6.8 Annexure H - Mechanical Project Specification

1.0 PARTICULAR SPECIFICATION

1.1 Preface

This annexure is supplementary to the tender document: Request for proposals for the construction of a hot isostatic press facility at CSIR (Pretoria site); and pertains to mechanical equipment and utilities to support the new press and building systems.

This particular specification contains the elements pertaining to site conditions, scope of works, and explanation of proposed new equipment or installations required for the mechanical part of the contract.

Consequently, all works shall be designed, supplied, delivered, installed, commissioned, and maintained completely as specified herein and in harmony with the original equipment manufacturers (OEM) requirements and the OHS Act, and as shown on drawings.

1.2 General work description

This specification entails the design, supply, installation, testing, commissioning, and maintenance of all new installations together with associated ancillary equipment for the full operation of installations completely as specified and as shown on the drawings.

The particular specification, general specification, technical specifications, and drawings shall be read in conjunction to the rest of the tender or contract document specification. Any inconsistencies ought to be raised for clarification by the engineer or principal agent.

1.3 Site design conditions

Project location (nearest town)	: CSIR Pretoria (6km from Pretoria CBD)
GPS co-Ordinates	: -25.74501, 28.28163
Altitude, m asl	: 1322
Average summer DB, °C	: 31.7°C
Average minimum DB, °C	: 3.9°C
Maximum noise rating, dBA	: 35 - 54dBA

1.4 Project drawings

All installations on the drawings shall be completely as specified and as indicated in the bills of quantities; and provided drawings form part of the mechanical scope of work. Drawings shall be issued upon request; listed as follows:

a) 12964 - ME001: Ground floor HVAC layout
b) 12964 - ME002: First floor HVAC layout
c) 12964 - ME003: Mechanical utilities layout

1.3 Scope of work

1.3.1 Design work

The tenderer shall familiarize himself with the design and where they are of the opinion that the selected routing or mounting is not feasible; shall raise such concerns with the engineer.

Moreover, the contractor shall evaluate the positioning of equipment in accordance with aesthetic requirements and attainment of the sought craftsmanship standards.

The contractor shall be responsible for the correct sizing of all equipment and ancillaries supplied such as flanges, valves, supporting brackets, and filters / separators. Additionally, such sizing shall also be as per manufacturer's recommendations.

The contractor shall be responsible the design and strengthening arrangements to effect mounting and / or plinths for all supplied installations, ramps leading into plantrooms, fasteners for supports, security fencing, and other ancillaries.

1.3.2 New installations

The press shall be supplied by others and located inside the newly renovated workshop. The proposed new mechanical plinth / plantroom shall be located next to the workshop. The installations forming part of the mechanical scope of work include the following:

a) Supply and installation of argon gas piping, from virgin argon gas storage and reclaimed argon storage, to the new press. Hiring of the virgin argon storage forms part of the mechanical scope. Reclaimed argon storage tank to be free issue.
b) Supply and installation of a new compressor system complete with a new compressor, compressed air piping from the compressor to the new press, dryer, water separator, filters, regulators, coil hoses, and blow guns.
c) Supply and installation of water piping from the proposed new evaporative cooling tower to the press. The water piping installation shall also include general plumbing to extend municipal water to the proposed new cooling tower and press. The proposed new cooling tower shall be free issue.
d) Supply and installation of new air-conditioning installations. Air-conditioning installations shall be new direct expansion (dx) units in the form of concealed ducted unit, cassette units, and CRAC air handling unit to provide precision cooling to the new metrology laboratory.
e) Supply and installation of new ventilation installations. Ventilation shall be provided either by extraction fans or filtered fresh air fans.

1.5 Argon installation

The proposed new press consumes a minor portion of argon during an operating cycle while most of the argon is recycled after an operating cycle. Hence, two argon sources are necessary for the press to operate viz. virgin and reclaimed argon storage.

1.5.1 Virgin argon storage

The tenderer shall supply and install the virgin argon storage system. This virgin argon storage shall be typical to the Afrox high purity multi cylinder pack (MCP) containing 15 off argon cylinders with a total argon storage mass of 261 kg at 200 Bar.

1.5.2 Reclaimed argon storage

The reclaimed argon storage shall be free issue by the client to the contractor. The tenderer shall rig into place the reclaimed argon MCP storage. Rigging shall be assumed to be from within CSIR premises, over the new “clear view” fence, and onto the proposed new mechanical plinth or plantroom.

The contractor shall prepare and propose the rigging method statement depending on the works program. The engineer and safety specialist shall review and approve the method statement.

The reclaimed argon MCP storage is approximately 1.5m wide, 1.2m high, and 2.2m deep and weighs 2250 kg (empty). The MCP has four lifting eye bolts on top and also has forklift provision at the bottom for handling purposes.

1.5.3 Argon gas piping

The argon piping shall operate at 200 Bar pressure and 50^{o}C (during reclaim cycle). The pipe nominal diameter shall be 25mm and schedule 40.

The tenderer shall supply and install stainless piping to handle argon in line with ASME B31.3: Process piping against which the tenderer’s welder shall be coded as a minimum. Alternatively, a coded welder as per ASME BPVC.IX-2021: Welding, Brazing, and fusing qualifications shall also be accepted. OSH Act, Pressure regulations shall be adhered to.

The piping shall also be in line with BS EN 10088-2: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes. Furthermore, the quality management process for the manufacture of the new piping system shall be in line with SANS 347: Categorization and conformity assessment criteria for all pressure equipment.

There shall be one pipe running from the two storages at the mechanical plinth leading into the press inside the building. Both the virgin and reclaimed argon gas storages shall feed this common pipe. However, the virgin argon storage shall feed via a non-return valve so that virgin argon storage cannot be charged with reclaimed argon during backflow recycling.

The virgin argon storage and reclaimed argon storage shall each contain a lockable shut off valve for isolation. Furthermore, each gas storage shall be provided with a safety valve for storage protection and a gauge for reading the storage pressure. The main argon supply line from the gas store shall have a bleed valve for maintenance purposes.

The very last connection piece to the multi cylinder packs, in the plant area, would be through a high-pressure stainless steel braided hose to allow for flexible positioning of replacement charged cylinder packs.

Moreover, there shall be 7 Nm^3 of argon vented or exhausted over 20 seconds directly from the press and out into atmosphere per operating cycle. The tenderer shall supply and install an exhaust pipe that shall be 2½ inches in diameter, protruding to at least 2m above the roof, and complete with a silencer exterior of the building. The silencer shall, beside reducing noise, blend the argon with air.

1.6 Compressed air installation

The proposed new press does not use compressed air. However, compressed air is required for purposes of cleaning workpieces. Regardless, the highest compressed air quality is required and shall be Class 02 in terms of ISO 8573-1:2010 Compressed air - Part 1: Contaminants and purity classes.

1.6.1 New compressor

The contractor shall supply, install, and commission to full operation a new screw type compressor. The compressor shall be rated to provide 1500 litres per minute at 10 Bar, complete with a 360-litre air receiver and 12-month maintenance.

The compressor shall be installed outdoors and shall be selected to withstand elements. Moreover, the compressor shall have motor protection against low/high voltage, high current, high temperature, open phase, reverse phase, and overload situations.

1.6.2 Dryer

The contractor supply, install, and commission to full operation a medium flow heatless adsorption dryer that does not require certification as a pressure vessel to match the new compressor. The dryer shall provide a constant outlet air dewpoint and with oil vapour reduction as per ISO8573-1: Class 01 with full feature electronic control display with energy saving capability and with 12-month maintenance.

1.6.3 Ancillaries

The contractor shall supply and install all necessary ancillaries to ensure compressed air purity and workshop usage. The ancillaries shall include a water separator, 5 off high efficiency filters, 5 off regulators, 5 off coil hoses, and 5 off aluminium blow guns.

1.7 Process water (cooling tower) piping installation

The contractor shall supply and install new 2-inch stainless steel water piping between the press and the cooling tower (within 25m). The cooling tower shall be free issue by the client and the contractor shall rig the tower into place and complete the piping installation. The contractor's program shall need to be co-ordinated with others.

Fabrication of process water supply manifold would need to take place or to be completed once the cooling tower is on site. The contractor shall further allow for a normal tap water supply leading the cooling tower for evaporative cooling effect.

1.8 Air-conditioning installations

1.8.1 Precision cooling

The contractor shall supply, install, and commission a precision cooling direct expansion (dx) air handling unit in the Metrology laboratory. The air handling unit shall control the laboratory to within the following temperature and humidity range:

Temperature	: 20 ± 1°C
Stability and uniformity	: ± 0.3°C per hour
Relative humidity	: 20 – 45%

The air handling unit shall be a computer room air conditioning (CRAC) unit complete with a filtered fresh air fan to introduce outdoor air into the laboratory in line with SANS 10400: Part O - Lighting and ventilation.

Supplied air shall be introduced into the laboratory via four (4) swirl air diffusers connected to a common air conditioning duct leading to the top of the CRAC unit. The return air stream shall be via a suitably sized wall mounted grille without undue noise.

The air-conditioning contractor shall be registered with the South African Refrigeration & Air-Conditioning Contractor's association as an Authorised Refrigeration Practitioner

1.8.2 General air-condition

The contractor shall supply, install, and commission to full operation general air-conditioning units configured as follows:

a) *New x-ray laboratory*: general air-conditioning with ventilation provided via a concealed ducted unit complete with an inline duct fan (with primary filtering) as indicated on the drawings.
b) *New Office:* general air-conditioning and ventilation (filtered fresh air supply) shall be provided via a ceiling mounted cassette unit and inline duct fan as indicated on the drawings.

The air-conditioning contractor shall be registered with the South African Refrigeration & Air-Conditioning Contractor's association as an Authorised Refrigeration Practitioner

1.9 Ventilation installations

1.9.1 *Proposed press / machine room*: similarly; Table 2 of SANS 10400 Part O (Lighting and ventilation) shall be used in approximating the machine room to parking garages. The underlying assumption being to guard against accumulation of hazardous gases (CO_2 and Argon). The table suggests 10 air changes per hour of ventilation for garages.

However, in order to guard against accumulation of dust in the machine room – outdoor supply fans shall be provided to replace the air expelled from the press room. The fresh air supply fans shall be complete with primary filters to prevent dust ingress.

Five supply fans shall be strategically placed along the machine room perimeter in order to ensure that the ventilation air sweeps the general area where the press shall be located as indicated on the drawings.

Only one extraction fan shall be provided which shall expel all the air fed into the machine room and this fan shall be complete with a variable speed drive in order to balance the expelled air amount to supplied air amount while guarding against undesired infiltration.

The assumption is that potential Argon leak would occur close to the press. Hence, since argon is heavier than air – all the fans shall be located at approximately 1 500 mm above finished floor level (about the standing height of a person).

The fans shall be interlocked with the press so that the funs run when the press is operational.

1.9.2 *Vacuum lobby*: The lobby is positioned to guard against an appreciable volume air from entering the metrology laboratory. The lobby leads into the laboratory through two doorways where only one door can be opened at a time thereby preventing a draft of air from outdoor infiltrating into the laboratory.

The suggestion is to not provide any mechanical air control apart from an operational control in the sense that; personnel shall be made aware of the strict metrology laboratory operating conditions and need to only open one door at a time. Moreover, the laboratory shall be complete with access control.

1.9.3 *Laboratory sample store:* Table 2 of SANS 10400 Part O (Lighting and ventilation) recommends 2 air changes per hour of ventilation for Wholesale stores and has been used to approximate the laboratory store. Consequently, only one wall mounted ventilation fan shall be allowed as shown on the drawings.

1.9.4 *Ablutions*: all ablutions shall be provided with stale air extraction fans as per Table 2 of SANS 10400 Part O (Lighting and ventilation).

1.10 Other work

1.10.1 Electrical

All outdoor isolators, for air-conditioning units, shall be provided by the Electrical Contractor from which the Mechanical Contractor shall feed the outdoor and indoor air-conditioning units.

The Mechanical Contractor shall be responsible for all wiring from outdoor isolators to air-conditioning units. Moreover, the Mechanical Contractor shall allow for a further isolator at proximity to each indoor unit for maintenance purposes.

1.10.2 Carpentry Work

All works to be co-ordinated with the Main Contractor. Moreover, cutting and drilling for installation of louvers, return air grilles, and supply air diffusers, fans, and mechanical equipment in general shall form part of this Mechanical Scope of Work.

1.10.3 Builder's Work

Builder's Work form part of the Mechanical Scope of Work and the Contractor shall be responsible and allow for the provision of all wall openings, appropriately designed & sized plinths, supporting brackets, and all building work as required by the Mechanical Installations.

1.10.4 Painting Work

Painting Work form part of the Mechanical Scope of Work and all painting shall be in accordance with SANS10064- 2011, SABS 097 - 1972, SANS 630 – 2009, And shall consist of:

Preparation	: In accordance with SANS 10064
Ground Coat	: 25 Micron red lead according to SANS 50312 type 11
Undercoat	: 25 Micron
Finish	: 25-micron alkyd enamel according to SABS 30
Colour	: In accordance with SANS 1091-1975

Necessary colour coding shall be as per SANS 10140: Identification colour markings (Contents of pipelines) would typically be Compressed Air (Artic blue or Pink for instrument air), Argon (Peacock Blue), Closed circuit cooling tower water (white), Drinkable spray water for cooling tower (Brilliant green).

1.11 Work program

The Main building construction period shall be in line within the principal contract period which period shall be co-ordinated with other disciplines. The mechanical contractor shall fit within the overall program and which may be adjusted from time to time. Moreover, the contractor shall take into account the lead times provided by the client of the free issue materials for integration into his program.

2.0 GENERAL SPECIFICATION

2.1 Preface

This general specification contains the standard parts of the mechanical tender and / or mechanical contract. The specification details the minimum offer which shall include design, supply, delivery, installation, commissioning, operation, and maintenance of materials and systems part of mechanical engineering installations. The installations shall be completely as specified, as reflected on the bill of quantities, and as shown on drawings.

2.2 Regulatory framework

The tenderer shall ensure that the installations, including all associated works and methodologies, comply with all the latest amendments of statutory requirements and regulations. The tenderer shall ensure conformance to the following:

a) Occupational Health & Safety Act, Act No. 85 of 1993
b) Construction Regulations
c) Pressure equipment regulations (PER 2009) as amended. Special note shall be made of the requirements for all persons working with and handling pressurized refrigerant gasses to be suitably registered as "competent" persons.
d) Government, Provincial and Local Authorities, Ordinances, Regulations, by-laws, Rules, and other legal instructions.
e) All works shall be executed to satisfy the National Building Regulations as applied through SANS 10400: The Application of the National Building Regulations, as amended, together with associated parts.
f) Commissioning shall be executed in accordance with the Chartered Institution of Building Services Engineers (CIBSE) Commissioning Guides M or American Society of Heating Refrigeration and Air-conditioning Engineers (ASHRAE) Guideline 1-1996.
g) Standard Specifications and codes of Practice issued by the South African National Standards and British Standards Institute.
h) SANS 10140-3 – 2017: Identification colour marking Part 3: Contents of pipelines
i) SANS 10142-1 – 2017: The wiring of premises Part 1: Low-voltage installations
j) SANS 10147 – 2014: Refrigerating systems including plants associated with air-conditioning systems
k) SANS 347 – 2012: Categorization and conformity assessment criteria for all pressure equipment
l) SANS 10173 – 2003: The installation, testing, and balancing of air-conditioning duct work
m) SANS 10191 -2007 Acoustics: Determination of sound power levels of noise sources - Guidelines for the use of basic standards for the reparation of noise test codes
n) SANS 10250-2 – 2010: The minimization of environmental pollution during the servicing and repair of automotive air-conditioning equipment Part 2: Servicing and repairs using refrigerant recycle equipment
o) SANS 193 – 2013: Fire dampers
p) SANS 1238 – 2005: Air-conditioning ductwork
q) SANS 1383 – 2008: Rigid urethane and isocyanurate foams for use in thermal insulation
r) SANS 1424 – 2013: Filters for use in air-conditioning and general ventilation

s) SANS 1445-3 – 2018: Thermal insulation materials for industrial applications Part 3: Bonded preformed mineral fibre pipe sections
t) SANS 1470-3 – 2008: Sound power labelling Part 3: Rotating electrical machinery
u) SANS 1498 – 2007: Algaecides for use in industrial cooling water
v) SANS 1508 – 2007: Expanded polystyrene thermal insulation boards
w) SANS 60335-2-24, IEC 60335-2-24; 2014: Household and similar electrical appliances – Safety Part 2-24: Particular requirements for refrigerating appliances, ice-cream appliances and icemakers
x) SANS 60335-2-30, IEC 60335-2-30; 2015: Household and similar electrical appliances – Safety Part 2-30: Particular requirements for room heaters
y) SANS 60335-2-40, IEC 60335-2-40; 2015: Household and similar electrical appliances – Safety Part 2-40: Particular requirements for electrical heat pumps, air-conditioners, and dehumidifiers
z) SANS 60335-2-41, IEC 60335-2-41; 2015: Household and similar electrical appliances– Safety Part 2-41: Particular requirements for pumps
aa) SANS 60335-2-51, IEC 60335-2-51; 2014 Household and similar electrical appliances– Safety Part 2-51: Particular requirements for stationary circulation pumps for heating and service water installations
bb) SANS 60335-2-88, IEC 60335-2-88; 2003: Household and similar electrical appliances– Safety Part 2-88 Particular requirements for humidifiers intended for use with heating, ventilation, or air conditioning systems
cc) SANS 60335-2-98, IEC 60335-2-98; 2010: Household and similar electrical appliances– Safety Part 2-98: Particular requirements for humidifiers
dd) SANS 60335-2-104, IEC 60335-2-104; 2003: Household and similar electrical appliances– Safety Part 2-104 Particular requirements for appliances to recover and/or recycle refrigerant from air conditioning and refrigeration equipment
ee) SANS 60598-2-19, IEC 60598-2-19; 1981: Luminaries Part 2: Particular requirements Section 19: Air-handling luminaries (safety requirements)
ff) SANS 60730-2-9, IEC 60730-2-9; 2013: Automatic electrical controls for household and similar use Part 2-9: Particular requirements for temperature sensing controls
gg) SANS 60730-2-11, IEC 60730-2-11; 2007: Automatic electrical controls for household and similar use Part 2-11: Particular requirements for energy regulators
hh) SANS 14644-1, ISO 14644-1, 2 and 3; 1999: Clean rooms and associated controlled environments Part 1: Classification of air cleanliness

Works shall be executed in accordance with good engineering practice and workmanship at all times. SANS specification shall take precedence in case of conflicting statements in the above specifications. All references to standards and regulations shall be deemed to apply to the latest, current, and / or as amended standard.

2.3 Contract management and control

Resources

The tenderer shall make available suitably competent, experienced, and capable resources for the timely execution of the works in accordance with the project specification. Project meetings shall be attended as requested by the Engineer, Principal Contractor and Employer. Upper-level management attendance shall be provided at regular site, contract, commercial and engineering meetings.

The tenderer shall submit an organogram of supervisory staff with names that will be involved in the project, showing the time in a month that each individual will be committing to the project against the project program (i.e., a resourced program).

The tenderer shall submit curriculum vitae of his key staff indicating relevant experience. All resources on site shall be certified via appropriate organizations demonstrating competence in their ability to perform the tasks required.

Program and completion

The tenderer shall provide a resourced program of the works, in accordance with the directives herein and in compliance with the form of contract. This program shall be provided within one week of appointment and shall clearly indicate all interdependencies related to works by others.

The tenderer shall ensure their program of works is co-ordinated with other disciplines in the project and satisfies the requirements of the main contractor and the principle building contract. The program of works shall be updated bi-monthly to indicate progress on site and to attend to any potential delays.

The contractor shall submit a detailed works program and anticipated cash flow estimate of his/her offer.

Suitable time shall be allocated to perform commissioning, validation, and hand-over upon approval of the engineer. Attention is drawn to the required completion dates and penalties as described within the contract conditions.

Lead time guarantee

The contractor shall submit with the tender offer a guarantee that all equipment and corresponding supply lead times, delivery, installation, and commissioning of all equipment can be achieved within the project time frame.

Quality management

The tenderer shall maintain an ISO9000 series compliant quality management system for the duration of the contract. The quality file shall be kept on site and shall be made available for inspection by the Engineer, Employer, or his agents.

Signed off quality control checklists, commissioning schedules and test certificates shall be provided prior with all invitations for inspection by the contractor. The Engineer reserves the right to charge the contractor at the prevailing Engineering Council rates for abortive inspections.

Only the highest possible standards of workmanship will be accepted. No inferior quality of workmanship will be accepted.

Scrutiny of drawings

All drawings, circuit or schematic diagrams prepared by or on behalf of the contractor for submission to the engineer in terms of the requirements of this specification shall have

been thoroughly checked, corrected where necessary and signed as approved by the contractor before submission to the engineer.

The scrutiny of any drawings by the engineer will include the review of the arrangement, type, and operational suitability of the equipment in general only. Approval by the engineer will not release the contractor from his responsibility for the proper operation of the installation or for its full compliance with the specification, drawings, local authority and statutory requirements, or for ensuring that the equipment can be physically accommodated within the space and via the access provided.

2.4 Documentation

Documentation shall be provided to demonstrate compliance with all applicable quality, regulatory and specified requirements. The following list of documentation will be required, as a minimum, in order to complete the commissioning phase of the project. All will be subject to approval by the engineer before implementation on site.

a) Contract particulars including contact details and company details of all parties to the contract
b) Emergency contact details for use in case of emergency and service call-out
c) General arrangement drawings, approved workshop drawings and as-built drawings
d) Critical spares list
e) Full parts list including component manufacturer's part numbers and contact details
f) Component manufacturers data sheets
g) Equipment configuration details including air flow balancing data
h) Inventory list with serial and part numbers and drawing references
i) Electrical and control panel layout drawings and wiring diagrams
j) Safety certification for the complete system
k) Operating and maintenance manuals
l) Factory acceptance test reports
m) Commissioning report and training documentation
n) Completed and signed training register for user personnel on the new installations
o) Product, equipment, and material Warranties
p) Escalation steps and basic troubleshooting guide

2.5 Hand-over documentation

The contractor shall provide a list of items and documentation for verification prior to handover. This list shall be circulated a minimum of 14 days prior to the request for handover of the project such that the list may be reviewed and amended as may be required.

Project handover is conditional upon receipt and verification of close-out documents. The typical handover documentation shall be issued as three (3) copies of each of the following - operating and maintenance manuals, as-built drawings, certificate of compliance, drawings of the entire wiring installation from distribution boards to equipment including terminations thereof, commissioning report including actual test results of all systems after commissioning, proof or certificate of training of end-user personnel, and a certificate of commitment for the maintenance and guarantee period as applicable via the contract.

2.6 Testing and commissioning

All safety devices shall be checked for effective operation by simulating the abnormal or overload conditions. All tests and results shall be recorded, and a test report shall be compiled for insertion in the operating and maintenance manual.

For all green buildings, technical buildings, pharmaceutical facilities, healthcare facilities and otherwise as requested the commissioning procedure shall conform to the requirements of ASHRAE Guideline 1.1 -2007: HVAC&R Technical Requirements for The Commissioning Process and to CIBSE Commissioning Code M: Commissioning Management.

2.7 Work allocation

The work allocation will consist of the following:

a) The end user will provide the necessary permanent electric power supply to a point required by the mechanical contractor. The Client will not supply any distribution boards and equipment, or lighting, or power, or ventilation installations.
b) Alterations, which may be required by the contactor, shall be approved by the engineer and form part of the contractor's scope of work e.g., drilling of access holes.
c) The contractor shall provide a site instruction book on site permanently.
d) The contractor shall provide their own tools, labour, temporary storage and accommodation, material, plant, transport, and equipment and execute the contract with a minimal disturbance to the end user. Pre-fabrication off site shall be adopted where possible.
e) The Contractor shall provide their own sheds and site offices.
f) The Contractor shall prepare all construction drawings and eventual as-built drawings, constituting the entire installation. Two sets of hard paper prints of construction drawings are required for scrutiny before construction is commenced.

2.8 Handling of material

The contractor shall be responsible for providing all the required equipment for the off-loading and proper handling or rigging of the material on site. They shall also be responsible for the installation into the correct position.

2.9 Setting out of work

The Contractor shall be responsible for the correct setting out of any holes, sleeves, penetrations, plinths, plant hangers and openings that may be required.

2.10 Shop drawing submittal

The contractor shall submit detailed "shop" drawings indicating the works to be completed. Shop drawings shall be provided to the Engineer within 14 days following confirmation of the intent to appoint or sooner as directed by the Employer, Engineer or agent.

Shop drawing submission shall be made in triplicate, at full scale, and shall include a cover sheet, date stamp, and approval stamp. Shop drawings shall clearly indicate works to be completed by others, i.e., power supplies, drains, water supplies, builder's openings, sleeves, and penetrations.

Shop drawings shall be compliance with ISO standards. Shop drawings shall indicate the particulars of the parties responsible for the design drafting, review, and approval of the drawings.

The scale, drawing size, revision number date and drawing particulars shall be clearly indicated on the drawings. Drawings shall include all sections, 3D views, assembly views, plan views and layouts as required to fully understand the works to be executed.

Works shall be executed strictly in accordance with shop drawings approved by the Engineer. Three copies of the approved shop drawings shall be maintained on site for the inspection of the Engineer at all times.

2.11 Working drawings

One copy of the approved shop drawings shall be maintained up to date to reflect the as built conditions on site. This drawing shall be marked up with all deviations from the approved drawings and shall be highlighted to show installation progress. This marked up drawing shall be copied and issued to the Engineer every time it may be requested.

2.12 Equipment Submittal

The contractor shall compile and submit three (3) booklets of the equipment selection and submittal to the Consulting Engineer within two weeks after appointment for approval. Performance and construction specifications shall be provided for each type of equipment. The equipment submittal booklet shall consist of:

a) Cover page stating the project name, the Client, the consulting engineer and the contractor with contact persons and details
b) The index page stating the contents and sections of the submittal with page numbers
c) General page containing a brief description of the project and the equipment offered
d) Introduction: brief history of the contractor, experience, personnel proposed for the project with brief CV and project photos where the equipment proposed was used.
e) Table of the equipment capacity of all equipment contained in the submittal showing the following:
f) Design conditions
g) Equipment name and designation
h) Area served
i) Operating capacity
j) Dimensions (length, width, height, and weight)
k) Starting current, running current and voltage
l) Noise level
m) Compliance with specification
n) Details of the equipment offered (one page per item installed).
o) General name of equipment offered previous project where equipment was used with reference from the Client
p) The Equipment: all technical specifications, photos where applicable, service interval and estimated operating life in years of the equipment. The technical specifications as a minimum shall state:
q) Capacities
r) Material of manufacture and type of finishes
s) Make

t) Model number
u) Manufacturer details
v) Estimated delivery date
w) Noise levels
x) Operating conditions and performance curves where applicable
y) Compliance with specifications
z) Electrical requirements and loading
aa) Energy efficiency measures of the equipment offered
bb) Any special sustainable design and details included in the equipment
cc) The completed schedule of information in the tender document
dd) Manufacturer's catalogues
ee) Control system and electrical schematics for the equipment
ff) Any other relevant information
gg) Motivation for the proposed equipment

hh) Conclusion
- Approval page for signature and date containing the following:
- The contractor’s name and responsible person signature
- The consulting engineer’s name and responsible person signature
- The Client's signature and responsible person
- Approval stamp by consulting engineer.

2.13 Operation and maintenance manual submittal

The contractor shall compile and submit one (1) booklet of the operation and maintenance manual to the engineer; two months prior to practical completion for approval. On approval by the consulting Engineer, the contractor shall prepare and submit three (3) copies of the approved operation and maintenance manual on practical completion sign off in both hard copy and soft copy. The operation and maintenance manual shall consist of the items as listed herein this specification or as detailed elsewhere in the particular specifications for installations involved.

a) Cover page stating the project name, the Client, the consulting engineer and the contractor with contact persons and details
b) The index page with contents, sections of the submittal with page numbers
c) General information on the project:
d) Name of project
e) Address of project
f) Start and completion date
g) The professional team and contacts
h) The contracting team and contacts
i) Emergency contact details of the contractor
j) Maintenance start and completion date
k) Major equipment suppliers and contact details

l) Description of the System
- Design conditions and technical specification
- Salient points of the installation
- Detailed description of the systems
- Health and safety considerations associated with the systems
- Detailed technical specification and description of all installed equipment

m) Table of the equipment capacity of all equipment and systems installed on the project showing the following:

- Equipment name and designation
- Area served
- Operating capacity
- Dimensions (length, width, height, and weight)
- Starting current, running current and voltage
- Noise level
- Compliance with specification

n) Supplier details and catalogues or technical manuals for each major equipment installed on the project.

o) Operating and Maintenance procedures
- Start and stop procedures
- Emergency procedures
- Procedures for the service, replacement and maintenance of all plant, equipment, and systems.

p) Operating and maintenance schedules and checklists:
- Weekly maintenance
- Monthly
- 3 monthlies
- Quarterly
- Yearly
- Minor service
- Major service
- Every 5 years
- Every 10 years

q) Commissioning results and details of each equipment and system
r) Training of end user details and attendance register sign off
s) Recommended spares
t) As built drawings and documentation
u) Equipment submittal approved page
v) Conclusion

w) Approval page for signature and date:
- The contractor's name and responsible person signature
- The engineer's name and responsible person signature
- The Client's signature and responsible person
- Approval stamp by the engineer.

2.14 Training

On completion of the entire sub-contract work, the contractor shall conduct a detailed training session on the installation works for the end user/client representatives. This training shall address the operations, maintenance, and all other requirements to maintain a fully functional service to the Client.

For the training to commence, the contractor shall compile and submit two (2) copies of the detailed training manual to the consulting engineer within three months prior to practical completion for approval by the engineer and the end user client. The submission will include the agenda for the training, the requirements and qualifications for the training and the duration.

From the consulting engineer, the contractor shall allow a minimum period of two weeks to train the end user in the proper functionality of the system. The training shall consist of both formal classroom training and hands on training on the completed project.

2.15 Defects liability period

The defects liability period shall be in accordance with the form of contract but shall not be less than 12 months. During the defects' liability period all patent and latent defects shall be attended to by the contractor without cost to the Client.

Any item which is repaired or replaced during the guarantee period shall be guaranteed for a further 12 months. The guarantee shall include parts, labour, shipping, transportation, consumables. No cost associated with equipment or workmanship failure or defect shall be attributed to the Client during the defects' liability period.

2.16 Warranty

The contract works shall remain under warranty for 12 months following practical completion of the works. Sectionalized practical completion shall necessitate sectionalized warranty. A warranty schedule shall be provided for the installation and contained within the O&M manual.

2.17 Maintenance

After first delivery of the installation (practical completion), there will follow a 12-month free maintenance and guarantee period. No costs of maintenance shall be incurred by the Client during the free maintenance period. All equipment shall be maintained as per manufacturer's recommendations. Moreover, as a minimum, the Contractor shall allow for maintenance as per Minor & Major Maintenance Schedules forming part of this specification.

2.18 Temporary use of equipment

No equipment forming part of the permanent installation shall be operated or used, during the construction period without the written permission by the engineer. Equipment shall be handed over to the employer in a new condition for the beneficial use of the Client.

2.19 Division of work

The division of work between the main contractor and the mechanical contractor together with other specialist contractors shall be as stated within the principle for of agreement and as specified.

2.20 Hours of work and site conditions

The site will remain in full operation during all mechanical works. Mechanical works shall be scheduled to minimize interruption to site activities. Works shall be scheduled for completion during normal working hours.

In the event of a need to work outside normal hours overtime rates may be affected in order to avoid client disturbance. In the event of a need to work outside normal working hours in order to achieve program commitments such time shall not be recoverable as a variation to the contract.

2.21 Access to the site

The site shall be secured. All personnel shall be required to adhere to the prevailing site terms and conditions of entry and security protocol. The terms and conditions include but are not limited to the following:

a) Registration of all personnel entering the with the security office
b) Criminal background checks must be submitted
c) All personnel entering the site shall be free of criminal record
d) All personnel may be searched at site access and during the course of their duties.

2.22 Storage of materials

Materials shall be stored in places allocated by the main contractor, employer or his agent. Stored equipment and materials shall be protected against damage, dust and dirt, corrosion, theft, and vandalism. Stored materials shall be safely stacked and shall not overload the construction beyond design limits.

2.23 Accessibility and maintainability

All equipment shall be so installed as to be readily accessible for operation, maintenance and repair. A minimum of 1.5 m service access shall be provided around all floor mounted central plant.

All electrical isolators shall be within 1 m of rotating plant and machinery and within clear sight of the equipment access provision.

Filters, belts, bearings, and other routinely maintained items shall be readily accessible from a comfortable and safe location. All items of the installation shall be readily accessible for quick and easy replacement. Adequate space shall be left around all items for the removal and replacement of parts.

2.24 Spares

A full set of spares for types of consumable items such as filters, strainers, belts, and lubricating fluids shall be kept on site and a full set shall be handed over on the anniversary of the first hand over date.

2.25 Material selection

All materials shall be selected to ensure compatibility with local conditions, the environment of application and suitability with the fluid or service carried. Where multiple

materials are utilized in an assembly or construction the compatibility of the materials shall be ensured.

Galvanic corrosion risk shall be mitigated by the use of non-conductive spacers, cathodic protection, or active protection. Materials shall exhibit fire and smoke characteristics in accordance with the rational fire design and National Regulations.

All insulation and cladding shall be applied by experts in the field. Joints shall be as far as possible below the piping and out of immediate view.

3. TECHNICAL SPECIFICATIONS

1. SCOPE: CEILING MOUNTED CASSETTE UNITS

The Ceiling Mounted Cassette Unit Installations shall be as specified under this section of the project specifications

1.1 APPLICABLE STANDARDS

The air-conditioning units and installation in general shall be in accordance with:

- SANS 1125: Room air conditioners and heat pumps
- SABS 0147: Refrigerating systems including plants associated with air-conditioning systems
- SANS 60335-2-40: Household and similar electrical appliances – Safety. Part 2 – 40: Particular requirements for electrical heat pumps, air conditioners and dehumidifiers
- SANS 10142-1-2003: The wiring of premises Part 1: Low-voltage installations
- SABS 1453: Copper tubes for medical gas and vacuum services

2. CASSETTE SPLIT TYPE UNITS

2.2 GENERAL

The units shall be of the heat pump type. The air-conditioning units shall be standard factory assembled, piped and wired. The units shall be thoroughly tested for all operating conditions. Spares shall be freely available in South Africa. On request, the Contractor shall provide the Engineer with performance test certificates.

The air-conditioning units and installation in general shall be in accordance with the cassette unit's supplier's recommendations. Any discrepancies between this specification and the supplier's recommendations that may influence the unit's performance or guarantee shall be clarified with the Engineer during tender stage.

The electrical power requirements to the condensing units shall be:

- Single phase when the cooling capacity of the unit is less than 10 kW.
- Three phase when the cooling capacity of the unit is more or equal to 10 kW.

The indoor unit and condensing unit shall be interconnected with refrigerant piping, electrical wiring and interlocking control cabling. The pipe and cable connections shall be made in accordance with the unit supplier's recommendations. The refrigerant shall conform to the Montreal Protocol and not be subject to the phasing out programme.

The indoor unit shall be of the 4-way blow type.

Indoor units shall have factory fitted, electrically operated condensate pumps with a drainpipe connection. Integral safety switches shall be provided to prevent the pump from running dry, and to prevent the cassette unit from operating when the condensate pump has failed. The indoor unit shall be fitted with fresh air connection knockout panel.

Each condensing unit with connected evaporator unit shall be clearly labelled to identify different split units

The outdoor unit coil shall be treated for corrosion with blygold, techni-coat, corium or any other method as approved by the Engineer.

All units shall be of Daikin manufacture or other approved. "Other approved" means approved by the Engineer during the tender stage.

2.3 PERFORMANCE SPECIFICATIONS

Cooling and heating capacities are room conditions, and all equipment shall be de-rated to meet these requirements.

De-rating shall be done to compensate for the following:

- Altitude above sea level.
- Refrigerant pipe lengths.
- Design conditions specified.

All units shall be capable of meeting total and sensible cooling requirements. Tenderers shall provide proof of de-rated capacities with their tender. All capacities specified are to be achievable at medium evaporator fan speed.

2.4 PROTECTION AND SAFETY DEVICES

Reverse phase, three phase overload, overload during startup, phase imbalance, phase loss and low voltage protection shall be provided for all three phase motors.

Protection fuses shall be provided for all control circuits.

The compressor shall have high and low refrigerant pressure protection.

The indoor and outdoor units shall comply with the safety requirements as set out in:

- SANS 60335-2-40: Household and similar electrical appliances – Safety. Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers.

2.5 ELECTRICAL

Generally, the power to cassette units shall be provided by the electrical contractor in a weatherproof isolator mounted within 1 m from the condensing unit. The mechanical contractor shall do the entire electrical installation from the isolator to the condensing unit and the indoor unit.

Where the electrical contractor provides a cable only to a distribution board that serves a group of air-conditioning units, the mechanical contractor shall provide the distribution board, connect the incoming power cable and shall do all the electrical wiring from the distribution board to the condensing units and the indoor units.

In all instances the mechanical contractor shall provide isolators as required. All electrical and control cables shall be neatly strapped with the refrigeration piping in a galvanised cable tray.

The entire electrical installation shall comply with:

- SANS 10142-1-2003: The wiring of premises Part 1: Low-voltage installations

On completion, the Contractor shall issue a compliance certificate for the entire electrical installation.

Electrical and control cables mounted between indoor and outdoor units shall be installed without joints in the cable and shall be of the UV protected type.

2.6 **CONTROLS**

Controls shall be of the hard wired, wall mounted electronic type. Controls shall be of the same manufacture as the air-conditioner. Controls shall be mounted over a flush mounted 100 mm x 50 mm electrical box. Control wiring shall be installed in a 20 mm electrical conduit from the controller to the air conditioning unit. The conduit and outlet box shall be chased into the wall by the Electrical Contractor. The electrical contractor shall install the conduit from the outlet box to 100 mm above ceiling level directly above the controller.

2.7 **REFRIGERANT CIRCUITS**

Refrigerant piping shall be in accordance with the following standards:

- SABS 1453: Copper tubes for medical gas and vacuum services
- SABS 0147: Refrigerating systems including plants associated with air-conditioning systems

Fittings shall be copper based capillary solder fittings in accordance with SABS 1067. All soldered joints on proprietary manufactured units shall be carefully checked and remade if found damaged in transit.

Pipe size selections shall be such as to produce moderately low velocities whilst:

- Ensuring proper oil return to the compressor and minimizing lubricating oil being trapped in the system.
- Ensuring practical lines without excessive pressure drops and with proper feed to evaporators.
- Preventing liquid refrigerant from entering the compressor during operation and at shutdown.

Refrigerant piping shall be sized and fitted with the necessary oil traps strictly in accordance with the unit manufacturer's requirements.

All refrigerant pipelines shall be insulated with the "Armaflex" type, lightweight, elastomeric nitrile rubber tube insulation. Insulation thickness shall be 13 mm.

Suction and liquid pipelines shall be insulated separately and joints on insulation shall be glued with the insulation manufacturer's recommended adhesive to create a vapour barrier.

The installation of trunking and trays shall form part of this mechanical contract.

5. INSTALLATION REQUIREMENTS

5.1 **INSTALLATION OF INDOOR AND OUTDOOR UNITS**

During installation, care shall be taken to ensure that no vibrations are carried over to structures to which the indoor and outdoor units are fixed.

Outdoor condensing units shall be installed on wall mounted brackets and / or a concrete slab as indicated on the project drawings.

Where installed on wall mounted brackets, the condensing unit shall be properly bolted to the mounting bracket with adequately sized fasteners. Bracket design to be checked by structural engineer.

Where installed on a concrete slab, the condensing unit shall be fitted on top of neoprene vibration isolating pads and 450 mm square concrete paving slabs.

5.2 INSTALLATION OF CONDENSATE DRAIN PIPES

If an outdoor unit (heat pump type) is mounted against a wall more than 1 m above ground / floor level, the unit shall be fitted with an uPVC drain pipe neatly saddled to the wall. Drain pipe sizes for outdoor units shall be to the supplier's recommendation.

Condensate drain pipes shall always run together with refrigerant pipes and shall always be installed in the same trunking and on the same cable trays for as far as the installation permits. Surface mounted drain piping shall only be allowed where condensate drain pipes run in a different direction to either a service duct, waste water pipe or any other location as indicated on the project drawings. Surface mounted drain piping shall be secured to the wall by means

Drain pipes shall run together with the refrigerant pipes to the outside unit where the condensate shall be drained.

All condensate pipes running from indoor units to waste water pipes, outlet gullies or open wastewater points shall be fitted with a U-trap at a location as indicated on the project drawings.

uPVC pipes shall be used for drain piping from indoor units. Drain pipe sizes for indoor units shall be ∅ 25 mm for all unit sizes.

The first 5m of drain piping shall be insulated with "Armaflex" type, lightweight, elastomeric nitrile rubber tube insulation. Insulation thickness shall be 13 mm. In ceiling voids, drain pipes shall be installed in galvanized cable trays. Where drain piping does not run with refrigeration piping in the same cable trays, 76 mm galvanised "Cabstrut" light duty cable tray shall be used. Drain piping shall be fixed to the cable tray with suitably sized cable ties installed at 500 mm intervals.

Horizontal mounted drain pipes shall be installed at a slope of 20 mm per 1 000 mm, ensuring positive drainage.

Where drainage piping or control cabling is required to be installed flush-mounted, positioning and chasing shall be done in good time to meet construction programs.

5.3 INSTALLATION OF REFRIGERANT PIPING

Refrigerant piping shall be arranged so that normal inspection and servicing of the compressor and other equipment is not hindered. Locations where copper tubing will be exposed to mechanical damage shall be avoided. Hangers and supports where piping go through walls shall be installed to prevent transmission of vibration to the building.

Refrigerant piping in ceiling voids and mounted internally against walls shall be installed in 101 mm wide galvanised steel Cabstrut light duty cable trays (per unit). Pipes shall be strapped over insulation to cable trays at 500 mm intervals with suitably sized cable ties. Cable trays shall be 152 mm wide where drainpipes run together with refrigerant piping (per unit).

Externally mounted refrigeration pipes and drainpipes shall be mounted in Cabstrut P9000 cable trunking (127 mm x 76.2 mm). Cable trunking shall be complete with clip on covers. Pipes and cables shall be strapped together every 500 mm with suitably sized cable ties and loosely fitted in the trunking. The trunking shall be manufactured from galvanised steel and epoxy powder-coated to a colour as specified by the Engineer.

Any insulation material not covered by the trunking and exposed to the elements shall be neatly strapped with cable ties to minimise the possibility of dirt and water entering between the insulation and refrigeration pipes.

1. SCOPE: CEILING SUSPENDED SPLIT TYPE UNITS

The Under-Ceiling Unit installations or Ceiling suspended split units shall be specified under this section of the project specification

2. APPLICABLE STANDARDS

The air-conditioning units and installation in general shall be in accordance with:

- SANS 1125: Room air conditioners and heat pumps
- SABS 0147: Refrigerating systems including plants associated with air-conditioning systems
- SANS 60335-2-40: Household and similar electrical appliances – Safety. Part 2 – 40: Particular requirements for electrical heat pumps, air conditioners and dehumidifiers
- SANS 10142-1-2003: The wiring of premises Part 1: Low-voltage installations
- SABS 1453: Copper tubes for medical gas and vacuum services

CEILING SUSPENDED SPLIT TYPE UNITS

2.1 **GENERAL**

The units shall be of the heat pump type.

The air-conditioning units shall be standard factory assembled, piped and wired. The units shall be thoroughly tested for all operating conditions. Spares shall be freely available in South Africa. On request, the Contractor shall provide the engineer with performance test certificates.

The air-conditioning units and installation in general shall be in accordance with the ceiling suspended unit's supplier's recommendations. Any discrepancies between this specification and the supplier's recommendations that may influence the unit's performance or guarantee shall be clarified with the engineer during tender stage.

The electrical power requirements to the condensing units shall be:

- Single phase when the cooling capacity of the unit is less than 10 kW.
- Three phase when the cooling capacity of the unit is more or equal to 10 kW.

The indoor unit and condensing unit shall be interconnected with refrigerant piping, electrical wiring and interlocking control cabling. The pipe and cable connections shall be made in accordance with the unit supplier's recommendations. The refrigerant shall be of the R22 type.

Each condensing unit with connected evaporator unit shall be clearly labelled to identify different split units.

The outdoor unit coil shall be treated for corrosion with blygold, techni-coat, corium or any other method as approved by the Engineer.

All units shall be of Daikin manufacture or other approved make. "Other approved" means approved by the Engineer during the tender stage.

2.2 PERFORMANCE SPECIFICATIONS

Cooling and heating capacities are room conditions and all equipment shall be de-rated to meet site design conditions requirements.

De-rating shall be done to compensate for the following:

- Altitude above sea level.
- Refrigerant pipe lengths.
- Design conditions specified.

All units shall be capable of meeting total and sensible cooling requirements. Tenderers shall provide proof of de-rated capacities with their tender. All capacities specified are to be achievable at medium evaporator fan speed.

2.3 PROTECTION AND SAFETY DEVICES

Reverse phase, three phase overload, overload during startup, phase imbalance, phase loss and low voltage protection shall be provided for all three phase motors.

Protection fuses shall be provided for all control circuits.

The compressor shall have high and low refrigerant pressure protection.

The indoor and outdoor units shall comply with the safety requirements as set out in:

- SANS 60335-2-40: Household and similar electrical appliances – Safety. Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers.

2.4 ELECTRICAL

Generally the power to ceiling suspended units shall be provided by the electrical contractor in a weather proof isolator mounted within 1m from the condensing unit. The mechanical contractor shall do the entire electrical installation from the isolator to the condensing unit and the indoor unit.

Where the electrical contractor provides a cable only to a distribution board that serves a group of air-conditioning units, the mechanical contractor shall provide the distribution board, connect the incoming power cable and shall do all the electrical wiring from the distribution board to the condensing units and the indoor units.

In all instances the mechanical contractor shall provide isolators as required. All electrical and control cables shall be neatly strapped with the refrigeration piping in a galvanised cable tray.

Where applicable, section 1.3 (electrical) of this project specification shall also apply to this section of the specification.

The entire electrical installation shall comply with:

- SANS 10142-1-2003: The wiring of premises Part 1: Low-voltage installations

On completion, the Contractor shall issue a compliance certificate for the entire electrical installation.

Electrical and control cables mounted between indoor and outdoor units shall be installed without joints in the cable and shall be of the UV protected type.

2.5 CONTROLS

Controls shall be of the hard wired, wall-mounted electronic type. Controls shall be of the same manufacture as the air-conditioner. Controls shall be mounted over a flush-mounted 100 mm x 50 mm electrical box. Control wiring shall be installed in a 20 mm electrical conduit from the controller to the air conditioning unit. The conduit and outlet box shall be chased into the wall by the electrical contractor. The electrical contractor shall install the conduit from the outlet box to 100 mm above ceiling level directly above the controller.

2.6 REFRIGERANT CIRCUITS

Refrigerant piping shall be in accordance with the following standards:

- SABS 1453: Copper tubes for medical gas and vacuum services
- SABS 0147: Refrigerating systems including plants associated with air-conditioning systems

Fittings shall be copper based capillary solder fittings in accordance with SABS 1067. All soldered joints on proprietary manufactured units shall be carefully checked and remade if found damaged in transit.

Pipe size selections shall be such as to produce moderately low velocities whilst:

- Ensuring proper oil return to the compressor and minimising lubricating oil being trapped in the system.
- Ensuring practical lines without excessive pressure drops and with proper feed to evaporators.
- Preventing liquid refrigerant from entering the compressor during operation and at shutdown.

Refrigerant piping shall be sized and fitted with the necessary oil traps strictly in accordance with the unit manufacturer's requirements.

All refrigerant pipelines shall be insulated with the "Armaflex" type, lightweight, elastomeric nitrile rubber tube insulation. Insulation thickness shall be 13 mm.

Suction and liquid pipelines shall be insulated separately and joints on insulation shall be glued with the insulation manufacturer's recommended adhesive to create a vapour barrier.

The installation of trunking and trays shall form part of this mechanical contract.

3. INSTALLATION REQUIREMENTS

The following standard drawings shall apply and shall be read in conjunction with this specification:

DRAWING DESCRIPTION	DRAWING NUMBER
Typical condenser mounting detail with isolator position (wall-mounted with U-trap)	TBC
Typical condenser mounting detail with isolator position (wall-mounted without U-trap)	TBC

3.1 INSTALLATION OF INDOOR AND OUTDOOR UNITS

During installation, care shall be taken to ensure that no vibrations are carried over to structures to which the indoor and outdoor units are fixed.

Indoor units shall be suspended from the ceiling and installed as indicated on the project standard drawings.

Outdoor condensing units shall be installed on wall-mounted brackets and / or a concrete slab as indicated on the project drawings.

Where units are installed on wall-mounted brackets, the condensing unit shall be properly bolted to the mounting bracket with adequately sized fasteners.

Where outdoor units are installed on a concrete slab, the condensing unit shall be fitted on top of neoprene vibration isolating pads and 450 mm square concrete paving slabs.

3.2 INSTALLATION OF CONDENSATE DRAINPIPES

The ceiling suspended unit is installed on the inside of an exterior wall with wall-mounted brackets where the condensate and refrigerant pipes penetrate directly behind the unit thought the wall. No integral condensate pump needed.

3.3 INSTALLATION OF CONDENSATE DRAINPIPES

If an outdoor unit (heat pump type) is mounted against a wall more than 1 m above ground / floor level, the unit shall be fitted with an uPVC drainpipe neatly saddled to the wall. Drainpipe sizes for outdoor condensing units shall be to the supplier's specification.

Condensate drainpipes shall always run together with refrigerant pipes and shall always be installed in the same trunking and on the same cable trays for as far as the installation permits. Surface mounted drain piping shall only be allowed where condensate drainpipes run in a different direction to either a service duct, wastewater pipe or any other location as indicated on the project drawings. Surface mounted drain piping shall be secured to the wall by means of galvanised steel saddles at no more than 1 m intervals.

Where ceiling suspended units are mounted on the inside of exterior walls on wall-mounted brackets, the mechanical contractor shall drill sufficiently sized holes through which refrigerant pipes, drainpipes and cable wires shall penetrate directly behind the indoor unit. Drainpipes running from the indoor unit through the wall shall be adequately sloped to ensure positive drainage.

All condensate pipes running from indoor units to wastewater pipes, outlet gullies or open wastewater points shall be fitted with a U-trap at a location as indicated on the project drawings.

uPVC pipes shall be used for drain piping from indoor units. Drainpipe sizes for indoor units shall be ∅ 32 mm for all unit sizes.

The first 5m of drain piping shall be insulated with "Armaflex" type, lightweight, elastomeric nitrile rubber tube insulation. Insulation thickness shall be 13 mm.

Where drainage piping or control cabling is required to be installed flush mounted, positioning and chasing shall be done in good time to meet construction programs.

3.4 INSTALLATION OF REFRIGERANT PIPING

Refrigerant piping shall be arranged so that normal inspection and servicing of the compressor and other equipment is not hindered. Locations where copper tubing will be exposed to mechanical damage shall be avoided. Hangers and supports where piping go through walls shall be installed to prevent transmission of vibration to the building.

Refrigerant piping in ceiling voids and mounted internally against walls shall be installed in 101 mm wide galvanised steel Cabstrut light duty cable trays (per unit). Pipes shall be strapped over insulation to cable trays at 500 mm intervals with suitably sized cable ties. Cable trays shall be 152 mm wide where drainpipes run together with refrigerant piping (per unit).

Externally mounted refrigeration pipes and drainpipes shall be mounted in Cabstrut P9000 cable trunking (127 mm x 76.2 mm). Cable trunking shall be complete with clip on covers. Pipes and cables shall be strapped together every 500 mm with suitably sized cable ties and loosely fitted in the trunking. The trunking shall be manufactured from galvanised steel and epoxy powder coated to a colour as specified by the engineer.

Any insulation material not covered by the trunking and exposed to the elements shall be neatly strapped with cable ties to minimise the possibility of dirt and water entering between the insulation and refrigeration pipes.

1. SCOPE: VENTILATION SYSTEMS

The following installations shall be specified under this section of the project specification:

- All fresh air and extraction systems

2. DESIGN CRITERIA

- Shall be as shown in the Particular Specification and as per Engineer's Instruction

3. APPLICABLE STANDARDS

The air-conditioning units and installation in general shall be in accordance with:

- SANS 1424-1987: Filters for use in air-conditioning and general ventilation
- SANS 1238:2005: Air-conditioning ductwork
- SANS 10173:2003: The installation, testing and balancing of air-conditioning ductwork
- SANS 60335-2-80: Household and similar electrical appliances – Safety Part 2-80: Particular requirements for fans
- SANS 10108: The classification of hazardous locations and the selection of apparatus for use in such locations

4. VENTILATION FANS

4.1 GENERAL

The combination of fan and attenuators shall be such that the specified noise levels are achieved.

Where no pressure requirements are indicated, the Contractor shall estimate the fan static pressure requirements for the system lay-out and tender accordingly. Where filters are included in the system, the static pressure losses through filters shall be estimated at ***150*** Pa through each stage of filtration.

Ventilation and extraction fan duties as specified on the tender drawings shall be checked against the respective system's design resistance once all information on the selected system is available. Where fan duties are found inadequate, the contractor shall notify the Engineer before ordering the equipment.

Fans shall be selected to operate at or as close to maximum efficiency as possible.

Attenuators shall be mounted directly onto the fan casing with flexible connections between the ducts and attenuators.

Fans shall be fitted with the manufacturer's nameplates permanently fixed to the casing in a prominent position, clearly indicating manufacturer, model number, size, speed, maximum operating speed, maximum power absorbed and serial number.

Fan air in/outlets not connected to ducting or equipment shall be protected with easy removable safety wire mesh screens.

Indicating arrows for both directions of rotation and direction of airflow shall be provided on fan casings.

All fans shall be installed in accordance with the manufacturer's requirements and recommendations.

All fans shall be mounted on anti-vibration mountings or supported from anti-vibration hangers.

Bearings shall be of the ball or roller type and shall be quiet in operation. They shall be sized to give a long life (not less than 100 000 hours) at the loads imposed by the application.

Belt guards shall be arranged to permit lubrication and use of speed counters with the guards in position. Belt guards shall have adequate ventilation for belt cooling.

The construction and design of electrical apparatus for ventilation equipment in hazardous environments shall comply with the relevant SANS specification, e.g. SANS 10108. The electrical installation shall comply with SANS 60335-2-80: Household and similar electrical appliances – Safety Part 2-80 Particular requirements for fans.

4.2 IN-LINE MIXED FLOW FANS

In line mixed flow fans shall be suitable for duct installation as indicated on the project drawings for the relevant ventilation and/or extraction system(s). Mixed flow fans shall be manufactured from a self-extinguishing material, be IP54 protected and be equipped with fan motor overload protection. Fans shall have compact overall dimensions with the overall diameter only slightly larger than the ventilation duct.

In-line mixed flow fans shall have two speed settings and shall be sized and selected so as to meet the required fan duty at the lower speed setting. In line mixed flow fans with their adjoining attenuators shall not exceed the NC level as set out in Section 1.2, Sound Control.

To minimise the transmission of vibration of fan noise, fans shall be resiliently mounted on rubber cushions or anti-vibration hanger rods.

4.3 IN-LINE AXIAL FLOW FANS

Axial flow fans shall be of the non-overloading, aerofoil type with peak power requirements occurring at normal operating pressure range. The fan motor shall have a rating exceeding this requirement. Axial flow fans shall operate at the highest possible efficiency at the lowest possible blade tip speed.

Impeller blades shall be manufactured from a die-cast aluminium alloy clamped in a split steel or aluminium cast hub. Hubs on larger fans shall be manufactured from hot dip galvanised steel. The blade pitch shall be adjustable at the hub. Cast steel hubs shall be electro-coated.

Axial flow fan casings shall be manufactured from hot dipped galvanised mild steel with predrilled flanges on both ends of the fan. An access panel of ample size shall be provided in the casing. All fasteners shall be zinc plated.

Fan motors shall be totally enclosed and shall be of the squirrel-cage induction type with protection to IP 55 standard. An external weather proof terminal box forming part of the casing shall be included in the design for motor connections. Where belt driven fans are used, belts shall be of the V-belt type with grooved pulleys. Belts shall be oil resistant, non-sparking and non-static. Belt drives shall comply with OHSA requirements.

Axial flow fans shall be statically and dynamically balanced in accordance with ISO 1940 – 1973 within grade G6.3.

Axial flow fans shall always be resiliently mounted on anti-vibration mountings to prevent carry over of vibration to the structure to which the unit is fixed.

Roof Mounted fans shall be of precision manufacture from glass fibre reinforced polyester resin giving a strong yet light-weight construction. The cowls shall be aerodynamically designed to produce the minimum possible resistance to airflow whilst offering full protection against the weather. Associated motors shall be asynchronous induction type motors with squirrel type external rotors. Moreover, shall be complete with a steel finger proof guard as standard; mounted to the inlet side of the fan.

Fans shall be installed with sound attenuators as specified in Section 1.2 of this specification. . In line centrifugal fans with their adjoining attenuators shall not exceed the NC level as set out in Section 1.2, Sound Control.

In-line axial flow fans shall be of the Donkin type Majax 2 or equally approved.

4.4 CEILING FANS

The Ceiling Fans shall be steel construction with three (3) aluminium blades epoxy painted, brilliant white. 1400mm diameter

Fan shall be mounted with a V-shaped ceiling hook with rubber bush fixed to the roof structure supporting the fan via a steel shackle with nut and bolt.

Both upper and lower fixings on the down red to have plastic canopies to conceal fixing.

Down rod to be adjusted to ensure a minimum height of the fan blades to be no less than 2.3 meters AF.F.L

The fans shall have individual surface mounted flush type speed regulator with four(4) speeds. The conduit to the fans and wall box to be provided by the electrician.

Fan motors to be no bigger than 220v motors with permanent capacitor 290 RPM max. Ceiling fans to be Luft LCF56 or other approved.

5. DUCTING

5.1 APPLICABLE DRAWINGS

The following standard drawings shall apply to the installation of ducting and shall be read in conjunction with this specification.

DRAWING DESCRIPTION	DRAWING NUMBER
Bends and turning vanes for various size rectangular ducts	STD-D15
Longitudinal seams for rectangular low pressure ductwork	STD-D16
Transverse Joints for rectangular low pressure ductwork	STD-D17
Hangers and supports for ducting without insulation and vapour barrier	STD-D18
Longitudinal seams and transverse joints for rectangular medium and high pressure ductwork	STD-D20
Fastening of flexible material to metal ductwork	STD-D21
Longitudinal seams and transverse joints for circular ductwork	STD-D22
Typical change in size and shape of duct cross-sectional areas	STD-D23
Bends and turning vanes for various size circular ducts	STD-D24

5.2 GENERAL

Sheet metal ductwork shall be manufactured in accordance with SANS 1238 and installed balanced and tested as set out in SANS 10173. The installation and manufacture of ductwork shall strictly be in accordance with SANS standard specifications with specific attention given to the following:

- Changes in size and shape of ducting: refer to SANS 1238, section 6.3. Particular requirements are given on the following standard drawing: TYPICAL CHANGE IN SIZE AND SHAPE OF DUCT CROSS-SECTIONAL AREAS, STD-D23.
- Access openings, doors and covers refer to SANS 1238, Section 5.3.
- Sealant requirements: refer to SANS 1238, Section 5.6.
- External ducting insulation: refer to SANS 10173, Section 5.4.
- Material thickness and duct stiffening for low pressure ductwork: refer to SANS 1238, Section 6 for rectangular ductwork and SANS 1238, Section 7 for circular ductwork.
- Radius and square bends as well as turning vanes: refer to SANS 1238, section 6.4. Typical bend layouts as set out in SANS 1238 are given on the following standard drawings: BENDS AND TURNING VANES FOR VARIOUS SIZE RECTANGULAR DUCTS, STD-D15 and BENDS AND TURNING VANES FOR VARIOUS SIZE CIRCULAR DUCTS, STD-D24.
- Unless the sheet-metal ductwork is inherently corrosion protected, all sheet-metal shall be protected against corrosion as outlined in SANS 1238, Section 8.

It shall be the responsibility of the installing contractor to ensure proper assembly and sealing of sheet-metal ductwork and insulation strictly in accordance with SANS specifications.

The air duct system shall be of the low-pressure type and the ductwork shall be manufactured of galvanised mild steel with general material requirements as set in section 5.1 and 5.2 of SANS 1238. The ductwork shall either be circular or rectangular in cross-section as indicated on the project drawings.

The first dimension given on the drawings for rectangular ductwork shall be read as the width on plan and the depth on section, and the second dimension shall be read as the depth on plan and the width on section.

The duct dimensions shown on the drawings are sheet metal dimensions. All final dimensions shall be checked on site or verified by means of architect's working drawings and structural drawings before the fabrication of the ducting.

Sealing membranes and adhesives for affixing insulation shall meet the indexes for surface spread of flame, heat contribution and smoke production as set out in section 4 of SANS 1238.

The inner surfaces of ducting shall be smooth, and no internal insulation shall be used. Dampers, sound attenuators, duct splitters and turning vanes shall be installed where indicated on the drawings.

Flexible connections shall be provided between all fans, sound attenuators and ducting. Flexible connections exposed to weather shall be provided with protecting galvanised sheet steel cover strips. The material used for flexible joints shall comply with the requirements as set out in SANS 1238, section 5.5. Flexible connections shall be provided on both sides of the equipment with a method as indicated on the following standard drawing: FASTENING OF FLEXIBLE MATERIAL TO METAL DUCTWORK, STD-21.

Ducting shall always be installed in such a way, that, especially in plant rooms, maximum height between the floor and the underside of ducting is achieved.

The installation and testing of hangers shall comply with the requirements as set out in SANS 10173. All hangers shall be treated against corrosion and shall be painted.

Reinforcement, duct stiffening and fastening accessories shall be galvanised and installed where required. Only duct accessories manufactured from compatible materials, which comply with SANS 10173, shall be installed with the ductwork. Tie rods shall be manufactured from galvanised steel. Rivets, screws, bolts and other fastening equipment shall be corrosion proof.

5.3 LONGITUDINAL SEAMS AND TRANSVERSE JOINTS

Pieces of ductwork shall be joined with the necessary sealants, as applicable, as set out in SANS 10173, Section 5.

5.3.1 Rectangular Ductwork

Longitudinal seams and transverse joints for rectangular ductwork shall be in accordance with SANS 1238, Section 6. Refer to the following standard drawings for typical details on longitudinal seams and transverse joints:

- LONGITUDINAL SEAMS FOR RECTANGULAR LOW-PRESSURE DUCTWORK, STD - 16
- TRANSVERSE JOINTS FOR RECTANGULAR LOW-PRESSURE DUCTWORK, STD – 17
- LONGITUDINAL SEAMS & TRANSVERSE JOINTS FOR MEDIUM AND HIGH-PRESSURE DUCTWORK, STD - 20

As an alternative to transverse joints specified in SANS 1238, other flanged joints such as MEZ-flanges will also be considered provided that they meet the SANS requirements.

MEZ-flanges or equivalent products shall be manufactured from cold rolled steel and hot-dip galvanised after manufacture.

5.3.2 **Circular Ductwork**

Longitudinal seams and transverse joints for circular ductwork shall be according to SANS 1238, Section 7. Refer to the following standard drawings for typical details on longitudinal seams and transverse joints:

- LONGITUDINAL SEAMS & TRANSVERSE JOINTS FOR CIRCULAR DUCTWORK

5.4 **THE HANGING AND SUPPORTING OF DUCTWORK**

Hangers and supports for rectangular and circular ductwork with no insulation shall comply with SANS 10173, section 5.3 *"Ductwork with no vapour barrier"*. The hanger and support types used for ducting with insulation may be used. In addition to these types, the types depicted in the following standard drawing may also be used: HANGERS AND SUPPORTS FOR DUCTING WITH NO INSULATION, STD-D18.

5.5 **FLEXIBLE DUCTING**

Flexible ducting shall comply with the requirements as set out in SANS 10173, section 5.7. Flexible ducting shall be proprietary manufactured with a fire rating to SABS 0177 Part 3 Class 1. The flexible ducting shall have an adequate working pressure and temperature range to suit the application of the installation.

Flexible ducting shall at all times be kept to a length not exceeding 1.5m. Flexible ducting shall not have more than the equivalent of one 90^{o} bend and bends shall be of maximum possible radius. Flexible ducting shall be supported with sufficient and correct brackets that will ensure maintenance of shape.

Flexible ducting shall be provided between air terminals, diffusers and all locations as indicated on the project drawings.

The inner core shall be of aluminium laminate with a heavy-duty steel helix core.

5.6 **TESTING OF DUCTWORK**

All ducting shall be leak tested in accordance with SANS 10173, section 4.3. No ducting shall have leakage rates in excess of 5 % of the required air flow rate in any section of ductwork or in excess of the SANS permissible leakage rates, whichever is the smallest.

6. AIR TERMINALS AND DAMPERS

6.1 **GENERAL**

Where selected by the contractor, air diffusion equipment shall be selected in accordance with the manufacturer's recommendations, capable of passing the specified air quantity at the appropriate throw without creating excessive resistance, noise or local draughts. All air diffusing equipment shall be capable of meeting the NC level requirements, as specified in section 1.2 – sound control, for the space environment where the equipment is installed.

In all instances where spigot boxes (plenums) are used for the connection of air diffusion equipment, the inside surfaces shall be painted black to prevent visibility of the internal surface from ground level.

During commissioning of the system, each grille, diffuser, valve etc. shall be set to deliver the specified air quantity. It is the Contractor's responsibility to check regenerated noise levels of grilles offered against the overall acoustic performance of the system required. Noisy grilles that exceed the NC level requirements of the given space shall be replaced at the Contractor's expense with more suitable types.

7. DOOR AND TRANSFER GRILLES

Transfer air grilles shall be complete with fixed curved blades and outer frame on both sides of the wall or partition. Transfer air grilles shall be of aluminium extruded type, naturally anodised or epoxy powder coated to a colour as specified by the Engineer. Openings in walls where transfer grilles are to be installed shall be provided by the Building Contractor.

Door air grilles shall be installed in wooden doors only. In cases where steel and glass doors are used, transfer grilles or transfer ducting as an alternative shall be installed. Door air grilles shall be of the chevron-blade type. Door air grilles shall be manufactured from extruded type 5OS anodised aluminium, naturally anodised or epoxy powder coated to a colour as specified by the engineer.

Transfer ducting shall comprise of galvanised sheet metal ducting and aluminium curved blade intake and outlet transfer grilles. Flexible ducting shall not be used as transfer ducting.

8. WEATHER LOUVRES

Weather louvres shall be manufactured of extruded aluminium sections and finished in a colour as approved by the Engineer. Louvres shall be of the Europair type WL or other approved.

Weather louvres shall be constructed with drip edges to blades and rigid frames to enable building in.

Weather louvres shall be watertight and shall prevent the entrainment of raindrops at a face velocity of up to 3 m/s.

Galvanized expanded metal or wire mesh screens with 12 mm opening sizes shall be fitted behind the blades of each weather louvre.

Top and bottom blades shall be fitted flush with the frame and be smooth without grooves, channels or recess where dirt or water can collect.

The free area through the louvre available for airflow shall be a minimum of 65 % of the nominal area of the louvre.

9. FIXING OF WALL-MOUNTED GRILLES AND LOUVRES

All wall-mounted grilles and louvers shall be fixed to a hard wood frame. The timber frames shall be supplied with the grilles as part of this installation.

The timber frames shall be manufactured in such a way that the grilles fit into them and such that the flanges of the grilles extend past the outer edge of the frames by approximately 5 mm. The timber frames shall be provided with the necessary cleats with which to mount them in brick or concrete walls. The depth of the timber frames shall be similar to the walls in which they are fitted.

The frames shall be supplied to the builder in good time so that they can be built into the walls. Should the mechanical contractor fail to do this, the frames shall be let into the walls afterwards and all builder's work, making good and painting shall be for the account of the mechanical contractor.

10. EXHAUST DISC VALVES

Disc valves shall be supplied and installed in the ceilings of the ablution areas and connected to the extract ducts by means of sheet metal spigots and flexible ducting.

The disc valves shall consist of a ring and central disc, which when rotated shall adjust the volume through the outlet. During commissioning of the system, each disc valve shall be set to exhaust the specified air quantity.

Disc valves in ceilings shall be of the polypropylene type, in a finish to match the ceiling colour. The valves shall be of the Europair DVS type or other approved.

11. VOLUME CONTROL DAMPERS

Volume control dampers shall be installed in branch ducting to ensure a balanced air flow to all duct sections.

Damper blades, links and damper frames shall be of rigid construction and manufactured from galvanised steel. Dampers shall comply with SANS 1238.

Dampers for positive volume control purposes shall be manual or electric actuator driven as specified. Dampers shall be of the link or gear type.

A manually adjustable damper shall be fitted with an external adjusting lever in an accessible position. The lever shall be mounted on a square shaft and fitted with a locking mechanism that clearly indicates the current position of the blade. "OPEN", "CLOSED" and "OPERATING POSITION" shall also be clearly marked on each damper.

The inside cross-sectional area of the damper shall be equal to that of the connecting ductwork and shall conform to the same standards of air-tightness as the rest of the ductwork system. The damper shall be fitted to the ducting in which it is installed by means of a flanged connection.

Dampers creating unacceptable vibrations and noise levels will be rejected and will need to be replaced at the Contractor's expense.

Multi-vane control dampers shall be of the opposed blade type.

12. FIRE DAMPERS

Fire dampers shall be installed where indicated on the drawings.

Fire/smoke control dampers shall comply with SABS 193 as amended, and shall be SABS marked with proven low leakage in the closed position.

Fire dampers shall be flanged both sides, and an access panel shall be provided in ducting at each fire damper, preferably on the upstream side of the damper.

Fire damper markings shall be as follows:

a) Manufacturer's name or trade name or trade mark.

b) Fire resistance rating, in hours.

c) Vital instructions regarding installation, direction of airflow, mounting position.

The open or closed status of the damper shall be clearly indicated outside the casing for inspection purposes.

Fire dampers shall have at least a 2 hour resistance rating when tested in accordance with SABS 193.

Fire dampers shall be fusible link operated.

Labels shall be installed on the ceiling grid below all fire dampers indicated their positions, and reading: "Fire damper above".

Dampers shall be sized so that the nominal free air area when in the open position is not less that the connected duct free air area.

Fire dampers shall be installed according to the manufacturer's and SABS requirements and recommendations.

Fire dampers shall be installed as to form part of a continuous barrier to passage of fire when in a closed position. Where a fire damper cannot be fitted immediately adjacent to the fire wall, the section of ducting between the damper and the wall shall be of at least the same metal thickness and fire rating as the damper casing.

Dampers shall be self-supporting in case of duct destruction due to heat. Care shall be exercised that the supporting frame be installed so that the closing device is accessible.

Sheet metal sleeves shall be provided for housing the fire dampers where fire dampers are mounted in walls. These sleeves shall be built into the walls by the building contractor. Retaining angles shall be installed on the four sides of the fire damper sleeve on both sides of the wall. The angles shall be fastened to the sleeves only, and not to the wall. The retaining angles shall lap the masonry by a minimum of 25 mm around the entire opening. Recommended minimum angle sizes are:

Largest dimension of fire damper	Angles
Up to 1 200 mm	38 x 38 x 3,2 mm
1 200 mm to 1 800 mm	44 x 44 x 2 mm
Over 1 800 mm	51 x 51 x 4,8 mm

Clearance shall be provided between the sleeve and the masonry opening on the top and at the sides of the fire damper to allow for expansion. Allow a gap of 1 mm for each 100 mm of sleeve width or depth, but the gap shall no exceed 15 mm.

All fixing and installation materials, i.e. bolts and nuts, rawl-bolts and mortar works shall be as per fire damper manufacturer's specification and shall not affect the fire rating of the fire damper installation. Combustible materials such as plastic or similar rawl-bolts and plugs are not permitted.

13. AIR FILTERS

13.1 GENERAL

Air filters of the make, type and size as specified on the drawings shall be installed.

Filters installed close to exposed air inlets, shall be protected by means of weather louvres and wire mesh screens.

Filter holding frames shall be of approved manufacturer with standardized dimensions to enable replacement with equivalent filters of all recognized manufacturers.

Construction and manufacture of all components shall be such that under no circumstances any un-filtered air can by-pass filters or filter banks.

Sufficient space shall be allowed in front or behind filters, to enable inspection and servicing.

13.2 FILTER MEDIA

Washable filter media shall be fitted behind hinged return air grilles where indicated on the project drawings. The filter media shall be of the Peter McLeod PM 100 type, 100 grams / m² density and 5 mm thick. The filter media shall be of the synthetic type and shall be capable of arresting lint of the return air. The filter media shall fit and extend past the outer perimeter of the wire mesh in the return air grille such that the bypass of unfiltered air is avoided. The filter media shall be fire proof. Glass fibre filter media type shall not be acceptable

14. PRIMARY PLEATED FILTER

Primary filters shall be of the 50 mm pleated washable panel type and of the Peter McLeod Manufacture. The media shall be synthetic and shall be of the self-supporting type. The media shall fit into and extend to seal all round in the panel frame to ensure that no air bypasses the media. The filter outer panel frame shall be of galvanised steel.

All filter accessories including the channel filter holding frames and clips shall be standard products of the filter manufacturer. Filter holding frames shall be manufactured from galvanised steel. Filter holding frames shall be bolted or riveted together, where necessary, and shall be suitably reinforced in larger arrangements to withstand all possible operating conditions. An airtight seal shall be provided where filter holding frames are joined together. All metal parts shall be sufficiently protected against corrosion.

Primary filter panels shall fit into channel holding frames with sealing gaskets located between filter panel and channel holding frame. Where the channel holding frames are located on the downstream side of the filter, at least two spring loaded clips shall be used to ensure a positive seal against the edge gaskets and to keep filter panel in place. Where the channel holding frames are located at the upstream side of the filter, at least four spring loaded clips shall be used. All clips shall be from stainless steel.

The primary filter shall be of filtration class G4 have an average ASHRAE arrestance of 90 %, SABS tested. The dust holding capacity shall not be less than 150 g per square meter. The initial (clean) and final (dirty) resistance of the filter shall be 65 Pa and 250 Pa respectively. The above-mentioned features shall be based on a rated face velocity of 2.5 m/s.

15. SOUND ATTENUATORS

All fans shall be fitted with attenuators such that room noise levels comply with Section 1.2: Sound Control of this tender specification.

Where attenuators are selected by the contractor, the attenuator shall be selected such that the pressure drop on both suction and discharge attenuators are minimized whilst meeting the noise level attenuation performance levels as required.

16. Where in-line axial flow Donkin Majax-2 fans are used, Donkin Silax or Silax-P cylindrical attenuators shall be used or equally approved. These attenuators shall have casings constructed from pre-galvanised steel sheet, glass fibre absorbing material and a 1.6 mm thick pre-galvanised wire mesh to retain the acoustic material. Where Silax-P attenuators are used, actuators shall have an acoustic pod constructed from pre-galvanised wire mesh and filled with fibre glass acoustic material. The acoustic material shall meet BS 476:Part 7, Class 1 spread of flame requirements.

17. ELECTRICAL

The electrical contractor shall provide an isolator within 1m from the ventilation fans. The mechanical contractor shall do the entire electrical installation from the isolator to the fans.

18. CONTROL

Generally, ventilation fans shall be supplied with a 24 hour, 7 day timer or shall be switched on/off with the light switch, whichever the case; the mechanical contractor shall be responsible for the supply and wiring of the necessary equipment.

Where fans are required to be interlocked with air conditioning units, the mechanical contractor shall provide the control DB with the necessary relays and control equipment. The ventilation fan shall switch on and off with the corresponding air conditioning unit. The control panel shall be labelled as indicated on the project drawing.

1. AIR COMPRESSORS

Compressors in the larger capacity ranges shall be equipped with positive pressure lubrication systems.

Compressors shall be operated within the selection and speed ranges recommended by the manufacturer.

Larger units shall be factory fitted with crankcase heaters as standard.

Compressors having nominal cooling capacities of 35 kW and larger shall be equipped with built-in capacity controlled steps (Depending on number of cylinders) of unloading cylinders.

Compressors with nominal cooling capacity exceeding 7 kW must start unloaded.

Open type compressors shall be directly coupled to the drive motor by means of flexible couplings.

Compressor and motor shall be mounted on a single robust bedplate of fabricated steel construction.

The following controls and instruments shall be provided as a minimum.

a. Suction and discharge pressure gauges with isolating valves,

b. Oil pressure gauge and low oil pressure safety switch on compressors with positive pressure oil feed,

c. Sight glass indicating oil level in crankcase.

Units of 7 kW and larger shall be fitted with a suction strainer and an oil filter with replaceable element and safety by-pass.

Initial charge of oil shall be provided.

Motor over-temperature & over-current protection shall be provided.

Serviceable compressors shall be equipped with shut-off valves on the suction and discharge sides.

Compressor and components of 40kg or heavier shall be fitted with lifting lugs.

Tenders for compressors of a manufacture not adequately backed by South African suppliers carrying sufficient stock of the complete line of spare parts which are subject to replacement will not be considered.

2. WATER CIRCUITS AND ACCESSORIES

2.1 PIPING

Piping layouts and circuits shall be laid out as shown on the drawings, including schematic drawings issued with the service.

Unless otherwise specified open circuit condenser cooling water piping shall be heavy class steel piping to SABS 62: 1971, amended and galvanised to SABS 763 : 1988 for type B articles, heavy duty.

Unless otherwise specified closed circuit condenser water piping, primary and secondary chilled water piping and closed-circuit hot water piping for heating circuits shall be medium class black piping to SABS 62 : 1971, painted or coated as specified prior to insulation where applicable.

Where specified in the detail specification chilled water piping and condenser water piping up to size 50mm diameter may be copper piping.

Where specified condenser water piping may be uPVC not less than class 6, or as specified.

Pipe connections from main circuits to unitary equipment such as fan coils, humidifiers etc. shall be annealed copper class 2 to SABS 460: 1985, as amended, of sufficient length to provide flexibility.

Fittings and accessories larger than 50mm nominal bore size shall be flanged with standard flanges to SABS 1123.

Compressed mineral fibre joint rings shall be used for flanged joint packings.

Fittings and accessories smaller than 50mm nominal bore may use screwed connections.

Screwed fittings shall be of malleable cast iron to SABS 509: 1975, amended. Ordinary light type or black iron fittings shall not be used.

Screw thread shall be to BS21 of ISO R7.

PTFE sealing tape or other approved sealing compound shall be used on screwed connections.

Welding to galvanised piping or fittings will not be permitted.

Where welding for whatever purpose is unavoidable the complete section shall be hot dip galvanised after manufacture.

Cold galvanising will not be accepted.

Full radius bends and sweep fittings must be used wherever possible. Elbows may only be used under exceptional conditions and only with written permission of the Engineer.

Where it is necessary to reduce pipes in size, reducing sockets only shall be used and not bushes.

In horizontal runs of piping, where there is only a slight fall eccentric fittings are to be used.

Pressure relief valves shall be of Spirax or approved manufacture and shall be installed in the positions indicated on the drawings.

Pressure relief valve drains shall be taken to a suitable safe discharge point.

Where pipes pass through walls etc., sleeve pipes must be provided by the Contractor. Sleeve pipes should be made in such a manner that they will not foul against any piping due to the natural expansions and contraction of the piping.

All pipelines must be provided with 15mm drain cocks at all low points in the system so that the pipework can be drained of liquid without dismantling. Sufficient drain points must be provided to drain the system completely.

Provision shall be made by tenderers in their tender price to have one in every twenty welded joints cut-out for inspection and testing and for making good afterwards.

Should any of the test welds prove unsatisfactory the Contractor will be called upon to have all welds on the installation X-rayed and examined, at his own expense, by an approved Inspection Authority.

The Contractor will then be required to submit written test and inspection reports by the Inspection Authority before the installation will be considered for acceptance.

Horizontal pipes shall be installed with a slope of a least 1 in 500 to allow venting of air to the expansion tank wherever possible. Air pockets shall be avoided. High points shall be provided with automatic air vent valves or air bottles. Air vents or bottles shall be designed for at least 1,5 times the working pressure of the system.

Piping in plant rooms shall be so arranged that normal inspection and servicing of equipment is not obstructed.

All pipes must be neatly fitted and shall be run in such a manner as to prevent the formation of air locks.

On all circuits, screwed unions or flanged joints are to be provided to allow for the easy dismantling of pipes. Unions or flanges must be provide at all Tee-offs and adjacent to all valves. Pipes up to 50mm nominal size may use unions but pipes larger than 50mm must be flanged. On straight or continuous runs of pipe, unions or flanges shall be provided at intervals not exceeding 20 metres.

Pipes which are not dimensioned on drawings shall be sized as follows:-

The velocity shall not exceed 3m/s.

The friction rate shall not exceed 140 kPa per 100m length.

The pressure drop through all circuits shall be approximately the same. If this cannot be achieved by pipe sizing alone due to excessive resultant velocities, throttling or balancing type valves shall be provided where required.

Pipe supports and the positions of anchors shall be such as to allow for movement due to pipe expansion and contraction or expansion joints in the building structure as applicable.

Expansion joints, where required, shall be of the bellows type manufactured from stainless steel or may be of the Viking Johnson pipe coupling or equal where moderate expansion movements are to be accommodated.

Expansion joints shall be rated at not less than 1,5 times the maximum working pressure in the system. Expansion joints in hot water piping shall be suitable for water temperatures up to 120ºC.

Pipe hangers shall be of the spring, roller, chain or rod type. The maximum spacing of hangers and the minimum diameter of hanger rods shall be as follows:-

Nominal Pipe Size (mm)	Maximum Span (m)	Minimum Rod Diameter (mm)
25	2,2	10
40	2,8	10
50	3,1	10
80	3,7	14
90	4,0	14
100	4,3	16
125	4,9	16
150	5,2	20
200	5,8	22
250	6,7	22
300	7,0	22

High compression type thermal insulation such as hard wood timber of the same diameter as the required insulation shall be provided between hangers and chilled and hot water pipes.

2.2 STRAINERS

Water strainers shall be of the pot or angle type. Strainers shall be designed for not less than 1 000 kPa or 1,5 times the maximum system working pressure whichever is the greatest. Strainer screens shall be of bronze, monel metal or stainless steel and shall have the following maximum perforation sizes:-

Strainer Size (mm)	Perforation Size (mm)
2 – 50	0,8
65 – 150	1,6
200 – 300	3,2
over 300	6,4

The effective free area of the screen shall in all cases be not less than 3 times the cross-sectional area of the inlet opening.

Strainers shall be installed in accessible positions where the strainers can be easily removed and cleaned.

2.3 PRESSURE GAUGES AND THERMOMETERS

Pressure gauges shall be of the "Bourdon" type to BS 1780 with at least a 100mm dial and calibrated in kPa with the maximum range not exceeding 1,5 times the system working pressure. Forged brass or gunmetal gauge cocks must be fitted with each pressure gauge.

Thermometers shall be of the replaceable glass type with bronze casings, fitted into pockets for removal without draining the system. The thermometers shall be calibrated in ºC (degrees Celsius) and the scale length shall be at least 170mm. Pockets shall be of brass, filled with oil and shall be installed vertically.

On pipes smaller than 50mm diameter, pipe sizes must be increased locally to install the sockets.

2.4 AIR RELEASE VALVES

Automatic air release valves shall be provided where shown on the drawings, but shall in addition also be fitted to piping at all high points and other places where air may accumulate. As these points depend on the installation of the system, full responsibility for fitting these valves rests with the Contractor.

Valves shall be of the inverted float type similar or equal to Honeywell, Braukmann or Spirax. They shall have either integral shut-off valves or be preceded by a lock shield valve.

Connections to the service pipe shall be made at the highest point to ensure complete venting. Valves shall be mounted with the inlet connection exactly vertical.

2.5 DRAIN COCKS

Drain cocks shall be of copper alloy and be of the screw down pattern type to BS2879 : 1957, Type A. They shall be fitted to all low points in the installation to ensure full draining of the system.

2.6 VALVES AND NON-RETURN VALVES

Isolating valves, unless otherwise specified in the detail specification shall be Saunders Type A or Type KB diaphragm valves or equal fitted with suitable diaphragms and rated for at least 1 000 kPa working pressure and the system temperature.

Diaphragm valves shall be provided with hand wheels. Valves of 80mm and larger which are installed higher than 2 500mm above floor level, shall be provided with chainwheels and chains.

Where isolating valves of the gate type are specified it shall be of the type with solid or flexible wedges in accordance with SABS 664 and SABS 776. Valves of 80mm nominal bore and smaller shall be of bronze or gunmetal.

In lieu of gate valves, other types of valves may also be offered provided that bodies, temperature and pressure ratings are generally as specified for gate valves and that the fluid pressure drop for wide open valves does not exceed that of 40 diameters of pipe of the same size.

Diaphragm type valves and gate valves shall not be used for balancing or throttling purposes.

Unless otherwise specified in the detail specification balancing valves shall be similar or equal to the STA-T shut-off/balancing valves. Valves shall be provided with drain cocks with hose connections and two pressure cocks across each valve to enable measuring the flow rate. A differential pressure gauge to measure the pressure drop across all the valves in the system and a flow chart for each valve size used shall be provided by the Contractor at first handover.

Throttling valves shall be either plug, globe, angle or "Y" valves. Provision shall be made to prevent opening and closing of throttling valves by unauthorised persons once they are set.

Check valves shall be of the swing or lift type with seats of neoprene, gunmetal or stainless steel, discs of bronze, gunmetal or stainless steel and bronze or cast iron bodies, suitably rated for system pressure and temperatures.

2.6 GENERAL

Flexible connections shall be provided at all chiller and pump connections and where indicated on the drawings. These shall be of nylon reinforced moulded neoprene rubber with metal flanges at both ends. Metal reinforcing will not be accepted.

The flexible connections shall be of spherical or double spherical construction as required.

The flexible connections shall be installed strictly in accordance with the manufacturer's recommendations and shall be suitable for the system working pressures and temperatures.

Pressure gauges, thermometers and shut-off valves shall be provided in the following positions in each water pipe circuit:

A pressure gauge, thermometer and shut-off valve before and after each condenser, dry cooler, air handling unit and self-contained air conditioning unit.

A shut-off valve at the in- and outlet of each cooling tower and fan coil unit.

A strainer shall be provided at the suction side of each pump.

A pressure gauge before and after each strainer and at each pump discharge for pump units.

A shut-off valve before each strainer and at each pump discharge for pump units.

Pressure gauges, thermometers, unions and shut-off valves shall be provided at the inlet and outlet of chilled water and central heating coils.

Strainers shall be provided upstream of coils and control valves.

2.7 TESTING OF PIPING INSTALLATIONS

Testing of the installation is to be carried out by the Contractor at his own expense in the presence of the Engineer. The following actions shall be carried out:

After the flushing and cleaning of the pipelines, all lines shall be completely filled with cold water and bled of all air.

The pipe system shall then be subjected to a test pressure of 1,5 times the working pressure by means of a test pump. This pressure shall be maintained for a minimum of 60 minutes.

Any leaks apparent during the test shall be made good and the test repeated until no further leaks exist. Items not capable of withstanding this test pressure shall be isolated from the pipe system.

3. INSTALLATION OF PIPEWORK

Pipework shall be installed in accordance with the service drawings issued with the detail specification.

The tender drawings are schematic and do not purport to show exact positions of pipes or specific details of construction of the latter. All final dimensions must be checked on site before preparation of manufacturing drawings and the fabrication of piping.

Where beams, stanchions or other obstructions interfere with the straight running of pipes; suitable offsets shall be provided or alternatively changes in the section of the particular pipe made, all in accordance with good engineering practice.

Sufficient off-sets or alternatively expansion bellows shall be allowed in piping installations to allow for expansion and contraction.

It is required that tenderers make themselves conversant with all the drawings of the particular building in order to determine the number of such offsets or changes in section and the positions in which they will be required.

Due allowance shall be made in the tender price for such offsets and changes required.

4. PRESSURE GAUGES

4.1 STANDARD PRESSURE GAUGES

Standard Gauges are to be of a high-quality dry gauge designed to provide reliable service on applications not corrosive to brass. These gauges housings should wither be of a ABS case or drawn steel type casing.

The standard lenses are to be of plexiglass and of the clear front design. The stem and connection are to be machined in one piece from brass.

The bourdon tubes are to be of high quality and made in the "C" configuration on pressure ranges of 40 Bar and lower and are the "coiled" or "spiral" safety tube on ranges above 40 Bar.

This spiral tube allows the higher pressure to be spread out over a greater area thereby reducing bourdon tube stress. The dial should provide precision movements for accurate readings to a standard 12.570 of full scale tolerance. The dials should be UV resistant with readings provided in kPa (kilopascals). Duel scale with PSI and kPA will also be accepted.

Pressure Gauges should be suitable for applications in hydraulics, process, petrochemical, medical, food, pharmaceutical and most industrial and commercial applications.

Should options and variations be proposed in this tender, it shall be required that samples be provided.

Should the gauge be subjected to direct physical shock, Rubber Case Protectors (RCP) shall be installed.

Recalibrating adjustment screw shall be provided and shall be accessible through the dial to facilitate re-setting of the gauge to the zero point without disassembling the gauge.

Should special connections be required such as female threads, straight threads (flare or swivel type) and or special O-ring connections. It shall be deemed to be included in the price of the gauge.

Certificate of Calibration shall be provided with each gauge. Certificates of Calibration shall provide the user with a serial numbered gauge along with a calibration sheet against a primary pressure standard and shall traceable to the National Institute of Standard and technology (formerly National Bureau of Standards)

Working Pressure Limitations :

a. Dynamic Pressure: The working pressure should be limited to 60% of the dial range.

b. Static Pressure: The working pressure, where no sharp fluctuations occur, should be limited to 90% of the dial range.

Ambient Temperature: -18 °C to 60°C

1. SCOPE: OVERBLOW PRECISION COOLING UNIT – COMPUTER ROOM AIR CONDITIONING (CRAC)

The Overblow precision cooling air handling units (direct expansion units) shall be as specified under this section of the project specification

2. APPLICABLE STANDARDS

The air-conditioning units and installation in general shall be in accordance with:

- SANS 1125: Room air conditioners and heat pumps
- SABS 0147: Refrigerating systems including plants associated with air-conditioning systems
- SANS 60335-2-40: Household and similar electrical appliances – Safety. Part 2 – 40: Particular requirements for electrical heat pumps, air conditioners and dehumidifiers
- SANS 10142-1-2003: The wiring of premises Part 1: Low-voltage installations
- SABS 1453: Copper tubes for medical gas and vacuum services
- OHS Act, Pressure Equipment regulations

OVERBLOW PRECISION COOLING UNIT – COMPUTER ROOM AIR CONDITIONING (CRAC)

2.1 GENERAL

The units shall be of the heat pump type or with cooling plus electric heating.

The air-conditioning units shall be standard factory assembled, piped and wired. The units shall be thoroughly tested for all operating conditions. Spares shall be freely available in South Africa. On request, the Contractor shall provide the engineer with performance test certificates.

The air-conditioning units and installation in general shall be in accordance with the computer room air conditioning (CRAC) as per supplier's recommendations. Any discrepancies between this specification and the supplier's recommendations that may influence the unit's performance or guarantee shall be clarified with the engineer during tender stage.

The electrical power requirements to the condensing units shall be:

- Single phase when the cooling capacity of the unit is less than 10 kW.
- Three phase when the cooling capacity of the unit is more or equal to 10 kW.

The indoor unit and condensing unit shall be interconnected with refrigerant piping, electrical wiring, and interlocking control cabling. The pipe and cable connections shall be made in accordance with the unit supplier's recommendations. The refrigerant shall be of non prohibited type such as R410.

Each condensing unit with connected evaporator unit shall be clearly labelled to identify different split units.

The outdoor unit coil shall be treated for corrosion with blygold, techni-coat, corium or any other method as approved by the Engineer.

2.2 PERFORMANCE SPECIFICATIONS

Cooling and heating capacities are room conditions, and all equipment shall be de-rated to meet site design conditions on site.

De-rating shall be done to compensate for the following:

- Altitude above sea level.
- Refrigerant pipe lengths.
- Design conditions specified.

All units shall be capable of meeting total and sensible cooling requirements. Tenderers shall provide proof of de-rated capacities with their tender. All capacities specified are to be achievable at medium evaporator fan speed.

2.3 PROTECTION AND SAFETY DEVICES

Reverse phase, three phase overload, overload during startup, phase imbalance, phase loss and low voltage protection shall be provided for all three phase motors.

Protection fuses shall be provided for all control circuits.

The compressor shall have high and low refrigerant pressure protection.

The indoor and outdoor units shall comply with the safety requirements as set out in:

- SANS 60335-2-40: Household and similar electrical appliances – Safety. Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers.

2.4 ELECTRICAL

Generally, the power to the unit shall be provided by the electrical contractor in a weatherproof isolator mounted within 1m from the condensing unit. The mechanical contractor shall do the entire electrical installation from the isolator to the condensing unit and the indoor unit.

Where the electrical contractor provides a cable only to a distribution board that serves a group of air-conditioning units, the mechanical contractor shall provide the distribution board, connect the incoming power cable, and shall do all the electrical wiring from the distribution board to the condensing units and the indoor units.

In all instances the mechanical contractor shall provide isolators as required. All electrical and control cables shall be neatly strapped with the refrigeration piping in a galvanised cable tray.

The entire electrical installation shall comply with:

- SANS 10142-1-2003: The wiring of premises Part 1: Low-voltage installations

On completion, the Contractor shall issue a compliance certificate for the entire electrical installation.

Electrical and control cables mounted between indoor and outdoor units shall be installed without joints in the cable and shall be of the UV protected type.

In accordance with EN60204-1 norms, suitable for indoor installation, complete with:

- Main switch with door lock safety on frontal panel.
- Magneto thermic switches for each compressor and for supply fans
- Contactors for each load.
- Inverter compressors and supply fans equipped with EC electric motor don't require contactors.
- Transformer for auxiliary circuit and microprocessor supply.

2.5 CONTROL SYSTSEM

Microprocessor control system with graphic display for control and monitor of operating and alarms status. The system shall include:

- Built-in clock for alarms date and time displaying and storing.
- Built-in memory for the storing of the intervened events (up to 200 events recorded).
- Predisposition for connectivity board housing (MBUS RS485/JBUS, MBUS RS232/JBUS for GSM modem, LON, BACnet for Ethernet (SNMP- TCP/IP), BACnet for MS/TP). The electronic cards shall be optional accessories that shall be finalised prior to equipment procurement.
- Main components hour-meter.
- Non-volatile "Flash" memory for data storage in case of power supply faulty.
- Menu with protection password.
- Demand Limit function (for machines with double refrigerant circuit only).
- LAN connection.

2.6 REFRIGERANT CIRCUITS

Refrigerant piping shall be in accordance with the following standards:

- SABS 1453: Copper tubes for medical gas and vacuum services
- SABS 0147: Refrigerating systems including plants associated with air-conditioning systems

Fittings shall be copper based capillary solder fittings in accordance with SABS 1067. All soldered joints on proprietary manufactured units shall be carefully checked and remade if found damaged in transit.

Pipe size selections shall be such as to produce moderately low velocities whilst:

- Ensuring proper oil return to the compressor and minimising lubricating oil being trapped in the system.
- Ensuring practical lines without excessive pressure drops and with proper feed to evaporators.
- Preventing liquid refrigerant from entering the compressor during operation and at shutdown.

Refrigerant piping shall be sized and fitted with the necessary oil traps strictly in accordance with the unit manufacturer's requirements.

All refrigerant pipelines shall be insulated with the "Armaflex**"** type, lightweight, elastomeric nitrile rubber tube insulation. Insulation thickness shall be 13 mm.

Suction and liquid pipelines shall be insulated separately and joints on insulation shall be glued with the insulation manufacturer's recommended adhesive to create a vapour barrier.

The installation of trunking and trays shall form part of this mechanical contract.

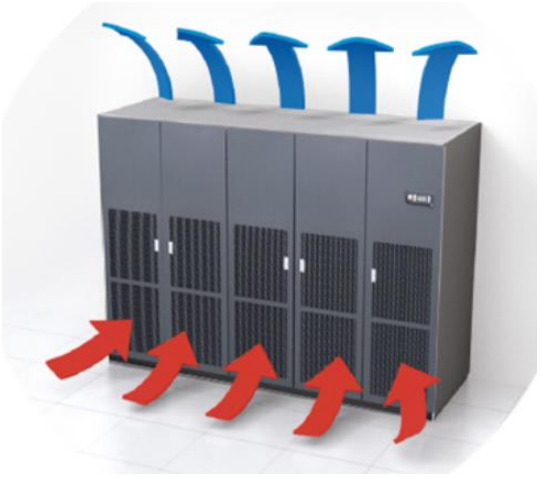
The air conditioner shall be supplied with a minimum R410A refrigerant charge.

Components for each refrigerant circuit shall include the following:

- Electronic expansion valve which allows high performance and system efficiency to ensure timely and accurate response to changes in temperature and pressure
- Sight glass.
- Filter dryer on liquid line.
- Pressure transducers with indication, control and protection functions, on low and high refrigerant pressure.
- High pressure safety switch with manual reset.
- Liquid receiver with accessories.
- Refrigerant circuit with copper tubing with anticondensate insulation of the suction line.
- Lubricant oil charge.
- Valves on gas delivery and liquid return for coupling to remote air-cooled condenser.
- 0÷10V proportional signal to manage the condensing control system of the remote air-cooled condenser.
- Oil separator on gas discharge.
- Condensing control by continuous variation of remote condenser fan rotation speed for operations with ambient temperature down to -15°C.

3. INSTALLATION REQUIREMENTS

The air handling side shall be floor standing with cold air supply outlet on top of the machine or "over blow". The return air stream shall be on the front of the machine as indicated below.



3.1 INSTALLATION OF INDOOR AND OUTDOOR UNITS

During installation, care shall be taken to ensure that no vibrations are carried over to structures to which the indoor and outdoor units are fixed.

Indoor units shall be placed directly on the floor slab, however, with appropriate rubber mounting to guard against undue vibration.

Outdoor condensing units shall be installed on wall-mounted brackets and / or a concrete slab as indicated on the project drawings.

Where units are installed on wall-mounted brackets, the condensing unit shall be properly bolted to the mounting bracket with adequately sized fasteners.

Where outdoor units are installed on a concrete slab, the condensing unit shall be fitted on top of neoprene vibration isolating pads and 450 mm square concrete paving slabs.

3.2 INSTALLATION OF CONDENSATE DRAINPIPES

If an outdoor unit (heat pump type) is mounted against a wall more than 1 m above ground / floor level, the unit shall be fitted with an uPVC drainpipe neatly saddled to the wall. Drainpipe sizes for outdoor condensing units shall be to the supplier's specification.

Condensate drainpipes shall always run together with refrigerant pipes and shall always be installed in the same trunking and on the same cable trays for as far as the installation permits. Surface mounted drain piping shall only be allowed where condensate drainpipes run in a different direction to either a service duct, wastewater pipe or any other location as indicated on the project drawings. Surface mounted drain piping shall be secured to the wall by means of galvanised steel saddles at no more than 1 m intervals.

Where ceiling suspended units are mounted on the inside of exterior walls on wall-mounted brackets, the mechanical contractor shall drill sufficiently sized holes through which refrigerant pipes, drainpipes and cable wires shall penetrate directly behind the indoor unit. Drainpipes running from the indoor unit through the wall shall be adequately sloped to ensure positive drainage.

All condensate pipes running from indoor units to wastewater pipes, outlet gullies or open wastewater points shall be fitted with a U-trap at a location as indicated on the project drawings.

uPVC pipes shall be used for drain piping from indoor units. Drainpipe sizes for indoor units shall be ∅ 32 mm for all unit sizes.

The first 5m of drain piping shall be insulated with “Armaflex” type, lightweight, elastomeric nitrile rubber tube insulation. Insulation thickness shall be 13 mm.

Where drainage piping or control cabling is required to be installed flush mounted, positioning and chasing shall be done in good time to meet construction programs.

3.3 INSTALLATION OF REFRIGERANT PIPING

Refrigerant piping shall be arranged so that normal inspection and servicing of the compressor and other equipment is not hindered. Locations where copper tubing will be exposed to mechanical damage shall be avoided. Hangers and supports where piping go through walls shall be installed to prevent transmission of vibration to the building.

Refrigerant piping in ceiling voids and mounted internally against walls shall be installed in 101 mm wide galvanised steel Cabstrut light duty cable trays (per unit). Pipes shall be strapped over insulation to cable trays at 500 mm intervals with suitably sized cable ties. Cable trays shall be 152 mm wide where drainpipes run together with refrigerant piping (per unit).

Externally mounted refrigeration pipes and drainpipes shall be mounted in Cabstrut P9000 cable trunking (127 mm x 76.2 mm). Cable trunking shall be complete with clip on covers. Pipes and cables shall be strapped together every 500 mm with suitably sized cable ties and loosely fitted in the trunking. The trunking shall be manufactured from galvanised steel and epoxy powder coated to a colour as specified by the engineer.

Any insulation material not covered by the trunking and exposed to the elements shall be neatly strapped with cable ties to minimise the possibility of dirt and water entering between the insulation and refrigeration pipes.

PRECISION COOLING: INDOOR UNIT – PROPOSED PERFORMENCE

MAIN CIRCUIT		
DESIGN CONDITIONS	°C	26.0
Dry bulb temperature	%	30
Relative humidity	m	1700
Altitude	m^3/h	4100
Air flow	Pa	20
ESP External Static Pressure	°C	35.0
Outdoor air temperature		
Coil working temperature		
PERFORMANCE AT DESIGN CONDITIONS		
Total cooling capacity gross	kW	17.2
Sensible cooling capacity gross	kW	17.2
Net cooling capacity	kW	16.8
Net sensible cooling capacity	kW	16.8
SHR		1
EER (Indoor unit)	kW/kW	2.43
Total power input (Comp + fans)	kW	7.09
Leaving air temperature	°C	10.6
Leaving relative humidity	%	79
Effective heat exchange area		
PERFORMENCE AT MINIMUM SPEED COMPRESSOR		
Total cooling capacity gross	kW	5.92
Sensible cooling capacity gross	kW	5.92
Net cooling capacity	kW	5.86
Net sensible cooling capacity	kW	5.86
SHR		1.00
EER (Indoor unit)	kW/kW	4.77
Total power input (Comp + fans)	kW	1.24
Leaving air temperature	°C	11.5
Leaving air relative humidity	%	74
Air flow	m^3/h	1500

PARTIAL LOADS WITH COMPRESSOR MODULATION						
Load	%	100	80	60	40	20
Outdoor air temperature	°C	35.0	35.0	35.0	35.0	35.0
Air flow	m^3/h	4100	3307	2514	1721	1500
Total cooling capacity gross	kW	17.2	13.8	10.3	6.88	3.44
Sensible cooling capacity gross	kW	17.2	13.8	10.3	6.88	3.44
Net cooling capacity	kW	16.8	13.5	10.1	6.8	3.37
Net sensible cooling capacity	kW	16.8	13.5	10.1	6.8	3.37
Compressors power absorption	kW	6.66	4.18	2.51	1.46	0.73
Fans power input	kW	0.43	0.27	0.16	0.08	0.07
Total power input (Comp + fans)	kW	7.09	4.45	2.67	1.54	0.8
Condensing temperature	°C	49.9	46.3	43.1	40.3	39.5
EER (Indoor unit)	kW/kW	2.43	3.1	3.86	4.47	4.3

COMPRESSORS		
Compressor type		SCROLL
Compressor nr	No	1
Compressors power absorption	kW	6.66

FANS		
Fans type		EC BASIC
Quantity	No	1
Air flow	m^3/h	4100
Fans power input	kW	0.43
SPF (Specific power factor)	W / l/s	0.38
Filters		
Noise data	dB (A)	47
Distance	m	1

WEIGHT & DIMENSIONS		
A	mm	785
B	mm	675
H	mm	1925
Weight	kg	240

ELECTRICAL DATA		
Power supply	V/ph/Hz	400/3+n/50
Max Electrical power absorbed	kW	9.48
Max absorbed current	A	18.7
Max inrush current	A	5.7
Power input	kW	7.09

PRECISION COOLING: OUTDOOR UNIT – PROPOSED PERFORMENCE

MAIN CIRCUIT		
REMOTE CONDENSER		
Quantity	No	1
Circuits	No	1
Outdoor air temperature	^{o}C	35.0
Condensing temperature	^{o}C	49.9
Air flow	m^3/h	6370
Rejection capacity	kW	23.5
FANS		
Fans power input	kW	.37
Quantity	No	1
Project pressure	Pa	100
WEIGHT & DIMENSIONS		
A	mm	1400
B	mm	665
H	mm	1027
Weight	kg	120
ELECTRICAL DATA		
Power supply	V/ph/Hz	230/1/50
Power input	kW	0.37
Total power input	A	0.60
Max absorbed current	A	2.62
AIR SUPPLY REMOTE CONDENSER		
Supply air direction		
NOISE DATA		
Total sound pressure	dB (A)	58
Distance	m	1

PRECISION COOLING: INDOOR UNIT – PERFORMANCE ON OFFER

MAIN CIRCUIT		
DESIGN CONDITIONS	°C	
Dry bulb temperature	%	
Relative humidity	m	
Altitude	m^3/h	
Air flow	Pa	
ESP External Static Pressure	°C	
Outdoor air temperature		
Coil working temperature		
PERFORMANCE AT DESIGN CONDITIONS		
Total cooling capacity gross	kW	
Sensible cooling capacity gross	kW	
Net cooling capacity	kW	
Net sensible cooling capacity	kW	
SHR		
EER (Indoor unit)	kW/kW	
Total power input (Comp + fans)	kW	
Leaving air temperature	°C	
Leaving relative humidity	%	
Effective heat exchange area		
PERFORMENCE AT MINIMUM SPEED COMPRESSOR		
Total cooling capacity gross	kW	
Sensible cooling capacity gross	kW	
Net cooling capacity	kW	
Net sensible cooling capacity	kW	
SHR		
EER (Indoor unit)	kW/kW	
Total power input (Comp + fans)	kW	
Leaving air temperature	°C	
Leaving air relative humidity	%	
Air flow	m^3/h	

PARTIAL LOADS WITH COMPRESSOR MODULATION						
Load	%					
Outdoor air temperature	°C					
Air flow	m^3/h					
Total cooling capacity gross	kW					
Sensible cooling capacity gross	kW					
Net cooling capacity	kW					
Net sensible cooling capacity	kW					
Compressors power absorption	kW					
Fans power input	kW					
Total power input (Comp + fans)	kW					
Condensing temperature	°C					
EER (Indoor unit)	kW/kW					

COMPRESSORS		
Compressor type		
Compressor nr	No	
Compressors power absorption	kW	

FANS		
Fans type		
Quantity	No	
Air flow	m^3/h	
Fans power input	kW	
SPF (Specific power factor)	W / l/s	
Filters		
Noise data	dB (A)	
Distance	m	

WEIGHT & DIMENSIONS		
A	mm	
B	mm	
H	mm	
Weight	kg	

ELECTRICAL DATA		
Power supply	V/ph/Hz	
Max Electrical power absorbed	kW	
Max absorbed current	A	
Max inrush current	A	
Power input	kW	

PRECISION COOLING: OUTDOOR UNIT – PERFORMANCE ON OFFER

MAIN CIRCUIT		
REMOTE CONDENSER		
Quantity	No	
Circuits	No	
Outdoor air temperature	^{o}C	
Condensing temperature	^{o}C	
Air flow	m^3/h	
Rejection capacity	kW	
FANS		
Fans power input	kW	
Quantity	No	
Project pressure	Pa	
WEIGHT & DIMENSIONS		
A	mm	
B	mm	
H	mm	
Weight	kg	
ELECTRICAL DATA		
Power supply	V/ph/Hz	
Power input	kW	
Total power input	A	
Max absorbed current	A	
AIR SUPPLY REMOTE CONDENSER		
Supply air direction		
NOISE DATA		
Total sound pressure	dB (A)	
Distance	m	

COMPRESSOR – PROPOSED PERFORMANCE

COMPRESSOR		
Motor power	kW	11
Discharge pressure	Bar	10
Discharge flow rate	L/min	1380
Drive type		Direct drive
Start system		Star-delta
Oil type		#46 Shell Carona S3 semi synthetic
Oil volume	L	7.6
Motor energy rating	%	90.3
Motor power factor		1.1
Power supply	V / ph / Hz	400 / 3 / 50
Full load current	A	29.7
Cooling method		Air cooled
Fan motor power	kW	0.19
Air flow of cooling fan (per fan)	m3/hr	3900
Minimum cable cross section per core	mm2	10
Dimensions (L x D x H)	mm	1740 x 750 x 1450
Weight	Kg	330
Noise	dB (A)	66
Receiver volume	L	360
Outlet pipe diameter		G ¾”

COMPRESSOR – PERFORMANCE OFFER

COMPRESSOR		
Motor power	kW	
Discharge pressure	Bar	
Discharge flow rate	L/min	
Drive type		
Start system		
Oil type		
Oil volume	L	
Motor energy rating	%	
Motor power factor		
Power supply	V / ph / Hz	
Full load current	A	
Cooling method		
Fan motor power	kW	
Air flow of cooling fan (per fan)	m3/hr	
Minimum cable cross section per core	mm2	
Dimensions (L x D x H)	mm	
Weight	Kg	
Noise	dB (A)	
Receiver volume	L	
Outlet pipe diameter		