

DETAILED TECHNICAL SPECIFICATION

FOR THE PROPOSED

HEATING, VENTILATION AND AIR CONDITIONING (HVAC) INSTALLATIONS

FOR

SENTECH DATA CENTRE – NASREC

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1. GENERAL SPECIFICATION

1.1 GENERAL TECHNICAL SPECIFICATION DOCUMENTS

The General Technical Specifications, which form part of these Tender Documents, are presented in a separate document.

The submission of a tender will confirm that the HVAC Contractor (**To be referred to as 'Contractor'**) has read the abovementioned document.

1.2 PROJECT SPECIFIC GENERAL SPECIFICATION

1.2.1 SCOPE OF WORK

1.2.1.1 Scope of work covered under this tender shall be for the supply of the necessary equipment, transport, installation, rigging, erection, testing & commissioning and handing over to the client in an operating condition of the systems as described hereunder. The actual extent of work vis-à-vis the distribution system shall be as indicated in the Tender drawings, bill of quantities and this detailed technical specification.

1.2.1.2 Minor Builder's Work has been included in this contract as enabling works for the installations. All other work, as later herein specified as being specifically excluded from this contract, shall be carried out by others in accordance with the details provided by The Engineer or the Contractor as applicable and as provided herein.

1.2.2 DRAWINGS

1.2.2.1 Document Transmittal

The **Dropbox** Document Transmittal platform is a formal process used by this Project to transmit documents to other Project Engineers and Contractors. The Engineer shall officially issue Construction Drawings, Site instruction, Technical specifications, Payment certificates and Drawing Registers through this online portal. Since this platform is a contractual document transmittal platform, the upload of an email notification to the recipient shall serve as receipt of the documents described in the drawing transmittal notification.

Other forms of transmittals may be used and shall be approved by the Project Managers. These forms may be file transfer platforms such as Skydrive, Accellion, e-mail, CD delivery/collection, etc.

1.2.2.2 Tender Drawings

The following drawings have been issued with this Tender as per the Drawing Register.

ITEM	DRAWING NO.	DRAWING TITLE	REV
1.	2121 2204-ST-ME-001-02	SENTECH DATA CENTRE – NASREC HVAC INSTALLATIONS	A

1.2.2.3 Architectural and Structural Drawings

The Contractor shall ensure that he is in possession of all information required for the installation of the Works and shall, if necessary, obtain copies of all relevant Architectural and Structural Drawings from the Architect and Structural Engineer.

1.2.2.4 Builder's Work Drawings

All Builder's Work and work to be carried out by others in accordance with the Specification has been indicated on the Tender Drawings. The Contractor shall check, approve, add to or alter such drawings as may be necessary to suit the Plant offered by him, and accepted by The Engineer, within the time stipulated in Clause 1.2.2.6 hereof from date of acceptance of his Tender and shall submit to The Engineer in duplicate any revision which shall be made to such Drawings.

Such Builder's Work Drawings shall indicate the location and extent of all foundations, bases, openings, timber frames and all other Builder's Work and the capacities and/or dimensions of all electrical and condensate water drain points and dimensions for all water drainage connections and any other work to be provided by others for the Works, as detailed in this Specification.

The Drawings shall be drawn to scale and in sufficient detail to enable the Builder to execute the work without any misunderstanding.

Within a reasonable period after receiving such Drawings, The Engineer shall signify his approval, or otherwise, and one signed copy of the approved Drawing shall be returned to the Contractor.

When approved, the following number of copies of each such Drawing shall be delivered to each of the following:

Quantity Surveyor	1 copy
Principal Contractor/ Project Manager	2 copies
Architect	1 copy
Structural Engineer	1 copy
Electrical Engineer	1 copy

1.2.2.5 Shop Drawings

The Contractor shall submit to The Engineer, for approval within the stipulated time, duplicate copies of all Shop Drawings as required for the manufacture and installation of the Works or as The Engineer may reasonably require.

All Shop Drawings for work outside of plantrooms shall be drawn to a scale of not smaller than one in twenty-five. All details shall be drawn to a scale to show the detail required.

Within a reasonable period after receiving such Drawings, The Engineer shall signify his approval, or otherwise, in writing and one signed copy of each approved Drawing shall be returned to the Contractor.

The Contractor shall not, unless otherwise directed by The Engineer, in writing, commence with any work prior to the approval of the relative Shop Drawings. Work installed prior to the approval of Shop Drawings shall be liable to rejection by The Engineer and removal and/or replacement by the Contractor, at his cost, if it is considered by The Engineer to deviate from the Specification.

Drawings approved as above described shall not be departed from except as authorized by The Engineer. The approval shall be limited to check conformity with the design requirements and shall not relieve the Tenderer of responsibility for Co-ordination or Installation fit.

The Engineer shall have the right at all reasonable times, to inspect at the factory of the Contractor, all Drawings of any portion of the Works.

1.2.2.6 Mistakes in Drawings

Any expense resulting from an error or omission in or from delay in delivery of the drawings, shall be borne by the Contractor.

The Contractor shall be responsible for any discrepancies, errors, or omissions in the Drawings and other particulars supplied by him, whether such Drawings and particulars have been approved by The Engineer or not, provided that such discrepancies, errors, or omissions are not due to inaccurate information or particulars furnished in writing to the Contractor by The Engineer or the Architect. The Employer shall be responsible for Drawings and information supplied in writing by The Engineer or the Architect and for the details of special work by either of them.

1.2.3 TRADE NAMES AND ALTERNATIVES

1.2.3.1 No trade names are mentioned in these documents. Contractors are required to propose equipment supplied by reputable manufacturers. The equipment supplied remains the responsibility of the contractor until warranties/ guarantees are met in full (by the contractor and his preferred equipment supplier).

1.2.3.2 **The tenderer is advised to offer the installation strictly in accordance with this Technical Specifications.** Equipment offered shall be taken to fulfill the requirements of the Tender drawings, BoQ, General Technical Specification and this Detailed Technical Specification.

1.2.3.3 All equipment or material which the Contractor represents, to be of the required quality and characteristics for the purpose intended, shall be permitted subject to all of the following requirements.

- i) It is not the intent of these Specifications to have the Contractor seek acceptance from The Engineer for the various interchangeable items of different manufacturers that are offered by the Contractor. It is the intent of these Specifications that alternative materials for major items of equipment, herein specified, be acceptable to The Engineer.
- ii) The burden of proof as to the quality and suitability of proposed equipment shall be upon the Contractor and the Contractor shall furnish all information necessary as required by The Engineer at no additional cost to the Employer.
- iii) There shall be no substitution for any accepted equipment, materials, component, design, or fabrication unless and until the proposed substitute has received written acceptance of The Engineer. The Engineer may require the removal of any substitute or unaccepted item which is installed by the Contractor without the written acceptance of The Engineer. All financial benefits accruing from the substitute equipment, materials, components, design, or fabrication shall be for the Contractor's cost.
- iv) Where use of the Contractor's proposed materials or equipment involves redesign of or changes to other parts of the work, the cost and the time required to affect such redesign or changes shall be considered in evaluating the suitability of the proposed materials or equipment. No additional cost will be paid by the Employer as a result of the Contractor's proposed materials or equipment.
- v) No test or action relating to the acceptance of substitute materials shall be made until the request for substitutions is made in writing by the Contractor, accompanied by the complete data as to the equality of the materials proposed. Such request shall be in ample time to permit approval without delaying the work.
- vi) Whenever classifications, rating, or other certification by a body, such as UL, NEMA, or SABS, is part of the Specification for any material, Proposals for use of alternative materials shall be accompanied by reports from the listed or equivalent independent testing laboratory indicating compliance with Specification requirements.
- vii) The Contractor shall reasonably demonstrate that an adequate supply of materials, repair parts, and specialties of its own design and manufacture, as well as materials, repair parts, and the specialty parts of the Suppliers, will be available promptly as the need by The Engineer may arise.
- viii) The cost of all testing required to prove the quality of the material proposed shall be borne by the Contractor.

1.2.3.4 It shall be understood that specifying materials, components, and/or equipment in this Specification shall not relieve the Contractor from its responsibility to produce the product in accordance with the Contractual requirements.

1.2.3.5 The Contractor shall submit data showing that the proposed materials or equipment meets the requirements stipulated in the Specifications.

2. DETAILED TECHNICAL SPECIFICATION

2.1 PROFESSIONAL REQUIREMENTS

To ensure acceptable standards of delivery all tenders must comply with the following criteria:-

1. The bidder must be registered with the Contractor's Industry Development Board (CIDB) in the Mechanical Engineering (ME) category
2. Proof of registration with professional body / bodies e.g.:
 - a. Electrical Contractors Board (ECB),
 - b. SARACCA (South African Refrigeration and Air-conditioning Contractors Association,

if a prospective bidder is compliant to specific ISO standards, proof of such certification needs to be provided, e.g. Management System Standards (ISO 9001, ISO 14001), Occupational Health And Safety Management Standard (ISO 18001 / OHSAS 18001), etc. (this is however a non-mandatory requirement). Further membership of any other technical governing bodies or applicable institutes may be provided.

2.2 SCOPE OF WORKS

2.2.1 HVAC Installations:

The proposed HVAC installation shall be for buildings including but not limited to:

- Data Centre

No additional ventilation shall be provided to the building.

The Contractor shall ensure that he is conversant with the layouts of the building and of other services before he commences with any work on these buildings.

Any challenges that the Contractor may experience during the contract period must be timeously discussed with The Engineer.

All the work shall be carried out in full conformance with these project specifications.

2.3 DESIGN APPROACH: HEATING VENTILATION AND AIR-CONDITIONING (HVAC)

2.3.1 Air-conditioning:

Data Centre

Summer	20.0 °C db ±1°C
Humidity	40% to 55% RH (approximately)
Winter	20 °C db ±1°C

The above temperatures are those at which the majority of people are considered to be comfortable, as indicated on a Comfort Chart. The relative humidity would not be positively controlled but would be indirectly controlled within the comfort range as a result of the design and selection of the cooling plant. The temperatures would be controlled within a tolerance of ± 1.5°C, i.e. maximum temperature=24.0 °C db.

2.3.2 Ventilated Areas

Ablution Areas & Store Rooms

N/A

Kitchens

N/A

Smoking Rooms

N/A

Parking basements

N/A

Ventilation Standards (SANS 10400-O:2011)

The design indoor environmental conditions are as follows:

	VENTILATION STANDARDS
Data Centre	7.5 liters/person/second

All materials, equipment brand names, equipment sizes/ capacities shall be strictly to the Engineer's approval. The installation of non-approved equipment shall result in rejection of the installations and neither the Client nor the Engineer shall be responsible for any material/ financial losses incurred by the contractor.

2.3.3 Design Codes for HVAC Installations

The HVAC installation shall be done in line with the applicable client specification as well as local and international standards, codes and regulations for HVAC systems, which include:

- A) Client specifications ,
- B) South African National Standards (SANS), e.g.
 - SANS 10400-A: General Principles and Requirements,
 - SANS 204 - Energy Efficiency in Buildings,
 - SANS 10400-O: 2011 - Lighting and Ventilation,
 - SANS 1238:2005 - Air-Conditioning Ductwork,
 - SANS 1424:1987 (2001-11-07) - Filters for Use in Air-Conditioning and General Ventilation
 - SANS 10147:2002 - Refrigerating Systems Including Plants Associated with Air-Conditioning Systems
 - SANS 10173:2003 - The Installation, Testing and Balancing of Air-Conditioning Ductwork.
 - SANS 10400:1990 - The Application of the National Building Regulations
 - SANS 60730-1:2007 / IEC 60730-1:2007 - Automatic Electrical Controls for Household and Similar Use Part 1: General Requirements
- C) American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standards: 2003/ 2007.
- D) Occupational Health and Safety Act (No. 85 Of 1993)

2.3.4 Summary

This section specifies the minimum requirements for A/C Units. The scope is to provide air cooled chiller connected to close control units, utilizing chilled as specified herein for cooling.

2.3.5 Chilled Water System

All close control units and chillers used in the building shall be from the same manufacturer, and shall be electrically controlled, with cooling drawn from the chilled water equipment. Supply air shall be discharged downward into the floor void, as shown on tender drawings. Units shall be of ultra-high cooling efficiency.

i. Evaporator Cooling and Heating Coils:

- a) Cooling duty return air (Air 'Onto' Evaporator) selection point is stated to be 21.4 °C_{db} / 13.4 °C_{wb} at 1700 meters above sea level.
- b) Cooling coils shall be suitable for air to water heat transfer
- c) The water coils shall be circuited for the most economic balance between heat transfer and water pressure drop.
- d) Heating coils shall be of the water to air heat transfer type using hot water.
- e) Coils shall be of the extended surface type, constructed of seamless copper tubes with mechanically bonded aluminum or copper fins.
- f) Coils shall be designed and constructed for a test pressure of 1 600kPa or the system working pressure times 1.5, whichever is the greatest.
- g) Coil face velocity shall be low enough to ensure that no condensate water is carried over in the air stream, generally not more than 2,5m/s.
- h) Where moisture carry-over may be a problem proper eliminators shall be fitted downstream of the coil.
- i) Coil casings shall be flanged and constructed of 1,6mm or thicker sheet steel hot dip galvanized after manufacture.
- j) Chilled and hot water distributors on multi-circuit coils shall ensure uniform water distribution between circuits.
- k) Evaporator coils must not have more than 12.7 Fins per inch

ii. Fan Motors:

Provide motors with the following characteristics (except where note or standard with the preferred equipment manufacturer as per BoQ):

- a) All motors used in the air conditioning installation shall be of the latest type and in accordance with all relevant SABS standards. All necessary overload protection must be provided.
- b) Motor nameplates shall list the full load motor efficiency.
- c) Evaporator fan motor shall have permanently lubricated, sealed bearings and inherent automatic-reset thermal overload protection or manual reset calibrated circuit breakers.
- d) The Evaporator fan shall be direct drive type
- e) Maximum discharge velocity out the evaporator centrifugal fan must be at a lower velocity than 12.5m/s

iii. Power input and Direct Digital Controls:

- a) The unit shall have a single power supply input and the project electrician shall provide a normal/emergency power switch over panel remotely.
- b) The unit controller shall enable unit capacity steps of 0%, 50% and 100% of both cooling and heating functions.
- c) The unit controller shall be available as a factory-installed option.
- d) Unit shall incorporate an outdoor coil defrost system to prevent excessive frost accumulation during heating duty.
- e) The controller shall actively monitor all modes of operation, as well as indoor-fan status, return-air temperature, supply-air temperature, outdoor-air temperature, voltage monitor controller (phase sequence relay) for monitoring the main incoming power supply for the unit supplied safety which gives protection on under-voltage, phase failure / imbalance and phase non-sequence.
- f) The controller shall have built-in diagnostics for thermostat commands for both staged heating and cooling and indoor-fan operation.
- g) The controller shall be equipped with a 5-minute time delay between modes of operation.
- h) Condenser fans control must be possible with ON/OFF sequencing ability from the controller to allow operation of unit under low ambient.
- i) The controller must have a pre-programmed 'flush cycle' for pumping only fresh air into the spaces served without cooling or heating. This flush cycle mode shall also work in emergency power outage scenario but not in emergency fire scenarios as the unit is to shut down completely in this later case.

iv. Unit Casing:

- a) Unit casing shall be constructed of corrosion proofed steel, precoated oven baked with a polyester epoxy powder coated external finish to suite external South African ambient conditions.
- b) Evaporator compartment interior surfaces shall be insulated with a minimum 45 mm Polyurethane foam injected panel for unit cooling capacities over 200kW and 25mm thick Polyurethane foam injected panels for unit capacities below 200kW.

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- c) Cabinet panels shall be easily removable for servicing.
 - d) Filters shall be accessible through an access panel.
 - e) The unit casings shall be supported on formed galvanized steel channel or structural channel supports. Maximum deflection shall not exceed 1:200. Holes shall be provided in the base rails for rigging shackles to facilitate overhead rigging.
 - f) Unit shall have a factory-installed internal condensate drain connection and a sloped condensate pan. The drain pan shall be from 1.2mm stainless steel and insulated on the underside to prevent condensation.
 - g) The Evaporator fan shall be connected with a flexible connection to the unit cabinet
 - h) A full-size hinged access door shall be provided for any section requiring service access. Removable casing panels shall not be allowed. Door frame shall be of rigid extruded aluminum. Adhesive-backed gasket applied to the frame shall not be allowed. Access doors shall be thermally broken and provided to the following components at a minimum: supply and return fan motors, supply and return fan inlets, filters, dampers, cooling/heating coils and any other serviceable component. Hinged access doors shall be complete with stainless steel hinges and multiple-point, single-handle compression-type latches to provide quick access and a positive air seal.
 - i) The unit must have a walk-in return air plenum with no slide in filters allowed.

2.3.6 Split Heat pump A/C Units (General)

N/A

2.3.7 Filtration (refer to clause 21 of the General Technical Specification)

Pleated washable primary filters, of the standard panel type, with zinc passivated mild steel frames shall not be thinner than 0,6mm. The filter frames shall be installed on all outdoor air intakes and upstream of all cooling or heating systems. Filter face velocity shall be low enough to ensure that no pressure above 220Pa is experienced when filters are dirty and the clean air filter shall generally measure air velocity not more than 2.5m/s at 60Pa across every filter.

Primary Air filters shall be minimum 50mm thick high performance washable pleated panel filters. The filters shall comply to EN779:

- Close Control Units: Filter Class G4
- Fresh Air Fan: Filter Class G4

The filter cartridge shall be sealed into the enclosing frame by means of a mediapack and frame. The filter media shall be a random layered, non-woven, synthetic, polyester fibre that has been saturation bonded.

Note that AS1324 requires all air filters to be labeled with a filter performance rating together with the manufacturers / distributors details. Filters shall be contained in a purpose made filter bank. Where filters are to be incorporated in a duct, the panels shall be suitable for side access. Filter face velocity shall be low enough to ensure that no pressure above 220Pa is experienced when filters are dirty and the clean air filter shall generally measure air velocity not more than 2.5m/s at 60Pa across every filter.

If the filter bank is not readily accessible from a 1,8m high ladder, a special platform (plus means of access in the form of a permanent cat ladder) is to be constructed by the Contractor to enable the regular maintenance of the filters to take place.

The Contractor shall be responsible for the initial filter panels installed during commissioning and testing, and for the cleaning of these just prior to the plant hand over. All filter replacements during the guarantee period are to be included in the 12 months free maintenance costs. One full set of filters shall be installed after expiry of the 12 months free warranty period.

While the air-conditioning plant is in operation up to and possibly after the premises opening, (depending on site conditions), temporary filter media must be installed over the panel filters to protect them from excessive dust.

2.3.8 Air Distribution

- a) Floor Void Air Distribution
 - Floor void space shall be used for air distribution and cooling of the data centre
 - The entire air distribution system shall be balanced to supply the air quantities evenly as required in various zones and rooms to maintain the specified room conditions.

- b) Fire Dampers (refer to clause 19 of the General Technical Specification)
 - Combination fire/smoke control dampers complying with SABS 193 and NFPA 90A are required in the positions indicated on the Tender drawings.
 - The dampers shall be UL (underwriters Laboratories) or SABS certified with proven low leakage in the closed position.
 - Dampers shall be actuated by fusible link, electrical solenoid or pneumatic means as specified in the Supplementary Specification.
 - Fire dampers shall be flanged both sides and access panels shall be provided in the ducting at each fire damper on the upstream side.
 - Each fire damper shall be clearly marked as per clause 4 of SABS 193.
 - Fire dampers shall have at least a 2-hour resistance rating when tested in accordance with SABS 193.
 - Insulating fire dampers shall be fitted where indicated on the Tender drawings.
 - The open or closed status of the damper shall be clearly indicated outside the casing for inspection purposes.
 - Dampers shall be sized so that the nominal free air area when in the open position is not less than the connected duct free air area.
 - Dampers shall be installed so 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 firewall, the section of ducting between damper and 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 frame be set so that the closing device will be accessible.
 - Suitable hand openings with tightly fitted covers shall be provided to make dampers accessible for inspection and maintenance

- c) Sound Attenuation (refer to clause 20 of the General Technical Specification)

Purpose made attenuators shall be used where necessary on supply, return and exhaust systems to ensure that the noise levels specified are achieved.

- d) SARACCA table to be used for duct manufacturing and installation

SARACCA
REVISED LOW PRESSURE DUCT METAL THICKNESS
CLASSIFICATION : POSITIVE PRESSURE : 500PA
NEGATIVE PRESSURE : 500PA
VELOCITY : 10m/s

Category	Longest Side L/S mm	Semi Peri-meter	Minimum Thickness mm	Maximum Spacing Between Joint mm	Maximum Spacing Between Stiffener mm	Joint Type	Type of Inter-mediate Stiffener	Maximum Spacing Between Hangers mm	Hanger Rod Dia mm	Hanger Angle mm	Measured Sheet Metal Mass Kg/m ⁵
1	Up to 750	<1150	0.6	2400	2400	S&D	Note 1	2400	6	40 x 2	4.9
2	Up to 750	>1150	0.6	2400	2400	Note 2 Slip on Flange	Note 1	2400	6	40 x 2	4.9
3	751 to 1350		0.8	2400	1500	Note 2 Slip on Flange	Note 1	2400	8	40 x 3	6.5
4	1351 to 2101		1.0	1500	1500	Note 2 Slip on Flange	Note 3	3000	8	40 x 6	8.12
5	> 2101		1.2	1500	1500	Angle ms Flange or Mezz Flange and Tie Rods	Note 3	3000	10	40 x 6	9.75
Notes: 1. Sheet Stiffening Either cross breaking, beading or pleating of longest side to be applied on all ducting where duct dimension is over 550mm 2. Slide on Flanges Up to 1350mm - 25mm flange, 1351-2100mm 35mm Flange > 2100mm 35mm Flange, and tie rod or mild steel 40 x 40 angle 3. Stiffener Inverted V strip or equal stiffener fixed on duct side to prevent panels vibrating and sagging. (Tie rods where necessary to prevent drumming, vibration and sagging).											

2.4 ELECTRICAL, AUTOMATIC CONTROLS AND MONITORING

a) Electrical

All electrical work shall be done in accordance with the latest wiring regulations and SABS codes.

The Contractor will be responsible for:

- i. The supply and installation of all the field wiring, control and switchboards associated with his installation.
- ii. The supply and installation of all cable trays and conduits required to undertake the field wiring
- iii. Supplying and installing the required equipment for the control panels specified.
- iv. The wiring from a local isolator (provided by the Electrical Contractor) to a 24 hour fan station, or through the stop/start station to such fan from this isolator. The stop/start station is to be supplied and installed by the (Mechanical and Fire) Contractor.
- v. The supply and installation of any control equipment, such as individual thermostats that are required, including all wiring to and from such equipment.
- vi. Providing a **Certificate of Electrical Compliance** to the Mechanical Consultant on completion of the mechanical electrical works.

In addition, the Contractor will be responsible for:

- i. The supply and installation of the main incoming supply cable/s to each air conditioning board, and for making off of these cables to the incoming side of the main isolator.
- ii. The provision of a separately protected electrical supply to each independent air handling/ fan coil/ split system AC unit, geyser, hydroboil, etc.
- iii. For the provision of specific conduits to be cast into concrete columns or slabs. These are to be detailed by the Contractors on his Builders Work drawings and given to the electrician so that they may be installed.

b) Automatic Controls and Monitoring

Only specified HVAC equipment shall be Building Management System (BMS) compatible and/or be linked to controllers/ schedule timers to be installed in an area to be agreed upon by the Client/ End User. The control of the inside temperature shall be by means of remote sensors with the adjustment controllers being of the wall mounted hard wired type. The controllers shall be handed over to the Manager soon after the installation has been tested and commissioned. Microprocessor controller shall be mounted in the electrical panel located on the unit. The unit will be provided with all necessary temperature, pressure sensors, filter switches and wiring for complete temperature controls and economizer operation.

Each Multi-Tenant Zoned Hideaway Unit (HAU) shall have a return air sensor and/or a number of averaging sensors as indicated on the BoQ. The sensors shall give input data to the AHU's controller which in turn shall be monitored via BMS. The room setpoint shall be adjustable through the BMS, however, the control office/Centre Management shall be able to adjust the setpoint +/- 4°C. Thereafter, the BMS shall require a password for any further adjustments to the set point temperature.

Provide an interface between the unit controls and the BMS. The BMS protocol shall be Modbus and the following Input/output functions shall be possible for all Package units and Hideaway units.

1. ALARM:

- Common Alarm 'Faulty Air Conditioner'

2. MONITOR (OUTPUT)

- ON / OFF

3. CONTROL

- ON/OFF remote switching
- Scheduled 7 Day scheduled timer (ON/OFF)
- *Temperature change would be an advantage but not mandatory*

Where systems are specified as being maintained "under fire conditions" all wiring will be suitable for the temperatures to be encountered.

c) General Electrical installations Standards

i) Conduit and Accessories

The conduit and conduit accessories shall comply fully with the applicable SABS specifications as set out below and the conduit shall bear the mark of approval of the South African Bureau of Standards.

- Screwed metallic conduit and accessories: SABS 1065, parts 1 and 2.
- Plain-end metallic conduit and accessories: SABS 1065, parts 1 and 2.
- Non-metallic conduit and accessories: SABS 950.

All conduit fittings except couplings shall be of the inspection type. Where cast metal conduit accessories are used, these shall be of malleable iron. Zinc base fittings will not be allowed.

Bushes used for metallic conduit shall be brass and shall be provided in addition to locknuts at all points where the conduit terminates at switchboards, switch-boxes, draw-boxes, etc.

Draw-boxes are to be provided in accordance with the Wiring Code and wherever necessary to facilitate easy wiring.

The conduit used shall have an external diameter of 25mm. In all other instances the sizes of conduit shall be in accordance with the "Wiring Code" for the specified number and size of conductors.

Only one manufactured type of conduit and conduit accessories will be permitted throughout the installation.

Running joints in screwed conduit are to be avoided as far as possible and all conduit systems shall be set or bent to the required angles. The use of normal bends must be kept to a minimum with exception of larger diameter conduits where the uses of such bends are essential.

All metallic conduits shall be manufactured of mild steel with a minimum thickness of 1.2mm for plain-end conduit and 1,5mm in respect of screwed conduit.

ii) Conduit in Roof Spaces

Conduit in roof spaces shall be installed parallel or at right angles to the roof members and shall be secured at intervals not exceeding 1,5m by means of saddles screwed to the roof timbers,

Nails or crampets will not be allowed. Where non-metallic conduit has been specified for a particular service, the conduit shall be supported and fixed with saddles with a maximum spacing of 450mm. The Contractor shall supply and install all additional supporting timbers in the roof space as required.

Under flat roofs, in false ceilings or where there is less than 0,9m of clearance, or should the ceilings be insulated with glass wool or other insulating material, the conduit shall be installed in such a manner as to allow for all wiring to be executed from below the ceilings.

Conduit runs from distribution boards shall, where possible, terminate in fabricated sheet steel draw-boxes installed directly above or in close proximity to the boards.

iii) Surface Mounted Conduit

Wherever possible, the conduit installation is to be concealed in the building work, however, where unavoidable or otherwise specified under Part 2 of the specification, conduit installed on the surface must be plumbed or leveled and only straight lengths shall be used.

The use of inspection bends is to be avoided and instead the conduit shall be set uniformly and inspection couplings used where necessary.

No threads will be permitted to show when the conduit installation is complete, except where running couplings have been employed.

Running couplings are only to be used where unavoidable, and shall be fitted with sliced couplings as a lock-nut.

Conduit is to be run on approved spaced saddles rigidly secured to the walls,

Alternatively, fittings, tees, boxes, couplings etc., are to be cut into the surface to allow the conduit to fit flush against the surface, Conduit is to be bedded into any wall irregularities to avoid gaps between the surface and the conduit.

Crossing of conduits is to be avoided, however, should it be necessary purpose-made metal boxes are to be provided at the junction. The finish of the boxes and positioning shall be in keeping with the general layout.

Where several conduits are installed side by side, they shall be evenly spaced and grouped under one purpose-made saddle.

Distribution boards, draw-boxes, industrial switches and socket outlets etc. shall be neatly recessed into the surface to avoid double sets.

In situations where there are no ceilings the conduits are to be run along the wall plates and the beams.

Painting of surface conduit shall match the colour of the adjacent wall finishes.

Only approved plugging materials such as aluminium inserts, fibre plugs, plastic plugs, etc. and round-head screws shall be used for fixing saddles, switches, socket outlets, etc. to walls, wood plugs and the plugging in joints in brick walls are not acceptable.

iv) Conduit in Concrete Slabs

In order not to delay building operations the Contractor must ensure that all conduits and other electrical equipment which are to be cast in the concrete columns and slabs are installed in good time.

The Contractor shall have a Representative in attendance at all times when the casting of concrete takes place.

Draw-boxes, expansion joint boxes and round conduit boxes are to be provided where necessary Sharp bends of any nature will not be allowed in concrete slabs.

Draw and/or inspection boxes shall be grouped under one common cover plate, and must preferably be installed in passages or male toilets.

All boxes, etc., are to be securely fixed to the shuttering to prevent displacement when concrete is cast. The conduit shall be supported and secured at regular intervals and installed as close as possible to the neutral axis of concrete slabs and/or beams.

Before any concrete slab is cast, all conduit droppers to switchboards shall be neatly spaced and rigidly fixed.

v) Wiring

Except where otherwise specified in this specification, wiring shall be carried out in conduit throughout. Only one circuit per conduit will be permitted.

No wiring shall be drawn into conduit until the conduit installation has been completed and all conduit ends provided with bushes. All conduits to be clear of moisture and debris before wiring is commenced.

The wiring of the installation shall be carried out in accordance with the "Wiring Code". Further to the requirements concerning the installation of earth conductors to certain light points as set out in the "Wiring Code" it is a specific requirement of this document that where plain-end metallic conduit or non-metallic conduit has been used, earth conductors must be provided and drawn into the conduit with the main conductors to all points, including all luminaires and switches throughout the installation.

Wiring for lighting circuits is to be carried out with 1,5mm² conductors and a 2,5mm² earth conductor. For socket outlet circuits the wiring shall comprise 2,5mm² conductors and a 2,5mm² earth conductor.

The loop-in system shall be followed throughout, and no joints of any description will be permitted.

The wiring shall be done in PVC insulated 600/1000 V grade cable to SABS 150.

Where cable ends connect onto switches, luminaires etc., the end strands must be neatly and tightly twisted together and firmly secured. Cutting away of wire strands of any cable will not be allowed.

3. SITE DETAILS AND PLANT OPERATING CONDITIONS

The following conditions have been used for the design of the replacement HVAC systems.

3.1 PLANT DESIGN AMBIENT CONDITIONS

Altitude:	1750m (Nasrec, Gauteng Province)
Outside Design Conditions:	Summer: 32 °C db and 20 °C wb
	Winter: 2 °C db

Lighting and Small Power Electrical Supply:

230V ± 10%/ 1 Phase/ 50Hz
400V ± 10%/ 3 Phase/ 50Hz

Other Three Phase Low Voltage Electrical Supply:

525V ± 10%/ 3 Phase/ 50Hz

3.2 INSIDE CONDITIONS REQUIRED

AIR-CONDITIONED AREAS:

Temperatures	Summer 20.0 °C db ±1°C
	Winter 20.0 °C db ±1°C
Relative Humidity	40% to 55% RH (approximately)

*NOTE: Heat load Calculations have been done and unit capacities selected by The Engineer. These are available to the contractor if required.

The above temperatures are those at which the majority of people are considered to be comfortable, as indicated on a Comfort Chart. The relative humidity would not be actively controlled but would be indirectly controlled within the comfort range as a result of the design and selection of the cooling plant. The temperatures would be controlled within a tolerance of ± 1.5°C, i.e. maximum temperature = 25.0 °C_{db}.

3.3 MINIMUM PLANT OPERATING CONDITIONS

All plant items will be suitable for operation in the environment in which they are to be located. As a minimum, all plant, motors, starters and ancillary equipment etc. will be suitable for operation at full capacity under the following conditions:

- Air cooling at an average temperature over 24 hours not exceeding 45°C dry bulb;
- Maximum conditions of 45°C dry bulb and 50 %relative humidity;
- Minimum conditions of -10°C dry bulb and 100 % relative humidity;
- Protection of all equipment exposed to atmosphere/ambient to EN 60529 - IP 65.

4. SITE VISIT

Refer to main Bid Document.

5. TEMPORARY OFFICES

Refer to main Bid Document.

6. AREAS REQUIRING SPECIAL ATTENTION

6.1 PIPING

6.1.1 Interconnecting Piping

The Contractor is to allow for all interconnecting piping to be carried out in air conditioning quality copper tubing in imperial sizes. All piping is to be clean and capped to prevent ingress of dirt. Soft drawn piping may be used in sized up to 15mm OD.

Existing drain points for condensate shall re-used. The Contractor is to allow for the connection from the evaporator unit to the condensate stubs, existing and new, and to include for a p-trap.

Any vertical suction piping is to be trapped every 3m to allow for oil return. During soldering (brazing), a permanent dry nitrogen purge must be in place.

The Engineer may require sample welds to be cut out to ascertain that this requirement has been complied with. A nitrogen regulator is to be used for this purpose. Oxygen regulators are not allowed, and direct connection of piping to the nitrogen cylinder is not allowed. Should defects be found, then further samples may be requested by the Engineer. The cost of rectifying defective piping installation will be for the Contractors' account.

6.1.2 Fitting and Valves

All bends and elbows are to be of long radius type. Allowance for expansion of piping is to be made as per the Engineer's General Specification. All fitting and valves are to be soldered joints.

6.2 PIPE INSULATION

For chilled water piping, proprietary expanded rubber insulation 18mm thick, such as Armaflex, may be used. Insulation is to be applied to the piping before installation takes place. Splitting of the insulation for application after piping installation is not acceptable. Butt joints are to be properly glued together and covered by self-adhesive P.V.C tape, or equal, taking great care not to compress the insulation material. Alternatively be insulated by means of "Thermaflex" Type 40 QE cross-linked polyethylene foam tube insulation, neoprene rubber foam with quick zip fastener, or equal. The insulation material shall meet the following minimum requirements:

Temperature range	: -80°C _{db} to +120°C _{db}
Thermal conductivity	: 0,038 W/m°C at 0°C
Thickness	: 10mm
Density	: 35kg/m ³
Odour properties	: Neutral
Cellular structure	: Totally closed
Fire properties	: Self-extinguishing to SABS

The insulation shall be applied to form a continuous and homogeneous vapour barrier over bends, supports, etc. Where these pipes are run in areas exposed to sunlight, they shall be installed inside suitable galvanized mild steel trunking or other approved method of covering.

6.3 CHILLED & HOT WATER VALVES

All globe and gate valves (except screwed gate) shall incorporate back seating on spindles to facilitate repacking of gland under pressure.

All valves installed shall be of a high standard of manufacture and well-known brand equal to **KSB, HATTERSLEY, OVENTROP, HOLMES & CRANE**.

Types of valves shall be of the same manufacture.

- Screwed valves shall be to BS.21 taper.
- Flanged valves shall be BS4504 standards with connecting flanges to match.
- ASA Standards will be accepted on steam installations
- (1050 kPa and over).
- Screwed valves to be used up to and including 50mm - 65mm and over flanged valves.
- Valves will be selected to conform to the pressure\temperature rating and duties applicable to the particular system or application where being installed.

All valves shall conform to the following material specifications:

- Bronze BS1400 LG 2-C/ASTM B62
- Cast Iron BS 1452 GR 14/ASTM 126 Class B
- Malleable ASTM A-47 GRD 32 510
- Ductile BS 2789 (1961) ASTM or A 395
- Cast Steel ASTM A 216 GRD W C B

Strainers shall be of the "Y" pattern bronze screwed with stainless steel screen equal to TOA fig. "Y" or cast iron body flanged, bolted cover with blow down plug and stainless steel screen to be fitted with extraction handle for easy removal to SHOWA fig. 33 or equal.

Screen perforations as follows:

- | | |
|----------------------------|------------|
| • Up to and including 50mm | 1.2mm dia. |
| • 65mm to 150mm | 2.0mm dia. |
| • 200mm and over | 3.5mm dia. |

Gate Valves (if applicable) shall be SABS 776-1975 Class B screwed, or equal, or cast iron body flanged with bronze rising spindle, and trim, outside screw and yoke, solid wedge disc, to BS 5150 J Fig. KF 502 or equal.

Globe Valves shall be bronze body screwed, internal screwed bonnet, rising spindle bronze to bronze tapered seats to Conti Fig. 70400 or equal, or cast iron body flanged with bronze rising spindle, and trim, outside screw and yoke to BS 5152 J Fig. KF 501 or equal.

Check Valves shall be bronze screwed, swing check type, bronze seats to Conti Fig. 77104 or equal, or cast iron body flanged solid, cast iron flap with bronze trim and bolted cover to BS 5153 J Fig. KF 601 or equal.

Alternative Wafer type non-slam check valves central pivoted butterfly flaps with bronze on BUNA N seats to DIN 3202 or API 594 J Fig. KF 301 or equal.

Balancing Valves shall be Crane, Tour or Anderson or equal, shut-off\balancing valve with pressure sensing points over the valve for determining water flow rates. All valves to have calibration markings and 65mm and over flanged cast iron Epoxy coated.

At all high points of the water systems fit PURG-O-Mat Fig. KS 69 or equal automatic air vents with integral check valves. Each air vent shall be preceded by a gate valve to allow maintenance of the air vents. Automatic air vents shall ensure positive removal of all air from water piping systems. At all low points of the systems fit 15mm diameter drain cocks with hose unions, these valves so located that the entire piping system can be completely drained. Fit such drain valves at equipment if necessary to allow complete drainage.

Closed circuit condenser water and chilled water systems shall be connected to an expansion tank. The tank shall be of adequate size to suit the system and shall be manufactured from 2mm galvanised sheet steel. The minimum water level in the tank shall be kept at approximately 300mm from the bottom by means of a 20mm nominal size ball valve. The tank shall be provided with a separate quick filling connection, overflow and a lid with an air vent.

At all equipment connections to vibrating equipment fit flexible connectors equal to Fig. KF 401 as supplied by EM Arnot or Kerr Valves. All flexible connectors shall have flanged joints and be capable of a 16 bar or 1,5 times the system working pressure whichever is the higher value.

Copper earthing straps shall be fitted over all flexible connections and shall be carried out in accordance with the standard wiring regulations (see Clause 31.1).

Pipe joints shall be neatly made, all pipe cuts properly cleaned and re-amerred. At all connections to equipment use flanged joints to conical face unions for smaller pipe sizes up to 40mm nominal bore. Incorporate sufficient flanged joints or unions to allow dismantling of sections of pipework to facilitate access to plant items for maintenance purposes. Use screwed joints of galvanised pipework up to and including 100mm nominal size and on black piping up to and including 50mm nominal size. Where galvanised piping is called for above 100mm diameter use black piping with welded joints and hot-dip galvanised after welding.

On black piping all sizes over 25mm diameter may be welded. Screwed joints on piping up to 25mm diameter shall utilise P.T.F.E. jointing tape equal to 3-M manufacture. For larger joints use Hemp and Stag or equivalent jointing compound. Flanged joints shall include Klingerite gaskets or equivalent. Caulking of joints will not be permitted. Connections to equipment where the pipe size is 65mm diameter and above shall be flanged.

Plug open ends of pipings, drains, fittings and equipment connections during installation to keep systems free of rubble, dirt and other foreign matter.

Maximum support spacing for pipework shall be:-

- 50mm diameter and smaller 3 m
- 65 to 100mm diameter 4.5 m
- above 100mm diameter 6 m

All piping systems shall be flushed out properly to ensure cleansing, prior to the operation of the plant.

Piping systems shall be tested by means of an hydraulic pump to twice the operating pressure of the system or, where it is not permissible due to the maximum allowable piping working pressure, the piping shall be tested to the limit set by such maximum allowable working pressure. Pressure gauges to be used during normal operation are to be protected when testing occurs.

6.4 PRESSURE GAUGES

All dial pressure gauges shall be snubbed or glycerine filled to prevent pointer vibration. Gauges shall have an accuracy of 2%. The range shall extend to 150% of the maximum operating pressure.

All inclined manometer differential pressure gauges shall have an accuracy of 2%. The range shall extend to 150% of the maximum operating pressure, with graduation being steps of 10 kPa.

All differential dial pressure gauges shall have an accuracy of 2% and shall not be less than 100mm diameter. Zero pressure reading shall be in the centre, and the range of scale on either side shall extend to 150% of the maximum operating pressure, with provision being made for individual pressure reading.

6.5 TEMPERATURE GAUGES

All direct reading thermometers and temperature reading devices shall have an accuracy of 0,5°C and a range of -10°C to 10°C for chilled water supply; 0°C to 20°C for chilled water return; 0°C to 40°C for condenser water supply and return, unless otherwise specified, with graduation being in steps of 1°C.

Stem thermometers shall be approximately 100mm long and dial type thermometers approximately 80mm diameter.

Wells shall be set vertical or at an angle to retain oil. Pipes smaller than 80mm bore shall be enlarged at points where wells are installed as per following table:

- Pipe bore (mm) 15 20 25 32 40 50 65
- Size of enlargement (mm) 32 40 50 50 50 65 80
- The sensor element shall be at the centre of the pipe.

6.6 INSULATION FOR CONDENSATE WATER PIPELINES TO PREVENT CONDENSATION

- a) NO PVC on drains.
- b) Copper on FCU drains
- c) Galvanised Steel on AHU drains.
- d) Insulation on condensate piping as per chilled water piping INSULATION CHART.

6.7 FINISHING & TIDYING

Progressive and systematic finishing and tidying will form an essential part of this contract. Under no circumstances shall spoil, rubble, materials, equipment or unfinished operations be allowed to accumulate unnecessarily and in the event of this occurring the Engineer shall have the right to withhold payment for as long as necessary in respect of the relevant works in the area(s) concerned.

6.8 FINISHING & TIDYING

Progressive and systematic finishing and tidying will form an essential part of this contract. Under no circumstances shall spoil, rubble, materials, equipment or unfinished operations be allowed to accumulate unnecessarily and in the event of this occurring the Engineer shall have the right to withhold payment for as long as necessary in respect of the relevant works in the area(s) concerned.

6.9 BURGLAR BARS

Burglar bars shall be installed at each external ventilation exhaust louvre which penetrates the facade of the complex.

The bars shall not be less than 15mm round bars, spaced at 125mm centres in both directions and welded into a frame. They are to be hot dipped galvanized after manufacture.

The burglar bar frame should be built into the masonry structures. Alternatively they can be bolted into the masonry structure (independent of any connecting ductwork) and the bolt heads tack welded to ensure they cannot be easily removed. The area of the tack weld is to be touched up with cold galvanizing paint.

A written confirmation that all openings in all the air conditioning and ventilation systems have been protected by the specified burglar bars will be required from the air conditioning Contractor. This certificate is to be provided at the beneficial occupation stage.

6.10 PAINTING

The installation shall be painted in accordance with an approved colour code. Such painting shall be only necessary to those items which would normally be visible when serviced, all mild steel or other components which would otherwise suffer corrosion if unpainted, however, shall be painted with two coats of rust-proof paint whether such components are normally visible or not. Items which are factory painted need not be repainted other than any making good which may be necessary. All plants requiring painting shall be correctly prepared and painted with two coats of enamel gloss after one coat of suitable rust-proof primer and an undercoat.

6.11 OTHER SERVICES**6.11.1 Fire Protection**

All systems shall incorporate the necessary fire protection and smoke protection features demanded by the National Building Regulations and the local authority. These features shall include but not be limited to detection devices, electrical actuator and fusible link operated fire dampers.

6.11.2 Smoke Control

In the event of a fire alarm, all air-conditioning units and ventilation fans shall be stopped by means of a fire relay provided by the Contractor.

The Smoke Detection Contractor shall allow for bringing the necessary wiring into the (HVAC) Contractor's (Rooftop Package and large hideaway) and Electrical Contractor's (small units) electrical panels, and connecting to potential free contacts.

7. COMPLETION, GAURANTEES & MAINTENANCE

7.1 TESTING

A **Testing and Commissioning Notice** shall be sent out to the Engineer accompanied with the test procedure 2 weeks prior to the scheduled Testing and Commissioning date.

All Equipment used for Testing and Commissioning shall have a **Valid Calibration Certificate** which must be placed on the test report. On completion, the installation shall be balanced, set and tested to establish the capacity and performance of the plant. All such tests shall be recorded and typed copies of all test recordings shall be included within the operating manuals later specified herein. The test reports shall set out the procedure, data and instrument readings obtained as compared with the required capacities and the manufacturer's name plate rating where applicable. Additional refrigerant and oil quantities must be considered and approved by the Equipment supplier before installation by Contractor. Refrigerant pipe sizes must also be considered for compensation due to pressure drop due to length of pipe runs & bends and approved by the equipment supplier prior to installation. All this data and approvals must be forwarded to the Engineer.

All performance figures obtained during testing and commissioning must be within +-10% of the specified performance figures given in the Tender drawings and Technical specification

The Air Handling/ Package Rooftop equipment shall be factory run tested for a minimum of eight hours to ensure proper operation.

7.2 END USER TRAINING

Upon completion of all works and all tests, the contractor shall furnish necessary operator's labor and helpers for operating the entire installation for a period not less than two weeks of ten hours each to enable the owner's staff get acquainted with the operation of the system. During this period the contractor shall train the owners personnel in the operation, adjustment and maintenance of all equipment installed.

7.3 OPERATING AND MAINTENANCE MANUALS

Three instruction manuals shall be provided for the new equipment. Each manual shall comprise of the following sections, bound in a vinyl plastic covered folder with the name of the project typewritten on a card inserted into a clear plastic covered cardholder on the front cover and spine and shall be handed to the Client on completion of the installation.

- **Index**
- **Description of Systems and Equipment** (as installed)
- **Operation of Equipment** (as installed)
- **Plant and equipment** (a schedule list of all major plants to include description, make, model number and supplier's name and address).
- **Commissioning Data (Signed off by Engineer)**
- **Inspection and Maintenance Instructions** (in schedule form setting out each item of the plant, the description and frequency of maintenance operations required).
- **Operating Instructions** (Plant running checklist and frequency of servicing, Safety precautions to be taken, Manual and automatic operation, Operator's duties, Lubricating oils and service instructions, Pre-start checklist for each system, Starting and stopping procedures)

-
- **Spare Parts** (list of spare parts to be supplied, as later specified herein, with detailed description of each part, make, model and part number and supplier's name and address)
 - **Descriptive literature** (for all items of plant and equipment)
 - **As-Built drawings in hardcopy and Autocad 2010 version electronic format** (of plant as installed to include plant layout drawings, control and wiring diagrams and schematic piping diagrams).

7.4 COMMISSIONING PROGRAMME

The Contractor shall adhere to the Main Contractor's programme for the installation, but shall ensure that his commissioning programme makes allowance for the following requirements:

- i. The blow-out of all supply air ducts for the various air conditioning and ventilation systems, shall be completed no later than 1 (one) week before Beneficial Occupation Date.
- ii. At the date of Beneficial Occupation, **ALL** systems shall be operating and the air conditioning system is fully operational, balanced, tested, commissioned, approved by The Engineer and handed over by that date.

7.5 GUARANTEE AND MAINTENANCE

The entire air conditioning and ventilation installation shall be subject to a guarantee and servicing of **12 months from the Beneficial Occupation date**, or from the date of the Taking-Over certificate as state below.

Expendables such as filters and refrigerant for the maintenance period must be included in the contract price. Oils and other such minor expendables shall also be included. The Contractor shall be entirely responsible for carrying out regular inspections at intervals not greater than 1 month.

A detailed inspection and service log book with check sheets showing all functions to be carried out at each inspection and service, is to be kept on site for all service activity and must be countersigned by a manager or facilities personnel as client representative. The equipment shall be services and maintained in strict accordance to the equipment manufacturer's recommended intervals and service item list. The Contractor shall draw-up and submit the INSPECTION & SERVICE SCHEDULE to the Engineer for their approval. The Service Schedule shall include for regularity of maintenance, service items at those intervals and recommended spare parts list. This schedule must be submitted 2 months before equipment handover and approved by the Engineer latest 3 weeks before scheduled handover of installations.

7.6 WARRANTIES

7.6.1 Taking-Over Certificate

When the whole of the Works have been substantially completed and have satisfactorily passed any Tests on Completion prescribed by the Contract, the Contractor may give a notice to that effect to The Engineer, with a copy to the Employer, accompanied by a written undertaking to finish with due expedition any outstanding work during the Defects Liability Period. Such notice and undertaking shall be deemed to be a request by the Contractor for The Engineer to issue a Taking-Over Certificate in respect of the Works. The Engineer shall, within 21 days of the date of delivery of such notice, either issue to the Contractor with a copy to the Employer, a Taking-Over Certificate, stating the date on which, in his opinion, the Works were substantially completed in accordance with the Contract, or give instructions in writing to the Contractor specifying all the work which, in The Engineer's opinion, is required to be done by the Contractor before the issue of such Certificate.

The Engineer shall also notify the Contractor of any defects in the Works affecting substantial completion that may appear after such instructions and before completion of the Works specified therein. The Contractor shall be entitled to receive such Taking-Over Certificate within 21 days of completion, to the satisfaction of the Architect, of the Works so specified and remedying any defects so notified.

7.6.2 Taking Over of Sections or Parts

Similarly, in accordance with the procedure set out in Sub-Clause 7.1, the Contractor may request and The Engineer shall issue a Taking-Over Certificate in respect of:

- a) any substantial part of the Permanent Works which has been both completed to the satisfaction of The Engineer and, otherwise than as provided for in the Contract, occupied or used by the Employer, or
- b) any part of the Permanent Works which the Employer has elected to occupy or use prior to completion (where such prior occupation or use is not provided for in the Contract or has not been agreed by the Contractor as a temporary measure).

7.6.3 Substantial Completion of Parts

If any part of the Permanent Works has been substantially completed and has satisfactorily passed any Tests on Completion prescribed by the Contract, The Engineer may issue a Taking-Over Certificate in respect of that part of the Permanent Works before completion of the whole of the Works and, upon the issue of such Certificate, the Contractor shall be deemed to have undertaken to complete with due expedition any outstanding work in that part of the Permanent Works during the Defects Liability Period.

7.6.4 Surfaces Requiring Reinstatement

Provided that a Taking-Over Certificate given in respect of any Section or part of the Permanent Works before completion of the whole of the Works shall not be deemed to certify completion of any ground, roof or surfaces requiring reinstatement unless such Taking-Over Certificate shall expressly so state.

7.7 DEFECTS LIABILITY

7.7.1 Defects Liability Period

In these Conditions the expression "Defects Liability Period" shall mean the defects liability period calculated from:

- a) the date of completion of the Works certified by The Engineer in accordance with Clause 8, or
- b) in the event of more than one certificate having been issued by The Engineer under Clause 8, the respective dates so certified, and in relation to the Defects Liability Period the expression "the Works" shall be construed accordingly.

The defects liability period for this contract shall however be not less than 12 calendar months from the date of certification by The Engineer.

7.7.2 Completion of Outstanding Work and Remedying Defects

During the Defects liability period, the Contractor shall:

- a) complete any minor works, if any, outstanding on the date stated in the Taking-Over Certificate as soon as practicable after such date, and
- b) execute all such work of amendment, reconstruction, and Remedying defects, shrinkages or other faults as The Engineer may, during the Defects Liability Period or within 14 days after its expiration, as a result of an inspection made by or on behalf of The Engineer prior to its expiration, instruct the Contractor to execute.

The expiration of the Defects Liability Period shall not exonerate the Contractor from any further liabilities arising at Law.

7.7.3 Cost of Remedying Defects

All work referred to in Sub-Clause 7.7.2 shall be executed by the Contractor at his own cost if the necessity thereof is, in the opinion of the Architect, due to:

- a) the use of materials, Plant or workmanship not in accordance with the Contract,
- b) where the Contractor is responsible for the design of part of the Permanent Works, any fault in such design, or
- c) the neglect or failure on the part of the Contractor to comply with any obligation, expressed or implied, on the Contractor's part under the Contract,

If, in the opinion of The Engineer, such necessity is due to any other cause, he shall determine an addition to the Contract Price and shall notify the Contractor accordingly, with a copy to the Employer.

7.8 CONTRACTOR'S FAILURE TO CARRY OUT INSTRUCTIONS

In case of default on the part of the Contractor in carrying out such instruction within a reasonable time, the Employer shall be entitled to employ and pay other persons to carry out the same and if such work is work which, in the opinion of The Engineer, the Contractor was liable to do at his own cost under the Contract, then all costs consequent thereon or incidental thereto shall, after due consultation with the Employer and the Contractor, be determined by The Engineer and shall be recoverable from the Contractor by the Employer, and may be deducted by the Employer from any monies due or to become due to the Contractor and The Engineer shall notify the Contractor accordingly, with a copy to the Employer.

8. SCHEDULE OF MAJOR HVAC EQUIPMENT PERFORMANCE REQUIREMENT

8.1 SCHEDULE OF AIR CONDITIONING UNITS

EQUIPMENT SCHEDULE : DATA CENTRE										
UNIT NO.	QTY	UNIT TYPE	UNIT MAKE	CAPACITY	FLOW (l/s)	INPUT POWER/ UNIT		WEIGHT (KG)		DIMENSIONS (L x W x H)
						Rated	Voltage	Indoor	Outdoor	
CH1	1	AIR COOLED CHILLER	TRANE/ EQUALLY APPROVED	250kW	-	93.13 kW	400V/3Ph/50Hz	-		-
CH2	1	AIR COOLED CHILLER	TRANE/ EQUALLY APPROVED	250kW	-	93.13 kW	400V/3Ph/50Hz	-		-
CCU1	1	CLOSE CONTROL UNIT	AIREDALE/ EQUALLY APPROVED	142kW	17500	15 kW	400V/3Ph/50Hz		-	3100 x 890 x 1980
CCU2	1	CLOSE CONTROL UNIT	HC/ EQUALLY APPROVED	142kW	17500	15 kW	400V/3Ph/50Hz		-	3100 x 890 x 1980
FAF1	1	FRESH AIR FAN	AMS/ EQUALLY APPROVED	-	90	0.165	230V/3Ph/50Hz			

9. MATERIALS SCHEDULE

The contractor shall complete the following schedules and submit them to the Representative/Agent within 21 days of the date of the acceptance of the tender.

The schedules will be scrutinised by the Representative/Agent and should any material offered not comply with the requirements contained in the specification, the Contractor will be required to supply material in accordance with the contract at no additional cost.

NB: Only one manufacturer's name to be inserted for each item.

ITEM	MATERIAL	MAKE OR TRADE NAME	COUNTRY OF ORIGIN
1.	AIR COOLED CHILLER		
2.	CLOSE CONTROL UNIT		
3.	FRESH AIR FAN		
4.			

NOTE:

Should the contractor wish to supply materials other than that originally offered, prior written approval must be obtained from the Representative/Agent before any orders are placed.

CONTRACTOR: _____

SIGNED: _____

DATE: _____

10. SCHEDULE OF IMPORTED MATERIALS AND EQUIPMENT TO BE COMPLETED BY TENDERER

ITEM	MATERIAL/ EQUIPMENT	RAND (R) (EXCL. VAT)
1		
2		
3		
4		
5		
6		

The Contractor shall list all imported items, materials and/or equipment which shall be excluded from the Contract Price Adjustment Provisions and shall be adjusted in terms of currency fluctuations only.

Copies of the supplier's quotations for the items, materials or equipment (provided that such costs shall not be higher than the relevant contract rate as listed above) should be lodged with the Representative/Agent of the Department within 60 (sixty) days from the date of acceptance of the tenders.

No adjustment of the local VAT amount, nor the contractor's profit, discount, markup, handling costs, etc. shall be allowed.

The Contractor is referred to the price adjustment formula as contained in the main contract and should acquaint himself / herself with the contents thereof.

CONTRACTOR: _____

SIGNED: _____

DATE: _____