprietary clamping-type latches with permanently attached handles that can be operated from both the inside and the outside of the door. Provide satin chrome plated finish to exterior components.
- Hang doors on edge-mounted, rising butt type self-closing hinges capable of holding the door fully open. Construct from chrome plated brass or heavy duty aluminium alloy. Provide stainless steel hinge shaft and nylon bearing surfaces.
- Securely bolt hardware to the door and frame by a method which minimises cold bridging and prevents the forming of condensation on the outside of the conditioner.

Silicone rubber or soft neoprene gaskets mechanically fixed to the door to ensure an airtight seal when latched closed. Fix to the door using a method that permits easy replacement. For fire rated seals, provide woven ceramic fibre material.

Insulation maximum 50mm thick. Construction and insulation properties to match the insulation of the duct, plenum or casing in which the door is located.

6.7.2.9 Electric Duct Heaters

To AS 3102.

Elements sheathed in steel or nickel alloy. Provide brazed spiral steel fins.

Assemble elements in a galvanized steel frame with terminal connections contained in an enclosed terminal box.

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

Fin rating < 20 W/m2.

6.7.3 Execution

6.7.3.1 Arrangement

Arrange ductwork neatly. Provide access to ductwork components which require inspection, entry, maintenance and repairs. Where possible arrange duct runs adjacent and parallel to each other and to building elements.

6.7.3.2 Spacing

Provide minimum clear spacing, additional to duct insulation, as follows:

- 25mm between adjacent ducts.
- 25mm between duct flanges or upper surfaces of ducts and undersides of beams and slabs.

- 50mm between ducts and electric cables.
- 150mm between ducts and ground, below suspended floors.

6.7.3.3 Flexible Duct Installation

Install flexible duct as straight as possible, extended with minimum number of bends. Maximise bend radius but not less than AS 4254 clause 2.8.5 (h).

Joints, securely fix flexible duct to rigid spigots and sleeves using sealant and draw band encased with at least two wraps of duct sealing tape.

Join lengths of flexible duct only for the purpose of providing an air tight or acoustic sleeve at a partition.

Support to AS 4254. Limit sag to < 40mm/m.

Maximum length of flexible duct sections, 6 metres including any rigid duct or sleeves used to join lengths of flexible duct. If rigid duct is shown on the drawings do not substitute flexible duct.

Flexible ducts used for air containing free moisture, locate supporting helix outside air stream.

6.7.3.4 Motorised Damper Installation

Locate dampers and damper motors in accessible positions, for blade and motor maintenance and blade seal replacement.

Mount sufficiently rigid to prevent flexing or distortion of the frame or ductwork during operation.

If 2 sets of dampers are connected to a single motor, provide linkages which allow either damper to be adjusted without affecting the other.

6.7.3.5 Cleaning Ducts

During installation progressively remove construction debris and foreign material from inside ducts.

6.7.3.6 Drainage

Provide drainage to AS/NZS 3666.1 at locations in ductwork where moisture may accumulate including at outside air intakes.

6.8 FANS

6.8.1 General

This section is applicable to the detail design, supply, fixing and testing of:

- EC, centrifugal, axial flow, mixed flow and propeller fans
- Window / wall mounted fans

6.8.1.1 Design

Fan Static Pressure

Calculate system resistances including pressure drops across dirty filters, wet cooling coils, heating coils, sound attenuators, dampers, plenums, ductwork, terminals, registers, door grilles and the like as installed.

Fan static pressures scheduled are approximate. Submit calculations for review.

Amend fans, drives, motors and electrical power supplies to accord with the calculated system resistances.

Where fan sound power levels exceed scheduled values, increase acoustic attenuation to achieve required sound levels. Submit acoustic calculations for review.

6.8.1.2 Fan Selection

Centrifugal fans

Provide fans selected so the air flow can be increased ≥ 5% above the rate in Fan schedules as follows:

- Against the corresponding increased system resistance as installed.
- Without unstable operation.
- By speed change alone.

Axial flow fans

Provide fans selected so the air flow can be increased ≥ 5% above the rate in Fan schedules as follows:

- Against the corresponding increased system resistance as installed.
- Without unstable operation.
- By pitch angle change alone.

Fans with variable speed drives

All fans: Provide fans selected to operate at ≤ 50 Hz under all conditions.

Fans with belt drives: Adjust fan speed during commissioning for motor to operate at ≤ 50 Hz under all conditions.

Fans with multi-speed motors

Two speed fans: Provide fans selected to perform both duties given in the Fan schedules

Fans with 3 or more speeds and single phase fans with adjustable speed control: Provide fans selected to achieve the duty stated in the Fan schedules at a speed ≤ 80% of highest speed.

6.8.1.3 Type Test Results

Provide only fans type tested by a Registered testing authority. Submit evidence of type tests as follows:

- Fan performance to BS 848-1, AS ISO 5801.
- Fan sound power levels to BS 848-2.6, BS EN ISO 5136 or ISO 10302.

6.8.1.4 Galvanized Steel Components

Hot dip galvanized components to AS/NZS 4680.

Coating thickness and mass to AS/NZS 4680 Table 1.

6.8.1.5 Performance

The maximum specific fan power in air distribution systems shall meet the requirements set out in the following table.

System type	SFP (W/(l/s))
Central balanced mechanical ventilation system with heating and cooling	1.6

Central balanced mechanical ventilation system with heating only	1.5
All other central balanced mechanical ventilation systems	1.1
Zonal supply system where fan is remote from zone, such as ceiling void or roof mounted units	1.1
Zonal extract system where fan is remote from zone	0.5
Zonal supply and extract ventilation units, such as ceiling void or roof mounted units serving single room or zone with heating and heat recovery	1.9
Local balanced supply and extract ventilation system such as wall/roof units serving single area with heat recovery	1.6
Local supply or extract ventilation units such as window/wall/roof units serving single area (e.g. toilet extract)	0.3
Other local ventilation supply and extract units	0.5
Fan assisted terminal VAV unit	1.1
Fan coil unit	0.5

Extending specific fan power for additional components is permitted as per the following table.

Component	SFP (W/(l/s))
Additional return filter for heat recovery	+0.1
HEPA filter	+1.0
Heat recovery – thermal wheel system	+0.3
Heat recovery – other systems	+0.3
Humidifier/dehumidifier (air conditioning system)	+0.1

6.8.2 Fan Types

6.8.2.1 Centrifugal

Select for high efficiency and quiet operation, not more than one fan size smaller than peak efficiency selection.

Arrangement to ANSI/AMCA standard 99-2404 arrangement 1, 3 or 9.

Casings

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

If the fan impeller is more than 1200mm diameter, provide a horizontally split casing.

Inlet bells to be removable, shaped for aerodynamically efficient air entry and close approach to impeller.

Provide inspection/access panels to casings of fans with impellers 650mm diameter. Seal panels airtight with neoprene gaskets.

Provide flanged or spigoted outlets to suit connected ductwork or equipment.

For fans not connected to ductwork provide removable inlet guards, discharge guards or both. Guards are not to restrict airflow.

Where moisture is likely to enter or condense inside a fan provide a 25mm drain point welded into base of scroll and stopped with non-ferrous screwed plug.

Bases

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

Provide at least 4 height saving mounting brackets

Impellers

Duty shaft power below 4kW select forward curved or backward inclined aerofoil type.

Duty shaft power 4 to 8kW select backward inclined curved aerofoil type.

Duty shaft power greater than 8kW select for greater efficiency either backward inclined aerofoil type.

Characteristics to be:

- non-overloading power characteristics
- Statically and dynamically balanced.
- Keyed to drive shafts by means of taper-lock fixing devices or taper keys.
- For overhung driven fans > 1000mm diameter, retained onto drive shafts by positive devices such as washers and set screws into tapped holes in shaft ends.
- Countersink in shaft for tachometer.

Bearings

For single width fans with impellers < 1250mm diameter and double width fans with impellers < 950mm diameter. Provide pillow-block mounted, self-aligning ball bearings, sealed for life, with a minimum rating fatigue life of 12 000 hours.

For single width fans with impellers ≥ 1250mm diameter and double width fans with impellers (950mm diameter. Provide plummer-block mounted roller bearings to AS 2729, with seals and grease relief, with a minimum rating fatigue life of 20 000 hours. Extend grease nipples for ready access.

Vary the default life if required e.g. if other bearing types are used, such as grease valve bearings. 50 000 hours and 80 000 hours (for larger fans) may be appropriate minimums in this case. Consult with manufacturers.

Motors

Provide electric motors that are compatible with fan requirements, providing efficient non-overloading fan units.

Power rating, the greater of the following:

- The fan limit load power at speed required for the air flow and resistance required in Design.
- The power required by the fan when the air flow is increased by 5% above the design air flow rate required in Design, against the corresponding increased system resistance.

Motor protection, minimum IP54.

Belt Drives

Endless wedge belt and V-belt drives not to be used.

Synchronous belts only to be used. Standard; To ISO 13050:1999, Curvilinear toothed synchronous belt drive systems

Drive Shafts

Provide the following:

- Designed so that the first critical resonant speed of the shaft is 130% of design maximum operating speed.
- Double width fans with shaft diameter > 60mm: Filleted stepped type to permit easy impeller removal.
- Keyed with taper-lock fixing devices for fixing of pulleys.
- Countersunk ends for tachometer application or, where the end of the shaft is not accessible, make provision for use of stroboscope or optical tachometer.
- Material: Mild steel or high tensile steel, as appropriate for the duty. Provide corrosion protection by solvent removable petroleum based protective coating formulated for machinery shafts and parts.

Guards

Provide belt guards complying with safety standards and:

- Rigid, removable and totally enclosing the drive and exposed shafts. Belts to be visible.
- Provide tachometer openings at fan and motor shafts.
- Allow scope for belt adjustment.
- Weatherproof, ventilated and drained where exposed to weather.

Provide inlet and outlet guards where fans are not connected to ducting. Provide shaft and coupling guards for exposed shafts. Guards must not restrict airflow.

Finishes

External surfaces: Equipment paint system, using GPC-P-162 primer to AS/NZS 2312:2002

Internal surfaces: Prime with zinc phosphate primer to GPC-P-162 to AS/NZS 2311:2000

High Temperature Exhaust Fans

Provide heat slingers and guards on shafts between the in-board bearings and fan casings. Locate in-board bearings clear of fire-rated insulation applied to fan casings.

6.8.2.2 Centrifugal Fans - In Line

Casings, rectangular or circular with spigot or flanges for duct mounting, with construction as follows:

- Steel: Metallic-coated steel sheet, spot welded. Brush and prime spot welds with zinc-rich organic primer to AS/NZS 3750.9.
- Fibreglass or plastic: Moulded fibreglass or impact resistant plastic with integral support foot.

Impellers, backward inclined or forward curved style as scheduled, constructed from metallic-coated steel, extruded aluminium or polypropylene. Balance impellers statically and dynamically.

Motors, direct mounted to impellers with minimum Class 155 insulation to IEC 60085. Provide sealed for life bearings with a minimum rating fatigue life of 8750 hours.

Electrical connection, provide terminal box external to fan casing and wired to fan motor.

Access:

- Impellers < 350mm diameter: Provide fan manufacturer's standard screw clamps both sides of the fan to permit the impeller-motor assembly or fan as whole to be removed.
- Impellers ≥ 350mm diameter: Provide an access panel in the casing to permit removal of impeller-motor assembly.

6.8.2.3 Axial Flow

Select fans with non-overloading power characteristics, high efficiency and low noise level, in the stable region and clear of blade stall.

Blade pitch angle to be close to mid-range and not less than 5° from the maximum pitch angle for which performance data is published.

Select adjustable pitch fans and motors to allow for 5% increase in airflow and 10% increase in pressure above design.

Casings

Tubular, flanged at each end, constructed from mild steel, fully welded, hot dip galvanized after fabrication.

Access:

- < 1000mm diameter: Sight hole in casing.
- ≥ 1000mm diameter: Provide access panels, securely bolted to casings and sealed with neoprene gaskets, for maintenance.

Impellers

Provide aerofoil section blades constructed from cast aluminium alloy polypropylene or glass reinforced plastic to the Axial flow fan schedule.

Pitch angle to be manually adjustable.

Balance all impellers. Fans up to 500 diameter may be statically balanced by selective assembly. All other fans to be statically and dynamically balanced.

Unducted Inlets / Outlets

Provide aerodynamically shaped bellmouth cones to inlets of fans.

Provide manufacturer's standard 15° conical diffuser outlets to convert velocity head to static pressure.

Provide galvanized steel or bronze mesh guards to both inlet and outlet.

Motors

Direct mount to impellers with minimum Class 155 insulation to IEC 60085.

Provide sealed for life bearings or grease packed bearings fitted with lubrication lines extending through the casing. Provide bearings with a minimum rating fatigue life of 17,500 hours, suitable for horizontal or vertical mounting as appropriate.

Electrical Connections

Provide terminal box external to fan casings and wire to fan motors.

Belt Drives for Axial Fans

Endless wedge belt and V-belt drives not to be used. Synchronous belts only to be used. Standard: To ISO 13050:1999, Curvilinear toothed synchronous belt drive systems

Guards

Provide belt guards complying with safety standards and:

- Rigid, removable and totally enclosing the drive and exposed shafts. Belts to be visible.
- Provide tachometer openings at fan and motor shafts.

- Allow scope for belt adjustment.
- Weatherproof, ventilated and drained where exposed to weather.
- Provide inlet and outlet guards where fans are not connected to ducting. Provide shaft and coupling guards for exposed shafts. Guards must not restrict airflow.

6.8.2.4 Roof Mounted Fans

Centrifugal, mixed flow, aerofoil axial or propeller.

Axial flow and propeller to comply with Axial flow fans.

Centrifugal fans to comply with Centrifugal fans - general purpose except as varied in the following:

- Casing: Scroll ≥ 1.2mm and side plates ≥ 2mm thick zinc-coated steel, riveted or spot welded with joints sealed.
- Bases: Metallic-coated steel sheets bolted to casings with at least 4 mounting brackets.
- Impellers: Constructed with extruded aluminium or zinc-coated steel blades secured between reinforced galvanized steel plates.
- Bearings: Self-aligning sealed for life ball or roller type.
- Finish: Brush and prime spot welds with zinc-rich organic primer to AS/NZS 3750.9.
- Motor minimum degree of protection: IP51.

Mixed flow fans:

- Impeller: Mixed flow with rotating parts vibrations isolated from the unit casings by suitable resilient mountings.
- Arrangement: Position the motor above the impeller to allow servicing from above the roof.

Housing Roof Mounted Fans

House fans in compact bases fitted with weathering skirts and a hinged or removable weatherproof cowl with bird screen.

Construct of, UV stabilised ABS, polypropylene, polyethylene, glass-fibre reinforced polyester or zinc-coated steel.

Vertical Discharge

Provide weatherproof galvanized steel, plastic or aluminium backdraft dampers where the weather may enter when units are stopped.

Backdraft damper closure, counter weighted or electrically driven.

Backdraft dampers on smoke spill fans to latch open or fail in the open position in the event of a fire.

Where backdraft dampers are not fitted, provide vermin mesh guards. Comply with AS/NZS 3666.1 clause 2.2.1.

Downflow Discharge

Provide galvanized steel, plastic or aluminium backdraft dampers where air leakage is to be minimised when units are stopped. Backdraft damper set closer, counterweighted or electronically driven. Provide vermin mesh guards. Comply with AS/NZS 3666.1 clause 2.2.1.

6.8.2.5 Motors Roof Mounted Fans

Provide bearings sealed for life or grease packed fitted with lubrication lines extending through roof cowls. Provide bearings with a minimum rating fatigue life of 8750 hours. Provide access to grease relief ports.

Minimum degree of protection IP55.

Belt or direct drive as appropriate. Preference to be given to direct drive.

Belt drives to be synchronous belt type.

Electrical Connection Roof Mounted Fans

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

6.8.2.6 Propeller Fans

Propeller fans designed for diaphragm, wall or cowl mounting as documented.

Impeller fans, direct driven with metallic-coated curved steel or glass reinforced plastic blades and balanced statically and/or dynamically.

Motor to have anti-vibration mountings.

Bearings sealed for life suitable for horizontal or vertical mounting.

Cowls, glass fibre or fabricated metal.

Unducted inlets and outlets to be metallic-coated steel or bronze mesh guards.

Finish to metal parts to be air drying enamel or powder coat.

6.8.2.7 Window and Wall Mounted Fans

Impeller to be plastic or metallic-coated steel propeller type.

Housing: Provide:

- Isolating mountings.
- Discharge cowls with bird mesh guards.
- Backdraft shutters constructed from lightweight nylon or aluminium blades, arranged to gravity close or to be electronically operated when fans are not operating.

6.8.2.8 Smoke Spill Fans

Comply with AS/NZS 1668:1 Fire and smoke control in multi-compartment buildings and requirements of Statutory Authority. Fans to be single width centrifugal or axial. For centrifugal fans provide heat slingers and guards on shafts between the inboard bearings and fan casings and locate inboard bearings to clear fire-resisting insulation of fan casings.

Time/temperature rating: Comply with AS 4429.

Submit type test certificates to AS 4429 Methods of test and rating requirements for smoke-spill fans.

6.8.3 Execution

6.8.3.1 Access

Arrange fans and accessories to allow service access for maintenance and removal and for replacement of assemblies and component parts, without disturbance of other items of plant, fire rating material and/or the building structure.

6.8.3.2 Duct Connections

Provide flexible connections to prevent transmission of vibration to ductwork. If under negative pressure, make sure that flexible connection does not reduce fan inlet area. If necessary, provide expansion pieces between fans and flexible connections.

6.8.3.3 Drains

Where moisture is likely to enter or condense inside a fan provide a trapped drain in accordance with AS/NZS 3666.1 and pipe to discharge point in accordance with AS/NZS 3500.2.

6.8.3.4 Vibration Isolation

Provide each assembly with at least four anti-vibration mountings, selected to give an isolation efficiency not less than 95%.

- Fans with motors > 3.5 kW: Metal spring and a neoprene spring cup in series. Include levelling screws and locknuts.
- Fans with motors ≤ 3.5 kW: Either double deflection neoprene or rubber in shear mountings or as for fans > 3.5 kW.

Locate the mountings so that the mounts deflect uniformly when the fan is operating and subject to all loads, including those imposed by the duct.

Arrange flexible duct connections so that the fan vibration isolation efficiency is not adversely affected.

6.8.3.5 Labels

Show the following:

- Manufacturer's name.
- Model.
- Serial number.
- Size.
- Direction of rotation, marked on casing.

6.9 INSULATION

6.9.1 General

This section relates to the detail design, supply, and fixing of acoustic and thermal insulation and sheathing of ductwork, piping, tanks, vessels and flues, used in air conditioning and mechanical systems.

Insulating materials include mineral wool (including glass fibre), polyester fibre, polyolefin foam and elastomeric foam

Facing materials include aluminium foil laminate and sheet metal

6.9.1.1 Abbreviations And Definitions

FRL: Fire resistance level

Mineral wool: Entangled mat of fibrous non-crystalline material derived from inorganic oxides or minerals, rock, slag or glass, processed at high temperatures from a molten state.

Polyester: Insulation manufactured from thermally bonded polyester fibres.

Polyolefin: Closed cell cross-linked polyolefin foam produced using non-CFC blowing agent.

R value: The thermal resistance (r = m2.K/W) of a component calculated by dividing its thickness by its thermal conductivity (R value = thickness/k value). R value does not include air space or surface resistances.

6.9.1.2 Installation Of Mineral Wool Insulation

Comply with the ICANZ Industry Code of Practice and Department of Labour requirements for the Safe Use of Glass Wool and Rock Wool Insulation.

Deliver mineral wool products to site in packaging labelled FBS-1 BIO-SOLUBLE INSULATION.

6.9.1.3 Fire Hazard Properties

Submit evidence of conformance with the following:

- All internal surfaces of insulation contained within ducting shall achieve either Group 1 or 2 (in sprinklered areas of the building) and 1S (in non-sprinklered areas of the building)
- All external surfaces of insulation encompassing the external surfaces of the ducting shall achieve either Group 1, 2 or 3
- Assembled duct systems to pass the UL 181 burning test.
- Materials with reflective facing test to AS/NZS 1530.3 clause A6.

6.9.1.4 Thermal Insulation Performance

Submit evidence of conformance to AS/NZS 4859.1.

6.9.1.5 Samples

Submit samples of the following:

- Each type of insulation, applied to a sample 1.5m long section of ductwork, including a site applied insulated transverse joint.
- Each type of insulation, including at least one transverse joint, bend and one hanger on a ≥ 1.5 m long section of pipe. If the piping system to be insulated using the respective type of insulation includes flanges, provide an insulated flange in the sample.

For each sample, provide cutaway sections to permit inspection of application details including insulation materials, adhesives, mastics, fixings and sheathing.

6.9.1.6 Alternatives

Do not submit alternatives for materials or methods that have lesser quality or characteristics in terms of the following:

- Performance.
- R value.
- Durability during and after installation.
- Corrosion resistance.
- Cold bridging.

6.9.2 Products

6.9.2.1 General

Ductwork insulation to AS 4254.

Insulation material types to be of the following:

- Mineral wool (glasswool or rockwool).
- Polyester.
- Polyolefin foam.
- Fire properties of external insulation refer to “Fire Hazard Properties” section

Provide piping insulation in conformance with the Minimum piping insulation thickness table.

Condensate drains from air handling plant if included in the Piping insulation schedule provide 25mm thick insulation.

6.9.2.2 Prohibited Materials

Do not use materials:

- Containing asbestos, lead, mercury or mercury compounds.
- Containing substances classified as hazardous in the Hazardous Substances and New Organisms Act 1996 (HSNO Act).
- Which use CFC or HCFC as blowing agents in the manufacturing process.

Materials in contact with stainless steel to have properties including leachable chloride content that does not cause corrosion or other deterioration of the stainless steel.

6.9.2.3 Insulation Materials

To AS/NZS 4859.1.

In batt, board or blanket form.

6.9.2.4 Semi-Rigid Insulation for Ductwork

Physical properties:

- Alkalinity: pH 7 - 9.
- Moisture absorption non-hygroscopic.

Batt or board form with a maximum mean deflection of 6mm for 50mm thick material and 20mm for 25mm thick material, tested as follows:

- Freely support a 900 x 1500mm test piece on its longer sides.
- Allow the test piece to stand for 10 minutes and measure the vertical deflection.
- Turn the test piece over and repeat the test.
- Average the results.

Minimum Absorption Coefficients Table

Insulation	Absorption coefficients (nominal) to AS ISO 354 at					
Perforated foil faced: R 0.9 to AS 4508	0.12	0.48	0.84	0.96	0.97	0.94

R 1.5 to AS 4508	0.23	0.62	1.00	1.07	1.12	0.78

6.9.2.5 Polystyrene Foam for Pipework

To AS 1366.3 Class S or SL self-extinguishing grade, machine cut to form tubular half-sections for pipe insulation or batts for insulating fittings. For tanks, vessels and heat exchangers, mould to shape.

Density (minimum):

- Moulded grades:
  - Class SL: 13.5 kg/m³
  - Class S: 16 kg/m³
- Extruded grade: 32 kg/m³.

6.9.2.6 Polyolefin Foam for Pipework

Closed cell cross-linked polyolefin foam produced using non-CFC blowing agent.

Insulation surface facing: Heat-bonded aluminium foil laminate

6.9.2.7 Phenolic, Polyurethane and Polyisocyanurate Foam for Pipework

Machine cut to form tubular half sections.

Density ≥ 32 kg/m³

6.9.2.8 Mineral Wool and Polyester for Pipework

Select from the following:

- Mineral wool (glasswool or rockwool) resin-bonded to form tubular sections.
- Polyester in moulded tubular sections.

Do not use mineral wool or polyester for piping with contents ≤ 10°C, except for the following:

- To provide a fire rated building penetration.
- For filling air gaps around valves and fittings.

6.9.2.9 Vapour Barrier

If vapour barrier performance is documented, provide a system with a vapour barrier classification of High to AS/NZS 4200.1.

6.9.2.10 Adhesives

Ductwork

Suitable for bonding facing to the insulation. Apply in an even coat.

Fire hazard properties - Smoke developed index: 0.

Low VOC properties.

Pipework

Mastic vapour barrier: Water vapour permanence to AS 1301.419s Condition B, or ASTM E96/E96M.

- Chilled water pipes: ≤ 15 ng/N.s.
- Cold water pipes: ≤ 50 ng/N.s.

6.9.2.11 Aluminium Foil Laminate Sheet

Ductwork

To AS/NZS 4200.1 as follows:

- Internal insulation heavy duty prior to perforation.
- External insulation heavy duty unperforated.

Test criteria: To UL 181 with performance to AS 4254 table 2.8.2.

Pipework

To AS/NZS 4200.1.

Glass fibre reinforced, aluminium foil-paper laminate.

Duty classification to AS/NZS 4200.1, Heavy duty.

Water vapour classification to AS/NZS 4200.1, High (permeance ≤ 0.002 µg/N.s).

6.9.2.12 Aluminium Foil Laminate Tape

Ductwork

To AS 4254 clause 2.2.1.

Label 'Compliant with AS 4254' at least every 200mm.

Adhesive non-toxic, high tack, synthetic pressure-sensitive type.

Liner silicone coated paper.

Backing aluminium foil laminate.

Pipework

Adhesives non-toxic, high tack, synthetic pressure-sensitive type.

Liner to be silicone coated paper.

Backing to be glass fibre reinforced, aluminium foil-paper laminate.

Minimum width 50mm.

Mechanical properties to AS 4254.

6.9.2.13 Elastomeric Foam Insulation

Ductwork

Chemically blown closed cell nitrile rubber in sheets or rolls. Provide with a smooth natural finish and vapour barrier properties.

To ASTM C534.

Physical properties:

- Thermal performance: As for the attached duct.
- Moisture absorption: Non-hygroscopic.
- Water vapour permeability: ≤ 0.065 ng/Pa.m.s.
- Non-chloride bearing.

Adhesive fix and seal exterior joints. Provide only solvent-based adhesive supplied by insulation manufacturer and designed specifically for the material being used.

Metal sheath insulation where:

- Exposed to sunlight.
- Subject to mechanical damage.

Alternatively where exposed to sunlight but not exposed to mechanical damage, provide 2 coats of tintable, water-based, rubberised, UV resistant, flexible paint finish to outdoor installations.

Pipework

Chemically blown closed cell nitrile rubber in tubular sections for pipe insulation, in sheets for insulating pipe fittings, and in sheets or rolls for large pipes, tanks, vessels and heat exchangers. Provide with smooth natural finish and vapour barrier properties.

To ASTM C534.

Physical properties:

- Non-chloride bearing
- Moisture absorption: Non-hygroscopic.
- Water vapour permeability: ≤ 0.065 ng/Pa.m.s.

Adhesive fix all joints. Use only solvent-based adhesive supplied by insulation manufacturer and designed specifically for the material being used.

6.9.3 Execution – Ductwork

Insulation Thickness

Duct Location	R value (m2.K/W)	Maximum Thickness (mm)
Rigid supply or return ductwork in non-air-conditioned spaces or voids that may be considered “external” to the thermal envelope, including plant rooms and roof/ceiling/subfloor spaces as applicable	0.68	25
Flexible air ducts less than 3m in length to an outlet or from an inlet (temporary works only)	0.68	25
Semi rifid air ducts less than 1m in length to an outlet or from an inlet	0.68	25
Rigid supply ductwork exposed to view in air-conditioned areas	0.68	25
Rigid return ductwork exposed to view in air-conditioned areas	0.68	25

6.9.3.1 Fixing Devices

To AS 4254 clause 2.7.

Pins stud welded fully annealed metallic coated steel.

Speed clips bevel edged metallic-coated steel with an area not less than that of a 25mm circle. Secure speed clips flush to the face of the insulation.

Cut off excess length of pins after insulation and speed clips have been applied or bend parallel with the insulation surface. Cover fixing pins and speed nuts on external insulation with aluminium foil laminate tape.

6.9.3.2 Insulation Overlap

Provide an overlap of at least 300mm where insulation changes from the inside of the duct to the outside.

6.9.3.3 Joints

Install insulation with the least number of joints practicable.

If insulation is applied in more than one layer, stagger longitudinal and end joints.

6.9.3.4 Insulation Near Moisture Producing Equipment

Where the likelihood exists of moisture accumulation inside ducts, in the vicinity of moisture producing equipment use only external insulation.

Metal sheath insulation in plant rooms and where nominated in the Ductwork insulation schedule.

6.9.3.5 Vapour Barriers

Free from perforations and leaks, continuous, and sealed continuously at penetrations.

Place vapour barriers on the side of the insulation that will be warm during cooling mode operation.

6.9.3.6 Application Of Tapes

Tape width ≥ 72mm.

Make sure surfaces are dry and free of dust and grease before applying tapes.

6.9.3.7 Completion Of Fabrication

After each length of duct or each fitting has been insulated inspect and remove any off cuts, drill swarf or other loose material.

Store under cover and protected from weather and the entry of foreign matter.

6.9.3.8 Internal Laminate Faced

Semi-rigid board or batt.

Surface facing factory applied perforated aluminium foil laminate.

6.9.3.9 Internal Laminate Faced Application

Cover parts of ducts designated to be insulated, with individual pieces of insulation for each side of the duct. Where this is not possible, butt join edges of adjacent pieces. Where multi-layers are used (round or oval ducts) stagger all joints.

6.9.3.10 Internal Laminate Faced Joins In Insulation

Cover joins with 100mm wide strip of facing material or tape located centrally over the join.

Longitudinal joins locate behind corner angles or cover strips.

6.9.3.11 Internal Laminate Faced Fixing Method

Select from the following:

- Corner angle and end nosing method.
- Free edge method.
- Fixing pins provide to AS 4254 clause 2.7.1 (g).

6.9.3.12 Internal Laminate Faced Corner Angle And End Nosing Method

Corners, overlap insulation on adjacent sides at corners. Hold insulation in position with metallic-coated steel corner angles. Fix corner angles under the turn back of the end nosing. For corner angles longer than 1600mm provide additional fixing at 1600mm maximum centres.

Corner angles:

- Ducts with faces < 300mm : 25 x 25 x 0.55mm, minimum.
- Other ducts: 40 x 40 x 0.55mm, minimum.

End nosings, at ends of ducts, hold insulation in position with U-shaped metallic-coated steel end nosings, with edges crimped towards the surface. Rivet end nosings to ducts.

Size 0.55mm thick with a minimum 50mm turn back over the insulation.

Square cut and butt tightly together edges of adjacent pieces of insulation. Cover with 50 x 0.55mm metallic-coated steel strip. Rivet cover strips under corner angles or under turn-back of end nosings. For cover strips longer than 1600mm , provide additional fixing at 1600mm maximum centres.

Fixing pins for ducts with faces 300mm, fix the insulation at 300mm maximum centres with at least one row per duct face.

6.9.3.13 Internal Laminate Faced Free Edge Method

Use only where larger duct side is 300mm.

Extend insulation proud of ductwork at each end, to provide cushion joints that fully seal during assembly.

6.9.3.14 Internal Metal Faced

Insulation type:

- Rectangular ductwork: Semi-rigid batts.
- Circular and oval ductwork: Flexible batts.

Surface facing perforated metal.

6.9.3.15 Internal Metal Faced Application

Cover parts of ducts designated to be insulated with individual pieces of insulation for each side of the duct. Where this is not possible, butt join edges of adjacent pieces. Overlap adjacent sides at corners.

6.9.3.16 Internal Metal Faced Rectangular Ductwork

Support insulation against duct surfaces with metal facing, cut and folded to the inside dimension of the duct to form overlapping joints at corners. Rivet the overlap at 300mm maximum centres.

Facing material, 0.55mm metallic-coated steel uniformly perforated with 2.5mm diameter holes providing 10% open area.

At ends of ducts hold insulation and metal facing in position with U-shaped metallic-coated steel end nosings, with edges crimped towards the surface. Rivet end nosings to ducts and rivet the overlap with the metal facing at 300mm maximum centres, with at least one rivet per duct face.

Nosing size 0.55mm thick with a minimum 25mm turn-back over the metal facing.

Fixing Z section 0.55mm metallic-coated steel fastened to ductwork and to facing with blind rivets. Provide adhesive cloth tape between the Z section and the duct. For duct sides over 600mm, hold in position at 600mm maximum centres with at least one row of rivets per duct face. Arrange to prevent condensation on cold surfaces.

6.9.3.17 Internal Metal Faced Circular Ductwork

Metal facing material, metallic-coated steel uniformly perforated with 2.5mm diameter holes providing 10% open area.

Fabricate the facing in the same manner as the circular duct, with helical lock seams for longitudinal joints. Lap transverse joints in the facing in the direction of air flow with a minimum overlap of 75mm. Wrap insulation around the facing so that the surface designed to be exposed faces the air stream, and fix with polypropylene straps. Slide the insulated cylinder into the circular ductwork sections. Where the insulation is terminated, and at joints, provide end caps or channels.

Metal Facing Table

External duct diameter (mm)	Metal facing thickness (mm)
≤ 650	0.6
>650, ≤ 950	0.8
>950, ≤ 1250	1

6.9.3.18 Internal Metal Faced Location

Apply metal facing to internal insulation in the following locations:

- 300mm each side of fire, smoke and volume control dampers.
- Air handling plant casings and plenums.
- All other locations where insulation may be subject to mechanical damage.

6.9.3.19 Internal Insulation

Install internal acoustic insulation to ductwork where shown on the drawings, and also to all supply air and return air ducting within plantrooms and all supply and return air ducting.

Thickness: as shown on drawings.

Internally insulate all air conditioning ductwork exposed to the weather.

Include all bends, branches and transitions. Fit double skin acoustic splitters to all mitre and close radius bends of internally insulated ducting.

Air Handling Units and Plenums: Provide 50mm thick acoustic lining with perforated metal to all internal surfaces of air handling units and supply/return plenums.

Register plenums: Provide 25mm thick internal acoustic insulation to all register plenums.

Type: 32 kg/m³ glasswool with aluminium foil tri-laminate encapsulation.

Sound Absorption Coefficient: Minimum normal incidence sound absorption coefficients of insulation and facing to AS1935, Acoustics – determination of sound absorption coefficient and impedance in impedance tubes.

Normal Incidence Sound Absorption Coefficients to AS1935 (min)

Frequency Hz	250	500	1000	2000
Insulation - 50mm 32kg/m3 with Al foil laminate	0.42	0.85	0.92	0.73

Internal Facing

Unperforated aluminium foil laminate for all internal insulation excepting for areas to be metal faced

Ducting and plenums in smoke spill systems, circular ducting, air handling unit housings and plenums over 1.5m high and ducts where air velocity may exceed 8 m/s: enclosed with perforated sheetmetal

Acoustically lined kitchen exhaust ducts: Encapsulated in imperforate material such as polyethylene terephthalate (e.g. ICI melinex) not exceeding 23mm thick and resistant to steam cleaning, enclosed by perforated sheetmetal

Application

Cover interiors of ducts using individual pieces of insulation for each side of the duct. Tightly butt edges of adjacent pieces.

Joints

General: Cover joints using 63mm wide aluminium foil laminate tape.

Longitudinal joints: Locate behind corner angles or cover strips.

Transition from internal to external insulation: Overlap materials 150mm. Apply sheetmetal retainers to ends of lining and wrap exposed end of external insulation with 150mm wide aluminium foil laminate tape. Apply mastic sealant to all seams and joints.
Fixing Method

Corners: Overlap adjacent sides at corners. Hold insulation in position using zinc-coated steel corner angles. Fix corner angles under the turn back of the end nosing. For corner angles longer than 1.6m provide additional fixing at 1.6m maximum centres.

Corner angles:

Ducts with faces <300mm: 25 x 25 x 0.5mm, minimum.

Other ducts: 40 x 40 x 0.55mm, minimum.

End nosings: At ends of ducts, hold insulation in position using U-shaped zinc-coated steel end nosings, with edges crimped towards the surface. Rivet end nosings to ducts.

Size: 0.5mm thick with a minimum 50mm turn back over the insulation.

Butt joints: Square cut and butt tightly together edges of adjacent pieces of insulation. Cover with 50 x 0.5mm zinc-coated steel strip. Rivet cover strips under corner angles or under turn-back of end nosings. For cover strips longer than 1.6m, provide additional fixing at 1.6m maximum centres.

Fixing pins: For ducts with faces ≥300mm, fix the insulation at 300mm maximum centres with at least one row per duct face.

Perforated Sheet Metal Liner

Metal facing material: Zinc-coated steel uniformly perforated with 2.5mm diameter holes providing 10% open area.

Rectangular ductwork

Support insulation using perforated sheetmetal liner cut and folded to form overlapping joints at internal corners. Rivet the overlap at 300mm maximum centres.

End nosings: At ends of ducts hold insulation and metal facing in position using U-shaped zinc-coated steel and nosings, with edges crimped towards the surface. Rivet end nosings to ducts and rivet the overlap with the metal facing at 300mm maximum centres, with at least one rivet per duct face.

Nosing fixing: Use Z section 0.5mm zinc-coated steel with a minimum 25mm turn-back over the metal facing and fastened to ductwork and to facing using blind rivets. provide adhesive cloth tape between the Z section and the duct. For duct sides over 600mm, hold in position at 600mm maximum centres with at least one row of rivets per duct face. Minimise cold bridging.

Circular ductwork

Provide perforated sheetmetal liner with helical lock seams. Lap transverse joints in the direction of air flow with a minimum overlap of 75mm. Wrap insulation around the facing with the sealed surface facing the air stream, and fix with polypropylene straps. Slide the insulated cylinder into the circular ductwork sections. Provide end caps or channels where the insulation is terminated and at joints.

6.9.3.20 External Laminate Faced

Insulation type flexible batts or blanket.

Surface facing factory applied aluminium foil laminate.

6.9.3.21 External Laminate Faced Application

Wrap insulation around the outside of ducts, covering the parts designated to be insulated. Minimise the number of joints.

Joints square cut and butt together the edges of adjacent pieces of insulation.

Apply a single piece of insulation to each face of a bend or transition. Insulate bends and transitions on round and flat oval ducts with individually mitred gores cut to fit the fitting.

Seal the vapour barrier at joints with 100mm wide aluminium foil laminate tape, applied centrally over the joint. Where the insulation is impaled over pins, seal the vapour barrier by covering pins with water-based mastic vapour barrier or reinforced aluminium foil faced tape at least 100 x 100mm.

Maintain insulation thickness over flanges, joints, stiffeners and other items that protrude from the face of the duct. Use one of the following methods:

- Carry the insulation material over the protruding item without cutting or joins.
- Insulate with 150mm wide strip of the same material as used for the duct. Fix with a row of pins and speed nuts on each side of the protruding item. Provide a continuous vapour barrier.

Apply proprietary 120mm wide polyolefin foam flange strips over flanges, joints and stiffeners.

6.9.3.22 External Laminate Faced Fixing Method

Materials other than polyolefin foam, select from the following:

Pin method: Provide pins to each face of the duct as follows:

- Horizontal ducts < 380mm wide: Pins not required.
- Horizontal ducts > 380, < 760mm wide: One row of pins along centreline to side and bottom duct faces at 380mm maximum centres.
- Horizontal ducts ≥ 760mm wide: Pins spaced at 380mm maximum centres.
- Vertical ducts <610mm wide: Pins not required.
- Vertical ducts ≥ 610mm wide: Pins spaced at 380mm maximum centres.

Strap and pin method: Provide 12mm wide polypropylene strapping at maximum 600mm intervals.

- Horizontal ducts ≥ 600mm wide: Hold insulation in position on the underside with fixing pins spaced at 400mm maximum centres with at least one row per duct face.
- Vertical ducts ≥ 600mm wide: Provide pins to all faces at 400mm maximum centres.
- Corner angle and strap method: Provide metallic coated sheet steel corner angles on all four sides of the duct. Retain with 12mm wide polypropylene strapping at maximum 750mm intervals. Provide angles as follows:
- 25mm nominal thickness insulation: 38 x 38mm.

- 50mm nominal thickness insulation: 63 x 63mm.
- Polyolefin foam: Provide pins spaced 50mm from all edges and spaced 200 to 300mm apart in all directions.

6.9.3.23 External Laminated Faced And Metal Sheathed

Insulation type semi-rigid batts.

Surface facing factory applied aluminium foil laminate.

External protection metal sheathing.

6.9.3.24 External Laminated And Metal Application

Comply with External - laminate faced.

Support insulation against the duct surfaces with 0.55mm metallic-coated steel cut and folded to the outside dimensions of the insulated duct.

Lap joints in sheathing at least 30mm and rivet at 100mm centres. Factory made joints may be of the grooved seam or spot welded type. Where necessary, provide for sheathing removal for maintenance or access, by providing self tapping screws that do not penetrate the vapour barrier.

If exposed to weather, seal joints with silicone mastic sealant.

6.9.3.25 Plenum Boxes On Air Outlets

Internal insulation, with perforated aluminium foil laminate, black finish.

Minimum insulation R value: 0.4 m2.K/W.

Turn facing back over raw edges of insulation for at least 75mm and bond the turn back to the insulation before installation. Provide fixing pins at 250mm maximum centres with at least one pin per face. Fully bond insulation around neck with adhesive.

6.9.3.26 Dampers

Internal: Leave clearance between insulation and edges of the splitter or manually operated damper blades.

External: For manual and motorised dampers, provide removable insulated sheet metal top hat sections to encase dampers.

6.9.3.27 Access Doors

Provide insulation to access doors and openings. Arrange to prevent condensation on cold surfaces.

6.9.3.28 Insulate Duct Flexible Connections

Insulate if the temperature of the air inside the duct may cause condensation on the outside of the flexible connection.

6.9.3.29 Insulate Duct Flexible Connections Method

If the insulation of the connecting ductwork is external laminate faced on one or both sides of the flexible connection, insulate duct flexible connection as required in the External laminate faced clause.

Any other insulation system, insulate duct flexible connection with elastomeric foam as required in the Elastomeric foam insulation clause.

6.9.4 Execution – Pipework

6.9.4.1 General

Do not apply insulation to piping joints until piping pressure testing is complete.

Preparation: Before installing insulation, remove weld slag, rust, grease and the like from the surface of the pipe and ensure it is clean and dry. For black steel pipe, apply one coat water-borne primer for steel to AS 4089 Type 3.

Do not apply insulation at supports until the spacers, vapour barrier (if any) and metal sheathing (if any) has been installed.

Install insulation with the least number of joints practicable.

If insulation is applied in more than one layer, stagger longitudinal and end joints.

6.9.4.2 Insulation Thickness

Minimum Piping Insulation Thickness Table

Temperature of piping contents ºC	Maximum thermal conductivity at mean temperature (W/m.K)	Nominal pipe size DN 15-40	Nominal pipe size DN 50-80	Nominal pipe size DN 100-125	Nominal pipe size DN 150	Nominal pipe size DN 200	Tanks, vessels and heat exchangers
≥ - 20º, <2ºC	0.037 at 20ºC	50	63	75	75	100	100
≥ 2º, <20ºC	0.037 at 20ºC	38	38	50	50	50	63
≥ 40º, <90ºC	0.037 at 50ºC	38	38	50	50	50	50
≥ 90º, <120ºC	0.038 at 65ºC	38	38	50	50	50	100
≥ 120º, <175ºC	0.042 at 90ºC	63	63	63	75	88	100
≥ 175ºC	0.047 at 120ºC	63	75	75	100	125	125

6.9.4.3 Cold Piping

Insulate piping carrying fluids at temperatures below ambient including chilled water piping, cold refrigerant and condensate piping, and associated valves and fittings.

6.9.4.4 Pump And Valve Insulation

Insulate all pumps, flanges, unions and valves as for attached pipework.

Arrange insulation so that it can be easily removed and refitted without damage and without reducing its insulating and vapour barrier performance. Locate joints in the insulation and sheathing to coincide with joints in the pumps, flanges, unions and valves. Secure sections with captive fasteners or latches.

6.9.4.5 Insulation Systems

Comply with the Insulation systems table for the selection and application of insulation systems.

Insulation Systems Table

Insulation system	Application for piping	Insulation material	Insulation surface facing	Insulation fixing material
Polyolefin foam	Cold	Polyolefin foam	Aluminium foil laminate as a vapour barrier	Adhesive
Cold system	Cold	Polystyrene foam Phenolic foam Polyurethane foam Polyisocyanurate foam	Aluminium foil laminate as a vapour barrier	Adhesive or oil based sealant

6.9.4.6 Cold Piping Systems

Polyolefin

Vapour barrier to be factory bonded aluminium foil laminate to insulation and provide a minimum overlap of 50mm at the longitudinal joint.

Extent of application of adhesive or sealant:

- To mating faces of insulation sections on joints between sections.
- To steel pipe to be insulated.
- To faces of insulation sections and pipe support blocks at joints.

Stagger longitudinal joints between sections a minimum of 75mm. Seal aluminium foil laminate overlap with contact adhesive or 50mm wide (minimum) self-adhesive aluminium foil tape, to complete the vapour barrier.

Butt joints 50mm minimum width aluminium foil laminate tape over joints. Neatly finish joints and provide a seal free of perforations or leaks.

Fix insulation at maximum 500mm centres with 12mm wide polypropylene, metallic-coated steel or aluminium straps.

For bends, cut insulation into segments and seal together with adhesive, or provide preformed bends, following bend contours. Fix to piping.

Cut insulation and form it to fit around fittings, valves and flanges. Provide loose mineral wool to fill air gaps and voids. Provide a continuous vapour barrier.

Elastomeric Foam Insulation

For straight and curved pipe provide preformed sections sized to suit the pipe. If practicable, do not slit. If slit, and for valves, fittings and large diameter pipes, fix with adhesive at joints.

Adhesive fix joints. Adhere to the pipe at end joints, for a distance of 25mm, to compartmentalise each section.

Provide metal sheath insulation:

- Where exposed to sunlight.
- Where subject to mechanical damage.

Where exposed to sunlight but not exposed to mechanical damage; provide 2 coats of tintable, water-based, rubberised, UV resistant, flexible paint finish to outdoor installations.

6.9.4.7 Sheathing

Location

Provide metal sheathing to all piping insulation (including buffer tanks):

- In plant rooms.
- Exposed to weather.
- Subject to mechanical damage.
- On valves, pipeline components and pumps in sheathed pipework.

Metal Sheathing

0.55mm thick aluminium, with stucco finish to conceal imperfections.

Cut and roll the metal sheathing to the correct size. Lap longitudinal and transverse joints a minimum of 40mm and arrange longitudinal laps to shed water. Cone down at terminations and transitions.

Fixing options:

- Clamp sheathing at 500mm maximum centres with 12 x 0.55mm aluminium sheet straps.

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

Provide pre-drilled lobster back bends containing at least 3 segments. Provide mitred elbows where the size of the piping or the radius of pipe bends do not allow the use of segmented bends. Provide each segment with an inner and outer swage formed at the transverse edges. Fix longitudinal joints with pop rivets of correct length so that the vapour barrier is not damaged. Further protect insulation vapour barrier with reinforced cloth tape where pop rivets are installed.

Weatherproof external joints and fixings with silicone sealant.

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

- Insulated strainers.
- Valves at pumps.
- Flow regulating valves.
- Control valves.
- Flexible connections.
- Demountable joints.
- Flow measuring devices.

6.9.4.8 Tank, vessel and heat exchanger insulation

Cold (< 20°C) Tanks, Vessels And Heat Exchangers

Polystyrene, phenolic, polyurethane or polyisocyanurate foam sheets.

Removable Covers

Provide removable insulated covers, attached with toggle action catches or self-tapping screws, to serviceable items.

Rigid Foam Sheet

Cold system refer to Insulation systems table.

Comply with Cold system.

Insulation layers to be sections cut to the shapes of tanks, vessels or heat exchangers, or sheets formed to fit the contours of tanks, vessels or heat exchangers. Apply the insulation in more than one layer. Glue the initial layer to tanks, vessels or heat exchangers and hold in place with 12 x 0.55mm metallic-coated steel straps, machine pulled, at 500mm maximum centres. Glue and strap subsequent layers to each other until the designated thicknesses are attained. Form ends with cut segments of insulation to match the contours of tanks, vessels or heat exchangers.

Joints to be staggered.

Elastomeric Foam Insulation

Adhere to total area of tank. Oversize at butt joints so that insulation is under compression. Seal joints with adhesive.

Method

Wrap insulation around the whole of the tank or vessel with joints tightly butted.

Installation: Form ends with cut segments of insulation to match the contours of the tank or vessel.

Fixing, 12 x 0.55mm metallic-coated sheet steel straps at 500mm maximum centres.

Metal Sheathing

To be 0.8mm aluminium sheet steel.

Install by cutting and rolling metal sheathing to the correct sizes. Lap longitudinal and transverse joints a minimum of 40mm and arrange longitudinal laps to shed water, with exposed edges swaged.

Clamp sheathing with 12 x 0.55mm aluminium sheet straps at 500mm maximum centres.

Weatherproof external joints and fixings with sealant.

6.10 LEAK DETECTION SYSTEMS

6.10.1 General

This section of the specification covers the design, supply, installation, testing, commissioning and thereafter maintaining of the Liquid Leakage Detection System during the twelve (12) months defect liability period.

The leak detection cabling system shall include the following capabilities:

- Provides alarm signals when any portion of the sensing cable becomes damaged/broken.
- If the cable becomes damaged or broken, the leak detection system shall continue to operate/monitor.
- Provides the alarm / leakage signal appropriate to the location of the leak (ie: records the distance from the end/start of the cable as applicable).

The Liquid Leakage Detection System shall be installed to the zones as shown in the drawings The contractor shall provide details shop drawings and subsequent finalised as-built drawings that clearly show the installed leak detection location and lengths.

The system components shall be designed to be installed according to pre-test limitations as approved or listed by a recognised testing laboratory. The installer must be approved by vendor for installation services at site.

All devices shall be designed for service encountered and shall not be readily rendered in-operative or susceptible to accidental operation. They shall be located, installed or suitably protected against mechanical, chemical or other damage, - which may render them in-operative. All devices for activating supplementary equipment shall be considered as integral parts of the system and shall function with system operation.

The complete system shall include an electronic system control panel, multiple control modules , distance type sensing cable and all required auxiliary accessories (such as hold down clips & tags/labels for the sensing cable). This system shall detect and locate multiple leaks simultaneously as well as cable break & power failure and activate the control panel alarm relays. The sensing cables shall be of such construction that no metallic parts shall be exposed to the environment. The system shall be provided with the flexibility of custom “cut-to-length” sensing cable to meet the exact length requirement at each area of protection and with pre-connectors sensing cable components. The system shall comply with CE, ESD (IEC 61000-4-5) and EMC (IEC61000-6-3 & IEC61000-6-1).

Individual leak detection systems shall be installed within each additional drain tray located below each fan coil unit serving the equipment rooms. These systems shall communicate alarms directly to the BMS.

6.10.2 System Performance

6.10.2.1 System Control Supervising Panel, Touch Screen Panel and Module

The System Control Supervising Panel shall have the ability to supervise and control up to 100 Modules and capable of monitoring up to a accumulated length of 19,200m (63,000 feet) of sensing cable and accumulated length of 1,000m (3,280 feet) for communication cable. These cables lengths shall not include the jumper cable.

The System Control Supervising Panel shall have a LCD display (4 lines X 20 characters) with backlight and a 90dB (max). buzzer with a silencing button. It shall also have LEDs indicating “POWER” (green), “LEAK” (red) and “TROUBLE” (red). (ie: “TROUBLE” means either cable break or power failure). The System shall sound an audible alarm upon detecting a “LEAK” and/or “TROUBLE”. If there is a cable break at any point along the sensing cable, the sensing cable length still in connection to the control units shall continue to function and detect leak (if any). This Fail-Safe Loop Back feature (Class A wiring) shall be incorporated as necessity to enhance the system capability. Once the alarm condition has been cleared, the System shall be capable to reset itself automatically.

The entire system must have the ability to be linked and supervised by a Touch Screen Panel with minimum screen size of 300mm display. This touch panel is able to pin-point leak location (i.e. highlight as a single point of leak location) exactly with the precision of +/-1m and display the zone map/floor plan accordingly with a “Red Dot”.

The Modules used at each site/zone shall be capable of adjusting the leak sensitivity level at site. For a liquid puddle size of about 20mm to 200mm shall be adjustable.

6.10.2.2 Centralised and Distributed Monitoring System

The System shall be capable of configuring into a Centralized and/or Distributed Monitoring system.

Centralised Monitoring System means: the System Control Supervising panel together with the Modules are housed in a custom enclosure panel at one location. This configuration shall provide ease of monitoring and installation of the battery back-up units and power supply source.

Distributed Monitoring System means: the System Control Supervising Panel is housed separately with the Modules. The Modules are mounted on each individual zone area (localized) as defined by client. This configuration shall provide a more reliable management of the system remotely and its independence power supply source.

6.10.2.3 Leak Sensitivity Adjustment

The individual Module used at each site/zone shall be capable of adjusting the leak sensitivity level at site. For a liquid puddle size of about 20mm to 200mm shall be adjustable.

6.10.2.4 Selective Site/Zone Alerting Capability

The individual Module at each monitoring site/zone shall have the capability to provide one separate dry contact relay output for selective remote site/zone faults alerting. Besides alerting via the System Control Panel, this feature shall be provided as an option to alert specific users or clients responsible for that particular site/zone and/or to activate localized solenoid valve which maybe use to control pressure water pipe.

6.10.2.5 Event Log Recording

The System Control Panel shall include an event log of up to 896 time and date stamped events stored on non-volatile memory and on a FIFO basis.

6.10.2.6 Power

The System shall be powered by 230 +/- 15% Vac, 50/60 Hz single phase. It shall be provided with the option to be powered by 12 to 24Vdc source.

6.10.2.7 Communication Interface

The System Control Panel output shall have two separate dry contacts which is for liquid leakage and for cable break/power failure. The dry contact relays output shall have a voltage free contact (N.O/N.C.) for external interfacing.

In addition, the System Control Panel shall be provided as an option for 4-20mA analogue signal or high level RS-485 (MODBUS) or TCP/IP (MODBUS) serial communication interface with the Building Management System (BMS).

6.10.2.8 Security

The System Control Panel shall need a password to access to the system menu and data.

6.10.2.9 Fail-Safe Loop Back (Class A Wiring or Token Ring)

The entire system must be able to connect as a Fail Safe Loop Back configuration. Thus, during any cable break point, the sensing cable that is still linked back to the system is still able to perform and activate an alarm when there is liquid leakage even before the cable break is restored.

6.10.2.10 Custom Sensing cable length to meet exact length requirements for each site

The sensing cable must be cut to the exact length to meet each zone or location requirement. No extra sensing cable length is allowed to be coiled up at the end of each zone or location.

6.10.3 Products

6.10.3.1 Sensing Cable

The liquid sensing cable shall detect the presence of water and other conductive liquids. The cable shall consist of four wires: two black wires serve as liquid sensors and two other wires serve as continuity links. All four wires shall be helically winded around a central core (function as carrier) and away from the surface area of this core (to protect the four wires physically). The cable shall be made of material which is non-flame propagating and self-extinguishing.

UL910 or NFPA262 standard of cable shall be supplied for environment that required to meet the fire standard or strong acid (such as highly concentrated sulphuric acid).

If required, cleaning the cable without removing it shall be possible using a slightly damp cloth.

The cable shall be dried and auto reset at the control unit within 15 seconds upon complete removal of leaked liquid. No air-dryer shall be required to dry the cable.

6.10.3.2 Accessories

Complete system accessories such as the connectors, jumper cable, hold-down clip & Tag/Label shall be provided by the system manufacturer.

6.10.3.3 Installation

The system shall be installed by qualified contractors, with the procedure recommended by the manufacturer.

6.10.4 Testing and Commissioning

The whole work shall be carried out to the entire satisfaction of the Project Engineer/Manager. The completed installation shall be in full operational condition before testing is to be carried out. The Contractor shall commission the entire installation in the presence of the Project Engineer/Manager and manufacturer’s representative. Test results shall be recorded in writing certified by the Contractor and the manufacturer’s representative.

The Project Engineer/Manager shall be at liberty to order such tests to be carried out to verify the reliability and performance of the system and check compliance with specifications herein provided. The Contractor shall provide all equipment and things necessary and bear all costs for executing the necessary test except where specified herein.

All defects and deficiencies in performance, reliability, safety, efficiency, appearance of finish shall be rectified and resettled by the Contractor to the entire satisfaction of the Project Engineer/Manager before acceptance.

Upon the completion of the work herein called for and the satisfactory fulfilment of all contractual requirements, the Contractor shall then commission the system installed in the presence of the Project Engineer/Manager and manufacturer’s representative. The system shall be in complete and perfect operational condition by then. The Contractor shall on commissioning conduct an instructional briefing to the users concerned on the safe and proper use of the system.

6.10.5 Servicing and Maintenance

The Contractor shall be required to provide maintenance service to the installation from the date of commissioning for a period of twelve (12) months during the Defect Liability Period (DLP). All costs for the maintenance service during (DLP) shall be borne by the Contractor.

During the maintenance period the Contractor shall undertake to replace, free of charge, all defective parts and materials as and when found and within twenty four (24) hours following notification of such defects from the employer.

6.11 MECHANICAL ELECTRICAL WORKS

6.11.1 General

This section relates to the detail design, supply, fixing and testing of electrical work and accessories, associated with simple, air conditioning, packaged plant and mechanical systems

6.11.1.1 Comply

Comply with the Electricity (Safety) Regulations 2010, AS/NZS 3000, AS/NZS 3008.1.2, AS/NZS 4251.1 and the New Zealand Electrical Codes of Practice for listed and prescribed work and with the utility network operator's requirements. Arrange for the required inspections of listed work. Pay all fees.

6.11.1.2 Qualifications

Carry out work under the supervision of an electrical licensed supervisor.

6.11.1.3 Safety Of Installation - Design By Electrician

Before installation work commences provide a declaration of conformity. The declaration of conformity is to comply with the Electrical (Safety) Regulations (2010), regulations 57 and 58. It must be signed by the designer of the installation.

6.11.1.4 Certificate Of Compliance

Supply a certificate of compliance to the owner, as required by the Electricity (Safety) Regulations (2010) regulation 67, within 20 days of completion as required by regulation 69.

- Arrange for the NUO to inspect before the meter installation, listed work inspection, polarity check and supply becoming live.
- Arrange for an inspector to inspect as required by regulation 70.

6.11.1.5 Producer Statements

Provide a 'producer statement - design' and 'producer statement - construction' to the satisfaction of the Building Consent Authority, for the complete mechanical electrical installation.

6.11.1.6 Compliance Schedules

Provide compliance schedules for the installation to the satisfaction of the territorial authority, in accordance with the New Zealand Building Code requirements for the mechanical electrical installation.

6.11.2 Products

6.11.2.1 Cables

Refer to the main electrical specification for requirements.

6.11.2.2 Wiring Systems

Provide wiring systems appropriate to the installation conditions and the function of the load.

6.11.2.3 Power Cables

Refer to the main electrical specification for requirements.

6.11.2.4 Cable Supports And Ducts

Cable trunking systems to AS/NZS 4296.

Conduits and fittings for electrical installations to AS/NZS 2053 Parts 1, 2, 3, 4, 5, 6, 7 and 8.

6.11.2.5 Steel Conduit

To AS/NZS 2053, hot-dip galvanized to AS/NZS 4680, for damp or exterior situations and complete with fittings and accessories brand matched as required by the conduit manufacturer.

6.11.2.6 Heavy Duty Rigid PVC Conduit

Not acceptable for use through the project.

6.11.2.7 Rigid PVC Conduit

Not acceptable for use through the project.

6.11.2.8 Flexible Conduit

Refer to the main electrical specification for requirements.

6.11.2.9 Ducted Wiring Enclosures

Provide purpose-made ducts. Provide rigid supports. Round off sharp edges and provide bushed or proprietary cable entries into metallic ducting.

Provide purpose-made accessories and covers to match the duct system. Provide screw-fixed covers or clip-on covers removable only with the use of tools.

Except for horizontal runs where the covers are on top, support wiring with retaining clips at intervals of not more than 1000mm.

6.11.3 Switchboards

To AS/NZS 3439.3.

Incorporate proprietary busbar systems for the interconnection of isolators, circuit breakers and other circuit protection devices.

Provide lockable doors with a circuit card holder unless enclosed in cupboards or in an area which is not readily accessible to the public.

IP rating IP42 minimum.

Weatherproof IP56 minimum (for external boards)

All switchboards/distribution board shall include fully enclosed separate sections for the independent housing of LV components, SCADA connection components and BMS/Comms components.Wall mounted for proprietary switchboards or floor mounted if assemblies > 2 m2.

Ventilation to maintain design operating temperatures at full load.

6.11.3.1 Switchboard Components

Rated duty, uninterrupted in non-ventilated enclosure.

Rated making capacity (peak), ≥ 2.1 x fault level (RMS) at assembly incoming terminals.

Utilisation category to AS 60947.1 clause 4.4.

Circuits consisting of motors or other highly inductive loads at least AC-23.

Select and adjust protective devices to discriminate under over-current and earth faults.

6.11.3.2 Switch-Isolator Units

To AS 60947.1 and AS/NZS 3947.3.

6.11.3.3 Moulded Case And Miniature Circuit Breakers

Moulded case breakers to AS 60947.1 and AS 60947.2.

Miniature circuit breakers to AS/NZS 60898.1 or AS 3111, minimum 6 kA rated.

Independent manual operation including positive ON/OFF indicator.

Trip type, moulded case breakers.

Miniature circuit breakers, fixed thermal, fixed magnetic.

Isolation facility required.

Current limiting, moulded case breakers.

Utilisation category, moulded case breakers:

- Final subcircuits category: Category A.
- Mains and submains: Category B.

Trip settings as required, seal, and label.

Connect interchangeable and integrally fused trip units so that trip units are not live when circuit breaker contacts are open.

6.11.3.4 Fuses With Enclosed Fuse Links

To AS 60269.1, AS 60269.2.0 and AS 60269.2.1.

Fuse links, enclosed, high rupturing capacity type mounted in a fuse carrier.

Breaking range and utilisation category:

- Distribution/general purpose: gG.
- Motors: gM.

Mount fuse-holders so that fuse carriers may be withdrawn directly towards the operator and away from live parts. Provide fixed insulation which shrouds live metal when the fuse carrier is withdrawn.

Provide barriers on both sides of each fuse link, preventing inadvertent electrical contact between phases by the insertion of screwdriver.

Provide 3 spare fuse links for each rating of fuse link on each assembly. Mount spares on clips within the spares cabinet.

Provide 3 spare fuse holder carriers for each size of fuse holder carriers on each assembly. Mount spares on clips within the spares cabinet.

Busbar mounted fuse holders, fuse carriers with retaining clips, minimum fuse holder 32 A.

6.11.3.5 Contactors

To AS 60947.4.1.

Enclosed, block type, air break, electro-magnetic.

Poles: 3

Rated operational current: The greater of:

- Full load current of the load controlled.
- ≥ 16 A.

Provide auxiliary contacts with at least one normally-open and one normally-closed separate contacts with rating of 6 A at 230 V a.c., utilisation category: AC-1.

6.11.3.6 Control Devices And Switching Elements

To AS 60947.1 and AS 60947.5.1.

Rotary switches, cam operated type with switch positions arranged with displacement of 60°.

Off position at the 12 o'clock position. Test positions must spring return to off position.

Control relays: Generally Auto / Off / Manual

Fire alarm relays: To AS 60947.5.1.

6.11.3.7 Indicator Lights

To AS 60947.5.1.

6.11.4 Motors

Provide motors selected in conformance with AS 1359.101, the application load characteristics, motor manufacturers' recommendations and the following:

- Motors ≥ 0.75 kW: Three phase.

6.11.4.1 Motor Rating

To AS 1359.101.

Maximum power rating, the greater of the documented minimum motor size and next preferred standard frame size above the maximum load of the driven equipment.

Duty: ≥ S1.

Class: ≥ 'continuous running'.

Speed: ≤ 1500 r/min.

6.11.4.2 Starting Performance

Designation: ≥ Design N to IEC 60034-12.

Speed and torque to suit the driven equipment. Ensure each motor develops torque relative to the starting load of the driven machine such that it runs up to full speed steadily and within a time period compatible with motor winding temperatures, class of insulation and rating of the starting equipment.

6.11.4.3 Motor Efficiency

All motors to be High Efficiency to AS/NZS 1359.5 Table A3 or Table B3.

6.11.4.4 Motor Environment

Site operating conditions to AS 1359.101 Section 5.

Electrical operating conditions to AS 1359.101 Section 6.

6.11.4.5 Motor Enclosure

Provide enclosures appropriate to the environment in which the motor operates.

Motor enclosure classification ≥ IP44 to AS 60529.

6.11.4.6 Motor Cooling

To AS 1359.106.

Classification ≥ IC01.

6.11.4.7 Motor Marking

Terminals to IEC 60034-8.

6.11.4.8 Motor Mounting

IM classification to AS 1359.107.

6.11.4.9 Motor Noise

To AS 1359.109.

6.11.4.10 Motor Vibration

To AS 1359.114.

Grade ≥ N (normal).

6.11.5 Variable Speed Drives

Variable speed drives shall be of the electronic variable frequency type suitable for the control of three phase squirrel cage induction motors, having operating characteristics compatible with the motor application.

The output shall be variable frequency of 1 to 50 Hz proportional to input signal to an accuracy of 1%. The voltage/frequency ratio shall provide the highest efficiency possible for a centrifugal load.

When operating at 50 Hz controller efficiency shall not be less than 95% and shall not cause an increase in motor losses of more than 1.5%.

Controllers shall be fully enclosed, protected to IP42 and wall mounted. Units shall not be mounted within switchboards.

Wiring to or from variable speed drives shall be steel wired armoured or neutral screen cable.

Controllers shall be capable of operating at 400C and 90% RH (non-condensing).

Radio interference of starters and generated supply power harmonics shall not exceed limits allowed by the relevant authorities.

Controllers or associated contactors shall accept an input signal for thermistor protection of the motor.

Acceleration and deceleration times shall be adjustable between 1 to 150 seconds.

The controller shall provide an output signal of 4 - 20 mA or 0 - 10V proportional to load.

The following features shall be provided:

- power interruption (or power restoration) shall not damage the starter
- controllers shall be capable of starting motors which are rotating
- LED indicators shall be provided for ON and RUN and for each type of trip incorporated

- motor current protection
- semi-conductor fuse protection (including spare fuses)
- over temperature trip
- phase loss trip
- over voltage trip
- under voltage trip
- remote trip through volt free contacts
- speed control inputs through either 4 - 20 mA or 0 - 10V signals

6.11.6 Starters

To AS 60947.1.

Electromechanical motor starters to AS 60947.4.1.

6.11.6.1 Starters Selection

Provide motor starters selected according to the following:

- Electricity distribution network limitations for starting currents and voltage flicker.
- Torque requirements for the motor load.
- Heating effects on the motor.
- Voltage drop during start due to starting currents.
- Time required to accelerate from rest to full speed.
- Number of starts per hour.

6.11.6.2 Starters Performance

Rated operational current, at least the full load current of the load controlled.

Rated duty, Intermittent class 12.

Utilisation category, AC-3.

Mechanical durability ≥ 3 million cycles to AS 60947.4.1.

Electric durability ≥ 1 million operations at AC-3 to AS 60947.4.1.

Mount with sufficient clearance to allow full access for maintenance, removal and replacement of coils and contacts, without the need to disconnect wiring or remove other equipment.

Provide separate auxiliary contacts with at least one normally-open and one normally-closed contacts with rating of 6 A at 230 V a.c., utilisation category: AC-1.

If the number of auxiliary contacts exceeds the number which can be accommodated, provide separate slave relays.

6.11.6.3 Direct-On-Line Starters

Direct-switching electromagnetic contactor type.

6.11.6.4 Motor Protection

Provide over-current protection with manual reset giving overload protection in each phase of supply as part of the equipment assembly for each motor starter.

Provide at least one normally-open and one normally-closed set of contacts rated at the starter control circuit voltage and minimum 4 A. Connect contacts to open the starter at the setting temperature.

Utilisation category AC-11.

Ensure relays are not affected by the shock of mechanical contactor operation. Provide sufficient clear space for the disconnection, removal and replacement of heaters, without disconnecting other equipment and wiring.

6.11.6.5 Single Phase Motor Protection

Provide overload units matching the motor heating curve characteristics.

6.11.6.6 Phase Motor Protection

General: Provide thermal overload protection relays for each motor.

Provide the following:

- Triple pole relays with differential trip bar operation for single phase protection, and ambient temperature compensation.
- Thermal overloads connected directly to contactor by means of proprietary links, except where operated separately by current transformers.
- Current transformers, to operate protection type thermal overloads, saturating at 10 to15 times full load current, Class 10P.

6.11.7 Execution

6.11.7.1 Power Cables

Unless unavoidable due to length or difficult installation conditions, run cables without intermediate straight-through joints.

Individual wiring of extra-low voltage circuits: Tie together at regular intervals.

Identify multicore cables and trefoil groups at each end with stamped non-ferrous tags clipped around each cable or trefoil group.

Identify the origin of all wiring by means of legible indelible marking.

Cable systems in:

- Accessible concealed spaces: insulated and sheathed in non-combustible conduit (i.e. steel).
- Inaccessible concealed spaces: Cable in non-combustible conduit (i.e. steel).
- Plant rooms: Cable in non-combustible conduit (i.e. steel), or on tray or in duct.
- Plastered or rendered surfaces: Cable in non-combustible conduit (i.e. steel).
- Stud walls without bulk insulation: insulated and sheathed in non-combustible conduit (i.e. steel).
- Walls filled with bulk thermal insulation: Cables in non-combustible conduit (i.e. steel).

6.11.7.2 Unsheathed Cables

Provide permanently fixed enclosure systems, assembled before installing wiring. Provide draw wires to pull in conductor groups from outlet to outlet, or provide ducts with removable covers.

6.11.7.3 Conduit Systems

If exposed to view, install conduits in parallel runs with right angle changes of direction.

For conduits in roof spaces locate below roof insulation and sarking. In accessible roof spaces, provide mechanical protection for light-duty conduits.

Allow for thermal expansion/contraction of conduits and fittings due to changes in ambient temperature conditions. Provide expansion couplings as required.

Solar radiation protection required for exposed conduits and fittings.

Provide flexible conduit to connect with equipment and plant subjected to vibration. If necessary, provide for adjustment or ease of maintenance. Provide the minimum possible length.

6.11.7.4 Switchboard Marking And Labelling

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.

6.12 PUMPS

6.12.1 General

6.12.1.1 Standard

Generally to AS 2417

Accuracy of measurement tolerance factors: To AS 2417 Grade 2.

6.12.1.2 Design

Single operation

Provide pumps selected for:

- Constant falling head versus quantity curve.
- Stable operation.
- Duty point near the maximum efficiency point for the impeller diameter.

Parallel operation

If pumps operate in parallel, provide pumps selected for:

- Constant falling head versus quantity curve.
- Stable operation.
- Duty point near the maximum efficiency point for the impeller diameter.
- No instability when operating either singly or in parallel at the same shaft speed.
- Shut-off head difference between pumps > 10% of that of the pump with the lowest shut-off head.

Static Pressure

Static pressures scheduled are approximate.

Calculate system head as it will be installed including static lift and pressure drops across boilers, chillers, heat exchangers coils, cooling towers, control valves, piping and the like

Adjust pump and motor selections and power supply capacity as necessary to suit the installed system. Follow specified pump and motor selection criteria maintaining specified reserve capacity. Submit revised selections for review.

Selection for Energy Efficiency

Variable speed pumps are to be selected for optimal efficiency at 50% flow conditions with operation up to 60Hz to achieve the design flow and pressure.

6.12.1.3 Submissions

System pressure drop calculations. Calculations are to be completed and submitted prior to ordering of pumps. Pump head scheduled is approximate only.

6.12.1.4 Pre-completion tests

Submit type test curves for each size and type of pump.

Submit type test curves for each size and type of pump marked with the duty point or range.

6.12.2 End-suction centrifugal pumps

6.12.2.1 Standard

General: To ISO 2858 or DIN EN 733.

6.12.2.2 Type

Provide single stage, radially split, close coupled, end-suction, back pull out pumps.

6.12.2.3 Bases

Mount pumps and motors on bases sufficiently rigid to prevent distortion under normal operating conditions. Select from the following:

Cold-formed bases: Mild steel plate minimum 6 mm thick.

Fabricated bases: Fully welded fabricated from hot rolled steel channel sections.

Inertia bases: Cast concrete with fabricated steel base with reinforcing bars welded between base sections, and with a combined weight at least that of the pump and motor.

6.12.2.4 Mounting

Provide at least 4 height saving mounting brackets.

Provide spring mountings at each bracket as scheduled.

6.12.2.5 Drip trays

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

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

Drainage: Provide 25 mm diameter sockets for drainage. Drain to the nearest waste with DN 25 copper pipe.

Sealant: Seal between trays and pumps with silicone sealant.

6.12.2.6 Casing

Pressure rating:

- For systems with a design pressure ≤ 500 kPa: Minimum static test pressure of 1.6 MPa.
- For systems with a design pressure > 500 kPa: Minimum static test pressure of 1.6 MPa or 1.5 times the total of the pump shut-off head plus the static and system pressures, whichever is the greater.

Material:

- For fluid temperatures < 90°C, pumping clean water: Cast iron to AS 1830 Table 1 (ISO 185/JL/250), minimum.
- For fluid temperatures ≥ 90°C: Bronze, grade 836B.
- For open systems including cooling tower water and for pumping aggressive water: Bronze, grade 836B.

Drip well drainage: Provide embossed, drilled and tapped drainage holes in seal drip wells. Drain to AS/NZS 3666.1.

Jointing: Provide gaskets or O-rings, or both, compatible with the liquid to be pumped and shaped to prevent contact between the liquid and the casing fixings.

6.12.2.7 Connections

Piping connections:

- Screwed connections: Screwed female fittings to AS ISO 7.1. Provide union on each connection. Do not provide screwed connections for working pressures > 250 kPa, temperatures > 100°C or connections ≥ DN 50.
- Flanged connections: To AS 2129, minimum Table E or equivalent.

Fluid release: Provide embossed, drilled and plugged openings at the lowest casing points for drain cocks.

Pressure gauge tappings: Provide accessible, embossed, drilled and plugged openings integral with casings.

6.12.2.8 Rotating assemblies

Balancing: Statically and dynamically balance completed rotating assemblies.

Shaft: Solid grade 316 stainless steel, machined all over, free of stress concentrations.

- Maximum surface roughness: 25 µm, under sleeves, seals and bearings.
- Maximum deflection:
- Torsional: 0.002 radians.
- Lateral: 1 µm/mm of shaft length.

Impellers:

- Type: One piece shrouded type with machined sealing collars.
- Material: Grade 836B bronze.
- Securing to shaft: Use a key and locking nut.
- Locking nut: Grade 316 stainless steel, or bronze.

- Parallel operation pumps: Matched impellers.
- Maximum diameter: ≥ 90% of maximum impeller size for the casing.

Shaft sleeves: Provide a sleeve extending the full length of the seal housing.

Thrower rings: Fit water thrower rings to shafts.

6.12.2.9 Couplings for direct coupled pumps

Couplings: Direct couple pumps and motors with flexible spacer couplings.

Spacers: For rear access pumps, provide spacer couplings long enough to permit removal of rotating elements without disturbing piping connections or motor alignment. Provide a spigot for the flanged joint between the coupling and the spacer.

Coupling guards: Enclose couplings in coupling guards.

6.12.2.10 Bearings

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

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

6.12.2.11 Shaft seals

Provide seals compatible with the working conditions, including temperature and pressure of the fluid being pumped.

Mechanical seals: Provide carbon elements rotating against a ceramic stationary face.

Packed gland seals: Provide glands long enough to seal the fluid being pumped. Provide lantern rings if recommended for the particular duty.

Drains: Provide a drain from shaft seal well on pumps fitted with packed gland seals and all pumps on open water systems. Run drain to fall continuously to building waste.

6.12.2.12 Motors

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

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

Minimum degree of protection: IP54.

6.12.2.13 Marking

Direction of rotation: Provide permanent indication on the principal component of the casing, indicating the direction of rotation.

Name plates: Attach to the casing permanent labels indicating the following:

- Make.
- Model.
- Serial number.
- Casing material.

- Impeller material.
- Shaft material.
- Impeller diameter (if reduced).
- Seal type.

6.12.3 In-line circulating pumps

Comply with the requirements for End-suction centrifugal pumps except as follows.

6.12.3.1 Mounting

Orientation: Suitable for mounting with the shaft vertical or horizontal.

6.12.3.2 Construction

Impellers: Stainless steel or bronze. May be fixed to the motor shaft.

Radial bearings: Ceramic sleeve or ball bearing.

Axial bearings: Carbon/ceramic sleeve or ball bearing.

Pump housings: Cast iron or bronze.

Casing arrangement: Back pullout.

Shaft seals: Mechanical type.

Motor: Flanged.

6.12.3.3 Sealing

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

6.12.4 Installation

6.12.4.1 Pumps and motors

Adjust mountings so that units are level. Following connection and filling of piping, and before operation, align pumps and motors.

Maximum misalignment: < 50% of the manufacturer's recommended maximum.

Packing: Minimise the number of packers and shims.

Dowelling: Dowel pumps and motors after a running in period. Fix the position of the pump with dowels at diagonally opposite feet and, following final alignment, dowel the motor at diagonally opposite feet. Provide parallel type dowels.

6.12.4.2 Piping

Support pipes independently of pumps.

Connectors: Provide flanges, for removal of pump casings without disturbing piping. If the connecting piping is ≥ DN 50, screwed connectors with unions may be provided.

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

Pumps with packed gland seals: Drain drip well to the nearest waste with DN 25 copper pipe.

6.13 PIPING

6.13.1 General

This section is applicable to the detail design, supply, fixing and testing of:

- piping, valves, fittings and accessories used in air conditioning and mechanical systems
- including, chilled and refrigerant.
- including, strainers, isolating, non-return, level control, throttling, pressure relief, air relief and pressure reducing valves.

6.13.1.1 Standards

Pressure piping: Comply with AS 4041-2006, Pressure Piping to statutory requirements.
Water supply: To AS/NZS 3500:1.1, 1998 Performance requirements and AS/NZS 3500.1:2003 plumbing and drainage – water services.

6.13.1.2 Design

Base design pressures on the following:

- The maximum hydrostatic head at the location.
- The pump shut off head at the maximum impeller size for the pump casing.

Provide piping systems complete with all necessary piping, valves, supports, guides, drains, vents, expansion compensation and all fittings necessary for their safe and efficient operation.

Installation to follow the line of walls, ceilings, etc., and include all necessary offsets and arrange to avoid interference with the building or other services regardless of whether or not these aspects are shown on the drawings.

Make provision for plant isolation and maintenance. Locate valves and other components in ceilings where they are easily accessible and where access or leaks will not cause inconvenience or risks to occupants, or damage to water sensitive equipment.

Arrange connections to plant to permit dismantling of the plant without disturbing other pipes and to permit removal of the plant without removal of the piping. Provide union on at least one side of each screwed valve and screwed pipeline component requiring removal for inspection or maintenance.

Make all connections to plant by one of the following methods:

- Flare compression joints (up to 20mm copper and only where there is no vibration)
- Screwed brass unions (up to 50mm size and for pressures up to 800 kPa)
- Bolted flanges (no limitation)

6.13.1.3 Submissions

Design

System pressure drop calculations. Calculations are to be completed and submitted prior to ordering of pumps. Pump head scheduled is approximate only.

For piping expanding more than 20mm submit pipe expansion and stress calculations with structural loadings.

Valves

Valve Schedule: Submit a detailed schedule of valve types showing manufacturer, figure number, materials, pressure rating and application.

Calibrated balancing valves: For each type and size of valve, submit a manufacturer's calibration chart relating pressure drop to fluid flow across the valve opening range.

Flow limiting valves: For each type and size of valve, submit a manufacturer's report verifying that ± 5% of the flow rate is maintained over the selected pressure differential control range.

Schedule of Piping Systems

System	Design Pressure (MPa)	System Type	Piping Material
Chilled water	1.0	Closed	Pipes ≤ 100DN: Copper Pipes > 100DN: Copper or Steel
Vent pipes to open expansion tanks	1.0	Open	Copper
Cold water	1.0	Open	Copper
Drains	0.2	Open	Generally: Copper Ceiling spaces: Copper

6.13.2 Copper piping

6.13.2.1 Standard

To AS/NZS 1572

6.13.2.2 Copper Jointing

Select from the following except where a specific jointing method is documented:

- Silver brazed capillary joints
- Brass flanges with brass nuts and bolts
- Flare compression joints: ≥ 20 DN nominal size and only where no vibration occurs
- Proprietary grooved joints

6.13.2.3 Copper Fittings

Capillary fittings including adaptor capillary fittings with threaded ends or compression-type connector ends, to AS 3688, of copper or dezincification-resistant copper alloy.

Compression fittings including adaptor compression fittings with connector-ends for screwed or capillary joints to AS 3688, flared type, of copper or dezincification-resistant copper alloy. Unions, bronze, proprietary manufacture, with ground or accurately machined face joints. Flanges, brazing metal to AS 2129. Demountable joints, expand pipes into flanges and braze.

Copper Permanent Joints

Provide brazed slip joints. Provide either capillary fittings, or expand one pipe over the other leaving a minimum clearance and an effective overlap.

Copper Slip Joint Overlap Table

Nominal pipe size, DN	Overlap (mm)
≥ 15, < 20	12
≥ 20, < 32	15
≥ 32, < 50	25
≥ 50, < 80	30
≥ 80, < 125	35
≥ 125, < 200	40

6.13.3 Steel piping

6.13.3.1 Steel Pipe For Closed Systems

- If water in the system does not come into contact with the atmosphere, provide pipe to the following:
- AS 1074
- BS EN 10216-1
- BS EN 10217-1
- API 5L
- ASTM A53/A53M

6.13.3.2 Steel Pipe For Aerated Systems

If water in the system comes into contact with the atmosphere, provide seamless pipe, or welded pipe to API 5L grade B.

6.13.3.3 Steel Jointing

Select from the following except where a specific jointing method is documented:

Black steel pipe:

- Butt welded
- Welded-on flanges
- Proprietary grooved joints

Galvanized steel pipe:

- Screwed and socketed up to 50mm size
- Galvanized screwed flanges
- Underground pipe: Welded and hot dip galvanized after fabrication to AS/NZS 4680
- Proprietary grooved joints

6.13.3.4 Steel Fittings

Butt weld fittings (e.g. bends and tees). Provide sweep tees and long radius type bends.
Steel for fabricated pipe fittings to be the same grade and wall thickness as the pipe. Fittings for non-vertical lines to have eccentric reducing fittings installed to avoid gas binding, liquid retention or both.

6.13.4 Pipe Sleeves

Provide pipe sleeves where pipes pass through walls, floors, ceilings and roof. Pipe sleeves can be omitted when pipes pass through internal walls and formed openings are provided.

Pipe sleeves at non-fire rated partitions shall be PVC pipe section. Pipe sleeves shall be of such a size that an annular clearance of 7mm can be maintained between the pipe and the sleeve. The sleeve shall be flush with the partition on either side. The annular space between pipe sleeve and pipe shall be caulked with fibreglass. Provide sealing plates at both sides of partition to seal in fibreglass.

Pipe sleeves for metal pipes in fire rated partitions shall be galvanised steel pipe with a minimum wall thickness of 1.6mm and of the same size as for non-fire rated partition. The annular space between pipe and sleeve shall be caulked with ceramic fibre rope. Pipe insulation section penetrating at fire rated partition shall be protected by an approved intrumescent material. For PVC pipes, the pipe penetrations shall be protected by approved intrumescent fire collars.

Pipe sleeves at floors shall be copper and shall project 50mm above finished floor level. The annular space between pipe and sleeve shall be caulked with approved ceramic fibre rope and capped with stainless steel caps on each side. Within plant rooms and wet areas, sleeves shall be made waterproof between pipe sleeve and floor. Provide over flashing to ensure water does not run down between sleeve and pipe where pipe or the room may be cleaned with running water.

Escutcheon plates, to the approval of the Engineer, shall be provided where pipework passes through walls, floors and ceilings which are visible in spaces.

6.13.5 Pipework Thermal Insulation

The following pipe systems shall be insulated:

- All CHW pipework.

No insulation is to be installed until the item to be insulated has been proved to be water, air or gas tight as applicable. Before application of insulation, all un-galvanised steelwork shall be coated as specified in clause “Painting”.

All pipework and equipment insulation shall be neatly trimmed around valve handles, drain cocks, vents, etc. to enable normal operation and maintenance without the need to remove the insulating material.

In plant rooms the insulated pipework shall be clad with G.I. cladding. Cladding shall be pre drilled and care taken during installation to avoid damage to the vapour barrier.

A high standard of workmanship and appearance is required. Poor or untidy appearance, dented or scratched cladding, tapering of cladding and careless location of joints in cladding shall constitute grounds for non-acceptance.

All insulation shall be continuous through slots and sleeves in building structures.

All insulated piping resting directly on hangers or supports shall be provided with 2.5mm thick saddle plates curved to closely fit the finish outside diameter of the insulation, covering 10 mm of the perimeter of the insulation and 200mm long. Saddle plates shall be centred on the support point.

All piping fittings (for example, valves, strainers, pump casings, tees, reducers, etc.) either welded, threaded or flanged, shall also be insulated.

No insulation shall be allowed to cover nameplates, test valves, inspection, drainage or adjustment devices when located within the area to be insulated.

Saddles, supports and anchoring members shall be embedded in the insulation of the insulated unit to which they are attached, so that the thermal barrier at those points is equal to that of the adjacent surfaces.

Expansion joints and flexible connections shall not be insulated on those portions that are subject to movement.

6.13.6 Valves and fittings

6.13.6.1 Valve Components

Valve size at least the nominal pipe size, unless a smaller size is necessary for throttling purposes or flow measurement. Provide extended shafts or bodies to butterfly and ball valves to allow full thickness of insulation without restricting movement of hand-wheel or lever. Automatic control valves refer to the Automatic controls section.

Connections:

- Valves ≤ DN 50: Screwed to AS ISO 7.1 and AS ISO 7.2.
- Valves > DN 50, valves in headers: Flanged to AS 2129

Hand-wheels and handles to be removable, with the direction of closing marked permanently on hand-wheels. Copper alloy valves to be dezincification resistant and stamped accordingly. Valves for water circuits open to air including open condenser water circuits, body bronze for sizes ≤ DN 50.

6.13.6.2 Valve Installation

If practicable, install with the stem horizontal.

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

Flow measuring valves, install with pressure tappings accessible.

6.13.6.3 Valve Identification

Tag all valves and flow measuring devices for identification purposes. Provide a circular brass disc attached to the valve by a stainless steel wire drawn through the holes in the disc on each valve provided with operating hand-wheel or lever stamp the valve identification mark on the disc in characters 10mm high.

Valves without operating hand-wheels, mark by aluminium or brass strap 20mm wide by 90mm long stamped in the same manner as the valve identification discs. Attach by wire to the body of the valves.

6.13.6.4 Valve tables

Copper Piping Systems: Open Circuit Condenser Cooling Water Systems

Function	Valve type	Size range (mm)
Isolating	Copper alloy wedge gate, ball or diaphragm	15 - 65
Isolating	Butterfly	≥ 65
Isolating	Cast iron wedge gate or diaphragm	≥ 80
Non-return	Copper alloy lift or swing check	15 - 65
Non-return	Cast iron lift or swing check	≥ 80
Throttling or balancing	Copper alloy globe, needle or diaphragm	15 - 65
Throttling or balancing	Butterfly	≥ 65
Throttling or balancing	Proprietary integral globe with press tappings/locking stem	No size limitation
Level control	Copper alloy ball float	15 - 50
Pressure relief	Copper alloy	15 - 65
Pressure relief	Cast iron	≥ 80
Bleed	Ball	15 - 65

Gauge	Ball	15 - 65
Drain	Ball	15 – 65

Steel and Closed Copper Piping Systems: Chilled Water, Heating Water, Closed Circuit Condenser Cooling Water Systems

Function	Valve type	Size range (mm)
Isolating	Copper alloy wedge gate	15 - 50
Isolating	Ball or diaphragm	15 - 65
Isolating	Cast iron wedge gate or diaphragm	≥ 80
Non-return	Copper alloy lift or swing check	15 - 50
Non-return	Cast iron lift or swing check	65 - 100
Throttling or balancing	Copper alloy globe, needle or diaphragm	15 - 65
Throttling or balancing	Cast iron globe or diaphragm	≥ 80
Throttling or balancing	Proprietary integral globe with press tappings/locking stem	No size limitation
Level control	Copper alloy ball float	15 - 65
Level control	Cast iron ball float	≥ 80
Pressure relief	Copper alloy type	15 - 65
Pressure relief	Cast iron type	≥ 80
Air relief	Copper alloy automatic air vent	15 - 20
Strainer	Copper alloy	15 - 65
Strainer	Cast iron	80 - 150
Pressure reducing	Copper alloy	15 - 100
Pressure reducing	Cast iron	15 - 100
Bleed	Ball	15 - 65
Gauge	Ball	15 - 65
Drain	Ball	15 - 65

6.13.7 Water valves and fittings

6.13.7.1 Water Valves

Working pressure rating minimum 1.4 MPa and to suit the system pressure requirements.

Working temperature rating to suit the system requirements.

Limitations on size and type:

Isolating valves:

- Gate valves: No limitation
- Ball valves: ≤ DN 50
- Butterfly valves: > DN 50

Throttling valves:

- Globe valve: No limitation
- Calibrated balancing valve: No limitation
- Butterfly valve: > DN 65

Valves for potable water: To AS/NZS 3500.1

6.13.7.2 Gate Valves

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

Standards:

- Bronze valves: To AS 1628
- Flanged cast iron valves: To AS/NZS 2638.1

Construction:

- Body:
  - ≤ DN 80: Bronze
  - >DN 80: Cast iron
- Seats: Integral seats for bronze valves, replaceable bronze seats for cast iron valves.

6.13.7.3 Ball Valves

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

Construction:

- Body: Bronze
- Ball: Hard chromed brass
- Gland seal: Adjustable
- Seat: PTFE

Reduced bore ball valves constructed as for full bore ball valves. May be used for drains, air vents and gauges.

6.13.7.4 Butterfly Valves

Tapped lug type to BS EN 593.

Operation:

- ≤ DN 150: Positive locating operating bar, parallel to the disk with notch plate
- > DN 150: Geared or motorised operators
- All sizes used for throttling and balancing: Geared operators
- Construction:
- Body: Cast aluminium or cast iron
- Shaft: Stainless steel
- Disc: Bronze generally, stainless steel for condenser water systems
- Disc fixing method as follows:
  - One-piece disc and shaft
  - Disc keyed and screwed to shaft
- Seat: Bonded EPDM.

6.13.7.5 Non-Return Valves

Flanged valves for water to AS 4794.

Disc type:

- Body: Stainless steel or bronze
- Disc and spring: Stainless steel

Swing type: To AS 1628.

- Body: Bronze or cast iron
- Plates: Bronze or stainless steel

Dual flap type:

- Body: Cast iron
- Pin and spring: Stainless steel
- Seat: Integral nitrile rubber
- Plates: Bronze or stainless steel

6.13.7.6 Globe Valves

Inside screw design.

Construction:

- Body:
  - ≤ DN 50: Bronze.
  - DN 50: Steel.
- Stem and gland: Forged brass.

6.13.7.7 Calibrated Balancing Valves

Continuously adjustable graduated limit stop for precise setting of the maximum valve opening, a numeric indication of valve opening position, and pressure tappings across the variable orifice.

Accuracy and repeatability errors, ± 5% or better over the normal measuring range of the valve.

Handwheel scale resolution, < 2.5% of full scale.

Construction:

- Body:
- ≤ DN 50: Dezincification resistant copper alloy of Brinell hardness > 130
- DN 50: Cast iron
- Seat: PTFE.

6.13.7.8 Automatic/Dynamic System Balancing Valves

Pre-calibrated special purpose valve which automatically controls flow rate within 5% tolerance, with an internal spring loaded cartridge control mechanism and external tappings for pressure and temperature.

Construction:

- Body: To suit the piping and fluid

- Cartridge: Passivated stainless steel, spring loaded type, incorporating a variable ported piston stamped with the manufacturer's identification number

6.13.7.9 Pressure Independent Control Valves

Pressure Independent Control valve for modulating 2 way control valves. Incorporates two valves in one body pressure self-regulating valve and control valve. Includes test points.

Construction:

- Body: Forged nickel-plated brass
- Ball: Chrome-plated brass
- Seal: PTFE
- Shaft: Chrome-plated brass
- O-ring: EPDM
- Characterising disk: TEFZEL
- Regulator: Stainless steel
- Diaphragm: Polyester-reinforced silicone
- Spring for valve cone: Stainless steel

6.13.7.10 Pressure Relief Valves

Direct acting, spring loaded with adjustable setting to AS 1271.

Construction:

- Body: Bronze or cast iron
- Valve disc and seat: Bronze

6.13.7.11 Pressure Reducing Valves

Self-actuated, spring loaded with adjustable setting.

Construction:

- Body: Bronze or cast iron
- Valve disc and seat: Bronze

6.13.7.12 Ball Float Valves

Copper or plastic float with stainless steel or copper linkage.

Copper alloy to AS 1910. Bronze body, needle and pins.

Cast iron body, bronze needle and pins.

6.13.7.13 Strainers

15 kPa maximum pressure drop.

Construction:

- Body: Bronze or cast iron
- Screen: Stainless steel

Strainers > 65mm diameter, fit a 25mm ball valve blowdown.

6.13.7.14 Automatic Air Vents

6.13.7.15 Float operated.

Construction:

- Body: Copper alloy
- Float: Non-metallic
- Seat: Stainless steel

6.13.7.16 Vacuum Breaker Valves

Ball valve operation.

Construction:

- Body: Copper alloy or stainless steel
- Valve and seat: Stainless steel

6.13.8 Instruments

6.13.8.1 Instrument Location

Test plugs in each pipe connection to every heat exchanging device and wherever else shown on the drawings.

Thermometer wells for each pipe mounted temperature sensor.

Provide test plugs or valved tappings at each pump automatic control valve and wherever else shown on the drawings.

6.13.8.2 Pressure gauges

Bourdon tube type to AS 1349.

Full scale between 130% and 200% of maximum working pressure.

Construction:

Case: Glass filled nylon. Minimum diameter 100mm.

- Lens: UV stabilised polycarbonate.
- Dial: UV stabilised polycarbonate.
- Indicating pointer: Adjustable.
- Configuration: Direct mounting, bottom entry.
- Bourdon pipe material: Stainless steel for hot water systems. Phosphor bronze for other services.

Mount gauges vertically free from vibration. Provide gauge line connection cocks. If necessary, eliminate needle fluctuations caused by pressure fluctuations, by either of the following:

- An orifice or restrictor.
- A capillary pipe pressure pulse damper.

For gauges not permanently connected seal outlets of isolating valves with flared seal cap nuts.

6.13.8.3 Thermometers

Mercury in steel type.

6.13.8.4 Accuracy, 1% of full scale deflection or better.

Construction:

- Case: Glass filled nylon. Minimum diameter 100mm.
- Lens: UV stabilised polycarbonate.
- Dial: UV stabilised polycarbonate.
- Indicating pointer: Adjustable.
- Bulb: Grade 316 stainless steel.
- Configuration: Direct mounting, bottom entry.

Install thermometers vertically, free from vibration, in thermometer wells.

6.13.8.5 Sensing points

Suitable for the service fluid up to maximum pressures and temperatures. Machined brass hexagon body with nordel synthetic rubber cores and gasketted brass hexagon screw cap.

Screw into sockets welded to pipes and extended above insulation.

Arrange for use with glass stem thermometers. Use the same material as the pipe. Weld or braze to pipes. Fill pockets with conductive medium.

Extend to within 5mm of opposite pipe wall and extended above insulation.

If thermometer pocket would otherwise decrease the pipe cross sectional area by more than 25%, provide a section of larger diameter at the location to mount the pocket.

Provide stainless steel thermometer wells of the separable type to enable the sensing element to be withdrawn without draining the system. Screw wells into a boss welded to the pipe, to suit the installed sensing element and extended above insulation. Fill wells with conductive medium.

6.13.8.6 Water flow measurement

Low loss pitot type averaging sensor, with 2 flared isolating valves for connection of pressure lines.

Stainless steel.

Installation to comply fully with manufacturer's recommendation for installation, connection and valving. Provide manufacturers recommended straight lengths of pipe upstream and downstream of tapping point. Mount in the piping using an adaptor bushing and welding boss.

Accuracy within 1.5% over the range of flow anticipated.

Stability, within ± 0.125% over five years.

Repeatability ± 0.1%.

Provide a stamped tag showing normal, maximum and minimum flows, pipe size, serial number and related data.

Graduated meters incorporating variable pulsation dampening control, integral equalising valve, 2 bleed valves, and a direct reading scale linear to flow rate. Provide nylon connecting hoses suitable for a pressure of 1030 kPa.

6.13.9 Installation

6.13.9.1 Arrangement

Changes of direction to be long radius elbows or bends where practicable, and swept branch connections. Provide elbows or short radius bends where pipes are led up or along walls and then through to fixtures. Do not provide mitred fittings.

6.13.9.2 Installation

Install piping 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.

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

Provide at least 25mm clear between pipes and between pipes and building elements, additional to insulation.

Join dissimilar metals with fittings of electrolytically compatible material.

6.13.9.3 Accessibility

Provide access and clearance at fittings which 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.

6.13.9.4 Gauges

Locate thermometers, pressure gauges and similar instruments so that they are easily read after installation.

6.13.9.5 External Preparation

Remove scale, rust, burrs and grease and ensure that surfaces are clean and dry.

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

6.13.10 Supports

6.13.10.1 Support Systems

Provide hangers, brackets, saddles, clips, and support system components, incorporating provisions for adjustment of spacing, alignment, grading and load distribution. Support pipework from associated equipment or building structure. Support valves, strainers and major line fittings so that no load is placed on adjacent tubes or transmitted to them during operation and maintenance.

Support types, proprietary metallic-coated steel channel section with clamps and hangers sized to match external diameter of pipe being supported.

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

Do not provide saddle type supports for pipes DN 25.

If pipe and support materials are dissimilar, provide industrial grade electrically non-conductive material securely bonded to the pipe to separate them. Provide fixings of electrolytically compatible material.

Uninsulated pipes, clamp piping supports directly to pipes.

Insulated pipes:

- Spacers: Provide spacers at least as thick as the insulation between piping supports and pipes. Extend either side of the support by at least 20mm.
- Spacer material: Rigid insulation material of sufficient strength to support the piping and suitable for the temperature application.
- Vapour barriers: For cold pipes apply aluminium foil tape over the circumference of the spacer to form a vapour barrier. Fit to spacer before installation of the bracket on the pipe.
- Metal sheathing: Provide a 0.55mm thick aluminium sheet band between the aluminium foil tape and the support for the full width of the spacer.

6.13.10.2 Support Spacing

Ferrous pipes to AS 4041 Table 3.28.2.

Copper pipes to AS 4809 Table 6.2.

Other non-ferrous pipe to AS/NZS 3500.1 Table 5.2.

Hanger Size Table

Outside diameter of pipe or sheathing (mm)	Minimum hanger diameter (mm) Light series	Minimum hanger diameter (mm) Heavy series
< 20	6	6
≥ 20, < 35	10	10
≥ 35, < 65	12	12
≥ 65, < 120	12	16
≥ 120, < 220	16	16
≥ 220, < 275	16	20
≥ 275, < 325	20	24
≥ 325, < 410	24	30

The above table does not account for any seismic support requirements, which shall be advised by the contractors seismic specialist.

6.13.10.3 Flexibility

Provide pipe anchors offsets or expansion devices and pipe guides which accommodate expansion and contraction, and minimise the transmission vibration and noise to building structures. Locate anchors and guides at equal distances on each side of expansion devices. Weld or securely clamp anchors to bare pipe. If limitations in the strength of structures prevent 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.

6.13.10.4 Flexible Connections

Minimise the transmission of vibration and noise through the piping. Provide flexible connections between piping and vibrating sources.

Connections to major plant items to be reinforced rubber type, spherical shape with flanged ends. Elsewhere flexible reinforced nylon hose.

6.13.10.5 Sleeves

Provide sleeves that permit normal pipe movement through all walls, floor slabs, and building elements.

6.13.10.6 Cover Plates

Where exposed to view provide cover plates fixed to the pipe or insulation sheathing and free to move with respect to sleeve and building surface.

Non-ferrous metal, finished to match the pipe, or of stainless steel, close fitting and firmly fixed in place.

Cover Plate Sizes Table

Nominal pipe size, DN	Cover plate diameter
< 20	100mm
≥ 20, < 50	150mm
≥ 50	100mm larger than pipe

6.13.10.7 Joints

Minimise the number of joints. If practicable, provide welded or brazed joints or a proprietary pipe coupling system.

6.13.10.8 Demountable Joints

Provide demountable joints as follows:

- At connections to mechanically cleanable heat transfer vessels and pumps.
- At maintenance locations.

Pipes > DN 50 to be flanged type.

6.13.10.9 Flanged Joints

Metal flanges, full face flanges with undistorted machined joint faces, to AS 2129.

Minimum flange thickness 12mm.

Bolting to AS 2129 Appendix C and AS 2528.

Material:

- Corrosion resistant environments: Zinc-plated steel.
- Corrosive environments: Material with equivalent corrosion resistance to, and compatible with, the flanges.

Flange jointing material to be preformed proprietary type at least 0.8mm thick.

Install flanges square with the run of pipe and aligned parallel to each other. Do not correct misalignment by bolting.

6.13.10.10 Screwed Joints

To AS ISO 7.1 and AS ISO 7.2. Do not provide long screws or barrel nipples. Seal threads of screwed connections with degreased PTFE tape or a thread sealing compound.

6.13.10.11 Drains

Water systems to have valved drains to the bottom of riser piping and as necessary to drain liquids completely from piping.

Other drains to have drains to drip trays, automatic air vents and equipment with drain points.

Drain size minimum DN 20. Match equipment drain size if larger.

Pipe drains to discharge points via air breaks.

Air inlet vents to be provided at high points in the system.

Drain Size Table

Nominal size of pipe to be drained, DN	Nominal size of drain and valve, DN (minimum)
> 50, ≤ 100	20
> 100, ≤ 150	25
> 150, ≤ 300	32
> 300	50

6.13.10.12 Air Release Vents

To be Copper pipe.

Provide 15mm minimum size air vents at the following locations:

- High points of the system.
- Sections of the piping in which air may collect.
- Upstream from each item of equipment.

Provide a 150mm high riser set vertically from the pipe. Connect the air vent to the top of the riser. Size to be pipe diameter.

Water systems to have manual air vents.

6.13.10.13 Grading

Water systems to be graded to rise in the direction of flow to points of air venting, except, if the water piping is exposed in a run with other services, run the water piping to the same grade as the other services.

Minimum grade: 1 in 200.

6.13.11 Completion tests

6.13.11.1 Hydrostatic Testing

Isolate items of equipment not designed to withstand test pressures. Leave pipe joints exposed to enable observation during tests. Secure pipes and fittings in position to prevent movement during tests. Restrain expansion bellows.

For steel piping, introduce corrosion inhibiting chemicals. Use chemicals from a water treatment specialist in accordance with the specialist's instructions and under the specialist's supervision. Leave pre-treated water in the system until the system is ready for chemical cleaning and flushing.

Test completed piping systems including equipment designed to withstand test pressures. Isolate equipment not designed to withstand the test pressure.

There is to be no loss of pressure over the test period after taking account of changes in ambient temperature.

Test pressures:

- Pressure piping: To AS 4041.

- Other piping: Test systems at 1.5 times the working pressure or 1 MPa, whichever is the greater, for at least 24 hours.

6.14 SEISMIC DESIGN AND INSTALLATION

6.14.1 General

This section covers the seismic restraint requirements for suspended engineering systems, both vibration and non-vibration isolated and/or related suspended equipment.

All hangers' supports, equipment etc. for the mechanical installation are required to be designed and installed to safely resist earthquake forces without compromising the continuing operation of the installation.

All equipment, ductwork, pipework, etc. shall be provided with restraints to resist seismic forces in addition to the normal fixing and supports as provided by the Contractor.

The Contractor shall allow for the costs of complying with this section of the specification. Special attention shall be given to the design of flexibly mounted equipment restraints, which shall allow freedom for vibration control, together with the appropriate earthquake protection.

This clause shall apply to complete assemblies, and subassemblies. All installed plant and equipment (including proprietary plant, pipework and other components) shall be designed by the Contractor to withstand, without exceeding working stresses:

- A horizontal earthquake-induced force acting through the centre of gravity equal to its weight multiplied by a seismic factor as stated in the "Seismic Requirements for Mechanical and Electrical Services".
- Maximum gravity loads under expected operating conditions (including allowances for temperature movement, fluid pressure surges and the like).
- Wind loads induced by the application of the maximum 3-second gust expected every 50 years, multiplied by the appropriate factors as detailed in NZS 4203

Co-ordinate with the main building Contractor and all their sub-contractors, the Architect and Structural engineer in respect of the design and installation of seismic restraints to NZS4219

Considering the nature of the building, where services are exposed, seismic restraints and supports will be required that complement rather than dominate the architecture of the building.

Prior to fabrication of seismic restraints and supports the shop drawings are to be submitted to the Architect for their review and final approval.

All bracing and restraints are to be painted as per the Architects specification.

6.14.2 Standards

To comply with this clause the installation is to be analysed and the detail design done in accordance with the provisions in the following Standards:

- NZS 4219:2009 'Seismic Performance of Engineering Systems in Buildings'.
- AS/NZS 1170 'Loadings Code' and be detailed in accordance with the appropriate material codes.

6.14.3 Seismic Requirements

The following table provides the design parameters for the temporary accommodation works and permanent works.

Seismic design for non-structural components

Design Parameters	SLS	ULS
Design working life	100 year	100 year
Importance Level	3	3
Return Period	1/25	1/2500
Return Period Factor	0.25	1.8
Soil	Type E	Type E
Z	0.13	0.13

6.14.4 Quality Assurance

The Supplier is required to retain a Chartered Engineer (Structural) experienced in seismic fixings of plant to complete the design and observation of all equipment installations. The Supplier is to make allowance for the Chartered Engineer to provide a Producer Statement PS1 (Design) and PS4 (Construction Review) prior to Practical Completion.

Seismic restraint designer shall layout and identify seismic restraint locations. The layout and identification of seismic locations shall comply with New Zealand Standard NZS 4219:2009, Seismic Performance of Engineering Systems in Buildings. Engineered seismic restraint submittal and shop drawings shall be (signed & sealed) by a chartered New Zealand Structural Engineer and shall be submitted to the designer of record for review and acceptance prior to installation.

Seismic design submittal shall include Quality Assurance guidelines for use by reviewing authorities during inspection.

The project specific seismic restraint submittal shall include the design of both the seismic restraints and vertical (gravity) supports of the system(s) at seismic restraint locations.

Seismic restraint and vertical support design information shall dictate the following:

- Seismic restraints: Brace arm material/size/type and load rating, anchorage, allowable spacing (transverse/longitudinal), brace installation angles and allowable tolerances, means for positive attachment to utilities at longitudinal/transverse locations, means for reinforcing vertical support rods (as required) at restraint locations.
- Vertical (Gravity) Supports: Vertical support spacing, type, size, and anchorage.
- After installation of the seismic restraints, but prior to inspection by local territory authorities, contractor shall submit to the designer of record for review and acceptance As Built Record Drawings accurately identifying all actual installed system layouts and seismic restraint locations.

6.14.5 Products

All seismic restraint bracketry and seismic anchorage connections to be those furnished by ISAT (International Seismic Application Technology) or approved equivalent.

6.14.6 Seismic Restraint Design

6.14.6.1 General Requirements

The anchorage supports and seismic restraints of systems listed below shall be designed to comply with and resist the seismic forces prescribed in the New Zealand Standard NZS 4219:2009 or the project specific design requirements, whichever is more stringent.

- All equipment including but not limited to: Process equipment, HVAC fans, VAV terminals, chillers, condensers, air handling units, pumps, electrical enclosures, generators, strut grids, and packaged air conditioners.
- All piping including but not limited to: hydronic piping, plumbing, and process piping.
- All ducts including but not limited to: HVAC, exhaust, ventilation, and flues.
- Applications not covered by standard systems shall be engineered and built by the applicable system contractor. Engineering shall be (signed & sealed) by a chartered New Zealand Structural Engineer and submitted to the designers of record for acceptance prior to installation. Cost to be borne by the contractor.
- All mechanical, HVAC fixtures and/or services installed in or attached to metal suspension systems for acoustical tile and lay-in panel ceilings including but not limited to: grills/diffusers, light fixtures, sprinkler heads and shall specifically comply with section 5.13, 5.14, & 5.15 of NZS 4219.

Seismic restraint transverse and/or longitudinal spacing shall not exceed the lesser of the following:

- That which develops seismic design forces equal to or less than the capacity of the building structure as specified by the project structural engineer.
- That which develops seismic design forces that are equal to or less than the capacity of the weakest part, component, anchorage, etc., contained within the seismic brace assembly.
- For pipe: Per tables 6 & 7 of NZS 4219:2009. For pipe sizes greater than those listed in tables 6 & 7, maximum spacing shall not exceed 12 meters transversely and/or 24 meters longitudinally where pipes are constructed of ductile materials & connection (copper, ductile iron, steel or aluminum and brazed, welded or screwed connections). For pipe sizes greater than those listed in tables 6 & 7 of NZS 4129:2009 and constructed of non-ductile materials and connections (i.e. cast iron, no-hub pipe, PVC/glass/plastic pipe), brace spacing shall not exceed 6 meters transversely and/or 12 meters longitudinally.
- HVAC systems: 12 meters transversely and/or 24 meters longitudinally for HVAC Sheetmetal ducts. Reduce to 6 meters transversely and/or12 meters longitudinally for non-ductile HVAC ducts (FRP).

Seismic restraint system specific system design requirements and exclusions:

Mechanical Pipe:

- Brace all pipe 50mm and larger and all pipes carrying hazardous material irrespective of size.
- Brace all trapezed systems supporting multiple pipes.
- Brace all suspended equipment over 10 kg.
- Brace all pipes supplying equipment designed for life safety (example: emergency generators).
- Bracing may be excluded from pipes suspended by individual hangers where the hanger length for all supports is 150 mm or less from the top of the pipe to the point of connection to the structure.
- Each straight run of pipe shall have at least two transverse brace locations and one longitudinal brace locations per NZS 4219, Sec. 5.8.4.1.
- All unbraced pipes must maintain 150 mm clearance from hangers and braces to suspended ceiling systems or other adjacent components.
- All vertical pipes shall have a minimum of two transverse restraints in each orthogonal direction and be installed within 2 pipe diameters of a vertical support.

HVAC Duct

- Brace all rigid ductwork and flexible ductwork > 1.5 m in length.

- Bracing may be excluded from duct when the hanger length for all supports, as measured from the top of the duct to the point of connection to the supporting structure, is < 200 mm.
- All unbraced ducts must maintain 150 mm clearance from hangers and braces to suspended ceiling systems or other adjacent components.
- Components installed in line to the duct system (fans, heat exchangers, humidifiers, etc.) weighing greater than 10 kg shall be braced and supported independent of the duct system.
- Dampers, grilles, registers, diffusers and louvers shall be mechanically fastened to the ductwork using screws or other methods (duct tape is not acceptable). Ducting to ceiling mounted components (grilles, etc.) must be flexible or designed to accommodate anticipated displacements.

Flexible Joints/Connectors:

- Install seismic flex joints for all mechanical, plumbing, HVAC duct, and electrical systems crossing the building seismic joints. Flex to accommodate the differential displacement specified by the project structural engineer. All systems crossing building seismic joints to be braced within 1.5 m of both sides of the joint.
- Install flexible connectors at all gas and fluid piping to equipment to withstand differential displacements due to building drift as specified by the project structural engineer.
- Install flexible connectors on all services to non-anchored equipment.

Vertical Support Design Requirements:

- All engineering system vertical supports shall comply with the requirements of NZS 4219 or the project specific seismic force requirements, whichever is more stringent.
- Vertical supports shall be designed and installed to account for vertical tension and compression loads including accumulated seismic component increases.
- Vibration isolation hangers (i.e. spring hangers, etc.) for suspended items shall be as provided or approved by the seismic system designer.
- Vertical supports, single hanger, trapeze hangers and their clamps, clips and methods of connection shall be constructed of ductile materials (i.e. copper, ductile iron, or steel).
- Excluded Utility Notations: Utilities excluded from seismic design requirements per the above guidelines shall be noted as such on the project specific seismic restraint layout drawings.
- Seismic restraints shall be installed to provide minimum of (2) transverse and (1) longitudinal braces per run. A "run" shall be defined as a length of 3 meters or more.
- The accumulated load of multiple items to any given support (with or without seismic restraints) shall be limited so as not to exceed the load limitations of the support assembly or those structural load limitations established by the structural engineer of record.
- Trapeze systems installed in a multi-layer configuration shall have seismic restraints designed and installed for each individual trapeze layer unless otherwise specifically detailed by the seismic designer.
- Do not use insulation inserts (i.e. calcium silicate, polyurethane, metal, etc.) at seismic brace connection locations without prior written approval from the seismic design engineer. Do not connect seismic bracing to insulation inserts without prior written approval from the seismic design engineer.

6.14.6.2 Anchors, Inserts and Fasteners

All anchors, inserts, fasteners or connections to the structure shall be submitted to the structural engineer of record for review and acceptance prior to installation.

Per NZS 4219, section 3.10.5, all post installed concrete anchors shall be seismically qualified per ACI 355.2.

Do not use any anchor or insert in concrete or metal decking with concrete fill, which does not have a signed structurally engineered design value based on its installed application.

Cast-in-place inserts (other than embedded bolts) used in concrete or metal decking with concrete fill, shall be ISAT Blue Banger Hanger, no substitutions allowed.

Do not use powder driven and power driven (Shoot-In) fasteners, expansion nails or internally threaded anchors in concrete or metal decking with concrete fill unless specifically approved by the seismic designer.

All beam clamps shall be constructed of malleable iron or steel. Single flange mounted beam clamps are allowed at vertical support locations only, shall include a retaining strap or J-hook and must be submitted to the project seismic designer for review and acceptance prior to installation. Beam clamps for use with brace arms must be specifically tested and approved for use with seismic loads.

6.14.6.3 Field Quality Control

The seismic designer or his representative shall conduct a field review of each seismic restraint location and provide a letter certifying general conformance with the seismic restraint system design. The review shall include:

- Verification of installation of rod stiffening components (as required)
- Verification of installation of retention straps at beam clamp vertical support installations
- Verification of brace arm orientation per the design (i.e. transverse/longitudinal & quantity)
- Verification of installation of Longitudinal Restraint Devices (as required)
- Verification that strut type and profile for brace arms and vertical support conforms with the design requirements.
- Beam clamps utilized for seismic anchorage comply with the seismic design and have been specifically tested and approved for use in shear load applications.
- Inspection of seismic restraints by the (IOR) Inspector of Record, and/or (AHJ) Authority Having Jurisdiction, and/or designers of record.

6.15 WATER STORAGE TANKS

6.15.1 Quality

6.15.1.1 Standards

Pressure vessels: To AS 1210.

Serially produced pressure vessels: To AS 2971.

Water, ice or brine tanks: To AS/NZS 3500.1.

Polyethylene tanks for water and chemicals: To AS/NZS 4766.

6.15.1.2 Pre-completion tests

Pressure vessels: Leak test.

Ice or brine storage tank cooling coils: Pressure test to 800 kPa.

6.15.1.3 Submissions

For vessels designed by contractor, submit design data and corrosion allowances as supplied to statutory authorities.

6.15.1.4 Inspection and certification

Provide and display certificates required by statutory authorities.

6.15.2 Pressurised expansion vessels

Provide a proprietary system.

Capacity: Sufficient to accommodate system expansion.

Provide a pressurised air space with air fill check valves on one side of the liner, and system fluid on the other side of the liner.

6.15.3 Water storage tanks

To AS/NZS 3500.1 Section 8.

6.15.3.1 Construction

Provide a cathodic protection system for steel tanks.

Mounting: Mount tanks on galvanized steel cradles or base rings.

6.15.3.2 Accessories

Provide thermometer, pressure gauge with gauge cocks, valved supply, 25 mm drain, lifting lugs, and inspection personnel access with cover, gasketted and bolted in position. Arrange to prevent the ingress of foreign matter.

6.15.3.3 Insulation

As per the insulation worksection.

6.16 TESTING AND COMMISSIONING

6.16.1 General

The objective of testing and commissioning is to set the plant to work and to verify that it performs in accordance with the design criteria and performance objectives.

Refer to the Station Controls Specification (CRL-BTM-BMS-000-SPE-0001).

6.16.2 Sustainability

This project is being constructed to achieve a IS rating – refer to the main contract conditions and include for all works necessary to contribute to the overall rating.

6.16.3 Quality

6.16.3.1 Standards

Comply with the following:

- CIBSE Commissioning Code A – Air Distribution Systems
- CIBSE Commissioning Code C – Automatic Controls
- CIBSE Commissioning Code M – Commissioning Management

- CIBSE Commissioning Code R – Refrigerant Systems
- CIBSE Commissioning Code W – Water Distribution Systems
- BSRIA AG3/89.2 – The commissioning of air systems in buildings
- BSRIA AG2/89 – The commissioning of water system in buildings
- BSRIA AG1/89 – Flushing and Cleaning of water systems
- Electrical installations to NZS/AS3000
- National Environmental Balancing Bureau (NEBB), Gaithersburg MD, USA., Procedural standards for testing, adjusting and balancing of environmental systems, second edition.
- ANSI/ASHRAE III. Practices for measurement, testing, adjusting and balancing of building heating, ventilating, air conditioning and refrigeration systems, by ASHRAE, Atlanta GA, USA.

6.16.3.2 Abbreviations And Definitions

The following definitions apply specifically to this section:

- Accuracy: The closeness of the agreement between the result of a measurement and the true value of the particular quantity being measured.
- Error: The measured value minus the true value of the particular quantity being measured.
- Resolution: The smallest difference between indications of a displaying device that can be meaningfully distinguished.

6.16.3.3 Completion Program

Provide a program consistent with, and forming part of, the construction program. Set out the proposed program for completion, commissioning, testing and instruction. Identify related works and timing of the works pre-requisite to successful and timely completion of the works.

Complete testing and certification of all fire safety measures before occupation of the building.

Revise the program as the project proceeds.

Include time in the program for the running period prior to Practical Completion.

6.16.3.4 Statutory Authorities

Provide demonstrations and tests for witnessing by the statutory authorities. Complete testing of systems before witness testing by the statutory authorities.

6.16.3.5 Witness Tests

Following completion of commissioning and testing, submit clearly legible test results and give notice for witness testing.

Witness testing is a separate activity. Do not merge witness testing with testing and commissioning.

Plan and coordinate tests with the work of other contractors.

Submit a programme showing dates, times and duration of tests.

Conduct witness tests, providing required instrumentation, technicians, and equipment manufacturers service persons.

During witness tests operate the plant under conditions appropriate to the tests. When necessary conduct tests out of hours.

Record witness test results and submit for witnessing on the spot.

6.16.3.6 Failed witness tests

If performance criteria are not achieved, remedy defects, recommission and test the plant, resubmit test data and give notice for further witness tests.

Costs incurred by the ER or Proprietor associated with repeated witness tests will be deducted from the contract sum.

6.16.3.7 Submissions

The contractor shall prepare and submit for review and approval the following commissioning specific documentation in accordance with the main contractors’ construction programme and the specified requirements.

6.16.3.8 Commissioning Plan

Provide a commissioning plan in conjunction with the Controls Specialist Contractor including the following:

1. Identification of all plant and equipment to that is to be commissioned.
2. Identification of the commissioning team members, contact details and duties. This should including staff, subcontractors, equipment vendors, and commissioning specialists.
3. Detailed commissioning methodologies for each item of plant or equipment in accordance with specified commissioning codes and standards listed above.
4. Pre-requisite tasks that must be completed before commissioning can commence.
5. Pre-commissioning checksheets for each system.
6. Commissioning forms including air and water testing and balancing. Provide a sample report for each typical system including:
    a. Air handling units
    b. Fan coil units
    c. Supply fans
    d. Exhaust fans
    e. Chilled water system; including pumps and chillers
    f. Heating water system; including pumps and heat pumps
7. Functional test plans based on approved BMS functional description.
8. Interface testing requirements to be integrated into Main Contractors overall interface test plan.

6.16.3.9 Commissioning Programme

Provide a commissioning programme in conjunction with the Controls Specialist Contractor identifying all commissioning tasks, durations, pre-requisites, inter-dependencies and resources to be integrated into the Main Contractor’s master construction and commissioning programme.

6.16.3.10 Ductwork Shop Drawings

Ductwork shop drawings provided shall show all balancing dampers required to commissioning the air system in accordance with CIBSE Commissioning Code A. Dampers are to be fully accessible for adjusting and setting during the commissioning.

6.16.3.11 Pipework Shop Drawings

Pipework shop drawings provided shall show all balancing valves, flow measuring stations and binder test points required to commission the water system in accordance with CIBSE Commissioning Code W. All balancing valves, flow measuring stations and binder test points are to be fully accessible for adjusting and setting during the commissioning. Binder test points shall be provide across all pumps, strainers, coils, chillers, heat pumps, control valves, heat exchangers and BMS pressure transducers to allow pressure and/or temperature measurements to be taken. The Mechanical Contractor shall co-ordinate with the Controls Specialist Contractor to ensure that all pipework tappings required for BMS instrumentation are correctly located to provide optimum measurement and control and that they are installed prior to pipework testing and flushing.

6.16.3.12 Control Valve schedule

Provide a control valve schedule including valve selection, technical datasheets and calculated valve authorities based on approved coil selections.

6.16.3.13 Commissioning valve schedule

Provide a commissioning valve schedule including valve selection, technical datasheets, calculated flowrates and pressure drops for all commissioning valves including fixed orifice regulating valves, variable orifice regulation valves, cartridge type flow limiting valves, orifice plates, and pressure independent control valves. Provide all commissioning valves as indicated on the mechanical drawings and as required to allow balancing and testing in accordance with CIBSE Commissioning Code W. Install in accordance with the manufacturer's recommendations, which shall be no less than five straight pipe diameters upstream and two straight diameters downstream. It is not acceptable to install line size commissioning valves; each valve must be selected for the required flowrate with a fully open pressure drop of no less than 3kPa to ensure stable and repeatable pressure/flow measurements.

6.16.3.14 BMS Functional description and I/O points list

Provide a written functional description (FD) of the BMS functionality for review. The FD will be based on the specified sequence of operations and developed into a fully working solution by the BMS contractor. It is critical that the FD is reviewed and approved by the Mechanical Consultant as this document will be the foundation of the functional testing plan required for the project.

All points are to be named using a structured method which is common across all trade interfaces connecting to the BMS within the project.

6.16.3.15 Pipework testing, cleaning and water treatment plan

Both open and closed loop pipework systems shall be pressure testing, flushed and cleaned. In accordance with CIBSE Commissioning Code W/BSRIA Guide AG1/2001.1. Provide a detailed cleaning and flushing plan and indicate on the pipework shop drawings all flushing bypasses, drains and vents required to carry out the flushing and cleaning.

6.16.3.16 Commissioning Results

Submit commissioning reports for commissioned systems indicating observations and results of testing and compliance or non-compliance with design requirements. Results shall cover air and water balancing, pump, fan and AHU performance testing, functional testing results in accordance with approved functional description, and interface testing.

6.16.3.17 Building Tuning Plan

Provide a 12 month building tuning plan as outlined in the general requirements section.

6.16.4 Commissioning

6.16.4.1 General

Aim

The objective of testing and commissioning is to set the plant to work and to verify that it perform in accordance with design criteria and performance objectives.

Commissioning

When each system is complete, including static tests, commission the system by setting it to work, adjusting and balancing to design capacity, setting controls, checking the operation of overload and safety devices, and correcting malfunctions.

The mechanical contractor shall engage a suitably qualified and experienced Testing and Balancing specialist to carry out the air and water testing and balancing.

The testing and balancing (TAB) specialist shall review the mechanical contractors ductwork and pipework shop drawings and develop project specific commissioning methodologies/procedures for incorporation into the mechanical commissioning plan. Any commission-ability issues should be raised with the mechanical contractor's commissioning manager.

Testing and Balancing (TAB) specialist shall use only calibrated instrumentation and provide evidence of recent calibration if requested.

All commissioning documentation is to be pre-written and approved so that it is only a case of filling in the measurements on site.

Measured data needs to be entered directly onto report sheets by the technician taking the measurements so that there are no errors in transferring information at a later date or by another person.

Commissioning of a piece of plant shall not proceed until the pre-commissioning documentation has been received by the commissioning technician.

Reports

Submit reports indicating observations and results of tests and compliance or non-compliance with requirements.

Notice

Give sufficient notice for inspection to be made of the commissioning of the installation.

Starting Up

Coordinate schedules for starting up of various systems and equipment. Give 5 working days' notice before starting up each item.

Before starting, verify that each piece of equipment has been checked for proper lubrication, drive rotation, belt tension, control sequence, circuit protection or for other conditions which may cause damage.

Verify that tests, meter readings, and documented electrical characteristics agree with those required by the manufacturer.

Verify wiring and support components for equipment are complete and tested.

If individual technical work sections require the attendance of a manufacturer's representative, have the manufacturers' representatives present on site to inspect and check and/or system installation before starting up, and to supervise placing equipment and operation.

Execute starting up under supervision of manufacturers' representative (if nominated in the respective technical work section) and appropriate contractors' personnel, in accordance with manufacturers' instructions.

Submit a report demonstrating that equipment has been properly installed and is functioning correctly.

Allow to attend to the installation twice, of 2 hour duration each, to make adjustments to suit the comfort conditions.

Mechanical Controls and Electrical Tests

Refer relevant sections.

Power, Fuel and Consumables

Provide all permanent power, fuel and consumables for commissioning and testing.

6.16.4.2 Instrumentation

Calibration and Certification

Provide appropriate accurate instruments. Submit current NATA certificate of calibration prior to commencement of testing.

Verify the end to end accuracy of instrumentation in accordance with ANSI/ASHRAE 114, Energy management control systems instrumentation.

Use only instruments that have been calibrated by a Registered testing authority. Provide copies of certification if requested.

Maximum period since last calibration, as recommended by manufacturer but not greater than 12 months.

Air Quantity At Diffusers, Outlets And Grilles

Hood adjustment factors, determine adjustment factor for each hood and associated anemometer by one of the following methods:

- Certified by a Registered testing authority for the type of diffuser or grille and direction of air flow being measured.
- Determined by duct pitot traverse for the particular type of diffuser or grille and direction of air flow being used on the project.

Instruments:

- Accuracy: Better than ± 5% of measured value.
- Resolution: Better than 1% of measured value.
- Range: Minimum measured velocity for instrument not more than 50% of measured velocity.

Total System Air Flow

For systems handling over 1000 L/s measure total system air quantity to ISO 5802.

Air Pressures And Differential Pressures

Instrument Specifications:

- Pressures ≤ 50 Pa: Electronic meter or inclined manometer with 50 Pa full scale, accuracy better than 5% full scale.
- Pressures > 50 Pa: Electronic meter, mechanical meter or inclined manometer with full scale not more than 400% measured value, accuracy better than 2.5% full scale.

Water Pressure And Differential Pressures

Instrument specifications:

- Accuracy: Better than ± 1% of full scale.
- Scale: Not more than 400% measured value.

Temperature

Air temperature instruments specifications:

- Accuracy: ± 0.2 K or better at measured value.

Chilled water and condenser water temperature instrument specification:

- Accuracy: ± 0.2 K or better at measured value.

Instrument specifications for other temperature applications:

- Accuracy: ± 0.5 K or better at measured value.
- Scale divisions (mercury-in-glass): 1.0 K or better.

Humidity

Sling psychrometer, aspirated psychrometer or electronic humidity meter.

Accuracy:

- ± 3% from 10 to 90% relative humidity where measured value tolerance is ≥ ± 5% relative humidity.
- ± half measured value tolerance from 10 to 90% relative humidity where measured value tolerance is < ± 5% relative humidity.

Water **Flow**

Instrument specifications:

- Accuracy: ± 5% including accuracy of differential pressure instrument (if used).
- Type: Pitot tube type flow sensors as specified in the Mechanical piping work section.

Electrical

Instrument specifications:

- Voltage < 600 V ac: Accuracy ± 3% of full scale.
- Voltage < 30 V dc: Accuracy ± 3% of full scale.
- Currents < 100 A: Accuracy ± 3% of full scale.
- Maximum period between calibration, as recommended by manufacturer but not more than 6 months.

Rotational Speed

Instrument specifications:

- Accuracy: ± 5% of measured value.
- Maximum period between calibration, as recommended by manufacturer but not more than 24 months.

Recording Instruments

Specifications for instruments collecting measured values over time:

- Accuracy: At least equal to that specified for the corresponding physical parameter above.
- Type: Electronic data logger with appropriate sensors or thermohydrograph.

Thermohydrographs, charge sensing element before use as recommended by the manufacturer.

6.16.4.3 Pre-commissioning

General

Pre-commissioning is to consist of a full range of pre-installation and installation checks to determine that individual component, equipment and systems are delivered and installed in accordance with the plans and specifications and are ready to be commissioned.

The contractor shall undertake a comprehensive pre-commissioning process in accordance with CIBSE Code M. Commissioning check shall be recorded in the form of a commissioning checklist that s to be submitted for review as part of the contractor’s commissioning plan.

Prior to commissioning, confirm that static tests are complete, inspect the whole installation, complete pre-start-up checklist and rectify outstanding items.

Existing CPO Roof Fans

The contractor shall measure the existing air flows of the main CPO fans at roof level and then re-measure once modifications have been done to ensure that the existing “duty” is maintained.

Electrical

Check field connections and switchboard terminations. Check fuse ratings, circuit breaker settings, and set overloads.

Drive Alignment

Align drives of ≥ 30kW motors on site

Hold Points: Give notice for witnessing of alignment prior to start up.

Water Systems

Water Treatment: Detergent flush, fill, vent and chemically treat recirculating water systems before commencing commissioning. Refer to Water Treatment Section.

Water Make-up Systems: Set pressurisation system make up and relief pressures. Set up feed and expansion systems. Set ball float levels.

Overflows: Test tank overflows to AS 3500.1:2003, Plumbing and drainage – water services.

Adjust cooling tower bleed rates.

Air Systems

Check for duct leakage and sealing of filters.

Provide a test report as per the CIBSE commissioning code requirements.

Authority **and Utilities**

Obtain approvals of applicable authorities and utilities.

6.16.4.4 Execution

When the installation is complete, commission the installation. Make the adjustments necessary to achieve the designated performance under continuous operating service conditions, including balancing, setting the controls, checking the operation of overload and safety devices, and correcting malfunctions.

Commission equipment according to manufacturer's instructions.

Operate plant steadily at full load and record air and water inlet and outlet conditions, flow rates and energy consumption.

Operate plant steadily at various part load points and check correct operation, recording operating conditions at each point.

6.16.4.5 Air Balancing

Balance each air handling and fan system.

Measure total air flow and branch flows using Pitot tube and electronic micro-manometer.

Grille measurements shall be taken using a calibrated flowhood with back pressure compensation. Establish grille calibration factors as appropriate by comparing grille flowrates against a duct pitot traverse.

Cross check against fan performance curves – both static pressure and power consumption.

Low velocity system: Proportionally balance registers and low velocity ducting systems downstream of VAV terminals.

Performance test Air Handling Units (AHU's) at full-diversified flowrate with simulated full filter dust loading flowrate (once downstream ductwork is proportionally balanced). Measure and record AHU external static pressure, fan pressures and component pressure drops e.g. pre-filters, filters, coils, fan speed and motor running current (A). Take duct static pressure setpoint measurements where appropriate and provide to the BMS contractor.

Performance test all fans. Measure and record fan main duct flow via pitot traverse, fan pressures, speed and motor running current (A).

Peak cooling airflow tests: Adjust terminals to simulate the airflows expected during maximum coincident cooling load by setting sufficient terminals to maximum air flow, and the balance to minimum air flow, whilst the system is on minimum outside air. Reduce the supply of air duct pressure by reducing the fan speed to the point where further reduction would lead to reduced terminal airflows. Record supply air, return air and outside air quantities, duct pressure at pressure sensor, and fan operating parameters.

Peak heating air flow test: Adjust terminals to air flow expected during maximum heating load, with all terminals on full heating. Record the supply air pressure and speed. Check minimum outside air flow rate.

The TAB specialist is to ensure that all VCD's are marked in their set position.

The TAB specialist shall identify sub-branch indices and system index and ensure index regulation devices are in the fully their open position.

All test holes shall be bunged and identified (for referencing back to system report and as-builts).

Balancing is complete when all the following conditions are met:

- All air quantities are within the tolerances in Air quantity tolerance table.
- Each air quantity measured deviates by less than the instrument accuracy from of the previous reading on the same component with the same instrument.
- Resistance across the cooling coil bank (if present) is equal to the wetted coil resistance.
- Resistance of the filter bank (if present) is equal to that of the filter when fully loaded with dirt.

- At least one outlet on each branch has its damper at the minimum pressure drop position.
- At least one sub-branch damper is at the minimum pressure drop position.
- At least one branch damper is at the minimum pressure drop position.
- The fan speed or pitch angle is at the lowest value consistent with the above.

Preparation for Air Balancing

Before starting air balancing make sure that all building work that may affect the air balance is complete. Including:

- All ceiling tiles are in place.
- All doors are hung and door grilles (if applicable) are installed.
- All doors and windows are open or shut consistent with their normal state.
- The building is airtight.
- The builder's work ducts, shafts and ceiling plenums are sealed airtight.

Before starting air balancing make sure that all other work that may affect the air balance is complete. Including:

- All ductwork complete and clean.
- There are no air leaks that can be felt. Check for leaks through doors, access panels, penetrations and joints in air handling units.
- Flexible duct is installed as documented and has not been damaged.
- All fire and balancing dampers are open.
- All interrelated air handling systems are complete and operating concurrently.
- Fans, coils filters and other mechanical components are complete and operating correctly.
- All electrical components including overloads and safety devices are complete and operating correctly.
- All other related work is complete and operating correctly.

Measurement Methods

Total and branch air quantities > 1000 L/s, measure to ISO 5802.

Other air quantities, use balancing and measurement methods recommended by ASHRAE or CIBSE.

Do not use the following methods for air quantity measurement:

- Coil, damper or filter traverse using any kind of instrument.
- Measurement using an instrument operating with air flow in the reverse direction to that for which it has been certified.
- Air quantity measurement derived from fan curves or fan performance tables.

Measurements at outlets

Use microprocessor based back pressure corrected air flow measuring hoods, results to be used for comparison only.

Tolerances

- Total air flows +5% of design.

- Air flow from individual outlets +10% of design.
- Air flow from any sub-branch +10% of design.
- Supply systems for induction units +5% of design.

Test conditions

For measurement of total air quantities simulate full dust loading of filters and condensate loading of cooling coils by blanking off a percentage of the face area.

Outlet Adjustment

Set air pattern adjustment to minimise draughts whilst avoiding temperature stratification during heating. Use duct dampers rather than register dampers to adjust airflows. Any adjustment at outlets shall not cause excessive noise on draughts.

Metering Plates

Balance 'Variflow' or equivalent flow metering plates by exchanging plates and/or plugging orifices to obtain design airflow at measured pressure drop.

Dampers

Mark final position of dampers when balancing is complete.

Test Holes

Seal all test holes at the completion of air balancing. Duct pressure class <500Pa Rubber or plastic rings. Duct pressure class > 500Pa coverplate of the same material as the duct.

Fan adjustment

Operate interrelated systems such as supply air, outside air and return air at the same time. When proportionally balanced with dampers of the index run fully open, adjust total air flow by varying fan capacity. Set for minimum energy consumption at design flow.

Adjust bade pitch angles or fan speed by changing drive pulleys or setting speed controller maximum output frequency. (Do not exceed 60Hz output).

Witnessing

Submit test reports and provide notice for witness testing.

Additional Balancing

Notwithstanding that air quantities may have been measured and are within tolerance. If so directed, adjust space air quantities to:

- Minimise drafts.
- Achieve temperatures in individual rooms or parts of rooms that are within the stated design conditions.

If air quantities are altered after submission of air balance reports, resubmit reports showing new values.

6.16.4.6 Water Balancing

Balance each water system.

Measure total flow via orifice plate, venturi meters or certified pressure drop across factory tested water chillers.

Compare with readings of pump performance curves, both lead/low and power/flow curves.

Measure terminal flows via calibrated balancing valves annubars or control valves with published flow coefficients.

The TAB specialist shall identify sub-branch indices and system index and ensure index regulation devices are in the fully their open position.

Regulating valve final set positions are to be locked and recorded on test sheets. Regulating valves shall not be regulated to below 25% open per manufacturers recommendations.

Where automatic flow limiting type valves (flowcon) are installed the valve size and cartridge installed shall be checked against the approved schedule as per of the waterside pre-commissioning proves. The TAB specialist shall measure the DP across the flowcon (at full cooling or heating flow) and compare to the scheduled minimum DP. Where branch regulating valves are installed with flowcon valves on the downstream terminals the regulating valves shall remain fully open. The TAB specialist shall measure the branch total via the regulating valves and include in the water balancing report.

Balancing is complete when all of the following conditions are met:

- All water quantities are within documented tolerances.
- Water quantities measured deviate by less than the instrument accuracy from the previous readings on the same component with the same instrument.
- At least one balancing valve on each branch is fully open.
- At least one branch balancing valve is fully open.
- For pumps with variable speed drives, the frequency to the motor is (50 Hz.
- The pump balancing valves (if fitted) are fully open.
- The pump impeller diameter is not more than 5% greater than that to achieve the above.
- Any other steps required to achieve lowest practicable pump power consumption have been taken.

Preparation **for** Water Balancing

Before starting water balancing ensure that:

- The system is complete.
- Initial chemical cleaning, flushing and treatment for corrosion and microbial control are complete.
- Pressure testing is complete and no leaks exist.
- All system cleaning is complete and system is filled with final treated water if used.
- Air has been thoroughly vented from all parts of the system.
- All automatic control valves are fully open.
- All strainers and water filters are clean.
- Water temperatures are close to documented operating temperatures.
- All inter-related systems are complete and operating concurrently.
- All electrical components including overloads and safety devices are complete and operating correctly.

Water Balancing Methods

Use balancing and measurement methods recommended by ASHRAE or CIBSE.

Test total flow of each pump individually if duty and stand-by pumps are installed.

In addition to the recommendations of ASHRAE and CIBSE, the following measurement methods are acceptable:

- Calibrated balancing valves including automatic balancing valves with a microprocessor based electronic meter supplied by the valve manufacturer, designed specifically for the purpose and displaying results in units of flow rate (not differential pressures).
- Any type of flow use Pitot type flow measuring device certified by the manufacturer to be accurate to within 5% over the range of water flow anticipated.
- Do not use the following methods for water flow rate measurement:
- Water flow rate derived from pump manufacturer's curves or tables for pump flow rate and pressure differential.
- Water flow rate derived from uncertified manufacturer's data on flow rate equivalent to pressure drops.

Flow tolerances

- Total pump flows +5% of design.
- Terminal flows +10% of design.
- Set bypasses of three way valves at 80% of design coil flow.

Variable Speed Pumps

Reduce impellers of oversized pumps to minimise power consumption. Refer Pumps section.

Balancing V**alves**

Set opening limit stops of balancing valves and permanently mark the balanced positions.

Witnessing

Submit test reports and provide notice for witness testing.

Heat Valve Testing

Test all heating valves for leakage.

Procedure:

- For a minimum of 12 hours shut off all heating plant and drive all heating control valves fully open. Run heating pumps during this period to circulate water through all heating coils.
- At the end of this period drive all heating valves fully closed.
- Start heating plant.
- Measure and record water temperature differentials across each heating coil. Treat any drop in temperature greater than the measurement tolerance as control valve leakage.
- Rectify any detected heating valve leakage and retest.

Water Heaters

Test automatic controls by operating safety and operating controls.

If the water heater plantroom is mechanically ventilated operate the external control interlocks to demonstrate that the burner and the ventilation fans are interlocked.

Test the flame failure relay for each of the following conditions:

- Simulate fuel stoppage by shutting off the main gas valve
- Simulate flame or pilot failure by removing each scanner eye

For each of the above, the gas solenoids shall close, the alarm shall ring, the appropriate alarm signal light shall light, the programming relay shall cycle to post-purge, and then off, requiring manual reset before the cycle can start again automatically.

Check the setting and operation of the operating thermostat and staging thermostat against a thermometer.

Check the setting and operation of the high limit safety thermostat. Set this thermostat at 5°C above the normal operating temperature. Operate each water heater manually, building up excess temperature above the normal operating temperature to observe the operation of the safety thermostat.

Check that external pump interlocks cycle the burner off without interrupting the post-purge cycle.

Check that the pump run-on timer operates whenever the water heater shuts down.

Check the water flow through the water heater and check the setting of the flow switch. Ensure that the flow switch trips when the water flow is reduced below the manufacturer's minimum flow rate.

Adjust burner (gas side) to achieve design water heater capacity.

Carry out combustion tests to confirm flue gas temperature, CO, O2, C O2 content.

Witnessing: On completion of commissioning submit certified test results and provide notice of tests to demonstrate water heater performance and operation of safety and operating controls.

6.16.4.7 Refrigeration Plant

Controls

Test the automatic controls by operating safety operating and staging controls.

Test the safety controls for high head pressure, low suction pressure, low evaporating temperature, low oil pressure, electrical overloads, flow switches and pump interlocks. Record the cutout temperature, pressure or flow for each cutout.

Site performance tests

For all chillers which have not passed factory full load tests, conduct on site full load capacity tests when sufficient cooling load is available.

Standards: ANSI/ASHRAE 30 Method of testing of liquid-chilling packages; ANSI/ARI 550/590, Chilling packages using the vapour compression cycle.

Test setup: Provide all necessary instrumentation and data loggers, including electrical, temperature and flow measurement sensors mounted in suitably designed sections of pipework.

Test conditions: Operate machine under steady conditions (water flows, temperatures and motor loads) for 15 minutes prior to test readings. Take sets of readings at 3 minute intervals. Ensure that power supply voltage complies with AS 3000, Electrical installations (Australia/New Zealand wiring rules).

Results: Compare measured capacity with rated capacity using manufacturer's application rating data. Measure condenser and chiller water pressure drops at design flows.

Site commissioning tests

For all chillers which have passed factory full load tests conduct on site commissioning test at best available loads at prevailing conditions, recording the following at 15 minute intervals for 1 hour:

- Chilled water flow rate, entering temperature, and leaving temperature.
- Condenser water flow rate, entering temperature, and leaving temperature (water cooled).
- Condenser air entering dry bulb temperature (air cooled).
- Electrical power at motor terminals.
- Steps of loading.
- Refrigerant liquid temperature at the condenser outlet.
- Refrigerant pressure in the condenser.
- Refrigerant gas temperature at the compressor inlet.
- Refrigerant pressure in the evaporator.
- Phase to phase voltages at man terminals of the chiller control panel.
- Phase currents at chiller control panel.
- Wet bulb temperature at cooling tower air inlet (air cooled).
- Plantroom temperature.
- Ambient temperature.
- Barometric pressure.

Witnessing
On completion of commissioning submit certified test results and provide notice of witness tests to demonstrate chiller performance and operation of safety and operating controls. Give notice of capacity tests.

Refrigerant and oil tests
Test the quality and moisture content of refrigerant and oil samples after commissioning. Submit reports.

6.16.4.8 Fire and Smoke Control System

Commission and test smoke control systems to AS/NZS 1668:1 and AS 1668.3.

Test air handling systems for correct operation in conjunction with fire protection and other related systems.

Verify that all systems return to normal operating mode after fire mode operation.

Test that fire and/or smoke dampers close fully with fans operating.

Conduct witness test as required by the relevant authority.

Include the following tests:

Liaise with the fire alarm contractor and test every smoke detector and sprinkler flow switch individually to ensure that the correct fire alarm relay is activated and that the equipment functions correctly.

- With the plant on, initiate a fire mode changeover from each fire alarm zone and verify the sequence of events. Repeat this series of tests with the plant off (after hours).
- Manual control of each item from the FFCP.
- Manual reset to normal mode from the FFCP.

- Test fire dampers and smoke dampers to ensure they close fully with fans operating.

Witnessing: Give notice of fire mode tests.

6.16.4.9 Plant Integration

Simulate a variety of plant operating conditions and check the integration of systems. Simulate normal running, start-stop, emergency, fault out of hours conditions and the like. Record the results of plant integration tests.

6.16.4.10 Multizone Systems

Provide the following tests on multizone systems in addition to other testing required:

Zone damper leakage:

- Seal cooling coil and close hot deck dampers fully. Measure air flow through hot deck and verify that it is within documented damper leakage limits.
- Seal hot deck or heating coil and close cold deck dampers fully. Measure air flow through cold deck and verify that it is within documented damper leakage limits.

Zone temperature sensors: test all zone temperature sensors and adjust so that difference in error between sensors is less than half the documented sensor accuracy.

Zone air balance: measure total air flows to zones with system fully open to cold deck then fully open to hot deck. Adjust hot deck flow so that neither air flow exceeds the tolerance allowed for total air flow.

6.16.4.11 Motorised Damper Leakage

All dampers required to close fully under any operating mode of the plant including motorised outside air dampers.

Leakage criterion, less than the stated damper leakage rate.

Procedure:

- Drive damper fully open and closed. Check for uneven motion and correct.
- Drive damper fully closed and test for leakage.

Site leakage test methods, either as follows:

- Scan blade edges for leaks with smoke pencil provided that gaining access to the damper will not affect the test results.
- Measure leakage air quantity by shutting return air damper and measuring leakage air quantity by pitot traverse. Correlate to damper manufacturer's published pressure/leakage charts.

6.16.4.12 Room Air Pressure Differentials

Adjust air flows and controls (where available) to achieve designated differential pressures between spaces or required to meet applicable codes and standards. Adjust systems to achieve the required sequence of differential pressures between successive rooms.

Pressure differentials without numerical value, adjust the systems so that the required air flow or pressure differential between the rooms is detectable.

Adjust systems with the rooms in normal operating condition and doors closed except where the normal operating condition requires that the doors be open.

Report locations of excessive building air leakage so they can be sealed.

Procedure
Adjust systems in the following sequence:

- Balance supply air to designated values and tolerances.
- Balance return and exhaust air to designated values and tolerances.
- Adjust controls (if applicable) to designated functions.
- Measure differential pressures.
- Re-adjust return and exhaust air quantities to achieve designated differential pressures if not achieved through the above. Do not alter supply air from designated values.

6.16.4.13 Sound Pressure Levels

Complete sound pressure level measurements, for the system in operation at full load as follows:

Internal: To AS/NZS 2107.

External: To AS 1055.1.

Measure the A-weighted sound pressure levels and the A-weighted background sound pressure levels at the designated positions.

Measure the sound pressure level and the background sound pressure level over the full range of octave band centre frequencies from 31.5 Hz to 8 kHz at the designated positions.

Correction for background noise to AS/NZS 2107 Table B1.

If a test position is designated only by reference to a room or space, do not take measurements less than 1m from the floor, ground or walls.

6.16.5 Commissioning Reports

6.16.5.1 General

All commissioning reports shall be completed in conjunction with the Controls Specialist Contractor and submitted to the client and ER for review and include but not be limited to the flowing information:

1. Introduction
1.1 Project Name
1.2 Location/Address
1.3 Client Details
1.4 Plant Reference, Plant Location, Areas served
1.5 Commissioning Standard e.g. for air balancing CIBSE Code A, for water CIBSE code W.
1.6 System Description
1.7 Commissioning Methodology including what instruments are used for each measurement, system setup parameters etc. Methods for the taking of measurements to be discussed and approved prior to taking the measurements. This will include what correction factors need to be taken.
1.8 Date of testing
1.9 Technician Name
1.10 Notes/Qualifications/Deficiencies
2. Equipment/System Details
2.1 Make/Manufacturer
2.2 Model
2.3 Size/Capacity
2.4 Serial Number

2.5 Design Performance Parameters e.g. fan or pump duty flow, pressures, speeds, running currents, diversified flowrates, total flowrates, etc.

2.6 Actual performance figures

3. Correction Factor Sheet

3.1 This sheet details the correction factors used and how they were calculated. The commissioning specialist shall explain how calibration factors are established and demonstrate to ICA if requested.

3.2 Calibration Sheet

3.3 This details all the equipment used in the commissioning including make model and serial numbers and the date of last calibration.

4. Fan or Pump Curve

4.1 Include equipment datasheet and curves for reference purposes.

5. Pitot Traverse

5.1 Reference the pitot traverse to a physical location, indicate duct size, velocity measured at each traverse point, average velocity, calculated flowrate, flowrate as a percentage of design and duct static pressure.

6. Proportional Balance Test Sheets

6.1 Include grille reference, design flowrate, calibration factor, measured flowrate, adjusted flowrate and percentage of design flowrate. Identify the index grille.

7. Schematics/Reference drawings

7.1 Include a system schematic detailing, pitot traverse locations, index terminals, branch & sub-branch regulation devices, grill reference numbers that correlate to report

6.16.5.2 Air Balance Report

Include the following on the air balance reports:

- Date, time and place of test.
- Instrumentation used and its date of calibration.
- Name, position and signature of person responsible for test.
- Ambient temperature and/or other relevant factors.

For each terminal grille and diffuser:

- Grille or diffuser reference number as shown on the shop drawings. List outlets on a branch by branch basis.
- Design air quantity.
- Measured value (e.g. L/s, m/s).
- Hood or instrument factor.
- Grille or diffuser manufacturer's area factor if applicable.
- Site measured air quantity in L/s calculated from the above.
- Measured air quantity as a percentage of design air quantity.
- Sum of measured branch and system air quantities and percentage of design.

For each fan:

- Fan designation and location.
- Total air quantity measurement method.
- Location of measurement point.

- Simulated wet cooling coil pressure drop and dirty filter pressure drop.
- Design air quantity.
- Pitot readings (if used) or other measured values used to independently determine total fan air quantity.
- Site measured air quantity in L/s calculated from the above.
- Measured air quantity as a percentage of design air quantity.
- Measured air quantity as a percentage of the sum of the individual diffuser and grille air quantities.
- Blade pitch and/or fan speed as applicable.
- Variable speed drive frequency (if VSD is installed).
- Measured motor current and name plate full load current.
- Show the final operating point on the fan characteristic curve.

Static pressure differentials across:

- Each filter bank when clean.
- Each cooling and heating coil.
- Each fan.

Duct static pressure at:

- Entry to filters.
- Entry to each fan.
- At duct discharge from air handling unit.
- At each riser connection for supply and return systems serving multiple floors.

6.16.5.3 Water Balance Report

Include the following on water balance reports:

- Date time and place of test.
- Instrumentation used and its date of calibration.
- Name, position and signature of person responsible for test.
- Ambient temperature and/or other relevant factors.

For each coil or terminal:

- Coil designation and location.
- Measurement method.
- Design water quantity.
- Measured values used to determine water quantity.
- Manufacturer's factor (if applicable).
- Site measured water quantity calculated from the above measured values.
- Measured water quantity as a percentage of design water quantity.
- Measured water quantity as a percentage of sum of individual coil water quantities.

- Hand wheel setting of calibrated balancing valves (where applicable).

For each pump:

- Pump designation and location.
- Impeller diameter.
- Water quantity.
- Head.
- If variable speed drive (VSD) is installed: VSD output frequency.
- Measured motor current and name plate full load current.
- Show the final operating point on the pump characteristic curve.

6.16.5.4 BMS Commissioning

The BMS contractor shall carry out and document the commissioning of the BMS system including:

- Point to point testing to verify correct communication between all field devices and controller I/O, analogue device calibration and scaling.
- Functional testing in accordance with the approved functional description.
- Integration of all high level interfaces (HLI). Demonstrate HLI points have been correctly mapped.
- ALL interfaces with other trades

6.16.5.5 Electrical (for Mechanical) Commissioning

The Electrical for Mechanical subcontractor shall perform the following electrical testing to be carried out in accordance with AS/NZS 3000 and AS/NZS 3017 which recommends the following:

- Visual inspection as per AS/NZS 3000 section 8.2
- Testing as per AS/NZS 3000 section 8.3 which includes the following mandatory tests:
- Continuity of the earthing system (earth resistance of the main earthing conductor, protective earthing conductors and bonding conductors).
- Insulation resistance (500V or 1000V megger tests after 1st fix)
- Polarity
- Correct circuit connections
- Earth loop impedance
- Operation of RCDs
- Checks that all terminals are securely fastened.
- Checks that all equipment is safe to operate, and that overloads, protection equipment, safety devices and interlocks have been properly set are all in working order.
- Checks of operating sequences and functions of all devices, and rotation and current draw of motors. (Please include the results for each circuit with a column adjacent stating ‘Maximum permissible to achieve disconnection time’ completed. ‘Maximum permissible’ figures from table 8.1 of AS/NZS 3000).
- Phase load testing and rebalancing of phases. Measure voltage drop on fully loaded circuits as directed by the Engineer.
- Testing of switchboards and power factor correction systems.

- Any emergency stop control circuits testing (if applicable).

6.16.5.6 Other Reports

- Fire damper drop test
- Interface testing
- Chiller/heat pump commissioning
- VSD commissioning

6.16.6 Completion

6.16.6.1 Witnessing

Once commissioning has been completed by the contractor and commissioning reports have been submitted and reviewed by the design consultant and ICA the contractor shall offer the systems up for witnessing. The intent of the witnessing is not to repeat the commissioning process but rather demonstrate to the consultants portions of the commissioning so that they can gauge with reasonable confidence that the systems are correctly commissioned. Consultant witnessing shall include the following:

- Air and water balancing including pump and fan performance.
- BMS functional testing according to the approved functional description including heating, cooling, scheduling, alarming and trending.
- Stable and automatic operation of the mechanical plant.
- Interface testing confirming the mechanical plant reacts correctly to inputs from other trades for example fan shutdown on fire alarm.

6.16.6.2 Tests under Automatic Operation

Procedure: Upon completion of commissioning, testing and witnessing and prior to practical completion, operate all plant for a seven day week under automatic control to demonstrate correct and reliable operation. Ensure that building is sealed. Give notice of this test.

Data logging: Record the following data at 10 minute intervals:

- Status of plant – on, off or fail.
- Outdoor dry bulb and wet bulb temperatures.
- Dry bulb temperature at each room temperature sensor.
- Relative humidity at sensors or return air grilles.
- Dry bulb temperature of air entering and leaving each coil.
- Supply air temperature to each zone.
- Position of outside air, return air and spill air dampers, heating and cooling valves.
- Speed of variable speed fan and pump motors.
- Chilled water and condenser water supply and return temperatures for each chiller.
- Heating water flow and return temperatures for each water heater.

Record sound level at each room temperature sensor (NC or NR) and externally.

Inspect plant and record any irregularity in performance, noise, vibration over heating etc.

Interrogate the building management system and print alarm reports, status reports and values of all controlled variables.

Adjustments: Make adjustments or corrections required by the ER.

Submissions: Provide certified test results and trend log graphs.

6.16.6.3 Practical Completion

Hand over plant in full working order at practical completion.

6.16.6.4 Performance During Defects Liability Period

If during the defect liability period temperature or humidity complaints are advised by the ER, log the room temperature and humidity over a period using a portable thermohydrograph or the mechanical control and monitoring system.

If during the defects liability period the plant does not meet design performance, rectify any defects and recommission and retest the plant.

6.16.6.5 Deferred Seasonal Tests

Conduct deferred seasonal tests when the plant is fully functional and operating under automatic control.

Test air conditioning systems at or near summer design conditions, above 30°C DB ambient whilst the building is occupied.

Test heating systems at or near winter design conditions, below 10°C DB ambient.

Data logging: Over 7 day periods in summer and winter record the same data required above for tests under automatic operation excepting for acoustic tests.

Witnessing: Give notice of tests. Submit test results for review.

6.16.6.6 Certification

Provide certification that the installation complies in all respects with the contract documents.

Provide certification of compliance with the relevant statutory requirements.

6.16.7 Re-commissioning

A full repeat of the work documented as commissioning is to be completed after the system has been operating for a continuous period of 12 months after practical completion. The purpose of re-commissioning is to determine whether the mechanical plant is operating as it did when originally installed. Its purpose is also to detect any deterioration or improvement in performance so that corrective action can be taken if necessary. Recommissioning need not involve total repeat of the original commissioning process.

6.16.7.1 Re-commissioning Instructions

Provide the following in the mechanical maintenance manuals in addition to that specified in the General requirements work section:

- Instructions for re-commissioning the system.
- Recommended tasks to be conducted when re-commissioning.
- Schedules to be used for recording re-commissioning data so that changes in the system over time can be identified.

6.17 VARIABLE REFRIGERANT FLOW SYSTEMS

6.17.1 General

Supply, deliver, install, test, commission and set to work new comfort cooling system installations and associated ancillary services generally in the positions indicated on the accompanying drawings and as detailed herein and in accordance with this specification, equipment schedules.

The system installed shall be a Mitsubishi Electric 2 pipe (simultaneous heating and cooling) or approved equivalent.

The indoor units and outdoor units shall be free from obstructions and have allowances for ease of access as per manufactures specifications.

The units shall be R410A, inverter driven heat pump units consisting of outdoor and indoor units connected through branch selector units, each having the ability to simultaneously cool or heat independently for the requirement of the space.

All refrigeration pipework system associated with the split systems shall comply with the requirements of AS1677.2. Submit calculations upon request from the Engineer.

Comfort cooling units shall achieve minimum energy efficiency ratio (EER) as set out in the following table.

Type	Cooling unit full load EER
Packaged air conditioners	2.6
Split and multi-split air conditioners	2.6
Variable refrigerant flow systems	2.6

6.17.2 Indoor Units

Indoor units shall be a mixture of 4-way cassette and wall-mounted hi-wall heat pump types with electronic control valves, which controls the refrigerant flow rate in response to load variations of the area.

All indoor units to be equipped with additional control / communications card to provide a status / fault signal from each unit ("CN52 plug in").

6.17.3 Outdoor Units

The outdoor units shall be a factory-assembled unit housed in a sturdy weatherproof casing constructed from rust proofed mild steel panels.

Outdoor units to be floor mounted on suitable structural supports.

The units shall be located externally with suitable demarcation barriers and access generally as indicated on the accompanying drawings.

6.17.4 Refrigerant Circuit

The refrigerant circuit shall include liquid and gas shut off valves and solenoid valves. All necessary safety devices shall be provided to ensure the safe operation of the system.

Master and Slave BC controllers shall be provided as necessary.

6.17.5 Pipework

All pipework to be run in refrigeration quality copper tube manufactured to BS6017, 1981/Cn-DHP and to strict tolerances. It should be cleaned internally to BS2871 part 2 1972 paragraph 19 and the ends sealed or capped.

The mechanical services contractor will be responsible for the installation and correct pipe sizing of all pipework in accordance with good refrigeration and air conditioning practice to all current standards.

Where ever possible fittings should be avoided as they only mean another joint. Therefore:-

- Bend tube rather than use fitting
- Swage tube rather than use fitting
- Pipework connections shall be sweated other than onto the sight glass and filter drier and final connections to the condensing unit and evaporator.
- Oil traps are to be fitted every 3m on all vertical runs or where necessary for the correct operation of the system.
- Suitable velocities for refrigerant must be maintained at all times for optimum efficiency of the unit.

6.17.6 Insulation

Suction line to be insulated as per the manufacturers recommendations.

External insulation lagging to be protected with two coats of Armaflex H.N paint.

6.17.7 Tray work

All tray work to be galvanised and routed where possible at high level, either suspended from the ceiling or within the ceiling void.

Internally exposed pipework (i.e. below ceiling) shall be routed on galvanised traywork with covered lids for protection and aesthetics. Covered lids to be suitably sized to accommodate ‘griplock’ type fasteners.

Externally exposed pipework shall be routed on galvanised traywork with painted galvanised lids for protection and aesthetics. Colour of lids to be agreed with LU. In addition, suitable bird protection shall be provided along the complete length of the exposed trawork. The ends of the external traywork shall be covered over to prevent vermin entering the traywork.

Covered lids to be suitably sized to accommodate ‘griplock’ type fasteners.

6.17.8 Controllers

Multi-function wall mounted remote controllers (PAC-YT-52 or equivalent) shall be mounted 1500mm off the floor level and be hard wired to each indoor unit. Individual controllers shall include the facility to locally switch the respective unit on or off, setpoint adjustment, change the operating mode and adjust the louvres/throws.

A centralised Controller AE200 shall be included for overall time scheduling, monitoring of plant, etc. This controller shall operate in conjunction with the DDC control system controlling other plant such as outside air fans, exhaust air fans and duct mounted electric heaters.

Include for the adaptor that allows for remote monitoring and fire shutdown facilities. This controller shall provide ‘high level’ control over the individual controllers.

This controller shall be hard wired into the existing fire alarm system and shut down all air conditioning plant in the event of the fire alarm.

The information is then fed back to the automatic control system.

The controller and power pack shall be enclosed within a secure metal cabinet located in the boiler room. The exact location of the pack within the boiler room shall be agreed with the Engineer.

6.17.9 Condensate Drainage

Each CCU shall be fitted with a condensate pump and connect to common copper condensate header insulated drain pipework. Condensate drainage where indicated shall route to connect to common headers and terminate either above ‘P/S’ traps of existing sinks/basins or over suitable drains with air gap allowances provided.

6.18 WATER TREATMENT

6.18.1 General

Provide water treatment and cathodic protection for open and closed water systems as necessary to ensure on-going operation and maintenance of the plant.

6.18.2 Design

Water treatment systems must:

- Limit corrosion rates to the following:
- Copper: ≤ 12 µm/year.
- Mild steel and iron: ≤ 150 µm/year.
- Stainless steel: ≤ 5 µm/year, with no pitting.
- Be compatible with the fluid being treated and the system construction.
- That is, the chemicals used must suit the materials in the system, not the reverse.
- Clean corrosion products and foreign matter from new piping.
- Effectively control:
- In closed systems: Corrosion, microbiological growth, pH, scale formation and sludge accumulation.
- In open systems: Chlorides, corrosion, sanitarying, microbiological growth including Legionella species, pH, scale formation, sludge accumulation, total alkalinity and total dissolved solids.
- Meet regulatory requirements.
- Not be hazardous in normal use.
- Not cause components to deteriorate or swell.

Cross references

6.18.3 Standards

Control of microbial growth: To the recommendations of SAA/SNZ HB 32.

Design, installation and commissioning: To AS/NZS 3666.1 as required by the Building Code.

Operation and maintenance: To AS/NZS 3666.2 as required by the Building Code.

Storage and handling of corrosive substances: To AS 3780.

6.18.4 Chemical dosing – closed systems

6.18.4.1 General

For each independent 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.

6.18.4.2 Feeder vessels

Provide a storage tank capable of withstanding the maximum pump pressure. Provide a funnel, DN 15 piping and valve 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.

6.18.5 Water filters

Provide proprietary filter systems consisting of storage tanks, piping, valves, instruments timers and controls to provide automatic backwashing.

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

Backwash cycle: Initiated by automatic timer with provision for manual override.

6.18.6 Water softeners

6.18.6.1 Construction

Provide proprietary regenerative systems consisting of a flow-through softener shell charged with softening material, a brine tank for the regeneration process, controls and instruments, manufactured as a complete package.

Avoid using automatic by-pass as the ingress of hard water can upset the chemical water treatment. A duplex unit or storage tank should be provided to ensure a supply of softened water at all times.

Brine tanks: Provide with full initial salt charge and maintain it until the end of the maintenance period.

Softening material: Insoluble in water and immune from acid attack.

6.18.6.2 Indication

Instruments: Provide dial type pressure gauges with isolating cocks to the inlet and outlet of softener tanks.

Water meters: Positive displacement type meters, with magnetic drive, brass body and 6 digit capacity, measuring cumulative flow in 10 L increments. Provide meters in manual or semi-automatic units of the resetting type, capable of being preset to any figure. Fit the meter to the outlet of the softener unit to record the total quantity of water passed through.

6.18.6.3 Controls

Backwash: Provide flow control devices to automatically regulate backwash and brine flow rates to the designated maximum.

Regeneration controls:

- Manual: Manually operated valves.
- Semi-automatic: A single multi-port valve.
- Automatic: Select from the following:

- Valves controlling a preset cycle, actuated by a time switch capable of being set to enable regeneration to take place at selected times and days of the week, and incorporating a day omitting device.
- Automatic resetting type water meter, which initiates the regeneration process on a throughput basis.

6.18.7 Cathodic protection

6.18.7.1 Standard

General: Comply with the recommendations of AS 2832.4.

AS 2832.4 Appendix A gives general guidance. The standard as a whole is a guide standard only hence the comply with the recommendations provision.

6.18.7.2 System

General: Provide a cathodic protection system for the condenser water system, using an impressed current, designed and installed by a competent person.

Characteristics: Provide the following:

- Power supply, anodes and interconnecting wiring, incorporating a facility for periodic testing.
- Insulation to the return connection.
- Power supply: Provide solid state regulated D.C. power supply with balanced outputs and ammeter.
- Probe sockets: Provide sockets for cathodic protection probes. Locate where recommended by the cathodic treatment specialist.

6.18.8 Installation

Whenever chemically treated water is to be disposed of, ensure the requirements of the local water supply and drainage authority are obtained and complied with, both regarding quantity of treated water disposed of at any one time and manner of disposal.

6.18.8.1 Chemicals

Supply chemicals for pre-cleaning, cleaning, flushing and treatment of mechanical piping systems. Make sure of correct use of the chemicals by providing instructions and supervision.

Quantities: Supply sufficient quantities of chemicals to treat the water from the time of initial filling to beyond the end of the maintenance period.

The water volume of any given system is normally calculated by the installer of the mechanical services. The water treatment specialist is responsible for calculation of the chemical quantities and supply of the correct type for the system and components involved.

The design must take into account any health and safety requirements including provisions for safe storage and transport of chemicals, spillage control and management.

6.18.8.2 Test loops

General: Provide loops in water circulating systems containing corrosion coupons representing the respective metals in the system.

Standard: To ASTM D2688.

Coupons: Suitable for changing every 3 months.

6.18.8.3 Marking

Identify piping and storage vessels containing hazardous materials.

Standard: AS 1345.

AS 1345 is referenced in General requirements. Markers may be applied after painting i.e. not by the water treatment subcontractor.

6.18.8.4 Safety signs

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

6.18.8.5 Initial treatment

Provide treatment of water from its first introduction to systems during construction.

Before setting the systems into operation and commissioning, carry out initial chemical cleaning and flushing for control of corrosion and microbial growth.

Initial fill: Introduce chemicals into the initial fill water.

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

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 systems and clean strainers. Flush with clean water until cleaning chemicals are removed.

The mechanical contractor’s pipe fitter is likely to pre-clean and fill the system under instruction from the water treatment subcontractor using chemicals supplied by the water treatment subcontractor. Coordinate with the Mechanical piping work section.

Drain piping systems and charge with chemically treated water. Discharge to sewer. Conform to AS/NZS 4494.

6.18.9 Completion

Provide routine tests to AS/NZS 3666.3 before the building is occupied.

For bacteria including Legionella species: Sampled and tested by a Registered testing authority accredited to perform the specific tests.

It is important that testing be done by an authority accredited to perform the required bacterial tests. Authorities accredited for other water treatment testing may not necessarily be accredited for bacterial tests.

Legionella analysis: To AS/NZS 3896.

Bacteria analysis: Total plate count to AS/NZS 4276.3.1 or AS/NZS 4276.3.2 as appropriate.

7 Technical - Fire

7.1 CODES AND STANDARDS

The Contractor shall comply with relevant standards / codes associated within the project.

The Contractor must take full responsibility for the safety and appoint his/her own authorised competent persons.

Referenced Documents: The following Standards are applicable to this Subsection.

Standards	
NZBC	New Zealand Building Code
NZ 4541:2013	Automatic Sprinkler Systems
NZS 4510:2008	Fire Hydrant Systems for Buildings
NZ 4512:2010	Fire Detection and Alarm Systems in Buildings
SNZ PAS 4505:2007	specification for firefighting waterway equipment
SNZ PAS 4509:2008	New Zealand Fire Service fire fighting water supplies code of practice
NZBC F8 and AS/NZS 2293:3:2005	AS/NZS 2293.1:2005 “Emergency evacuation lighting for buildings – System design, installation and operation.”
AS 1074	Steel tubes and tubulars threaded or suitable for threading with pipe threads of Whitworth form
AS 1135	Rules for the design, fabrication, installation and inspection of non-ferrous pressure piping
AS 1216	Classification, hazard identification and information systems for dangerous goods
AS 1216.1	Part 1: Classification and class labels for dangerous goods
AS 1271	Valves, water gauges and other fittings for boilers and unfired pressure vessels
AS 1345	Identification of the contents of piping, conduits and ducts
AS 1349	Bourdon tube pressure and vacuum gauges
AS 1375	SAA Industrial Fuel-fired Appliances Code
AS 1585	Capillary and brazing fittings of copper and copper alloy
AS 2129	Flanges for pipes, valves and fittings
AS 2430	Classification of hazardous areas
AS 2430.1	Part 1: Explosive gas atmospheres
AS 2700	Colour standards for general purposes
AS 2832	Cathodic protection of metals
AS 2832.1	Part 1: Pipes, cables and ducts
AS 2832.2	Part 2: Compact buried structures
AS 2885	SAA Pipeline Code
AS 3000	SAA Wiring Rules
AS 1530	Methods for fire tests on building materials, components and structures; Part 1: Combustibility test for materials,1994
AS 1530	Methods for fire tests on building materials, components and structures; Part 2: Test for flammability of materials,1993

AS 1530	Methods for fire tests on building materials, components and structures; Part 4: Fire resistance tests of elements of building construction, 2005
AS 4825	Tunnel Fire Safety, 2011

7.2 AUTHORITIES' APPROVALS

Provide documents evidencing approval of regulatory authorities before Practical Completion.

If the responsible authority is required to or, pursuant to the powers vested in it, elects to perform or supply part of the Works, make the necessary arrangements with the authority and pay and bear the fees payable in connection therewith.

7.3 INSPECTION

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

Works ready for specified testing.

Enclosed work ready to be covered up or concealed.

During the period of manufacture of equipment being provided under this contract and if required, make available such facilities as may be necessary to enable the inspection of the component parts of any items of equipment and when required, detailed working drawings of such components shall be provided for the duration of such inspection only.

Any item of equipment supplied under the contract shall be liable to subsequent rejection because of faulty workmanship or material, notwithstanding the previous acceptance of its component parts.

7.4 TESTING AND COMMISSIONING

Carry out the required tests in the presence of the ER and an authorised representative of the relevant authority. Supply the apparatus and materials necessary. Submit the test results in writing. Replace and retest components, if any, which fail the required test.

The complete design and installation of all fire protection systems specified shall be operated to perform all proving tests as set down by and in the presence of all authorities having jurisdiction over such systems.

Upon completion of each installation and system, test all equipment to determine the satisfactory operation of the system.

Sectional testing and commissioning shall be carried out during all phases of the works and include any systems that are ‘taken out of service’ that then require ‘reinstating’ to ensure the safe operation and continuity of the station is not compromised.

Seal off items of equipment not designed to withstand the test pressure. Securely anchor pipes and fittings in position to prevent movement during the tests.

Do not cover or conceal work until it has been tested. Leave pipe joints exposed to enable observation during the tests.

7.4.1 Additional Testing

Where required by the Fire Brigade, the Engineer, or any other body having jurisdiction, carry out such additional tests as required to prove the correct functioning of all systems.

7.4.2 Commissioning References

- AS1670.1 Fire detection, warning, control and intercom systems – System design, installation and commissioning

7.4.3 Commissioning Dossier and Staging of Works

The testing and commissioning of the works shall be done in accordance with section 2.0 and in conjunction with the Controls Specialist Contractor.

The station shall remain operational 24hr/7days per week.

Minimum testing to be carried out includes;

- Testing of the interfacing between new fire detectors with the existing smoke detection system
- Testing of hydrant systems
- Testing of sprinkler systems

7.5 SAMPLES

All samples shall be from typical production runs and except where this is not possible shall not be specials.

Samples shall be in the colour and finish specified and intended for the Project. Where samples are coloured or in other ways specially finished for the Project then up to three samples may be required by the SI to enable colours and finishes to be compared in addition to additional samples required to obtain acceptable standards or manufacture and finish.

Samples are required of:

- Flow switches
- All types of sprinkler heads.
- Smoke and heat detectors.
- Building occupant warning system speakers.

Information shall be provided for the following proposed items of equipment:

- Sprinkler pumps.
- Sprinkler alarm valves, gate valves, check valves, etc.
- Fire Indicator Panel with in-built building occupant warning system panel.

7.6 CALCULATIONS

Hydraulic Calculations shall:

- Be prepared for all piping, pumping and storage systems to indicate that the required pressures and flows are achieved.
- Be submitted to the relevant inspecting authority for approval prior to submission to the engineer.
- Be fully comprehensive and set out so that they are readily understood. Computerised calculations are acceptable provided they clearly indicate the Fire Protection Inspection Services Pty Ltd approved method of calculation and component data/system used.
- Be submitted with relevant workshop drawings.

7.7 PAINTING AND IDENTIFICATION

Supply and install all necessary equipment to identify the system to conform to the “Preliminaries” section.

Items of equipment provided as part of this subcontract, eg. control panels, etc shall be painted off-site in accordance with the requirements herein.

Where damage occurs to the paintwork of equipment, the damaged item shall be returned to the respective paintshop where it will be refinished with primer and final coats to restore the surface to its specified conditions of colour, finish and quality.

All panels and the like shall be cleaned down and polished with automotive polish prior to practical completion.

Exposed pipes, valves, brackets, hangers etc shall be painted with one (1) coat of primer and finished with one (1) coat of best quality oil paint of selected colour as specified by the architect.

Galvanised surfaces shall be etched primed before painting.

7.8 EXCAVATION

Carry out all necessary excavation as specified under “Excavation & Pipework Requirements” section.

7.9 PIPE SUPPORTS

All pipes shall be adequately supported and securely fixed in accordance with the drawings and to the satisfaction of the ER. Such supporting and fixing to be carried out without causing any distortion, damage or stress on the pipes or pipe joints.

Pipes shall be supported at each collar and at spacing as specified in “Preliminaries” section.

7.10 VALVES

All valves to comply to those specified in the “Materials” section.

7.11 COMPLETION

On completion of installation and testing, turn on isolating and control valves, and purge and charge the installation.

Hand over the installation fully charged.

7.11.1 Accessibility

Locate pipe fittings requiring maintenance or servicing, including control valves, joints designed to enable removal of pipes, and the like, in accessible positions with adequate clearance and ventilation. As far as practicable install components such as pipe fittings so that they are removable without damage either to themselves or to the building structure or finishes.

7.12 WALL BOXES

Provide wall boxes to accommodate above ground valves, regulators and the like. The boxes shall be constructed of 1.2mm stainless steel plate continuous welded box construction with leading edge folded twice at 90o to form 25 x 25mm frontal surround. Fix to masonry backing with four 10mm galvanised masonry bolts. Set the bottom of the box to fall outward. Form four 10mm diameter holes in the frontal surround section at box floor level. Provide, to the box floor inlet and outlet pipes, sleeves formed of 1.2mm thick steel tube with 1.2mm galvanised flanges to pipe diameter plus 50mm. Bed each flange on epoxy mortar and rivet to the floor of the box with four 3mm diameter rivets.

Provide metal frame doors with 2.5mm clear float glass glazing. Affix to the glass with adhesive a white laminated plastic label 200 x 100mm, engraved with red letters "IN CASE OF EMERGENCY BREAK GLASS AND SHUT VALVES". Provide lock, keys and two 100mm brass hinges.

7.13 PIPING

If practicable, install piping so that it is concealed within service ducts or non-habitable enclosed spaces and does not appear on external walls. Otherwise, provide metal piping mounted on metal brackets and provide metal cover plates at penetrations. For piping embedded in concrete, install in continuous lengths without fittings. Do not lay across joints between adjoining sections of concrete through which reinforcement does not extend.

7.14 PITS

For below ground, house control valves and regulators in concrete access pits with removable pit covers.

Constructed to give 300mm clear space all around the fittings in the pit.

Use Grade N20 concrete to AS 1379, 100mm thick, reinforced with F82 fabric with concrete covers to AS3996. Mark pit covers with the work ‘GAS’.

Grade floor to a point on one side and provide a gravity drain to remove water from the pit. Do not connect the drain to other substructures or drains. Carry the pit walls up to 50mm above finished ground level. Cast in the pit cover frame flush with the top. Trowel the top smooth.

7.15 AUTOMATIC FIRE SPRINKLER SYSTEM

7.15.1 Design of System

Design the complete sprinkler system in conformity with all requirements of the relevant authorities and in accordance with the latest addition of NZS 4541:2013 Automatic Fire Sprinkler Systems.

All piping and equipment shall be placed so that they do not interfere or inhibit the functioning or placement of other building services and components. Coordinate with all other building services, including hydraulic, mechanical, structural and electrical contractors.

The sprinkler service shall include, but not be limited to, the following:

7.15.2 Design Parameters

The building comprises of, but shall not be limited to, the following design parameters:

To the requirements of NZS 4541:2013 Automatic Fire Sprinkler Systems Part 2 with the determination of Fire Hazard classifications to be determined with the client.

7.15.3 Water Supplies

The water supply to the sprinkler system shall be by means of a grade 3 water supply.

This shall consist of one means of water supply supplied from the street main.

The existing incoming towns main water supply to the sprinkler valve room shall be retained.

7.15.4 Valves

General

All valves shall conform to the relevant New Zealand, Australian or British Standard.

Valve shall be bronze up to and including 80mm.

100mm and above shall be Cast Iron.

Screwed pattern up to and including 50mm.

Flanged from 65mm and greater.

Valves to be manufactured to a minimum working pressure of not less than 2,000 kPa.

Flanged valve to be a minimum of Table `E'.

Valves within the system which will be subject to pressures in excess of 2,000 kPa shall be manufactured to withstand those pressures.

Flanged valves subject to pressures in excess of 2,000 kPa shall be supplied with Table `H' flanges.

All valves of a particular type shall be of the one manufacture. Any bronze or gunmetal components shall be of a type not subject to dezincification.

Gate Valves

Gate Valves and control valves shall be used for isolating services. Screwed bronze valves up to and including 50mm . Flanged up to and including 80mm. Cast Iron, flanged Gate Valves, 100mm and greater.

Control Valves

Shall be of approved manufacture with tested brass body and loose valve to conform to AS1718.

Check Valves

Shall be of the Swing Check type with bronze body up to and including 80mm.

The screwed patterns shall be used for valves up to and including 50mm in accordance with AS1628

65mm and 808mm or equivalent.

Cast Iron flanged Check Valves from 100mm and above in accordance with BS3464.

Note: (Check Valves on pump sets to have lever arm and counterweight fitted).

Globe Valves

- To be used for system balancing and throttling.
- 15mm to 50mm with screwed ends
- 65mm to 80mm with full faced flanged ends.
- 100mm and greater to be Cast Iron and flanged.

7.15.5 Automatic Fire Sprinkler Control Valve Sets

Check and confirm that the existing sprinkler valve room complies with NZS4542:2013 and if not supply and install new sprinkler control valve set in the new sprinkler valve room.

Each valve set shall consist of the following items:-

- A stop valve to isolate the water supply, including approved anti-tamper device.
- An alarm valve, functioning as a check valve to maintain the boosted pressure within the installation. A reduction of installation pressure will open the valve and allow water to pass through and actuate alarms. The valve shall also incorporate means for admitting water to the turbine local water motor alarm bell.
- A combined 15mm test and 50mm drain valve for testing and drainage purposes.

- Pressure gauges, complete with the appropriate connection to indicate the supply mains and installation pressures.
- Leather straps, brass locks, keys and labels for fixing of valves in their normal operating position.
- Valves connection for the manual start electric jacking pump.
- Pressure switches as necessary to operate booster pumps, mechanical plant shut down, fire alarms, electric alarm bell, interface to security company/fire brigade call out and monitoring facility via FIP, etc.
- All pressure switches and alarm controls to be mounted down stream of the retarding chambers.
- Necessary valves and associated piping.
- Control valves shall be clearly labelled identifying the control valve number and which zone it serves.
- Emergency instructions and block plan.
- Trafolyte labels on all valves, pressure gauges, pressure switches and the like.

7.15.6 Flow Test Equipment

Flow test equipment shall be permanently installed on the valve set which requires the greatest flow rate in the sprinkler valve room.

The equipment shall consist of test flow pipework connected into the installation pipework above the alarm valve, an isolating gate valve, a regulating globe valve, a petcock upstream of the regulating valve and an approved flow measuring device installed in the pipework, all to the approval of the Engineer.

7.15.7 Additional Sprinkler Heads

Submit with this Tender a fixed price schedule of rates for additional sprinkler heads, as noted on the Tender Forms, as may be required for works as a result of Client Changes after Tender, in accordance with tender forms.

7.15.8 Sprinkler Heads

Prepare shop drawings that indicate the layout of sprinkler heads based on the fire hazard classification as mentioned in this Specification. The layout shall be co-ordinated with the building structure, and all other services, including lighting and air conditioning outlet positions, ductwork, structural beams and the ceiling layout.

Sprinkler heads to be installed below ceiling shall be coordinated with light fittings and air-conditioning diffusers to achieve a consistence and symmetrical pattern to the ceiling.

Allowance shall be made for obstructions caused by ductwork and beams.

Piping shall be installed to meet the Construction Program prior to erection of ceiling and ductwork.

New sprinkler heads shall be as follows:

(a) New sprinkler heads below ceiling shall be spray pattern 15 mm 68°C. semi recessed type chrome plated with white escutcheon plate in all areas.

(b) New exposed sprinkler heads shall be 15 mm 68°C bronze type without escutcheon fixed directly to range pipes to be used in plantrooms and general areas where piping is exposed.

Allowance shall be made for the installation of pipework and sprinkler heads in garbage chutes, etc.

New concealed space sprinkler heads shall be 10mm 68°C bronze type attached directly to range pipes to be used in false ceiling and roof spaces.

Sprinkler heads shall be located in positions such that they will not interfere with ductwork, light fittings, etc.

The sprinkler heads shall have operating temperature ratings and orifice sizes suitable to the environment and hazard respectively, to which they are being installed.

Spares

Allowances shall be made for the provision of a spares box and spare sprinkler heads in the sprinkler valve room, all in accordance with NZS4541 and AS2118.

7.15.9 Sprinkler Guards

Wherever sprinkler heads are subject to damage or if the head is less than 2130 mm from floor level the sprinkler heads shall be protected by a suitable type approved guard.

The guard shall not obstruct the normal function of the sprinkler heads.

The guards shall be cadmium plated steel and robust in construction. Guards shall be provided in all locations where accidental damage is likely to occur.

The guards shall be to the approval of the Engineer.

7.15.10 Sprinkler Shields

Shields shall be placed where necessary to prevent sprinkler heads from discharging directly on to electrical switch gear or open motors. Shields shall also be used in selected locations fabricated from 1.6 mm thick galvanised steel and painted in a selected colour where required.

7.15.11 Flow Switches

The flow switch shall be approved by the relevant authorities.

The flow switches shall be mounted at the take-off point to each designated area to indicate the operation of a sprinkler head in that area.

The flow switches shall have an inbuilt time delay before contacts close to initiate FIP signal.

The time delay may be via a suitable time delay circuit incorporated in the FIP provided that the circuit is fault monitored.

The flow switches shall be of the glandless magnetic pole type of ME Mack manufacture or approved equal.

Each flow switch shall have a ∅20 mm solenoid test valve, strainer and ∅15m bypass connected to a 50 mm NB galvanised drain for regular testing. The flow switch shall be activated by a 24 volt DC signal from the FIP.

7.15.12 Solenoid Test Valves

Solenoid test valves shall be provided for automatic testing of the sprinkler system flow switches via the FIP.

7.15.13 Anti-Tamper Valve Monitoring Devices

Anti-tamper valve monitoring devices shall be installed on all stop valves associated with the sprinkler system.

The monitoring devices shall be approved and be flame retardant UV resistant polyester or stainless steel casings.

The operating components shall be sealed within a shock resistant potting compound with LED indicator.

The monitoring devices shall be magnetically operated and shall initiate an alarm upon accidental or deliberate operation of any stop valve.

7.15.14 Security Company/Fire Brigade Call Out and Monitoring Facility

A direct Security Company/Fire Brigade call out and monitoring system shall be provided, allow to provide sprinkler actuation pressure switch to alert the security Company/Fire Brigade to the operation of the alarm valve via the FIP.

All wiring and connection from the sprinkler system actuation pressure switch to the FIP shall be by the fire services contractor.

7.15.15 Sprinkler Pumps

Sprinkler Jacking Pump

Allow to provide automatic electric jacking pump, all associated pipework, control panels, pressure switch, valves, and items of equipment.

Ancillary Equipment

Provide ancillary equipment such as starting mechanism, tools and spare parts in accordance with NZS4541 and AS2118.

7.15.16 Pressure Gauges

Pressure gauges shall be provided in accordance with NZS4541 and AS2118 and shall be of the Bourdon tube actuated type with a minimum face diameter of 100mm. The normal operating pressure shall be marked in red on the dial face and the selection of the gauge shall provide this pressure at not more than 75% of maximum collaborated pressure on the dial. Provide a gauge cock with each gauge.

The gauges shall have a matt black finish and shall be pipe mounted.

Each gauge shall have its function indicated by an engraved label and shall comply with AS1349.

7.15.17 Pressure Switches

Pressure switches shall be mounted as per AS2118.

The pressure switches shall be the mercury of micro switch type with a pressure range of up to 2000kPa with a clear case front for mercury and general purpose metal housing for micro switches.

Pressure switches provided for pump starting shall be manufactured to withstand a pressure range of up to 3,000 kPa.

Pressure switches shall be provided as required to perform all functions required by the Sprinkler Code including:

a) Actuate a security company/fire brigade call out and monitoring facility via the FIP.

b) Actuate an electric alarm bell.

c) Start the electric sprinkler jacking pump.

f) Fire mode operation of air conditioning system

g) Ancillary alarms and functions (eg. Fire alarm system, building occupant warning system).

Provide one isolating switch adjacent to each pressure switch for testing of systems.

The isolating switch shall be of the key operated rotary type with pilot light. The pilot light shall be illuminated when the electrical circuit associated with fire sprinkler equipment being tested is isolated. The key mechanism shall be arranged so that the key can only be removed when the switch is in the closed position.

7.15.18 Pipework

General

Pipe materials and wall thickness shall comply with the relevant New Zealand/Australian Standard Codes and Authorities' requirements.

Design all piping between existing water supply mains and new control valve set(s) and all piping downstream of the control valve(s) including all aspects associated with the correct support, anchorage and flexibility of the system.

Piping shown on the indicative preliminary drawings indicates the general run and connections. Piping may not be shown in its true position in every instance and all bends, offsets, elbows are not indicated.

Fully co-ordinate with the building components and provide all pipework, fittings and supports as required in their correct location for the correct operation of the system.

All pipework and equipment shall be accurately set, plumbed and levelled and hanger rods shall be true vertical alignment. Pipework and supports may have to be offset, lowered or raised as required or as directed on site for co-ordination with structure and building services.

Pipework or any other works which, in the opinion of the Engineer, are not installed as required shall be removed and replaced by this Sub-Contractor at no extra cost.

All pipework shall be located so that it will not interfere with the operation and maintenance of the building services.

All piping shall be cleaned out with high pressure compressed air to remove accumulated dirt, filings and foreign matter before sprinklers and outlets are fitted. Sprinkler piping shall be additionally flushed out with water.

Should any leaks develop in the various piping systems during installation, testing, and/or warranty period, repair same and make good any damage to the building structure, contents, etc. resulting from such leaks.

All piping which is concealed from view (within ceiling spaces, walls, ducts, etc) shall be pressurised with water and tested for leakage in the presence of the Development Manager before it is **enclosed**.

Materials

All steel piping shall be new medium or heavy grade tube conforming to AS 1074 - or any other black steel pipe as listed in AS 2118 and shall suit the pressure requirements of this project.

The tubes shall be clean and free from scale.

Above ground pipework installed before the sprinkler control valves shall be galvanised or hot dip galvanised after fabrication. All other sprinkler pipework shall be medium or heavy grade black steel.

All pipework exposed to the weather shall be galvanised.

Drain pipes shall be medium grade galvanised screwed and socketed.

Firelite pipe or equivalent will be accepted for this project.

Pipework shall be made up of the longest possible lengths of tubing to minimise joints.

Black steel pipework shall be prime coat painted before delivery to site and all pipe ends shall be capped with plastic or steel caps to prevent entry of foreign matter.

Provide heavy grade pipework to all sections of the piping reticulation that may be subject to pressures in excess of 1,600 kPa.

7.15.19 Fabrication and Installation

Screwed threads on steel piping shall be cut squarely with the axis of the tube. Threads shall be within the tolerance specified in AS 1722, Parts 1 and 2.

The ends shall be cut squarely with the axis of the tube.

Screwed joints shall comply with AS 1722 Parts 1 and 2 with trapper external (male) or internal (female) threads. Parallel threads may be used where provided on equipment or fittings.

Long screws, plain nipples or barrel nipples shall not be used.

For above ground pipes, screwed and socketed joints shall be used on pipes up and including 50 NB, above which size welded flanged joints only will be accepted.

Provide protection of the screwed threads by coating the threads with a good quality grease or other suitable compound.

Fittings for pipework shall be done by using either malleable cast iron fittings (up to 80 mm diameter) or steel butt welding fittings. Fabricated bends shall be made by butt welding elbow sections. Lobsterback bends and mitred bends are not acceptable.

Reduction in piping in not less than two pipe sizes may be made by using sockets cut and welded into the mains.

Only pipes of 50 mm diameter or greater shall be joined together by welding unless the joints are fabricated, welded and inspected in the workshops of fabricators whose welding procedures have been approved.

Flanges shall comply with AS 2119 - "Flanges and bolting for Pipes, Valves and Fittings" Table E or Table H to suit pressures, and may be steel welding neck flanges or slip-on welded to the pipe. Flange drilling shall conform to AS 2129. Flanges shall suit the pressure requirements of the project.

Flanges may be tack welded in-situ but all other welding of the flange to the pipe shall be carried out with the joint dismounted to ensure good welded quality.

Flange gaskets shall be made using 3 mm minimum thickness jointing material, suitable for the service and manufactured in accordance with the relevant standard.

Connection of distribution pipes to riser mains shall be made with a flanged joint at each branch.

7.15.20 Testing of Piping

The Engineer shall witness all hydrostatic tests.

Sprinkler piping systems shall be hydrostatically pressure tested in sections or in their entirety at an early stage to avoid delaying the work of other trades.

Testing shall be carried out before piping is boxed or otherwise covered by false ceiling, walls, ducts, etc.

Pipework and sprinkler heads in the vicinity of electrical and other equipment shall be tested before the equipment is installed. Alternatively, the equipment shall be adequately protected by this Sub-Contractor during testing.

Testing pressures for sprinkler pipework shall be 1400 kPa and held for a period of 2 hours without any pressure drop, or 400 kPa in excess of maximum static working pressure whichever is the greater.

All defects disclosed during testing shall be immediately rectified and new tests carried out after rectification work.

Items of plant and equipment liable to damage at the test pressure to be applied shall not be connected while pressure tests are being carried out.

Provide a sufficient number of plugs to blank off all outlets of the section of pipework to be hydrostatically tested. The plugs shall be removed on satisfactory completion of hydrostatic testing of each progressive section of work.

Where it is necessary to isolate sections of pipework prior to hydrostatic design, each section shall be isolated by means of a blank metal flange.

The as-installed drawings shall record each special isolating flange location.

On completion of the sub-contract, ensure that special isolating flanges have been removed from the piping reticulation to the satisfaction of the Engineer.

7.15.21 Roll Groove Couplings

Victaulic or other approved roll groove couplings may be used subject to the Engineer's approval. Roll groove couplings shall:

- Have approval of all relevant authorities.
- Be installed and supported strictly in accordance with the manufacturers recommendations.
- Not be used on vertical pipes unless specifically approved by the Development Manager.
- Not be used on the first joint of a floor area between the reticulation pipework and a rising main. Flanges shall be used at this location to allow for isolation of individual floors.
- Be a uniform type and the same brand throughout the fire services.
- Not be used on pipes smaller than 65 NB.
- Not be used on blank end pipe stubbs unless specifically approved by the Fire Protection Consultant.

Housing, gaskets and grooves shall be an approved combination and all couplings and gaskets shall be readily available from local suppliers.

Each housing and gasket shall be compatible with the pipe to which it is fitted.

The whole assembly shall be used in accordance with the manufacturer's recommendations.

The grooves shall not be cut, but are to be rolled and will be dimensionally compatible with the gaskets and couplings.

The gaskets shall be a central cavity pressure-responsive design suitable for the application and will be of rubber grade and compound approved for continual service within the applicable temperature and pressure ranges.

Housing shall consist of a one or more piece, ductile or malleable iron casting with nuts, bolts, locking toggle or lugs to secure the unit together. They shall be free from obvious surface porosity and mound flash.

7.15.22 Welding

General

Butt welds may be made with or without internal collapsible copper faced mandrills behind the welded joints. Permanent backing rings shall not be used.

All welding shall be done by experienced and competent tradesmen in accordance with AS CB15 for high pressure stages and around pressure pump sets. Standard industry practice shall be used on all other pipework. Welding operators for pressure piping shall hold Certificate No.2 (minimum) in accordance with AS 1796. For systems not defined as pressure piping all welding shall be done under the supervision of a welding operator certified as above.

All electric welding shall be free of defects such as cracks, lack of fusion, incomplete penetration, undercut, slag including, porosity, and all joints shall be properly prepared by bevelling and the like and preheated prior to welding, all as necessary to avoid stress concentration at the welded joint.

Welding electrodes shall be a type leaving a metal deposit having yield and ultimate strength not less than and similar to the parent metal.

Requirements for Completed Welds

In butt welds there shall be complete fusion between the weld metal and pipe material.

Unless butt welds have been dressed flush there shall be external weld reinforcement not less than 10 percent nor greater than 20 percent of the pipe thickness.

Joints in weld runs whether welding has been recommended or completed shall show no pronounced hump or crater in the weld surface. In butt joints the weld shall fuse the pipe walls at the roof without protruding excessively in to the bore. In general the penetration bead shall not exceed 1.5 mm although occasional slight excess of penetration is acceptable.

The weld metal as deposited shall be free from cracks, slag inclusions, porosity, cavities, undercut and other faults. The external surfaces of all weld shall be clean, regular and of consistently uniform contour.

Any fins, dags or other forms of swarf still connected to the pipe after drilling shall be removed by approved mechanical means.

Faulty Welds

Welds, which in the opinion of the Engineer, are faulty as a whole or part, or welds which fail under pressure test shall have the faulty portion removed by flame gouging, chipping or grinding and shall be rewelded using the same welding process as that used for the original welding. Such welds shall be re-inspected and/or retested after being repaired.

If in the opinion of the Engineer the weld cannot be repaired by the above method this Sub-Contractor shall remove a piece of pipe containing the faulty joint and shall replace with a new piece of pipe to approval.

The piping in which the ailed or faulty joint is located shall be rewelded, reinspected and retested at this Sub-Contractor's expense.

On Site Welding

Ensure that precautions are taken for protection of persons and property from injury by fire or explosion arising out of cutting and welding operations conducted on site.

Precautions taken should be in accordance with AS 1674 - 1974 - "Rules for Fire Precautions in Arc or Flame Cutting and Arc or Gas Welding Operations".

Approved fire blankets shall be used where necessary to prevent damage by sparks on building materials.

In order to maintain the required standard of welding throughout the project all welding equipment shall be kept in good condition.

Where necessary, staging and protection from the weather shall be provided to enable the welding operation to be performed correctly.

7.15.23 Pipe Hangers and Supports

The piping system and all associated equipment shall be properly supported by suitable clips, brackets and hangers in such a manner as to provide all necessary restraint to ensure its capability of accepting all normal loads and movements which can occur in the building areas served by the system without excessive noise transmission, vibration or displacement at connections and joints.

Sagging pipes or untidy runs will not be accepted.

Provide all necessary supplementary support work to secure pipe supports.

Pipe supports shall be constructed of mild steel.

Pipe supports exposed to the weather shall be hot dip galvanised after fabrication and shall be provided with galvanised hardware.

Hangers, etc. shall be placed as close as practicable to pipe flanges, valves etc. where these occur and shall be at intervals sufficiently close to allow not more than normal anticipated design stresses and deflections under full load conditions.

The maximum spacing of hangers and supports shall be in accordance with AS 2118.

Pipe supports shall be of an approved pattern obtained through normal trade sources, or, alternatively, detailed designs of the supports proposed shall be submitted and approval obtained prior to commencing work. Note: hangers providing inadequate support eg. made from wire etc. are NOT acceptable.

7.15.24 Fixings

All equipment and materials supplied as part of this sub-contract shall be fixed in position unless otherwise specified.

All fixings shall:

- Be approved by the Engineer.
- Comprise metal thread screws or bolts into expanding type masonry anchors for fixings to concrete or masonry.
- Comprise tapered woodscrews for fixings to timber framing.
- Be electro galvanised finish for all bolts, nuts, washers and screws.
- Be brass where installed externally to the building or in damp situations.
- Be provided with spring washers where installed on equipment which is subject to vibration.
- Be of no less corrosion resistance than the parts being fastened and shall be the same or more noble material so that they will not be preferentially corroded.

Nuts and bolts shall:

- Have heads which are hexagonal in shape.
- Be provided with flat washers.

- Have metric threads in accordance with AS 1275.
- Be tightened to show one full thread beyond the nut.

The following fixings are NOT acceptable:

- Fixings made by the use of explosive powered tools.
- Fixings made in the mortar joint in block or brickwork.
- Self tapping screws into sheet metal.

7.16 FIRE HOSE REEL SERVICE

7.16.1 Generally

Design, Supply, install, test and commission the hose reel service from the point of connection to all fire hose reels (existing) all in accordance with the NZ Building Code and AS 1221 and AS 2441.

Extend as specified, supplying all fittings, valves, brackets, pumps and sundry items to complete the installation including the hose reels to the approval of the NZFS, the local Council and the ER.

After commissioning of the installation submit a certificate to the ER certifying the installation is complete. Provide a flow test certificate to comply to AS1221 section 3.2.4.

7.16.2 Materials

The reticulation shall be constructed of solid drawn copper tube and dezincified brass or copper fittings all as specified previously under “Materials”. Joints shall be silver soldered as specified previously under “Jointing Materials”.

7.16.3 Fire Hose Reels

Not required in this contract. However should the requirement change, hose reels shall be wall mounted containing 36m of 20mm internal diameter fabric reinforced non-kinking rubber hose with adjustable nozzle. The reels shall be fitted with a gunmetal hub, red baked enamel mild steel side plates and stainless steel spacing rods and shall be in accordance with AS 1221 and approved by the Insurance Council of Australia.

The hose shall be led off by a fair lead to give a completely free withdrawal in any direction by one person and mounted 1500mm AFFL to the centre of the hub.

The hose shall be supplied with water from the water service through a 25mm screw down loose jumper type valve fitted with a union between valve and reel for maintenance purposes. The nozzle shall be attached to the valve by a device so that it cannot be removed until water supply is turned on.

The hose shall operate with a minimum flow rate of 0.33 litres per second and a running pressure of 210 kPa at the outlet of the nozzle when the hose is fully extended.

Fire hose reels shall be provided in accordance with the NZBC requirements. The system shall also be approved for use by the local water authority.

7.16.4 Fire Hose Reel Pumps

N/a.

7.16.5 Pipe Supports

Pipes shall be supported at each collar and at spacing as specified in “Preliminaries” section.

Valves

All valves to be installed to comply with the “Materials” section

7.16.6 Noise & Vibration Suppression

Supply and install all necessary equipment to identify the system to conform to section 2.0. Painting & Identification

Supply and install all necessary equipment to identify the system to conform to Section 2.0.

7.16.7 Flushing & Cleaning of Fire Hose Reel Services

Flush and clean the system as specified in the “Cold Water” section.

7.17 FIRE HYDRANT SERVICE

Design, Supply, install, test and commission the Fire Hydrant Service from the incoming water main to all fire hydrants required as per NZS 4510:2008 Fire Hydrant Systems for Buildings. This includes the Station, CPO hydrants and provisional for ‘future’ tunnel hydrants.

Include for all piping, fittings, valves, hydrant valves, pumps, control equipment electrical wiring and other sundry items of equipment as required for the installation in accordance with the New Zealand Building Code. Provide a flow test to comply to AS2419.1 Table E2.

After commissioning of the installation submit a certificate to the ER certifying the installation as complete. Provide a flow test certificate to comply to AS2419.1 table E2.

Where located in an above ground situation, the service shall be constructed of medium grade galvanised mild steel piping jointed by approved patented rolled grooved pipe and fittings equal in all respects to Victualic pattern.

Where located in below ground situations the service shall be constructed of copper tube and fittings. To all changes of direction where DICL fillings are used supply and construct concrete thrust blocks of sufficient size, design and location to prevent movement of the pipeline by means of the internal pressure. Thrust blocks shall be as specified under “Domestic Cold Water”.

All above-ground isolating valves installed on the fire hydrant piping system shall full-flow outside screw and yoke wheel gate valves of the indicating type, complying with AS 3579, or low torque wheel-operated multi-turn post indicator ball or butterfly valves with all metal actuating mechanisms closed by rotating the wheel clockwise and shall be:

- Be secured or locked in the open position; and
- Have affixed to the valve body or strap, a plate inscribed with the words ‘FIRE MAIN VALVE – SECURE OPEN’ in uppercase letters not less than 8mm high.

All gate valves installed on the fire hydrant piping system shall be “remotely monitored” gate valves with electronic anti-tamper devices. Fire trip wiring to the FIP to be by the fire services contractor.

7.17.1 Pipe Supports

All pipes shall be adequately supported and securely fixed in accordance with the drawings and to the satisfaction of the ER. Such supporting and fixing to be carried out without causing any distortion, damage or stress on the pipes or pipe joints. Pipes shall be supported at each collar and at spacing as specified in “Preliminaries” section.

7.17.2 Valves

Supply and install all valves as specified in “Materials” section.

Valves located in ground shall be provided with CI path box and lid set into concrete surround with PVC pipe riser around valve stem as specified in “Materials” section.

7.17.3 Noise & Vibration Suppression

Supply and install all necessary equipment to identify the system to conform to the “Preliminaries” section.

Painting & Identification

Supply and install all necessary equipment to identify the system to conform to the “Preliminaries” section.

7.17.4 Flushing & Cleaning of Fire Hose Reel Services

Flush and clean the system as specified in the “Cold Water” section.

7.17.5 FIRE BRIGADE BOOSTER CONNECTION

If required supply and install an approved fire hydrant booster valve (in accordance with AS2419) complete with:

- Pressure gauge
- Main isolating valve
- Full way non-return valve
- Fire Brigade supply and discharge connection points
- Connections to be to [N.S.W.F.B. or ACT Fire Brigade] requirements with threads protected by loose brass screwed caps fitted with brass security chains.
- Block plan of the system as specified in AS 2419.
- Notice of pressures
- Bleed valves
- Direction of flow arrow welded to pipe surface
- Leather or chain strap main gate valves.

The fire brigade booster connection shall be equal approved to the Galvin Engineering model 380177 with Galvin Engineering forged storz coupling model 380458F.

An enclosure for the fire brigade booster connection shall be constructed by others.

7.18 FIRE HYDRANTS

7.18.1 Internal Hydrants

Supply and install internal landing valve hydrants in approved locations with the centre of the valve 750mm above floor and having at least 300mm clearance and angled 35° down from the horizontal plane. Install hydrants clear of fire egress path.

The landing valves are to be equal approved to Galvin Engineering landing valves model 381269RGRE with Galvin Engineering forged storz coupling model 380458F.

7.18.2 External Fire Hydrants

Install each external hydrant on a 100mm GMS riser complete with a 450 x 450 x 100 thick concrete base finished 25mm above ground level. Paint a white band 100mm wide on riser and the letters FH in signal red 80mm high. Locate hydrants at least 10m away from building unless protected by a fire rated surround. Two hydrant valves shall be provided on each hydrant riser. Hydrant outlets to be

750mm above ground, fitted with a brass cap and chain. Allow for leather or chain strapped with No.3 padlock.

7.18.3 Testing of Pipework

Test all pipework 1700 kPa for a period of two hours. On completion test the installation under full supply conditions all to the satisfaction of the NZFS and the ER. Record pressure and flow results and advise, in writing, to the ER. All to conform to the requirements in the “Preliminaries” section.

7.18.4 Fire Hydrant Booster Pump

N/a.

7.18.5 Testing Apparatus for Hydrant Pumps

Where pumps are required the Hydraulics Contractor should supply and install the following equipment on the hydrant pump for the purpose of carrying out performance tests as required by AS 2419 – Fire Hydrant Installations (as amended).

Pressure gauges on both suction and discharge of pumps.

A suitably selected “Annubar” water testing element installed on the discharge side of the pump. The element shall be installed in accordance with the manufacturer’s instructions and as close as possible to the pump.

In conjunction with the Annubar element, provide and install a test landing valve(s) and suitable drain to enable testing of the pump. The test valve(s) shall be located as close as possible to the pump. The test pipeline and two in-line throttling valves shall be the same nominal bore as the pump discharge pipework and the drain shall be the same nominal bore as the pump discharge pipework and the drain shall discharge into a suitable stormwater pit.

7.18.6 Hydrant Pump Performance Tests

Prior to installation of hydrant pump the Hydraulics Contractor shall forward the completed performance test data certificates.

These certificates shall take the form of those illustrated in AS 2941 – Fixed Fire Protection Installations – Pumpset Systems and shall be issued and signed by the pump supplier.

A certificate shall be provided for the pump and the motor drive.

The hydrant pump shall comply in total with the requirements of AS 2941 – fixed Fire Protection Installations – Pumpset Systems (as amended).

7.18.7 Block Plans

Supply and install a block plan as detailed in AS 2419.1 showing the complete hydrant system. Install the block plan on the rear wall of the FBBV enclosure in a clear and visible location.

Submit a copy of the proposed block plan to the NZFS for approval prior to installing the block plans.

All block plans shall be in the form of photographic reproductions on photo-sensitive anodised aluminium sheets of 0.8 mm minimum thickness and shall be on a silver matt background with lettering and details in black.

The block plans shall be submitted to Main Contractor/ER for approval prior to being photo reproduced.

The block plans shall be mounted in anodised aluminium frames of extruded "U" section and affixed therein with an approved sealing strip. The block plans shall be fixed to the wall by nickel-plated brass screws counter-sunk in the frame.

The finished block plans shall be permanent, fadeless and completely sealed to preclude oxide formation.

Provide the required number of block plans in accordance with the requirements of the Fire Engineered Design Brief.

7.18.8 Signage

Provide the required signage regarding fire hose reel lengths, number of fire hydrant hoses required, etc in accordance with the requirements of the Fire Engineered Report.

7.18.9 Thrust Blocks

To all changes of direction on rubber ring jointed pipelines below ground install concrete thrust blocks to restrain the internal operating pressures of the pipeline under all conditions. Concrete mass shall be poured around and behind fittings and bear against virgin soil material. A minimum of 0.75 cubic metres of concrete shall be used at each position.

Materials

The reticulation shall be constructed of solid drawn copper tube and dezincified brass or copper fittings all as specified previously under “Materials”. Joints shall be silver soldered as specified previously under "Jointing Materials”.

7.18.10 Testing

All as previously specified under section 2.0.

7.18.11 Flushing

All as previously specified under “Cold Water” section 6.0.

7.18.12 Pipe Supports

All pipes shall be adequately supported and securely fixed in accordance with the drawings and to the satisfaction of the ER. Such supporting and fixing to be carried out without causing any distortion, damage or stress on the pipes or pipe joints. Pipes shall be supported at each collar and at spacing as specified in “Preliminaries” section.

7.18.13 Valves

Supply and install all valves as specified in “Materials” section.

7.18.14 Noise & Vibration Suppression

Supply and install all necessary equipment to identify the system to conform to the section 2.0.

7.18.15 Painting & Identification

Supply and install all necessary equipment to identify the system to conform to the section 2.0.

7.19 FIRE EXTINGUISHERS

7.19.1 Generally

Supply, install and commission the fire extinguisher system all to comply to AS 2444 BCA Part E1.6.

7.19.2 Installation

Fire Extinguishers to AS 2444

Fire Extinguishers

Location	Class	Type	Size
Electrical switchboards & Equipment	E	CO_2 (Carbon dioxide)	3.5kg
Kitchens	F	Wet chemical fire blanket	1200 x 600
Plant Rooms	A(E)	CO_2	3.5kg
Carparks	AB(E)	Powder Type	4.5kg
Office Areas	A	CO_2	3.5kg

Note: Buildings not covered by a Fire Hose Reel system require wet type fire extinguishers plus E type for electrical equipment.

7.20 FIRE DETECTION

7.20.1 General

Provide the detailed design, supply, installation, labelling, testing, commissioning, maintenance and authority approvals of a fire detection system as documented.

7.20.2 System Installer

The Fire Detection system shall be installed by a specialty trade licensed, authorised and manufacturer accredited to design, install, commission and maintain fire detection systems.

7.20.3 System description

7.20.3.1 General

System type: Addressable.

Interfaces:

- Emergency warning and intercommunications system
- Existing Main Fire Alarm Panel

7.20.3.2 Surge protection devices (SPD)

General: Provide all mode metal oxide varistor based series connected SPD to protect final equipment in racks and cabinets.

Standard: To AS 4262.1 and AS 4262.2.
Surge Rating: $I_{max} \geq 20$ kA per phase.
Residual Voltage: $U_p < 60$ 0V.
Visual indicator: Provide visual indication of SPD status.

Enclosure and installation: House SPD in a metal enclosure and protected with a suitable rated circuit breaker equal to or less than the load current rating of the SPD.

7.20.4 Standard

7.20.4.1 General

Standard: To AS 1670.1 and AS 7240.13.

7.20.5 Submissions

7.20.5.1 Technical data

Product data: Submit for the following:

- Sub Fire Alarm panel.
- Detectors.
- Manual call points.
- Fibre Optic Linear Heat Detectors
- VESDA panel

7.20.5.2 Samples

Samples: Submit for the following:

- Detectors.
- Manual call points.
- Fibre Optic Linear Heat Detector cable

7.20.5.3 Calculations

Submit calculations proving there is sufficient capacity on analogue loops, conventional zones and batteries. As a minimum the following should be included:

- Analogue loop - capacity of loop, quantity, type and running current of all devices
- Batteries - Battery capacity calculations to AS 1670.1 Appendix C

7.20.5.4 Shop drawings

General: Submit detailed shop drawings showing the following:

- Field device layout including circuiting of loops
- Dimensions and details of control and indicating equipment.
- Location.
- Circuit identification.
- Labelling details.

7.20.6 Products

7.20.7 Authorised products

7.20.7.1 General

Equipment: Provide equipment listed in the ActivFire Register of Fire Protection Equipment.

7.20.8 Control and indicating equipment

7.20.8.1 Standards

General: To AS 7240.2.
Air-handling fire mode control panels: To AS 4428.7.

Alarm investigation facility (AIF): To AS 4428.10.

Alarm signalling equipment: To AS 4428.6.

Power supply units: To AS 4428.5.

Fire brigade panel: To AS 4428.3.

Routing equipment: To AS 7240.21.

Wire-free alarm zone circuits: To AS 4428.9.

7.21 FIRE ALARM PANELS

The Fire Alarm Panel (FAP) shall be a wall or floor mounted cubicle with an internal hinged frame. All equipment shall be of modular plug in design, with the field terminations and power supply accessible by opening the internal frame.

A locked door keyed to 003 shall secure the control sections of the equipment. All controls and indicators shall remain visible with door closed.

User Interface: The Fire Alarm Panel shall have membrane touch and front panel controls with audible feedback, LCD display featuring operator prompts and common system status indicators. All essential controls shall be grouped together as per the Fire Fighters Facility layout in AS4428.

The FAP shall be configured as an Analogue/Addressable system with up to 159 Analogue/Addressable devices per loop. The installer shall determine the number of loops.

The FAP shall be capable of displaying the identity of each device with groups of devices allocated to zones.

Programming the system shall be done either on the manufacturer's premises, via a modem link (land line or wireless type), or on site via a portable computer. The configuration for the entire system must be held at each network point. The configuration for the entire system must be able to be updated from one point on the network. Systems that require configurations to be updated at individual points on the network will not be accepted.

Provide full communications and monitoring between the Sub Fire Alarm Panels and Main Fire Alarm Panel, such that an alarm on the Sub Fire Alarm Panels can be identified by individual device at the Main Fire Alarm.

7.21.1 Isolation

Isolating facilities: Provide on fire indicator panels to enable testing without the transmission of alarm signals to the fire brigade.

7.21.2 Capacity

Spare zones: 50% minimum.

7.22 DETECTORS

7.22.1 Type

Type of fire detectors have been identified on the accompanying design drawings.

7.22.2 Standards

Carbon monoxide (CO) fire detectors: To AS 7240.6.

Duct sampling units (DSUs): To AS 1603.13.

Heat detectors: To AS 7240.5.

Point type smoke detectors: To AS 7240.7 and AS 1603.2.

Integral heat detector/alarm units: To AS 1603.3.

Integral smoke detector/alarm units: To AS 3786.

Multi-sensor fire detectors: To AS 7240.15.

Multi-point aspirated smoke detectors: To AS 1603.8.

Optical beam smoke detectors: To AS 1603.7.

Remote indicators: To AS 1603.15.

Visual warning devices: To AS 1603.11.

7.22.3 Self-indicating detectors

General: Provide a light emitting diode mounted in a clearly visible position, which illuminates whenever detector operation causes an alarm condition to register on the fire alarm panel. Provide self-indicating devices which, if faulty, will not render the detector inoperative under fire conditions.

Mounting positions of light emitting diodes: Conform to the following:

- Visible detectors: On the outside of the detector or its base.
- Detectors concealed above ceilings: On the underside of the ceiling immediately below the detector.
- Detectors in other concealed spaces: On a visible panel close to the entry to the concealed space housing the detector.
- Remote indicators: To AS 1603.15.

7.23 MANUAL CALL POINTS

7.23.1 General

Standard: To AS 1603.5 and AS 7240.11.

7.24 EXTERNAL ALARM INDICATION

Provide an external strobe on the outside of the building to AS 1670.1 Section 3.8; visible from the main approach and as near as possible to the designated building entry point.

7.24.1 Standards

Bell circuits: To AS 4428.1.

Strobe lights: To AS 1603.11.

7.24.2 Power supply

To the strobe light and ≤ 2 others: From the fire indicator panel battery power supply.

To additional strobe lights: From the mains supply. Provide appropriate interface relays, operated by the fire indicator panel.

7.25 MAGNETIC DOOR HOLDERS

7.25.1 General

Standard: To AS 4178.

7.25.2 Control facilities

Standard: To AS/NZS 1668.1.

Signals: Provide ancillary control device circuits and connections for automatically controlling and releasing magnetic door holders to operate the relevant doors under fire alarm conditions.

7.26 POWER SUPPLY

7.26.1 General

Surge protection: Ensure that normal operation is maintained and that voltage surges in the power source do not damage the control and indicating equipment.

7.26.2 Batteries

Capacity to AS 1670.1 sec 3.16.4

The batteries shall have the capacity to maintain the system in normal working condition for 72 hours after which sufficient capacity remains to operate two worst case alarms and associated control for 30 min.

Sealed batteries: Cycle the batteries before practical completion so that greater than or equal to 100% of nominal capacity is available at practical completion.

7.27 EXECUTION

7.27.1 Fire alarm monitoring

7.27.2 General

Standard: To AS 7240.21.

Connection: The new fire alarm panels shall be connected to the main fire alarm panel. The monitoring of the new fire alarm panels shall therefore be done via the existing main fire alarm panel interface with the existing monitoring service.

7.27.2.1 Detectors

7.27.2.2 Installation

Consider extension brackets for detectors installed in ceiling spaces.

General: Install detectors so they can be easily inspected and tested in situ, and readily withdrawn from service.

Integral smoke detector/alarm units: To AS 1670.6.

The installer must coordinate onsite with existing conditions for final device placement. In particular, attention should be given to locations of existing air supply and lighting. Adjustment of device locations to accommodate existing conditions is not grounds for variation

7.27.2.3 Smoke detectors in lift shaft or other difficult to access space

Install means (smoke tubes, etc.) to perform all required tests without engaging specialist lift trade or any other trades to provide access.

7.27.3 Installation wiring

7.27.3.1 General

To AS 1670.1 Section 3.24.

7.27.4 Testing

7.27.4.1 General

Tests: Carry out tests, including out-of-hours tests, to demonstrate the automatic fire detection and alarm system's performance to AS 1670.1 Section 7 and the compliance Sections of the relevant parts of the AS 1603 series. Include the following:

- Test components for correct function and operation.
- Demonstrate detection and alarm performance on site, to at least the level stated in the manufacturer's performance specification for that device.
- Test alarm zone identification.
- Demonstrate air sampling system operation for 14 days with data logger to verify stability of detectors and devices.
- Demonstrate addressable device operation for 14 days with data logger to verify stability of detectors and devices.
- Test interface to interconnected systems.
- Demonstrate correct shutdown sequences during fire mode.
- In situ testers: To AS 1603.16.

Witnessing: Give sufficient notice to allow the Principal to witness all testing. Testing will not be considered valid unless the Principal or Principal's representative has been given the opportunity to witness test.

Test Report: Provide signed and dated reports recording the results of each test which are to be incorporated within the operation and maintenance manuals.

Authorities Inspection and witnessing: Notify local authority as required to perform inspection and witnessing.

7.28 SAMPLES

Submit samples of accessories not specified as proprietary items as below;
Flow Switches

- All types of sprinkler heads
- Isolation valves
- Fire Indicator Panel
- Sprinkler alarm valves, gate valves, check valves etc
- Fibre Optic Heat Detector cable
- Smoke Detectors
- Heat Detectors
- Manual Call Points

7.29 OPERATING AND MAINTENANCE

7.29.1 Maintenance

Maintenance Period: Co-extensive with the Defects Liability Period.

During the maintenance period, provide regular maintenance to AS 1851.8, including the following:

- Weekly procedures: To AS 1851.8, Clause 3.1.
- Monthly procedures: To AS 1851.8, Clause 3.2.
- Yearly procedures: To AS 1851.8, Clause 3.3. Carry out the yearly procedures at the end of the maintenance period, irrespective of the duration of the period.
- Emergencies: Attend to emergencies within 2 hours of being notified, and promptly rectify the faults, including the replacement of faulty materials or equipment. The cost of attendance, rectification and replacement shall be borne by the Contractor if the fault was caused by defective materials, equipment or installation.

Maintenance documentation: To AS 1851.8, Section 4.
Certification: At the end of the maintenance period, upon satisfactory completion of the above procedures, certify in writing that the installation is operating correctly.

8 Technical - Hydraulics

8.1 ABBREVIATIONS

The following abbreviations are used throughout the specification:

- AAMA American Architectural Manufacturers Association
- ABS Acrylonitrile-butadiene-styrene.
- AS Australian Standard
- AS/NZS Joint Australian/New Zealand Standard
- ASTM American Society for Testing and Materials
- AWCINZ Association of Wall and Ceiling Industries of New Zealand Inc.
- BCA Building Consent Authority
- BRANZ Building Research Association of New Zealand
- BS British Standard
- CSIRO Commonwealth Scientific and Industrial Research Organisation
- GRP Glass-fibre reinforced polyester
- HERA Heavy Engineering Research Association
- LBP Licensed Building Practitioner
- MPNZA Master Painters New Zealand Association Inc.
- NZBC New Zealand Building Code
- NZS New Zealand Standard
- NZS/AS Joint New Zealand/Australian Standard
- NZTA New Zealand Transport Agency (previously TNZ)
- NUO Network Utility Operator
- PS1 Producer Statement – Design
- PS2 Producer Statement – Design Review
- PS3 Producer Statement - Construction
- PS4 Producer Statement – Construction Review
- SARNZ Scaffolding and Rigging Association New Zealand Inc.
- SED Specific Engineering Design
- SMACNA: Sheet Metal and Air Conditioning National Association Inc., USA
- TA Territorial Authority
- TNZ Transit New Zealand (Transit New Zealand is now New Zealand Transport Agency NZTA, some specifications are still prefixed TNZ)
- PVC-U Unplasticised Polyvinyl Chloride.

8.2 AUTHORITIES

The whole of the work shall be carried out by or under the full supervision of a fully licensed contractor in accordance with the drawings and specification, and to the satisfaction of the ER and to the Standards and Regulations of any authority having jurisdiction over the works and in particular those listed below: -

- New Zealand Building Code G10/AS1 Piped Services
- New Zealand Building Code G12/AS1 Water Supplies
- New Zealand Building Code G13/AS1 Sanitary Water
- AS/NZS 3500.1 Plumbing and Drainage – Water Services
- AS/NZS 3500.2 Plumbing and Drainage – Sanitary Plumbing and Drainage
- AS/NZS 3500.3 Plumbing and Drainage – Stormwater Drainage
- AS/NZS 3500.4 Plumbing and Drainage – Heated Water Services
- AS/NZS 5601: 2010 Gas Installations
- NZS 4219:2009 Seismic Performance of Engineering systems in buildings
- Building Consent Authority (BCA) requirements
- Local Water & Sewer Authorities

Pay the relevant authorities all fees and charges legally demandable including:

- Inquiry fees
- Commencement of work fees
- Road opening fees
- Service connection fees

The Contractor shall submit evidence that:

- Requirements of authorities relating to the work under the contract have been ascertained prior to the commencement of the hydraulic services installation
- Fees to authorities, if any, have been paid and all types of approvals obtained.
- Certificates of compliance with regard to the extent of the installation. Such certificates have to be obtained on completion of the installation.
- All fittings, pipes, accessories and the like used in the works shall bear approval marks where and as required by the regulatory authorities.
- Test certificates for all essential service fittings. Be provided prior to completion.

8.3 CODES AND STANDARDS

Materials and workmanship shall conform to New Zealand Standards and Codes where not in conflict with the provisions of this Specification, including but not limited to the standards and codes listed below: -

Standards	
NZBC	Building Act 2004
	Building Regulations 1992
	Health and Safety in Employment Act 1992
	Health and Safety in Employment Regulations 1995
	New Zealand Building Code
	Resource Management Act 1991
	Smoke-free Environments Act 1990
	Plumbers, Gasfitters and Drainlayers Act 2006
AS/NZS 3500.1	Plumbing and Drainage – Water Services
AS/NZS 3500.2	Plumbing and Drainage – Sanitary Plumbing and Drainage
AS/NZS 3500.3	Plumbing and Drainage – Stormwater Drainage
AS/NZS 3500.4	Plumbing and Drainage – Heated Water Services
AS/NZS 5601	2010 Gas Installations
NZS 4219:2009	Seismic Performance of Engineering systems in buildings
	Building Consent Authority Requirements
AS 1074	Steel tubes and tubulars threaded or suitable for threading with pipe threads of Whitworth form
AS 1135	Rules for the design, fabrication, installation and inspection of non-ferrous pressure piping
AS 1216	Classification, hazard identification and information systems for dangerous goods
AS 1216.1	Part 1: Classification and class labels for dangerous goods
AS 1271	Valves, water gauges and other fittings for boilers and unfired pressure vessels
AS 1345	Identification of the contents of piping, conduits and ducts
AS 1349	Bourdon tube pressure and vacuum gauges
AS 1375	SAA Industrial Fuel-fired Appliances Code
AS 1585	Capillary and brazing fittings of copper and copper alloy
AS 2129	Flanges for pipes, valves and fittings
AS 2430	Classification of hazardous areas
AS 2430.1	Part 1: Explosive gas atmospheres
AS 2700	Colour standards for general purposes
AS 2832	Cathodic protection of metals
AS 2832.1	Part 1: Pipes, cables and ducts
AS 2832.2	Part 2: Compact buried structures
AS 2885	SAA Pipeline Code

AS/NZS 3000	SAA Wiring Rules (Electrical Installations)

Where some doubts exist as to the appropriate standard, the decision shall be made by the ER before commencement of any work on or off the site. If a doubt exists as to whether a section of the design is able to comply with the relevant authorities regulations the ER shall be notified prior to the commencement of any work. No consideration of claim for redundant work shall be given if the ER is not notified.

8.4 TESTING AND COMMISSIONING

8.4.1 General

The objective of testing and commissioning is to set the plant to work and to verify that it performs in accordance with design criteria and performance objectives.

Sectional testing and commissioning shall be carried out during all phases of the works and include any systems that are 'taken out of service' that then require 'reinstating' to ensure the safe operation and continuity of the station is not compromised.

When each building services system is complete commissioning is to occur. This is to include but is not limited to static tests, setting the system to work, adjusting and balancing to design capacity, setting controls, checking the operation of overload and safety devices, and correcting malfunctions.

The commissioning programme is to commence during the construction phase with the preparation of a Commissioning Management Plan in conjunction with the Controls Specialist Contractor.

Upon completion of the installation and commissioning works, the contractor shall submit a commissioning report to the building owner.

8.4.2 Standards

Comply with the following for all building services commissioning activities:

- CIBSE Commissioning Code M: Commissioning Management
- CIBSE TM13
- AS/NZS 3500

8.4.3 Scope

The following systems shall be commissioned:

- Domestic Cold Water
- Domestic Hot Water
- Water metering, including BMS and I/O interfaces
- Stormwater/fire water Systems
- Sanitary water systems

8.4.4 Commissioning Management

The commissioning process is to be completed in accordance with the requirements of the CIBSE Commissioning Code M:2003 Commissioning Management.

Liaise with the Controls Specialist Contractor and the appointed Commissioning Manager to plan, coordinate and manage the commissioning activities.

- Confirmation of the commissioning scope and services to be provided under the contract
- Commissioning team details
- Commissioning programme indicating key activities and dependencies
- Schedule of commissioning work method statements

8.4.5 Submissions

The Hydraulics Contractor shall be responsible for comprehensive pre-commissioning, commissioning and quality monitoring of the various installations carried out under this contract.

The contractor shall prepare and submit for review and approval the following commissioning specific documentation in accordance with the main contractors' construction programme and the specified requirements.

Allow to prepare a detailed and comprehensive Commissioning Plan and Inspection and Test Plan (ITP) in conjunction with the Controls Specialist Contractor, to attend the pre-commissioning and commissioning, to carry out a review of the operation and maintenance manual and to carry out an independent review of the commissioning report.

8.4.6 Commissioning Plan

Provide a commissioning plan in conjunction with the Controls Specialist Contractor including the following:

1. Identification of all plant and equipment to that is to be commissioned.
2. Identification of the commissioning team members, contact details and duties. This should including staff, subcontractors, equipment vendors, and commissioning specialists.
3. Detailed commissioning methodologies for each item of plant or equipment in accordance with specified commissioning codes and standards listed above.
4. Pre-requisite tasks that must be completed before commissioning can commence.
5. Pre-commissioning check sheets for each system.
6. Sample pre-commissioning check sheets for each system including:
    a. Pipework pressure testing
    b. Drainage flood testing
    c. Pipework flushing and disinfection
    d. Pipework insulation
    e. Pumps
    f. WCs
    g. Wash hand basins
    h. Sinks
    i. Thermostatic mixing valves / tempering valves
    j. Showers
    k. Backflow prevention devices
    l. Electric hot water cylinders
    m. UV treatment set
    n. Recycled water pumps set
    o. Sump pumps
    p. Water meters
7. Commissioning forms for all systems including:
    a. Sanitary fixture operation and flow rates
    b. Thermostatic mixing valves / tempering valves HW temperatures

c. Hot water return balancing valves
d. Backflow prevention device
e. Electric hot water cylinders
f. Water treatment systems
g. Pumps calibration
h. Water meters calibration
i. BMS calibration

8. Interface testing requirements to be integrated into Main Contractors overall interface test plan.

8.4.7 Inspection and Test Plan

The Hydraulics Contractor is to prepare a detailed and comprehensive Inspection and Test Plan (ITP) in conjunction with the Controls Specialist Contractor prior to commissioning and testing and shall submit the ITP for approval a minimum of six (6) weeks before approval to proceed is required. The ITP shall be reviewed and signed off by the Hydraulics Contractor’s third party consultant prior to the submission of the ITP to the ER for approval.

The Hydraulics Contractor shall be responsible for commissioning the various installations carried out under this sub-contract in accordance with the programme and to the approval of the Proprietor and Local Authorities.

The Hydraulics Contractor and the ER are to witness the commissioning of all hydraulic services systems installed under this contract including pumps, pipework, fittings, equipment, etc.

The purpose of the ITP is to:

- Ensure that all items that should be checked are checked;
- Produce a permanent record of the commissioning checks carried out.

Accordingly, the check list must be built up from information contained in this specification from suppliers, manufacturer’s installation and commissioning data and from experience in commissioning similar equipment and systems.

Subject all systems to a pre-commissioning, commissioning and testing procedures before they are put into service. Provide all tests instruments and other testing facilities required to verify system and equipment performance and to complete all inspection test plan records. Any work which does not comply with the specification shall be made good.

The Hydraulics Contractor is to prepare a summary commissioning report identifying commissioning dates, the tests carried out and the outcomes and changes made as a result of the commissioning process. The report must identify the guidelines used, detail the commissioning process (tests conducted and dates and changes made as a result of each test) and how it strictly adhered to these guidelines.

The report must identify each system/feature, certify it complies (or not) with the contract documents, list outstanding commissioning issues, requirements for future commissioning/testing activities and list any seasonal testing required in the future. As noted above, the Hydraulics Contractor is to allow for their third party consultant to carry out an independent review of the summary commissioning report.

Allow in the Contract Price to pay the Local Authorities for any necessary and chargeable testing work.

Final commissioning shall be conducted in the presence of the Hydraulics Contractor, the Main Contractor and ER. Provide all necessary access equipment, instruments, connections, skilled and unskilled labour required for the tests. The cost of such provision shall be included in the tender price.

8.4.8 Commissioning Programme

Provide a commissioning programme in conjunction with the Controls Specialist Contractor identifying all commissioning tasks, durations, pre-requisites, inter-dependencies and resources to be integrated into the Main Contractor's master construction and commissioning programme.

8.4.9 Hydraulic Commissioning

The Hydraulic Contractor shall perform and document the following commissioning activities for witnessing by the Hydraulic Consultant and Commissioning Engineer (CE) for review (it is no acceptable for the Hydraulic Contractor to rely solely on the local authority inspections and test records):

- Pressure testing of **ALL** pipework prior to concealing and final fix of tapware and equipment.The pipework shall be tested to a pressure of 1500 kPa for a period of not less than 15 minutes to comply with G12/AS1. Pressure test forms shall include the following information:
  - Project name
  - Location/Address
  - Client Details
  - Pipework material
  - Working pressure
  - Test pressure
  - Drawing (highlighted) indicating extent of test
  - Date of test
  - Test start time and pressure
  - Test finish time and pressure
  - Test PASS or FAIL
  - Notes/Qualifications/Deficiencies
  - Space for signoff by commissioning manager
- Flush all pipework with clean water after successful pressure test and prior to installing tapware. Final flush to be completed with clean water.
- Flood test all stormwater and drainage pipework.
- Flood testing of all buried sanitary and stormwater drainage prior to backfilling of pipework. Test forms to include:
  - Project name
  - Location/Address
  - Client Details
  - Pipework material
  - Drawing (highlighted) indicating extent of test
  - Date of test
  - Test PASS or FAIL
  - Notes/Qualifications/Deficiencies
  - Space for signoff by commissioning manager
- Water meter commissioning
- Set all thermostatic mixing valves (TMV) to design set-point. Show TMV locations and measured hot water temperature at each connected fixture on drawing and demonstrate to CE/ER.
- Pump commissioning
- Safe trays and overflows testing

- Expansion control and temperature/pressure relief valve testing
- Operational checks on the hot water system including:
    - Flow rate at outlet points
    - Flow and return temperatures
    - Balancing valve position and flow rate for each branch
- Inlet and outlet pressure for pressure reducing valves
- Hydraulic based controls monitoring devices and alarms testing

8.4.10 Commissioning Results

Provide commissioning results verifying correct and compliant operation of the completed hydraulic systems to the hydraulic consultant and CE/ER for review.

8.4.11 Commissioning Witnessing

Once commissioning has been completed by the contractor and commissioning reports have been submitted and reviewed by the ER and CE the contractor shall offer the systems up for witnessing. The intent of the witnessing is not to repeat the commissioning process but rather demonstrate to the consultants portions of the commissioning so that they can gauge with reasonable confidence that the systems are correctly commissioned. Consultant witnessing shall include the following:

- Testing of selected sanitary fixtures including operation, HW temperatures, tapware flow rates, etc.
- BMS control, monitoring and alarm interface.
- Water metering

8.4.12 Testing generally and sterilisation systems

Make all tests as shall be required or ordered by the authorities having jurisdiction, using the methods prescribed by them.

Furnish all necessary material, equipment and skilled labour for testing the work. All necessary water for the tests will be from site supply.

The Contractor shall pay for and make good all damage to work and materials resulting from the tests.

All tests shall be made in the presence of the ER and authorities. Give not less than 48 hours' notice in writing to these parties before making tests.

Every facility shall be made available to the ER for the inspection of any part of the work or apparatus during the progress of the project and on completion such shall be tested in the Contractor's or Manufacturer's workshop as directed by the ER.

A record of all tests shall be kept on site and the Contractor shall obtain certificates of satisfactory completion of the whole of the installation.

Provide in duplicate to the ER all certificates of tests issued by the authorities.

All piping shall be tested as early as possible after installation of each section of pipework but before any piping joints are concealed, ceilings installed or finishing trades have commenced their work and pipes are grouted in or otherwise concealed.

Pipework systems in which copper tube conforming to AS 1432 is used, must not be subjected to internal water pressure tests which are greater than the following test pressures:

Copper Tube – Type B

Water Pressure Tests Copper Tube

Nominal Size (mm)	**Water Pressure Test to not greater than;2000kPa**
DN15 DN18 DN20 DN25 DN32 DN40 DN50 DN65 DN80 DN90 DN100 DN125 DN150 DN200	2100 2100 2100 2100 2100 2100 2100 1400 1400 1400 1400 1400 1400 1000
Copper Tube – Type D	
Nominal Size (mm)	Water Pressure Test to not greater than; 500kPa
DN32 DN40 DN50 DN65 DN80 DN90 DN100 DN125 DN150	2100 2100 1400 1400 1400 1200 1000 1000 1000

PROHIBITED: Air testing of any water pipe during the progress of the works or completion of the works.

Testing may be required at any time during the progress of the works, for the examination of any materials used and inspect the workmanship employed. Any materials and workmanship that are not in accordance with the specification and drawings may be rejected.

Supply all labour, plugs, pressure gauges, measuring gauges, plumbing equipment and necessary materials and equipment etc. required for testing. The Hydraulics Sub-Contractor is responsible for the disposal of test water.

Precautions shall be taken during testing of pipe services to pressurise to the limits recommended by the manufacturer of the piping materials. Seal off items of equipment not designed to withstand the test pressure.

Pipework fittings, valve and ancillaries damaged, such as annealed copper tube yielding and distorting at joints and other pipework either breaking, cracking, fittings leaking or blown off or apart from pipework, caused by excessive test pressures and procedures shall be replaced at no cost to the Proprietor.

Ensure solvent cement joints have been cured for at least 24 hours before testing.

Underground or enclosed works shall not be covered or concealed from view until it has been inspected, tested and approved by the Authorities concerned.

Carry out progressive testing of the services shown on the drawings and/or nominated in the Section and required by the respective Authorities.

The following types of tests shall be applied to the pipe services:

- Sewer Drainage and Stormwater Plumbing
- Water test by gravity to the flood point of each pipe being tested.
- Sanitary Plumbing
- Water test by gravity to the flood point of each pipe section being tested.
- Cold Water, Hot Water, Warm Water Services
- Fill pipework with water, remove all air from the pipework and then water pressure test the pipework section.

Before applying water pressure tests check with the manufacturers of each different piping material installed, considering the material of which the pipes and fittings are manufactured, the class pipe (i.e. suitable for certain pressures) and the pipe wall thickness to determine which maximum pressure should apply to the water test to be applied to each particular pipe material and pipe diameter.

On completion the works shall be tested under normal working conditions and as directed and passed by all Authorities having jurisdiction over the works. All defects shall be remedied immediately and the tests re-applied to the satisfaction of the Authorities. Make good at no cost any defects disclosed during tests.

Provide two (2) copies of all Approvals and Test Certificates issued by the Authorities.

All plant and equipment having electrical connections shall be tested for insulation and earth resistance and approved by the Supply Authority. Give seven (7) days written notice of commencement of final tests.

All pipelines shall be flushed clean then charged with disinfectant using 50mg of chlorine per litre of water. The system should remain charged for a period of at least three days, checked and adjusted for free residual chlorine and flushed out thoroughly with clean water before being used. Repeat procedure where necessary.

8.5 SCHEDULE OF WARRENTIES

The following is a summary of the warranties and warranty periods called for in work sections.

	Materials	**Workmanship**
	Manufacturer / supplier	Installer / Applicator
Hydraulic services systems	2 years	1 year
Drainage	2 years	2 years
Plumbing (Hot & Cold Water System)	2 years	2 years
Sanitary and Stormwater drainage	5 years	5 years
Electrical services	2 years	1 year
Building management systems	2 years	1 year

Steel metalwork	5 years	2 years
Aluminium metalwork	5 years	2 years
Stainless steel metalwork	5 years	2 years
Stainless steel components	5 years	5 years
Hot Dip Galvanizing and Metal Spray	15 / 2 years	5 years / 6
Painting and Clear Finishing, interior and exterior	15 / 2 years	5 years /6 months
Sealants	10 years	10 years
Flashings	15 years	5 years

8.6 SAMPLES

Samples shall be:

- Submitted to the ER a minimum of four (4) weeks prior to the placement of the order of the product in question and within sufficient time for procurement, manufacturer and delivery to site so as not delay installation program.
- Submitted of all equipment/accessories whose appearance will be visible and any other items as requested.
- Approved by the ER in writing prior to placement of orders and installation.
- Be labelled to identify their intended use.
- Be held on site after approval and used as a standard for acceptance or rejection of subsequent production units. The Contractor shall be responsible for the security of all samples that they have provided and shall replace any samples found to be missing during the construction. Samples may or may not be returned on completion of the project.

As a minimum, the following samples shall be submitted for approval:

- Fixture traps
- Air admittance valves
- Solenoid valves and timeclocks
- Tundishes exposed to view and not in plantrooms
- Sample of penetration sleeve detailing acoustic insulation
- Any proposed plastic water supply pipework (e.g rehau or equal)
- Thermostatic mixing valves
- Grating for grated trench drains
- Floor wastes
- Bucket floor wastes
- Water meters including BMS interfaces
- Level monitoring probes including BMS interfaces
- Valve tags
- Pipework identification markers

8.7 FIXING AND SUPPORTING OF PIPES

All service pipes shall be positioned in locations as approved by the ER before installation commences. All pipes shall be adequately supported and secured to adjacent roof trusses Pipework must not come into contact with any other service pipes or part of the building structure unless insulated with 25mm thick sectional mineral wool lagging.

All pipework shall be free to move without causing stresses in the pipework or in the pipe joints.

Support shall be galvanised mild steel "Unistrut" P1000 (or equal and approved) channel complete with purpose made galvanised spring nuts, framings, fittings and pipe clamps for each pipe. Alternative methods of fixings may be used provided the proposed method is detailed, discussed and approved by the ER prior to the commencement of any work dependent upon such an approval. Approved fabricated mild steel brackets shall have ground off neat square ends drilled holes.

Mild steel brackets must be hot dipped galvanised after fabrication. Vertical frames where used to support suspended horizontal runs shall allow for complete adjustment of clamp support to suit pipe grading as required. Channels shall be galvanised steel bolt fixed direct or with purpose made clips to walls or underside slab. On completion of work remove all cement droppings, dirt etc. from pipe supports, pipework and fittings.

All copper pipes shall be separated from supports by approved material.

Where pipes are insulated, the pipes shall be supported inside the insulation with timber ferrules.

Where the structure is of masonry or concrete, the support shall be fastened either by bolts firmly grouted in or by expanding type bolt device equal to "Loxin".

Explosive power fastening tools shall only be used where specifically approved beforehand by the ER.

Appropriate screws shall be used for fastening supports to timber.

All bolts and screws shall be sized to suit the load but in no case shall the diameter be less than 8 mm for fastening to timber, steel masonry or concrete. Smaller bolt sizes may be approved by the ER.

Sanitary, Vents and Downpipes – Non Pressure Lines

Pipe Support Spacing – Non-Pressure Lines

Pipe	Vertical	Horizontal / Graded
Ductile iron Internal External	3.0 m 2.0 m	2.0 m 2.0 m
Galvanised Steel Internal External	3.0 m 2.0 m	2.0 m 2.0 m
Copper Internal External	1.8 m 1.8 m	1.8 m 1.8 m
PVC-U Internal External	1.8 m 1.8 m	0.9 m 0.9 m

Fibre Reinforced Pipe Internal External	3.0 m 2.0 m	1.5 m 1.5 m

In case of rubber ring jointed pipes there shall be a fixing at least at each collar or pipe fitting. Brackets shall be adequate to restrain the effect of the internal forces of piping, including sideways movement.

Pipe Support Spacing – Pressure Lines

Pressure lines			
Size	Steel Pipe	Stainless Steel or Copper Pipe	Plastic Pipe
15 mm	2.0 m	1.8 m	0.7 m
20 mm	2.0 m	2.0 m	0.7 m
25 mm	2.5 m	2.25 m	1.0 m
32 mm	2.5 m	2.25 m	1.0 m
40 mm	2.5 m	2.5 m	1.5 m
50 mm	3.0 m	2.5 m	1.5 m
65 mm	3.0 m	3.0 m	1.5 m
100 mm	4.0 m	3.5 m	2.0 m
125 mm	4.5 m	4.0 m	2.5 m
150 mm	4.5 m	4.0 m	3.0 m

Copper soil, waste and vent pipes shall be regarded as being fixed at all supports where no provision has been made for axial and/or lateral movement. Provision for movement shall be achieved by the provision at the support of an annular space around the pipe of not less than 8mm clear.

The fire-resisting performance of the building element is not to be impaired by the installation of Hydraulic Services. All penetrations in fire structures must be made fire-resistant with the same hourly rating protection required for the structure to prevent the spread of fire from one compartment to another.

Vertical copper soil and waste pipes must be clear to move vertically at least 8mm in both directions through ceilings and roofs, through which they pass. Vertical soil and waste pipes must be restricted against downward vertical movement at their junctions with house drains, at offsets and changes of direction below Ground Floor Level and at branches at all floors.

Pipes shall be supported against sagging or distortion and must be held to line and grade by means of approved clips, saddles or other fixings.

Install 'Powersorb' type brackets or approved equal hangers for main riser pipes where vibration or expansion will occur.

Plan hot water pipe routes, on site, to ensure that sufficient offsetting is achieved to compensate for length increases due to expansion of the pipe. Pipe brackets on hot water pipework systems are to be guide type only and are not to restrain the pipe from longitudinal movement.

Ensure that branch pipes are maximum lengths from main pipe circuits before being retrained by entering built in positions, such as passing through walls or concrete floors.

8.8 CHASING AND DRILLING

Provide all the necessary chasing cutting and drilling of brick walls, ceiling, etc. to allow the fixing and passage of pipes through the structure.

Chases to be sawcut before breaking-out or be cut with approved mechanical saws.

Set out in ample time all positions required after having established the position of the pipes and obtained approval for same from the ER.

After installation of piping within chases ensure that piping is properly fixed with copper or brass clips (ferrous fixing shall not be used) and chases made good with cement mortar. Ensure that adequate allowance is made for expansion and contraction by piping within chases by lagging with compressible insulation.

Chasing shall be carried out as follows:

- Brickwork shall have been built a minimum of 7 days prior to chasing.
- Chasing shall be carried out using a machine specifically designed for the purpose. Do not use hand tools.
- Chasing shall be on the same side of the wall and vertically above the outlet it serves.
- Minimise horizontal chasing. Obtain approval from ER and structural engineer prior to horizontal chasing. In ensuite bathrooms chasing for services shall be as specified.
- No chase shall be deeper than 35mm or wider than 80mm or 3 conduit pipes. Pipes shall be installed so they are approximately 5mm below the surface of the bricks. Pipe sizes larger than 25mm shall be provided with block out in walls.
- Where two or more chases are necessary in close proximity they shall be at least 100mm apart.
- No chases on opposite sides of a wall shall be within 150mm of each other.
- No notching or drilling through lintels, wall stiffeners, control joints or the like shall be made without the approval of the ER.
- All voids in chases shall be filled with sand/cement mortar prior to cement rendering. This work is the responsibility of the services Sub-Contractor
- All chases wider than 35mm or serving 2 or 3 pipes shall be done with the approval of the ER.
- No chasing shall be done in walls which are proposed to remain unrendered. These areas can be identified from the schedule of finishes. Where a wall is to remain unrendered, surface mount services to a configuration approved by the ER.
- Do not chase Reinforced Concrete walls without the prior approval of the ER.

Where the above conditions cannot be complied with, immediately notify the ER and await instruction before proceeding.

8.9 BUILDING PENETRATIONS

Set out core holes and sleeves in floors, walls, beams and columns and obtain approval of the set out prior to placing concrete.

Where pipes pass through walls, floors, beams or columns, provide purpose-made metal with 12mm clearance all round pipes, packed with gunned silicone rubber joint sealer (self-extinguishing grade).

Pipes passing through walls below ground level shall be provided with a water stop puddle flange.

Penetrations for metal pipes in fire rated walls, ceilings or floors shall incorporate galvanised mild steel sleeves, overall diameter not less than 40mm larger than the penetrating pipe. Seal with a fire stop material/fire prevention, to comply with AS 1530 Part 4. The fire collar must be suitable for the material which is penetrating the fire rated wall, ceiling or floor.

Ratings for pipe penetration fire collars are to be the same fire rating of the wall, ceiling or floor penetrated, to comply to AS 1530 Part 4.

Hydraulic Contractor to provide fire rating certification for all installed hydraulic services, such as fire stop collars, sealants, materials and the like, to maintain the integrity of the fire compartments. Certification shall be provided by an independent party.

Where cold water lines emerge from wall, floor or ceiling surfaces, provide cover plates or non-ferrous metal, finished to match the pipe, or of stainless steel as follows:

Pipe Diameter: Cover plate diameter (nominal):

- Up to 20mm 65mm
- Up to 50mm 100mm
- Larger than 50mm 50mm larger than pipe

8.10 DIFFERENTIAL MOVEMENT

Allow for differential movement control joints / expansion joints / expansion bellows where movement is expected and/or defined.

The geotechnical site investigation report predicts there is potential for liquefaction induced settlement leading to differential movement between the building and the ground in which pipework is buried. Provide movement control joints and flexible couplers to all services connections at the building perimeter.

- Location: Pipework passing through the perimeter of the building
- Arrangement: Arrange to minimise the number of movement control joints.
- Magnitude: Accommodate the predicted movements of at least 50mm

8.11 PROTECTION

The Hydraulic Contractor shall be entirely responsible for all apparatus, equipment and appurtenances furnished by him or his Sub-Contractors in connection with this work, and special care shall be taken to protect all parts thereof in such a manner as may be necessary or as directed. This protection shall include covers, crating, sheds, stores or other means to protect the apparatus, equipment and materials from the weather and to prevent dirt, grit, plaster or other foreign substances from entering the working parts of machinery or equipment.

Special care shall be taken to keep all open ends of pipes, ducts, flues, etc. closed while in storage or during course of installation.

The Hydraulic Contractor shall protect all parts of the building and the work of other Contractors from damage which may be caused by the Contractor’s workmen or Contractors. The Hydraulic Contractor shall be responsible for making good any such damage.

8.12 UNDERGROUND METAL PIPING PROTECTION

Provide corrosion protection for underground ferrous piping and underground non-ferrous metal piping in corrosive areas

Select from the following protection methods:

- Impermeable flexible plastic coating
- Sealed polyethylene sleeve
- Continuous wrapping using proprietary petroleum taping material

Provide sacrificial anodes or impressed current for cathodic protection. Incorporate a facility for periodic testing.

Comply with the recommendations of AS 2832.1

8.13 PIPING, CLEANING, PROTECTION AND INSTALLATION

Before installation, remove loose scale, burrs, fins and obstructions.

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

After installation all piping to be flushed with clean water at the highest possible velocity and flushed out until all foreign matter is removed.

Install piping 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.

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

Provide at least 25mm clear between pipes and between pipes and building elements, additional to insulation.

Join dissimilar metals with fittings of electrolytic compatible material.

Provide access and clearance at fittings which 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.

Sheath or sleeve metal piping chased into masonry or encased in concrete so that expansion or contraction can take place without damage to the pipe or to the material or surface finish of the surrounding element.

8.14 NOISE AND VIBRATION SUPPRESSION

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

Except for external equipment which is not connected to the structure of any building, support rotating or reciprocating equipment on mountings as follows:

- For static deflections <15mm: Single or double deflection neoprene in-shear mountings incorporating steel top and base plates and a tapped hole for bolting to equipment.
- For static deflections >15mm: spring mountings.
- Select mountings to achieve 95% isolation efficiency at the normal operating speeds of the equipment.
- Spring mountings shall be free-standing laterally stable springs with at least 12mm clearance between springs and other members such as bolts and housing.
- Ratio of mean coil diameter to compressed length at the designated minimum static deflection: >0.8:1
- Minimum travel to solid of at least 150% of the designated minimum static deflection.
- Levelling bolts and lock nuts
- 5mm neoprene acoustic isolation pads between baseplate and support
- Vertical resilient limit stops: To prevent spring extension when unloaded, to serve as blocking during erection and which remain out of contact during normal operating.

- Snubbing: Snub the springs to prevent bounce at start-up.
- Set and adjust vibration isolation mounting supports to give adequate clearance for free movement of the supports.
- Provide inertia bases with mass at least that of the equipment supported.
- Steel or steel-framed reinforced concrete. Position foundation bolts for equipment before pouring concrete.
- Support on vibration isolation mountings using height saving support brackets.

Internal noise levels from hydraulics plant inside the development should not exceed the levels given below. Unless stated otherwise, the noise level criteria should not be exceeded with the plant operating under all normal operating conditions. Provide treatment to achieve the specified noise criteria.

Noise Criteria

SPACE/ACTIVITY TYPE	NOISE LEVEL 1eq dB(A)
Carparks	65
Lobbies	50
Office Spaces	45
Plant rooms	65
Toilet	65

External noise levels emitted by noise producing hydraulics plant such as booster pumps, etc. at all property boundaries and nearby buildings on adjacent properties shall meet the requirements of:

- Local Council
- Environment Protection Authority
- Any other relevant statutory authority.

Noise from the hydraulics system should be minimised by:

- Limiting pipe velocities in water systems to not more than 1.5m/s
- Laying out pipes to minimise the number of changes in direction and installing pipes so that the effective cross sectional area of the pipe is maintained at pipe bends and junctions.
- Selecting valves and fittings that minimise the generation of noise.
- Installing pressure reducing stations as required to eliminate excessive pressure at the terminal valves.
- Controlling structure-borne noise (i.e. plant and pipe vibration transmitted into the building structure) with the use of plant isolation mounts, resilient sleeves, etc.
- Provision of water hammer arrestors in reticulation piping to dishwashers and washing machines.

The Contractor shall minimise the transmission of vibration to the building structure to ensure the noise and vibration criteria are achieved by:

- Statically and dynamically balancing rotating plant and equipment. Out of balance should not exceed 0.03mm kg/kg of rotating element after installation. Where specified, provide balancing test certificates.
- Providing isolation mounts or hangers for vibrating plant and equipment.
- Providing inertia blocks where required to limit the vibration amplitude.
- Isolating piping, electrical conduit, etc. subject to vibration from the building structure.

- Providing flexible connections where piping is connected to vibrating plant and machinery.
- Submit a schedule of isolation mounts indicating make, model, rated load and static deflection, actual load and static deflection, unloaded height, fully loaded height.
- Waste pipes over habitable rooms or noise sensitive areas shall be lagged with a layer of 8kg/m2 loaded vinyl having an outer aluminium foil backing, separated from the pipe with a layer of 25mm thick open cell foam. Overlap all joints in the loaded vinyl by minimum of 50mm and tape airtight with aluminium tape.

8.15 SEISMIC RESTRAINT

Arrange all components, other than service items exempted in NZS 4219, to resist seismic loads determined in accordance with NZS 4219. Securely fix all plant and equipment to the building structure. Do not rely on gravity and/or friction to resist seismic forces. Use horizontally restrained type anti-vibration mounts.

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.

Refer to structural specifications for further details.

8.16 PIPE AND VALVE IDENTIFICATION

General: Colour code service pipes and conduits exposed to view or in accessible locations such as ducts and ceiling spaces. They shall be painted and labelled to conform to the requirements of AS 1345 – Identification of Piping, Conduits and Ducts as follows:

Service Identification

PIPE IDENTIFICATION COLOUR	
SERVICE	COLOUR
Sanitary / Sanitary Plumbing	Black
Surface / Stormwater	Black
Cold Water Service	Green (G21)
Hot Water Service	Green (G21)
Warm Water Service	Green (G21)
Recycled Water	Lilac
Air Supply	Light Blue (B25) with Dark Blue band (B24)
Oxygen Supply	Yellow (Y14) with Dark Blue band (B24)
Suction	Primrose (Y21)
Heating	Green (G21)
Fire Hose Reel & Fire Hydrant	Red (R13)
Steam	Silver Grey
Gas	Primrose (Y21)

- Exposed pipework and pipework located in walk-in duct, ceiling spaces and plant rooms shall be painted continuously in the colour indicated above and identification markers added.
- Copper pipes shall be painted with a suitable etching paint before applying finishing enamels. Other steel pipes shall be painted with a coat of zinc chromate primer.
- After applying one layer of etching or primer undercoat, two (2) layers of enamel paint shall be applied.
- Painting shall be carried out by an experienced painter.

- Pipe markers shall be of the vinyl, pressure sensitive, self-adhesive type consisting of combined flow direction arrow and name of service.
- Markers shall be provided on all hydraulic pipe lines at not greater than 3 metre centres. Additional markers shall be provided for:
- Both sides of a wall or partition through which a pipe passes;
- A marker adjacent to tee, valves, outlets and pumps;
- Both legs of a bend;
- Both sides of a pipe which can be approached from two directions.

Marker sizes shall be as follows:

Minimum Service Identification Markers Sizes

PIPE SIZES	MARKER SIZE
65 O.D. and above	460 x 57
40 O.D. and less than 65 O.D.	460 x 29
Up to 40 O.D.	460 x 29 (cut to suit)

Marker locations shall be approved prior to their application to the service pipework.

Prior to the application of pressure sensitive, self-adhesive type pipe markers, clean pipe surfaces with steel wool to remove oxide films and dirt.

Each vinyl pipe marker shall in addition to the pressure sensitive, self-adhesive attachment be secured to the pipework by two (2) 4.8mm wide, light duty, nylon, cable ties, with the ties positioned 50mm from each end of the pipe markers, securing the pipe markers to the pipework.

Pipe markers that peel off or crack shall be replaced with new pipe markers without additional cost.

Instruments, gauges, indicators, control equipment and valves, installed as part of the works shall be clearly labelled and identified with the correct associated function. Coordination of references used within the building management system shall be undertaken to ensure compatibility of all nomenclature.

Equipment identification shall be accomplished with “Traffolyte” labels – white on a black background fixed by screws or rivets.

Adhesive type fixings with labels attached to equipment are not acceptable.

Provide and attach to each isolation valve a round metal tag, 50mm in diameter manufactured from 1mm thick aluminium sheet. Each valve shall be engraved with an identification number, the service and areas served. Provide inscribed on the tags the design flow rate for each valve when it is in the system balanced position. The numbering system shall relate to the ‘As Installed” set of drawings. Fix metal tags securely to balance valves with 2mm diameter copper wire.

Equipment identification shall be with Traffolyte labels and equal, having white letters on background. All valves are to be identified by brass discs, engraved and fixed to the hand wheel with screws or bolts. Comprehensive schedule of valve and relative function shall be incorporated in the maintenance schedule.

8.17 VOLATILE ORGANIC COMPOUNDS (VOCs)

8.17.1 Extent

All paints, sealants and adhesives are to meet low-VOC benchmarks throughout the building services installation for both exposed and concealed applications.

8.17.2 Applied Coatings / Paints

Any applied coatings must have:

- An approved Environmental Choice NZ (ECNZ) eco-label
- Meet the requirements of a 'Excellent' rating against the Infrastructure Sustainability rating tool from the Infrastructure Sustainability Council of Australia
- All paint finishes on steel work including MCC's shall be no thicker than 0.4mm and the sheet metal shall be equal to or greater than 0.4mm.
- Material Group Numbers shall be in accordance with Appendix A of C/VM2 and tested to either ISO 5660 part 1 and part 2 or ISO 9705, Or in lieu of testing as defined in Table A1 of Appendix A of C/VM2.

8.17.2.1 Substitution

The contractor is required to obtain approval of the Architect before substituting the finishes listed above. TVOC data must be provided for any alternative painted finish and must meet the criteria in the table above before the Architect can approve its use.

A test report from a competent laboratory comparing the VOC limits of the product as measured against the limits set by each of the above schemes is acceptable to show compliance as long as the units of measure are the same. If VOC levels are determined by laboratory testing, the supporting information must include the test report from a laboratory competent to complete the relevant test method.

Laboratories may demonstrate their competency by being accredited or registered to ISO/IEC 17025 from International Accreditation New Zealand (IANZ) or other recognised accreditation agency (e.g. NATA in Australia).

8.17.2.2 Review and Sign-off

The Contractor must provide to the main contractor monthly reporting including a VOC datasheet for every compliant product used and the quantity supplied and used of that product. The datasheet must have TVOC levels highlighted and include the calculation method used and where available evidence of testing from a NATA or ISO/IEC 17025 registered laboratory.

At the end of construction works, the contractor is to undertake a final audit to ensure that all paints used meet the VOC limits listed above.

8.17.3 Adhesives and Sealants

All adhesives and sealants must meet the requirements of the Greenguard scheme.

8.17.3.1 Substitution

The contractor is required to obtain approval of the Architect before substituting the finishes listed above. TVOC data must be provided for any alternative painted finish and must meet the criteria in the table above before the Architect can approve its use.

A test report from a competent laboratory comparing the VOC limits of the product as measured against the limits set by each of the above schemes is acceptable to show compliance as long as the units of measure are the same. If VOC levels are determined by laboratory testing, the supporting information must include the test report from a laboratory competent to complete the relevant test method.

Laboratories may demonstrate their competency by being accredited or registered to ISO/IEC 17025 from International Accreditation New Zealand (IANZ) or other recognised accreditation agency (e.g. NATA in Australia).

8.17.3.2 Review and Sign-off

The Contractor must provide to the head contractor monthly reporting including a VOC datasheet for every compliant product used and the quantity supplied and used of that product. The datasheet must have TVOC levels highlighted and include the calculation method used and where available evidence of testing from a NATA or ISO/IEC 17025 registered laboratory.

At the end of construction works, the contractor is to undertake a final audit to ensure that all paints used meet the VOC limits listed above.

8.18 Insulation

All insulation used as a part of the building services installation is to be free of ozone depleting gases in manufacture and composition. This includes but is not limited to chilled water pipe work, refrigerant pipe work, ductwork, hot and cold water pipes and water tanks.

The manufacturing process of thermal insulants often changes. Manufacturer's data must be provided confirming that no ozone depleting gases have been used in the manufacture process and in the composition of the material.

All insulation must have an approved Environmental Choice NZ (ECNZ) eco-label.

The Contractor must obtain approval of the design team or client before substituting insulation listed in this specification.

8.19 PVC

PVC products (pipework, conduits) are not permitted for use for any of the permanent works or any below ground works associated with the temporary works.

All cabling for the project (temporary and permanent) shall be LSF/XLPE type. No PVC cabling shall be used.

8.19.1 Temporary Accommodation

PVC products shall only be permitted for above ground sanitary and storm water systems.

8.19.2 General

Manufacturers and suppliers of common uses of PVC products must obtain independent third-party verification to demonstrate that their products fully comply with the Green Building Council of Australia Best Practice Guidelines for PVC.

Common uses of PVC in buildings include, but are not limited to:

- Pipes, conduit and associated fittings
- Wire and cable insulation
- Flooring and resilient wall covering products etc.

Products containing recycled PVC content are to be documented and comply with the Best Practice Guidelines. Any claims of recycled content in such products by suppliers or manufacturers must be independently verified. This requirement is incorporated in the Best Practice Guidelines for PVC in the Built Environment. Re-used PVC is exempt from the Best Practice Guidelines.

Documented compliance of a PVC product to the guidelines can be demonstrated using any of the following pathways:

- ISO 14001 certified EMS that includes the requirements of the Best Practice Guidelines
- Independently audited manufacturer's declaration of compliance to the Best Practice Guidelines: or
- Product third party certification of the compliance to the guidelines (ISO type 5 certificate or eco label)

Full details of the Guidelines can be sought from the Green Building Council of Australia's (GBCA) website under the document; Literature Review and Best Practice Guidelines for the Life Cycle of PVC Building Products.

8.20 FIRE STOPPING SYSTEMS

This section relates to fire rated service penetration systems and control joint fire stopping systems and includes:

- fire resistant barrier for seismic and other movement gaps
- formulated compound of incombustible fibres
- fire-stop composite sheets
- fire-stop collars, grilles and dampers
- fire-stop wraps and pillows
- fire-stop sealants and foams
- fire-stop mortars

8.20.1 Warranty - Manufacturer/Supplier

Provide a material manufacturer/supplier warranty:

- Provide this warranty on the manufacturer/supplier standard form.
- Commence the warranty from the date of practical completion of the works.

8.20.2 Warranty - Installer

Provide an installer warranty:

- Provide this warranty on the installer/applicator standard form.
- Commence the warranty from the date of practical completion of the works.
- Qualifications

Installers to be experienced, competent trades people familiar with the materials and techniques specified.

8.20.3 No Substitutions

Substitutions are not permitted to any of the specified systems, components and associated products listed in this section.

8.20.4 Manufacturers Information

Submit type test certificates for each combination of fire stopping system, application, type of service, and substrate and penetration orientation. Include drawings of tested details.

- Submit report to AS 4072.1 appendix C.
- Submit evidence that systems specified without reference to brand conform to specified requirements.
- Submit copies of relevant manufacturers' instructions, for systems specified without reference to brand.
- Material data sheets (MSDS): Submit MSDS for systems specified without references to brand.
- Give notice if substrate or penetrations or both are not suitable for fire stopping.

8.20.5 Labelling Of Fire Rated Services Penetrations

All service penetrations to fire cells and fire separation systems are required to comply with all the designed fire integrity of the specified systems. Label all fire rated service penetrations to AS 4072.1 using the Certified Identification System provided by CID International Ltd.

Each fire stopping installation to have a permanently fixed tag or Label containing the following information:

- Manufacturer's name
- Name and address of installer
- Date of installation

Refer to CID International Ltd at www.cidcert.com to record all service penetrations.

8.20.6 Inspections

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

- Service penetrations completed and ready for fire stopping.
- Finish fire stopping, before being concealed.

8.20.7 Fire Stopping System Compliance

To NZBC C/AS1, Part 6: Control of Internal Fire and Smoke Spread.

8.20.8 Information Required For Code Compliance

Provide the following compliance documentation:

- Manufacturer's, and or supplier's warranty
- Installer's warranty
- Producer Statement - Construction from the installer
- Other information required by the BCA in the Building Consent Approval documents.

8.20.9 Certification

Submit evidence of compliance, to the recommendations of AS 4072.1 Appendix B.

Submit a certification document for installed fire stopping penetration and control joints.

- Form: To figure B1 of AS 4072.1

Schedule: Submit a schedule of installed fire stopped penetrations and control joints.

- Form: To figure B2 of AS 4072.1

8.20.10 Products

8.20.10.1 Compressible Fire Stopping

Fire resistant barrier comprising of water resistant intumescent strips between layers of flexible foam. For seismic gaps fit fixing brackets to manufacturer's instructions. Fire tested to AS 1530.4. Butt joints and end seals to be stopped with fire rated sealant. Refer to SELECTIONS for type.

8.20.10.2 Fire Sealing Strips

Compressible fire resistant strip comprising of mineral wool. Tested to NZS/AS 1530.1. Butt joints and end seals to be stopped with fire rated sealant. Refer to SELECTIONS for type.

8.20.10.3 Fire Collars

Consists of intumescent material encased in a steel collar with fixing tabs, tested to AS 1530.4, and AS 4072.1. Refer to SELECTIONS for type.

8.20.10.4 Fire Wraps

Intumescent strip or wrap. Tested to AS 1530.4. Refer to SELECTIONS for type.

8.20.10.5 Fire Pillows for Temporary Protection

Cloth bag with high temperature fire resistant granular material. Tested to AS 1530.4 and AS 4072.1.

8.20.10.6 Fire and Acoustic Sealant

One part sealant to AS 1530.4, AS 4072.1 and BSEN 1366.4 to provide up to 4 hours fire integrity and up to 3 hours insulation. Tested to ASTM C1519 - 10 for Dynamic movement and artificial age test. Refer to SELECTIONS for type.

8.20.10.7 Fire Rated Expanding Foam

Expanding polyurethane foam to AS 1530.4 and AS 4072.1. Do not use around plastic or insulated pipes or cables. Refer to SELECTIONS for type.

8.20.10.8 Fire Stop Mortars

Re-enterable cement based compound, mixed with water. Non-shrinking, moisture resistant. Insoluble in water after setting. Refer to SELECTIONS for type.

8.20.11 Execution

8.20.11.1 Delivery, Storage And Handling

- Take delivery of materials and goods and store on site and protect from damage.
- Protect finished surfaces, edges and corners from damage.
- Move/handle goods in accordance with manufactures requirements.
- Reject and replace goods that are damaged or will not provide the required finish.

8.20.11.2 General Preparation

Fire stopping after services have been installed through penetrations and properly spaced and supported, after sleeving where appropriate, and after removal of temporary lines, but before restricting access to the penetrations, including before dry lining.

Supply ventilation for non-aqueous solvent-cured materials. Apply fire stopping material to uniform density. Finish surfaces to a uniform and level condition. Maintain cable separation. Protect adjacent surfaces from damage arising through installation of fire stopping.

Allow for thermal movement for the pipes and ducts. Reinforce or support fire stopping materials with non-combustible materials when:

- The unsupported span of the fire stopping materials > 100mm.
- The fire stopping materials are non-rigid.

To large openings provide fire stopping capable of supporting the same loads as the surrounding element or provide similar structural support around the opening.

8.20.11.3 Installation of Compressible Fire Stopping

To NZBC C AS/1 Part 6: Junctions of fire separations clause 6.12.5. Ensure any rough protrusions in gap/joint to be removed before incursion of fire rated strip.

8.20.11.4 Installation of Compressible Fire Sealing Strips

To NZBC C AS/1 Part 6: Junctions with roof clause 6.12.7 and 6.17 Fire Stopping. Ensure any rough protrusions in gap/joint to be removed before incursion of fire rated sealing strip.

8.20.11.5 Installation of Fire Wraps - Solid Construction

Fit pipe fire wraps to PVC-U and or PE pipes where they penetrate the wall or floor. Install to the manufacturer's installation instructions. Position pipe wrap firmly around the pipe and remove self-adhesive strip. Press firmly onto adjoining face and slide into position. If the gap between the pipe wrap and the concrete is greater than 5mm, backfill with fire-rated sealant. If the gap is less that 5mm apply a 10mm deep bead of fire-rated sealant.

8.20.11.6 Installation of Fire Wraps - Hollow Core Walls

Fit pipe fire wraps to PE pipes where they penetrate the wall or floor. Install to the manufacturer's installation instructions. Position pipe wrap firmly around the pipe. Press firmly onto adjoining face and slide into position. Fit steel bands if the gap between the pipe wrap and the concrete is greater than 5mm, backfill with fire-rated sealant. If the gap is less that 5mm apply a 10mm deep bead of fire-rated sealant.

8.20.11.7 Installation of Fire Collars

- Ensure substrate around pipe penetration is flat and free from obstructions.
- Face fix fire collars with structural fixings to each exposed side of the fire rated plasterboard lined wall to solid in-wall blockings.
- Face fix fire collars to only the underside of concrete floor penetrations using appropriate size masonry anchors.
- Seal around pipes with acoustic fire rated sealant to provide smoke and acoustic seal.

8.20.11.8 Installation of Multi-Cable Transits

Encase and separate cables with fire rated sleeve system. Fill remaining space with the sleeves and seal with water repellent UV resistant fire sealant to a depth of 20mm each face. Hollow structures to have a metal cavity constraint system to constrain sealing product.

8.20.11.9 Installation of Cable Tray Penetrations

Separate cables from each other with appropriate size flame retardant rubber sheets. Fill remaining space with flame retardant rubber sheets. If gas and water tightness is required, seal with water repellent UV resistant fire sealant to a depth of 10mm to each exposed face of the sheets. Hollow structures to have a metal cavity constraint system to constrain sealing product.

8.20.11.10 Installation of Multi-Mix Transits for Cables And Pipes

Sleeve cables and pipes with fitting intumescent sleeves. Plastic pipes to be sleeved with crushing material. Fill remaining space with filler sleeves and seal with water repellent UV resistant fire sealant to a depth of 20mm each face. Hollow structures to have a metal cavity constraint system to constrain sealing product.

8.20.11.11 Installation of Cable, Steel, Copper and Plastic Pipe Penetrations

Fit fire resistant plugs to each end of the penetration. Plug to form a tight fit to pipes and cables and to wall of penetration.

Oversized holes or out of line conduit or pipes to be wrapped with intumescent (crushing for plastic pipe) material with excess space filled with fire retardant rubber and sealed with water repellent UV resistant fire sealant to a depth of 20mm.

8.20.11.12 Installation of Fire Pillows for Temporary Protection

Pack firmly into opening and around pipes and cable services. Overlap the pillows a minimum of 50mm and ensure that they overhang the perimeter of the opening. Fill gaps that cannot be filled with pillows, and gaps around services, with fire rated sealant.

8.20.11.13 Installation of Fire and Acoustic Sealants/Foams

Clean all surfaces from dust, dirt or other contaminants. Mask adjacent areas and remove immediately after tooling. Prime edges if required by sealant manufacturer. Fill all joints to required depth with a backing rod or bond breaker tape prior to sealant application.

Fire rated expandable polyurethane foam to 15mm wide joints maximum in fire walls.

8.20.11.14 Routine Cleaning

Carry out routine trade cleaning of this part of the work including periodic removal all debris, unused materials and elements from the site.

8.20.11.15 Defective or Damaged Work

Repair damaged elements. Replace damaged where repair is not possible or will not be acceptable. Leave fire stopping system to the standard required for following trades.

8.21 FLASHINGS

8.21.1 Qualifications

Work to be carried out by tradesmen experienced, competent and familiar with the materials and techniques specified.

8.21.2 Verify Dimensions

Verify dimensions against site measurements prior to fabrication.

8.21.3 Durability Requirements

Design and install the flashings appropriate for the durability applications in accordance with NZBC B2/AS1. NZBC B2/AS1, 3.2 requires that all hidden elements have at least the same durability as that of the element that covers it. Refer to NZBC B2/AS1 Table 1: Durability Requirements of Nominated Building Elements and NZBC E2/AS1 Table 20 Material selection.

8.21.4 Compatibility Requirements

Each flashing material shall be selected in accordance with NZBC E2/AS1 Table 20 to minimise corrosion. The exposure zone is to NZS 3604 Clause 4.2 and is defined as zone C. For compatibility of materials in contact and subject to run-off, refer to NZBC E2/AS1 table 21 and NZBC E2/AS1 table 22.

8.21.5 Design

For flashings where there are no specific details or drawings, provide a full size mock-up of the flashing to integrate components into the weathertight system. Co-ordinate with the trades affected by the installation.

8.21.6 Products

8.21.6.1 Flashing Materials

Acceptable materials for flashings are described in NZBC E2/AS1, 4.0. Material, grade and colour as detailed and scheduled. Ensure that materials used for flashings are compatible with the building and cladding materials and their fixings. Fabricate flashings from a ductile grade of metal designed for lateral strength by folding, stiffening or ribbing on external edges, having a maximum un-stiffened width of 300mm.

8.21.6.2 Fixings

Rivets, screws, nails and cleats to be compatible with the materials being fastened. Fasteners complying with the corrosion requirements of AS 3566 are suitable for use with ZINCALUME® steel products. Use only low carbon non-conductive sealing washers.

8.21.6.3 Joints - Sealants

Neutral curing silicone rubber sealant that is acetic acid free with low resistance to compression and be-able to withstand large temperature variations.

8.21.6.4 Joints - Solder

Eutectic solder of 60% tin/40% lead using a suitable proprietary flux.

8.21.7 Execution

8.21.7.1 Delivery

Keep flashings dry in transit. Take delivery of flashings in an undamaged condition. Reject all damaged materials.

8.21.7.2 Storage

Store materials and accessories on a level, firm base, in dry conditions, well ventilated, out of direct sunlight and completely protected from weather and damage. Ensure storage areas are away from current work areas. Cover to keep dry until fixed.

8.21.7.3 Handling

Avoid distortion and contact with potentially damaging surfaces/substances. Do not drag flashings across each other, or across other surfaces. Protect edges, corners and surfaces from damage.

8.21.7.4 Substrate

Do not commence work until the substrate is of the standard required by the installer for the specified flashings, level and in true alignment.

8.21.7.5 Protect

Protect surfaces, window and door joinery, and finishes already in place, from the possibility of damage during the installation process.

8.21.7.6 Confirm Layout

Before commencing work confirm the proposed installation of the flashings and expansion joints and other visual considerations of the finished work.

8.21.7.7 Co-ordinate Installation

Co-ordinate installation of flashings with associated trades.

8.21.7.8 Installation

Install flashings in accordance with NZ Metal Roof and Wall Cladding Code of Practice and in compliance with NZBC E2/AS1, 4.0 Flashings. For very high wind zones and where the pitch of the roof is below 10° the flashing joint laps shall be sealed with sealant at each end of the lap to prevent the ingress of water.

Form hem on vertical upstands of hidden flashings to prevent capillary action. Refer to NZBC E2/AS1 Table 7 for general dimensions of flashings.

8.21.7.9 Fixings

Fix flashings with fasteners appropriate to the situation. For fixing flashings with proprietary brackets or clips ensure they are aligned to allow for movement and are compatible with the flashing material.

Fix screws with the shank perpendicular to the surface of the flashing with the washer fitted firmly against the flashing. Screws to be compatible with the flashing material.

Rivets 'blind' or 'pop' are to be sealed when used. Aluminium rivets are compatible with zinc or AZ coated steel. Monel and stainless steel rivets can be used to fix galvanized steel flashings. Minimum diameter of rivet to be used is 4.0mm. Drill hole 1mm larger than the rivet size. Seal head of rivet with neutral cured silicone.

8.21.7.10 Jointing - Sealants

Clean surfaces to be lapped using a solvent ensuring all traces of the solvent are removed with a clean rag. Apply sealant by gun in a continuous bead of approximately 5mm diameter. Width of sealant when compressed should not exceed 25mm. Sealant joints shall be mechanically fixed for strength. Refer to NZ Metal Roof and Wall Cladding Code of Practice for details.

8.21.7.11 Jointing - Solder

Solder joints in galvanized steel and non-ferrous metals when specified with lead/tin solder. Clean joint ensuring it is dry and free of grease immediately prior to applying a proprietary flux. Lap the flashing 25mm in the direction of the water flow and fasten the lap with rivets or screws at 50mm centres. Completely sweat the joint to avoid leaving any flux residue. Wash down the joint to remove any trace of flux.

8.21.7.12 Completion

A final inspection by the installer shall take place after completion of the flashing work. Any defects or subsequent damage shall be made good.

- Protect new work from damage.
- Replace all damaged or marked elements.
- Leave work to the standard required for following procedures.
- Remove debris, unused materials and elements from the site.

8.22 ELECTRICAL WORK

This section relates to the detail design, supply, fixing and testing of electrical work and accessories, associated with simple, air conditioning, packaged plant and mechanical systems

8.22.1 Comply

Comply with the Electricity (Safety) Regulations 2010, AS/NZS 3000, AS/NZS 3008.1.2, AS/NZS 4251.1 and the New Zealand Electrical Codes of Practice for listed and prescribed work and with the utility network operator's requirements. Arrange for the required inspections of listed work. Pay all fees.

8.22.2 Qualifications

Carry out work under the supervision of an electrical licensed supervisor.

8.22.3 Safety Of Installation - Design By Electrician

Before installation work commences provide a declaration of conformity. The declaration of conformity is to comply with the Electrical (Safety) Regulations (2010), regulations 57 and 58. It must be signed by the designer of the installation.

8.22.4 Certificate Of Compliance

Supply a certificate of compliance to the owner, as required by the Electricity (Safety) Regulations (2010) regulation 67, within 20 days of completion as required by regulation 69.

- Arrange for the NUO to inspect before the meter installation, listed work inspection, polarity check and supply becoming live.
- Arrange for an inspector to inspect as required by regulation 70.

8.22.5 Producer Statements

Provide a 'producer statement - design' and 'producer statement - construction' to the satisfaction of the Building Consent Authority, for the complete mechanical electrical installation.

8.22.6 Compliance Schedules

Provide compliance schedules for the installation to the satisfaction of the territorial authority, in accordance with the New Zealand Building Code requirements for the mechanical electrical installation.

8.22.7 Products

8.22.7.1 Cables

Generally to the recommendations of SAA HB 301.

Electrical equipment to AS/NZS 3100.

Fire and mechanical performance classification to AS/NZS 3013.

Selection of cables to AS/NZS 3008.1.2.

Distribution cables to AS/NZS 4961.

Testing to AS/NZS 3017.

8.22.7.2 Wiring Systems

Provide wiring systems appropriate to the installation conditions and the function of the load.

8.22.7.3 Power Cables

Standard: LSH or XLPE cables: To AS/NZS 5000.1. (No PVC shall be used)

Use multi-stranded copper cable generally.

Minimum size:

- Power sub-circuits: 2.5mm2.
- Sub-mains: 6mm2.

8.22.7.4 Cable Supports And Ducts

Cable trunking systems to AS/NZS 4296.
Conduits and fittings for electrical installations to AS/NZS 2053 Parts 1, 2, 3, 4, 5, 6, 7 and 8.

8.22.7.5 Steel Conduit

To AS/NZS 2053, hot-dip galvanized to AS/NZS 4680, for damp or exterior situations and complete with fittings and accessories brand matched as required by the conduit manufacturer.

8.22.7.6 Heavy Duty Rigid PVC Conduit

Not permitted for use for any temporary and permanent works.

8.22.7.7 Rigid PVC Conduit

Not permitted for use for any temporary and permanent works.

8.22.7.8 Flexible Conduit

Not permitted for use for any temporary and permanent works.

8.22.7.9 Ducted Wiring Enclosures

Provide purpose-made ducts. Provide rigid supports. Round off sharp edges and provide bushed or proprietary cable entries into metallic ducting.

Provide purpose-made accessories and covers to match the duct system. Provide screw-fixed covers or clip-on covers removable only with the use of tools.

Except for horizontal runs where the covers are on top, support wiring with retaining clips at intervals of not more than 1000mm.

8.22.7.10 Switchboards/MCC

To AS/NZS 3439.3.

Incorporate proprietary busbar systems for the interconnection of isolators, circuit breakers and other circuit protection devices.

Provide lockable doors with a circuit card holder unless enclosed in cupboards or in an area which is not readily accessible to the public.

IP rating IP54 minimum.

Wall mounted for proprietary switchboards or floor mounted if assemblies > 2 m2.

Ventilation to maintain design operating temperatures at full load.

8.22.7.11 Switchboard Components

Rated duty, uninterrupted in non-ventilated enclosure.

Rated making capacity (peak), ≥ 2.1 x fault level (RMS) at assembly incoming terminals.

Utilisation category to AS 60947.1 clause 4.4.

Circuits consisting of motors or other highly inductive loads at least AC-23.

Select and adjust protective devices to discriminate under over-current and earth faults.

8.22.7.12 Switch-Isolator Units

To AS 60947.1 and AS/NZS 3947.3.

8.22.7.13 Moulded Case And Miniature Circuit Breakers

Moulded case breakers to AS 60947.1 and AS 60947.2.

Miniature circuit breakers to AS/NZS 60898.1 or AS 3111, minimum 6 kA rated.

Independent manual operation including positive ON/OFF indicator.

Trip type, moulded case breakers.

Miniature circuit breakers, fixed thermal, fixed magnetic.

Isolation facility required.

Current limiting, moulded case breakers.

Utilisation category, moulded case breakers:

- Final subcircuits category: Category A.
- Mains and submains: Category B.

Trip settings as required, seal, and label.

Connect interchangeable and integrally fused trip units so that trip units are not live when circuit breaker contacts are open.

8.22.7.14 Fuses With Enclosed Fuse Links

To AS 60269.1, AS 60269.2.0 and AS 60269.2.1.

Fuse links, enclosed, high rupturing capacity type mounted in a fuse carrier.

Breaking range and utilisation category:

- Distribution/general purpose: gG.

- Motors: gM.

Mount fuse-holders so that fuse carriers may be withdrawn directly towards the operator and away from live parts. Provide fixed insulation which shrouds live metal when the fuse carrier is withdrawn.

Provide barriers on both sides of each fuse link, preventing inadvertent electrical contact between phases by the insertion of screwdriver.
Provide 3 spare fuse links for each rating of fuse link on each assembly. Mount spares on clips within the spares cabinet.

Provide 3 spare fuse holder carriers for each size of fuse holder carriers on each assembly. Mount spares on clips within the spares cabinet.

Busbar mounted fuse holders, fuse carriers with retaining clips, minimum fuse holder 32 A.

8.22.7.15 Contactors

To AS 60947.4.1.

Enclosed, block type, air break, electro-magnetic.

Poles: 3

Rated operational current: The greater of:

- Full load current of the load controlled.
- ≥ 16 A.

Provide auxiliary contacts with at least one normally-open and one normally-closed separate contacts with rating of 6 A at 230 V a.c., utilisation category: AC-1.

8.22.7.16 Control Devices And Switching Elements

To AS 60947.1 and AS 60947.5.1.

Rotary switches, cam operated type with switch positions arranged with displacement of 60°.

Off position at the 12 o'clock position. Test positions must spring return to off position.

Control relays: Generally Auto / Off / Manual

Fire alarm relays: To AS 60947.5.1.

8.22.7.17 Indicator Lights

To AS 60947.5.1.

8.22.7.18 Motors

Provide motors selected in conformance with AS 1359.101, the application load characteristics, motor manufacturers' recommendations and the following:

- Motors ≥ 0.75 kW: Three phase.

8.22.7.19 Motor Rating

To AS 1359.101.

Maximum power rating, the greater of the documented minimum motor size and next preferred standard frame size above the maximum load of the driven equipment.

Duty: ≥ S1.

Class: ≥ 'continuous running'.

Speed: ≤ 1500 r/min.

8.22.7.20 Starting Performance

Designation: ≥ Design N to IEC 60034-12.

Speed and torque to suit the driven equipment. Ensure each motor develops torque relative to the starting load of the driven machine such that it runs up to full speed steadily and within a time period compatible with motor winding temperatures, class of insulation and rating of the starting equipment.

8.22.7.21 Motor Efficiency

All motors to be High Efficiency to AS/NZS 1359.5 Table A3 or Table B3.

8.22.7.22 Motor Environment

Site operating conditions to AS 1359.101 Section 5.

Electrical operating conditions to AS 1359.101 Section 6.

8.22.7.23 Motor Enclosure

Provide enclosures appropriate to the environment in which the motor operates.

Motor enclosure classification ≥ IP44 to AS 60529.

8.22.7.24 Motor Cooling

To AS 1359.106.

Classification ≥ IC01.

8.22.7.25 Motor Marking

Terminals to IEC 60034-8.

8.22.7.26 Motor Mounting

IM classification to AS 1359.107.

8.22.7.27 Motor Noise

To AS 1359.109.

8.22.7.28 Motor Vibration

To AS 1359.114.

Grade ≥ N (normal).

8.22.7.29 Starters

To AS 60947.1.

Electromechanical motor starters to AS 60947.4.1.

8.22.7.30 Starters Selection

Provide motor starters selected according to the following:

- Electricity distribution network limitations for starting currents and voltage flicker.
- Torque requirements for the motor load.
- Heating effects on the motor.
- Voltage drop during start due to starting currents.
- Time required to accelerate from rest to full speed.

- Number of starts per hour.

8.22.7.31 Starters Performance

Rated operational current, at least the full load current of the load controlled.

Rated duty, Intermittent class 12.

Utilisation category, AC-3.

Mechanical durability ≥ 3 million cycles to AS 60947.4.1.

Electric durability ≥ 1 million operations at AC-3 to AS 60947.4.1.

Mount with sufficient clearance to allow full access for maintenance, removal and replacement of coils and contacts, without the need to disconnect wiring or remove other equipment.

Provide separate auxiliary contacts with at least one normally-open and one normally-closed contacts with rating of 6 A at 230 V a.c., utilisation category: AC-1.

If the number of auxiliary contacts exceeds the number which can be accommodated, provide separate slave relays.

8.22.7.32 Direct-On-Line Starters

Direct-switching electromagnetic contactor type.

8.22.7.33 Motor Protection

Provide over-current protection with manual reset giving overload protection in each phase of supply as part of the equipment assembly for each motor starter.

Provide at least one normally-open and one normally-closed set of contacts rated at the starter control circuit voltage and minimum 4 A. Connect contacts to open the starter at the setting temperature.

Utilisation category AC-11.

Ensure relays are not affected by the shock of mechanical contactor operation. Provide sufficient clear space for the disconnection, removal and replacement of heaters, without disconnecting other equipment and wiring.

8.22.7.34 Single Phase Motor Protection

Provide overload units matching the motor heating curve characteristics.

8.22.7.35 Phase Motor Protection

General: Provide thermal overload protection relays for each motor.

Provide the following:

- Triple pole relays with differential trip bar operation for single phase protection, and ambient temperature compensation.
- Thermal overloads connected directly to contactor by means of proprietary links, except where operated separately by current transformers.
- Current transformers, to operate protection type thermal overloads, saturating at 10 to15 times full load current, Class 10P.

8.22.8 Execution

8.22.8.1 Power Cables

Unless unavoidable due to length or difficult installation conditions, run cables without intermediate straight-through joints.

Individual wiring of extra-low voltage circuits: Tie together at regular intervals.

Identify multicore cables and trefoil groups at each end with stamped non-ferrous tags clipped around each cable or trefoil group.

Identify the origin of all wiring by means of legible indelible marking.

Cable systems in:

- Accessible concealed spaces: insulated and sheathed in non-combustible conduit (i.e. steel).
- Inaccessible concealed spaces: Cable in non-combustible conduit (i.e. steel).
- Plant rooms: Cable in non-combustible conduit (i.e. steel), or on tray or in duct.
- Plastered or rendered surfaces: Cable in non-combustible conduit (i.e. steel).
- Stud walls without bulk insulation: insulated and sheathed in non-combustible conduit (i.e. steel).
- Walls filled with bulk thermal insulation: Cables in non-combustible conduit (i.e. steel).

8.22.8.2 Unsheathed Cables

Provide permanently fixed enclosure systems, assembled before installing wiring. Provide draw wires to pull in conductor groups from outlet to outlet, or provide ducts with removable covers.

8.22.8.3 Conduit Systems

If exposed to view, install conduits in parallel runs with right angle changes of direction.

For conduits in roof spaces locate below roof insulation and sarking. In accessible roof spaces, provide mechanical protection for light-duty conduits.

Allow for thermal expansion/contraction of conduits and fittings due to changes in ambient temperature conditions. Provide expansion couplings as required.

Solar radiation protection required for exposed conduits and fittings.

Provide flexible conduit to connect with equipment and plant subjected to vibration. If necessary, provide for adjustment or ease of maintenance. Provide the minimum possible length.

8.22.8.4 Switchboard Marking And Labelling

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.

Electrical and Mechanical Specification for the type of fittings, wiring, conduits, control gear, etc.

8.22.9 Testing And Commissioning Electrical

On completion, test the work in accordance with, the Electricity (Safety) Regulations 2010, AS/NZS 3000, AS/NZS 3017 and other relevant standards. Complete testing prior to energising circuits.

Tests to demonstrate the suitability and proper operation of any item or system are to be made as may be directed during or after manufacture, construction, installation or commissioning up to the end of the guarantee period.

Provide, for the duration of the work, testing and regulating equipment required for commissioning and regulating the completed installation.

Submit the Electrical work for inspection and test and prove to the satisfaction of the network utility operator that the installation complies with all Acts and Regulations and has been tested and proved to be sound.

8.23 MANUFACTURES DIRECTIONS

Manufactured articles, materials and equipment are to be supplied, installed, connected, erected, used, cleaned and commissioned in strict conformity with manufacturer’s printed directions unless otherwise specified. In any case, the Hydraulic Contractor is to obtain from the Supplier agreement that the product as used or specified is being used or specified in accordance with the manufacturer’s requirements and practice. Retain manufacturer’s directions for such articles on site for the Proprietor’s reference.

8.24 SPARE PARTS AND SPECIAL TOOLS

At least 8 weeks before the date for practical completion, submit a schedule of tools, portable instruments and spare parts necessary for maintenance of the installation. For each item state the recommended quantity and the manufacturer's current price. Include the following in the prices:

- Checking receipt, marking and numbering in accordance with the spare parts schedule.
- Packaging and delivery to site.
- Referencing equipment schedules in the operation and maintenance manuals.
- Suitable means of identifying, storing and securing the tools and instruments. Include instructions for use.
- Painting, greasing and packing to prevent deterioration during storage.

Replace spare parts consumed during the maintenance period.

8.25 CAPPING OFF

During the construction, leave all unfinished work in safe condition as per Work Cover requirements, protect the works against damage or loss through any cause whatsoever, and seal off open ends of pipe in such a manner as to prevent the entry of foreign matter into the lines until the works have been handed over on completion.

8.26 CLEANING OF SERVICES

After installation and prior to testing the piping and storage vessels, each service shall be thoroughly cleaned and flushed out. All valves, seats, tap washer and strainers shall be checked for any foreign matter and cleaned. Damaged seats and washers shall be replaced.

On completion of all work, all tools, supplies, unused materials and waste materials shall be removed and the work left in a clean and tidy condition.

8.27 ACCESSIBILITY

The Hydraulics Contractor shall ensure that all commissioning devices can be conveniently and safely accessed during the commissioning process to allow regulation and measurements. Such devices include:

- Control valves

- Flow limiting valves
- Pressure reducing valves
- Thermostatic mixing valves
- Automatic air vents
- Manual air vents
- Control instruments such as pressure sensors, temperature sensors, flow sensors or switches
- BMS controllers and isolators
- Isolation valves
- Backflow prevention devices
- Water and electrical meters

Furthermore the contractor shall ensure that all equipment that requires on-going regular maintenance is located to allow safe and convenient access by facilities staff and service subcontractors. The contractor may be asked to demonstrate access provisions as part of the commissioning and/or training process.

Ceiling access panels should be coordinated across all trades and be shown on the coordinated RCP shop drawings for review and approval by the design team.

Particular care should be taken with respect to plantroom layout to ensure where possible equipment can be replaced in the future without impacting adjacent plant or requiring major structural modifications.

8.28 WORKMANSHIP

All equipment to be installed in a tradesman like manner, complying with AS 3500, the latest relevant regulations, all local requirements and this specification.

Wherever possible, pipes shall be suspended from slab and walls to eliminate the number of vertical risers from ground to structure. Pipes shall be run parallel with walls, slabs and each other.

8.29 EQUIPMENT

All equipment offered in the tender must comply with the requirements of the specification.

If equipment is offered as complying with the specification and at a later date this is found not to be so then the particular item of equipment will be rejected and replaced with the complying equipment at no extra cost.

Non-complying equipment may be offered as an alternative only.

The Hydraulic Contractor is free to submit details for potential cost savings with regards to alternative materials and fixtures in addition to their complying tender.

Attention should be given to the delivery time of equipment and in this respect tenderers shall only offer equipment that can be delivered in time to work in with the construction programme.

Equipment capacities shall be as scheduled on the drawings or in this specification.

8.30 SCHEDULE OF RATES

The Hydraulic Contractor is to supply a detailed Schedule of Rates as defined in the main contract.

8.31 EXCAVATION AND PIPE WORK REQUIREMENTS

8.31.1 Excavation

Any person involved in excavation type work on this site should be aware that it is reclaimed and contaminated ground containing corrosive and toxic compounds and as such appropriate Health & Safety plans should be put in place before undertaking such work.

Excavation work backfilling and surface reinstatement shall be undertaken by the Contractor as part of his contract scope of work for all buried services installed within the scope of works of this contract. All excavations and backfilling shall be in accordance with the relevant section of the following referenced documents.

8.31.2 Water

- AS/NZS3500 Parts 1.1 and 1.2 – Water Supply
- AS/NZS3500 Parts 4.1 and 4.2 – Hot Water Supply

8.31.3 Sewerage

- AS/NZS3500 Parts 2.1 and 2.2 – Sanitary Plumbing and Drainage

8.31.4 Stormwater

- AS/NZS3500 Parts 3.1 and 3.2 – Stormwater drainage

Note: Generally all in ground pipework excavation shall be allowed for as excavation in rock

Excavate to the lines, levels and grades as required for underground services specified in the relevant services sections, including drainage, hydraulic and the like. Unless otherwise specified make the trenches straight between manholes, inspection points, junctions etc., with vertical sides and uniform grades. Excavation around trees to be done by hand ensuring protection of existing flora.

Shall consist of the removal of natural un-weathered materials which cannot be removed until broken up by means of jackhammers. This does not include loose bounders, brick and old pavements.

Excavate trenches in sections of suitable length, lay and bed the relevant service length and backfill the trench section, with the minimum of delay and if possible on the same working day, unless otherwise specified or permitted.

Trench Widths shall be subject to regulatory authority requirements, keep trench widths to the minimum consistent with the laying and bedding of the relevant service, and the construction of manholes and pits.

If the Hydraulic Contractor has exceeded the sectional area of excavations in consequence of any injudicious working, slips, falls blasting or any other cause other than by directed, then the Hydraulic Contractor shall, at his sole cost, remove such extra material and make good and fill.

Trench Depths shall be as required by the relevant service and its bedding method.

Cut back roots encountered in trenches to not less than 600m clear of the relevant service. Remove such other obstructions including roots, stumps, boulders and the like which may interfere with the proper functioning of the service.

During excavation the Contractor shall advance the work in a careful, secure and safe manner and shall take all precautions against accidents and where necessary erect shoring/timbering to prevent earth or other material slipping or failing in or being shaken from the faces or sides of the excavation.

Payment for the supply, erecting, withdrawing or abandoning or shoring/timbering shall be included in the Contractors tender price.

The dewatering and disposal of all waters entering the Contractor's excavations shall be solely the responsibility of the Contractor. Any damage incurred by rainwater or rainwater runoff into the Contractor's excavations shall be solely the responsibility of the Hydraulic Contractor. Such damage shall be reinstated by the Contractor to the satisfaction of the regulatory authority at his cost and no claim for additional cost will be allowed.

The Hydraulic Contractor shall provide and maintain efficient hoardings, barriers, night lights and temporary traffic arrangement as required by the Authority having control of the streets and/or roads. The Contractor shall apply for and obtain approval of all proposed temporary traffic arrangements required to carry out the works. The Contractor shall restore to the satisfaction of the local authorities all public and private streets, roads, lanes, footpaths, paved areas cultivated or grassed surfaces and all fences which may be disturbed by the operations of the Contractor. All trenches over 1.5mm in depth shall have parrawebbing erected on both sides of the trench.

Surplus spoil shall mean such excavated material that is not required for the purpose of this contract and shall be removed from the site by the Contractor. The Contractor shall bear all costs associated with the disposal of surplus spoil including all cartage and tip fees.

The use of explosives will not be permitted.

8.31.5 Tunnelling

Provide tunnelling in lieu of trenches where required by Authorities.

Tunnelling shall comply with the requirements of the required authority. The use of explosives will not be permitted. Use adequate shoring to prevent the collapse of the tunnel under all conditions.

Leave shoring in tunnel and backfill with sand under pressure after approval of pipework by Authorities and the Proprietor.

8.31.6 Existing Services

Where underground existing service lines and surface drainage works and underground pipes, conduits or cables exist in the vicinity of the works, the Hydraulic Contractor must take care to protect such services. Any damage to such services must immediately report to the Main Contractor.

The cost of the necessary repairs or renewals shall be borne entirely by the Hydraulic Contractor, should negligence on the Contractor's part be proven.

8.31.7 Excavation In Existing Pavement and Roadways

When excavating through existing pavement, saw the pavement and/or road to a depth of at least 100mm and then remove the material with pneumatic tools. If required by the Proprietor, trenches across the existing roads shall be excavated and the pipeline constructed therein so that half the roadway is always maintained open to traffic.

Allow to place 25mm thickness steel plates to Council approval over open drainage trenches during and after each day's work so as vehicular and pedestrian traffic flow is maintained.

8.31.8 Making Good

The Contractor shall be responsible for and shall make good any damage he may cause to the building and surfaces generally and any other works that may be distributed or injured by cartage, work generally or other operations. The reinstatement shall be at least as good as state of repair as before commencement.

8.31.9 Existing Service Connections

The Hydraulic Contractor shall seal off all existing service connections to Authorities mains to their satisfaction and approval.

8.31.10 Gradients

Lay drains to gradients complying with the relevant authority's requirements to the levels, if any shown on the Drawings and in any case not less than the following:

Minimum Sanitary Pipe Gradients

Pipe diameter (mm)	Fall
65	1 in 40
80	1 in 60
100	1 in 60
125	1 in 80
150	1 in 100

Minimum Stormwater Pipe Gradients

Pipe diameter (mm)	Fall
90	1 in 90
100	1 in 120
150	1 in 200
225	1 in 350
300	1 in 350
375	1 in 350

8.31.11 Pipe Laying

Lay pipelines to uniform gradients falling to the outlets, straight between required changes of direction, properly supported, with watertight joints aligned flush at internal surfaces and with spigot ends pointed in the direction of flow. Provide the necessary fittings and accessories, including junctions, branches, inspection and cleaning openings, expansion joints, and the like.

Provide inspection openings as required by the regulatory authority and in any case so that each straight length of sewer line can be inspected in at least one direction. Seal the openings with purpose-made covers fixed by a jointing method appropriate to the pipework. Raise the openings to surface level.

Flush the pipeline with clean water and leave it clean and free from debris on completion.

Lay a detectable strap or plastic tape in the trench after pipe laying, testing and initial backfilling for all services.

Provide a marker plate at ground level at each change of direction of the underground pipeline, engraved to show the direction of the line and the name of the service. Inset the marker in a 150 x 150 x 150mm concrete block, with top set flush with the finished ground or surface level.

8.31.12 Bedding and Backfilling – Underground Pipe Installation

Unless otherwise specified bed the pipework on a continuous underlay of pipe bedding material, compacted in granular, or minimum thickness after compaction as required by the relevant standard, but in any case not less than 75mm. Grade the bedding evenly to the required gradient of the pipework.

Where the base of a trench is unstable or water charged ground, drains shall be supported on steel reinforced concrete beams and piers designed for that purpose.

Submit details of all beams and supports for approval before commencing installation.

Form chases where necessary to prevent sockets, flanges or the like from bearing on the trench bottom or the bedding. Fill and compact the chases with granular bedding material after the laying and testing of the pipes.

Backfilling of excavations shall be carried out under this contract.

Backfilling over Mains may, subject to the approval of the ER and testing authority be carried out prior to testing of the Mains, except at the pipe joints.

Backfilling of Mains shall be minimum 150 mm thick over the top of the pipe at the joints. The remainder of the backfill in the trench shall be stabilised selected excavated fill, as approved by the ER and Consultant.

Immediately after the pipe line has been tested to the satisfaction of the Consultant the trench shall be backfilled in the following manner:-

- The fill material shall then be carefully and continuously placed, rammed, and watered around and over the pipe until the firmly compacted filling completely covers the pipe for the full width of the trench.
- The remainder of the trench shall then be backfilled with approved material, placed in layers not exceeding 150 millimetres loose thickness and compacted to a density of at least 95% of modified Maximum Dry Density as determined by AS 1289 procedures.

In PIPE TRENCHES compact so that the pipe is buttressed by the walls of the trench. Unless otherwise specified, backfill with general filling, with no stones retained on a 25mm sieve occurring within 150mm of the service. For materials other than the above as cover or back-filling to particular services, refer to the relevant services Sections.

Do not place filling against concrete until the concrete has been in pace for fourteen days, unless otherwise approved.

Back-fill for services under roads, pavements and concrete slabs shall be gravel sub-base class 2 compacted to 98% MMDD placed as nominated for general filling.

Provide compaction tests for all service trenches on the basis of not less than one test per service branch or as directed.

Protect the works during compaction from damage by compaction operations. Compact by hand if necessary to prevent damage or disturbance to services, pipe joints and the like.

Prior to and during placing, bring the materials to within 2% of the optimum moisture content determined to AS 1289 Method E1.1 for the filling type. The surface may be lightly sprinkled with water during compaction if necessary to replace moisture loss.

Unless over-ridden by regulatory authority requirement or otherwise specified, the following table shall apply for minimum cover over pipes:

Minimum Cover for Drainage

Pipes not subject to vehicular loading:	450mm
Pipes subject to vehicular loading – Not in roadways: Under sealed roadways: Under unsealed roadways:	600mm 600mm 750mm
Pipes in embankments or subject to construction equipment loading:	750mm

8.31.13 Anchorages

Install anchorages in the form of lateral or longitudinal anchor blocks, of not less than 15 MPa concrete, to restrain lateral movement in pipelines at bends and changes of direction on pipework above 100mm diameter. Bear anchor blocks against the body of the fitting only, clear of joints, and against firm undisturbed ground or compacted filling.

Where Rubber Ring Jointed Pipelines and the gradient is greater than 1 in 20 (5%) concrete stops shall be provided 150mm thick and built around the pipe extending from the bottom of the trench up to a height of 300mm above pipe and recessed 75mm into each side of the trench.

Submit to the ER all details of the in ground pipe systems including proposed positions of concrete thrust blocks for approval before installation of pipework commences.

8.31.14 Bedding Fittings

Provide flexible joints by installing short lengths (not more than 600mm) of flexibly jointed pipe on each side of concreted fittings, pits, manholes and the like, in principle as illustrated in AS 3500 Part 2.

8.31.15 Concrete Encasing

Unless otherwise permitted by the relevant authority, concrete encase the following:

Vitrified clay sewer pipelines beneath buildings;

Pipelines which cannot be provided with the required minimum cover;

Pipelines beneath the ground slab of the CPO building (Not including pipelines in the floor voids or service trenches)

Encasement shall consist of 15 MPa concrete, not less than 150mm above and below the pipe and 150mm each side or the width of the trench, whichever is the greater.

8.31.16 Drains Beneath Building

Where sanitary drainage drains pass beneath footings surround pipes by not less than 150mm of 20 MPa concrete measured clear of the line of collars.

With the exception of ductile iron penetrations build into structural concrete, where drains of any kind pass through foundation walls make neat opening, minimum 6 mm clear of pipe all round.

Suitable arch wall construction so that no superimposed loading is imparted to pipe. Seal pipe in approved manner. At outer walls make suitable approved provisions to prevent ingress of rodents and other vermin.

8.31.17 Connections to Existing

Connect new pipelines to existing drains as follows:

To existing pipelines less than 300mm remove an appropriate length of the existing pipeline and insert a new junction and new pipework consistent with the existing pipeline.

As part of the Civil work the Civil Contractor will provide a Sanitary drainage inspection chamber for connection into the pit from the new branch drains under the building.

Connections to the Civil Contractor work shall be made by connecting to the new service provided as part of the early works. Connect to the pipe in a neat tradesman like manner.

Arrange valves together where practicable in operational grouping, in convenient and readily accessible positions.

8.31.18 Above Ground Pipework Installation

Install pipework in straight lines and uniform grades without sags. Provide bends and sets as required, and sufficient unions, flanges, isolating valves and the like for satisfactory removal of piping and fittings for maintenance. Arrange and support pipework as necessary where suspended, so that it remains free from vibration whilst permitting necessary movements such as thermal expansion and contraction. Provide the fittings and components connected up and ready for testing the service. Keep the number of joints to a minimum.

Do not install copper in contact with steel, zinc or other materials likely to generate electrolytic, galvanic or corrosive action. Make junctions between dissimilar metals with special fittings manufactured in suitable compatible material.

Use bends where practicable in preference to elbows. Use elbows where pipes are led up or along walls and then through to fixtures.

Arrange valves together where practicable in operational grouping, in convenient and readily accessible positions.

Pipework runs in false ceilings, roof spaces, under suspended ground floors plant rooms, and the like. Arrange adjacent to and horizontally parallel with each other and with walls, beams and the like. Keep at least 150mm above ground surface if under suspended ground floors. Provide adequate spacing of at least 25mm between pipes or pipe insulation, 50mm between pipes or pipe insulation and electrical cables. Take off branches at right angles.

8.31.19 Accessibility

Check size and location of all access doors and openings shown on architectural, structural and hydraulic services drawings to ascertain if they satisfy authorities' requirements.

Locate pipework in accessible positions, with adequate clearance, pipe fittings requiring maintenance or servicing, including inspection openings, cleaning points, joints designed to enable removal of pipes, control valves and the like.

As far as practicable, install plumbing work inside buildings so that it is removable without damage to the building structure or finishes.

Where practicable, conceal pipework so that it is accessible within ducts or non habitable enclosed spaces and does not appear on external walls. Obtain prior approval for the location of exposed pipework.

If pipework is proposed to be enclosed so as to be not accessible after completion, obtain prior approval for the location of pipe runs and pipe fittings, and record the actual locations on work as executed drawings.

8.31.20 Capping Off

During construction, temporarily seal open ends of pipes to prevent the entry of foreign matter into pipe systems. Provide purpose-made covers of pressed steel or rigid plastic. Do not use rags, paper or wood plugs.

8.31.21 Cleaning Out

Clean out piping of loose scale and dirt before installation, and again after installation and sealing of joints. Flush piping systems through with clear water at a velocity sufficient to remove foreign matter and until only clean water is discharged at outlets. Leave the system free of foreign matter on completion.

8.31.22 Clear-Outs

Install clear-outs in positions as indicated on the drawings, and as required by local authorities. Allow to extend from drain lines to finished surface level using a 60% junction and 30% bend.

Provide 100mm diameter, brass clear-outs at finished floor level.

8.31.23 Workmanship Generally

Co-ordinate installation of pipework with other types of trade pipe runs or duct runs so that all services can be installed and maintained without hindrance.

Lay pipes in continuous lengths wherever practicable and bend in order to minimise joints.

Make all connections to valves, taps, tanks, etc., pipes of other materials and dismantling points. For pipes 65 bore and over, connections shall be made with flanged joints and with threaded union joints for pipes 50 bore and under.

Brazing shall be carried out by first-class tradesmen experienced in work being carried out.

Open ends in pipework being erected shall be properly protected by metal caps at end of each day's work or at the end of each section of work.

Valves and inspection panels and all items, which require access at any time, shall be placed in a position that is fully accessible for maintenance and operation.

Where pipes are led up or along walls and then through fixtures, pipes shall not be bent but shall be fitted with gunmetal elbows to allow for correct fitting of cover plates. Mitred elbows will not be permitted.

Except where specifically mentioned in conjunction with a particular item of work, cast bends shall not be used. Care must be taken that sufficient unions or flanged joints are installed to allow satisfactory removal of fittings for inspection or repair, all as approved on site by the Consultant.

Pipes shall be spaced clear of all services. A minimum of 75 horizontally and 150 vertically shall be maintained from any electrical conduit cable or fitting.

All piping shall be cut square with the run and all cutting burrs removed with a proper pipe reamer. Pipework generally shall be concealed in false ceiling spaces or in the ducts provided.

Joints will not be permitted within the thickness of walls or floors unless it can be demonstrated that no other option is practicable or possible.

Only hexagonal nipples shall be used on screwed pipework; barrel nipples or running joints will not be permitted.

Pipework concealed in pipe ducts or plinths shall be provided with easy access to cleaning eye.

8.32 MATERIALS

8.32.1 Generally

All materials and workmanship shall be in accordance with the relevant section of the following referenced documents.

All materials shall be of the best quality and type of their kind. They shall conform to the requirements of the latest relevant specification of the Standards Association of Australia or New Zealand, or if no Australian or New Zealand Standards exist, to the requirements of the relevant British Standard Specification.

All materials delivered to the site must be protected in a manner suitable for storage on a building site. Materials shall be stored away from all damp and the ends of pips shall be sealed.

All pipes and pipe fittings shall be obtained from approved manufacturers.

The word 'piping' shall mean all pipes, fittings and accessories connected there to.

Piping shall be of the diameter as shown on the drawings and the schematics. (All diameters are internal diameters).

8.32.2 Temporary Accommodation Works (Plaza and B2 Level)

Omitted for clarity. Refer to Revision 7 of this specification for requirements relating to Temporary Works.

8.32.3 Permanent Works

All pipework and associated fixings, supports etc. running in-ground shall be of materials appropriate and / or have protective coatings appropriate for the works.

8.32.3.1 Buried Pipework

Materials for in-ground pipework shall be as follows;

System	Material	Notes
Storm water	HDPE, RCRRJ	
Sanitary Sewer For corrosive ground	HDPE Vitrified Clay to AS/NZS EN 295	 Joints with fixed rubber ring manufactured to acid resistant standard.
Cold Water supply For corrosive ground	Polyethylene to AS/NZS 4130 or “Insapipe” proprietary HDPE jacketed polyurethane. Cast Iron with PE sleeve	 Tyton Lok joints

8.32.3.2 General - Above Ground Pipework

Materials for above ground pipework shall be as follows:

System	Material	Notes
Sanitary Sewer	Copper	
Storm Water	TBC	To be determined
Hot and Cold Water supply	Copper	

Vent Pipe	Copper	

8.32.4 Water

Pipes and fittings shall carry WaterMark and New Zealand Standard approval numbers. They shall comply with the relevant building and construction codes, including the requirements of the following documents where applicable:

- AS2345 Dezincification resistance of copper alloys
- AS/NZS2492 Cross-linked polyethylene (PE-X) pipes for pressure applications
- AS/NZS2537 Mechanical jointing fittings for use with cross-linked polyethylene (PE-X) pipe for hot and cold water applications
- AS/NZS3500 Parts 1.1 and 1.2 – Water Supply
- AS/NZS3500 Parts 4.1 and 4.2 – Heated Water Supply
- AS/NZS4020 Testing of products for use in contact with drinking water

8.32.5 Sanitary

- AS/NZS3500 Parts 2.1 and 2.2 – Sanitary Plumbing and Drainage

8.32.6 Stormwater

- AS/NZS3500 Parts 3.1 and 3.2 – Stormwater drainage

8.32.7 Measurement of Materials

Make available appropriate and approved metric gauges and/or scales for measuring and/or weighting all materials supplied.

8.32.8 Rejection of Unsatisfactory Materials

In the event of materials being of a mixed description and quality, the Company shall have power to order to have those portions of the materials which in his opinion are unsuitable for the works, picked out, marked and stacked where directed and all defective or unsuitable materials removed from the site.

8.32.9 Copper Tubes and Fittings

Copper Tubes shall be solid – drawn couplings with the following standards:

Copper Tube Standards

- Water Services Pipes	AS 1432	Type B
- Gas Service Pipes	AS 1432	Type B
- Soil and Waste Pipes	AS 1432	Type D
- Vent Pipes	AS 1432	Type D
- Stormwater Pipes	AS 1432	Type D

- Copper Fittings to AS 1589
- Capillary Fittings to AS 3688 Silver solder joints only.
- Flanges to AS 2129

- Use capillary fittings, silver brazed slip joints, or flanged joints.
- Use low temperature silver brazing alloy rods to AS 1167, classification B2 and oxyacetylene heating.
- Screwed joints to AS 3500.4.

Using a proper tool, soften and expand the pipe to form a slip joint of not less than the following lengths.

Nominal Pipe Size	Length of Slip Joint
15-20 mm	10 mm
25-32 mm	12 mm
40-65 mm	16 mm
80-100 mm	20 mm

8.32.10 Brass Tubes and Fittings

Brass tubes for sanitary plumbing lines to urinals and trade waste applications and any associated vent pipes to a minimum height of 300mm above the floor level shall be round section of 70/30 brass solid drawn, having an arsenic component, 1.6mm minimum wall thickness complying with AS 1572 – Copper and Copper Alloys – Seamless Tubes for Engineering Purposes and dimensionally with AS 1432 – Copper Tubes for Plumbing, Gas Fitting and Drainage Applications. Fittings shall comply with AS 1589 – Copper and Copper Alloy waste fittings and shall be dezincification resistant.

Jointing shall be by silver brazing with filler rods complying with AS 1167 – Welding and Brazing – Filler Metals and containing not less than 15% silver.

8.32.11 Unplasticised Polyvinyl Chloride Pipes (PVC-U)

8.32.11.1 Temporary Works – Below Ground Pipework

Omitted for clarity. Refer to Revision 7 of this specification for requirements relating to Temporary Works.

8.32.11.2 Temporary Works – Above Ground Pipework only

Omitted for clarity. Refer to Revision 7 of this specification for requirements relating to Temporary Works.

8.32.11.3 Permanent Works – All pipework Above and Below Ground

PVC-U pipes and fittings are not permitted for any of the permanent works (above or below ground).

8.32.12 Cast Iron Pipework

Cast iron pipes and fittings must comply with AS 1631 and to AS 1631, Table 1A with bituminous coating and lining to AS 1631, Clause 13.2. Epoxy coated for trade waste applications and Spigot and socket joints to AS 1646 with rubber joint rings.

Bolted gland joints to AS 1631 Clause 10.2 and Spigot end joints Gibault or other approved clamp type fittings and galvanised iron bolts.

8.32.13 Fibre Reinforced Cement Pipes and Fittings

Fibre Reinforced Cement (FRC) pipes and fittings for sanitary plumbing and stormwater drainage systems shall be manufactured and installed in with accordance with AS 4139 and shall be rubber ring jointed in accordance with the manufactures instructions.

8.32.14 Ductile iron Pipe and Fittings

Ductile iron pipes and fittings for water services shall be:

- Manufactured and installed in accordance with AS 2280, AS/NZS 2544 classed as
- Below ground class 9 or above ground class 10.

Jointed in accordance with manufactures instructions with flanges for above ground installations and rubber ring for below ground installations

8.32.15 Galvanised Mild Steel Piping And Fittings

Galvanised mild steel pipe shall be:

- In conformity with heavy grade AS 1074 – Steel Tubes and Tubulars for Ordinary Service
- Approved by Local Authority
- Galvanized in accordance with AS 4118.2.1 Fire Sprinkler Systems and AS 1650 Hot Dipped Galvanized Coatings on Ferrous Articles.
- Screw jointed with approved compound for the service or patented approved galvanized rolled grooved coupling.
- Polytec coated or wrapped with approved protective tape where located underground.

Galvanized malleable iron fittings shall:

- Conform with BS 1256
- Be hot dipped galvanized
- Be screw jointed with approved compound for the service or patented approved galvanized rolled grooved coupling.
- Polytec coated or wrapped with approved protective tape where located underground.

8.32.16 Stainless Steel Materials

Stainless steel sections shall:

- Conform to AS 1769 – Welded Stainless Steel Tubes for Plumbing Applications – for pipe sections.
- Conform to AS 1449 – Wrought Alloy Steels – Stainless and Heat Resisting Steel Plate Sheet and Strip – for fabricated sections.
- Grade 321 for flue pipes
- Grade 316 for special corrosive agents
- Grade 304 for general fabrication

Approved by Local Authority
Joints shall be lapped and Argon arc welded.

Compression fittings are only to be used on seamless stainless steel tubing.

8.32.17 PVC-U Pressure Pipes And Fittings

PVC-U pressure pipes and fittings for discharges shall be:

- Manufactured and installed in accordance with AS 1477 Parts 1-6 and AS 2032.
- Solvent-cement or rubber ring joints: To AS 2032.
- Pipe Classes:
  - Class 4.5 for a maximum working pressure of 0.45MPa (45m head approximately) at 20oC material temperature.
  - Class 6 for a maximum working pressure of 0.6 MPa (60m head approximately) at 20oC material temperature.
  - Class 9 for a maximum working pressure of 0.9 MPa (90m head approximately) at 20oC material temperature.
  - Class 12 for a maximum working pressure of 1.2MPa (120m head approximately) at 20oC material temperature.
  - Class 15 for a maximum working pressure of 1.5MPa (150m head approximately) at 20oC material temperature.
  - Class 18 for a maximum working pressure of 1.8MPa (180m head approximately) at 20oC material temperature.

8.32.18 PVC-U Pressure Pipe For Water Services

PVC-U pipe and fittings for water services are not permitted for the B2 level temporary and permanent works.

8.32.19 Cross Linked Polyethylene Pipe & Fittings (PE-X)

Cross linked polyethylene pipe and fittings (PE-X) are not permitted for hot and cold water services for the B2 level temporary and permanent works.

8.32.20 Polypropylene Pipe And Fittings (PE-HD)

PE-HD pipes and fittings for trade waste, greasy waste discharges shall be:

- Be in accordance with ISO 9001.
- Black injection moulded polypropylene pipes and fittings used for underground services are to be fusion welded and above ground pipes to be mechanical jointed.

8.32.21 Plastic Pipe – Gas Services

No gas services are to be installed for the temporary or permanent works.

8.32.22 Pre-Cast Reinforced Concrete Pipes

Pre-cast reinforced concrete pipes for stormwater systems shall be:

- Manufactured and installed in accordance with AS 4058 Class 'X' (2) and to be installed in accordance with AS 3725.
- Junctions and bends shall be made with pits.
- Use rubber ring joints in accordance with manufacturer's instructions conforming to AS 1646.

8.32.23 Materials For Sub-Soil Drainage

Pipework shall be either:

Sub-soil drainage to be laid on blue metal 20mm single size round or crushed aggregate conforming to AS 2758.1.

Geotextile fabric of mass not less than 150 gms per square metre.

8.32.24 Vitrified Clay Pipes & Fittings

Vitrified clay pipes and fittings for sewer systems shall be

- Manufactured and installed in accordance with AS 1741, Class Y.
- Shall be jointed with black sewer standard type rubber rings, complying with AS 1693 or 'HEPSLEEVE' type jointing process.

8.32.25 Access Chamber And Pit Construction

Construct pits, sumps, access chambers and the like to the dimensions and locations as shown on the drawings and as follows, unless otherwise specified.

- Access chambers, pits and sumps shall be precast concrete where scheduled, cast in-situ structures shall be made on site.
- Floors and Walls in situ concrete: 20MPa unreinforced unless otherwise shown. Thickness not less than 100mm, unless otherwise shown or specified.
- Walls of square of rectangular pits not more than 1500mm deep may be brickwork 230m thick in cement mortar, rendered instead of unreinforced concrete.
- Walls of spun precast sections not less than 60mm thick. Floor cast in situ or prefabricated. Provide cored holes as required.
- Finish to exposed surfaces to be smooth, equal to steel trowelled render or concrete cast in steel forms. Cove of splay internal corners. Bench floors and fall to drain.
- Render (If required): 1 cement:3 sand minimum thickness 20mm.
- Reinforcement: If depth of pit exceeds 1500mm: F718 mesh to AS 1304 in floor, and in walls from depth 1200mm downward. Cover 50mm from inner face of walls and lower face of floor. Place main wires in walls horizontally.
- Ladders to AS 1657 stile type to clause 5.7 or individual rung type to clause 5.8 as applicable. Provide ladder to pits deeper than one metre, cast or built into the pit walls clear of drain outlet openings or discharges.
- Rungs of mild steel rod, galvanized to AS 1650, 450mm wide.
- Rung spacing to be 300mm maximum, 250mm minimum with bottom rung not more than 450mm from the floor and top rung not more than 450mm below surface level.
- Top level of cover or grating, including frame: in paved areas, flush with paving surface Gratings taking surface water run off: As necessary to receive the run off without ponding.
- Build inlet and outlet pipes into the pit walls during construction. In existing pits, make openings of the correct size and pack the joint around the pipe to the full thickness of the wall with 1:3 mortar.
- All access chambers, stormwater pits and grated sumps whether of the precast type or cast in situ shall have the entire base of each pit or sump benched with 4:2:1 concrete to form half pipe channels for straight through or branch flow. The benching shall have considerable slope from the structure walls to the half pipe channel. In all cases 50mm cross fall shall be provided at the pipe inverts across the structure.

8.32.26 Pit Covers

Provide each pit with a pit cover as shown on the drawings or scheduled, of a size appropriate to the pit.

Ductile iron covers shall be complete with frames with all edges machine fitted and have removable plastic lifting hole plugs. All covers and frames shall be set to the level of the finished surface levels and filled in with the same materials as used for the surrounding surface. Provide a brass edge trim around each cover situated inside the building.

8.32.27 Gratings For Sumps And Grated Drains

Refer to the Architectural Specification for gratings and grating drain specifications. The contractor shall supply and install the gratings.

8.32.28 Rainwater Outlets

Refer to the Architectural Specification for Rainwater outlet specifications. The contractor shall supply and install the outlets.

8.32.29 Vinyl Floor Wastes

Install where required in vinyl areas as specified in the Architectural Specification.

8.32.30 Bucket Trap Drainage Wastes

Supply and install where indicated on the hydraulic services drawings bucket floor wastes with grate suitable for specified floor finish and with secondary strainer. Bucket traps to be SPS model R150SR-BT 316 with Stainless Steel Grate or Square finish Q150SR-BT 316 with Stainless Steel Grate or equal and approved.

8.32.31 Garbage Floor Wastes

Supply and install where indicated on hydraulic services drawings to the Garbage Room SPS model Q225 ABA, the grate to be in Aluminium Bronze or (316 Stainless Steel) or equal and approved.

Provide 100 diameter “P” trap under the floor wastes and connect to the sanitary system with secondary strainer.

8.32.32 Plant Room Floor Wastes

Provide and install where indicated on the hydraulic services drawings for the Plant Room SPS model TIA 100F3 with galvanised ductile iron grates on 100 diameter outlet body or equal and approved.

Provide a 100 diameter “P” trap under each outlet.

8.32.33 Stainless Steel Trough And Gratings

Provide and install stainless steel trough and grate system with minimum of 1% grade to the 100mm diameter outlet. All joints to be stainless steel welded and troughs manufactured from 1mm thick material. The design shall incorporate a built-in safe-tray system.

Provide and install non-slip trench grating to troughs to the duty as required.

Material: 304 Grade Stainless Steel

Provide security bolting of grates at each section.

8.32.34 Disconnector Traps

Provide disconnector traps (including gully traps and boundary traps) of the same material as the pipework.

Covers: Gully traps: Ductile iron grating

Boundary traps: Sealed inspection cover

8.32.35 Valve Boxes

Provide ductile iron valve boxes with removable covers for access to underground valves.
Set beneath each box a shaft formed of pipe to give clear access to the valve wheel or spindle. Set top flush with pavement surface, or 15mm above unpaved surfaces and encase in formed concrete 150mm deep and 150mm wide to sides of box with top surface trowelled smooth.

8.32.36 Access Pits

House, stop valves, control valves and the like if installed below ground in concrete access pits with removable pit covers.

Internal Dimensions to give 300mm clear space below and on all sides of the fittings in the pit.

Sides and Floors 20 MPa concrete, 100mm thick, reinforced with F82 fabric to AS 1304.

Grade floor to a point on one side and connect to the stormwater drainage system in 100mm vitrified clay pipe. Carry the pit walls up to 50mm above finished ground level. Cast in the pit cover frame flush with the top. Trowel the top smooth.

8.32.37 Wall Boxes

Provide wall boxes to accommodate above ground valves, regulators and the like.

1.2mm galvanized steel plate continuous welded box construction with leading edge twice folded at 90o to form 25 x 25mm frontal surround.

Fix to masonry backing with four 10mm galvanised masonry bolts.

The bottom of the box shall fall outwards. Form four 20mm diameter holes in the frontal surround section at box floor level.

8.32.38 Reflux Valves

Provide ductile iron reflux valves for stormwater and sanitary drainage. Manufactured and testing to AS 3718 and AS 3578.

Install within a pit where positioned underground, to the requirements for access pits in this specification.

8.32.39 Flanges

Flanges shall:

- Conform with AS 2129 Table E
- Be brass for copper tube
- Be hot dipped galvanized mild steel for galvanized mild steel tube.
- Be jointed with 6mm thick reinforced rubber insertion.
- Use gunmetal bolts with a tensile strength of 500 MPa on brass flanges.
- Use galvanized steel bolts in accordance with AS 2451 on ductile iron and steel flanges.

- Bolts and nuts below ground shall be insulated with PVC-U washers and sleeve and the pipe protected with Denso Primer and Tape for two metres either side of the flange as specified.

8.32.40 Fittings Generally

Provide the necessary fittings for the proper functioning of the hydraulic service, including taps, valves, pressure and temperature control devices, strainers, gauges, automatic controls, alarms and the like to the following standards unless otherwise specified:

- Safety valves generally (including relief valves): To AS 1271
- Pressure and temperature relief valves for storage water heaters: To AS 1357.
- Pressure reducing, pressure limiting and pressure ration valves for storage water heaters: To AS1357.
- Non-return devices for water storage heaters: To AS 1357.
- Vacuum relief valves for storage water heaters: To AS 1357.
- Air release valves to AS 1271.
- Water hammer devices to be 15mm stainless steel. Installed on all cold water supplies to each amenities room, etc.
- Thermostats and energy regulators generally: To AS/NZS 3161.
- Thermostats and over-temperature energy cut-outs for electric water heaters: To AS 1308, adjustable or fixed settings as required.
- Water gauges to AS 1271.
- Mark each fitting in accordance with the relevant standard.

8.32.41 Valves: General

Valves shall be placed in easily accessible position for operation and repairs.

Approved type of valves only shall be used. The Contractor shall provide a selection of suitable valves for approval by the Engineer.

Control valves shall be of the loose jumper valve pattern unless indicated otherwise.

All valves 65mm and over shall be flanged. All other valves shall be screwed. Screwed valves shall be provided with unions to facilitate maintenance removal. Valves up to 65 mm shall be all bronze. Valves 80 mm and over may be ductile iron with DR bronze trim. The spindles for gate valves shall be non-rising type and must not project into the bore of the valve when the valve is in full open position. The bore must be clear and unobstructed in this position.

The internal seats and washers of valves must be cleaned of all foreign material during installation. Any valve faces or seats found damaged on completion of the installation shall be replaced.

Stopcocks shall be used generally for domestic cold water services, gate valves for hot services.

Valves with the exception of built-in recess cocks shall not be directly silver soldered in to pipe lines.

All valves shall be suitable for the system pressure or test pressure together with shock loadings imposed by check valve closure.

Check valves shall be approved by the Local Authority, manufactured and tested to AS 3718 and AS 1628. All check valves are to have non-water hammer characteristics incorporating spring loaded bronze valve seat, installed in the horizontal position only.

Install valves with spindles in a vertical position where practicable.

Conceal valves wherever possible in ducts or non-habitable enclosed spaces provided that they shall in any case be accessible. Valves installed in ducts shall be positioned at 600mm above finished floor level.

Valves in Visible Positions: Match finish to that of adjoining visible pipework.

Sluice Valves to be installed on all incoming water, fire hydrant and sprinkler services. Provide and locate flanged valves in underground valve box to comply with AS 2638.

Where valves are located in service ducts or other enclosed space, provide access openings approximately 300mm square in the structural elements and cover with removable cover plates.

Install valves to control and cut off gas flow in gas lines to AS 5601, Clause 2.6.2 and to approval list AG 201 of AGA and ALPGA 'Approved Appliances and Components'.

Reduction valves, pressure limiting valves, or ration valves to produce the specified reduction in pressure. Prior to installation obtain a guarantee from the manufacturer stating the reduction in pressure and flow rates obtained under test conditions.

Provide isolating valves on each branch line from the main service lines of all hydraulic services to isolate all connected equipment, including hot water units, amenities, fixtures and elsewhere as shown on the drawings. Stop valves shall be loose jumper type fitted with 'O' ring seals to the spindle, manufactured and tested to AS 3718 and AS 1718.

Install globe valves on hot water reticulation systems to AS 1357.2 and as indicated on drawings. Fit with unions on each side of valve for easy maintenance and removal.

Balancing Valves to be installed on all hot water return lines as indicated on drawings to comply with AS 1357.2. Valves 50mm and under series STAT for valves 65mm to 100mm series STAF. Valves to be installed with unions for easy maintenance and removal. Valves shall be suitable for water temperatures not exceeding 99oC and pressures not exceeding 1600 kPa.

Ratio Valves shall be hand wheel operation, ductile iron rubber lined diaphragm valves installed to the discharge side of the sub-soil and sewage drainage pumps.

Hot Water Tempering Valves to comply with the performance requirements of AS 1357.2 and installed in accordance with AS 3500.4. Tempering valves to be adjustable between 35^{o}C – 55^{o}C.

8.32.42 Gate Valves

Gate valves up to and including 80 mm diameter shall be

- Manufactured of DR brass, having a solid wedge, inside screw and non-rising stem.
- Handwheel baked epoxy enamel coated aluminium alloy on all sizes, secured by brass handwheel nut.
- Gland to be machined from brass bar; of generous length for adjustment of packing as required
- matching piece machined from DR brass bar: ample depth of thread for amp adjustment of gland
- Ceramic cord packing
- Stem machined from DR brass bar; smoothly finished Acme form actuating thread to fit wedge.

NOTE: All bronze gate valves shall conform to Australian Standard AS 1628, having DR stamped on the valve body to indicate that they are de-zinc resistant.

Gate valves over 80mm diameter shall be flanged and constructed of ductile iron with the following:

- Cast iron handwheel
- DR Bronze wheel

- Cast iron stuffing box
- DR Brass stem
- Cast iron bonnet
- DR Bronze wedge nut
- DR Bronze wedge facing ring and wedge
- DR Bronze body seat ring
- Cast iron body.

Valves

LOCATION	SIZE	TYPE	MATERIAL	CONNECTIONS
All locations	Less than 80mm	Full bore gate	Copper alloy	Screwed
Above ground and in pits	Less than 80mm	Full bore gate	Copper alloy	Screwed
Above ground and in pits	80mm or larger gate, or	Full bore sluice	Ductile iron	Flanged
LOCATION	SIZE	TYPE	MATERIAL	CONNECTIONS
All locations	65mm	Full bore	Brass with brass cap	Screwed

8.32.43 Stop Valves

Stop valves up to and including 50 mm diameter shall conform in all respects to the requirements of the local water authority.

Stop valves shall be connected to the pipework by means of screwing connections; silver soldering or brazing of cocks or valves directly to copper pipes will not be permitted.

Stop valves shall have loose jumpers; replaceable washers and seats 'O' ring seals in preference to packed glands and shall be clearly marked to show the direction of flow.

Over 50 mm (Including Globe Valves): These valves shall be constructed of DR bronze and shall have a stem machined from cast bronze rod to BSLG4. They shall be provided with a replaceable stainless steel valve and seat hand wheels are to be fibre filled plastic.

8.32.44 Non-Return Check Valves

Construction of valves shall be as specified for valves generally, Check valves shall be horizontal pattern with non water hammer characteristics incorporating a spring loaded bronze valve seat. The body shall be globe shaped and designed to give a clear passage equal in area to that of the pipe to which it is to be connected. The body is to be fitted with a screw hexagon headed inspection cap or cover and a flow direction arrow cast on raise metal on one side.

8.32.45 Flow Control Valves

Supply and install to all tapsets, flow control valves similar to those manufactured by “JEM FLO” or approved equal.

Each flow valve shall incorporate a spring loaded non-return valve and shall control flow in the cold and hot water lines to achieve

- 9 litres per minute for showers
- 4.5 litres per minute for basins
- 7.5 litres per minute for sinks

- 4.5 litres per minute for WC cisterns.

Furnish and install to each hot and cold faucet a flow regulated water management system.

The constant flow regulators shall automatically adjust to pressure variation in the hot and cold water systems. The maximum tolerance to the flow rate shall be 10%.

The installation of the constant flow regulators must be carried out by our approved installers and a written guarantee for 24 months shall be provided at the completion of the work.

The installation of hot and cold faucets flow rates must be balanced to suit a 50% - 40% hot and cold water mix to eliminate temperature fluctuations and maintain a shower balance of no more than 1oC variation.

8.32.46 Thermostatic Mixing Valves

Water temperature regulated by a single hand control and capable of delivering water at the temperature of either of the supply systems and at any temperature in between and suitable for controlling single or multiple outlets, as appropriate, to comply to AS 4032 and AS/NZS 3500.

The valve shall be approved and be equal to Heatguard TMV3-8 2 in 1 (Reliance Water Controls) thermostatic mixing valve or equal and approved, in a lockable stainless steel cabinet or approved equal unless located in the undercroft. The installation shall be complete with isolation valves, check valves, unions, temperature test point etc., as required for a complete installation.

Controls: incorporate the following:

- A temperature sensitive automatic control which maintains temperature at the pre-selected setting and rapidly shuts down the flow if either supply system fails, or if the normal discharge water temperature is exceeded.
- Hot water flush facility.

The temperature must be set at 43.5ºC for all amenities so that they are suitable for people with disabilities personal and at 50ºC in all other cases.

The use of tempering valves will not be allowed.

At completion a complete service log sheet for each valve and a certificate of the whole installation must be submitted to the ER.

Servicing and maintenance to be performed for a period of 12 months from the date of installation.

8.32.47 'Y' Strainer

Strainers shall be installed after the water meter and on each branch line with a flow control valve, solenoid or thermostatic mixing valve.

Strainers are to be capable of arresting particles larger than 1.2mm having a mesh surface area of not less than four (4) times that of the pipe.

Check valve and control valve before each strainer. Fit each strainer with valve and drain line to facilitate east of maintenance.

8.32.48 Unions

Unions shall be three (3) piece brass, bull nose taper type unions. Brass and nylon olive type connections shall not be used under any circumstances. Unions shall be located on the outlet side of all valves.

8.32.49 Backflow Prevention

Supply and install backflow prevention devices to all water supplies serving fixtures with possible cross connection hazard to conform with AS 3500.1 Section 4 and AS 2845 Parts 1 to 3.

Water supply to the mechanical plantrooms is to incorporate reduced pressure zone devices (RPZD's). RPZD's are to be supplied and installed complete with resilient seated isolation valves immediately upstream and downstream of the device. All pipework to be flushed clean prior to installation of RPZD.

All fire hose reels that are to be supplied with water from the metered domestic service shall have a testable double check valve installed on the water supply prior to the hose reel as required by AS3500 Part 1.2. The double check valve shall be supplied and installed complete with resilient seated isolation valves immediately upstream and downstream of the device.

Provide three (3) copies of the certification certificates for the backflow prevention devices installed to enable them to be included into the maintenance manuals.

Provide details of all cross connections and register the same with the local water authority.

Commission all backflow devices prior to practical completion. Internal devices to be housed in a purpose made stainless steel cabinet with exposed related tundishes to be chrome plated.

8.32.50 Tundish

Tundish shall be constructed of 1.6mm thick copper. Where exposed to view, tundish shall be chrome plated except in plantroom and ceiling space areas.

8.32.51 Safe Trays

Supply and install safe trays constructed of 1.8mm sheet copper to AS 1566. Joints shall have soldered edges, be reinforced and turned up 50mm. A 50mm outlet shall be fitted. Also provide hardwood separation spacers to prevent galvanic corrosion.

8.32.52 Gauges / Thermometers

Pressure gauges shall be installed on the suction and discharge sides of all pump sets and equal to those manufactured by Shearer Wright, be a minimum of 100mm diameter and be graduated in metres head and kilopascals of bronze construction mid pointing and activated by a double spring. Each gauge shall be complete with an approved gunmetal stop cock under the gauge and connected to the pipework, in accordance with CB 0 Code for pump tests.

Provide adjacent to the hot water flow and return lines vapour pressure type thermometers with a range of 10°C to 120°C.

Fix each thermometer head to a 150 x 25mm pre-painted timber panel in a position adjacent to the equipment served and easily visible for the balancing of the system.

Provide on the upstream side of each balancing valve a thermometer well having an internal bore of not less than 16mm and inserted in a section of pipe having a free flow area of not less than the line being served.

8.32.53 Jointing Materials

Rubber Ring Gaskets for spigots and socket joints on CI pipes shall be moulded on the type recommended by the pipe manufacturer for the joint to be used. This shall be sufficiently durable to last the life of the pipe without leaking under the proposed conditions of usage.

Lubricant for lubricating the rubber ring gasket and the outside surface of the spigot end of the pipe shall be of an approved non-toxic vegetable base type and shall be applied in accordance with the manufacturer's instructions.

Bolts and Nuts shall conform to Australian Standards AS 1110 and AS 1112 and shall be 316 stainless steel where pipes are buried, or hot dipped galvanised where above ground.

Where flanged joints are to be made between copper pipes and ductile iron pipes or fittings, high tensile brass bolts and nuts conforming dimensionally to the above standards shall be used. The high tensile brass shall have an ultimate tensile strength of at least 460 MPa.

Rubber insertion for flanged joints shall be of approved quality and sufficiently durable to last the life of the pipe without leaking.

Cement Mortar for pipe jointing shall be proportioned accurately by volume and mixed thoroughly with water as directed by the ER Mortar shall be used fresh and in proportion of one (1) part cement to two (2) parts sand.

Unplasticised Polyvinyl Chloride (PVC-U) pipes shall be jointed by solvent-welding of the type recommended by the manufacturer. Clean joint with approved solvent cleaning fluid. Apply liberally an even layer of the approved solvent cement to both surfaces of the joint and allow to stand to become touch dry. Apply a second coat to both surfaces of the joint and push together. Remove surplus solvent with a clean, dry cloth complying with AS/NZS 3879.

Silicone sealant shall be self-polishing with anti-fungicide addictive equal to Ciba-Geigy manufacture and used as recommended by the manufacturer. White shall be used around vitreous china sanitary ware and clear for seal under fixture taps and stainless steel.

Silver Brazing: Joints in copper tubes and brass pipe shall be made with copper phosphorous brazing alloy complying with the requirements of Australian Standard 1167 - 1971 Table 2 Copper Phosphorous brazing alloy, alloy designation B4 having a silver content between not less than 14.5% and 15.5% and the remainder being phosphorous between 4.5% and 5.5% with a melting range of 645 deg. C Solidus and 700 deg. C Liquidus.

The tip colour identification shall be AS K185 (or BS 381 C) Brown.

Soft solder joint will NOT be acceptable.

Hemp is NOT acceptable as a joint sealant

8.32.54 Piping Insulation

Hot water supply pipes are to be insulated in accordance with the requirements of Section 8 of AS/NZS3500.4. Cold water supply lines are to be insulated in accordance with the requirements of Section 5 of AS/NZS3500.1.

For insulated piping, completely cover the pipe with insulation fitted tightly to the pipe surface and secured with wires, straps, adhesive, adhesive tape or other appropriate means. If insulation is installed in sections, butt the joints closely together without gaps. Over connection unions and couplers, install the insulation so that it is readily removable.

Fittings: Provide insulation of thermal resistance equivalent to the piping.

Hot water, Warm water, Cold water in air conditioned plenums etc., and hydronic heating pipelines wherever they are installed throughout the building shall be insulated with Thermotec 4-zero [or equal approved such as Armstrong FR or Tontine], insulation in one (1) metre lengths. The insulation shall be a minimum 20mm thick in internal locations and a minimum 40mm thick in external locations. It is noted that to achieve 40mm thickness it may be necessary to install multiple layers of insulation. Locations where insulation is required include:

1. Hot water;
2. Warm water;
3. Hot, cold and warm water piping in walls;
4. Cold water under 50mm-diameter located external to the building;
5. Cold water under 50mm-diameter located in basement carparks or in roof and plantroom spaces;
6. Cold water under 50mm-diameter located in locations near windows, ventilators or external doors; and
7. Cold water under 50mm-diameter located in locations in contact with cold surfaces such as metal roofs, metal framework, or external metal cladding materials.

"Thermotec 4 Zero" insulation shall be covered with reinforced aluminium foil incorporating an overlap. Provide and fix to longitudinal joints and circumferential butt joints 75mm wide, self-adhesive reinforced aluminium tape.

Metal sheathing location: Insulated piping in plantrooms, external locations and where exposed to view.

Cover piping with metal sheathing sprung over the insulation in one piece with laps at least 30mm wide, and fastened with self tapping screws or snap head rivets at 150mm maximum centres. Preform the sheathing to match the shape of the insulated pipe and fittings. Position laps to avoid water penetration. In external locations weatherproof the joints and fixings using a non-setting mastic.

Material: 0.5mm thick zinc-coated steel sheet.

Hot water and Cold water copper pipework within stud wall framing, chased in masonry or concrete walls shall be hard drawn pre-lagged type similar to 'KEMLAG" or equal and approved.

Clean the surfaces to remove scale, rust, grease and dirt and prepare surfaces to suit the insulation. Restore surface coatings, which have been damaged or affected by welding.

Do not install insulation until the piping has been tested.

Identification markers to be added after insulation has been completed.

Provide pipe supports formed to fit around the insulation.

Protection for pipes larger than DN25 either

a. protect the insulation at the support point with metal sheathing; or
b. replace the insulation at the support point with a shaped wooden spacer block. Butt the insulation up to the wooden block and seal with silicone compound. Clad the block and insulation in 0.5mm zinc-coated steel sheet extending 100 mm each side of the support.

8.32.55 Expansion Joints

Supply and install approved expansion joints to all copper and PVC-U soil, waste, relief and main vent lines. Expansion joints in copper tube and PVC for all vent lines, drainage lines, hot water flow and return lines, cold water lines, gas lines etc., shall be installed on each line at intervals not exceeding 3000mm on both vertical and horizontal pipelines and on either side of building expansion joints.

8.32.56 Water Hammer

To all applicable services as previously described, necessary precautions are to be observed to prevent the possibility of water hammer. Any occurrence of this condition shall be rectified at no extra cost.

Special care shall be taken to avoid transmission of vibration using anti-vibration inserts and special purpose support brackets and frames to isolate the pipes as required.

Should dust, noise or vibration be caused and is such as to constitute an annoyance to occupants of any such areas, the Contractor will be required to take such corrective action as is necessary, and incur any cost involved.

8.33 SANITARY DRAINAGE

8.33.1 Generally

Supply, install, test and commission all sanitary drainage from soil and wastes and fixtures to the sanitary drainage provisional connection point provided by the Civil Contractor. Provide all necessary pipes, junctions, bends, pits, floor wastes, excavation, supports, backfilling, testing and sundry equipment required for the installation. Pipeline positions shall be determined on site in conjunction with all other disciplines to ensure adequate coordination of all services and elements. Coordination shall be carried out prior to any setting out, excavation and pipe installation taking place.

Execute the works, using only materials and structures as approved by the local authority and to the satisfaction of the ER.

8.33.2 Sanitary Drainage Connection

Make the connection to the sanitary drainage point in an approved manner and to local inspector's requirements.

Ascertain the depth, position and suitability of the sanitary connection points prior to the commencement of any work and incorporate any adjustments required to execute the work. No claims for redundant work will be considered due to failure to comply with this requirement. Make connection to the existing sanitary drainage connection.

8.33.3 Materials

Pipework materials shall be as follows:

- Above ground — PVC-U DWV grade (temporary works only)
- Greasy waste or trade waste — HDPE or Vitrified Clay
- Laboratory / chemical drains — Vulcathene
- Below ground — HDPE
- Below contaminated / corrosive ground — Vitrified Clay

8.33.4 Excavation

Carry out all necessary excavation as specified under "Excavation & Pipework Requirements" section.

8.33.5 Backfilling

Supply all necessary material and carry out backfilling as specified under "Excavation & Pipework Requirements" section.

8.33.6 Gradients

Pipelines shall be laid true to line and bore from point to point.

Unless otherwise indicated on the drawings pipelines shall be graded in accordance with the Authorities requirements and as specified under "Excavation & Pipework Requirements" section.

8.33.7 Filled Ground

Where indicated on the drawings and/or encountered on site pipelines shall be supported as directed and as previously specified under “Excavation & Pipework Requirements” section.

8.33.8 Overflow Gully

Supply and install an overflow gully to provide a safe release from the connection point. Gully shall be constructed of 100mm diameter “P” trap and 100mm riser. Top of riser shall incorporate 200mm cast iron grate with concrete surround. Terminate gully top to comply with current authorities’ regulations.

8.33.9 Testing

Provide a hydrostatic test to choke level for a minimum period of 15 minutes and as required by the testing authority and the ER and as specified under “Preliminaries” section.

8.33.10 Access / Inspection Pits

Supply and install inspection pits at changes of direction. Pits to be reinforced concrete of appropriate dimensions to Code with depths to match invert levels of pipeline and as specified in “Materials” section.

Pits, covers and frames shall be as specified under “Materials” section.

8.33.11 Clear Outs

Provide and install clear-out inspection fittings to provide rodding access to all lines.

Riser from pipeline shall extend vertically to finished floor level and terminate with a brass screw out and frame.

8.33.12 Pipe Laying

Carry out necessary pipe laying as specified in “Excavation & Pipework Requirements” section.

8.33.13 Concrete Encasing

Carry out all necessary concrete encasing as specified in “Excavation & Pipework Requirements” section.

8.33.14 Reflux Valves

Supply and install all reflux valves in the locations indicated or as required by the local sewer authority and as specified in the “Materials” section.

8.33.15 Floor wastes

Supply and install floor wastes in locations as indicated on the drawings or as required by the local sewer authority and as specified.

8.33.16 Bucket traps

Supply and install all bucket traps in the locations indicated on drawings or as required by the local sewer authority and as specified in the “Materials” section.

8.33.17 Acoustic treatment

Allow to acoustically treat all sanitary drainage, stacks and downpipes installed within ducts and ceiling space where located above habitable areas.

Acoustic treatment of PVC-U and Copper Waste Water Pipe shall be a lagging material consisting of a 4kg limp barrier, faced with lightweight Aluminium Foil, and a laminate of 25mm thick (minimum) acoustic grade, hydrolysis resistant foam.

Acoustic wrapping is to be “Acou-Stop” ABW4-25 or equal and approved.

Install in strict accordance with manufacturers recommendations and specifications.

Installation to the pipe shall ensure at all times a tight butt join of the foam and a minimum limp barrier overlap of 20mm.

8.34 STORMWATER DRAINAGE AND DOWNPIPES

8.34.1 Generally

Supply, install, test and commission all storm water drainage to the storm water connection interface with the Civil Contractors work. Provide all necessary pipes, junctions, bends, pits, floor drains, excavation, supports, backfilling, testing and sundry equipment required for the installation. Pipeline positions shall be determined on site in conjunction with all other disciplines to ensure adequate coordination of all services and elements. Coordination shall be carried out prior to any setting out, excavation and pipe installation taking place.

Execute the works, using only materials and structures as approved by the local authority and to the satisfaction of the ER.

8.34.2 Storm water Connection

Make the connection to the Civil Contractors storm water work in an approved manner and to site engineers and local Authorities requirements.

Ascertain the depth, position and suitability of the storm water connection points prior to the commencement of any work and incorporate any adjustments required to execute the work. No claims for redundant work will be considered due to failure to comply with this requirement.

8.34.3 Materials

Pipes and fittings for storm water drainage shall be of vitrified clay sewer grade up to 255mm and precast concrete or fibre reinforced cement pipe over 225mm as specified under “Materials” section.

Refer to Section 6.2 “In-ground Pipework” materials for this site.

8.34.4 Excavation

Carry out all necessary excavation as specified under “Excavation & Pipework Requirements” section.

8.34.5 Back-Filling

Supply all necessary material and carry out back-filling as specified under “Excavation & Pipework Requirements” section.

8.34.6 Gradients

Pipelines shall be laid true to line and bore from point to point.

Unless otherwise indicated on the drawings pipelines shall be graded in accordance with the Authorities requirements and as specified under “Excavation & Pipework Requirements” section.

8.34.7 Filled Ground

Where indicated on the drawings and/or encountered on site pipelines shall be supported as directed and as previously specified under “Excavation & Pipework Requirements” section.

8.34.8 Testing

Provide a hydrostatic test to choke level for a minimum period of 15 minutes and as required by the testing authority and the ER and as specified under “Preliminaries” section.

8.34.9 Access / Inspection Pits

Supply and install inspection pits at changes of direction. Pits to be reinforced concrete of appropriate dimensions to Code with depths to match invert levels of pipeline and as specified in “Materials” section.

Pits, covers and frames shall be as specified under “Materials” section.

8.34.10 Gratings

Supply and install all pit gratings as specified in “Materials” section.

8.34.11 Pipe Laying

Carry out necessary pipe laying as specified in “Excavation & Pipework Requirements” section.

8.34.12 Concrete Encasing

Carry out all necessary concrete encasing as specified in “Excavation & Pipework Requirements” section.

8.34.13 Sub Soil Drains

Provide subsoil drains to intercept groundwater seepage and prevent water build-up behind walls and under floors, pavements and landscape beds. Connect subsoil drains to surface drains or to the storm water drainage system as applicable.

Follow the minimum clear depths, measured to the crown of the pipe, where the pipe passes below the following elements:

- 100mm below formation level of the pavement, kerb or channel
- 100mm below the average gradient of the bottom of footings.
- Below the finished surface of unpaved ground, levels as indicated on drawings.
- At junctions of subsoil pipes provide tees, couplings or adaptors to AS 2439.1.

Minimum trench width to be 450 mm.

Grade the trench floor evenly to the gradient of the pipeline. If the trench floor is rock, correct any irregularities with compacted bedding material. Bed piping on a continuous underlay of bedding material, at least 75 mm thick after compaction. Lay the pipe with one line of perforations at the bottom.

If necessary, form chases to prevent projections such as sockets and flanges from bearing on the trench bottom or underlay.

Place the material in the pipe surround in layers # 200 mm loose thickness, and compact without damaging or displacing the piping.

Depth of overlay:

- To the underside of the bases of overlying structures such as pavements, slabs and channels.
- To within 150 mm of the finished surface of unpaved or landscaped areas.

Provide polymeric fabric formed from plastic yarn composed of at least 85% by weight propylene, ethylene, amide or vinyledenechloride, and containing stabilisers or inhibitors which provide resistance to deterioration due to ultraviolet light.

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

Provide polyester permeable filter socks capable of retaining particles of 0.25 mm size. Securely fit or join the sock at each joint.

Subsoil pipeline schedule

Sub Soil Drainage

Location	Pipe size (nominal)	Pipe type
General	100	Slotted rigid PVC-U
General	150	Slotted rigid PVC-U

8.34.14 Pits

Provide a smooth, seamless finish, using steel trowelled render or concrete cast in steel forms and as specified in the "Materials" section.

Cove or splay internal corners with metal access covers and grates to AS3996.

The top of cover or grate, including frame in paved areas shall be flush with the paving surface.

In landscaped areas 25 mm above finished surface and Gratings taking surface water runoff located to receive runoff without ponding.

Pit Cover Schedule

Pit Schedule			
Pit Type	Size mm	Cover Type	Remarks
Inlet Pits	450 x 450	Grated	Base of pits to be benched to suit pipe
Inlet Pits	600 x 600	Grated	Base of pits to be benched to suit pipe
Access /Inlet pits	900 x 900 with	600x600 grate	Base of pits to be benched to suit pipe

8.34.15 Sub-Soil / Stormwater Pumps

Supply and install sub-soil/stormwater pumps as specified in "Pumping" section.

8.34.16 Roof outlets

Install roof and balcony drainage outlets in the positions indicated on the drawings and as scheduled by the Architect. Refer to the Architects Specification for details.

Outlets must be installed in accordance with manufacturer's instructions and requirements.

Support each sump during construction with wire ties, set level both ways, to suit roof falls.

8.34.17 Drainage Turn Ups (D.T.U.)

Install drainage turn up in spoon drains by terminating pipe collar at the invert of the spoon drain. Cast iron grates are only required if specifically noted on the drawings.

Encase drainage turn up riser in 150mm thickness concrete surround.

8.34.18 Acoustic treatment

Allow to acoustically treat all suspended stormwater plumbing and downpipes installed within ducts and ceiling space where located above habitable areas.

Acoustic treatment of PVC-U and Steel Pipe shall be a lagging material consisting of a 4kg limp barrier, faced with lightweight Aluminium Foil, and a laminate of 25mm thick (minimum) acoustic grade, hydrolysis resistant foam.

Acoustic wrapping is to be “Acou-Stop” ABW4-25 or equal and approved.

Install in strict accordance with manufacturers recommendations and specifications.

Installation to the pipe shall ensure at all times a tight butt join of the foam and a minimum limp barrier overlap of 20mm.

All joins are to be taped with a 48mm wide aluminium tape such as PPC 493 reinforced tape.

8.35 SANITARY PLUMBING

8.35.1 Scope of work

Sanitary plumbing works above ground shall include all those works generally considered by authorities and trade practice to be soil, waste, vent above ground as distinct from drainer's work.

Plumbing as defined in this Section shall comprise the following: -

Sanitary Plumbing waste, condensate and vent pipes above ground.

8.35.2 Description of Work

Sanitary Plumbing shall be the connection of the above floor fixtures and vents to the drainage system.

The Hydraulic Contractor shall provide for protection of all fittings and pipework after installation and secure them against damage and shall be completely responsible for the replacement of any damaged or disfigured fitting, pipe or fixture at his own cost.

8.35.3 Material Schedule

Materials for Sanitary Plumbing

Description	Size	Material
Sanitary Plumbing	40 – 150	PVC-U DWV grade (Temporary works only)
Vents	50 – 100	PVC-U DWV grade (Temporary Works only)

Except as otherwise specified or directed, all internal exposed piping adjacent to plumbing fixtures, including traps and fittings shall be chromium plated finished. Where passing through a finished wall, floor or ceiling, piping shall be fitted with approved chrome plated wall plates. Chrome plating to comply with AS1192 – Electroplated Coatings of Nickel and Chromium.

All other exposed piping shall be cleaned free of cement droppings and other debris.

All PVC-U/PE-HD pipes penetrating floor slabs, fire and smoke walls and any fire rated element shall be provided with an approved fire stop collar to match the required FRL.

8.35.4 Supporting and Fixing Pipes

All pipes shall be adequately supported and securely fixed in accordance with the drawings and to the satisfaction of the ER. Such supporting and fixing to be carried out without causing any distortion, damage or stress on the pipes or pipe joints. Pipes shall be supported at each collar and at spacing as specified in “Preliminaries” section.

8.35.5 Fixture Traps

75mm water seal traps shall be provided for the following fixtures:

- Sinks50 mm two part universal pattern.
- Basin 40 mm CP copper two part S or P-trap with 40 mm CP extension riser.

8.35.6 Vent Pipes

Terminate all vents through roof with an approved cowl. Finish vents 3 metres above ground level in trafficable areas, 300mm above roof level and 6 metres clear of openings and fresh air intakes as required by AS/NZS3500 and the local authority and as indicated on the drawings. Flashing of vents, which penetrate the roof, shall be carried out within the hydraulics scope of works.

8.35.7 Inspection Openings & Gates

Install inspection openings in accessible locations so that each section of pipework can be cleaned. Inspection opening sizes shall be in accordance with authorities’ requirements. Install bolted testing gates on all stacks at each floor level, at each stacks base and on all relief vents at each alternate floor.

8.35.8 Joints

All joints shall be in conformity with that specified under the relevant “Materials” clause.

8.35.9 Expansion Joints

Supply and install approved expansion joints to all copper and PVC-U soil, waste, relief and main vent lines. Expansion joints in copper tube and PVC shall be installed on each line at intervals not exceeding 3000mm on both vertical and horizontal pipelines and on either side of building expansion joints.

8.35.10 Branches

When a branch line enters a vertical pipe the branch fitting must be wholly outside the vertical pipe such that the internal bore of the pipe is maintained at all times. For vertical branches of up to and including 80mm a radius of at least 25mm must be maintained on the throat of the bend and a radius of 50mm for larger junctions.

All horizontal branches shall connect to the main branch line through a 45^o or sweep type junction.

8.35.11 Offsets

Use sweep bends of 300mm radius (or alternatively No 2 x 45^o bend), and provide maximum fall between bends.

8.35.12 Pan Collars

Unless otherwise noted all pan collars to soil type fixtures shall be of approved PVC materials and pattern. Collar shall incorporate an approved neoprene rubber ring joint.

8.35.13 Tundishes

Supply and install tundishes in areas required for mechanical drainage. Tundishes to be chrome plated where exposed and to comply with the “Materials” section.

8.35.14 Testing

Provide a hydrostatic test to maximum choke level to the satisfaction of the authority and the ER and to comply to “Preliminaries” section.

8.35.15 Fire stopping / fire stop collars

All pipes passing through any fire rated element shall be treated to achieve a Fire Resistance Rating (FRL) of not less than the fire rating of the element that the service is passing through. Where any non-metallic pipes (e.g. PE-HD, PVC-U, PE-X, PE, etc.) pass through any fire rated element they shall be surrounded by a sealant of intumescent material capable of completely sealing the pipe penetration under fire conditions.

The Hydraulics Contractor shall provide an independently approved certification of all systems and/or methods of treatment proposed provided prior to the ordering of any materials. Certification must be for the situation that is proposed to be used. Generic certifications will not be accepted.

The proposed fire rating systems offered by the Hydraulics Contractor shall comply with the requirements set down in BCA and shall be installed to achieve a Fire Resistance Rating (FRL) of not less than 120/120/120 for all non-service penetrations with insulation waived on all services penetrations except for service risers in accessible cupboards, storerooms and the like.

The Hydraulics Contractor shall provide an independently approved certification of all systems installed. The certification of the methods of treatment to be provided at the end of the project shall detail all penetrations and all openings treated in the building. A detailed schedule shall be provided giving the penetration number, location, services details if any, methods of treatment, the fire test report numbers and the fire resistance levels expected to be achieved.

The Hydraulics Contractor shall agree the proposed method of treatment with the independent fire integrity consultant prior to installing the treatment and shall install the agreed treatment system strictly in accordance with the approved test report. The proposed fire rated treatments shall be applied by a Contractor experienced in this type of work. All installed systems must comply with an approved test conducted in accordance with the requirements of AS1530 Part 4 and all applicable Building Codes and shall demonstrate that the method of treatment has achieved the specified FRL. All installed methods shall, at all times, allow for the thermal expansion of the services or structural elements.

Provide detailed drawings showing the location of all penetrations treated. The schedule and drawings are to be included in the Maintenance Manual.

The Hydraulics Contractor is referred to the Architectural Drawings for the fire rating of the walls and slabs.

All systems shall be installed in accordance with the requirements and regulations of all Authorities having jurisdiction over the project.

In addition, the installation shall comply with the latest edition of the relevant New Zealand Standard (including Amendments). These standards shall include but not be limited to:

- BCA — Building Consent Authority (BCA)
- ASNZS 1530 — Methods for Fire Tests on Building Material, Components and Structures
- ASNZS 4072 Part 1 — Components for the Protection of Openings in Fire Resistant Separating Elements Service Penetrations and Control Joints.

The Hydraulics Contractor shall arrange for all inspections required by the relevant authorities at suitable stages of the contract to enable the inspecting authority to ascertain that the treatment methods are being installed to their requirements and complies with the test reports.

These inspecting authorities shall include an independent fire integrity consultant. The Hydraulics Contractor shall submit the name of their proposed fire integrity consultant to the ER for approval. The costs associated with the fire integrity consultant shall be included as part of the tender price.

A copy of each of every inspection report of each Authority and the fire integrity consultant shall be forwarded to the ER immediately it is available.

8.35.16 Floor wastes

Use U trap with 100mm riser and 50mm or 65mm outlet of self-cleansing pattern.

Standard floor wastes grates in suspended slabs shall comprise CP brass screwed grate set at a level to ensure correct drainage of floor areas.

Floor waste / shower wastes installed in areas where vinyl flooring is to be installed are to be SPS Lo-Grime variable height type suitable for vinyl flooring and to have clamp ring. The Hydraulics Contractor is referred to the AFC issue of the Architectural Contract Drawings for information as to where vinyl flooring is proposed.

Each floor waste gully or shower waste gully is to have an inspection opening at its base.

Where located in showers, kitchens and similar frequently washed down areas provide a standard safe waste tray. Drill three 4mm diameter holes through riser above tray to drain seepage trapped by tray.

Floor wastes within cleaners store rooms are to be provided with a Grate seal to prevent foaming back through the grate.

8.35.17 Acoustic treatment

Allow to acoustically treat all suspended sanitary plumbing, stacks and downpipes installed within ducts and ceiling space where located above habitable areas.

Acoustic treatment of PVC-U and Copper Waste Water Pipe shall be a lagging material consisting of a 4kg limp barrier, faced with lightweight Aluminium Foil, and a laminate of 25mm thick (minimum) acoustic grade, hydrolysis resistant foam.

Acoustic wrapping is to be “Acou-Stop” ABW4-25 or equal and approved.

Install in strict accordance with manufacturers recommendations and specifications.

Installation to the pipe shall ensure at all times a tight butt join of the foam and a minimum limp barrier overlap of 20mm.

All joins are to be taped with a 48mm wide aluminium tape such as PPC 493 reinforced tape.

“S” trap and other difficult fittings shall be “boxed”, ensuring that overlaps are maintained on all joins.

“Boxing” should take place primarily and pipework then “lagged up” to them ensuring a snug fit.

8.36 DOMESTIC COLD WATER SERVICES

8.36.1 Generally

Supply, install, test and commission all domestic cold water pipes from the authority’s main to all fixtures, fittings and faucets requiring domestic cold water. Include for all pipework, bends, offsets, brackets, pumps, taps and outlets and sundry equipment required for the installation.

Pipe materials shall be as follows:

- Main runs and risers to branch isolation valves: Copper Type B
- Within toilet cores after branch isolation valves: Copper Type B
- All pipes within any wall: pre-lagged copper type B
- Between fixture valves and fixture stainless steel braided connectors
- Below ground “Insapipe” proprietary HDPE jacketed Polyurethane.

Except as otherwise specified or directed, all internal exposed piping adjacent to plumbing fixtures, including valves, taps and fittings shall be chromium plated finished. Where passing through a finished wall, floor or ceiling, piping shall be fitted with approved chrome plated wall plates. Chrome plating to comply with AS1192 – Electroplated Coatings of Nickel and Chromium.

All other exposed piping shall be cleaned free of cement droppings and other debris.

Negotiate with authority for the supply of all meters, take delivery from authority’s store and install on site, complete with all valves and fittings required.

8.36.2 Water Main Connection

Investigate, locate and connect to the existing town mains for the services as required and extend to the new reticulation.

Allow for a suitable and BMS compatible digital water meter and install water meter assembly complete with backflow prevention device in in tunnel in an approved manner and connected to the BMS.

8.36.3 Water Meters

All pulse water meters are to be suitable for connection to the BMS. Confirm proposed meter with the BMS supplier prior to order.

All meters are to have an on-board counting mechanism which provides an absolute count (rather than a pulse to an external device) that is then read remotely by the BMS.

Meters are to be provided that are able to generate a pulse for every 1L, 10L, 100L and 1000L.

The accuracy of each water meter is to be validated to within 2.5% accuracy.

8.36.4 Valves (In-Line)

To pipelines supplying cold water to each group of fixtures, supply and install valves for the purpose of shutting down the system for isolation and maintenance purposes as specified in “Materials” section. Locate valves behind access panels or within accessible ducts. Valves located in ground shall be provided with CI path box and lid set into concrete surround with pipe riser around valve stem as specified in “Materials” section.

8.36.5 Connection To Fixtures

Provide unions at wall or floor surface and at fixtures and appliances to allow removal and replacement without the need to adjust connections.

8.36.6 Thrust Blocks Anchor Points

To all changes of direction on rubber ring jointed pipelines below ground install concrete thrust blocks to restrain the internal operating pressures of the pipeline under all conditions. Concrete mass shall be poured around and behind fittings and bear against virgin soil material. A minimum of 0.75 cubic metres of concrete shall be used at each position.

8.36.7 Testing

Provide a water pressure test of 1500 kPa for a period of two hours. Disconnect any equipment connect to the service not rated to the test pressure, before testing commences and to conform to the "Preliminaries" section.

8.36.8 Taps And Faucets

Supply and fix the taps and faucets specified in the "Sanitary Fixtures & Fittings and Tapware" section or as selected by the Architect or ER. Unless indicated otherwise taps and faucets shall be all brass construction. All connections and cover plates shall be bright chromium plated finish. Taps shall be fitted with anti-splash nozzles, except for hose cocks and/or where otherwise specified.

Taps shall incorporate:

- Loose Jumper Valve incorporating neoprene washer
- Fitted with O ring seal
- Vandal resistant handle
- Vandal resistant aerator
- Flow control devices.

8.36.9 Flushing & Cleaning Of Water Supply Services

Immediately after the satisfactory completion of the sectional/first fix and the whole system/final fix hydraulic pressure tests the Hydraulics Contractor shall flush out, remove all foreign matter and clean all the systems. Water systems shall be flushed out with clean water. Whenever possible the flushing medium shall be fed into the system at high points and flushed out at low points on the system via suitably sized valve or plugged wash-out points. The flushing and cleaning medium shall be fed into the system at the highest pressure that the system will safely withstand and be carried out for a sufficient period of time to ensure that all foreign matter is removed. The flushing shall be witnessed by the ER for the duration of the flushing of each service and shall be recorded by the Hydraulics Contractor and certified by the ER.

8.36.10 Backflow prevention

Supply and install an approved BFPD in the domestic cold water supply and irrigation system as required by the Water Authority and as specified in the "Materials" section.

Contractor is to maintain device for a period of 12 months and will include maintenance instructions in as-built manuals to be supplied at end of project establishing an authorised maintenance programme including registration and certification of device.

In order to comply with AS/NZS3500 Part 1.2 Section 4, a caution sign complying to AS1319 must be made and installed at every outlet that is served with water from the reduced pressure zone devices (RPZD's). The caution sign shall be clearly and permanently labelled to state

'CAUTION NOT FOR DRINKING'

Provide isolation valves upstream and downstream of valve and line strainer at inlet to BFPD.

Flush piping before installing device and test device after installation and prior to operation in service.

8.36.11 Hose taps

Provide and install hose taps with flow restrictors, anti-vandal heads and hose connection vacuum breaker.

All hose taps to be minimum 6 star WELS rated (<4.5L/minute flow rate) either by selection or fitting flow restrictors.

8.36.11.1 External Hose Taps

Each tap shall consist of a 20mm diameter copper riser with a back plated elbow and a 20mm diameter brass finish hose tap. The tap shall be 450mm above the floor unless otherwise directed.

The hose tap shall be installed against a block or concrete wall, the back plated elbow fixed to the wall or hardwood timber post with three (3) x 20mm brass screws, screwed into 20mm x 6mm expanding plastic plugs.

8.36.11.2 Internal Hose Taps

Internal hose taps shall have concealed pipework connection with chrome plated cover dome. Hose tap and vacuum breakers to be chrome plated. Hose tap handles to match tap handles where applicable.

8.36.12 Recycled Water

8.36.12.1 Labelling

Additional marking and signage of pipework and outlets is required as per AS/NZS 3500.1.

8.36.12.2 Pressure pumps

Supply and install cold water pressure pumps and control panels for all details see “Pumping” section.

8.36.12.3 Backflow Prevention

Backflow prevention is to be provided for recycled water connections through the installation of a reduced zone pressure device as indicated on the schematic drawings.

8.37 DOMESTIC HOT WATER AND WARM WATER SERVICES

8.37.1 Generally

Supply, install, test and commission the domestic hot water service and warm water service from the hot water heaters to the fixtures and appliances. Include for all piping, fittings, supports, insulation (as per the materials section), hot water heaters, valves, circulating pumps and other sundry items of equipment required for the installation.

The new hot water system shall consist of a flow and return system from the hot water plant where indicated on the drawings. The hot water is to be circulated at 65°C. Thermostatic mixing valves will be located in all other areas to maintain the water at 50ºC or 43.5ºC.

Self-regulating trace heating tape shall be provided to the hot water flow pipework if the distribution routes are in excess of 6m from the heater to the outlet.

Pipe materials shall be as follows:

- Main runs and risers to branch isolation valves: Copper Type B
- Within toilet cores after branch isolation valves: Copper Type B
- All pipes within any wall: pre-lagged copper type B
- Between fixture valves and fixture stainless steel braided connectors

8.37.2 Testing

Provide a water pressure test of 1500 kPa for a period of two hours. Disconnect any equipment connected to the service not rated to the test pressure before testing commences. Testing is to conform to “Preliminaries” section.

8.37.3 Connection To Fixtures

Provide unions at wall or floor surface and at fixtures and appliances to allow removal and replacement without the need to adjust connections.

To pipelines supplying cold water to individual fixtures, supply and install isolation valves for the purpose of shutting down the water supply to the individual fixture for maintenance. These isolation valves are to be in addition to the isolation valves nominated above for the purpose of shutting down the system for maintenance. Connections from the isolation valve to the individual fixture shall be by stainless steel braided connectors.

8.37.4 Control Valves

Install valves in pipelines supplying to each group of fixtures and well as for the purpose of shutting down the system for isolation and maintenance purposes as specified in “Materials” section. Each group of fixtures is defined as one of the following:

1. A male toilet area;
2. A female toilet area;
3. A disabled toilet;
4. A cleaners room; or
5. Tea Room

Valves located within the building are to be located behind access panels or within accessible spaces.

8.37.5 Expansion And Contraction

Make adequate provision for expansion and contraction by the provision of clips/brackets with wooden expansion blocks so that under all working conditions no strain is imposed on pipework or fittings, Pipes located in walls and floors shall be provided with sufficient insulation so that expansion and contraction does not impose a strain on the pipework or finished surfaces. No joints will be allowed within or under concrete slabs where slab is on ground.

Branch pipes off straight lengths of unrestrained supply pipes shall incorporate a minimum of 3 long radius pipe bends and a straight length of pipe not less than 1000mm long between the branch connection and the first branch pipe restraint to facilitate movement of the supply pipe without imposing strain on the pipe connections and fittings.

8.37.6 Valves

Refer to “Materials” section for valves. Balancing valves shall be all bronze globe valves with limited stop in the open position. All other valves must be bronze.

8.37.7 Pipe Supports

Pipes shall be supported at each collar and at spacing as specified in “Preliminaries” section.

8.37.8 Noise & Vibration Suppression

Supply and install all necessary equipment to identify the system to conform to the “Preliminaries” section.

8.37.9 Painting & Identification

Supply and install all necessary equipment to identify the system to conform to the “Preliminaries” section.

8.37.10 Flushing & Cleaning Of Water Supply Services

Flush and clean the system as specified in the “Cold Water” section.

8.37.11 Samples

Submit samples of accessories not specified as proprietary items as specified in the “Preliminaries” section.

8.37.12 Tapware

Supply and install all Tapware to comply to the “Cold Water” and the “Sanitary Fixtures, Fittings and Tapware” sections or as selected by the Architect or ER.

8.37.13 Thermostatic Mixing Valves

Supply and install thermostatic mixing valves to all disabled toilets and all sanitary fixtures, as indicated on the drawings, used for personal hygiene strictly to manufacturer’s requirements and in accordance with the local authority’s requirements.

All valves to comply to those specified in “Materials Section”.

8.37.14 Hot Water Heaters

Provide the hot water system with the following:

An automatic surface mounted temperature control thermostat with adjustable ranges on automatic over-temperature cut out to shut down the fuel or power supply should the thermostat malfunction.

A temperature and pressure relief valve to conform to the requirements of AS 1357 and terminate over a tundish or FW as noted on drawings.

A copper safe tray shall be supplied and installed under the boiling/chilled water units and shall be constructed of 1.8mm sheet copper. Joints shall have soldered edges, be reinforced and turned up 50mm. A 50mm outlet shall be fitted and sealed to the tray and discharge in the position noted on the drawings.

8.37.15 Hot Water Storage

Connect to hot water storage tanks in the location indicated on the drawings.

A pressure limiting valve must be installed on the inlet side of the hot water storage tanks, isolating valves, unions and all other items necessary to complete the installation.

Minimum hotwater storage tank capacity to be 42kW/hr in order to be able to provide 650L/hr at 65ºC output (2L/sec simultaneous flow).

All manifold headers shall be one size bigger than the largest connecting service pipe.

All water heaters provided are to meet the New Zealand Minimum Energy Efficiency Performance Requirements (NZ MEPS) and shall satisfy NZS 4305 requirements.

8.37.16 Solar Water Heaters

Not required under this contract.

8.37.17 Hot Water Circulating Pump

Supply and install dual hot water circulating pumps to the requirements as specified in the "Pumping" section.

8.37.18 Boiling/chilled water units

Install boiling water units finished in white enamelled casing, equal to "Billi". Each unit shall have a storage capacity and single phase element as scheduled, and shall be thermostatically controlled. The boiling water units are specified in the Architectural Specification.

Each unit shall fit automatically and be complete with inlet and outlet connection, drain plug, steam condensing, cowl and spring loaded non-drip fixed outlet tap.

8.37.19 Backflow prevention

Supply and install an approved BFPD in the domestic hot water supply as required by the Water Authority and as specified in the "Materials" section.

Contractor is to maintain device for a period of 12 months and will include maintenance instructions in as-built manuals to be supplied at end of project establishing an authorised maintenance programme including registration and certification of device.

Provide isolation valves upstream and downstream of valve and line strainer at inlet to BFPD.

Flush piping before installing device and test device after installation and prior to operation in service.

8.37.20 Thermal insulation

Provide all necessary insulation to hot water piping to prevent heat loss.

Insulation shall not be provided until all relevant tests and inspections have been carried out.

Insulation shall be as specified in "Materials" section.

Insulation to piping chased into walls to be Prelag by Kembla or approved equal. Ensure that such insulation permits adequate expansion and contraction.

Thermal insulation exposed to outside or internally to view shall be provided with continuous metal sheathing. Painting of insulation for UV protection alone will not be accepted.

Metal sheathing exposed to view shall be painted to the Architects specification where required by the Architect.

8.38 PUMPING

8.38.1 Sub-soil pumps

Provide a sub-soil/stormwater pumping system, generally comprising:

- Dual submersible pumps
- Controls and wiring on essential power supply
- Rising main
- Holding pit and covers

All to form a complete and approved installation, in the locations indicated on the drawings.

Provide precast concrete holding pit in position as indicated on the drawing. Provide in situ concrete base in accordance with holding well supplier recommendations and specification. Bench base of well to pumps. Allow to complete top covers and frame to match pavement and finished pavement levels.

Provide pumps to comply with the following requirements:

- Submersible type
- Have casing made of GG-25 and stainless steel shaft.
- Have lubricated for life, maintenance free motor shaft bearings and high quality silicon carbide mechanical seal independent of direction of rotation; lip seal oil lubricated.
- Have waterproof cabling
- Have three phase, 415 volts, 2900 rpm electric motor
- Have TCS-Thermo-Control-System and DI-System for Seal Monitoring.

Provide control panel, level controllers and wiring to give automatic operation of the pumps.

Control panel to be located where shown on plans and fixed to wall and shall be suitable for external installation exposed to weather conditions.

Refer to the BMS specification for description of operation and functionality.

Provide a rising main to comply to the following requirements:

Rising main to be Copper tube.

Provide unions, non-return and gate valve on rising main adjacent to the pump chamber fixed to the tunnel wall.

Provide supports, excavation, bedding, backfill, fixings, brackets etc. for rising mains and pumping line – as before specified.

Connect to main gravity drainage junction to local authorities requirements.

8.38.2 Domestic cold water booster pump

Servicing domestic cold water, in location as indicated on the drawings

Provide cold water pumps to give approved water pressures.

Booster pumps to include:

- pumps (number as required to meet performance curve of nominated system)
- manifold piping
- controls
- base plate
- pressure tanks

and be automatically controlled by variable frequency control motors and a variable speed controller.

Pumps to:

- be vertically mounted in line multi stage centrifugal type
- have cast iron casings, stainless steel shaft and stainless steel impellers
- have mechanical seals
- have screwed connections
- be driven by 415 volt, 3 phase 2900 rpm TEFC electric motor.

Controls panel to incorporate the following:

- Main isolation switch

- duty selector switch
- Manual /off / auto selector switch for each pump
- Motor and control circuit breakers
- DOL contractors with hand reset thermal overloads
- BMS monitoring
- Automatic alternation
- Lights for:

    - power on 1 off
    - pump run 1 off per pump
    - pump fail 1 off per pump
    - Loss of prim alarm
- Volt free contacts
- Run on timers
- Audible alarm with mute button
- All mounted on a sheet metal non-weatherproof cabinet
- Wiring from level switches in tanks to activate booster pumps

Provide all necessary wiring between control panel, pumps and within control panel. All wiring to comply with SAA Wiring Rules and Governing Authority requirements.

Manifold piping to:

- be copper, as before specified for cold water
- include valves
- be generally as indicated on the drawings
- include anti-vibration (flexible) couplings at pump sections and discharges
- enable:

    - removable of each pump while remaining components operable
    - by-pass
    - test drain
    - testing pump operation and pressures

The whole assembly to be fixed on plinth with approved rubber-in-shear anti-vibration mounts and expansion fasteners.

Note that pumps, piping to be suitable for working pressure equal to maximum mains pressure plus maximum pump pressure (i.e. with “closed” head).

Provide pressure gauge and pet cocks to inlet and outlet of pump sets.

8.38.3 Hot water circulating pumps

Supply and install at each hot water return pump set vertical support frames comprising galvanised steel unistrut P1000 channel or approved. Fix the hot water return pumps associated pipework and electrical control panels to the vertical support frames.

Dual Pumps shall be mounted in the vertical position with interconnecting pipework and valves.

Provide and install gate valves, check valve, pressure gauges and gauge control valves on the inlet and outlet of each pump.

Provide stainless steel flanged vibration eliminators on the suction and delivery connection to each pump. Provide stainless steel vibration eliminators on the pipework connection to and from the pump set group.

Provide air eliminators on each side of the pump.

Provide and install anti-vibration mounts as required.

Provide electrical power, control and alarm wiring with conduits from the pumps electrical control panels to pump motors. Pumps to have thermal overload protection auto/off/manual selector for each pump, auto/change-over selection switch, motor, circuit breakers, AC on light, pump run lights, pump fail lights, alarm button and mute button.

Electrical wire each pump for 24 hours running with an automatic change over to the second pump after each 24 hour duty.

8.38.4 Pump control panels

Supply and install all equipment necessary to operate the pumps specified under hydraulic services.

Allow for all control cabinets, mounting brackets, contactors, isolating and control switches, auxiliary switches, alarms, wiring between pump and panel, panel and level controls, and other associated equipment necessary for the safe and effective operation of the pumps as required for the installation and in accordance with statutory requirements to AS 3000.

Provide a high level BACNet compatible interface for each pump control panel or pump set for connection to the site BMS system.

Provide a complete specification and drawings of pumps and control equipment prior to installation.

8.39 SANITARY FIXTURES FITTINGS AND TAPWARE

8.39.1 Generally

Supply, install and commission all sanitary fittings and tapware connected to the hydraulic services.

Allow to take delivery, store as necessary and install. Provide all fixings, necessary cutting, securing of brackets to walls, levelling and connection to various services required for satisfactory operation.

All items shall be new and free of chips, cracks and crazing and defects and shall be subject to inspection prior to installation.

All fixtures nominated are to be taken as read “or approved”. If an “approved” product is proposed by the Hydraulics Contractor, the ER shall have the sole authority to determine whether the “approved” product proposed is acceptable. Any ruling issued by the ER on whether the “approved” product proposed is acceptable is final and no further discussion will be considered. All tap ware is to be taken as being required to be supplied in bright chrome finish.

Refer to the architectural elevations and plans for the room locations and for the setout of all fixtures. Do not use the hydraulic drawings for setout or rough in of services.

Refer to the AFC Issue of the fixtures prepared by the Architect for all fixtures and fittings required for this project.

Prior to placing orders, obtain guarantees from the manufacturer that any items which craze or show any other defects within twelve months of issue of certificate of practical completion will be replaced providing that such crazing or other defects are not caused by abuse.

Fix and support fixtures strictly to the manufacturer's recommendations.

All exposed brackets shall be white enamelled. All exposed connections shall be chrome plated unless specified otherwise.

All cisterns shall have anti-vandal kit fitted where accessible by the general public.

8.39.2 WELS (Water Efficiency Labelling Scheme) Ratings

The following minimum WELS ratings are required for all fixtures and fittings within the building:

- Showers 3 WELS, <9L/min flow rate, with "Shower timer – Standard Model" or equal approved.
- Toilets / WCs 4 WELS, 4.5L/3L dual flush, average <3.5L/flush
- Urinals 0.8L/ flush with individual smart flush controllers
- Hose Taps 6 WELS, <4.5L/min flow rate (to be installed with flow restrictors)
- Cleaners Sinks 4 WELS, <7.5L/min flow rate
- Hand Basins 6 WELS, <4.5L/min flow rate
- Dishwashers 5 WELS
- Kitchen sinks 6 WELS, <4.5L/min flow rate

Proof of the flow rates of each water fixture that has been used should be provided in the form of WELS rating documentation. Product data sheets or Certificates stating the flow rate of each fixture in accordance with AS/NZS 6400:2005 can be supplied as an alternative to WELS rating documentation if a product has not been WELS certified.

8.40 SEISMIC DESIGN AND INSTALLATION

8.40.1 General

This section covers the seismic restraint requirements for suspended engineering systems, both vibration and non-vibration isolated and/or related suspended equipment.

All hangers' supports, equipment etc. for the hydraulics installation are required to be designed and installed to safely resist earthquake forces without compromising the continuing operation of the installation.

All equipment, pipework, etc. shall be provided with restraints to resist seismic forces in addition to the normal fixing and supports as provided by the Contractor.

The Contractor shall allow for the costs of complying with this section of the specification. Special attention shall be given to the design of flexibly mounted equipment restraints, which shall allow freedom for vibration control, together with the appropriate earthquake protection.

This clause shall apply to complete assemblies, and subassemblies. All installed plant and equipment (including proprietary plant, pipework and other components) shall be designed by the Contractor to withstand, without exceeding working stresses:

- A horizontal earthquake-induced force acting through the centre of gravity equal to its weight multiplied by a seismic factor as stated in the "Seismic Requirements for Mechanical and Electrical Services".
- Maximum gravity loads under expected operating conditions (including allowances for temperature movement, fluid pressure surges and the like).

- Wind loads induced by the application of the maximum 3-second gust expected every 50 years, multiplied by the appropriate factors as detailed in NZS 4203

8.40.2 Standards

To comply with this clause the installation is to be analysed and the detail design done in accordance with the provisions in the following Standards:

- NZS 4219:2009 ‘Seismic Performance of Engineering Systems in Buildings’.
- AS/NZS 1170 ‘Loadings Code’ and be detailed in accordance with the appropriate material codes.
- For NZS 4219:2009, the Importance Level (IL) in Table 1 shall be taken as 2.

8.40.3 Design Criteria

The annual probability of exceedance (return period) shall be chosen from AS/NZS1170 corresponding to the importance level and the design working life (50 years).

8.40.4 Quality Assurance

The Supplier is required to retain a Chartered Engineer (Structural) experienced in seismic fixings of plant to complete the design and observation of all equipment installations. The Supplier is to make allowance for the Chartered Engineer to provide a Producer Statement PS1 (Design) and PS4 (Construction Review) prior to Practical Completion.

Seismic restraint designer shall layout and identify seismic restraint locations. The layout and identification of seismic locations shall comply with New Zealand Standard NZS 4219:2009, Seismic Performance of Engineering Systems in Buildings. Engineered seismic restraint submittal and shop drawings shall be (signed & sealed) by a chartered New Zealand Structural Engineer and shall be submitted to the designer of record for review and acceptance prior to installation.

Seismic design submittal shall include Quality Assurance guidelines for use by reviewing authorities during inspection.

The project specific seismic restraint submittal shall include the design of both the seismic restraints and vertical (gravity) supports of the system(s) at seismic restraint locations.

Seismic restraint and vertical support design information shall dictate the following:

- Seismic restraints: Brace arm material/size/type and load rating, anchorage, allowable spacing (transverse/longitudinal), brace installation angles and allowable tolerances, means for positive attachment to utilities at longitudinal/transverse locations, means for reinforcing vertical support rods (as required) at restraint locations.
- Vertical (Gravity) Supports: Vertical support spacing, type, size, and anchorage.

After installation of the seismic restraints, but prior to inspection by local territory authorities, contractor shall submit to the designer of record for review and acceptance As Built Record Drawings accurately identifying all actual installed system layouts and seismic restraint locations.

8.40.5 Products

All seismic restraint bracketry and seismic anchorage connections to be those furnished by ISAT (International Seismic Application Technology) or approved equivalent.

8.40.6 Seismic Restraint Design

8.40.6.1 General Requirements

The anchorage supports and seismic restraints of systems listed below shall be designed to comply with and resist the seismic forces prescribed in the New Zealand Standard NZS 4219:2009 or the project specific design requirements, whichever is more stringent.

- All equipment including but not limited to: Pumps, electrical enclosures, backflow prevention devices.
- All piping including but not limited to: hydronic piping, plumbing, and process piping.
- Applications not covered by standard systems shall be engineered and built by the applicable system contractor. Engineering shall be (signed & sealed) by a chartered New Zealand Structural Engineer and submitted to the designers of record for acceptance prior to installation. Cost to be borne by the contractor.
- All fixtures and/or services installed in or attached to metal suspension systems for acoustical tile and lay-in panel ceilings including but not limited to: grills/diffusers, light fixtures, sprinkler heads and shall specifically comply with section 5.13, 5.14, & 5.15 of NZS 4219.

Seismic restraint transverse and/or longitudinal spacing shall not exceed the lesser of the following:

- That which develops seismic design forces equal to or less than the capacity of the building structure as specified by the project structural engineer.
- That which develops seismic design forces that are equal to or less than the capacity of the weakest part, component, anchorage, etc., contained within the seismic brace assembly.
- For pipe: Per tables 6 & 7 of NZS 4219:2009. For pipe sizes greater than those listed in tables 6 & 7, maximum spacing shall not exceed 12 metres transversely and/or 24 meters longitudinally where pipes are constructed of ductile materials & connection (copper, ductile iron, steel or aluminium and brazed, welded or screwed connections). For pipe sizes greater than those listed in tables 6 & 7 of NZS 4129:2009 and constructed of non-ductile materials and connections (i.e. cast iron, no-hub pipe, PVC-U/glass/plastic pipe), brace spacing shall not exceed 6 meters transversely and/or 12 metres longitudinally.

Seismic restraint system specific system design requirements and exclusions:

Pipe:

- Brace all pipe 50mm and larger and all pipes carrying hazardous material irrespective of size.
- Brace all trapezed systems supporting multiple pipes.
- Brace all suspended equipment over 10 kg.
- Brace all pipes supplying equipment designed for life safety (example: emergency generators).
- Bracing may be excluded from pipes suspended by individual hangers where the hanger length for all supports is 150 mm or less from the top of the pipe to the point of connection to the structure.
- Each straight run of pipe shall have at least two transverse brace locations and one longitudinal brace locations per NZS 4219, Sec. 5.8.4.1.
- All unbraced pipes must maintain 150 mm clearance from hangers and braces to suspended ceiling systems or other adjacent components.
- All vertical pipes shall have a minimum of two transverse restraints in each orthogonal direction and be installed within 2 pipe diameters of a vertical support.

Flexible Joints/Connectors:

- Install seismic flex joints for all mechanical, plumbing, HVAC duct, and electrical systems crossing the building seismic joints. Flex to accommodate the differential displacement specified by the project structural engineer. All systems crossing building seismic joints to be braced within 1.5 m of both sides of the joint.
- Install flexible connectors at all gas and fluid piping to equipment to withstand differential displacements due to building drift as specified by the project structural engineer.
- Install flexible connectors on all services to non-anchored equipment.

Vertical Support Design Requirements:

- All engineering system vertical supports shall comply with the requirements of NZS 4219 or the project specific seismic force requirements, whichever is more stringent.
- Vertical supports shall be designed and installed to account for vertical tension and compression loads including accumulated seismic component increases.
- Vibration isolation hangers (i.e. spring hangers, etc.) for suspended items shall be as provided or approved by the seismic system designer.
- Vertical supports, single hanger, trapeze hangers and their clamps, clips and methods of connection shall be constructed of ductile materials (i.e. copper, ductile iron, or steel).

Excluded Utility Notations: Utilities excluded from seismic design requirements per the above guidelines shall be noted as such on the project specific seismic restraint layout drawings.

Seismic restraints shall be installed to provide minimum of (2) transverse and (1) longitudinal braces per run. A "run" shall be defined as a length of 3 meters or more.

The accumulated load of multiple items to any given support (with or without seismic restraints) shall be limited so as not to exceed the load limitations of the support assembly or those structural load limitations established by the structural engineer of record.

Trapeze systems installed in a multi-layer configuration shall have seismic restraints designed and installed for each individual trapeze layer unless otherwise specifically detailed by the seismic designer.

Do not use insulation inserts (i.e. calcium silicate, polyurethane, metal, etc.) at seismic brace connection locations without prior written approval from the seismic design engineer. Do not connect seismic bracing to insulation inserts without prior written approval from the seismic design engineer.

8.40.6.2 Anchors, Inserts and Fasteners

All anchors, inserts, fasteners or connections to the structure shall be submitted to the structural engineer of record for review and acceptance prior to installation.

Per NZS 4219, section 3.10.5, all post installed concrete anchors shall be seismically qualified per ACI 355.2.

Do not use any anchor or insert in concrete or metal decking with concrete fill, which does not have a signed structurally engineered design value based on its installed application.

Cast-in-place inserts (other than embedded bolts) used in concrete or metal decking with concrete fill, shall be ISAT Blue Banger Hanger, no substitutions allowed.

Do not use powder driven and power driven (Shoot-In) fasteners, expansion nails or internally threaded anchors in concrete or metal decking with concrete fill unless specifically approved by the seismic designer.

All beam clamps shall be constructed of malleable iron or steel. Single flange mounted beam clamps are allowed at vertical support locations only, shall include a retaining strap or J-hook and must be submitted to the project seismic designer for review and acceptance prior to installation. Beam clamps for use with brace arms must be specifically tested and approved for use with seismic loads.

8.40.6.3 Field Quality Control

The seismic designer or his representative shall conduct a field review of each seismic restraint location and provide a letter certifying general conformance with the seismic restraint system design. The review shall include:

- Verification of installation of rod stiffening components (as required)
- Verification of installation of retention straps at beam clamp vertical support installations
- Verification of brace arm orientation per the design (i.e. transverse/longitudinal & quantity)
- Verification of installation of Longitudinal Restraint Devices (as required)
- Verification that strut type and profile for brace arms and vertical support conforms with the design requirements.
- Beam clamps utilized for seismic anchorage comply with the seismic design and have been specifically tested and approved for use in shear load applications.

Inspection of seismic restraints by the (IOR) Inspector of Record, and/or (AHJ) Authority Having Jurisdiction, and/or designers of record.

8.41 ACOUSTICS

The following acoustic treatment requirements are as supplied by the Acoustic Consultant and is provided for information. The Hydraulics contractor should verify in the first instance that they have obtained the latest version of the Acoustic Consultant's specifications and details prior to commencing work.

8.41.1 Supply Water Pipes

When supply water pipes are rigidly connected to building surfaces, flow-induced vibration in the pipes transfers to the structure and radiates as noise. This noise can be simply treated by eliminating rigid contact between the pipe work and building and by reducing the pressure in the pipes.

To control transmission of water noise as far as possible, the following is recommended:

- Include pressure reducers of regulators (if necessary) such that the pressure at each tap or other appliance does not exceed 150 kPa;
- If a higher pressure is necessary for any reason, polybutylene pipes should be used to connect between the appliance (such as taps, toilets, faucets, shower mixers etc) and nearest point of attachment to any part of the building structure. For example, the copper sweep bend between wingback wall fitting and tap may be replaced with a length of polybutylene pipe "straight connector" attachment. This breaks the direct metal contact between tap and building structure. Alternatively, a section of braided steel flexible could be used.
- All supply pipes should be vibration isolated from the building structure using either:
    - proprietary acoustic clips such as "Acoustic Pipe Clips S – Series" which incorporate as EPDM rubber lining inside the metal brackets (available from Plumbing World) or
    - a flexible foam strip such as 9-12 mm thick Armaflex or Unisil 4700 between the clip/structure and the pipe.

- Do not attach fresh or wastewater pipe work directly to a single stud wall adjacent to as occupied space. If this is unavoidable, ensure that pipe work is resiliently mounted and attached to a false stud or dwang (i.e. one not connected to the wall lining on the occupied face of the wall). Alternatively, lengths of polybutylene pipe may be used in place of copper pipe at wall connections.

8.41.2 Wastewater Pipes

The following is recommended with respect to the waste water system:

- All waste pipes located in a ceiling cavity of a different tenancy should be externally wrapped using one of the following options:
    - Acoustop Barrier Wrap ABW/4-12 (supplied by Forman Insulation)
    - Acoustop FlexiLagg AFL/4-12 (supplied by Forman Insulation)
    - Any 12-25 mm thick insulation blanket or preformed fibreglass pipe insulation wrapped externally with a mass loaded vinyl (minimum surface density 4 kg/m2).

Alternatively, where bathrooms are stacked vertically, wastewater noise can be controlled with the use of full height walls around the bathrooms – one layer of Gib carried up and sealed to the underside of the slab with flexible sealant, would be sufficient provided insulation is included in the ceiling cavity of the apartments.

- Where there are pipework penetrations through the separating elements in habitable rooms, the pipework should be enclosed for its full height in each flat. The enclosure should be constructed of 2 layers of 10 mm standard plasterboard and the pipes wrapped with one of the aforementioned wrapping options.

There should be no direct connection between the waste water pipe system and the building structure. A flexible foam strip such as “Armaflex” should be located between the clip/structure and the pipe. Where pipes are lagged in ceiling cavities, the foam backed lagging will be appropriated as a vibration isolation material.

Appendices

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Appendix A Mechanical, Fire and Hydraulic Equipment Schedules

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