

**DBSA**  
**HUEWELLAND PRIMARY SCHOOL**  
**MECHANICAL INSTALLATION**  
**(HVAC)**  
**PART 1: STANDARD SPECIFICATION**  
**C O N T E N T S**

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**PART 1: STANDARD SPECIFICATION**

**1. PART OF THE SPECIFICATION**

The Standard Mechanical Specification covers the general technical requirements of the mechanical installation. These specifications shall be read in conjunction with the document in its entirety. If the conditions and/or specifications contained herein are at variance with anything contained in the detail specification, the latter shall take precedence, otherwise these Standard Mechanical Specifications shall apply as if duly included.

**2. MINIMUM REQUIREMENT**

The conditions and/or specifications in this section shall be regarded as the absolute minimum requirement. More stringent similar conditions and/or specifications stated in the detail specification shall take preference to those in these Standard Mechanical Specifications.

**3. PROPRIETARY MATERIALS**

The Tenderer's attention is drawn to the Detail Specification and Bills of Quantities generally which forms an integral part of the specification, specifically to the following clauses:

*Where the term "or other approved" is used in connection with proprietary materials or articles, it is to be understood that approval shall be at the discretion of the Principal Agent.*

*Where brand or trade names are referred to in the Detailed Specification and Bills of Quantities, these shall indicate the quality and type of material or fitting required and no substitution of materials so specified will be permitted unless the authority of the Principal Agent has been obtained in writing before tenders close.*

**4. STANDARD TYPE AND MAKE OF EQUIPMENT**

Once installation has commenced with the appropriate approvals for using any type and make of article or equipment, the same type and make of article or equipment shall be used throughout the project for that specific application unless otherwise specified.

**5. STANDARD OF WORKMANSHIP**

The workmanship under this contract shall be of a high standard and to the satisfaction of the Principal Agent.

**6. STANDARD OF MATERIALS**

All materials and equipment supplied and/or installed under this contract shall be new and the best of their respective kinds and shall comply with the requirements laid down in the latest editions of the relevant SANS or BS and their amendments and with the requirements of this specification.

**7. VARIATIONS**

The Principal Agent reserves the right to instruct the Contractor to carry out variations to the contract in accordance with the conditions of contract.

**8. CONSTRUCTION, PLANT, ETC.**

Tenderers shall include in their prices for the supply of all scaffolding, hoisting, ladders, trestles, dust sheets and everything necessary for the proper performance of the contract, for clearing and removal of all rubbish due to the work, for the protection of the work from damage due to the building operations, other contracts and the weather. In existing buildings Contractors shall in particular take adequate precautions to the satisfaction of the Principal Agent to prevent damage to existing apparatus during erection operation.

**9. MATERIAL, OFF-LOADING AND STORAGE**

Tenderers must make due allowance in their tenders for the off-loading of materials and the storage and safe custody thereof according to manufacturer's specifications on or off site until such can be accommodated or is required on site.

**10. ACCESS TO BUILDING**

Workmen are to be identified to security and issued with access/identity cards. Identifiable uniforms must be worn by workmen and supervisors on site.

**11. INSPECTION OF LOCALLY MANUFACTURED SUPPLIES**

Where locally manufactured plant or materials are offered, the Principal Agent reserves the right to inspect such plant or goods during manufacture and to reject items that do not conform to the Employer's requirements. Where a number of units are ordered, the Contractor shall notify the Principal Agent when one unit has been completed so that the Principal Agent may inspect and approve it.

**12. ORDERING MATERIALS**

The Contractor is warned to place all orders for materials or special articles as early as possible as he will be held solely responsible for any delay in the delivery of such goods.

**13. PACKING**

The Contractor will be held responsible for packing all plant and other goods in such a manner as to ensure freedom from any loss or damage in transit. Unless otherwise specifically agreed upon, receptacles will not be returned or paid for and no additional charges will be allowed for packing or packing materials.

**14. SAMPLES FOR TEST**

The Contractor shall furnish, without delay, such samples for testing, or other purposes, as called for, or may be called for, by the Engineer, who may reject all materials or workmanship not corresponding with the approved sample.

Notwithstanding that samples and approved brands of materials, etc. are exhibited or included in classified lists at the offices of the Principal Agent, the Engineer may retest any samples, brands of materials, etc. included in the contract and reject articles and materials, etc. that do not strictly comply with the specification.

**15. DAMAGE TO BUILDINGS AND THE MISUSE OF FACILITIES**

Any damage done to the buildings, roads and landscaped areas by the Contractor, or his men, shall be made good by the Contractor. Should the Contractor, or his personnel, be granted leave by the Principal Agent to utilise on-site facilities and such facilities be misused or damaged, the facilities shall be cleaned and/or repaired to the satisfaction of the Principal Agent (It should be understood however, that the provision of facilities (toilets, etc.) in terms of the Preliminaries costs called for in the tender document, are the responsibility of the Contractor).

**16. PROTECTION OF EMPLOYER'S EQUIPMENT**

The Contractor shall ensure that any computers or other valuable equipment of the Employer is sufficiently protected against work or dust by means of temporary coverings or sealed-off partitions.

**17. INSPECTIONS, TESTING, COMMISSIONING AND HANDING OVER**

17.1. The Contractor shall provide all tools and instruments required for inspections, testing and commissioning of the works as detailed in the detail Technical Specification.

17.2. First Offer for Acceptance (First Inspection)

Once the Contractor has completed the total installation, written notice shall be given to the Principal Agent in order that a mutually acceptable date may be arranged for a joint inspection. During the course of the inspection the Engineer, in collaboration with the Principal Agent, will compile a list of items (if any) requiring further attention. These items shall be identified by checking each and every clause in the contract (all specifications and drawings) in relation to the offered installation.

A copy of this list of outstanding items will be provided to the following:

- (a) Principal Contractor – for action
- (b) Contractor – for action.
- (c) Principal Agent – for information

17.3. Subsequent and/or final offer for Acceptance (Subsequent and/or final Inspection)

The Contractor shall similarly provide written notice that he is ready for an inspection of the remedial work done on the offending items. If the installation is accepted as complete at this stage, by both the Engineer and Principal Agent, the Principal Agent may certify the works as completed. If at this stage there are still outstanding items requiring attention, irrespective of whether those items were identified during prior inspections or not, the procedure will continue until the entire installation has been correctly completed to the satisfaction of the Principal Agent.

#### 17.4. Tests

In addition to the above, the Contractor shall have the complete installation tested and the correct operation of all plant demonstrated to:

- (a) Engineer, and/or
- (b) The Principal Agent.

Subsequent to the above testing and approval, the Contractor, in the presence of the Engineer, shall test the works as per the Detail Technical Specification.

#### 17.5. First Delivery

First delivery (See conditions of contract) may only be proceeded with after final acceptance and testing have been completed successfully.

### 18. **CONTRACTOR'S LIABILITY IN RESPECT OF DEFECTS (Maintenance Period)**

The Contractor shall make all adjustments necessary for the correct operation of the plant for a period of 12 (twelve) months after the date of first delivery of the Principal Building Contract. The Contractor shall make good any defects due to inferior materials or workmanship that may arise during this period. If, during this period, the plant is not in working order for any reason for which the Contractor can be held responsible or if the plant develops defects, the Contractor will be notified and immediate steps shall be taken by him to remedy the defects or to make any adjustments required.

Should such defects occur so frequently as to become objectionable or should the equipment otherwise prove unsatisfactory during the abovementioned period, the Contractor, if called upon by the Engineer, shall replace at his own expense the whole, or such parts thereof, as the Engineer may deem necessary, with apparatus to be specified by the Engineer.

The contractor shall within 8 hours of callout report to site, investigate and carry out the necessary minor repairs. Major repairs shall be done within 24 hours.

### 19. **ARRANGEMENTS WITH SUPPLY AUTHORITIES**

The Contractor shall apply for and complete all the formalities necessary for compliance with any statutory requirements as necessary. He shall also make himself available for all statutory authority inspections in order to complete all the formalities and tests. Inspection fees shall be allowed for in the tender.

### 20. **COMPLIANCE WITH REGULATIONS**

The entire installation shall be carried out in accordance with the latest revision and amendments of the following:

- (a) The Code of Practice for the Wiring of Premises issued by the South African Bureau of Standards, SANS 10142-2003.
- (b) The Occupational Health and Safety Act.
- (c) The municipal by-laws and any special requirements of the supply authorities of the area and district concerned.
- (d) The local fire-brigade regulations.
- (e) The applicable SABS specifications, or the BS specifications where no SABS specifications exist

No claims for extras in respect of failure by the Contractor to comply with any of the above regulations will be considered.

Where conflict exists between any of the above regulations and the specification, the said conflict must be referred to the Principal Agent in writing for his ruling.

The Contractor shall be responsible for serving all notices and paying all fees due in terms of the laws and regulations mentioned.

**21. TAKING RESPONSIBILITY FOR THE INSTALLATION (For normal electrical or electrical within mechanical installations)**

- 21.1. Before any inspection or hand over of the electrical installation or part thereof takes place, the Electrical Contractor (employed by the Mechanical Sub-contractor) will present a Certificate of Compliance of the electrical installation or part of the installation to be handed over as defined in the regulations of the OSH Act of 1993, as amended.
- 21.2. With first delivery, the Contractor shall accept in writing the responsibility for the total installation as installed by him by certifying the correctness of the installation in accordance with and on the certificates of compliance of the work as per the Specification.

**22. ELECTRICAL INSTALLATION**

**22.1. SUPPLY**

A single and three phase, 50 Hertz electrical supply will be provided by others at the points shown on the drawings. This tender shall include for the supply points and all other cabling, conduits, cable racks, trays, switchgear, panels, distribution boards, etc., necessary for the satisfactory operation of every part of the installation as well as for the connection of the supply cable into control panels, etc.

**22.2. CONTROL PANEL**

A motor control and switchgear board shall be supplied and installed in each plantroom at the position indicated.

Each board shall be fitted with the following:

- (i) A main isolator.
- (ii) A set of copper busbars of adequate size, if the peak current on the board exceeds 50 amperes per phase.
- (iii) Individual motors shall be supplied through a circuit breaker and suitable D.O.L., automatic Star-Delta, or slip ring starter.
- (iv) All other equipment shall be supplied through a circuit breaker
- (v) In the case where the rupturing capacity of a circuit breaker is lower than the rupturing capacity of the electric feed system at the specific point, the circuit breaker shall be protected by H.R.C. fuses of adequate size.
- (vi) Phase rotation protection
- (v) Over/under current protection.

All starters shall be equipped with auxiliary contacts, which shall be brought to an easily accessible terminal block for the purpose of remote control (if specified). An ammeter with suitable scale shall be fitted to each motor above 7.5 kW output on at least one phase, and shall be installed in the panel next to the relevant switchgear.

Switchgear panels and boards shall be factory pre-wired so that the only "on site" connections to be made will be the main connection, the supply to each motor, and the control system connections to the terminal block.

Each item on the board, switches, instrument control, etc., shall be clearly labelled in white print on black, hard plastic labels, which shall be neatly glued onto the back panel of the Board.

All switchgear and distribution boards shall be of the metal clad surface type, with a framework, which is electrically continuous and properly bonded to earth.

The boards shall be equipped with hinged steel doors adequately braced each with a flush lock and two keys.

All boards shall be treated with two layers of rust inhibiting paint.

Switches, push-buttons, and indication lamps and gauges shall be so installed that they remain fastened to the doors when doors are opened.

The layout of each board as well as the wiring diagrams and details of the switchgear provided shall be approved by the Consulting Engineer before any manufacture is commenced.

All wiring in distribution boards shall be labelled to ease the later tracing of circuits; these shall correspond to drawing labelling.



### 22.3. WIRING

All boards which are to be mounted outdoors shall be weather proof and guaranteed by the manufacturers for such outdoor operation.

The wiring of the plant shall be carried out by the contractor in surface work in the plantrooms and concealed work in all finished spaces. Wiring shall be done by means of solid drawn or lap-welded screwed tubing and PVC insulated copper conductors, or in multicore PVC/SWA/PVC cable. The main runs of conduit or cable shall preferably be carried out at high level (if possible in false ceiling spaces). Distribution shall be vertically down to the required points. All electric conduit and conduit fittings must be thoroughly inspected for defects before installation, and all sharp edges and burrs removed. Bushes and locknuts are to be used where conduit enters switch boxes.

The proposed location of tubing and cables shall be approved by the Consulting Engineer before commencement of work.

Conduit to be installed under plaster finish shall be installed in good time so as not to delay the Building Contractor or cause finished plaster to be chased.

All electrical cables shall be fastened to cable racks or shall be laid in cable ducts. Cables carried in racks shall as far as possible be laid parallel and shall be neatly installed. Descents shall be firmly secured with provision for the swinging of flexible tubing or cables where attached to moving machines and electrical motors.

Sizes of conduit, conductors and cables shall be at least equal to those laid down in the relevant tables of the Code of Practice.

Flexible conduit and cables shall be provided wherever it is necessary to avoid transmission of vibration. No joints in cables or wires will be permitted in a conduit. The ends of cables shall be properly made off. Terminal lugs shall be used wherever special clamp-washers or sleeve terminals are not provided on equipment. Conductor strands may not be cut away or reduced in size, and care must be taken to select switchgear, etc., with terminals of adequate size for looping, etc., where necessary.

No open wiring will be permitted at any point in the system, with the exception of the copper bus-bars in the switchgear boards. These shall be taped up with PVC tape with the relevant phase colours.

### 22.4. BOXES

Where boxes are used in concrete or masonry, approved removable cover plates shall be supplied. For 100 mm x 100 mm boxes, standard blank metal switch-type cover plates may be used, but for larger boxes, removable cover plates of metal or other approved material must be supplied with bevelled edges and must be neatly painted.

Cover plates shall be large enough to overlap and cover any gaps between the draw box and the masonry or concrete, and must be finished off to match the surroundings so as not to mar the architectural appearance of the building.

## 22.5. WIRING IN CONDUIT

No joints shall be allowed and all looping must be done through approved connectors at fitting points.

The live phase shall be connected at the switching point. All wiring in conduit shall conform to the requirements of SANS 10142 (Table 4 of SABS 0142-1981 as amended). Not more than one circuit shall be accommodated in one circuit unless special permission is obtained from the Engineer. Before any wires are drawn into the conduit, a swab is to be drawn through to clear any water, dirt etc.

## 22.6. PVC INSULATED CABLES

LT cables with PVC insulation must conform to the requirements of SANS 1574 (SABS 150 of 1970 as amended), and must be laid according to the requirements as set out in the Electrical Specification of this document.

## 22.7. SOLID CONDUIT

All conduits shall be of heavy gauge steel, screwed and conform to SANS 61386 (SABS 162 of 1987 as amended). No conduit shall be less than 20 mm in diameter.

All joints shall be screwed and all outlets fitted with rustproof iron boxes. Conduit must be either screwed or lock-nutted on both sides and bushed on the inside of the box or board to which it is attached.

The whole conduit system shall be electrically and mechanically continuous over all joints by means of screwed couplings, well bonded and efficiently earthed by means of earthing terminals and earth continuity conductors. The contractor must keep in touch with the builder and install all conduits so as not to delay his work and to ensure the closest co-operation. Every effort must be made to avoid running conduit in "U"-form, but where this is unavoidable; provision should be made, if possible, to drain the conduit.

All chasing of brickwork, etc., for conduit shall be carried out under this contract.

## 22.8. MINIATURE CIRCUIT BREAKERS

All miniature circuit breakers of the single and double pole type shall be 250 volt grade, and triple pole breakers shall be 600 volt grade. Circuit breakers shall be of the Heinemann, F.W. or other approved make. MCBs may be secured directly to the front panel in which case this panel shall be hinged and wiring taped together to allow for easy movement of the panel. Preferably the MCBs shall be mounted on a metal frame attached to the board casing, access being given to the MCBs and connections by a removable or hinged panel, suitably slotted for toggles, etc.

## 22.9. FUSES

Where circuits are scheduled to be fed through fuses, these shall be mounted directly on the panel. All rewireable fuses shall be of the porcelain bridge type, of approved manufacture, connected through bushed insulated holes in the panel. An I.C. fuseboard unit may be used instead of separate fuses. Connections shall be made through the back of the panel so that no surface wiring results. Tinned copper fuse wire shall be fitted to suit the loading indicated

in the schedules, where rewirable fuses are used, and cartridge fuses shall be fitted with the appropriate cartridges.

#### 22.10. CHASING OF CONCRETE COLUMNS, BEAMS AND SLABS

The Contractor must take particular care that all pipes, boxes etc., in columns, beams or slabs are fitted before the concrete is cast. Where, however, through unforeseen circumstances it becomes necessary to chase columns, beams, or slabs, the permission of the Engineer must first be obtained. Where this is not done, the Contractor will be held responsible for any damage to the structure which may result.

#### 22.11. EARTHING

The whole installation shall be efficiently earthed to the satisfaction of the Engineer, the Inspector of Factories, the Supply Authority, and strictly in accordance with the Code of Practice for the Wiring of premises. Any points proposed as earthing points by the Contractor shall first be approved by the Engineer before connection.

#### 22.12. FLEXIBLE CONNECTIONS

Flexible connections shall be of "Kopex" manufacture or approved type. All flexible connections shall be properly earthed to ensure earth continuity.

#### 22.13. CABLE TRAYS AND LADDERS

22.13.1. The contractor shall supply and install all cable trays or ladders as specified or as required by the cable routes including the necessary supports, clamps, hangers, fixing materials, bends, angles, junctions, reducers, T-pieces, etc.

22.13.2. Metal cable trays shall be manufactured from perforated rolled steel. Only the following metal cable tray types may be used:

- (a) Less than 250mm wide 1,6mm minimum thickness with 12mm minimum return.
- (b) 250mm and Wider equivalent to trays supplied by "PERFORATION AND CONDIDURE", or other approved, manufactured from 2mm thick steel with folded over returns and a minimum up stand of 50mm.
- (c) 250mm and Wider 2,4mm minimum thickness with 76mm minimum return as alternative to (b) above.

The return of trays shall not be perforated and the top of the return shall be smooth. The same cable tray type shall be used in long parallel tray runs.

22.13.3. Metal cable ladders shall consist of a 76mm high side rail of 2mm minimum thickness. Cross pieces consisting of P3300 "SANKEYSTRUT", or other approved, channel sections shall be spaced at maximum intervals of 250mm. Where cables of 10mm<sup>2</sup> or cross pieces shall be 125mm. Cables shall be clamped in position by means of purpose made cable clamps that fit into the cross pieces. Cross pieces consisting of slotted metal rails which accommodate plastic or metal cable binding bands, may be used in vertical cable runs against walls, etc.

Where the prior approval of the Engineer has been obtained. These cross pieces are not acceptable in horizontal cable runs.

22.13.4. Rigid unplasticised PVC trays are acceptable. Only the following tray types may be used:

- (a) Less than 50mm 3,0mm minimum wide and 40mm minimum return.
- (b) 250mm and wider 4,0mm minimum thickness and 60mm minimum return.

22.13.5. Metal cable trays and ladders shall be finished as follows:

- (a) In coastal areas (for all applications): Hot-dipped galvanised to SANS 121 and SANS 32 or epoxy powder coating.
- (b) False ceiling voids: Electro-galvanised or epoxy powder coating.
- (c) Vertical building ducts: Hot-dipped galvanised to SANS 121 and SANS 32.
- (d) Plant Rooms, Substations, service tunnels or basements: Electro-galvanised or epoxy powder coating.
- (e) Damp areas, exposed to weather: Hot-dipped galvanised to SANS 121 and SANS 32 or epoxy powder coating.
- (f) Undercover industrial applications: Hot-dipped galvanised to SANS 121 and SANS 32 or epoxy powder coating.

The abovementioned finishes shall apply unless specified to the contrary. Hot-dipped galvanised or electro-galvanised trays and ladders shall be cold galvanised at all joints, sections that have been cut and at places where the galvanizing has been damaged. Powder coated trays and ladders shall likewise be touched up at joints, cuts and damaged portions using spray canisters recommended by the manufacturer of the trays and ladders.

22.13.6. Trays shall be supported at the following maximum intervals:

- |     |   |                       |
|-----|---|-----------------------|
| (a) | 1,6mm thick metal trays with 12mm return              | 1,22m maximum spacing |
| (b) | Metal trays with folded over return and 50mm up stand | 1,22m spacing         |
| (c) | 2,4mm thick metal trays and 75mm return               | 1,5m spacing          |
| (d) | Metal cable ladders                                   | 1,5m spacing          |
| (e) | 3,0mm thick PVC trays with 40mm return                | 1,0m max. Spacing     |
| (f) | 4,0mm thick PVC trays with 60mm return                | 1,5m max. spacing     |

In addition, trays and ladders shall be supported at each bend, off-set and T-junction.

22.13.7. Joints shall be smooth without projections or rough edges that may damage the cables. The Specialist Controls Contractor will be required to cover joints with rubber cement or other hardening rubberised or plastic compounds if in the opinion of the Engineer, joints may damage cables. Joints shall as far as possible be arranged to fall on supports. Where joints do not coincide with supports, joints shall in the case of trays with single returns be made by means of wrap-around splices of the same thickness as the tray ends shall butt tightly at the centre of the splice and the splice shall be bolted to each cable tray by means of at least 8 round head bolts, nuts and washers. Splices shall have the same finish as the rest of the tray. Where joints which do not coincide with supports occur in trays with folded over returns, tight fitting metal guide pieces, at least 450mm long, shall be inserted in the folded returns to provide the necessary support to the two cable tray ends. Splices as described above shall be provided if trays sag.

22.13.8. Trays shall be bolted to supports by at least two round head bolts per support. Bolts shall be securely tightened to avoid cables being damaged during installation.

22.13.9. The supports for cable trays and ladders shall in all cases be securely fixed to the structure by means of heavy duty, expansion type anchor bolts. It is the responsibility of the Specialist Controls Contractor to ensure that adequate fixing is provided since cable trays and ladders that work loose shall be rectified at his expense.

22.13.10. Horizontal and vertical bends, T-junctions and cross connections, shall be supplied by the Specialist Controls Contractor. The dimensions of these connections shall correspond to the dimensions of the linear sections of which they are connected.

The radius of all bends shall be 1000mm minimum. The inside dimensions of all horizontal angles or connections shall be large enough to ensure that the allowable bending radius of the cables is not exceeded. Sharp angles shall have 45° cornices.

22.13.11. Cables shall be installed adjacent and parallel to each other on the trays with spacings as determined by the current ratings. Horizontal trays and ladders shall in general be installed 450mm below slabs, ceilings, etc. to facilitate access during installation.

22.13.12. All metal trays and ladders shall be bonded to the earth bar of the switchboard to which the cables are connected. Additional bare copper stranded conductors or copper tape shall be bolted to the tray or ladder where the electrical continuity cannot be guaranteed.

## **23. ELECTRIC MOTORS**

### **23.1. STANDARD SPECIFICATION**

All electric motors shall comply fully with the relevant standard specifications:

- SANS 1804: "Standard Specification for Three Phase Induction Motors".
- BS 2613: "The Electrical Performance of Rotating Electrical Machinery".

- BS 170: "The Electrical Performance of Fractional Horsepower Electric Motors and Generators".

## 23.2. MOTOR SPECIFICATIONS

- (a) Standard Squirrel Cage Motors shall be three phase (or single phase up to THREE kW), continuously rated, screen-protected drip-proof, suitable for direct-on-line or star-delta starting.
- (b) High-starting-torque squirrel-cage motors shall be three-phase, continuously rated, screen-protected drip-proof, with a special arrangement of rotor conductors giving high starting torque and moderate starting current and suitable for direct-on-line or star-delta starting.
- (c) Slip-ring motors shall be three-phase, continuously rated, screen-protected drip-proof, with continuously rated slip rings and brushers and brushgear suitable for automatic starting.
- (d) Fractions kW motors shall be continuously rated, totally enclosed single phase, capacitor-start induction run type, shaded pole or three-phase squirrel-cage where required.
- (e) Motors suitable for part-wound starting shall be three phase, continuously rated, screen-protected drip-proof with wound rotor circuits suitably rated to provide continuous full load power when fully switched and to provide starting in graded steps sufficient to overcome the starting load torque without exceeding the specified starting current.
- (f) Hermetically sealed motors shall be three phase squirrel cage motors, totally enclosed with suitable internal cooling medium and suitable insulation to provide continuous full load power under the specified ambient conditions.
- (g) Pole-changing motors shall be three-phase, continuously rated, screen-protected drip-proof with cage rotor and separate stator windings providing several numbers of poles with various interconnections of the windings. The use of pole-changing motors to alleviate starting conditions shall be limited to 2:1 speed ratios. Additional speed ratios shall only be used where the driven load specifically so requires. Pole-changing rotor circuits are not recommended and shall only be used in exceptional circumstances with the proper approval of the Engineer. Dahlander connections providing a 2:1 speed ratio with variable torque and variable power characteristics of the motor may be used to drive centrifugal fans and centrifugal pumps. Dahlander connections providing constant torque characteristics may be used for high friction loads and connections providing constant power characteristics may be used for constant power loads viz. machine tools.

Motors with a speed in excess of 1500 r/min except in the case of centrifugal compressors, will not be accepted unless agreed to by the Engineer.

## 23.3. MOTOR RATINGS

When determining motor rating, the following shall be taken into account:

- (a) All motors shall be rated for continuous full load duty.
- (b) The Continuous Maximum Rating (C.M.R.) of the motor shall be 20% in excess of the full load running duty of the load in order to withstand the tolerance of 105% - 120% in the tripping characteristics of over-load protection devices allowed in BS 4941 Part 1.
- (c) All starting times, irrespective of the load characteristics or the method of starting **shall be limited to 20 seconds** unless prior approval to the contrary is obtained from the Engineer. The safe locked rotor time shall be well in excess of the run-up time to allow protection discrimination.
- (d) All motors shall be capable of a **minimum** of three **consecutive** starts per hour with the load connected and employing the method of starting to be installed without exceeding the allowed temperature limits of the insulation. In addition, the motor shall be capable of the numbers of starts per hour for the particular load as may be specified or as may be experienced under normal operating condition.
- (e) Unduly over-rated motors resulting in a low power factor and efficiency are not acceptable.
- (f) The motor starting torque and speed/torque characteristics shall be carefully matched to that of the load to ensure that the motor does not stall at a low speed. A safety margin shall be allowed to overcome voltage drops and load fluctuations. The maximum torque developed by the motor in its final running condition (i.e. when the motor is switched to it's final running configuration in the case of pole-changing motors and all starting devices have been switched out of circuit in the case of assisted starting) shall be 1.6 times the rated full load torque to overcome temporary overloads and voltage fluctuations.
- (g) The actual ambient temperature in which the motor will be operating (and not the prevailing outside ambient temperature only) shall be considered.

It is a requirement that the above information and any other requirements that will affect the type of motor to be used be submitted to the motor manufacturer when ordering the motor. The Contractor may at the discretion of the Engineer be required to submit written proof that the **motor manufacturing** will guarantee the performance of the motor for the expected duty and load.

Special attention shall be paid to the starting requirements of motors. It is essential that the starting torque produced by motors under the starting conditions specified, will be sufficient to accelerate the load within the time period allowed by the manufacturer of the motor with a maximum starting time of 20 seconds (refer above). The contractor may be required to submit calculations showing accelerating torque available, load torque characteristics and run-up time. The following formula may be used to calculate the run-up time:

$T_e$	=	equivalent accelerating torque in N-m
$T_1$	=	Maximum accelerating torque in N-m
$T_2$	=	Minimum accelerating torque in N-m
$GD^2$	=	Moment of inertia of the rotating parts of the load and motor in kg-m <sup>2</sup>
$N$	=	Final speed in r/min.

t = Run-up time in seconds

Accelerating torque is the difference between motor torque and load torque at any given speed on the torque/speed characteristic curve.

Where inching operations occur or where motors are controlled by pressure or level switches where frequent cycling duty may occur, motors shall be capable of 40 starts per hour.

#### 23.4. MOTOR WINDINGS

All motor windings shall have Class E or better insulation. The following maximum temperatures as determined by the resistance method may not be exceeded:

Class of Insulation	23.4.1. Altitude					
	0 – 1000m	1200m	1400m	1600m	1800m	2000m
E.....	150°C	112.6	111.2	109.8	108.4	107
B.....	120°C	118.4	116.8	115.2	113.6	112
F.....	140°C	138	136	134	132	130
H.....	165°C	163.7	162.5	161	160	158.7

The above figures comply with BS 2613 and SANS 1804 (SABS 948 as amended) for a maximum cooling air temperature of 40°C. Where higher ambient temperatures occur (particularly in cases where heaters are installed), the above temperatures shall be reduced in accordance with BS or SANS specifications.

All windings shall be varnished and baked. The insulation shall provide protection against dust, oil and high humidity as well as aggressive vapours and gases where these are specified.

End-windings shall be carefully wrapped and supported to prevent movement and prevent mechanical damage due to vibrational stresses.

#### 23.5. MOTOR PROTECTION

23.5.1. Motor protection shall be provided as follows:

Type of Protection	Application
Thermal overload	All motors.
Magnetic overload	Only for short circuit protection when acting on circuit breakers with sufficient rupturing capacity.
Thermistor over-temperature	All motors of 25 kW and more.



Single phasing	All 3-phase motors without thermistor over-temperature protection.
Earth fault	Only when condensation in motors can take place, e.g. standby close coupled pumps on chilled water system.
Phase reversal	All centrifugal compressor circuits and large reciprocal compressors or other circuits where phase reversal can cause damage.
Under voltage	As specified.
Over-temperature	Auto-transformer starters, liquid starters and resistor starters.

23.5.2. All the protection specified in the detailed Technical Specification shall be supplied.

23.5.3. Motor overload (O/L) protection shall be provided in accordance with BS 587. O/L protection shall be provided by means of thermal trips or relays actuating contactors, manual motor starters or circuit breakers. **HRC fuses are not acceptable for this purpose.**

23.5.4. On motor starters on which the overload protection forms an integral part of the starter the protection shall be by means of temperature compensated bimetal thermal O/L trips indirectly heated by separate heating elements in each phase and connected in series with the load. The O/L trips shall be adjustable within the range of approximately 75% to 120% of the rated current of the motor.

23.5.5. Where motors are used frequent repetitive cycles or for inching operations, magnetic overload protection with time delays may be used provided the motor is suitably rated for the duty.

23.5.6. Single phasing protection where provided shall be inherent in the overload protection unit in the case of integral motor starters. Protection schemes depending solely on the excess current drawn by the motor during the single phasing are not acceptable.

23.5.7. Magnetic over current trips or relays for short circuit protection may never be allowed to actuate contactor starters and may only operated on suitably circuit breakers.

23.5.8. Short circuit protection shall be provided by means of HRC fuses or suitably rated circuit breakers.

23.5.9. Thermistor over-temperature protection shall be installed. The thermistor control units shall where possible be integrated with the motor starter. Care shall be taken to select units with sufficient current rating to operate the contactor coil.

- 23.5.10. Thermistor protection may not be provided in lieu of over current protection.
- 23.5.11. Motor protection shall be “ENGLISH ELECTRIC” type “CMM” OR “P & B GOLDS” type “M”, or other approved, for all motors where preferred. Thermal (or magnetic if required) overload, single phasing (or phase unbalance) and earth fault protection relays as well as auxiliary relays where required, shall be included. The relays shall be housed in a panel mounted unit in a withdrawable case.
- 23.5.12. Motor protection relays shall not be allowed to operate on metering current transformers, but shall be connected to separate protection class current transformers matched to the motor full load current and the relay power consumption.
- 23.5.13. In all cases where protection relays are used, “CHAMBERLAIN AND HOOKHAM”, or other approved, test blocks type shall be provided to facilitate remote testing or relay operation, current transformers, etc.
- 23.5.14. Proven electronic protection relays are acceptable.
- 23.5.15. Where motors which are not described in BS specifications, e.g. semi-hermetic compressor motors, etc. are used, protection shall comply with the manufacturer's requirements.
- 23.5.16. Special attention shall be paid to motors driving high inertia loads to ensure that motors are adequately protected against sustained over currents but do not trip unnecessarily during starting.
- (a) Shorting of the over current protection during starting is not acceptable.
  - (b) Increased overload settings on protection units are not acceptable.
  - (c) Connecting the overload relay in the delta loop in star-delta starting applications thus providing no protection during starting, is not acceptable.

Saturable core current transformers providing a normal over current characteristic up to 120% of full load current may be used provided they are properly matched. Alternatively, separate starting and running over current protection units shall be used. For star-delta starting methods, the latter can be achieved by connecting the starting over current unit in the main supply line to the motor and the running over current unit in the delta loop. For other starting methods, a change-over arrangement is required to switch from the starting to the running after the starting time has lapsed. For motors larger than 50 kW electronic integrating type relays with individually adjustable time/current characteristics shall preferably be used. Whichever protection method is used, a safe discrimination between “safe locked rotor time” and “starting time” shall be maintained.

## 23.6. MOTOR PROTECTION - THERMISTORS

**All motors with ratings of 25 kW and higher and all motors with a rating of 15 kW and more that are subjected to run-up times in excess of 15 seconds shall have thermistors for over-temperature protection installed in the stator windings.** Three thermistors, one per phase, shall be installed in single wound motors and 6 thermistors shall be installed in double wound motors.

Where thermistors are installed in the end-winding, the “Curie Point” shall be 5°C above the temperature. Where thermistors are installed in the winding “hot spot”, the Curie Point shall be 15°C above the temperature values stated.

The thermistors shall comply with the following:

- (a) Only Positive Temperature Co-efficient (PTC) thermistors shall be used.
- (b) Thermistors installed in motors connected to supply voltages up to 600 V shall be flash tested at 2 kV r.m.s. Additional insulation shall be provided on higher voltage machines.
- (c) A varnished Terylene or glass fibre sleeve shall be fitted around those parts of the thermistor leads, which are embedded in the winding for mechanical protection of the leads. Care shall be taken that the sleeve does not cover the thermistor bead.
- (d) The thermistor shall be inserted in the winding in such a way to ensure best thermal contact with the adjacent conductors of the winding.
- (e) All leads from thermistors to the protection control units shall be twisted pairs to minimise stray voltage pick-up. Screened cables shall be used where the control units are far from the motor.
- (f) All the thermistors acting on one control unit shall be connected in series.

Where thermistors are installed it is essential that relay panels be safeguarded against high voltages in case of a short circuit between sensor and motor windings. Isolation transformers are recommended for this purpose.

## 23.7. MOTOR CONSTRUCTION

The housing, end-shields and feet of totally enclosed surface-cooled motors shall be of cast iron to BS 1452. Standard protected, internally cooled motors may be of welded steel construction. A condensation hole shall be provided at the lowest point in the motor frame.

It is essential that the correct mounting type is selected for each application.

Motor terminals shall be clearly marked, U, V, W or U1, V1, W1 and U2, V2, W2. An earth terminal shall be provided at a convenient position on the motor frame. Vulcanised rubber insulation shall not be used for the connection from windings to the terminals.

When viewed from the drive shaft end, the motor rotor shall rotate in a clockwise direction when the R-W-B supply leads are connected to the U-V-W motor terminals.

All terminals shall be totally enclosed in a waterproof box sealed with gaskets and shall be complete with nuts, locknuts, lugs, etc. Cable boxes for PILCA cables shall be complete with tinned brass wiping gland and armour clamps. PVC cables shall be terminated using compression glands with shroud. Cables shall be provided with a means of support to remove the weight of the cable from the gland. All terminal boxes shall be large enough to ensure proper termination of the cables and connection of cores without exceeding the allowable bending radius. All terminal boxes shall be capable of being rotated through 360°. Where

condensation may form on motor terminals, e.g. certain centrifugal refrigeration compressors, terminal boxes shall be hermetically sealed and filled with silica gel.

Motors shall as far as possible have pre-lubricated and sealed ball or roller bearings. Unsealed bearings shall be loaded conservatively in order that the grease need not be renewed at intervals of less than one year. Bearings shall be suitable for flat or V-belts drives where these are indicated without the use of outrider support bearings. Belt pulleys and couplings shall be balanced.

Bearings shall be protected against possible shaft eddy current and shall be suitable to withstand vibrations caused by reciprocating or unbalanced loads.

Anti-condensation heating elements shall be provided in the motor windings for the following motor applications:

- (a) Close-couples motors and pumps in chilled water systems.
- (b) Standby motors in refrigeration installations where the ambient air surrounding the motor may drop below the dew point.
- (c) Pumps installed in damp areas where the pumps will not run continuously.

The heating elements shall be arranged to prevent terminals and exposed connections becoming damp. As an alternative to heating elements, a low voltage transformer (approx. 50V) can be switched into the circuit when the motor is stationary to provide a continuous circulating current in the motor windings.

Where requested copies of type test certificates for routine and performance tests in accordance with SANS 1804, BS 2613 or BS 170 shall be submitted before delivery of the motors. In additions the Manufacturer's guarantee that the motor will comply with the duty as described in this specification, shall be submitted. Curves of Torque/Speed and Current/Speed shall be provided on request.

The client reserves the right to witness all routine or performance tests and shall be notified in writing 14 days before the commencement of such tests.

Motors that have become damp shall be dried out before connection to the supply. Damaged motors resulting from non-compliance with this requirement, shall be rectified by the Contractor at his cost.

### 23.8. STAR-DELTA STARTERS

- (a) All star-delta starters including resistors where applicable shall be rated for 15 starts per hour unless automatic time delays are incorporated which will prevent more frequent starts than the starter rating allows. In no case however, shall ratings be less than 3 consecutive starts per hour. Starters for plugging duty shall be rated at 40 starts per hour.
- (b) The timers for open transition star-delta starters, shall be a break-before-make, snap acting type with a distinct time delay before make, of sufficient length to quench the arc on the star contactor but short enough to prevent magnetic flux decay in the motor with consequent high transients.
- (c) All star-delta starters shall be electrically interlocked via N/C contacts on the contactors.
- (d) The timing and control circuit for closed transition star-delta starters, shall be designed to employ only one timer to initiate the star-to-delta changeover. The closed transition switching shall be inherent in the arrangement of the auxiliary contact operation. A “policeman” timer to protect the transition resistance may be added.
- (e) An overall “policeman” timer shall be provided on all closed transition star-delta starters in addition to the star-delta changeover timer to disconnect the load if the total allowable starting time is exceeded. The make and principle of operation, e.g. electronic vs. electro-mechanical, shall be different from the star-delta timer. On 2-wire control systems the “policeman” timer must lock out and shall be manually reset in order to prevent recycling.

## 24. CONTROL EQUIPMENT

### 24.1. GENERAL

The equipment offered must meet the following minimum specified standards. The Trade names only mention the name of a product, which will be acceptable if it is installed. Tenderers can offer another product to the product mentioned in the specification, if it is of similar or improved type and quality and if it has been accepted by the Engineer in writing.

All equipment shall operate from a 24 V supply.

### 24.2. CONTROLLERS

24.2.1. The controllers shall be of the microprocessor based programmable controllers with a fixed operating system.

24.2.2. Each controller shall be composed of the following:

- a) Analog input ports
- b) Digital input ports
- c) Control modules for P, PI, PID and digital control
- d) Numerical calculation modules

- e) Logic calculation modules
- f) Analog output ports
- g) Digital (on/off) output ports
- h) Dedicated service module socket
- i) Updating of readings twice per second

24.2.3. Configuration of the controller shall be carried out in the following ways:

- (a) Using a hand held service module.
- (b) Using a personal computer with graphic configuration software.
- (c) Down loading of a previous up-loaded configuration from a PC or service module.

24.2.4 Each controller shall display the following on an alpha numeric panel with keypads:-

- (a) Temperature in °C.
- (b) Relative humidity in % RH.
- (c) Pressure in Pa.

24.2.4. The controllers shall be used to read temperature, pressure and relative humidity and to adjust valve and damper actuators proportionally. It shall also be used to reset supply air temperature set points in relation to outside air temperature.

The controller shall be designed to be DIN rail mounted into a standard electrical panel with the face of the controller protruding through the panel front cover. The controller housing shall be manufactured from polycarbonate, blended with ABS.

The controller offered shall be engineered to be used as a stand-alone controller, but must incorporate technology to be connected and to communicate to a supervisory control system through a high speed (RS 485) serial communication bus.

### 24.3. PRESSURE DIFFERENTIAL SWITCHES

Pressure differential switches shall be used as digital inputs to the control system to give dirty filter alarms and fan run stop indication. The switches shall be used to interlock the control system with fan operation, thus ensuring that humidifiers and steam heaters are not activated if the fan is not in operation. The switch point shall be adjustable to suit the specific requirement. In general the following shall apply:

- (a) Pressure differential over roll filter : 150 Pa
- (b) Pressure differential over bag filter : 250 Pa
- (c) Pressure differential over hepa filter : 300 Pa

- (d) Pressure differential in supply air and return air ducts : 100 Pa

The pressure differential switches must be designed to operate in an environment where the duct pressure can increase to 1500 Pa. The pressure differential switches shall be connected with appropriated PVC tubes, which will be connected on a static pressure probe, which will be mounted on the duct. The pressure probe shall consist of a 50 x 50mm galvanised plate, with a copper tube protruding through it. The plate shall be pop riveted to the duct with the probe protruding into the duct. All piping shall be neatly attached to the duct.

#### 24.4. PRESSURE TRANSMITTERS

Pressure transmitters shall accurately measure low differential pressures and shall convert the measurement into a standard proportional 0-10 Volt signal.

The transmitters shall have the following features:

- (a) Low zero drift time.
- (b) Low sensitivity to ambient temperature change.
- (c) Low hysteresis.
- (d) Good over rangeability.
- (e) High accuracy.
- (f) Splash proof dust type case.

The pressure transmitters shall be required to measure duct static pressure in low pressure duct systems and shall have a measuring range from 0-600 Pa. It shall be designed to operate in an environment where the duct pressure can increase to 500 Pa.

#### 24.5. TEMPERATURE TRANSMITTERS

##### 24.5.1. General

##### 24.5.1.1. Accuracy

- (a) Duct, emersion, strap-on and outdoor sensors : 1% accuracy
- (b) Return air sensors : 1,2% from +10 to + 30°C  
and 3,5% from to +10°C and from 30°C to +40°C

##### 24.5.1.2. Protection

Minimum protection to be IP 54

##### 24.5.1.3. Ambient Operating Limits

Temperature	:	0 to +50°C
Humidity	:	10 to 90% rh

#### 24.5.2. Emersion or Duct Mounted Type

24.5.3. The temperature transmitters shall provide active sensing of air or water temperature and shall produce a 0-10 Volt DC signal, directly proportional to the sensed temperature. The transmitters shall be used to provide an analogue input to the plant controllers. The temperature transmitters shall use a positive temperature compensation, silicon sensor and shall be available in the following modules:

- (a) Emersion/duct mounting.
- (b) Return air mounting.
- (c) Outdoor mounting.
- (d) Strap-on mounting.

24.5.4. The temperature ranges of the various transmitters shall be as follows:

- |     |                        |   |               |
|-----|------------------------|---|---------------|
| (a) | Chilled water          | : | 0° to + 40°C  |
| (b) | Cold duct supply       | : | 0° to 40°C    |
| (c) | Hot duct supply        | : | 20° to +120°C |
| (d) | Outdoor air            | : | -20° to +40°C |
| (e) | All other applications | : | 0° to +40°C   |

#### 24.5.5. 24.5.3. Room Type

The room type temperature transmitter shall be to the type described for the duct mounted type, with the exception that the control components shall be accommodated in a neatly designed and attractive housing with sufficient openings for room air circulation over the temperature sensing element. The room sensors shall not be equipped with an adjustment facility, or with temperature indication. Room sensors shall be designed for installation on a 50 x 50mm existing electrical box. The temperature range shall be 0°C to +40°C.

## 25. **WELDING**

Welding shall be carried out in accordance with the current edition of SANS 10044 Parts I to VII where applicable.

All welded filler of butt joints shall be free from porosity, cavities and entrapped slag. Joints shall be ground smooth, if required for aesthetic reasons only, without effecting weld strength.

The joints in the weld run, where welding has been recommended, shall be as smooth as possible and shall show no pronounced hump or crater in the weld surface.



The profile of the weld shall be uniform, of approximately equal leg length and free from overlap at the toe of the weld. Unless otherwise specified the surface shall be either flat or slightly convex in the case of filler welds and with reinforcement of not more than 3mm in the case of butt welds.

The weld face shall be uniform in appearance throughout its length.

Filler metal electrodes shall be of an approved type for the material being used and shall be kept in a dry condition. All electrodes shall conform to SANS 455.

Only welders in possession of a valid approved competence certificate shall be employed.

All welds must show proper fusion. Unless otherwise specified in the technical specification, the contractor shall allow for the removal and testing by an approved body of 5% of the welded joints in the system. These will be removed at random as indicated by the Engineer and tested. Should faulty welding be discovered, all other joints shall be X-ray tested by the SANS or an approved body, all at the expense of the Contractor. The expenses involved in the testing of joints shall be included in the tender form.

**DBSA**  
**HUEWELLAND PRIMARY SCHOOL**  
**MECHANICAL INSTALLATION**  
**(HVAC)**  
**PART 2: PROJECT SPECIFICATION**  
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**MECHANICAL INSTALLATION**  
**(HVAC)**

**PART 2: PROJECT SPECIFICATION**

**1. GENERAL REQUIREMENTS**

This installation shall be suitable in all respects for operation under the atmospheric conditions and electricity supply as outlined in the schedules. The onus is on the tenderer to ascertain any other local conditions or peculiarities which might affect the working of the plant, and no allowance in price or standards of materials or workmanship will be made for any ignorance on the part of the tenderer in this respect. This applies to the nature and construction of the building, details of which can be obtained from the Architects.

All materials and workmanship supplied under this contract shall be of the highest quality. Installation work shall be done in accordance with the best modern engineering practice, and where installations are required for medical and/or advanced research proposes, reliability and accuracy in operation are the major requirements. The Engineer shall have the right to reject and demand satisfactory replacement at the Contractor's cost, or any part of it, which is his opinion, does not conform to the highest standards of material and workmanship. The installation shall be required to run for long continuous periods, and it is essential that all installations shall be capable of operating continuously and satisfactorily over such periods.

**2. VISIT TO SITE**

Tenderers must acquaint themselves with local site conditions such as access area available on site, type of ground, space available for on-site fabrication, storage, transport, loading and unloading facilities, scaffolding, tackles and tools needed, as no claims by the Contractor, which may arise from ignorance of the site conditions, will not be considered.

**3. SCOPE OF THE WORKS**

This contract shall cover the supply, delivery, installation, commissioning, testing and handover of the new HVAC installation at the Huewelland Primary School

**4. PROGRAMMING AND GUARANTEE**

Programming

After the contract has been awarded, the Contractor will immediately produce a programme of execution and will be held to that programme until the plant is completed.

Guarantee

The 12 months guarantee period will only commence after the entire plant is completed and first delivery/ practical completion has been taken.

**5. MATERIAL AND WORKMANSHIP**

- 5.1. The contract works shall be executed in accordance with the specified standards and level of workmanship, to the satisfaction of the Engineer.

- 5.2. All materials shall be of the quality specified and the Contractor shall, upon request of the Engineer, furnish him with proof to his satisfaction that the materials are of the specified quality.
- 5.3. All materials and equipment used for the installations shall be new and undamaged.
- 5.4. The Contractor shall, if requested by the engineer, provide samples of material and equipment for approval. If judged necessary by the Engineer, such samples, may only be returned after the completion of the installation, in order to ensure that the quality of the installed product is the same as that of the approved sample.

## **6. REFERENCE SPECIFICATIONS AND STANDARDS**

- 6.1. The latest revision of any Specification referred to in this specification, will be applicable.
- 6.2. Where a specification or standard is not specifically referred to, it will be assumed that the relevant SABS, ISO, BSS, DIN or equivalent American standard, listed in order of preference will apply.
- 6.3. The SI ("Le Systeme International d' Unites") – Metric System of Units will apply. Refer to SANS – M33A: The International Metric System: Guide to the use of the SI in South Africa.
- 6.4. The entire new installation shall be carried out in accordance with:
  - 6.4.1. The Application of the National Building Regulations SANS 10400 (including all SANS addenda).
  - 6.4.2. The South African Bureau of Standards Code of Practice for wiring of Premises SANS 10142.
  - 6.4.3. The Occupational Health and Safety Act No 85 of 1993.
  - 6.4.4. The Standard Specification for the Air-conditioning and Ventilation Services for the Provincial Administration of the Republic of South Africa, as amended, issued by the Chief Director: Work of KwaZulu Natal Provincial Administration.
  - 6.4.5. Refrigeration Systems including Plants associated with Air-conditioning Systems SANS 10147.
  - 6.4.6. The installation testing and balancing of Air-Conditioning Ductwork SANS 10173.
  - 6.4.7. Air-conditioning Ductwork SANS 1238.
  - 6.4.8. Filters for use in Air-conditioning and General Ventilation SANS 1424.
  - 6.4.9. The General Electrical Specification for the Provincial Administration of the Republic of South Africa Part 2E.
  - 6.4.10. The Municipal by laws and any special requirements of the Supply Activities of the area or district concerned.
  - 6.4.11. The Municipal Fire Regulations.
  - 6.4.12. Room air-conditioners and heat pump SANS 1125.
  - 6.4.13. Non-ducted air conditioners heat pumps testing and rating performance SANS 5151.

## **7. DRAWINGS**

### **7.1. ENGINEER'S DRAWINGS**

- 7.1.1. Unless otherwise specified, the Engineer's Tender drawings are not manufacturing drawings and the dimensions given are only sufficient for tendering purposes or to enable the contractor to complete manufacturing drawings. It is the responsibility of the contractor to verify all dimensions.
- 7.1.2. The Engineer shall make available to and at the request of the contractor any available record drawings of the present installation.

### **7.2. CONTRACTOR'S DRAWINGS**

- 7.2.1. The contractor will be furnished, on request, with the Engineer's drawings.
- 7.2.2. The contractor shall supply two (2) copies of each detail design drawing for approval. The contractor shall allow the Engineer one (1) week for drawing approval. After a marked-up copy with all the Engineer's comments has been returned, the contractor shall update the original, which shall then be submitted to the Engineer for signature. This will ensure that all prints used for construction will be certified as approved.
- 7.2.3. Two (2) copies of the certified drawing shall be issued to the Engineer for distribution.
- 7.2.4. The contractor will be required to produce the following detail design drawings:
  - (a) Builder's Work Drawings.
  - (b) Mechanical Drawings  
  
These are all Workshop and Equipment Layout Drawings required for the manufacture and erection of the installations.
  - (c) Instrumentation Drawings, such as:  
  
Schematic Control Diagrams.  
General Arrangement Drawing of Control Board.
  - (d) Electrical Power Drawings, such as:  
  
General Arrangement Drawing of Switchboard.  
  
Circuit Diagrams and interconnecting diagram giving cable schedules with numbers and sizes corresponding with the circuit diagrams and interconnection diagram.
- 7.2.5. Unless otherwise specified, cable routes shall be superimposed on the Mechanical Layout Drawings, showing the runs and fixing details.
- 7.2.6. Any work done by the contractor without an approved signed drawing, will be at the risk of the contractor.
- 7.2.7. The Contractor shall update all drawings ("record drawings") once the installation has been completed. One (1) set of paper prints and one (1) set of sepia copies shall be supplied to the Engineer as part of the O & M Manual.

### **7.3. EQUIPMENT DRAWINGS**

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- 7.3.1. The contractor shall provide the Engineer with working drawings of all items of equipment, with a detail technical specification of the equipment, for approval, before placing an order for the equipment.

**8. OPERATING AND MAINTENANCE MANUAL**

- 8.1. The contractor shall, at his cost, prepare and supply manuals for the successful operation and maintenance of the installation.
- 8.2. Six weeks prior to the commencement of commissioning, the contractor shall supply a draft of the manual to the Engineer for approval. Two weeks after commissioning, the Contractor shall supply three (3) additional manuals, which have been updated and included all commissioning data and “record” drawings.
- 8.3. These manuals shall contain the following information:

**INDEX OF CONTENTS**

**SECTION 1: SYSTEM DESCRIPTION**

A comprehensive description of the installation.

**SECTION 2: OPERATING INSTRUCTIONS**

- 2.1 Starting and stopping instructions.
- 2.2 Pre-start checks.
- 2.3 Equipment running checks.

**SECTION 3: MECHANICAL EQUIPMENT**

The following information shall be provided in full for each item of equipment:

- 3.1 General information
- Description, Make, Model Number, Name and Address of Supplier, Manufacturer, etc.
- 3.2 Design information
- Design Data Sheet containing all design and selection parameters, calculations, selection curves, etc.
- 3.3 Settings and values recorded during commissioning.
- 3.4 Manufacturer’s Brochures and Pamphlets.
- 3.5 Maintenance Data and Schedules
- The lapse of time between services and the description of the service required of each part, lubrication requirements, etc.
- 3.6 Schedule of Spares.

## **9. INSPECTIONS AND TESTING**

### **9.1. INSPECTIONS (PART III, SAACE – 1978)**

The Engineer shall have general supervision and direction of the Contract Works. Supervision shall comprise such periodic visits as the Engineer may consider necessary to inspect the Contract Works for conformity with the Contract documentation and to provide clarification and further information as necessary.

The Engineer shall have the power at any time to inspect and examine any part of the Contract Works or any materials intended for use in or on the Contract Works, either on the site or at any factory, workshop or other place where such parts or materials are being constructed or manufactured or at any place where same are lying or from where they are being obtained and the Contractor shall give all such facilities as the Engineer may reasonable require to be given for such inspection and examination.

The Contractor shall not be liable for the cost of inspecting materials at the place of manufacture, construction or storage nor be responsible for any travelling or accommodation costs arising out of the execution of such inspection, etc.

### **9.2. TESTING**

9.2.1. The Contractor shall supply all test equipment, test facilities and everything necessary, at his cost, to perform these tests. The minimum testing and commissioning equipment that is required, is as follows:

1. Pitot tube and manometer.
2. Hot wire anemometer.
3. Crane type manometer for balancing valves.
4. Thermometer for insertion into pipe and duct pockets alongside temperature detectors.
5. Sling psychrometer.
6. Revolution counter suitable for measuring fan and motor shaft rotation.
7. Megger equipment.
8. Clamp on ammeter.
9. Voltmeter.
10. Power factor meter.
11. Ohmmeter suitable for continuity testing.
12. Neon type ON/OFF test lamp.
13. Maximum indicating ammeter suitable for measuring peak motor starting currents.
14. Vacuum pump.



15. Thermo couple – electronic or calibrated micrometer gauge.

9.2.2. The contractor shall record all measurements taken during testing and shall do the necessary adjustments until the Engineer is satisfied with the results.

9.2.3. The Engineer shall be notified one (1) week in advance of any tests so that he may witness such tests.

9.2.4. Unless otherwise specified, the contractor will be required to perform the following tests:

#### Electrical Switchboards

- (a) A simulated functional test in the factory to ensure the correct operation of equipment, controls, interlocks and measuring circuits.
- (b) A 2,5 kV pressure test in the factory

#### Ducting

Pressure test medium and high pressure ducting in terms of SANS 10173: Code of Practice for the Installation, Testing and Balancing of the Air Conditioning Ductwork.

#### Refrigerant Piping

Refrigerant pipes and equipment shall be tested in terms of SANS 10147: Code of Practice for Refrigeration and Air Conditioning Installations.

Prior to the pressure test, equipment which has been factory tested and refrigerant charged, as well as any other equipment which could be damaged or cause personal injury by imposed pressure test, shall either be isolated or removed from the system. Safety relief valves and rupture discs where not part of factory sealed systems shall also be removed and openings plugged.

Pressure control and excess pressure protection shall also be provided. The pressure test shall be applied in two stages, before any joints are insulated or piping covered. The test gas shall be dry nitrogen.

The first stage shall be at 69 kPa with every joint checked with a thick soap or colour indication solution. The test pressure and ambient temperature is to be recorded to which the system is exposed.

The second stage shall be tested at pressure not less than the lower of the system design operating pressure or the protecting pressure relief device with 10% increments above 690 kPa. The final pressure shall be maintained for 24 hours with the system pressure and ambient temperature recorded. Should any leaks be found, then the joints shall be removed, thoroughly cleaned and re-installed as a new joint. Joints repaired by calking, remelting or back welding shall not be acceptable. After the necessary repairs, the system shall be re-tested.

Following a successful pressure test, each system shall be relieved and evacuated to an absolute pressure 300 micrometers. The ambient temperature is to be higher than 2°C during a vacuum test. Once the desired vacuum is reached, the vacuum shall be closed and stand for 1 hour. Should the pressure rise over 500 micrometers after 1 hour, the system shall be evacuated down to 300 micrometers and left for 1 hour. The system shall not be charged until a vacuum of at least 500 micrometers is maintained for 1 hour without a vacuum line. Should any leaks occur, they are to be repaired with vacuum procedure redone.

## **10. COMMISSIONING AND HANDING OVER**

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## 10.1. PROCEDURE

### 10.1.1. Physical Completion

After physical completion of the erection phase of the installations, the Engineer will issue a Defects List certifying that commissioning can proceed. Items which would not influence the commissioning process could, at the discretion of the Engineer, be attended to during commissioning stage.

### 10.1.2. Commissioning Stage

After commissioning the Engineer will issue a second Defects List (the Commissioning Defects List). Any outstanding work will be recorded on this list.

### 10.1.3. Engineer's Certificate

After completion of all outstanding items and receipt of all manuals and drawings as recorded on the Commissioning Defects List the Engineer will issue a First Delivery Certificate. This certificate will accompany a certificate of acceptance by the Client's representative.

The one year maintenance and guarantee period will commence on the date of the First Delivery Certificate.

## 10.2. COMMISSIONING

The Commissioning of the entire installation shall be carried out timeously. The workshop drawings, to be produced by the Contractor, are to be perused and approved, in principal, by the Contractor's Commissioning Engineer who is to confirm that the installation as indicated can be commissioned.

The commissioning of the installation shall be in terms of the following codes, or any other code approved by the Engineer:

(a) Air Distribution Systems:

SANS 10173: Code of Practice for the Installation, Testing and Balancing of Air Conditioning Ductwork.

(b) Refrigeration Systems:

CIBS: Commissioning Code: Series R: Refrigeration Systems.

(c) Control System:

CIBS: Commissioning Code: Series C: Automatic Controls.

(d) Water Distribution Systems:

CIBS: Commissioning Code: Series W: Water Distribution Systems.

The Contractor shall submit the Commissioning program to the Engineer, at least four (4) weeks prior to the commencement of commissioning.

The power connections to the various installed equipment must be energized to facilitate commissioning of the installation.

To enable this switch-on to take place the installation must be substantially complete.

The Contractor shall inform the Engineer within (4) weeks of his appointment, what time allocation has been allowed for commissioning purposes. This must be reflected on the Critical Path Schedule to be submitted by the Contractor.

### 10.3. TRAINING AND MAINTENANCE

The Contractor shall provide a suitably qualified and trained person to train the Employer's staff in the correct operation and maintenance of the installation. The Contractor shall allow for this person to be full time on site as called for in the maintenance contract conditions.

## 11. **MAINTENANCE DURING THE GUARANTEE PERIOD**

During the contract and guarantee period, the Contractor shall be fully responsible for complete maintenance of the installation as specified in the included maintenance contract. Whilst the guarantee period on material, equipment and labour performed commences on the date when the Engineers Certificate and the Clients Certificate of Acceptance is issued and expires one calendar year later.

Maintenance of the installation shall mean the regular servicing, lubrication, repairing, cleaning and adjustment of the installation as per the included specification, as well as the free of charge replacement of any defective components of the new installed equipment during the guarantee period.

## 12. **STATUTORY AND REGULATORY REQUIREMENTS**

The installations shall be designed, erected, commissioned and maintained in compliance with the following appropriate regulations as specified in the Standard Technical Specification.

In addition, the contractor shall exempt the Employer from all losses, costs or expenditures which may arise as a result of the Contractor's negligence to comply with the requirements of the regulations enumerated in this Clause.

It shall be assumed that the Contractor is conversant with the abovementioned requirements. Should any requirement, by-law or regulation, which contradicts the requirements of this Document, apply or become applicable during erection of the installation, such requirements, by-law or regulation shall overrule this document and the contractor shall immediately inform the Engineer of such a contradiction.

Under the circumstances shall the Contractor carry out any variations to the installations in terms of such contradictions without obtaining the written permission to do so from the Engineer.

## 13. **ARRANGEMENTS WITH THE SUPPLY AUTHORITY**

It shall be the responsibility of the Contractor to make the necessary arrangements at his own cost with any Statutory Authority and to supply the labour, equipment and means to inspect, test, commission and to hand over the installation.

The Contractor shall supply and install all notices and warning signs that are required by the appropriate laws or regulations and/or by these documents.

#### 14. **DESIGN PARAMETERS**

The following design parameters shall apply:

##### Ambient Conditions

Altitude	:	1 393 m
Barometric Pressure	:	102.4 kPa
Summer DB	:	32°C
Winter DB	:	1°C
Ambient Condensing Temperature	:	35°C

##### Indoor Conditions

14.1.	Summer Inside	DB	:	24°C ± 1°C
	Winter Inside	DB	:	22.0°C ± 1°C

#### 15. **AVAILABLE SERVICES**

Details of available services on site:

##### Electrical Supply

400 V/230 V	:	± 5%
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<u>Steam Supply</u>	:	N/A
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##### Municipal Water Supply

Available pressure	:	N/A
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#### 16. **NOISE AND VIBRATION CONTROL**

The Contractor shall be responsible for maintaining noise and vibration transmission from his equipment to the building structure and adjacent rooms within the limits suggested in the SANS "Code of Practice for the Rating of Noise for Speech Communication and with the respect to Annoyance, Code Number 10103 - 1994.

In order to attain the noise levels specified below, the Contractor shall provide the necessary spring type vibration mountings under all rotating equipment, flexible pump piping connections, etc.

All noise and vibration control equipment must be clearly shown on the Contractor's drawings which are to be submitted for approval.

Noise levels specified below may be amended in the supplementary specification if a specific part of the contract works so requires. This shall not however relieve the Contractor of the responsibility of meeting the requirements of the above clauses as far as the remainder of the contract work is concerned.

The following table is an excerpt from the abovementioned SANS code.

<u>Type of indoor space</u>	<u>Intruding noise</u>
-----------------------------	------------------------

	<u>level dB(A), max</u>
Hospital ward, theatre, church, cinema, concert hall, small office, reading room, conference room, lecture room	25 - 35
Large office, business store, department store, meeting room, small quiet restaurant	35
Large restaurant, secretarial office (with typewriter), gymnasium	45
Large typing halls	55
Workshop (according to intended use)	45 - 75

Noise generating equipment such as fans, compressors, pumps, motors etc. shall be selected to operate as close to the point of maximum efficiency as possible. It is the responsibility of the Tenderer to check operating noise levels of the equipment before tendering. Tenderers offering equipment with low noise ratings may receive preference.

Tenderers are advised to calculate sound levels on the system offered before tendering. Where it is not possible to meet the specified sound levels due to the noise generated by the equipment, or due to inadequacies in the building structure, or the design of the plant, such deficiencies shall be stated in the tender together with the Tenderer's recommendations and cost implications.

The Contractor shall submit noise estimating sheets for all systems as well the insertion loss ratings of sound attenuators for approval before ordering. Failure to do so may result in additional costs to the Contractor if noise levels in any area should exceed the specified limits.

If the noise levels exceed the values specified above, the Contractor shall be responsible to carry out all the necessary rectifications at his own expense.

## **17. CODING, LABELLING AND NOTICES**

### **17.1. GENERAL**

The Contractor shall supply and install all coding, labelling and notices as required under this Clause.

The wording shall be in English.

To reduce the possibility of incorrect labels and/or notices, the Contractor shall submit a schedule of labels and notices to the principal agent for approval. Costs to rectify inscriptions, resulting from the failure by the Contractor to obtain approval, will be for his account.

### **17.2. CODING**

#### **17.2.1. General**

Codes and numbers for wiring shall be CRITCHLEY IZ-type, or other approved, Cable Marker interlocking endless expanding markers, as supplied by CABLE ACCESSORIES (PTY) LTD. CRITCHLEY C-type, or other approved, Cable Markers shall only be used with the approval of the Engineer where wires and piping have already been terminated.

Lettering shall be marked in black on a white background.

#### 17.2.2. Electrical

Provide and install the following coding:

- (a) Numbering of both ends of power and control conductors in switchboards.
- (b) Numbering of both ends of field cables.
- (c) Numbering of both ends of individual field conductors within cables of control circuits only, where such conductors are not uniquely identified by means of insulation colour codes.

### 17.3. LABELLING

#### 17.3.1. General

Labelling shall be CRITCHLEY UNILABEL, or other approved, Cable Marker, as supplied by CABLE ACCESSORIES, or engraved "IVORENE" or "TRAFOLITE" labels.

Black letters on a white background shall be used.

Labels shall be fixed with screws or acceptably glued to all equipment.

#### 17.3.2. Equipment

All mechanical, electrical and instrumentation equipment shall be identified by means of an equipment code.

Minimum height of letters: 10mm.

### 17.4. NOTICES

17.4.1. Supply and install all notices required in terms of Statutory Regulations.

17.4.2. In terms of the Occupational Health and Safety Act, Act 85 of 1993, the following notices are required:

#### **(C.52)**

At the entrance to each plantroom, the following notice shall be provided:

- (a) Prohibiting unauthorized persons from entering.
- (b) Prohibiting unauthorized persons from handling or interfering with electrical apparatus.
- (c) Directions as to procedure in case of fire.
- (d) Directions as to restoration of persons suffering from the effects of electrical shock.

#### **(C.73)**

Manufacturer's Plate on Pressure Vessels:

- (a) Manufacturer's name.
- (b) Country of Origin.

- (c) Maker's Number.
- (d) Year of Construction.
- (e) Maximum permissible working pressure in Pascal.
- (f) Capacity in cubic metres
- (g) Name and Number of Code of Manufacture.

## **18. PAINTING AND MARKING**

### **18.1. GENERAL**

All steelwork, piping, lagging, etc. supplied under this contract shall be painted as required under this clause:

Exposed portions of boilers, calorifiers, cylinders, etc. in the plant room shall be properly cleaned, primed and painted two coats of heat resistant paint.

All other exposed metal parts such as pumps, belt guards, all piping, pipe lagging, fittings, dampers, fans, coils, motors, pumps, packaged units, control panels, steelwork, exposed ducts and lagging, expansion tanks, make-up tanks, cooling tower, unit shelters, etc. shall be cleaned, primed, undercoated and finished in a high quality gloss paint of approved colour.

All external equipment exposed to the weather must be cleaned, primed and painted with two coats of epoxy paint.

The lagged surface of calorifier, headers and pipes shall be primed, undercoated and finished in a high quality gross of approved colour. Unlagged steam piping shall be painted with heat resistant paint.

All plants shall be generally painted in accordance with SANS 10140 as indicated below.

#### **Machinery, Structural steelwork etc**

- |    |   |   |             |
|----|---|---|-------------|
| 1. | All exposed metal parts<br>Checker plates, Pipe supports<br>Handrails, Base plates                                    | : | Black       |
| 2. | Body portions of machines   | : | Olive Green |
| 3. | All machinery external to<br>the building (except piping<br>and valves and fittings)                                  | : | Dove Grey   |
| 4. | All moving parts which are<br>visible when operating. In-<br>side surfaces of all machine<br>guards, belt guards etc. | : | Orange      |
| 5. | All handles, levers, handwheel<br>centres adjustment knobs, etc.  | : | Yellow      |
| 6. | All lagging on boilers, calo-<br>rifiers, tanks, cylinders etc.   |   |             |

	except on piping and pump sets and ducting)	:	Aluminium
7.	Electrical distribution boards (except where transparent covers are used)	:	Light Grey
	Control panels Indicator panels		
8.	Water treatment plant (except on piping.		
	Air Conditioning plant (except on piping.	:	Light Blue
9.	All points which constitute a physical hazard, e.g. (stay-wires, low pipes, access doorways, etc.)	:	Yellow and Black Cross Hatch
10.	Drainage piping	:	Black

## 18.2. PIPING, PUMPS, VALVES, FITTINGS ETC.

18.2.1. The colour code for pipelines and machines is based on the following:

- |     |               |   |  |
|-----|---------------|---|--|
| (1) | SANS, 10140-3 | : | Identification colour marking; Contents of Pipelines |
| (2) | BS 1710-1975  | : | Identification of pipelines                          |

18.2.2. All unlagged black piping, holder bolts, supports anchors fittings, etc. shall be painted in accordance with British Standard Specification No. BS 1710.

18.2.3. In enclosed horizontal or vertical ducts, surfaces, mezzanine spaces and basements where pipelines are already painted or galvanised or are lagged, painting may be restricted to 150 mm long lengths at a maximum spacing of 4 m, and at all branches, tees, valves, and at the entry from such ducts, spaces, etc.

18.2.4. Except where otherwise specified all piping on surfaces shall be painted with a primer, an undercoat and a finishing coat in an approved high quality gloss paint. to the colour indicated in the schedule. This also applies to all holder bolts, supports, anchors, fittings and valves. Where only 150 mm lengths of the pipe are painted the colour and specification of the painting shall be in terms of this clause.

18.2.5. Pump sets, valves, fittings, etc. shall be painted the same basic colour as the pipelines, except those of fire fighting services, which shall be painted red.

### 18.2.6. Bands

The length of the band shall be same as the final pipe diameter, but not less than 100 mm. Where three strips are required per band, each strip shall be one third of the final pipe diameter but not less than 35 mm. Where 150 mm lengths alone are colour painted, the 50 mm band shall be centrally placed on the 150 mm length.

## 18.3. ARROWS



The direction of flow shall be indicated with a 25 x 100 mm long black arrow at intervals of approximately 4 m and at valves and junctions. Flow lines shall be marked with an F and return lines with an R at each arrow.

#### 18.4. SERVICE OUTLETS

Where outlets require identification the colour identification shall take the form of coloured centre pieces on handwheels or cocks, and/or other suitable approved marking on the neck of the outlet fittings as specified. The colour shall primarily be that of the pipe colour and where banding is used, the colour shall be that of the band and stroke.

#### 18.5. RADIATORS AND PIPES IN FINISHED AREAS

All radiators, pipes, fittings etc. in finished areas such as wards, offices, passages, etc. shall be cleaned, primed, undercoated and finished in a high gloss paint to match the existing finish.

#### 18.6. IDENTIFICATION COLOURS

<u>Basic Pipe Colour</u>	<u>Banding Colour</u>	
Cold water supply (drinking water)	Brilliant green	Cornflower
Condenser water	Brilliant green	White
Boiler feed water	Brilliant green	Crimson/white/Crimson
Boiler condensate lines	Brilliant green	Crimson/Emerald Green/Crimson
Chilled water lines	Brilliant green	White/Emerald Green/White
Domestic hot water	Brilliant green	Crimson/Cornflower
Fire fighting mains	Signal red	
Central heating hot water	Brilliant green	White/Yellow/White
Steam	Pastel grey	
Gas (except air and medical gas)	Light stone	
18.6.1. Compressed air		Artic blue
Ducts and conduits for electric services	Light orange	
Diesel	Golden brown	White
Acids and alkalis	Jacaranda	

#### 18.7. IDENTIFICATION COLOUR CODES

<b><u>Colour name</u></b>	<b><u>Colour classification no.</u></b>
Artic blue	F28
Brilliant green	D10
Cornflower	F29
Crimson	A03
Emerald green	A14
Golden Brown	B13
Jacaranda	F18
Light stone	C37
Light orange	B26
Pastel grey	G54
Signal red	A11

#### 18.8. COLOUR CODING FOR DUCTWORK

All ducting in plantrooms is to be colour coded according to the schedule below. If the duct is internally lined, then the whole duct surface shall be painted in accordance with the schedule below. If the duct is externally lined with insulation, then the ducting must be painted with a symbol to the relevant colours. The form of these symbols are to be as follows:

- (a) In order to make the colour clearly visible it may be necessary to paint the symbol colour onto a neutral colour background. This background colour is to be agreed upon by the Consulting Engineer.
- (b) The colour symbols are to be 150 mm wide band, running around the duct. The background colour is to extend 300 mm on either side of the colour symbol strip.
- (c) In the case of conditioned air where the colour symbol is both red and blue, one colour strip is to be used (150 mm wide) but the two colours shall alternate each being 200 mm long.

<b><u>Duct/Air type</u></b>	<b><u>Colour</u></b>	<b><u>Colour No.</u></b>
Ventilation Air Supply	Blue with Yellow Band	F11 and C61
Exhaust Air	Brown	B07
Reticulated air	Grey	G25
Outside air	Green	P14
Hot deck (on dual duct)	Blue with Red Band	F11 and A14

Cold deck  
(on dual duct)

Blue with Dark  
Blue Band

F11 and F02

The colours as defined as above are according to SANS 10173-1980

## 19. **SPLIT UNITARY SYSTEMS**

### **General**

The units shall be of the Midea inverter series or other approved. The units shall be supplied and installed in the positions shown on the drawings. The Sub-Contractor is to note that the indoor unit shall be mounted against the wall or in the ceiling or on the ceiling, suspended from the roof structure or slab, in terms of the suppliers' recommendations.

Each system shall consist of an indoor unit connected to an outdoor unit.

- a) Each unit shall be equipped with an extended auxiliary condensate drain pan and the condensate must be drained to each drain point indicated on the drawing through an insulated 22mm uPVC pipe. Drain piping built into walls shall be copper class O diameter 22mm. No drain shall be surface mounted and the onus is therefore on the air conditioning Sub-Contractor to ensure that his drain pipes are in position when the walls are being built.
- b) The temperature controls shall be accommodated in the remote fan switch housing and shall consist of a temperature adjustment facility and temperature scale. Each unit shall be equipped with a time delay safety circuit which shall delay the restart of the compressor for approximately 3 minutes even if the air conditioner is manually restarted too quickly. **The wiring between the remote controller and the unit shall not be surface mounted and is therefore to be done in conduit chased into the wall.**
- c) The thermostat control shall be installed in a position indicated by the Engineer. Each outdoor unit shall conform to the following specification:
- d) The unit shall be mounted on purpose made galvanized unistrut wall brackets where indicated. The wall brackets forms part of this contract.
- e) The unit shall accommodate the refrigerant compressor, the condenser fan and air-cooled condenser coil. The compressor shall be installed on anti-vibration mountings as provided by the manufacturer.
- f) The condenser coil shall be protected against damage by a removable wire mesh screen.
- g) Each unit shall be auto restart.

### **Piping**

- a) The system must be charged with R410A refrigerant.
- b) The indoor and outdoor unit must be interconnected with copper refrigerant piping in terms of the suppliers' recommendation. The tenderer is to note that the distances between the indoor and outdoor units and the relevant pipe sizes have been indicated on the drawings. The return of oil to the compressor is to be ensured by the installation of traps at regular intervals.
- c) All piping through walls shall pass through sleeves which shall be properly sealed after installation. Installation through sleeves shall be continuous.
- d) All surface mounted piping shall be installed in suitably sized rectangular PVC Cabstruct trunking, complete with removable cover plate and bends, securely fixed to the walls.

- e) All piping and cabling above ceilings shall be installed on factory manufactured galvanised steel cable tray, hung from the structure above.
- f) All refrigerant, liquid and suction, shall be separately insulated with thermoflex insulation. Insulation exposed to weather conditions shall be covered with suitable galvanized steel trunking (see Clause 18.7) and also be covered with cloth and painted with "Foster seal".
- g) All refrigerant piping shall be seamless cold drawn copper piping.
- h) The insulation shall be applied to form a continuous and homogenous vapour barrier over bends, supports, etc.
- i) Inside the building (ceiling voids) piping shall be installed on "Cabstrut" or other approved heavy-duty galvanised cable basket wide enough to accommodate both pipes and the drain piping. Piping may not be suspended from these cable racks.
- j) Horizontal piping may be strapped to cable trays with 10mm wide cable ties. Care shall be taken not to pinch or damage the pipe insulation when strapping to cable trays. Any damaged insulation shall be completely removed and replaced to the satisfaction of the Engineer.
- k) All piping shall be run so to avoid passing through ductwork, recessed light fixtures or interference with electric light outlets.
- l) Where piping protrudes through building structures, pipe sleeves are to be installed, as part of the contract, to ensure easy removal thereof. No pipes may be built or plastered directly into the structure.
- m) The contractor shall be responsible for the drilling of the holes and making good on the outside of the building to the plaster and paint.
- n) When completed, the installation shall ensure a complete vapour barrier and any signs of sweating or dripping shall cause the installation to be rejected

## 19.1. INDOOR UNITS

Indoor units shall be of the concealed ceiling type ducted units as well as mid-wall units, installed in the positions and according to the capacities shown on the drawings.

Each unit shall have an electronic expansion valve which controls refrigerant flow rate in response to load variations of the room.

The fan shall be of the dual suction multi-blade type and will be statically and dynamically balanced to ensure low noise and vibration free operation.

The address of the indoor unit shall be set automatically in case of individual and group control.

### 19.1.1. Ducted Units

The ducted unit shall consist of an evaporator coil, corrosion resistant condensate drip tray, supply air fan, fan scroll, fan motor, controls and efficient long life filter all mounted in an attractive compact casing.

The unit shall be fixed to the roof rafters or slab with four (4) correctly sized suspension bolts. An additional purpose made galvanised drip tray with drain piping to the outside of the building shall be installed under the unit.

The unit shall be fitted with twin double inlet, silent running, centrifugal drum fans within properly sized aluminium or steel fan scrolls. The fan blades shall be of dynamically balanced aluminium or other non-ferrous metal manufacture, mounted on a common shaft and driven by a continuously rated two-speed electric motor, resiliently mounted on a suitable cradle. The fan motor is to be fitted with self-aligning sealed bearings.

The fan motor shall be of the single phase, permanent split capacitor type with built-in re-settable overload protection. The motor shall have multi speed windings and shall be factory connected to a terminal box. All wiring is to be marked to correspond with labelled terminals matching the motor wiring diagram.

Supply air shall be ducted to grilles provided as an integral part of the unit or to diffusers, through a custom made galvanised sheet metal plenum, including 25mm thick sonic liner with spigots for flexible duct connections of the number and sizes as indicated on the drawings.

Air shall be returned to the unit through grilles provided or through a similar plenum as described above, including return air grille and removable filter medium secured behind a wire mesh screen in a hinged panel accessible from the air-conditioned area.

The evaporator coil shall consist of a multi-pass coil of heavy gauge, solid drawn copper tubing mechanically expanded into aluminium cooling fins. The coil shall be provided with an automatic defrost thermostat to prevent excessive frosting.

The evaporator coil shall be completely sealed off to ensure that maximum supply air flows over the coil.

The unit shall be efficient and extremely quiet in operation and the noise level shall not exceed 38 dB's on the "A" scale at a distance of three meters from the unit.

The units shall be self contained and set to deliver air that is filtered and cooled, or filtered and heated as may be required. The units shall be suitable for a single phase, 220V, 50 Hz, AC power supply.

Heating shall be by reverse cycle only.

#### 19.1.2. Wall mounted units

The wall mounted unit shall consist of an evaporator coil, mildew-proof polystyrene condensate drip tray, supply air fan, fan scroll, fan motor, controls and efficient filter all mounted in an attractive compact casing.

The unit shall be installed on and including the manufacturer's standard metal mounting plate fixed to the wall with two (2) correctly sized concrete wall bolts.

The unit shall be fitted with twin double inlet, silent running, centrifugal drum fans within properly sized aluminium or steel fan scrolls. The fan blades shall be of dynamically balanced aluminium or other non-ferrous metal manufacture, mounted on a common shaft and driven by a continuously rated two-speed electric motor, resiliently mounted on a suitable cradle. The fan motor is to be fitted with self-aligning sealed bearings.

The fan motor shall be of the single phase, permanent split capacitor type with built-in re-settable overload protection. The motor shall have multi speed windings and shall be factory connected to a terminal box. All wiring is to be marked to correspond with labelled terminals matching the motor wiring diagram.

The supply air louvres shall be of the auto-swing type with remote pre-set and automated vertical airflow direction control. Horizontal airflow control shall be by means of manually adjustable flaps situated behind the supply air louvres.

Air shall be supplied from the bottom of the unit and returned through top and front mounted grilles. The front grille shall be easily removable for washing.

The evaporator coil shall consist of a multi-pass coil of heavy gauge, solid drawn copper tubing mechanically expanded into aluminium cooling fins. The coil shall be provided with an automatic defrost thermostat to prevent excessive frosting. The evaporator coil shall be completely sealed off to ensure that maximum supply air flows over the coil.

The air filter shall be of the easily accessible and removable mould resistant resin net type, washable with mild detergent. The filter media shall be arranged so that no air bypasses the filter at the edges.

The unit shall be efficient and extremely quiet in operation and the noise level shall not exceed 35 dB's on the "A" scale at a distance of three meters from the unit.

The units shall be self contained and set to deliver air that is filtered and cooled, or filtered and heated as may be required. The units shall be suitable for a single phase, 220V, 50 Hz, AC power supply.

Heating shall be by reverse cycle only.

## 19.2. PIPING INSTALLATION

The pipe routes shown on the drawings are generally diagrammatic. The runs and arrangements of piping shall be as indicated, subject to modifications as required to suit conditions at the building, to avoid interference with work of other services and for proper convenient and accessible location of all parts of the piping system. All required offsets, fittings, valves, traps, drains, etc. may not be indicated but allowance must be made in tenders for all such necessary items to be furnished.

Piping shall be installed as straight and direct as possible, neatly spaced and in general forming right angles with, or parallel to walls or other piping.

The pipe sizes shall be installed by the contractor for the sizes of units offered in accordance with the manufacturer's specifications. Any discrepancy between this specification and the manufacturer's specification is to be brought under the attention of the Engineer.

The piping network shall be connected using "Y Branch" joints complete with the necessary reducers with the matching insulation as supplied by "LG" or other approved.

Suction and liquid pipes are to be insulated separately and not grouped together as for a single line. "Thermoflex" or other approved pipe insulation as per Clause 20.7 shall be used.

All piping shall be run so to avoid passing through ductwork, recessed light fixtures or interference with electric light outlets.

Where piping protrudes through building structures, pipe sleeves are to be installed, as part of the contract, to ensure easy removal thereof. No pipes may be built or plastered directly into the structure.

The contractor shall be responsible for the drilling of the holes and making good on the outside of the building to the plaster and paint.

Pipe sleeves must be of similar material as the pipe and must be large enough to allow enough free space for movement.

Where specified and where the opening between the sleeve and pipe is large and unsightly, blank cover plates must be installed.

Sleeves through outside walls, slabs and piping through roofs and windows must be sealed off watertight.

All sleeves must be installed neatly and made watertight. The opening between the pipe and sleeve must be sealed off by means of silicon rubber or any other approved product.

Where piping is installed through ceilings approved blank cover plates must be used to ensure a neat finish.

Where pipes run in areas exposed to sunlight (between outdoor units and the building), they will be installed inside suitably sized galvanized mild steel trunking.

Inside the building (ceiling voids) piping shall be installed on galvanized cable baskets wide enough to accommodate both pipes and the drain piping. Piping may be strapped to cable trays with cable ties.

Piping shall be installed strictly in accordance with the manufacturer's requirements. Pipe sizes are indicated on the drawings.

## **20. REFRIGERANT PIPING**

All piping and fittings shall be of the best quality seamless, dehydrated, de-oxidised refrigeration class copper tubing, suitably sized for the unit installed and in accordance with SANS 460 as amended.

All refrigerant piping shall be "Maksal" Type RL hard drawn refrigeration copper tubing in accordance with ASTM B280-88.

Only jointing by means of capillary fittings will be allowed except in cases where equipment needs to be removed from the piping system for regular maintenance or replacement. In such cases joints between the equipment and piping shall be with DZR brass compression fittings.

Capillary type fittings shall comply with SANS 1067 - Part 2 or any of the related ISO 2016, DIN 2856 and BSS 864 - Part 2 specifications.

Soldering flux shall be used to remove residual traces of oxides, to promote wetting and to protect the surface to be soldered from oxidation during heating.

The flux shall be applied to clean surfaces and only enough should be used to lightly coat the areas to be joined and should be applied as soon as possible after cleaning.

Only the following solders shall be allowed to be used on capillary joints:-

<b><u>Composition</u></b>	<b><u>Specification</u></b>
97/3 (97% tin and 3% copper)	SANS 24 – DIN 1707
96/4 (96% tin and 4% silver)	SANS 24 – DIN 1707
75/25 (75% tin and 25% zinc)	

Resin core and acid core solder **shall not be used at all.**

No welding of refrigeration systems will be allowed unless the pipe system is continuously filled and under pressure using nitrous gas.

All soldered joints, on factory supplied equipment, shall be carefully checked before commissioning and remade if found damaged in transit.

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.

A refrigerant charging connection shall be provided in the liquid line. Before charging the system with refrigerant the circuit shall be leak tested and dehydrated.

All pipes, vessels, etc. operating below ambient dew point shall be insulated and a vapour barrier provided.

An isolating valve shall be installed in both the liquid and gas lines where connected to the evaporator unit. Valves shall be of the bronze body, ball type.

When completed, the installation shall maintain a complete vapour barrier and any signs of sweating or dripping shall cause the installation to be rejected.

All piping shall be rigidly supported, both vertically and horizontally.

Inside the building (ceiling voids) piping shall be installed **on** "Cabstrut" or other approved medium-duty galvanised welded wire mesh cable tray wide enough to accommodate both refrigerant pipes and the drain piping. The mesh pitch shall not exceed 100x50mm with longitudinal side-wall wires spaced at intervals of not more than 25mm.

Outside the building piping shall be installed **on** "Cabstrut PW100" or other approved heavy-duty welded galvanised cable ladder wide enough to accommodate both refrigerant pipes and the drain piping, including galvanised sheet metal covers painted to colour match the walls. Rung spacing shall be at 300mm intervals.

All wire mesh cable trays shall be supported on "Unistrut P2000" or other approved 41x41x1.5mm galvanised channels including galvanised hold down saddles, bolts, nuts, washers and screws. The channel shall be supported from 8mm diameter hanger rods including washers and nuts. Channels to be spaced at intervals not exceeding 1500mm.

All cable ladders shall be supported on "Unistrut P1000" or other approved 41x41x2.5mm galvanised channels including galvanised hold down cup, bolts, nuts, washers and screws. The channel shall be "Rawl" bolted directly to external walls or slabs. Channels to be spaced at intervals not exceeding 1500mm.

All piping shall be secured to cable trays and ladders with "Cabstrut Q-series" or other approved adjustable type galvanised cross rung clamps **only**. Care shall be taken not to pinch, compress or damage the pipe insulation when securing piping to cable trays and ladders. Any damaged insulation shall be completely removed and replaced to the satisfaction of the Engineer.

**Strappings and cable ties will not be permitted.**

Hangers and supports where piping penetrates through walls shall be designed to prevent transmission of vibration to the building.

Supports must be installed near to joints and fittings. Pipe clamps shall be installed at the following centre to centre distances.



<b>Nominal Pipe Size</b>	<b>Centre to Centre Spacing</b>	
<b>Copper</b>	<b>Horizontal Pipe</b>	<b>Vertical Pipe</b>
12 mm	1.0 m	1.2 m
15 mm	1.2 m	1.5 m
22 mm	1.5 m	1.8 m
28 mm	1.9 m	2.1 m
35 mm	2.1 m	2.4 m
42 mm	2.4 m	2.7 m
54 mm	2.4 m	3.0 m
66 mm	2.4 m	3.0 m
76 mm	2.5 m	3.0 m

Extra support must be supplied at T-offs, valves and other heavy fittings.

#### 20.1. DRAIN PIPING

Provision shall be made for condensate drainage from the inside of the building to the outside of the building by means of uPVC piping of not less than 20mm inside diameter.

Piping shall run above ceilings and vertical down in the positions indicated on the drawings. All piping shall terminate at ground level where it shall be routed to the nearest drain point.

Drain piping shall be installed without any loops in the piping where condensate can accumulate. The pipes shall have a uniform slope (1:100) from the unit to the outside and show be tested in the presence of the Engineer.

All drain piping in ceiling voids **shall be insulated as per Clause 20.7 Drain piping** on external walls shall be copper class O.

#### 20.2. PIPE INSULATION (SANS 1445 & SANS 1508 AS APPLICABLE)

The copper piping installed inside the building shall all be insulated with "Thermaflex" or other approved insulation. Vapour barrier integrity will be critical to prevent dripping. No zip type insulation will be allowed. Liquid and gas lines shall be insulated separately.

The insulation material shall meet the following minimum requirements:

Temperature range : -80°C + 120°C

Thermal conductivity : 0,038 W/m K at 0°C

Thickness : 15 mm

Density : 35kg/m<sup>3</sup>

**Odour Properties** : **Neutral**

Cellular Structure : Totally closed

Fire Properties : Self-extinguishing

The insulation shall be applied to form a continuous and homogenous vapour barrier over bends, supports, etc. All joints and seams shall be glued. **Non-drip tape shall not be used for assembling seams and joints.**

All fittings and valves shall be wrapped with black non-drip tape.

When completed, the installation shall ensure a complete vapour barrier and any signs of sweating or dripping shall cause the installation to be rejected.

### 20.3. CONTROLS

#### 20.3.1. Individual control unit

The contractor shall supply and install hard-wired remote controllers in the positions indicated on the drawings. All control wiring shall be to the manufacturer's recommendation.

The controller shall perform the following functions:

- a) Start/Stop.
- b) Temperature setting.
- c) Airflow setting.

The controller shall display the following:

- a) Operation display.
- b) Filter sign.
- c) Temperature setting display.
- d) Timer display.
- e) Airflow display.
- f) Abnormal operation display.

The controller shall control all indoor units of one room simultaneously.

### 21. AIR TERMINALS

The air conditioning Contractor shall supply and install all air terminals in the positions shown and of the capacities and sizes shown on the drawings, or of capacities and sizes to suit the application.

**The type and finish of the air terminals must be approved by the Engineer in consultation with the Principal Agent prior to an order being placed.**

All grilles shall be manufactured of aluminium with a white powder coat finish unless otherwise specified. Where specified or shown on the drawing, grilles shall be connected to the main duct by way of a flexible duct. The Tenderer shall make provision in his tender for a plenum box to which the flexible duct and grille is to be fitted. The Contractor shall be responsible for the balancing and setting of all dampers so that the specified air quantities are obtained at each air terminal.

#### 21.1. RETURN AIR GRILLES

Return air grilles installed to ceilings shall be of the fixed horizontal blade type. Each grille shall have a double frame, consisting of an outer frame being the ceiling mounted sub-frame and an

inner frame that is hinged and clipped to the outer frame. The grille shall also be equipped with a removable washable filter media. The outer frame shall have a flange that is projected 32mm beyond the inner edge of the mounting frame.

Fixing holes shall be done by the manufacturer at each end to receive oval headed or Phillips screws for attachment to the ceiling. The heads of the screws shall have a similar finish to the grilles.

Return air grilles installed to exposed ducting are of the same type as the supply air grilles where specified.

#### 21.2. SUPPLY AIR DIFFUSERS

Diffusers shall be of the adjustable swirl diffusers constant volume type, suitable for ceiling installation, complete with a low body profile and radial front face plate.

The diffuser shall provide a high induction and radial distribution of air even at minimum air quantities, to ensure efficient air distribution throughout the comfort zone of the room.

#### 21.3. WEATHER LOUVERS

As shown on the drawings ducts shall terminate with a weather louver located outside the building. The weather louvers shall be of the "Trox AWK" or other approved type finished with epoxy colour coated finish to architect's detail.

Weather louvers shall include a blade section and vermin screen with mosquito net, plenum box and duct connection spigot.

#### 21.4. DISC VALVES

All disc valves shall be of the "Trox Z-LVS" or other approved type according to the sizes shown on the drawings. The valves shall consist of a valve ring and central disc fitted with a sealing strip. Airflow adjustment shall be by way of a rotating central disc, which alters the gap between the disc and the valve. The units are to be supplied with a sub-frame for installation purposes.

### 22. **SOUND ATTENUATORS**

The Contractor shall supply and install a silencer in each position shown on the drawings. The silencers shall be factory supplied from an approved manufacturer and shall be selected and installed so that sufficient sound attenuation is obtained to maintain the noise level created by the equipment in all spaces in the building to the specified standards in Clause 16.

Pressure ratings of fans at the specified quantities are to be adjusted by the Contractor to take into account any difference between pressure drop across sound attenuation equipment installed.

Sound attenuators in ductwork after supply air fans shall be designed for an insertion loss large enough to limit the total sound pressure level of the noise at a distance of 1.5 meters directly in front on the first air outlet in the duct system to the noise level specified.

Sound attenuators shall be manufactured by a reputable specialist manufacturer in accordance with published specifications. The units shall generally be manufactured from galvanised mild steel with a woven glass cloth acoustic media retained behind a galvanised wire mesh. The acoustic media shall have a Class 1 fire rating to BS 476. The unit shall be compatible with the fan diameter and at least twice its length.

The Contractor shall submit noise estimating sheets for all systems as well as the insertion loss ratings of sound attenuators for approval before ordering. Failure to do so may result in additional costs to the Contractor if noise levels in any area should exceed the specified limits.

## **23. SUPPLY AND EXHAUST FANS**

The fresh air supply/extract fans shall be installed as indicated on the drawings and shall be of the Donkin series or other approved.

The centrifugal box fan shall be constructed from galvanized sheet metal with standard clip-on flanges. The motor/impeller assembly is fixed in the casing by means of electro-plated rods. The motor shall include IP55 protection and induction bearings.

The inline tube fan's housing shall be of heavy gauge steel with scratch proof powder coated finish. The fan motor shall include IP54 protection and induction ball bearings.

Fan capacities are listed in the Schedules of Information.

An electrical isolator shall be provided within one meter of the fan. The connections to the fans and isolators form part of this contract.

## **24. DUCTWORK AND DUCT TESTING**

### **24.1. GENERAL**

Insulated and un-insulated ducted ventilation systems are to be installed in the positions shown on the drawing. The general specification for all items is covered in this clause and the contractor shall supply and install the relevant items for each system as shown on the drawings.

The ventilation to the toilets shall be done via the in-line ducted extraction fan unit.

Unless otherwise specified or noted, ductwork casings and plenum chambers shall be made of galvanized sheetmetal.

All ductwork indicated on drawings is schematic. Therefore, changes in duct sizes and/or location must be made where necessary to conform to space conditions without additional cost to the owner. Dimensions given on drawings, including all acoustically lined ducts shall be actual sheetmetal sizes.

Galvanized and stainless steel ductwork shall not be fitted with any copper or copper alloy parts unless the junctions between ductwork and such parts are so insulated that electrolytic inter-action is prevented.

### **24.2. DUCTWORK CLASSIFICATION**

All ductwork shall be manufactured and erected according to standards as set down by the SANS Standard Specification for Air conditioning Ductwork SANS 1238/1979.

Contractors may use "MEZ" flanges as supplied by Messrs Europair or Ventline or any other approved make for rectangular ducting, provided they are installed in strict accordance with the manufacturer's recommendations and that they are completely air-tight. Between the flanges the Contractor is to apply an inseal rubber gasket or any other approved seal.

This specification must be read in conjunction with the SANS standard and the section on ductwork, fittings etc. that follows, act as a guide only.

Ducting is to be classified as follows:

**Low Pressure:** When the air velocity is less than 10 m/sec the duct system total static pressure is less than 500 Pa.

**Medium Pressure:** When the air velocity is less than 10 m/sec and the duct system total static pressure is below 1,5 kPa.

**High Pressure:** When the air velocity is higher than 10 m/sec and the duct system total static pressure is between 2,5 kPa and 1,5 kPa.

#### 24.3. SCHEDULE OF SHEETMETAL THICKNESS FOR RECTANGULAR DUCTS

##### LOW PRESSURE

Longer Side of Duct Cross-Section (mm)	Sheet Thickness (minimum)
	Steel (mm)
Up to 400	0,6
401 - 600	0,6
601 - 800	0,8
801 - 1000	0,8
1001 - 1600	1,0
1601 - 2000	1,0

#### 24.4. SCHEDULE OF SHEETMETAL THICKNESS FOR CIRCULAR DUCTS

##### LOW PRESSURE DUCTS

Size (mm)	Nominal Thickness
	Steel (mm)
Up to 300	0,5
301 - 450	0,6
451 - 800	0,8
801 - 1000	1,0
1001 - 1200	1,2

Low velocity ducts shall be strongly and rigidly constructed and joints shall be mechanically tight as well as substantially air-tight. Sheet metal for slips and drive caps shall be of the same material and thickness as the ducts. The ducts shall be cross-braced between joints where necessary to give more rigidity to the ductwork.

All transverse joints, duct stiffening, beading, seams etc. must conform to the SANS standard as laid down.

#### 24.5. RADIUSSED BENDS AND SPLITTERS

Radiused bends must be used wherever possible except in cases where the installation space is so restricted that other types of bends must be used. The throat bending radius for radiused bends shall be equal to or greater than 0,75 times the duct width.

Where this is not practical, the throat radius shall be at least 100 mm and splitters must be used, the construction of which must comply with clause 5.5.2.2. of the SANS standard. For any radiused bend that does not comply with the above, the same clause shall apply.

Positions and details of splitters can be seen on Standard drawing No. STD 16.

Rectangular bends that have no throat radius but a full heel radius are to have splitters fitted that comply with clause 5.5.2.2 of the SANS standard.

**NB. Splitters shall extend along the whole radius of the bend.**

#### 24.6. SQUARE BENDS AND GUIDE VANES

Each bend must have metallic guide vanes, the thickness, strength, and durability of which shall be at least equal to those of the material of the bend. For low pressure ductwork the guide vanes must be of the single-skin type with a maximum spacing of 60 mm. They shall extend over the full 90° of the bend, and the vane radius is to be equal to 2.5 times the spacing. (Refer to standard drawing No. STD 16).

For medium and high pressure ductwork the guide vanes shall be of double-skin aerofoil type and spacing shall be as shown on standard drawing no. STD 15.

#### 24.7. ACCESS PANELS

The Contractor shall supply and install access panels at each of the automatic pressure control and fire dampers. Access panels shall be of the Europair type AP and shall be supplied in accordance with the sized indicated on the drawings. Each panel shall be internally insulated with 15mm sonic liner, which will be neatly secured and finished off. Access panels shall be manufactured from 0,80mm galvanised sheetmetal and shall be cross braced for rigidity. Each panel shall be equipped with locks and a purposely manufactured frame, which will be connected to the supply air duct. A rubber gasket shall be inserted to ensure an air tight seal between the panel and duct.

#### 24.8. TRANSFORMATIONS AND OFFSETS

When a taper is used in either a "diverging" or "contracting" air flow and the duct size is either increased or decreased the sides are not to be pitched to a greater angle than 22.5degrees.

If a square offset is used (say to pass a beam) then the square elbows are to be fitted with turning vanes as already mentioned.

#### 24.9. FLEXIBLE CONNECTIONS

Flexible connections shall be provided in connections between fans and ducts or casings where required to prevent excessive movement or vibration being transmitted through the ducts and where specified elsewhere in this specification or where indicated on a drawing.

All flexible duct connections shall be sized by the Contractor to suit the spigot sizes or outlet sizes of fans, air conditioning units etc. and the length of the flexible joint shall not exceed 250 mm. The material, when fitted, shall be free from folds and shall not be under tension.

Flexible connection material must comply with the SANS standard.

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The Contractor is to note however, that no flexible connection material may be joined together with adhesive only, but must also be neatly stitched.

#### 24.10. FLEXIBLE DUCTING

Flexible ducting shall be standard micro perforated Aludec flexible ducting insulated externally with 25mm aluminium foil backed fibre glass insulation of 16mm<sup>3</sup>/kg density.

The operating limits of this flexible ducting is to be:

Max. static pressure	:	300 mm W.G.
Max. velocity	:	20 m/s
Temperature range	:	-30°C to 121°C

The ducting is to be Sonodec Type 25P flexible ducting supplied by Messrs Europair Africa (Pty) Ltd or any other approved manufacturer. Which-ever type of flexible duct is used, the contractor shall ensure that no noise is generated from it and that it is non-combustible.

#### 24.11. DUCT SUPPORTS

Duct hangers and supports must be in accordance with the following clauses:

Ducts must be fixed, supported or hung from surfaces in either of the following ways:

- (a) Band iron strap hanger to support horizontal duct on wall - for small size ducts that have a width less than the height. The band must be anchored into the wall at top and bottom with any approved fastener. Refer to standard drawing no. STD 13.
- (b) Shelf type bracket to support horizontal duct on a wall - for ducts that have width greater than height. The vertical angle leg must be anchored securely into the wall with any approved fastener. Refer to standard drawing STD 13.
- (c) Supports for vertical ducts through floor or ceilings etc. shall be angle supports projecting beyond the opening in the floor or ceiling etc. and shall be metal screwed into the ducts. Refer to standard drawing STD 13.
- (d) Band iron strap hanger to support vertical duct to wall. (For small ducts). Refer to standard drawing STD 11.

The band must be anchored into the wall with any approved fastener.

- (e) Angle brackets for supporting vertical ducts to wall. (For large ducts). The bracket must be anchored securely to the wall with any approved fastener and metal screwed to the duct. Refer to standard drawing no STD 11.

All angle iron brackets used are to be neatly cut and the ends must be grinded smooth.

Holes in mild steel brackets for bolts are to be drilled and no holes cut with a cutting torch will be permitted.

No ducts are to be hung from other services.

#### 24.12. STRAP HANGERS

Strap hangers must be metal screwed to the duct sides. The size of the straps and spacing thereof will vary with the duct size, as shown below.

Hangers sizes for rectangular ducts (for horizontal ducts)

	Wider Side of Duct	Steel Rod Dia.	Strap Hangers	Trapeze Shelf Angles	Max. Spacing
<b>Low Press. Duct Work</b>	Up to 450	10	25 x	25 x 25 x 3	3000
	451 - 800	10	2000	25 x 25 x 3	3000
	801 - 1600	10	-	40 x 40 x 3	2500
	1601 - 2000	10	-	50 x 50 x 3	2500
<b>Med. and High Press. Duct Work</b>	Up to 450	10	-	40 x 40 x 3	3000
	451 - 800	10	-	40 x 40 x 3	2500
	801 - 1600	10	-	50 x 50 x 5	2500
	1601 - 2000	10	-	50 x 50 x 6	2000

All dimensions in millimeters.

Hangers sizes for round ducts (for horizontal ducts)

Nominal Diameter	Steel Rod	Steel Strap Dimension s	Max. Spacing Low Press. Ducts		Medium and High Press. Ducts	
			Rect.	Spiral	Rect.	Spiral
Up to 200	10	25 x 3	2000	3000	1800	3000
201 - 450	10	25 x 3	2500	3500	2500	3500
451 - 800	10	25 x 3	2500	3500	2500	3500
801 - 1200	10	25 x 3	2500	3500	2500	3500

All dimensions in millimetres.

#### 24.13. BRANCH DUCT AND OUTLET SPIGOT TAKE-OFFS

Contractors are to make use of the clinch lock detailed in the accompanying standard drawing no. STD 24 when securing branch ducts or spigots or collars to main ducts.

As an alternative the branch duct, spigot or collar may be attached to the main duct by means of a turned over flange plus a 1,6 mm galvanized sheetmetal flange, sealed and pop-riveted every 150 mm. Refer to standard drawing no. STD 24. No other method of fixing will be permitted unless approved by the Consulting Engineer. These methods will be strictly adhered to.

Ceiling diffuser spigots are to be installed as indicated on the standard drawing no. STD 24 only when there is a false ceiling. When there is no false ceiling the method indicated for branch ducts shall be used. Whatever method is used, the Contractor is to ensure that no fibre-glass ends are exposed to the air stream. If he needs to seal off the fibre-glass, he shall use linen tape and recommended duct sealer or "Foster Seal" or any other approved sealer.

#### 24.14. AIR FLOW BALANCING



Air quantity measurements in main and branch ducts shall be performed by pitot tube, traverse of the entire cross sectional area of the duct. Ducts having velocities of 5 or more meters per second shall be measured by inclined manometers (draft gauge) or magnehelic gauges. Openings in ducts for pitot tube insertion shall be sealed with snap-in plugs after air balance is complete. Outlet and inlet air quantities shall be determined by direct reading anemometers in accordance with outlet and inlet manufacturer's recommendation.

Corrected total air quantities shall be obtained by adjustment of fan speeds. Branch duct air quantities shall be adjusted by volume dampers where called for in the supplementary specification. Dampers shall be permanently marked after air balancing has been completed so that they can be returned to their correct position if disturbed at any time. All dampers are to be clearly marked to indicate their open and closed positions.

Volume adjusters may be used to balance air quantities at outlets and inlets provided that final adjustments do not produce sound levels in excess of heretofore specified limits, or objectional drafts. **NB:** Air quantity adjustments by outlets, deflectors, grids or air scoops will not be permitted.

All flow systems shall be adjusted and balanced so that air quantities at outlets are as specified and the distribution from supply outlets do not cause drafts and the air flow is uniform over the face of each outlet.

Total diffuser volume for low pressure duct systems, measured by means of an anemometer, shall be at least 95% of actual fan supply (measured by means of a duct traverse taken with a pitot tube and water manometer).

## **25. DUCT INSULATION**

### **25.1. GENERAL**

Internal insulation shall comply with SANS 1238 and external insulation shall comply with SANS 10173.

All portions of the ductwork that are intended to be insulated shall be completely lined with the insulating material.

### **25.2. CUTTING AND JOINTING**

All joints in insulating material shall be neatly butted and sealed and, except where portions of ductwork are not intended to be insulated, there shall be no interruptions or gaps.

Rigid insulating material shall be cut and fitted to ensure tight, overlapped longitudinal joints, the top pieces being supported by the side pieces and the side pieces by the bottom pieces.

Transverse joints in insulating material shall be formed as follows:

- (a) Each transverse joint of insulating material at a duct joint shall have a metal nosing of not less than one (1.0) mm thick.
- (b) Each transverse joint in insulating material other than at the joints referred to in (a) above shall be covered with a sealing membrane.

### **25.3. EXTERNAL LOW DENSITY INSULATION (Use on ducting elsewhere than Plantrooms)**

Low density insulation shall be aluminium foil faced fibreglass insulation of a density not less than 36 kg/m<sup>3</sup> and a thickness of 25mm.

Insulation shall be secured to the ducts with an approved fireproof adhesive. The insulation shall either be spirally wound onto the ducts, or alternatively shall be applied in blanket form. The insulation shall further be strapped on using 12 mm wide nylon strapping applied with the appropriate strapping and joining machine.

Joints and laps of cooling ducts shall be vapour sealed, using vapour-barrier compound, impermeable tape, or strips of vapour-barrier material and adhesive. The tape to be used shall be "Arno Aluminium Foil Ducotape no. C 430" as supplied by Messrs "Europair" or other approved.

Insulation for hot ducts does not require a vapour barrier except in the event where ducts are used for alternate heating and cooling.

Blue and red adhesive tape shall be used for cold and hot air ducts respectively.

## **26. FILTERS**

### **26.1. PRIMARY FILTERS**

The primary filters shall be where specified or show on drawing be fitted either held into galvanised frames with clips and sealing gasket or mounted into slides and situated upstream of the fan. The filter frames shall be flashed to the casing to prevent unfiltered air bypassing the filter bank.

Filters shall be selected to produce a face velocity of not more than 2.5m/s and shall comply with EN 779 Class G4.

Each filter shall have an average arrestance of 90% and a dust holding capacity of at least 650g/m<sup>2</sup> face area.

The primary filters shall be washable and of the "Trox" series or other approved.

## **27. DAMPERS**

Dampers shall be sized at a maximum face velocity of 6m/s and shall be fitted with meze flange on the duct connection side. Damper blades shall be airfoil profiled aluminium operated with gears to provide an opposed blade action. Manual dampers shall have sturdy locking quadrants and dampers to be motorised shall have suitable extended shafts.

### **27.1. CYLINDRICAL AIR FLOW RATE BALANCING DAMPERS**

The dampers shall be used to adjust air volume flow rates and pressures and shall be of circular design. Air flow adjustment shall be done via a manual control knob with positive locking click stop system (2° increment adjustments). No tools shall be required for the adjustment setting. The casing and blade shall be manufactured from galvanised sheet metal. The adjusting device and bearings shall be made from plastic PPE, with fire protection rating (UL 94V-0)

## **28. ELECTRICAL EQUIPMENT AND WIRING**

### **28.1. SCOPE OF WORK**

This tender shall include for the supply points and all other cabling, conduits, cable racks, trays, switchgear, panels, distribution boards etc, necessary for the satisfactory operation of every part of the installation.

A 220V/380V electrical isolator shall be provided within one metre of the unit in the positions shown on the drawing. The electrical connections from the isolator to the air conditioner as well as all interconnecting wiring between indoor and outdoor units form part of this specification.

The onus lies with the air conditioning Contractor to ensure that the electrical power point provided complies with the position and requirements of the air conditioning manufacturer.

All wiring (power and control) shall be PVC insulated twisted pair overall screen 1,25mm diameter polythene sheathed cable.

No surface wiring shall be allowed and all wiring shall be installed inside the partition walls and above ceilings inside conduit or on cable racks.

As part of the contract, the Contractor shall connect the unit(s) to the isolator(s) to the control panel to the on/off switch and in the distribution board provided by others.

Each room's air conditioning system shall be controlled from the thermostat controller. The final position of the thermostat controller shall be determined on site. The contractor shall be responsible to ensure that the conduit system is installed in due time without any delays to the contract. The installation of the conduits shall be done by others.

As part of the contract, the Contractor shall connect the supply and extract fans to the isolator(s). The electrical conduits, etc for the operation of the lights and fans inside the toilets shall be done by others.

### **28.2. WIRING IN CONDUIT**

Conduit and conduit accessories exposed to weather condition will be of the Bossal type or other approved, otherwise conduit and conduit accessories shall be of the UPVC type. No joints shall be allowed and all looping must be done through approved connectors at fitting points.

The live phase shall be connected at the switching point. All wiring in conduit shall conform to the requirements of Table 4 of SANS 10142 as amended. Not more than one conduit shall be accommodated in one circuit unless special permission is obtained from the Engineer. Before any wires are drawn into the conduit, a swab is to be drawn through to clear any water, dirt etc.

### **28.3. ELECTRICAL WIRING**

The electrical equipment and installation shall conform fully to the requirements of the Occupational Health and Safety Act No. 85 of 1993 and amendments thereof, and shall also be in accordance with the South African Bureau of Standards Code of Practice for the Wiring of Premises and amendments thereof (SANS 10142) as amended.

Conduit to be installed under plaster finish shall be installed in good time so as not to delay the Building Contractor or cause finished plaster to be chased.

All electrical cables shall be fastened to cable racks shall be laid in cable ducts. Cables carried in racks shall as far as possible be laid parallel and shall be neatly installed.

Descents shall be firmly secured with provision for the swinging of flexible tubing or cables where attached to moving machines and electrical motors.

Sizes of conduit, conductors and cables shall be at least equal to those laid down in the relevant tables of the Code of Practice.

Flexible conduit and cables shall be provided wherever it is necessary to avoid transmission of vibration. No joints in cables or wires will be permitted in a conduit. The ends of cables shall be properly made off. Terminal lugs shall be used wherever special clamp-washers or sleeve terminals are not provided on equipment. Conductor strands may not be cut away or reduced in size, and care must be taken to select switchgear, etc., with terminals of adequate size for looping, etc., where necessary.

No open wiring will be permitted at any point in the system, with the exception of the copper bus-bars in the switchgear boards. These shall be taped up with PVC tape with the relevant phase colours.

## **29. SYSTEM CONTROL DESCRIPTION**

All areas shall be air-conditioned with split unit systems, with varying indoor units. (ie. Ducted or Mid-wall)

The temperature to the indoor units will be controlled through a wall mounted controllers.