

P3589 SANSA, MATJIESFONTEIN**HVAC TENDER DOCUMENT****DOCUMENT CONTROL**

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SECTION 1: SCOPE OF WORK

This subcontract will include the supply, installation, testing, commissioning and guarantee of the air-conditioning and ventilation systems for the new office development, Matjiesfontein, Western Cape.

All measurements for pricing purposes are to be taken from the attached drawings and are to be correlated with the Pricing Summary sheet.

General description of the air-conditioning and mechanical ventilation is as follows:

- New Development which consists of the following areas:
 - **Gate House**
 - **Generator Room**
 - **Ablutions**
 - **Offices**
 - **Boardrooms**
 - **Auditorium**
 - **Sleeping Pods**
 - **Equipment Rooms/Data Halls**
 - **Workshops**
- All areas will be mechanically ventilated in accordance with the SANS 10400-0-2011 Edition 3 statutory requirements.
- AC to the offices and general areas will be supplied via DX split units (ducted hide-away units/ Cassette units/ Midwall units). The indoor units are interconnected to the remote condensing unit via refrigeration piping and field wiring, the piping and field wiring to be housed in wire mesh cable trays. Duty/Standby controls to be allowed for in areas where indicated. Units to automatically switch between duty and standby without any interruptions - controls to allow for this. All indoor equipment selections must be based on on-coil of 24°C DB / 17.1°C WB and meet the sensible load requirements.
- NASA equipment room temperature to be maintained between 18°C -23°C DB with humidity range between 45-55% RH. CRAC unit configuration to allow for N+1 control and equal run time between units. CRAC units to be selected with on-board dehumidification and humidification control. CRAC units to be compatible with external ATS (provided by site electrician).
- SANSA equipment room and NOC temperature to be maintained between 18°C -23°C DB with humidity range between 45-55% RH. CRAC unit configuration to allow for N+1 control and equal run time between units. CRAC units to be selected with on-board dehumidification and humidification control. CRAC units to be compatible with external ATS (provided by site electrician).

SECTION 2: CONDITIONS OF TENDER

2.1. ISSUE OF TENDER DOCUMENTS

Before the submission of any tender, the Tenderer shall check the documents issued and the number of pages contained in each document and if any are found to be missing or duplicated or any figure or writing indistinct, or if the Schedule of Quantities or Schedule of Rates contains any obvious errors, the Tenderer shall apply to the Engineer at once to have the same rectified, as no liability will be admitted by the Employer or the Engineer in respect of errors in any tender arising out of any matter referred to in this paragraph.

The Principal Building Agreement and the Preliminaries applicable to the Principal Contract are available for inspection at the offices of the Consulting Engineer, Quantity Surveyor or the Principal Agent.

It is hereby deemed that the Tenderer shall have carried out a full and detailed inspection of all the drawings and tender documents and shall have inspected the Site prior to the submission of a tender for the project. By submitting a tender, the Tenderer shall be deemed to be fully informed as to the nature and degree of complexity of the project, the constructional problems related thereto, the conditions under which the work is to be carried out, the means of access to the Site and generally of all matters which may influence his Tender.

No claim of any nature whatsoever will be considered after the submission of tenders, due to failure on the part of the Tenderer to fulfil this obligation.

2.2. CURRENCY

All prices must be quoted in South African Rands. Black ink shall be used in all cases.

2.3. TENDER ALL-INCLUSIVE

The Tenderer shall allow in the tender full compensation for all labour, material, small tools, construction plant, temporary works, taxes, levies and everything else necessary for the execution and completion of the works in accordance with the tender documents.

2.4. TENDER FORM

The tender shall be signed and witnessed on the tender form incorporated herein. Unit rates and amounts shall be entered against each item of work given in the schedule of quantities and it shall be fully priced and totalled to show the tender sum and the summary thereof shall be signed.

Project penalty clauses will be determined by the Developer during final contract negotiations.

2.6. TENDER QUALIFICATION

Tenders shall be submitted strictly in accordance with the tender documents. Any point of doubt or difficulty should be cleared with the Engineer as early as possible during the tender period. Should any query be found to be of significance, all Tenderers will be informed accordingly by the Engineer as early as possible.

The tender sum shall not be conditional on the award of or performance on other contracts.

2.7. ALTERNATIVE TENDERS

If, in addition, the Tenderer desires to submit for consideration any alternative method of construction, time for completion or any other variation or possible saving, separate tender forms, schedules of quantities and/or a statement should accompany the tender setting out the salient features of the alternative or variation proposed.

No alternative tender will be considered unless a tender without any qualifications and strictly on the basis of the Tender Documents is also submitted.

Where it is desired to submit an alternative tender involving modifications to design or qualifications of the tender documents, the following procedure must be observed:

- (i) It shall be accompanied by supporting information, drawings, calculations and a priced alternative schedule of quantities to enable its technical acceptability, construction time and price to be fully assessed.
- (ii) When a qualified tender is submitted, it shall be made in the form of an alternative offer, showing the financial or other implications of the qualification(s) on the unqualified tender.
- (iii) Any alternative tender involving modifications to design will be assessed on its merits and may be accepted. An accepted alternative design will become the design for the purpose of the contract.
- (iv) A decision whether or not to adopt a technically acceptable modified design will be governed by the amount of the overall saving which the modified design can be reliably expected to achieve. Matters to be considered in arriving at the overall saving will include the effect of any deferment in starting date arising from extra time needed for the preparation of an amended Contract for signature.

2.8. AUTHORITY FOR SIGNATORY

The tender, if by an individual, must be signed by that individual or by someone on his behalf duly authorised thereto and proof of such authority must be submitted with the tender. If the tender is by a company, it must be signed by a person or persons duly authorised thereto by a Resolution of the Board of Directors, a copy of which, duly authorised by the Secretary of the Company, shall be submitted with the tender.

2.9. SUBMISSION OF TENDERS

Tenders shall be submitted via email.

Each tenderer is required to return the complete set of tender documents with all the required information and complete in all respects.

Tenderers shall not tamper with the tender documents which shall be submitted as issued. Any tender document found to have been unbound and rebound or tampered with could be deemed to be unacceptable.

Tenders which are not endorsed in the prescribed manner and/or received after the closing date and time for the receipt of tenders, will not be considered.

All tenders shall be submitted and shall be clearly marked:

“SANSA – HVAC INSTALLATION”

It is the responsibility of the tenderer to ensure delivery and receipt of email tenders.

The Tender opening will be closed event and not take place in public.

2.10. TENDER WITHDRAWAL OR MODIFICATION PRIOR TO CLOSING DATE

Any Tenderer has the right to withdraw, modify, or correct his Tender after it has been delivered, provided that the request for such a withdrawal, modification, or correction, together with full details of such modification or correction, is received at the address for submission of Tender in writing or by telegram before the time set for delivery of Tenders.

The original Tender as amended by such written communication will be considered as the Tenderer's offer.

2.11. TENDER WITHDRAWAL OR MODIFICATION AFTER CLOSING DATE

- (i) The Engineer may ask any Tenderer for a clarification of this Tender or to amend or adjust imbalanced tendered rates in accordance with clause 2.13 hereafter. Nevertheless, no Tenderer will be permitted to alter his Tender Price after the Tenders have been opened. However, clarifications which do not change the Tender Price may be accepted.
- (ii) Tenders shall remain valid for a period of thirty (30) days from the time set for opening of the Tenders and no tender may be withdrawn during this period unless the Engineer informs the Tenderer in writing before the end of this period that his tender is not accepted.
- (iii) Should a Tenderer amend or withdraw his Tender after the time set for the receipt of the Tenders and during the period of its validity, but prior to his being notified of the acceptance of this original Tender, or should a Tenderer after having been notified that his Tender has been accepted,
 - (a) give notice of his inability to execute the Subcontract in terms of this Tender; or
 - (b) fail to sign a contract; or
 - (c) fail to execute the contract according to the contract documents.

he shall pay either the difference between his Tender and a less favourable Tender accepted in terms of the provisions of sub-clause 2.11.(4) below, or, if the Engineer decides to invite fresh Tenders, he shall pay all additional expenses which the Engineer will have to incur in this regard, as well as any difference between his Tender and the accepted new Tender; provided that the Employer may fully or partly exempt a Tenderer from the provisions of this condition if he is of the opinion that the circumstances justify the exemption.

- (iv) When, in the circumstances mentioned in sub-clause 2.11. (3) above, it is not deemed desirable to invite fresh tenders, the Employer may accept another tender from those already received.

2.12 ADDITIONAL INFORMATION GIVEN OR REQUIRED

Only information given formally in writing to Tenderers by the Engineer during the tender period will be regarded as binding on the Subcontract. Verbal information, given during the tender meeting or at any other time prior to the award of the Subcontract, will not be regarded as binding on the Subcontract.

The Tenderer shall submit with his Tender the information, data design calculations and drawings as applicable as may be required in terms of the certificates, schedules, and forms to be completed by

the Tenderer, special conditions of contract and/or project specification contained in these contract documents. The Engineer reserves the right, in the event of such details being insufficient, to call for further information. The Tenderer shall furnish such additional information within seven (7) days of such a call for further information.

The Tenderer shall make full allowance in the relevant scheduled rates for all costs in connection with the preparation of designs and drawings, and furnishing of the necessary information that may be required by the Engineer.

All written information submitted by the Tenderer, together with and in support of his Tender, shall be considered to form the basis on which the Tender has been prepared and submitted.

2.13. AMENDMENTS TO TENDER BY EMPLOYER

2.13.1 Arithmetic errors

The Engineer reserves the right to correct arithmetical or other errors in the extension of rates and totals in the Tender. In no case will tendered rates be adjusted when correcting such errors.

2.13.2 Imbalance in quoted rates

In the event of there being any rate which are declared to be unacceptable by the Engineer for reasons which the Engineer will indicate, the Tenderer will, in terms of clause 2.12 above, be requested to

- (a) justify any specific rates, i.e. to give a financial breakdown of how such rate or rates were obtained, and subsequently to
- (b) consider amending and adjusting such rate or rates while retaining the tender sum derived under clause 2.13.1 unchanged and fixed. It must be understood that in the event of the Tenderer refusing to adjust any rate or rates to the satisfaction of the Engineer, such refusal may prejudice his tender.

2.14. ACCEPTANCE OR REJECTION OF TENDERS

The tender of any Tenderer may be rejected if it does not conform to these conditions of tender and show any additional items not originally included in the tender documents, conditional or incomplete offers, irregularities of any kind in either the tender form or the priced schedule of quantities, or if the rates and amounts tendered in the schedule are obviously unbalanced and the Tenderer, after being called upon to adjust same in a reasonable manner, fails to do so within a period of seven (7) days after receiving notification to that effect.

The Engineer does not bind itself to accept the lowest or any tender and reserves to itself the right to accept the whole or any part of a tender as it may deem expedient, nor will it assign any reason for the acceptance or rejection of any tender, be it the whole or part of the tender.

2.15. PROPOSED CONSTRUCTION PROGRAMME

The contract period for completing the whole of the Works will be as per the principal contract programme as submitted by the principal contractor.

2.16. EXPENSES

The Employer will not be responsible for or pay for expenses or losses which may be incurred by any Tenderer in the preparation of this Tender or in visiting the site in connection therewith.

2.17. PRICE VARIATIONS

The value of certificates issued shall not be increased or decreased by applying a “Contract Price Adjustment Factor”.

2.18. HEALTH AND SAFETY

Tenderers are to note the requirements of the Occupational Health and Safety Act pertaining to South Africa and the corresponding Construction Regulations. The Tenderer shall be deemed to have read and fully understood the requirements of the above Act and Regulations and to have allowed for all costs in compliance therewith.

2.19. QUERIES

All queries regarding this tender shall be referred to Alex Meyer and Lucille Grové at Ekcon (Pty) Ltd, telephone no +27 21 930 9360, Alex@ekcon.co.za and Lucille@ekcon.co.za

SECTION NO. 3: AC & VENTILATION

2.1 STANDARD SPECIFICATION

2.1.1 AC & VENTILATION

This specification is to be read in conjunction with the Standard Specifications which can be found in Annex A.

The following list of specifications, publications and codes of practice shall be read in conjunction with the supplementary specifications.

- Occupational Health and Safety Acts and Regulations
- SABS 10400 – The application of the National Building Regulations (1990)**

** Not issued with this document, but available at the contractor's expense from the SA Bureau of Standards, Private Bag X191, Pretoria, 0001.

2.2 PROJECT SPECIFICATION

2.2.1 FINISHING AND TIDYING

Progressive finishing and tidying will form an essential part of this contract. On no account must spoil, rubble, materials, equipment or unfinished operations be allowed to accumulate in such a manner as to unnecessarily impede the activities of other people in the building. In the Event of this occurring, the employer shall have the right to withhold payment for as long as may be necessary in respect of the relevant works in the area concerned.

All finishing and tidying shall be carried out to the best advantage of the project as a whole and in the closest co-operation with other contractors on a daily basis.

2.2.2 SCAFFOLDING AND PLANT

All plant required for the execution of the contract shall be supplied by the AC Contractor.

The AC Contractor shall provide his own scaffolding. For installation purposes the tenderer shall allow for his own lifting equipment, cranes, etc which may be necessary to complete the installation as none of these facilities will be available on site.

2.2.3 QUALITY OF MATERIAL

All material where not explicitly specified, shall comply with the applicable South African Bureau of Standards Specification.

2.2.4 BUILDING WORK

Building work required for this installation will be done by the Builder. All building work requirements and plant room details shall be supplied by the Mechanical Subcontractor timeously to allow the Builder sufficient time to perform the work. It is the responsibility of the mechanical subcontractor to liaise with the Builder in this regard.

2.2.5 SUPERVISION AND IDENTIFICATION

At all times while on the premises, all artisans and labourer members of the Contractor's staff shall wear clothing adequately marked with the Contractor's name or acceptable identification.

The work shall be done by or at all times be under the personal supervision of a qualified artisan (or qualified technician) in the respective trade.

2.2.6 SUBMISSION AND APPROVAL OF DRAWINGS

The Contractor shall prepare working drawings of all the equipment of the installation. Drawings shall be submitted to the Engineer for approval before manufacturing commences. It is the Contractor's responsibility to co-ordinate all dimensions on his work drawings with that of the specific equipment being installed.

All drawings shall be prepared on a CAD system, and submitted to the Engineer in DWG format.

3.2.7 UNIT/FAN REQUIREMENTS

All air conditioning unit and fan requirements shall be as indicated on the drawings.

All units are to be controlled by wall-mounted controllers.

3.2.8 CONDENSATE

The A/C Contractor is to allow for all uPVC condensate lines within 1m of the AC unit. The plumber is to reticulate from there. All condensate lines are to be trapped.

2.2.9 ELECTRICAL

The AC contractor is to provide power to all the AC and ventilation equipment specified under this contract. The electrical contractor shall provide a cable to terminate at the mechanical equipment electrical DB and equipment isolators.

Local isolators shall be provided by the electrical contractor within 1,5m from all mechanical equipment where DB boards are not provided. Final connections between the isolator and the units are to be carried out by the mechanical contractor.

2.2.10 PAYMENT CERTIFICATES

Payment Certificates will be issued at the frequency as shown in the Conditions of Contract.

2.2.11 RECORD OF DRAWINGS

On completion of the installation but before the plant is handed over to the employer, the Contractor shall provide on CAD the as-built revisions of the tender drawings.

The drawings shall be sufficient in detail to enable the employer's staff to maintain, dismantle, reassemble and adjust any parts of the works.

2.2.12 MAINTENANCE AND GUARANTEE

It is part of the tender requirements that the Contractor shall guarantee the plant and equipment to be supplied and installed by him under this contract.

The whole of the works carried out and the plant, equipment and materials supplied and installed by the Contractor shall be guaranteed unconditionally in all respect for a period of twelve calendar months commencing on the issue date of the completion certificates for the Installation.

If during the said guarantee period any plant, equipment and materials are considered to be objectionable or prove faulty or inefficient, then the Contractor shall remove and/or make good free of charge such objectionable, faulty or inefficient equipment as directed in writing by the Engineer. Any plant, equipment and materials thus replaced or made good under this clause shall be guaranteed for a further period of twelve months from the date of replacement or making good, which date shall be certified in writing by the Engineer.

During the guarantee period, the Contractor shall maintain and keep in perfect order, repair and clean the Installation.

The Contractor is responsible for material and labour during the twelve month maintenance period.

The contractor shall include in his operating and maintenance manuals a register, to be filled in at every service, and counter signed by the Building Manager after every service.

2.2.13 OPERATING AND MAINTENANCE MANUALS

General

The Contractor shall submit to the Engineer for approval, two weeks before completion of the installation, one copy of the updated maintenance and operating manuals for the plant and materials supplied.

The Engineer will return to the Contractor, within three working days of their receipt by him, a copy marked with any changes which are necessary.

The Contractor shall modify the manuals as required by the Engineer. On completion of the installation, and on the day of handing over the installation to the Employer, the Contractor shall provide three copies of the final operating and maintenance manuals for the plant and materials supplied. These manuals shall be bound in book form with hard plastic covers to withstand constant use and 3 soft copies are to be provided.

All manuals shall be properly indexed to facilitate easy reference.

Contents of manuals

The manuals shall include:

- A general description of the plant.
- A list of recommended servicing tools and specialist equipment.
- Exploded drawings or detailed spares list from which every item of every piece of equipment can be positively identified for ordering replacements.
- A list giving the name and address of the local agent for each item of equipment.
- A list giving the name and address of the manufacturer of each item of equipment.
- A copy of all test certificates obtained with the plant.
- A preventative maintenance programme for all equipment, broken down into monthly, bi-monthly, quarterly and annual services, with detailed service, items on all equipment for each service.
- Operating instructions for each item of equipment.
- A description of the plant control systems.
- Performance data and/or characteristic curves.
- As-built drawings of the installation.
- Commissioning data.

2.2.14 SPECIFICATION FOR TESTING AND COMMISSIONING

General

All equipment and systems shall be tested in the presence of the Engineer or his representative. At the discretion of the Engineer parts of the system or systems may be tested, but testing as a complete unit is compulsory.

Testing and Commissioning Programme

The Contractor shall submit, at least one week before commencing any testing and commissioning a complete programme for such work for approval by the Engineer.

The programme shall include:

- (a) A bar chart covering all activities;
- (b) Names and addresses of companies involved in each activity;
- (c) The way in which each test will be carried out complete with pro forma forms for tabulating results

Plant and Materials testing and commissioning procedure

The Contractor shall submit, at least one week before commencing any testing and commissioning a complete program for such work for approval by the Engineer.

2.2.15 CONDITIONS ON SITE

Location	:	Matjiesfontein
Altitude	:	972m
Outside summer conditions (Max)	:	38°C dB / 22°C WB
Outside winter conditions (Min)	:	1.0°C dB
Inside conditions	:	22°C dB \pm 1.5°C unless stated otherwise 50% RH \pm 10% RH
On Coil	:	24°C dB / 50% RH
Sound level (Max) inside (except otherwise specified)	:	NC 40
Outside of property boundary	:	
day time	:	50 dBA
night time	:	40 dBA

Air-cooled equipment selection shall be based on an ambient air temperature of 40°C dB

2.2.16 DUCT WORK

All ductwork shall be supplied and installed as indicated on the drawings. The ductwork shall comply with the requirements of low-pressure ductwork as specified in Part 18 of the Standard Specifications (to be provided upon request)

All supply air ducting within the building where ceiling are installed, shall be externally insulated in accordance with Part 36 of the Standard Specifications (to be provided upon request).

All the dimensions shown on drawings are clear internal dimensions.

All diffusers, grilles and louvers, etc. shall be supplied and installed as indicated on the drawings.

All flexible connections shall be taped with duct tape, as well as strapped with steel straps.

All duct joints shall be canvas sealed.

2.2.17 VENTILATION SYSTEMS

Fans shall be supplied and installed as indicated on the drawings.

Fans shall be installed on anti-vibration mountings and connected to the ducting via flexible canvas connections on both sides, to eliminate vibration transfer to the structure of the building.

The performance requirements of the fans, as well as the method of switching, are specified on the drawings and schedules.

All fresh air introduced into the building as well as mixed return air on the air handling units will be filtered by high efficiency duplex panel filters with a dust holding capacity of 550g and an arrestance value of 92%, unless otherwise stated on the drawings.

All fresh air and exhaust fans will be switched from a 7day/24hr timer in the distribution boards supplied by the Site Electrician as part of the main building contract.

2.2.18 GENERAL SPECIFICATION OF VRV AND DX SPLIT AIR-CONDITIONING INVERTER TYPE (VRV N/A FOR THIS PROJECT)

General

The air conditioning system shall be an air cooled, split type multi heat recovery system consisting of multiple outdoor units and multiple indoor units per zone, each unit or groups of units having capability to control heating or cooling independently to suit the requirements of the building.

The equipment supplied and installed shall conform to the building design requirements without limitations. The equipment offered shall be suitable for the application without compromising the equipment performance and to be in accordance with the design duties given on the equipment schedules on the respective drawings.

The refrigeration compressor in the outdoor unit shall be equipped with inverter controller and capable of changing the rotating speed to follow variations in cooling or heating load based on the temperature set point.

The indoor unit, air handling units shall be wall-mounted type.

The refrigerant used shall be R410A. The refrigerant piping shall be capable of being extended up to 150m with a 50m level difference without any oil traps.

The system shall be capable of operating continuously at ambient temperatures between -5°C and 40°C.

Both indoor and outdoor units shall be assembled, tested, and charged with refrigerant at the factory.

Outdoor Units

The outdoor units shall be factory-assembled units housed in sturdy weatherproof casings constructed from rustproofed galvanised steel panels coated with a baked epoxy powder finish.

The units shall each have a minimum of two scroll compressors and be able to operate even when one of the compressors is out of order.

The noise level shall not be more than 55 dB(A) at normal operation measured horizontally 1m away and 1,5m above ground.

The compressor shall be of highly efficient hermetic scroll type and equipped with inverter control capable of changing the speed in accordance to the cooling or heating load requirement.

The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminium fins to form a cross fin coil. The aluminium fins shall be covered by anti-corrosion resin film.

The refrigerant circuit shall include liquid and gas shut off valves and a solenoid valves. All necessary safety devices shall be provided to ensure the safety operation of the system. The following safety devices shall be part of the outdoor unit:

High Pressure Switch, Overload Relay, inverter Overload Protector, Fusible Plugs.

The unit shall be equipped with an oil recovery system to ensure stable operation with long refrigerant piping runs.

Indoor Units

Indoor units shall be of the wall mounted type. They shall have electronic control valves, which control refrigerant flow rate in response to load variations of the room. The fans shall be of the multi blade type and 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, In case of centralized control, it shall be set by liquid crystal remote controller.

Control

Wired remote type computerized PID controllers shall be used to maintain correct room temperatures and interrogate the system log.

Units shall be equipped with a self-diagnostic and logging system for easy and quick maintenance and service.

The LCD (Liquid Crystal Display) remote controllers shall memorize the latest malfunction code for easy maintenance, It shall be able of controlling up to 16 indoor units and change fan speeds individually in the group.

Refrigerant Piping

Refrigeration piping shall be carried out in seamless copper tubing. All piping shall be kept properly sealed against moisture and dirt at all times. Bends in soft drawn material shall be made with long radius using proper tools. If hard drawn piping material is used then only long radius brazed bends may be used.

The piping shall be correctly sized using the equipment manufacturer's method or software. The additional refrigerant charge shall be accurately calculated by the same method. The maximum pipe lengths shall be adhered to.

All branch connections shall be by means of “refnet” depending on the brand and make of units, type joints with moulded insulation as supplied by the air conditioning equipment manufacturer. The joints shall be installed with the connections on a horizontal plane or with the direction of flow in a vertical plane.

Only synthetic oil compatible with the refrigerant shall be used shall be used to lubricate any cutting, reaming and flaring tools.

Only phosphor copper brazing rods shall be used without any flux on the piping joints. The pipework shall be continuously purged with low pressure nitrogen during all brazing operations.

Simple purging of the refrigerant lines between the indoor and outdoor sections is not acceptable. The lines shall be correctly pressure tested with nitrogen plus a small amount of refrigerant to 3.8 MPa for R410A and left for 24 hours to ensure pressure does not drop. The piping shall then be purged using a vacuum pump to –100 kPa (for more than 2 hours) and ensure that it holds this vacuum for 1 hour to the satisfaction of the engineer. The system shall then be charged in the liquid state with the calculated amount of additional refrigerant by using an accurate charging scale (charging cylinder cannot be used). Only once the system is correctly charged shall the refrigerant valves on the outdoor units be opened.

The pipework arrangement for multiple outdoor units shall be correctly arranged to meet the equipment manufacturer’s requirement. On multiple outdoor units an insulated oil equalisation line shall be installed between the units.

All piping shall be supported at regular intervals from the structure by means of unistrut, saddles and straps or mounted on galvanised cable tray supported on galvanised unistrut brackets. The contractor shall allow for neat coring of holes through the structure where necessary for the passage of refrigeration and drainpipes.

The liquid and suction gas pipes shall be separately insulated with Armaflex or equal and approved closed cell insulation and the fittings wrapped in non-drip tape to provide a neat appearance. The wall thickness of the insulation shall be as follows:

PIPE DIA (mm)	WALL THICKNESS (mm)
6.34 (1/4)	9
6.34 (1/4)	9
13.7 (1/2)	13
15.88 (5/8)	13
19.05 (3/4)	19

Preliminary Testing

The Contractor shall allow for preliminary commissioning of the VRV system by the equipment manufacturer’s authorised representative.

After charging the system with additional refrigerant as detailed above electrical power to all indoor and outdoor units shall be switched on. Power shall be supplied to the outdoor units for at least 9 hours prior to running the initial test.

The equipment test sequence shall be run, and action taken to correct any errors, which are shown on the remote controller.

Each piece of equipment individually and each completed system as a whole shall be correctly adjusted as required to give satisfactory performance. Control systems shall be adjusted and placed in operation.

2.2.19 PROJECT SPECIFIC

The following is to be noted as project specific:

- Blu-chem treatment to be allowed for on the condenser's coils.
- Preferred suppliers for DX inverter split systems are Daikin or Samsung.
- Preferred suppliers for DX CRAC units are Intramech, Sturlz or Carrier.

SECTION 4: PRICING SUMMARY

ANNEXURE A: STANDARD SPECIFICATIONS

LIST OF STANDARD SPECIFICATIONS

- PART 11: STANDARD SPECIFICATION FOR AIR FILTERS
- PART 13: STANDARD SPECIFICATION FOR PAINTING
- PART 14: STANDARD SPECIFICATION FOR ROOM AIR CONDITIONING UNITS
- PART 15: STANDARD SPECIFICATION FOR NOISE AND VIBRATION
- PART 17: STANDARD SPECIFICATION SOUND ATTENUATORS
- PART 18: STANDARD SPECIFICATION FOR AIR DUCTS
- PART 19: STANDARD SPECIFICATION FOR HEATING AND COOLING COILS
- PART 21: STANDARD TECHNICAL SPECIFICATION FOR FANS
- PART 27: STANDARD SPECIFICATION FOR TESTING AND COMMISSIONING
- PART 32: STANDARD SPECIFICATION FOR FIRE DAMPERS
- PART 35: STANDARD SPECIFICATION FOR VENTILATION EXTRACTION SYSTEMS
- PART 36: STANDARD SPECIFICATION FOR THERMAL INSULATION
- PART 39: STANDARD SPECIFICATION FOR DRAWINGS AND OPERATING INSTRUCTIONS

PART 11: STANDARD SPECIFICATION FOR AIR FILTERS

1 GENERAL

- 1.1 Only those filter units shall be acceptable which the N/S Subcontractor can show to the satisfaction of the Mechanical Engineer that either the filter unit as a whole, or the actual filtering elements, media curtains, cells, holding frames, etc. incorporated in filter units assembled in his own workshop are the standard products of a reputable manufacturer, regularly engaged in the fabrication of the particular type of air filter. If an imported product, the N/S Subcontractor shall be able to prove that such products are well represented in the Republic of South Africa.
- 1.2 Only filters tested by the South African Bureau of Standards to the Ashrae standard 52-68 will be acceptable. Arrestance (gravi-metric), efficiency (photometric), dust holding capacity and resistance against air velocity shall be documented according to the above test.
- 1.3 Frames and filters shall be constructed in such a manner that the passage of unfiltered air is prevented. Gaskets shall be provided between filters and frames and filter frames unit casing.
- 1.4 Each filter bank shall be supplied with an identification label stating the type of filters, quantity of filter elements, model numbers and all other information necessary for reordering filter material.
- 1.5 Filters shall be adequately protected against dirt during construction and shall not be operated until the system is thoroughly cleaned. Filters must be put in regular operating condition before the fans which they connect are operated for any purpose.
- 1.6 A manometer shall be installed on each filter bank. The gauge will indicate correctly the resistance to airflow of the filter. The full scale reading of the manometer shall be between 30 and 60 percent higher than the change-out pressure of the filters.
- 1.7 Filter dimensions shall be selected to suit the configuration of the air handling unit.
- 1.8 All filter accessories including the filter holding frames and clips shall be standard products of the filter manufacturer.
- 1.9 All metal parts shall be sufficiently protected against corrosion.
- 1.10 All metal parts shall be coated with baked enamel or equivalent paint.

2 PANEL FILTERS

- 2.1 Each filter bank shall consist of a factory made robust sectional steel supporting frame, which shall accommodate the filter cells.
- 2.2 All filter cells on the same project shall have the same dimensions.
- 2.3 Filter cells shall be easily removable from the upstream or downstream side of the filter, and shall be easily washable in the upstream direction.
- 2.4 The filter medium shall be pleated and bonded to the media holding frames.

3 AUTOMATIC ROLL FILTERS

- 3.1 Filters shall be of the automatic renewable medium type, in which a roll of medium is unwound across the airstream by a mechanism controlled by the air pressure drop through the medium.
- 3.2 All factory wiring shall be run in rigid conduit terminating in fittings suitable for the location.
- 3.3 The differential pressure control shall be adjustable to any cut in and cut out pressures from 50 Pa to 150 Pa with a pressure differential from 10 to 20 Pa. Initial adjustment shall be as prescribed by the media manufacturer.
- 3.4 Filters shall be provided with suitable means to stop the travel of the medium when the end of the roll is reached and operate a visual signal on the main switchboard to indicate the need for renewal.
- 3.5 The replaceable filter medium shall be freely available from stocks in the Republic of South Africa in minimum lengths of 15 meters.

4 HEPA FILTERS

- 4.1 Filter frames and retaining mechanisms shall be supplied and installed by the filter manufacturer.
- 4.2 The filter to frame seal shall be a routed fluid seal. The sealing fluid shall be a silicon type, be highly viscous, non-solidifying and shall not support bacteria or bacteria growth. The sealing fluid shall be selected for the particular application.
- 4.3 The filter material shall be water repellent.
- 4.4 The filter shall not be water repellent.
- 4.5 The filter media enclosing frame shall be corrosion protected steel.
- 4.6 The filter media enclosing frame shall be manufactured of wood.
- 4.7 The filter media enclosing frame corner joints shall be lightning joints, glued and either screwed or nailed in both directions.
- 4.8 The complete filter installation shall be leak tested by the filter manufacturer. The leak test shall be either a DOP or sodium flame test.
- 4.9 The filter efficiency of each filter cell shall be tested and certified.

5 GREASE ELIMINATORS

- 5.1 Grease eliminators shall comprise of crimped wire type filter units arranged in a V-formation.
- 5.2 The unit shall be made up of interlocking frames for the individual filter units, or bolted in a common assembly. The ends of the assembly shall be suitably blanked off.
- 5.3 Each pair of filter units shall be provided with a readily removable drip tray.
- 5.4 Filters shall be fitted with suitable handles.
- 5.5 The filter depth shall not be less than 50 mm.

PART 13: STANDARD SPECIFICATION FOR PAINTING

1. SCOPE

This specification covers the requirements for surface preparation and application of paint systems to industrial installations mainly for protective, but also for decorative purposes.

It does not cover painting for marine and other severely corrosive conditions.

2. REFERENCED STANDARDS

The latest edition (including all amendments) of the following standard are referred to in this specification:

IEQ-13 VOC

Green Star: Volatile Organic Compound (VOC) paint performance requirements

SABS 630: Decorative high gloss enamel paint for interior and exterior use

SABS 679: Zinc chromate primers for steel

SABS 681: Undercoats for paints

SABS 801: Epoxy-tar paints

SABS 912: Calcium plumbate primers

SABS 1158: Two-pack epoxy-resin-based primers

SABS 1325: Two-pack epoxy-resin-based solution and solvent-free finishing paints

SIS 05 59 00: Pictorial surface preparation standards for painting steel surfaces

3. GENERAL REQUIREMENTS

- 3.1 The paint manufacturer's instructions shall be strictly adhered to.
- 3.2 Paint shall not be applied over any surface containing traces of grit, grease, oil, loose rust, loose millscale or corrosion products of any kind.
- 3.3 Metal surfaces to which paint is applied shall be dry. Painted surfaces which are to be overcoated shall be hard dry before overcoating.
- 3.4 All traces of soluble salts and corrosive air-borne contaminants shall be thoroughly washed from the surface prior to painting after which the surface shall be dried and painted immediately thereafter.
- 3.5 Air used for blast-cleaning or spraying shall be free from all traces of water and oil.
- 3.6 When blast-cleaning, a satisfactory anchor pattern blast profile shall be achieved. If the abrasive used for blast cleaning is sand, then it shall be free of clay. Alternatively an approved grit shall be used.
- 3.7 Paint shall not be applied within 50 mm of areas which are to be welded.
- 3.8 Welds and adjacent parent metal shall be deslagged, inspected and approved and all spatter shall be removed prior to painting.

- 3.9 The weld area shall be wire brushed and all contaminants shall be removed prior to painting. The weld area shall then be flushed with fresh water and allowed to dry. In the case of rust formation, the weld area shall again be wire brushed.
- 3.10 Contact surfaces of structures which are to rest on concrete or other floors shall receive the full paint system prior to erection.
- 3.11 Areas where the paint coating has been damaged during transportation, erection or otherwise, shall be repaired as follows:
- Rust spots shall be removed by means of a wire brush or emery paper and the surrounding paint, which is still intact, shall be feathered for a distance of 20 mm beyond the damaged area. Spot painting shall consist of all the coats previously applied and shall overlap the undamaged area by 20 mm.
- Where the shop coat has been allowed to age for a few months before painting, it shall be lightly sanded or rubbed with steel wool or scrubbed with sugar soap solution, using a bristle brush. The surface shall then be rinsed with clean water.
- 3.12 Mating or contact surfaces shall be protected from corrosion by ensuring that the two surfaces brought into contact with each other are prepared and primed in accordance with the specification. The primed surfaces shall be brought together while the paint is still wet.
- 3.13 Surfaces which are to be friction bolted shall be prepared in accordance with this specification, but shall receive no paint coating.
- 3.14 Areas which will be inaccessible after erection shall receive the full specified coating system, before erection or assembly.
- 3.15 Steel embedded in concrete shall only be painted to 50 mm below the concrete surface.
- 3.16 Sharp edges and cut ends shall be rounded and shall then receive the specified dry film thickness of paint.
- 3.17 The N/S Subcontractor shall ensure that the final finishing coat obscures the previous coat.
- 3.18 The manufacturer's recommended thinners shall be used for any particular paint.
- 3.19 Primed steelwork, piping etc, which is to be delivered to site shall be stacked on bearers and shall be clear of the ground. Wherever possible channels, angles etc, shall be stacked in such a way that water cannot collect on the steel.
- 3.20 Paint dry film thickness shall be measured using a non-destructive thickness gauge.

4. STEELWORK

All steelwork which is not galvanised, chrome plated or otherwise protected against corrosion shall be given a coat of protective paint at the manufacturer's works and the N/S Subcontractor shall maintain this protective coat until the work is finally painted.

4.1 Surface Preparation

All surfaces shall be thoroughly degreased, wire brushed, sanded or sandblasted with a suitable degreaser, then rinsed with fresh water and allowed to dry. The surface shall then be

wire brushed to move loose rust and loose mill-scale to a St 3 finish to Swedish Standard SIS 05 59 00.

4.2 Shopcoat

Priming: One coat zinc chromate primer to SABS 679, Type I shall be applied to a dry film thickness of 25-35 µm. Only Plascon products are allowed.

4.3 Site Painting

a) Undercoat

One coat of universal undercoat to SABS 681, Type II shall be applied to a dry film thickness of 25-35 µm. Only Plascon products are allowed. Green Star requirement that undercoat is to have a VOC of less than 65 grams/litre.

Undercoat and finishing coat paints shall not be mixed prior to application of the undercoat. Green Star requirement that gloss enamel is to have a VOC of less than 75 grams/litre.

b) Finishing

One coat of high gloss enamel to SABS 630 in the specified colour shall be applied, to a dry film thickness of 25-35 µm. Only Plascon products are allowed.

The total dry film thickness for the coating system shall not be less than 90 µm.

5. CHEQUER-PLATE OR EGG-CRATE FLOORING AND SUPPORTING FRAMES

Chequer plate and egg-crate flooring shall not be delivered to site with a bituminous coating.

Finishing

Three coats of epoxy tar (brown or black) to SABS 801, Type II, shall be applied at a dry film thickness of 70-80 µm per coat. Overcoats shall be applied within a minimum of 16 h and a maximum of 48 h. Green Star requirement that epoxy is to have a VOC of less than 200 grams/litre.

6. MOTORS, GEARBOXES, PUMPS, ETC

6.1 Surface Preparation

The surfaces to be painted shall be abrasive blast cleaned to Grade C Sa 2 1/2 of Swedish Standard SIS 05 59 00.

6.2 Priming

One coat of epoxy primer zinc chromate/iron oxide to SABS 1158, Type II shall be applied to form a uniform coat and to fill all porosities in the castings. Green Star requirement that epoxy primer is to have a VOC of less than 60 grams/litre.

6.3 Undercoat

One coat of chemical resistant epoxy enamel shall be applied in a colour sufficiently different from the finishing coat to make it discernible. Green Star requirement that undercoat is to have a VOC of less than 65 grams/litre.

6.4 Finishing

- a) One coat of chemical resistant epoxy enamel to SABS 1325 Type II in the specified colour shall be applied.
- b) The blast profile for this system shall be more than 75 µm.
- c) If overcoating the primer after two weeks, abrade to a matt surface with 220-350 grit waterproof paper and rinse with fresh water.
- d) Green Star requirement that finishing coat is to have a VOC of less than 65 grams/litre.

7. GALVANISED STEEL

If painting over galvanised steel should be specified for decorative or identification purposes the following procedure shall be followed:

- 7.1 Ensure that the galvanising is clean and that all traces of corrosion preventative (protection against white rust) have been removed.
- 7.2 Apply one coat of calcium plumbate primer to SABS 912 to a dry film thickness of 25 to 35 µm (Green Star requirement that primer is to have a VOC of less than 60 grams/litre).
- 7.3 Apply an undercoat and finishing coat as specified in 4.3 above (Green Star requirement that undercoat and finishing coat is to have a VOC of less than 65 grams/litre).
- 7.4 All paints/primers must not contain any added lead in the form of driers or pigments.
- 7.5 The Contractor/Sub-contractor is to obtain approval of the design team or client before substituting the applicable products and at the end of construction works, the contractor is to undertake a final audit to ensure that the correct products have been used.

PART 14: STANDARD SPECIFICATION FOR ROOM AIR CONDITIONING UNITS

1 GENERAL

- 1.1 Unit shall be standard products of reputable manufacturers regularly engaged in the fabrication of the specific equipment.

2 CAPACITY

2.1 Cooling

- 2.1.1 The units shall be able to deliver their stated capacities at an ambient temperature of 35°C DB and a room temperature of 27°C DB.
- 2.1.2 The units shall be able to deliver their stated capacities continuously.
- 2.1.3 The units shall be able to deliver their stated capacities with the units delivering their stated amount of fresh air to the conditioned space. The temperature of the uncooled fresh air shall be the same as the ambient temperature.

2.2 Heating

- 2.2.1 The units shall be able to deliver their stated capacities continuously.

3 HEAT EXCHANGE SYSTEM

3.1 Compressor

- 3.1.1 The compressor shall be a hermetically sealed unit.
- 3.1.2 The compressor shall be mounted on springs with rubber seating.

3.2 Evaporator

- 3.2.1 The evaporator shall be a multi pass copper coil with copper fins or aluminium fins.
- 3.2.2 The fin spacing shall be adequate to ensure even with build-up of dirt on fins the unit still meets its capacity as stated.

3.3 Condenser

- 3.3.1 The condenser shall be a single or multi pass copper coil with mechanically bonded copper or aluminium fins.

3.4 Condenser fan

- 3.4.1 The fan shall be rated for continuous duty.
- 3.4.2 The fan shall be of the non-overloading type.
- 3.4.3 The fan shall be rated for continuous duty with long life bearing.
- 3.4.4 The fan motor shall be rated for continuous duty with long life bearing.
- 3.4.5 The fan motor shall be a totally enclosed motor.

3.4.6 Noise levels shall remain below 80 dBA.

4 SAFETY CONTROLS

4.1 Heat exchange circuit

4.1.1 The compressor shall be protected against over current and over temperature.

4.2 Heaters

4.2.1 The heaters shall be fitted with safety thermostats to protect the heaters against over temperature.

5 CONTROLS

5.1 The units shall be fitted with a manually adjustable thermostat.

5.2 The thermostat shall automatically select cooling, heating or recirculation according to the return air temperature.

5.3 The unit shall be fitted with an on-off switch.

6 AIR DISTRIBUTION

6.1 Fan

6.1.1 The fan shall be a silent running fan.

6.1.2 The fan shall be of the non overloading type.

6.1.3 The fan shall be selected to have a small variation in delivery, between the system resistance of a clean filter and a dirty filter.

6.1.4 The fan shall be a low speed fan.

6.2 Grilles

6.2.1 The outlet grilles shall be adjustable.

6.2.2 The grilles shall not rattle, hum or vibrate under any operational conditions.

6.2.3 The grilles shall not melt with half the outlet grilles blocked and the heaters on at full capacity.

6.3 Filters

6.3.1 The unit shall filter outside air as well as return air.

6.3.2 The filter shall be of the washable and removable type.

6.3.3 The filter shall be easily accessible for cleaning purposes.

6.3.4 The filter shall prevent the clogging of the evaporator coil.

7 CONSTRUCTION

7.1 Casing

- 7.1.1 The casing shall be constructed from heavy gauge steel.
- 7.1.2 The casing shall be painted with stove enamel.
- 7.1.3 The casing shall be acoustically and thermally insulated.
- 7.1.4 The casing shall not drum, vibrate or emit noises when the compressor comes in operation.
- 7.1.5 The casing shall be treated for corrosion.
- 7.1.6 The unit shall be acceptable to the Mechanical Engineer.

7.2 Condensate

- 7.2.1 The unit shall be constructed to collect the condensate from the evaporator coil.
- 7.2.2 The fan shall not carry condensate over into the conditioned space.
- 7.2.3 The collected condensate shall be piped to the outside of the casing with an adequately sized pipe.
- 7.2.4 The condensate shall not collect in the casing.
- 7.2.5 The thermal and acoustic isolation shall not be able to absorb condensate.
- 7.2.6 Condensate drainage shall be taken to points as indicated by the Mechanical Engineer.

8 NOISE AND VIBRATION

- 8.1 The noise and vibration of the compressor shall be kept as low as possible.
- 8.2 The unit shall be acoustically tested by the SABS and a copy of the test shall be produced on request.
- 8.3 The unit shall equal or surpass the noise criterium laid down in Part 15 of this specification.
- 8.4 The casing shall not drum, vibrate or emit noises.
- 8.5 The grilles shall not drum, vibrate or rattle.

9 TYPES

- 9.1 The above specification shall be applicable to wall type, window-type or split type room air conditioning unit, or computer room units.
- 9.2 The type of unit shall be specified in Part 5 of this document.

PART 15: STANDARD SPECIFICATION FOR NOISE AND VIBRATION

1 SCOPE

This specification covers the requirements for maximum allowable noise and vibration levels in non-residential indoors and outdoors spaces and residential outdoor spaces.

2 REFERENCED STANDARDS

The latest edition (including all amendments) of the following standards are referred to in this specification.

SABS 0103 : The measurement and rating of environmental noise.

BS 4675: Mechanical vibration in rotating and reciprocating machinery.

Part 1: Basis for specifying machines with operating speeds from 10 to 200 revolutions per second.

3 NOISE

3.1 Non-residential indoor and outdoor spaces

The noise level due to equipment used shall not exceed the maximum desired residual sound level L_{Aeq} specified in Column 2 of Table 1 of SABS 0103.

Alternatively the Mechanical Engineer may request that the noise level comply with a specified noise criteria. The octave band frequency spectrum shall be as shown in the noise rating curve (Figure 1).

Where applicable, the noise level due to equipment used in outdoor spaces shall comply with the requirements of the local authority.

3.2 Residential outdoor spaces

Unless otherwise specified and when determined on the boundary of the property, the noise level due to equipment used shall not exceed the residual sound level L_{Aeq} specified in Columns 2, 3 and 4 of Table 2 of SABS 0103 or give rise to unfavourable public reaction.

3.3 Determination of sound levels

The residual sound levels L_{Aeq} shall be measured as prescribed in SABS 0103.

Readings for indoor environments shall be taken at normal ear level and shall not be taken at a point nearer than 1,5 m from diffusers or grilles.

4 VIBRATION

4.1 Equipment Vibration

The vibration severity on the surface of equipment shall not exceed the values specified for quality group B in Table 2 of Annexure A of BS 4675 : Part I.

The vibration measurements shall be determined in accordance with Section 4 of the abovementioned specification.

4.2 Vibration Isolation

- 4.2.1 The installed equipment shall not induce severe vibration levels in adjoining building structures or other machinery.
- 4.2.2 For this purpose, isolators shall be selected and installed to isolate the vibration forces thereby minimising the transmission of such forces to the building structure or adjoining equipment.
- 4.2.3 The type of vibration isolators shall be approved by the Mechanical Engineer. Centre frequencies of octave bands (Hz)

PART 17: STANDARD SPECIFICATION FOR SOUND ATTENUATORS

1 GENERAL

- 1.1 Sound attenuators shall be generally manufactured, selected and supplied by the fan manufacturer.
- 1.2 Sound attenuators shall be factory made units of a make approved by the Mechanical Engineer, and consist of a casing, internal baffles and sound absorbing lining material.
- 1.3 Sound attenuators shall be suitable for the system working pressure, velocity and for an air temperature up to 80EC.
- 1.4 Casing shall be constructed of galvanised sheet metal, of which the minimum thickness is in accordance with requirements laid down in Part 18 of this specification.
- 1.5 The sound absorbing lining material shall be odourless, non-flammable, rot-proof and shall not tear loose as a result of the airstream flowing over it.
- 1.6 Sound attenuators shall be provided complete with mating flanges.

2 AIR CONDITIONING APPLICATIONS

- 2.1 In the case of normal air conditioning applications, sound attenuator panels shall be covered with expanded metal.
- 2.2 Sound attenuators shall be provided complete with mating flanges. The size of the flanges shall be at least as that specified for ducting of the same duty and dimensions.

3 SPECIAL APPLICATIONS

- 3.1 Sound attenuators in the air flow of kitchen extraction systems shall have a sound absorbing lining which shall not absorb any grease or fat.
- 3.2 In the case of corrosive airflow applications the sound attenuator materials shall be suitable for the application.

PART 18: STANDARD SPECIFICATION FOR AIR DUCTS

1 GENERAL

- 1.1 Ducting shall be manufactured according to SABS 1238-1979 as amended.
- 1.2 All duct dimensions, including dimensions for internally insulated ducts refer to the clean internal cross-sectional area.
- 1.3 Unless specified in the Project Specifications, type 316 stainless steel shall be used for stainless steel ducting.
- 1.4 Opposed blade balancing dampers shall be installed on all branch ducts feeding more than one air outlet.
- 1.5 Dampers shall not be used to create artificial resistance in the system in order to reduce fan air flow capacity. Reduction of air flow shall be accomplished by reduced fan speed or by changing the fan blade angle.
- 1.6 All ducts passing through concrete or brick walls shall be isolated from the walls by means of a high density glass fibre collar of at least 20 mm thickness.
- 1.7 Galvanised steel shall be used for ducting for air conditioning and ventilation unless otherwise specified. No Silicon shall be used or welding done on any galvanised steel ducts.
- 1.8 Black mild steel of a minimum thickness of 1,6 mm thickness shall be used for grease contaminated exhaust systems. All joint shall be welded.

2 DUCT HANGERS

- 2.1 Duct hangers shall be as follows:

Longest duct dimensions (mm)	Round hangers (mm)	Galvanised Strap hangers (mm)	Shelf Angles (mm)	Maximum Spacing (mm)
Up to 760	6	25 x 1,6	25 x 25 x 3	3,0
761 - 1000	10		38 x 38 x 3	3,0
1001 - 2100	10		50 x 50 x 3	2,4
2101 - 2400	10		50 x 50 x 6	2,4
2401 and over	12		50 x 50 x 6	2,4

- 2.2 Round hangers shall not protrude below the lowest part of the shelf angles.

3 FLEXIBLE DUCT CONNECTIONS

- 3.1 Flexible connections between ducting and vibrating equipment, or where otherwise specified, shall be fitted with flanges identical to those specified for ducting of the same duty and dimensions.

PART 19: STANDARD SPECIFICATION FOR HEATING AND COOLING COILS

1 GENERAL

- 1.1 Only those coils which the N/S Subcontractor can show to the satisfaction of the Mechanical Engineer are standard product of a reputable manufacturer, regularly engaged in the fabrication of the particular type of coil, shall be acceptable. If an imported product, the N/S Subcontractor shall be able to prove that such products are well represented in the Republic of South Africa.
- 1.2 Coils shall be selected with pipe connections only on the one side.
- 1.3 Coils shall be selected in accordance with ARI Code 410-64, with economic pressure drops to suit the complete pipe and pumping system.
- 1.4 Each coil section shall be securely mounted in a die formed 1,5 mm thick galvanised steel casing, arranged for mounting to other sections, backload, unit casings, etc.
- 1.5 Coils shall be provided with inlet, outlet, vent and drain connections for each section.
- 1.6 Coil section shall be supported on hot dipped galvanised angle frame sections. Supports for cooling coils shall not damage the drip pans and shall be arranged so that condensate cannot run down past the drip pans.
- 1.7 Coils shall be accurately levelled during installation.
- 1.8 Pressure gauges and thermometers shall be installed in the piping on both sides of each bank of coils.
- 1.9 Each coil shall be complete with isolating valves in the supply and return water pipes.
- 1.10 Each bank of coils shall be fed through an angle strainer, control valve, calibrated balancing valve, and isolating valves.
- 1.11 Coils shall be constructed and tested for a test pressure of not less than 1500 kPa or 1,75 times the normal working pressure, whichever is the largest.
- 1.12 Coils shall be suitably protected during transport and installation. Coils having loose or damaged fins at the time of final inspection will be rejected and shall be replaced with new coils at no extra cost to the Owner.
- 1.13 Coils shall be of the extended surface type constructed of copper tubing with a minimum outside diameter of 13 mm, with plate fins.
- 1.14 Fins shall be of aluminium or copper. Fins shall extend at right angles to the tubes.
- 1.15 Coils shall be selected for the correct altitude media density and a fouling factor of 0,088 m² K/kW.

2 COOLING COILS

- 2.1 Fins shall be spaced at least 3 mm apart.

- 2.2 Plate fins may be flat or formed and shall have nominal thicknesses of not less than 0,11 mm. Plate fins shall be provided with integral spacing collars extending the full width of space between the fins. Tubes shall be tightly and permanently expanded into the spacing collars.
- 2.3 Coils shall be of the serpentine type.
- 2.4 Coils fitted in air handling units with sprays or into air handling units installed after a spray section or air washer shall have copper tubes and copper fins.

3 HEATING COILS

- 3.1 The specification as for cooling coils applies with the following exceptions:
 - 3.1.1 Helical or plate fins may be used.
 - 3.1.2 A minimum fin spacing shall be 2 mm.
 - 3.1.3 The minimum material thickness of the fins shall be 0,16 mm.
- 3.2 Steam heating coils shall be of the single pass type and shall have supply and return tapplings for each section.
 - 3.2.1 Tubes of steam heating coils shall be arranged so that expansion stains cannot occur and headers shall be welded steel, brass or copper.

4 FACE VELOCITIES

- 4.1 Face velocities for all coils shall not exceed 2,5 m per second.

5 DRIP PANS

- 5.1 Drip pans shall be fitted under each cooling coil section.
- 5.2 Drip pans above each other shall not be joined into each other.
- 5.3 Drip pans shall be arranged so that no droplets are carried over the drip pan. The minimum distance drip pans shall extend to the downstream side of any coil shall be 350 mm.
- 5.4 Drip pans shall be at least 50 mm deep at the coil and may reduce to a depth of 25 mm at the end away from the coil.
- 5.5 Drip pans shall be manufactured to extend to the upstream side of the coil. A lip of at least 25 mm extending upwards at an angle of 45° on the upstream side of the coil shall from part of the drip pan.

6 DIRECT EXPANSION COILS

- 6.1 Direct expansion coils shall be as the specified cooling coils.
- 6.2 The outlet headers shall be arranged to prevent trapping of oil.
- 6.3 The liquid distributors shall be arranged to ensure an even distribution of liquid refrigerant.

- 6.4 Each circuit of each direct expansion coil shall be provided with a thermal expansion valve of the gas charged type. Valves shall have external equalizer connections, external superheat adjustments with seal caps and soldered joins or flanged pipe connections.
- 6.5 Expansion valves shall require less than 2,2°C superheat change to move from the fully open to the fully closed position. The superheat setting shall be 6°C at full load unless otherwise specified.
- 6.6 Each expansion valve shall be provided with an external strainer regardless of any internal strainer that may be incorporated in the construction.

PART 21: STANDARD TECHNICAL SPECIFICATION FOR FANS

1 GENERAL

- 1.1 Requirements under the above heading apply to fans which are not integral parts of condensing units, cooling towers, air handling units or similar equipment designed and manufactured as complete units by the manufacturer unless referred to.
- 1.2 Fans shall be statically and dynamically balanced. In the case of direct driven fans the balancing shall be done on the motor/impeller assembly.
- 1.3 Electrical protection gear characteristics shall be determined by the fan/motor assembly characteristics.
- 1.4 Fans handling air or gases with abnormal qualities shall be selected for the relevant application.
- 1.5 Extract fans shall have suitable access doors to allow for cleaning of the inside of the casing and the impeller.
- 1.6 No fan shall be operated for any purpose, such as temporary ventilation, testing, etc. until the connected ducts have been cleaned and the filters, if any, have been put in regular operation.
- 1.7 Fans shall be selected to operate in the stable region and as close as possible to the point of maximum efficiency.
- 1.8 Large fans shall be manufactured in easily assembled parts to facilitate installation. This shall not affect the static or dynamic balance of the fans.
- 1.9 All finished parts of fans, such as shafts and bearings, shall be properly protected from rust and foreign mater by means of suitable wrappings and protective grease coatings unit commissioning of fans.
- 1.10 The design total fan resistance as indicated in Part 21 shall be finally checked when all the information on selected system elements is available.
- 1.11 Fans shall be of reputable manufacture and approved by the Mechanical Engineer.
- 1.12 Fans shall be selected for the correct air density and temperature.
- 1.13 All fan accessories shall be the product of the manufacturer of the specific fan it is used with.
- 1.14 Flexible connections shall be fitted with flanges matching those of the fan.

2 CENTRIFUGAL FANS

- 2.1 Bearing shall be of the self-aligning ball or roller type and shall be selected for quiet operation as recommended by the bearing manufacturer. Bearing shall be selected for an average life of not less than 200 000 hours, allowance being made for the dead weight of wheel and maximum belt pull. Should the bearings prove to be noisy during the maintenance period, they shall be replaced by a more suitable type. Only bearings supplied by the one manufacturer shall be used on one project of centrifugal fans.
- 2.2 Fans shall be of the direct driven type.

- 2.3 Fans shall be driven by V-drives.
- 2.4 V-drives shall be matched sets of "Fenner" or equivalent. V-drives shall be selected with a service factor and additional factors as recommended by the manufacturer. Operation of over 16 hours per day and 4 starts per hour shall be the determining factors. Service factors shall be applied to motor power and not absorbed fan power.
- 2.5 V-drives tension shall be installed and operated according to the manufacturer's instructions.
- 2.6 V-drives tension shall be checked and set after two hours of continuous operation and thereafter daily for two weeks of operation.
- 2.7 The fan and motor shall be mounted on a common frame and means shall be provided to adjust the belt tension.
- 2.8 Adequately ventilated drive guards shall be provided. Care shall be taken that the motor cooling air is not blown onto or into the drive guards.
- 2.9 Drive guards shall be constructed to permit maintenance and the use of speed counters with the guards in position.
- 2.10 Fans shall be supplied with mating flanges.
- 2.11 Fans with impeller diameters above 750 mm shall be provided with access doors in the casing.
- 2.12 Fans shall be fitted with vortex dampers. The vortex damper shall be manufactured by the fan manufacturer.
- 2.13 All connections to ductwork, plenums, etc. shall be flexible. Flexible connections shall be minimum of 100 mm long and attached to the fan, ductwork, plenums, etc. in such a way that it can be removed and replaced without disturbing any of the aforementioned equipment.
- 2.14 Flexible connections shall be air tight.
- 2.15 Vibration isolators shall be installed.
- 2.16 A drainage plug shall be installed at the lowest point of the fan casing.

3 AXIAL FLOW FANS

- 3.1 Multiple airfoil blades shall be fitted.
- 3.2 Blades shall have an adjustable pitch angle.
- 3.3 Access doors of ample size shall be provided in the casing of long casing fans.
- 3.4 A weatherproof external terminal box forming an integral part of the casing shall be provided as standard for motor connections.
- 3.5 Fans shall be direct driven with the motor in the air stream.
- 3.6 Fans shall be belt driven. Externally mounted, totally enclosed motors shall be carried on adjustable mounting bases. Internal belt fairing and external belt guards shall be fitted.

- 3.7 Inlet cones manufactured by the fan manufacturer shall be fitted to fans of which the inlet is not connected to ducting with the same diameter.
- 3.8 Fan motors shall be flange mounted.
- 3.9 Fans intended for use within ductwork shall be of the long casing type such that the casing completely shrouds the fan and motor assembly.
- 3.10 Fans having only one end attached to ductwork, plenums, walls, etc. shall be the short casing type.

The fan shall be so installed that the motor is accessible.
- 3.11 Anti-vibration mountings shall be utilized.
- 3.12 Fan selection shall be made ensuring that a stall condition will not occur.
- 3.13 Vortex dampers shall match the fans and be manufactured by the fan manufacturer.
- 3.14 Controllable pitch fans shall have pneumatic or electric actuators. To ensure smooth operation throughout the range there shall be a balance between the control force and return force.
- 3.15 All connections to ductwork, plenums, etc. shall be flexible. Flexible connections shall be a minimum of 100 mm long and attached to the fan, ductwork, plenums, etc. in such a way that it can be removed and replaced without disturbing any of the aforementioned equipment.
- 3.16 Flexible connections shall be air tight.

4 PROPELLER FANS

- 4.1 Fans shall be resiliently mounted on rubber cushions or by other approved means.
- 4.2 Fan shall be ring mounted.
- 4.3 Fans shall be plate mounted.
- 4.4 Fans shall be direct driven with total enclosed motors.
- 4.5 Mounting rings or plates shall be die cast or die formed to smooth curves where the air enters the wheels. Mounting plates shall be heavy enough to prevent distortion and shall be adequately braced to prevent vibration.
- 4.6 Fans shall be suitable for speed control.
- 4.7 Speed controllers shall control the speed in steps and be suitable to receive external signals.
- 4.8 Speed controllers shall control the speed in steps and shall be hand operated.

5 WINDOW/WALL TYPE EXTRACT FANS

- 5.1 Fans shall be "Woods Xpelair", "Ventaxia" or similar approved.
- 5.2 Fan shall be suitable for single phase operation.
- 5.3 Fan shall be reversible.

- 5.4 Fans shall be supplied complete with mounting accessories.
- 5.5 Required air volumes shall in all instances be selected at low speed.
- 5.6 Fans shall include dual speed motors.
- 5.7 Fans shall include electrically operated shutters.
- 5.8 Fans shall include manually operated shutters.
- 5.9 The shutters shall be closed when fan is not operational.
- 5.10 Fan controller shall be included. The controller shall be capable of switching the fan on and off, select low or high speed and reverse the motor.

6 ROOF EXTRACT FANS

- 6.1 Roof Extract Fans shall be "Brooks", "Woods" or equivalent factory assembled type.
- 6.2 Impeller shall be of the vane-axial type.
- 6.3 Impeller shall be of the centrifugal type.
- 6.4 Impeller shall be of the mixed flow type.
- 6.5 Fans shall be selected for quiet operation and shall have ball and roller bearings with dust tight seals.
- 6.6 All metal exposed to weather shall be corrosion resistant or coated so as to prevent corrosion.
- 6.7 Fan shall include automatic shutters.
- 6.8 Sound attenuating kerb shall be provided.

PART 27: STANDARD SPECIFICATION FOR TESTING AND COMMISSIONING

1 GENERAL

- 1.1 All equipment shall be commissioned in accordance with CIBSE.
- 1.2 All equipment and systems shall be tested in the presence of the Mechanical Engineer or his representative.
- 1.3 At the discretion of the Mechanical Engineer parts of the system or systems may be tested by testing as a complete unit is compulsory.

2 TESTING AND COMMISSIONING PROGRAM

- 2.1 The N/S Subcontractor shall submit, at least four weeks before commencing any testing and commissioning a complete program for such work for approval by the Mechanical Engineer.
- 2.2 The program shall include:
 - 2.2.1 A bar chart covering all activities.
 - 2.2.2 Names and addresses of companies involved in each activity.
 - 2.2.3 The way in which each test will be carried out complete with pro forma forms for tabulating results.

3 EQUIPMENT AND PROCEDURE

- 3.1 The subcontractor will ensure that all pre-commissioning, commissioning, and quality monitoring of all equipment shall be undertaken in exact accordance with the relevant CIBSE Commissioning Codes for:
 - The cooling plant - CIBSE Commissioning Code R: Refrigeration Systems,
 - Heating plant - CIBSE Commissioning Code R: Refrigeration Systems,
 - Air distribution - CIBSE Commissioning Code A: Air Distribution Systems,
 - HVAC controls - CIBSE Commissioning Code C: Automatic Controls.

CIBSE Commissioning Code M: Commissioning Management is applicable to all equipment.

The sub-contractor is to produce a Commissioning Report once completed with commissioning. As a minimum, the Commissioning Report will contain the following information:

- Requirements for witnessing including full details of tolerances applicable to all parameters;
- Commissioning program including specific period of time for client witnessing;
- Appropriate health and safety risk assessment and method statements for the tasks to be completed;
- Commissioning method statement for each system;
- Pre-commissioning checklists for each system;
- Commissioning checklists; and

- Commissioning certification for each system countersigned by the design engineer, commissioning specialist (independent or otherwise) and the accepting authority (where relevant), and including the record sheets provided in each CIBSE code.
- 3.2 For all mechanical services, project knowledge is to be properly transferred to the building owner and building management team.

The subcontractor shall provide to the owner at building handover the following:

- Design intent report,
- As-built drawings (complete set),
- Operations & Maintenance Manual,
- Commissioning Report; and
- Training to ensure that building management staff has all the information and understanding needed to operate and maintain the features and systems in the building.

Sufficient training must be provided to ensure that the building managers and staff members have all the information and understanding needed to operate and maintain the commissioned features and systems of the building. As a minimum, the training of building management staff shall include:

- Information provided in the Design Intent Report (including energy/environmental features);
 - Review of controls set up, programming, alarms and troubleshooting;
 - Review of O&M manuals;
 - Building operation (start up, normal operation, unoccupied operation, seasonal changeover, shutdown);
 - Measures that can be taken to optimise energy efficiency;
 - Occupational Health & Safety (OH&S) issues;
 - Maintenance requirements and sourcing replacements; and
 - Procedures for obtaining and addressing occupant satisfaction feedback.
- 3.3 The equipment supplied under this Contract shall be subject to inspection by the Mechanical Engineer or his Nominated Agent at all stages of manufacture.
- 3.4 The tests and commissioning procedure as laid down and such additional tests as the Mechanical Engineer may reasonably require to prove compliance with the Specification shall be carried out at the N/S Subcontractor's Work and at Site.
- 3.5 The N/S Subcontractor shall give reasonable notice of time and place in writing to enable the Mechanical Engineer to inspect and witness tests of materials and equipment. He shall provide the Mechanical Engineer with facilities for witnessing same and for any additional tests or inspection of any portion of the works as required by the Mechanical Engineer.
- 3.6 The N/S Subcontractor shall at his own cost render all assistance and supply all labour, appliances and by other materials, as the Mechanical Engineer may require to check the setting out, measure up and inspect any portions of the works at any stage during fabrication, construction, erection or painting (please see Green Star IEQ-13 VOC requirements for paints).

During such operations, the N/S Subcontractor shall if required, suspend any or all of the Works, without having claim for loss or damage as a result thereof.

- 3.7 The testing of the plant (or any part thereof) supplied under this contract shall be carried out through its full operating range (or part thereof) as required by the Mechanical Engineer.
- 3.8 All such tests and inspections and the necessary inspection facilities shall be provided at the N/S Subcontractor's expense.
- 3.9 At the commencement of and during the whole of the Commissioning and Testing Periods, the N/S Subcontractor shall have available on site all essential spares and tools considered necessary to enable repair work of defective parts to be carried out immediately in the event of a breakdown.
- 3.10 The N/S Subcontractor shall be responsible for the proper operation and maintenance of the plant throughout the period of the tests and until the operator training period is complete.
- 3.11 Acceptance by the Mechanical Engineer of any plant item, following such inspection or tests, shall not relieve the N/S Subcontractor of any obligations under this Contract.
- 3.12 All pumps shall be lined up and tested as a complete set. Test certificates in triplicate shall be supplied before despatch.
- 3.13 Balance tests to be carried out on all rotors and motor/impeller combinations.
- 3.14 All such other test as required by the Mechanical Engineer to prove compliance with the specification, shall be carried out.

4 TEST CERTIFICATES

- 4.1 The N/S Subcontractor shall provide three copies of test certificates in respect of all materials and equipment, further copies are to be bound into the operating and maintenance manuals.

5 INSULATION TESTS

- 5.1 All electrical wiring and equipment shall be subjected to insulation tests. All instruments and other equipment for the tests shall be provided by the N/S Subcontractor.

6 DRAINING AND CLEANING

- 6.1 On completion of the pressure test on a section of pipework the water used for testing shall be drained away as quickly as possible to remove as much dirt and dross as possible. After completion of a pipework circuit the circuit shall be flushed through to remove all pipe scale, dross and similar materials.
- 6.2 The N/S Subcontractor shall provide all necessary connections, by-pass pipes, temporary strainers, temporary make-up pieces, to enable the systems to be drained and cleaned.
- 6.3 Additionally, on boiler commissioning, steam lines are to be charged with steam to full operating pressure and allowed to cool. This procedure is to be carried out three times over a period of two days. Following the third cycle the pipes are to be open ended and blown through. These procedures are to be supervised by the Mechanical Engineer.

7 PLANT COMMISSIONING

- 7.1 The N/S Subcontractor shall arrange at his cost for the manufacturer's representatives to check over and fully commission all major items of equipment. This work is to be carried out by skilled engineers preferably employed by the manufacturers, who are completely familiar with the equipment involved and shall be capable of training the operating and maintenance staff in the duties they are to perform.
- 7.2 On completion of the plant commissioning the N/S Subcontractor shall obtain written confirmation from the various manufacturers that they have completed all commissioning work and are satisfied that the items of plant for which they are responsible are functioning satisfactorily.
- 7.3 Copies of the manufacturer's written confirmation shall be sent to the Mechanical Engineer.

8 TESTS ON COMPLETION

- 8.1 On completion of the balancing and commissioning of equipment the plant shall be put into normal operation and the final adjustments of the equipment shall be made.
- 8.2 Thereafter the Tests on Completion shall be carried out to ensure that the plant will fulfil the functions for which it has been supplied.
- 8.3 Such tests shall include the following:
- (a) Simulated tests for all alarm and safety cut out equipment to prove the operation of the equipment.
 - (b) Simulated tests on automatic controls to prove the ability of the controls to correct conditions which are outside the required design conditions. The tests shall be carried out by manually changing the desired values to produce an incorrect condition and then re-setting the controls to the design conditions and checking the operation of valves, etc. to restore the design conditions.

- (c) Operational tests on the Plant to demonstrate that it is giving the rated output and efficiency.
- 8.4 The N/S Subcontractor shall provide all necessary temporary measuring and recording equipment. The equipment shall be of a type generally used for this type of testing and shall be to the approval of the Mechanical Engineer. All instruments shall be accurately calibrated before the tests begin.
- 8.5 On completion of the whole of the tests and when the N/S Subcontractor is satisfied that the entire plant is operating satisfactorily and will fulfil the function for which it has been supplied, he shall submit to the Mechanical Engineer triplicate copies of all test records and charts together with reports on all the tests called for in this Specification. The Mechanical Engineer shall reserve the right to ask for any reasonable additional tests or for the repetition of previous tests in order to prove that the operation or the plant is satisfactory and in accordance with the Specification and Drawings.

PART 32: STANDARD SPECIFICATION FOR FIRE DAMPERS

1 SCOPE

This specification covers dampers intended for use in air-conditioning and ventilation ducts in order to restrict the spread of fire, hot gasses and smoke in buildings.

2 REFERENCE STANDARDS

SABS 044, Part III	:	The fusion welding of steel: Tests for the approval of welding procedures and production welds.
SABS 193	:	Fire dampers

3 REQUIREMENTS

- 3.1 Fire dampers shall comply with SABS 193.
- 3.2 Unless otherwise specified, dampers shall be built into walls and be air tight due to fumigation requirements.
- 3.3 The configuration (round or rectangular) and overall dimensions of dampers shall be as specified.
- 3.4 If so specified dampers shall be fitted on the downstream side with a heat insulating shield. The minimum period of thermal shielding shall be as specified (see Clause 3.2.2 and 3.9 of SABS 193).
- 3.5 The fire resistance rating shall be as specified.
- 3.6 Welding on dampers shall comply with the requirements for Grade B welds given in Section 7 of SABS 044, Part III.
- 3.7 Dampers shall be of the single or multiple blade or curtain type, as specified.
- 3.8 The actuator may be electrically, pneumatically or spring operated, as specified. The damper shall operate effectively on the voltage and current specified (in the case of electric operation) or the air pressure specified (in the case of pneumatic operation).
- 3.9 Where damper operation is controlled by a fusible link, the link shall melt at 70oC, unless a different temperature is specified.
- 3.10 Dampers with a specified "fail close" or "fail open" safety position shall be actuated with a single-acting pneumatic piston for the non-safety movement and spring actuation for the safety movement.
- 3.11 Dampers shall be painted in accordance with the applicable clauses of General Specification no 13. The sealing areas of damper blades shall, however, not be painted.

PART 35: STANDARD SPECIFICATION FOR VENTILATION EXTRACTION SYSTEMS

1. SCOPE

This specification covers the material, constructional and dimensional requirements of 4 types of hoods as listed in Section 3, as well as the most essential requirements for the associated ducting and fans.

2. REFERENCED STANDARDS

The latest edition (including all amendments) of the following standards is referred to in this specification.

SABS 044, Part V:	The fusion welding of steel : Tests for the approval of welders, where weld procedure approval is not required.
SABS 0173 :	The installation, testing and balancing of air-conditioning ductwork.
SABS 193 :	Fire dampers.
SABS 763 :	Hot-dip (galvanised) zinc coatings.
SABS 1238 :	Air conditioning ductwork.
ISO 1996 :	Assessment of noise with respect to community response.
NFPA 33 :	Spray application using flammable and combustible materials.

3. TYPES

Hoods shall be one of the following types as specified:

- 3.1 Hoods for kitchens
- 3.2 Hoods for laboratories
- 3.3 Hoods for industrial applications
- 3.4 Hoods for paint spray booths.

4. GENERAL REQUIREMENTS

- 4.1 The N/S Subcontractor shall be responsible for obtaining approval for the installation from the local authority.
- 4.2 The general design and construction of hoods shall comply with the applicable SMACNA standards.
- 4.3 The face velocity shall be sufficient to ensure efficient operation of the hood, even when the fat filters are dirty and shall, unless otherwise specified, not be less than 30 m/min.
- 4.4 Flexible joints, sealants and internal insulation, where applicable, shall comply with Sections 4.6, 4.7 and 4.8 respectively of SABS 1238.
- 4.5 Painting, where specified, shall comply with General Specification Part 13 : PAINTING.
- 4.6 Ducting, attenuators and fans outside buildings shall be protected against the ingress of water. Materials, which are not inherently corrosion resistant, shall be painted.

- 4.7 Where more than one canopy is served by the same ducting system the N/S Subcontractor shall ensure that the design and balancing of the system is such that the flow of air through each canopy is sufficient.
- 4.8 Where lights are specified they shall be vapour and dust proof.
- 4.9 Hoods shall be designed to facilitate cleaning.
- 4.10 Where applicable, provision shall be made for liquids that condense on the hood interior to run down into a drip channel. If so specified, a drip channel shall also be provided on the outside of the hood.
- Two hand-removable cleaning plugs shall be provided on each channel (as applicable) on opposite corners of the hood.
- 4.11 The N/S Subcontractor shall ensure that provision has been made for sufficient vents in the room to compensate for air exhausted from the room.
- 4.12 Hoods shall be of rigid construction and flat surfaces sufficiently cross-braked to prevent drumming.

5. HOODS FOR KITCHENS

5.1 Design

- (a) Hoods shall be designed to effectively perform the following functions:
- Remove steam and fat from the cooking area in order to prevent it from condensing on the walls and ceiling of the room.
 - Prevent food odours from spreading to the rest of the building.
 - Ventilate the room and remove excessive heat.
- (b) The hood shall be constructed and installed as shown on the drawings.
- (c) Joints in the hood shall be welded and shall be leak proof. The welds shall comply with SABS 044, Part V.
- (d) A removable drip tray shall be installed to catch drips from the duct or filters, which shall be taken to the nearest available drain point as indicated by the Mechanical Engineer.
- (e) The entire hood shall be designed and constructed so as to facilitate cleaning and shall drain into easily cleanable trays or gutters mounted on the inside and outside of the hood.

5.2 Dimensions

- (a) The inner edge of the hood shall extend at least 230 mm in a horizontal direction beyond the cooking appliance(s) for every 1 m vertical clearance between the hood and the top of the cooking appliance.
- (b) The edge of the hood shall be at least 2 130 mm above the floor.

- (c) The depth of the hood from the bottom edge to the top shall be at least 600 mm.

5.3 Material

- (a) Hoods shall be fabricated from one of the following materials, as specified:
- (i) ASTM 316 stainless steel
 - (ii) ASTM 304 stainless steel
 - (iii) ASTM 430 stainless steel
 - (iv) Galvanised mild steel. Galvanising shall comply with SABS 763 for general applications (Table 1).
 - (v) Black mild steel painted in accordance with General Specification Part 13: PAINTING.
- (b) The nominal thickness of sheeting used for hoods shall be not less than 1,2 mm.

5.4 Filters

- (a) If fat filters are specified the hood shall be supplied complete with filter frames (bolted to the hood frame), fat filters and drip trays. The filters shall be of a type approved by the Mechanical Engineer and shall be easily removable and washable.
- (b) The components of filters shall be non-combustible.
- (c) In order to reduce fire hazards the distance between the lower end of the filter and the top of the cooking appliance shall be at least the following:
- (i) No open flame 760 mm
 - (ii) Open flame of the charcoal type 1 370 mm
 - (iii) Open flame, other than in (ii) 1 070 mm

6. HOODS FOR LABORATORIES

6.1 Design

- (a) Hoods for laboratories shall be designed for the effective extraction of the fumes, vapours or gasses specified.
- (b) Hoods shall normally consist of side, back and top enclosure panels, a work surface and an exhaust.
- (c) It shall be of the bench type (in which case it shall be provided with a work surface) or the walk-in type, as specified.
- (d) The following facilities shall be provided if so specified:
 - (i) An exhaust plenum with adjustable slots for the regulation of air flow distribution.
 - (ii) Operable glass doors for observation and shielding purposes. The doors shall be horizontally, vertically, or horizontally and vertically operable, as specified.
 - (iii) Filters for the removal of fumes, vapours or gasses.
 - (iv) Lights with a safety classification in conformance with the contaminants handled.
 - (v) Service outlets, such as gas and water pipes.
 - (vi) Sinks.
 - (vii) Air bypass openings for the maintenance of a constant air flow over the face of the hood.
 - (viii) Airfoil entry devices to prevent the outfall of contaminants.
- (e) Design face velocities shall be at least as follows:

Nature of materials handled	Concentration			Design face velocity, m/min	
	Gases, vapours ppm	Dusts, fumes mists mg/m ³	Mineral dusts pp m ³	Average	Minimum
Highly toxic	0,1	0,1	-	45	38
Moderately toxic General lab use	0,1 - 100	0,1 - 15	175 x 10 ⁶	30	24
Non-toxic	100	15	175 x 10 ⁶	18	15

Terms used above are defined as follows:

Design face velocity: A general term used to describe the air velocity required to ensure that contaminants released in the hood are captured and removed.

Average face velocity: The total quantity of air passing across the face, divided by the face area.

Minimum face velocity: The minimum acceptable velocity at any point on the operating opening.

- (f) If so specified provision shall be made for compensation of variations in pressure drop across the filter due to filter loading.

6.2 Dimensions

The general configuration and overall dimensions of hoods shall be as shown on the drawings.

6.3 Materials

- (a) Hoods shall be made of one of the following materials, as specified.
 - (i) ASTM 316 stainless steel
 - (ii) ASTM 304 stainless steel
 - (iii) ASTM 410 stainless steel
 - (iv) Galvanised mild steel. Galvanising shall comply with SABS 763 for general applications (Table 1).
 - (v) Black mild steel painted in accordance with General Specification Part.13.
 - (vi) Aluminium of the type approved by the Mechanical Engineer.
 - (vii) Any other suitable material approved by the Mechanical Engineer.

In the selection of a suitable material the following shall be considered:

- (i) The nature of the hood fumes
- (ii) The temperature to which the material will be subjected.
- (iii) Flame and smoke spread rating.
- (iv) Corrosion due to chemical or electrochemical action.
- (v) Dissolution due to solvent and oil fumes.

6.4 Filters

- (a) If so specified the hood shall be equipped with a suitable removable and washable filter.
- (b) The contaminations to be filtered out and the filtration efficiency shall be as stipulated in the Project Specification.
- (c) Filter systems which will be considered are as follows:
 - (i) High efficiency absolute filters in combination with a coarse prefilter.
 - (ii) Spray washers and wet collectors for the removal of soluble, toxic effluent or effluent with an obnoxious odour.
 - (iii) Odour filters and scrubbers such as activated carbon filters and spray-type scrubbers.
 - (iv) Any other suitable filter system approved by the Mechanical Engineer.

- (d) Provision shall be made for the replacement or cleaning of filter elements without contaminating the surroundings or causing injury to personnel.

7. HOODS FOR INDUSTRIAL APPLICATIONS

7.1 Design

- (a) Hoods shall be designed to effectively confine or capture contaminants released by a process with a minimum rate of air flow into the hood. The contaminants may consist of:
 - (i) dust, fumes and smoke, which are solid particulate matter.
 - (ii) mists and fogs, which are liquid particulate matter.
 - (iii) vapours or gases.
- (b) Hoods shall be one of the following types as specified:
 - (i) Enclosures which contain contaminants released inside the hood and prevent the latter from escaping by a continuous inflow of air.
 - (ii) Booths which are enclosed with one side open to allow workers access to the process.
 - (ii) Exterior hoods which provide contaminant control by including air flow around a process some distance away, at a velocity high enough to motivate the contaminated air to the hood opening.
 - (iv) Receiving hoods which catch contaminants that are thrown into or rise up to them and where the flow of contaminant is induced by the process itself.
- (c) Where possible hoods shall be flanged to improve its effectiveness.
- (d) Machine hoods shall be shaped to fit closely around the moving machinery with openings located to catch the inertial at their source.
- (e) Hoods shall be of sturdy construction and firmly mounted.
- (f) Where applicable hoods shall be easily removable for maintenance purposes.

7.2 Dimensions

The general configuration and overall dimensions of hoods shall be as shown on the drawings.

7.3 Materials

- (a) The requirements for materials for industrial hoods are the same as those specified in 6.3
- (b) Aluminium shall not be used where abrasive materials are involved.
- (c) Galvanised steel shall not be used where temperatures exceed 200 °C.

7.4 Filters

- (a) If so specified hoods shall be equipped with suitable removable and washable filters, cyclones or other means for cleaning the exhaust air.

- (b) The contaminants to be filtered out and the filtration efficiency shall be as stipulated in the Project Specification.
- (c) Provision shall be made for the easy replacement or cleaning of filters or the clearing of collecting bins without contaminating the surrounding or causing injury to personnel.

8. HOODS FOR SPRAY PAINT BOOTHS

Spray paint booths shall comply with the requirements of NFPA 33.

9. DUCTS

- 9.1 Ducts shall preferably be designed, constructed and installed in accordance with SABS 1238.
- 9.2 Ducts shall preferably not pass through fire walls or partitions, but where this is unavoidable the requirement of clause 3.5.2 of SABS 0173 shall be complied with.
- 9.3 Ducts shall be fabricated from one of the materials listed in 6.3, as specified.
- 9.4 Galvanised steel ducts shall not be used for exhaust systems contaminated with grease or where the exhaust gas temperature exceeds 200 °C.
- 9.5 Where there is the possibility of liquid forming in the ducts, the joints shall be welded to prevent leakage.
- 9.6 Duct design shall be based on an air speed of 10 m/s.
- 9.7 The construction of ducts shall be such that it will not cause drumming or other objectionable noise.
- 9.8 Provision shall be made for the thermal movement of ducts due to temperature variations.
- 9.9 Unless otherwise specified ducting shall not be insulated on either the inside or outside. If insulation is specified, it shall comply with Section 4.8 of SABS 1238 and Section 4.4 of SABS 0173.
- 9.10 Gases and vapours shall be released at such a height and position that
 - (a) it does not have an adverse effect on the environment;
 - (b) will not constitute a fire hazard, and;
 - (c) will not cause re-circulation to air intakes.

10. FANS

- 10.1 The fan shall be capable of supplying the required amount of air against the system resistance. Provision shall be made for additional resistance due to loading of the filters and for reduced efficiency of the fan due to dirt collecting on the impeller. For heavy dust loading a self-cleaning type impeller shall be selected.
- 10.2 The fan shall be capable of maintaining a minimum air speed of 10 m/s in the duct, or the transport velocity of the contaminants.

- 10.3 The noise level of fans and sound alternators shall not exceed NC 45 for normal industrial applications and NC 50 for heavy industrial applications.
- 10.4 Fans shall be located outside occupied areas and close to the point of discharge to the atmosphere to avoid the spread of contaminants through leakage.
- 10.5 Where possible fans shall be located downstream of air cleaning equipment.

11. ELECTRICAL INSTALLATION

- 11.1 The fan shall be equipped with a local isolator and an enclosed, wall mounted stop/start station.
- 11.2 Unless otherwise specified, the fan motor control panel and electrical wiring shall be moisture proofed to IP 55.
- 11.3 Electrical equipment shall be selected for the fault rating specified by the Mechanical Engineer.
- 11.4 Interconnecting cabling shall be carried out in PVC/SWA/PVC cable.
- 11.5 The schematic diagram of the control panel shall be submitted to the Mechanical Engineer for approval prior to manufacture.
- 11.6 The N/S Subcontractor shall be responsible for the following:
- (a) The supply and installation of one surface mounted distribution/control panel for the hood.
 - (b) The supply and installation of the interconnecting cables between the control panel and the fan.

The panel shall have the following features and/or equipment:

- (i) An incoming main isolator with external switch handle interlocked with the access door to ensure that the board cannot be opened whilst live.
 - (ii) A system "ON"/"OFF" press button selector.
 - (iii) A thermal overload feature on the fan.
 - (iv) System run and system trip indicator lights.
 - (v) A suitable starter.
- 11.7 Equipment on and in the panel shall be labelled with engraved labels clearly stating the function of the equipment.

12. DAMPERS

- 12.1 The ducting shall be fitted with a fire damper where indicated on the drawing. The fire damper shall comply with SABS 193 and shall have a fire rating of at least 0,5 h when tested in accordance with SABS 193. Heat shielding is not required (See Section 3.2.2 of SABS 193).
- 12.2 Ducts shall be fitted with lockable, balancing, butterfly dampers where indicated on the drawings. The dampers shall comply with Section 5.6 of SABS 1238.

13. ATTENUATORS

- 13.1 When measured in accordance with ISO Standard 1996 the sound level rating of the exhaust system shall not exceed a rating of NR 45 at any position in the hood at ear level. If the noise level should exceed this value, a suitable attenuator shall be installed.
- 13.2 Where applicable the attenuator shall be protected against the absorption of fat or moisture.

14. TESTING

Unless otherwise agreed the N/S Subcontractor shall be responsible for supplying the necessary equipment and for conducting the following tests to prove compliance with the relevant requirements of this specification.

14.1 Equipment

- (a) Calibrated thermal anemometer
- (b) Titanium tetrachloride*
- (c) Wooden, cotton-tipped swabs
- (d) Thirty-second smoke bombs or dry ice
- (e) Rotating vane anemometer
- (f) Stopwatch.

14.2 Test procedure

Perform tests with the hood sash raised to its normal operating height and at 25 and 50 percent opening. Remove as much equipment from the hood as possible and test in the following manner:

(a) Face velocity

For this test, the auxiliary air, where provided, is to be off. Form an imaginary grid pattern by dividing the vertical and horizontal dimensions by 4. Take velocity readings with the calibrated heated wire anemometer, 100 mm behind the front face of the hood, at the intersections of the grid lines (a total of 9 readings). Avoid blocking the air flow with the body while taking readings.

When the average face velocity must be at least 30 m/min this average may deteriorate to 28 m/min before correction and then must be returned to 30 m/min. Individual readings may not vary more than $\pm 10\%$ empty, or $\pm 25\%$ with equipment.

With the sash fully opened, the average face velocity must be at least 80 percent with the same tolerances as above.

(b) Reverse air flows and dead air spaces

For this and all the following tests, the auxiliary fan shall be operating where provided.

Swab a strip of titanium tetrachloride along both walls and the hood floor in a line parallel to the hood face and 150 mm back into the hood. Swab a large A on the back

of the hood and on each side. Define movement of air towards the face of the hood as reverse air flow, and define lack of movement as dead air space.

Swab the work top of the hood, being sure to swab lines around all equipment in the hoods. All smoke should be carried to the back of the hood and out.

Test the operation of the bottom air bypass air foil, where provided, by running the cotton swab under the air foil. Test the flow of auxiliary air, where provided, by holding the cotton swab in the air stream. In both cases, the smoke should be drawn into the hood. Before going on to the next test, move the cotton swab around in the face of the hood; if there is any reverse air flow, the exhaust capacity test should not be made.

(c) Exhaust capacity

Ignite and place a 30-second smoke bomb near the centre of the work surface, making sure that the hole on the side of the smoke bomb faces into the hood. When the bomb starts smoking, pick it up with tongs and move it around in the hood. There shall be no visual or odour indications of smoke outside the hood

This test may also be conducted by means of a piece of dry ice instead of the smoke bomb.

(d) Air flow indicator

Check the air flow indicator, if provided, to see if it is operating properly.

(e) Auxiliary air

Where auxiliary air is used, measure the total amount of air provided with a rotating vane velometer and stop watch. The percentage of total exhausted air provided by an auxiliary supply shall not exceed 70 percent. The velocity of auxiliary air shall not exceed 60 m/min.

(f) Exhaust fan

Check for proper performance.

(g) Building conditions

During the tests, the building air conditioning or ventilation system shall be operating in a normal fashion. During the smoke test, the room doors shall be opened and closed to assure no leakage from the hood occurs due to this source of disturbance.

PART 36: STANDARD SPECIFICATION FOR THERMAL INSULATION

1 GENERAL

- 1.1 All thermal insulation work shall be executed by a specialist in this specific field.
- 1.2 The work shall be executed in a workmanlike manner and the final surface shall be of a neat, smooth and symmetrical finish.
- 1.3 Thermal insulation of equipment shall comply with BS CP3005 - 1969, provisions of BS 1334, BS 1558 and BS 476 or the latest amendments as applicable.
- 1.4 Oil, grease, rust, scale and dirt shall be removed from surfaces by means of a suitable cleaning agent before the application of insulation.
- 1.5 No equipment shall be insulated until tested and approved.
- 1.6 Adhesives, sealants and coatings shall be compatible with the insulation material.
- 1.7 Certified test reports from an instance approved by the Mechanical Engineer shall be submitted by the N/S Subcontractor in which the following information is given:
 - (a) The thermal conductivity of insulating materials at operating temperature.
 - (b) The surface spread of flame or insulating materials, adhesives and other finishes.
 - (c) The permeance vapour barrier systems (cold water systems).
 - (d) The sound absorption co-efficient of insulating materials (internally insulated ducts).
- 1.8 Pipes shall be painted with bitumastic paint before application of insulation.
- 1.9 Surface spread of flame of insulation cladding shall be in accordance with BS 476 Class I Specification.
- 1.10 The permeability of insulation cladding around chilled water pipes shall not be more than 1.
- 1.11 Thickness of insulation cladding will be checked by the Mechanical Engineer after completion of insulation work. If any thicknesses are less than that recommended by the manufacturer, the N/S Subcontractor will be requested to apply one extra coat over the whole installation at his own expense.
- 1.12 Insulation, adhesives and finishes shall be resistant to rotting, mould, fungus growth, decay or attack by vermin.
- 1.13 Continuity of the vapour barrier shall be ensured.

2 CHILLED WATER PIPES

- 2.1 All supply and return pipes shall be insulated with preformed sections of insulation with a heat transmission co-efficient not higher than 0,035 watts per square metre degree C.
- 2.2 The insulation thickness shall not be less than 25 mm. Insulation on pipes larger than 125 mm in dia. shall not be less than 40 mm.
- 2.3 The preformed sections of insulation shall be provided with a factory applied canvas finish. During installation the N/S Subcontractor shall ensure that the canvas finishes overlap each other by at least 25 mm on all joints.
- 2.4 A vapour-proof protective cladding equivalent to "FOSTER SEALFAS coating 30-36" or "DECADEX FIRECHECK" shall be brush-applied over the canvas covering. The application shall be as follows:

FOSTER 30-36 - 2 coats each at 1,6 m² per litre DECADEX FIRECHECK - 2 coats each at 1 m² per litre
- 2.5 Circumferential joints to the insulation shall receive one application of "FOSTER FOAMSEAL 30-45" or equivalent, to the full thickness of the insulation during erection to obviate lateral migration of moisture vapour along the pipe when in service.
- 2.6 All points where pipe supports are used or where the vapour barrier is broken due to cut-outs in the insulation, shall be sealed with "FOSTER FOAMSEAL 30-45" or equivalent during erection.
- 2.7 Circumferential and longitudinal laps to the canvas shall be adhered with "FOSTER SEALFAS coating 30-36" or equivalent before application of final coats.
- 2.8 Bends and fittings shall be insulated and covered as described for pipes.
- 2.9 At no point shall the insulation be less than 25 mm thick over any pipe or fitting.

3 INTERNAL AIR DUCT INSULATION

- 3.1 All air conditioning supply and return air ducts shall be internally insulated with 25 mm thick insulation to the latest edition of the relevant SABS Specification unless otherwise specified.
- 3.2 Insulation material shall be resin bonded, mineral or glass fibre with a protective synthetic membrane specifically designed for internal duct insulation.
- 3.3 All leading and trailing edges of insulation shall be fitted with a metal nosing piece to keep the insulation in place. This nosing piece shall cover the insulation for a minimum distance of 30 mm over the entire perimeter.
- 3.4 In addition to the welded pins, positioned as described in the latest edition of the relevant SABS Specification, the insulating material shall be glued to the sheetmetal ensuring a 100% area adhesion.
- 3.5 The minimum insulation material density shall be 24 kg/m³.
- 3.6 Any damage to the insulation or membrane shall be repaired to the satisfaction of the Mechanical Engineer.

4 EXTERNAL DUCT INSULATION

- 4.1 Air conditioning supply and return air ducts shall be externally insulated with insulation of at least 25 mm thickness where external insulation is specified.
- 4.2 Insulation material shall be resin-bonded mineral or glass fibre with a protective aluminium facing specifically designed for external duct insulation.
- 4.3 Insulation shall be installed in a neat and workmanlike manner.
- 4.4 Insulation shall be adhered to the duct surface by means of "FOSTER SAFETEE DUCTFAS ADHESIVE 81-99" or equivalent.
- 4.5 The N/S Subcontractor shall ensure a 100% area-bonding between the duct and insulation.
- 4.6 The insulation on the sides and bottom of the duct shall be pinned with mechanical fasteners as described for internally insulated ducts.
- 4.7 All joints shall be taped with an aluminium adhesive tape approved by the Mechanical Engineer.
- 4.8 The continuity of the vapour barrier shall be insured.

5 METAL CLADDING OF PIPES

- 5.1 All chilled and hot water pipes in plantrooms shall be provided with a 0,5 mm thick galvanised sheetmetal cladding over the insulation material. The cladding shall be installed after the vapour-proofing has been approved by the Mechanical Engineer.
- 5.2 Care shall be taken not to damage the vapour barrier.
- 5.3 Cladding shall be secured by stainless steel bands every 500 mm. Self-tapping screws shall not be used.
- 5.4 The sheetmetal covering shall be cut at pipe supports or hangers.
- 5.5 No dents or any damage to sheetmetal covering will be accepted at the final inspection.

6 VALVES AND FITTINGS

- 6.1 Valves and fittings shall be insulated with resin-bonded mineral, wool or glassfibre with a minimum density of 96 kg/m³.
- 6.2 Plaster of at least 13 mm thick shall be applied over a steel mesh covering the insulation. The plaster shall be of the asbestos hard setting compound type, trowelled to a neat, smooth and symmetrical finish.
- 6.3 The insulation of valves and fittings shall fit neatly to the rest of the pipe insulation.
- 6.4 Care shall be taken that all valves and fittings can be operated without damaging the insulation.
- 6.5 The end plates of strainers shall be insulated with suitable closed cell foam rubber to prevent any dripping.

7 HOT WATER PIPES

- 7.1 Hot water pipes shall be insulated as described for chilled water pipes.

8 STEAM PIPES

- 8.1 Steam pipes shall be insulated as for hot water pipes but with the following insulation thicknesses:

Pipes up to 40 mm dia.	- 40 mm
Pipes bigger than 40 mm dia.	- 50 mm

- 8.2 Steam valves, flanges and fittings shall be insulated as for hot water valves and fittings but with the insulation thicknesses as specified above.
- 8.3 Condensate pipes shall be insulated as specified for hot water pipes.
- 8.4 Condensate valves, flanges and fittings shall be specified as for steam valves, flanges and fittings.

9 THERMAL STORAGE VESSELS AND HEAT EXCHANGERS

- 9.1 Insulation shall consist of a 100 mm thick layer of resin-bonded mineral, wool or glassfibre with a density of 96 kg/m³.
- 9.2 The insulation shall be covered with a 0,5 mm thick sheetmetal covering properly dished and strengthened to ensure a neat installation.
- 9.3 All manholes and inspection welded seams shall be provided with easily removable sections.
- 9.4 Where pipes are connected to the equipment a flange of sheetmetal shall be provided fitting neatly around the pipe and welded or screwed to the sheetmetal covering over the insulation.
- 9.5 No dents or any damage to the sheetmetal covering will be accepted at the final inspection.

PART 39: STANDARD SPECIFICATION FOR DRAWINGS AND OPERATING INSTRUCTIONS

1 N/S SUBCONTRACTOR'S DRAWINGS

- 1.1 The N/S Subcontractor shall provide all drawings necessary for the execution of the contract and shall submit such general and detailed drawings of the plant and apparatus included in the "Extent of Contract" as the Mechanical Engineer may reasonably require to approve the construction of the plant.
- 1.2 Details and drawings of all major items of equipment made by the N/S Subcontractor or his suppliers shall be submitted for approval without specific request from the Mechanical Engineer.
- 1.3 The abovementioned drawings shall be submitted to an agreed programme to suit the construction of the plant.
- 1.4 All drawings shall be clearly numbered and marked with the equipment item number as listed by the successful N/S Subcontractor in his equipment schedule.

2 APPROVAL OF N/S SUBCONTRACTOR'S DRAWINGS

- 2.1 The N/S Subcontractor shall submit for approval, in principle, copies of all drawings required by Clause 39.4.1 and all general arrangement drawings of equipment showing overall dimensions, full foundation requirements, building connections and the position of each item relative to the building and other adjacent equipment. The Mechanical Engineer may require from the N/S Subcontractor further detail drawings and/or calculations which clarify features not adequately shown on the layout drawings.
- 2.2 The Mechanical Engineer will return to the N/S Subcontractor within ten working days of their receipt by him, one copy of each drawing marked "APPROVED IN PRINCIPLE" or marked with any changes which are necessary.

The N/S Subcontractor shall immediately modify the details and drawings as required by the Mechanical Engineer. The nature and date of each modification and a distinguishing symbol shall be added and the drawings submitted again for approval.

- 2.3 Two copies of each drawing shall be submitted for approval. Five copies of the final General Arrangement and detail drawings shall be issued to the Mechanical Engineer by the N/S Subcontractor within ten days of receipt by him of approval, in principle, by the Mechanical Engineer.

Further copies shall be provided as may be required by the Mechanical Engineer, either before or after final approval.

- 2.4 The N/S Subcontractor shall provide a complete and comprehensive drawing schedule, updated with each drawing issue, for the use of the Mechanical Engineer.

The drawing schedule shall be issued every time drawings are issued.

- 2.5 The N/S Subcontractor is to ensure that all plants offered can be accommodated in the positions shown on the drawings.
- 2.6 The approval in principle of drawings by the Mechanical Engineer shall not relieve the N/S Subcontractor of any responsibility in terms of the Contract.

2.7 The N/S Subcontractor shall be responsible for any discrepancies, errors, or omissions in the drawings and other particulars supplied by him whether such drawings and particulars have been approved by the Mechanical Engineer or not provided that such discrepancies, errors or omissions are not due to inaccurate information or particulars furnished in wiring to the N/S Subcontractor by the Employer or the Mechanical Engineer.

2.8 All dimensions shall be in S.I. metric units.

3 DRAWINGS FOR CONSTRUCTION

3.1 The N/S Subcontractor shall provide at his own expense all copies of drawings required by him in the execution of the work, and shall also at his own expense supply to the Mechanical Engineer such drawings and copies thereof as are provided for in the Specification.

4 RECORD DRAWINGS

4.1 On completion of the installation but before the Plant is handed over to the Purchaser the N/S Subcontractor shall provide two negatives on linen of each of the following drawings showing the services as fixed:

- (a) Complete 1:50 scale layouts of pipework inside the Plant Rooms.
- (b) Large scale details of the Plant Rooms (at least 1:50 scale).
- (c) Complete 1:50 layout drawings of the whole installation.
- (d) Detailed drawings of all items of plant.
- (e) Details of any other items requested by the Mechanical Engineer.

4.2 The drawings shall be sufficient in detail to enable the Employer's staff to maintain, dismantle, reassemble and adjust all parts of the Works.

4.3 The layouts shall show the location of all manual and automatic valves, control panels, sensors, thermostats, etc.

4.4 The wiring diagrams shall indicate all motor kilowatt ratings and circuit breaker and contactor ratings and settings.

4.5 A copy of the wiring diagram shall be mounted in the Plant Room in a glass fronted frame. The diagrams shall be printed by a non-fading process.

5 OPERATING AND MAINTENANCE MANUALS

5.1 General

The N/S Subcontractor shall submit for approval, four weeks before completion of the installation two copies of the maintenance and operating manuals for the plant and equipment supplied.

The Mechanical Engineer will return to the N/S Subcontractor within ten working days of their receipt by him, one copy marked with any changes which are necessary.

The N/S Subcontractor shall modify the manuals as required by the Mechanical Engineer and submit to the Mechanical Engineer, within ten working days, two revised copies of the manual. On completion of the installation but before the plant is handed over to the Employer, the N/S Subcontractor shall provide three copies of the final maintenance and operating manuals for the plant and equipment supplied. These manuals shall be sewn and bound in book form with hard plastic covers to withstand constant use.

All manuals shall be properly indexed to facilitate easy reference.

5.2 Contents of Manuals

The manuals shall include:

- (a) A list of recommended servicing tools and specialist equipment.
- (b) A list of spares to be supplied by the N/S Subcontractor to cover the period of warranty.
- (c) A priced list of recommended spares necessary for a period of 2 years of operation.
- (d) Exploded drawings or detailed spares list from which every item of every piece of equipment can be positively identified for ordering replacements.
- (e) A list giving the name and address of the local agent for each item of equipment.
- (f) A list giving the name and address of the manufacturer of each item of equipment.
- (g) A copy of all test certificates obtained with the plant.
- (h) A list of recommended lubricants.
- (i) A preventative maintenance programme for all equipment.
- (j) Operating instruction for each item of equipment.
- (k) Performance data and/or characteristic curves.

Note

Drawings and any other information to be bound into the final manuals duly updated to indicate the supply "as fixed".

ANNEXURE B: DRAWINGS

A/C & VENTILATION

Drawing Number	Revision	Drawing Name
P3589-M-01	F	GROUND FLOOR HVAC LAYOUT
P3589-M-02	B	GROUND FLOOR HVAC SECTIONS AND 3D
P3589-M-03	B	GROUND FLOOR NASA EQUIPMENT ROOM
P3589-M-04	A	GROUND FLOOR SANSA EQUIPMENT ROOM

ANNEXURE C: SUB-CONTRACT AGREEMENT AND CONDITIONS