
HVAC Technical Specification

MAY 2023

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TECHNICAL SPECIFICATION

1.1. Introduction

This specification covers the supply, delivery, erection, wiring, installation, testing, commissioning and handing over in complete working order, ready for immediate use and the subsequent guarantee for a period of twelve months of all plant and equipment necessary for the complete Air-conditioning and Ventilation System at NHLS Rustenburg Laboratory. All the work shall be carried out to the complete satisfaction of the Employer and Engineer.

1.2. Standards and Regulations

All the design work was conducted in accordance with the following standards:

- SANS 10400, Municipal By-Laws, OHS Act, Local Fire Department Regulations and/or requirements of the Supply Authorities.
- SANS 10400 – A, General Principles and requirements.
- SANS 10400- O, Lighting and ventilation
- SANS Code SANS 204 for Energy Efficiency in Buildings shall be used as a guide to provide energy management in the building.
- SANS 1125 - Room air conditioners.
- SANS 1424 - Filters for air-conditioning and general ventilation.
- SANS 10252-1 - Water supply and drainage for buildings
- SANS 193 - Fire dampers.
- SANS 14520 - Gaseous fire-extinguishing systems. Physical properties and system design. Part 1: General requirements.
- SANS Code SANS204 for Energy Efficiency in Buildings
- Regulations and/or requirements of the Power Supply Authorities. The Electricity Act 1984 (Act 41 of 1984) as amended.
- SANS 05 Transport, handling and installation of electrical cables.
- SANS 10142-1:2006 (Ed 1.5) The Wiring Of Premises Part 1: Low-Voltage Installations
- SANS 204 - Energy efficiency in buildings
- SANS 164 - All switched socket-outlets shall be suitable for mounting in 100 x 100 x 50mm or 100 x 50 x 50mm boxes.
- SANS 1663 - All switches shall be suitable for mounting in 100 x 50 x 50mm boxes.

All losses, costs or expenditures which may arise as a result of failure to comply with any regulation applicable to this service as specified above shall be for the account of the contractor.

Should any requirement, bylaw or regulation which applied at the time of tender or which becomes applicable during the supply of the installation, contradicts any requirement of this or the standard specifications, such requirement, bylaw or regulation shall over-rule this or the standard specifications and the Contractor shall inform the Engineer immediately of such a contradiction. The Engineer shall also inform the Contractor of any contradiction of which he is made aware of during the supply of the installation.

Precedence of Regulations

The order of precedence, in order of descending importance, for these requirements shall be:

- Statutory and Regulatory Requirements;
- Rustenburg Metropolitan Municipality By-laws;
- Client Standard Specifications;
- General and Project Specific Mechanical Specification; and
- National and International Standards.

The latest revision of any specification, code of practice or standard referred to in this specification shall apply.

Equipment, materials and operational methods shall in order of preference, comply with the relevant SANS, NS, ISO, BSS, DIN or equivalent American Standard whether prescribed or not

Precedence of technical documentation

The order of precedence shall be as follows for clarifying any design and installation:

- Detailed Technical Drawings;
- Technical Specification;
- Bill of Quantity.

Bills of Quantities

Tenderers shall tender on the equipment specified, however, alternative equipment similar to that specified, may be offered as an alternative cost to the main tender bid.

The following Bills of Quantities are intended to describe the equipment in the tender and are not to be considered fully comprehensive. It shall remain the responsibility of the Tenderer to check the quantities of equipment in accordance with the drawings and no extras shall be entertained should it be found that the Equipment Schedules do not include or identify all the equipment required per the Scope of Work identified on the drawings and/or specifications.

1.3. Site Conditions and Inside Conditions Required

Johannesburg has a hot summer (Nov–Mar) and a mild, drier winter (May–Sep). The peak travel times are Mar–May and Oct–Dec.

Site Conditions

Project Location NHLS Rustenburg Laboratory

Altitude 1217 m

Outside Design Conditions Summer 23°C db and 12°C wb

Inside Conditions Required

Temperatures Summer 22.5°C +/-1.5°C db

Relative Humidity 50% RH

Noise Levels

The noise levels within the building shall not exceed the figures listed below (NC 40 etc.). The measurement of noise level shall be defined by ASHRAE and design is guided by SANS10400 Part O

Selection of equipment is to achieve the required attenuation. The below table shows the noise levels used during the design selection of the indoor units

Table 1 — Noise Levels

ITEM	AREA	NR LEVEL
1.	Offices / Laboratory	25-30
	Boardrooms	25-30
	Executive Offices	30-35
	Secretaries and General Offices	35-40
2.	Meeting Rooms	25-30
3.	Restaurants/Cafeteria	35-40
4.	Kitchens	45-50
5.	Toilets	40-45
6.	Basement Parking Area	50-55
7.	Stairwells	
	to service areas	40-45
	to function areas	35-40
8.	Plant rooms	
9.	Site Boundary	40-45

1.4. Ventilation requirements

The rooms ventilation design was guided by SANS 10400 Part O. Table 1 tabulates the minimum air required which was used in heat load calculations. The room population was calculated in accordance with the class occupancy of each building as stipulated in Table 2.

Filtered fresh air will be introduced to all spaces according to the National Building regulations. The fresh air systems shall consist of weather covers, attenuators, filters, fire dampers, fresh air fans diffusers, ducting and volume control dampers. Various extraction systems are also included in the scope of works.

Table 2 — Design Population

The below table tabulates the occupancy class for each room aligned to the population.

Class of occupancy of room or storey or portion thereof	Population
A1, A2, A4, A5	Number of fixed seats or 1 person per m2 if there are no fixed seats
E1, E3, H1, H3, H4	2 persons per bedroom
E4	16 persons provided that the total number of persons per room is not more than 4
H5	16 persons per dwelling unit provided that the total number of persons per room is not more than 4
G1	1 person per 15 m2
J1, J2, J3, J4	1 person per 50 m2
C1, E2, F1, F2	1 person per 10 m2
B1, B2, B3, D1, D2, D3	1 person per 15 m2
C2, F3	1 person per 20 m2
A3, H2	1 person per 5 m2

Table 3 — Air requirements for different types of occupancies

Type of occupancy	Minimum outdoor air requirements		Requirement
	Air changes per hour	L/s per person	
Public halls Assembly halls Churches Theatres (including lobbies and auditoriums) Cinemas	10 10 10 10	7,5 7,5 7,5 7,5	Air supply required per person with required minimum air changes per hour
Dry-cleaners and laundries Commercial dry-cleaners (working areas) Storage/collection area Laundries	— 10 10	120,0 7,5 7,5	Air supply required per person with required minimum air changes per hour
Educational buildings Classrooms Laboratories Libraries	2 2 2	7,5 7,5 6,5	Air supply required per person with required minimum air changes per hour
Food and eating facilities (public) Dining rooms and restaurants Cafeterias Bars and cocktail lounges Kitchens	10 10 10 20	7,5 7,5 7,5 17,5	Air supply required per person with required minimum air changes per hour
Photographic darkrooms	—	10,0	Air supply required per person
Dwelling units Kitchens Other living areas Bathrooms and shower rooms Rooms containing a toilet pan or urinal	10 2 10 10	50,0 5,0 25,0 25,0	Air supply required per person with required minimum air changes per hour
Shops Malls, arcades, warehouses Wholesale stores Sales floors, showrooms, dressing rooms	— 2 2	7,5 7,5 7,5	Air supply required per person with required minimum air changes per hour

Sports and amusement facilities			
Ballrooms and discos	10	7,5	Air supply required per person with required minimum air changes per hour
Bowling alleys (seating area) Playing area (gymnasiums, etc.) Locker rooms	10	7,5	
	–	10,0	
Spectator areas	15	7,5	
Health spas and slimming salons	6	5,0	
	2	7,5	
Garages	10	7,5	Air supply required per
Parking garages			square metre of floor area
Motor car repairs	30	10,0	Air supply required per square metre of floor area Air supply required per person with required minimum air changes per hour
Ticket kiosks	2	5	
Health care facilities			Pressure relative to adjacent area shall be positive
Surgical and critical care:			Pressure relative to adjacent area shall be positive
Operating theatres and suites	20	–	Pressure relative to adjacent area shall be positive
Wound intensive care (burns)			Pressure relative to adjacent area shall be negative
Critical and intensive care, treatment and delivery rooms	6	–	Pressure relative to adjacent area shall be negative
Trauma, ER waiting rooms, radiology waiting rooms and triage	6	–	Pressure relative to adjacent area shall be negative
Diagnostic and treatment areas:	12	–	Pressure relative to adjacent area shall be negative
Bronchoscopy, sputum collection, examination room and treatment room (general)	12	–	Pressure relative to adjacent area shall be negative
Medication room	4	–	Pressure relative to adjacent area shall be negative
Physical therapy and hydrotherapy			Pressure relative to adjacent area shall be negative
Inpatient nursing areas:	6	–	Pressure relative to adjacent area shall be negative
General wards, paediatric wards and labour/delivery/recovery/postpartum rooms	2	–	Pressure relative to adjacent area shall be negative
Airborne infection/protective environment wards and anterooms or airlocks	12	–	Pressure relative to adjacent area shall be negative
Laboratories			Pressure relative to adjacent area shall be positive
Microbiological (molecular)	6	–	Pressure relative to adjacent area shall be negative
Bacteriological P1			Pressure relative to adjacent area shall be negative
Bacteriological P2, P3 and P4	12	–	Pressure relative to adjacent area shall be negative
General biochemistry, cytology, histology, nuclear medicine, pathology and serology	6	–	Pressure relative to adjacent area shall be negative
Radiology			Pressure relative to adjacent area shall be negative
General radiology areas	6	–	Pressure relative to adjacent area shall be negative

Hotels, motels, resorts, dormitories and similar facilities	2	7,5	Air supply required per person with required minimum air changes per hour
Lobbies	10	7,5	Air supply required per person with required minimum air changes per hour
Conference rooms	19	7,5	Air supply required per person with required minimum air changes per hour
Assembly rooms	2	7,5	Air supply required per person with required minimum air changes per hour
Bedrooms	2	7,5	Air supply required per person with required minimum air changes per hour
Living rooms (suites)	10	17,5	Air supply required per person with required minimum air changes per hour
Central kitchens	10	50,0	Air supply required per person with required minimum air changes per hour
Private kitchens			

			Air supply required per room
Libraries			Air supply required per person with required minimum air changes per hour
General	2	7,5	Air supply required per person with required minimum air changes per hour
Bookstock	2	7,5	Air supply required per person with required minimum air changes per hour
Offices			Air supply required per person with required minimum air changes per hour
General	2	7,5	Air supply required per person with required minimum air changes per hour
Meeting and waiting spaces	2	7,5	Air supply required per person with required minimum air changes per hour
Conference and board rooms	10	10,0	Air supply required per person with required minimum air changes per hour
Cleaner's rooms	10	1,0	Air supply required per square metre of floor area
Stages, TV, radio and movie film	10	7,5	Air supply required per person with required minimum air changes per hour
Rooms containing baths, showers, toilet pans or urinals			Air supply required per room
Serving a dwelling unit or a bedroom	15	25,0	Air supply required per bath, shower, toilet pan, urinal stall or 600 mm of urinal space
All others	20	20,0	Air supply required per room
Transportation			Air supply required per person with required minimum air changes per hour
Waiting rooms, ticket and baggage areas, corridor and gate areas, platforms, concourses	10	7,5	Air supply required per person with required minimum air changes per hour
For occupancies other than those listed above, the minimum outdoor air requirements shall be as determined by the local authority			

1.5. Confirmation of Issues

Notwithstanding anything to the contrary as may be set down in the contract Agreement, but rather as an extension to these clauses, it will be in the interest of the Contractor to ensure that any verbal instruction, directive, explanation, etc., given as well as any agreement made or whatever, whether it will involve a variation or not, is confirmed in writing by the Engineer and/or the Principal Agent within 14 days of it being given or made.

Failure on the side of the Contractor to do so may invalidate any claim for a variation to the works and additional payment.

1.6. Manufacturer's Ratings

All equipment specified shall operate well within the manufacturer's ratings. Any tender offering equipment for use beyond these limits will not be considered.

Tenderers shall submit manufacturer's ratings and all technical information of all equipment offered for the full range of capacities, requirements, pressure & temperature ranges, sizes, etc.

1.7. Sound and Vibration Control

The Contractor shall be responsible for the detail design and/or selection of all sound and vibration control equipment. Sound and vibration control shall be designed to give the resultant sound pressure levels specified, when based on the sound characteristics of the rooms given. The vibration isolation system shall be designed and selected and adjusted for a maximum total transmissibility of not more than 2,5%.

All rotating equipment shall be balanced, both statically and dynamically and shall not have any critical speeds within 30% of the operating speed. In addition, all rotating equipment and associated pipe work and ductwork shall be provided with vibration isolation mounts.

Isolators shall give both horizontal and vertical deflection and the amplitude shall not exceed 3 mm.

All pipe and duct connections to vibrating equipment shall be flexible to allow freedom of the equipment to move.

All vibration isolation equipment shall be designed and selected after selection of the relevant equipment and shall be approved by the engineer before ordering of the equipment.

Each spring mounting shall be provided with 7 mm thick neoprene acoustical pads.

The air conditioning and ventilation systems shall be designed to maintain the background noise levels as specified below. The design target shall be the first mentioned NR value. If the second NR value is exceeded then corrective measures shall be implemented (refer to Table 1 – Noise Levels)

1.8. Materials, Workmanship and Equipment Offered

- a. Materials and equipment offered shall be new and of the best quality and as specified herein. Workmanship offered shall be executed in the most substantial manner under the inspection and to the entire satisfaction of the Engineer.
- b. The entire installation shall be in accordance with:
 - The National Building Regulations and Building Standards, Act No. 103 of 1977 as amended in 1984 and all amendments thereafter,
 - The latest revision of SABS 0400: The Applications of the National Building Regulations, as amended,
 - SANS Code of Practice for the Wiring of Premises 142 of 1981, as amended,
 - The Machinery and Occupational Health and Safety Act No. 85 of 1993,
 - Any other relevant by-laws of local or other authorities.
 - In accordance with manufacturers specification and installation brochure
- c. It shall be the responsibility of the Contractor to ensure that the quality of the workmanship and the installation of equipment meets the requirements specified by the Engineer and that the work is carried out in such a manner that the equipment performance meets the requirements provided by the manufacturers and suppliers.

- d. All materials shall be of the qualities specified and the Contractor shall, upon request by the Engineer, furnish the Engineer with proof to his reasonable satisfaction that the materials are of the specified quality. If so required, the Engineer may call for samples of the material and equipment for approval. Such samples shall be submitted within 14 days of the request.
- e. Any fittings or item of equipment not specifically mentioned but obviously necessary for the successful completion of the installation is to be included so as to form a complete working installation.
- f. If any materials or workmanship are not in accordance with the provisions of the agreement, then the same shall, at the cost of the Contractor, be removed and/or re-executed and all rejected materials shall be removed from the site.
- g. The Contractor shall, if so requested, during the continuance of the contract/agreement, keep the Contractor and the Engineer informed regarding the placing of all orders for materials and the progress of manufacture or any article or materials.
- h. Where alternatives for such materials, goods and equipment are permitted, the Contractor shall be liable for latent defects in such materials, goods and equipment and or the cost of making good physical loss and repairing damage to the works resulting there from.
- i. No second hand equipment may be offered or installed unless it is discussed and approved by all relevant parties.

1.9. Approved Manufacturers

All equipment offered, must adhere to the minimum requirements as specified in the technical specifications section of this document. It is required from all contractors to submit data sheets / brochures including all technical specifications to the engineer at the tender stage as well as prior to ordering. The Engineer shall review and adjudicate the submitted technical brochure prior to ordering of equipment.

1.10. Allocated Space

The physical sizes of the equipment offered shall be suitable for the locations shown on the drawings and shall be positioned in such a manner to ensure reasonable access all around the equipment for maintenance purposes and as may be recommended by the suppliers of the equipment.

The Contractor shall, at tender stage, check and ensure that enough space has been allocated for the erection of his equipment and services, taking note of other services sharing the same space. Should the spaces indicated on the Engineer's drawings not be adequate, the tenderers shall at the time of tender advise the Engineer accordingly and, where relevant, submit with their tenders a sketch indicating the required space.

1.11. Coordination with Other Trades

The Contractor shall plan his work in advance and shall coordinate all space requirements in conjunction with the Principal Agent, especially where other trades share the same space. Where conflicts occur, the Contractor shall request clarification from the Engineer.

1.12. Power and Drain Connections

All plumbing between equipment, water and drain points shall form part of this contract and the Contractor shall supply and deliver the equipment required.

The power supply from the distribution boards up to a main isolator including the final connections from the isolator to the equipment shall form part of this contract. The Contractor shall therefore supply all electrical and control equipment required for the final connections.

1.13. Waterproofing

Where any work pierces waterproofing, including waterproof concrete and roofing, the method of installation shall be approved by the Architect and/or Engineer before the work is carried out.

All necessary sleeves, caulking, skirts, soaker sheets, flashing, etc., required to make the openings absolutely water-tight shall be provided by the Contractor, but shall be handed over to others for installation

1.14. Welding

All welding, during the manufacturing or pre-assembling of the equipment, shall be performed according to the latest technology using the latest developed and approved welding equipment by a qualified welder, and where exposed it shall be smoothly finished off.

1.15. Insurance and Surety

The Contractor shall carry Insurance and Surety in accordance with the contract requirements.

1.16. Guarantee

The Contractor shall guarantee that the equipment offered shall give satisfactory and efficient service, for a period of one year from the date of practical completion, and to replace or repair, with a minimum of delay and free of charge, any components which shall fail other than by fair wear and tear during this period. Consumable components are excluded from the guarantee

1.17. Omissions and Variations During Tender

When the Tenderer desires to make omissions or variations from the specification, he shall record these on the equipment schedule (under section 6.1) together with references to the relevant sections of the specification.

2.1 HVAC SYSTEM INSTALLATION

2.1.1 Scope of Work

The Contract, as detailed in these specification documents comprises of the manufacture, supply, transport and delivery, hoisting, installation, testing, setting in operation, leaving in complete work order, and guarantee of the entire air conditioning plant and, except so far as the contract otherwise provides, the provision of all labour, materials, contractor's equipment etc, whether of a temporary or permanent nature required in and for such manufacture, supply, offloading, hoisting, installation, testing, setting in operation, leaving in complete working order, guarantee so far as the necessity for providing the same is specified in or reasonably to be inferred from the contract.

Minor builder's work has been included in this contract as enabling works for the HVAC installation. All other work, as later herein specified as being specifically excluded from this contract, shall be carried out by others in accordance with the details provided by the engineer or the contractor as applicable and as provided herein.

3.1.1 Selection & Ordering of Materials And Equipment

The Contractor shall note the following:

- Materials of similar class or service shall be of one manufacturer.
- Capacities, sizes and dimensions given are minimum unless otherwise indicated.
- Deliver and store manufactured materials in original containers, which shall indicate clearly the manufacturer's name, brand and identifying number. Clearly mark or stamp with manufacturer's name and rating.
- Specified equipment shall be as hereinafter specified.
- It is the Contractor's responsibility to ensure that all materials and equipment provided are entirely

suitable for the application. Materials and equipment which are not suitable for the application, or are not to the satisfaction of the Engineer, shall be replaced by materials and equipment which are suitable and which are to the satisfaction of the Engineer. All such replacement costs shall be for the account of the Contractor.

It shall remain the responsibility of the Contractor that all equipment requiring a lead time with respect to delivery shall be timeously submitted in keeping with the programme, so as to ensure timeous delivery and installation.

3.1.2 Drawings

Tender Drawings

The following drawings have been issued with this Tender:

Project Name:		NHLS RUSTEBURG LABORATORY
DWG/DOC No.		DESCRIPTION
No. Drawings	REV	
2405 ME 00	0	NHLS RUSTEBURG LABORATORY LOWER GROUND FLOOR HVAC LAYOUT
2405 ME 01	0	NHLS RUSTEBURG LABORATORY GROUND FLOOR HVAC LAYOUT
2405 ME 02	0	NHLS RUSTEBURG LABORATORY FIRST FLOOR HVAC LAYOUT

Architectural and Structural Drawings

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

Builder's Work Drawings

All Builder's Work and work to be carried out by others in accordance with the Specification has been indicated on the Tender Drawings. The Contractor shall check, approve, add to or alter such drawings as may be necessary to suit the Plant offered by him, and accepted by the Engineer, within the time stipulated in Section 3.1.1 Programme, hereof from date of acceptance of his Tender and shall submit to the Engineer in duplicate any revision which shall be made to such Drawings.

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

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

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

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

Architect

1 copy

Shop Drawings

The Contractor shall submit to the Engineer, for approval within the time stipulated in Clause 1.5.5 hereof duplicate

copies of all Shop Drawings as required for the manufacture and installation of the Works or as the Engineer may reasonably require.

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

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

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

Drawings approved as above described shall not be departed from except as authorised by the Engineer.

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

Mechanical drawings

These are all workshop and equipment layout drawings required for the erection of the installation.

The Contractor shall check in detail the Engineers and Architect drawings issued and take measurements on site before workshop drawings are issued for construction or equipment is manufactured, to ensure that the equipment will fit into the space available. Positions and sizes of openings through walls, floors, etc., as indicated on the Engineering/Architect drawings shall be adhered to.

All piping routes and piping accessories shall be shown in detail on the mechanical drawings.

Drawings, except Contractor's drawings, shall be submitted for approval. The drawings shall be submitted no later than six weeks after the date of acceptance of the tender. The Contractor shall base his drawings on the Architects and Engineer's drawings issued to him by the Client.

The Contractor is advised to submit three copies of the mechanical workshop drawings for comments by the representative after which his original drawings shall be updated and submitted for signature to ensure that all drawings issued for construction are certified as approved by the Engineer.

The following information shall be supplied with workshop drawings:

- Certified dimension drawings, indicating pipe sizes, location of equipment, component parts and installation details.
- Manufacturer's specifications, including materials, type and capacity ratings.
- A list of all deviations from the plans and specifications and reasons for the deviation.
- Electrical control panel wiring diagrams and panel layout drawings.
- Pipe support and bracket construction detail drawings.
- Any work carried out by the Contractor without approved drawing shall be at the Contractor's own risk and any changes required to conform to the contract Documents or to co-ordinate his/her work with other trades shall be for the account of the Contractor.
- Approval of drawings by the Engineer shall not relieve the Contractor of his responsibilities to carry out the work in terms of the contract documents.
- The mechanical drawings shall be updated (if applicable) during the contract period and shall be included in the Operating and Maintenance manual as required.

Mistakes in Drawings

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

contractor.

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

As-Built drawings and wiring diagrams

These are up-to-date approved drawings at the completion of the contract. Tenderers shall allow in their price for submitting to the Engineer a set of each of the up-to-date general arrangement drawings, shop drawings, together with the O&M manuals specified herein.

3.1.3 GENERAL REQUIREMENTS

- By virtue of submitting a tender it shall be deemed that the Tenderers have satisfied themselves with all aspects of the project and in particular with the Contractual Conditions pertaining to the Principal Contract and that due allowances have been included in the tender price.
- Under no circumstances will claims for additional costs, in respect of the foregoing, be entertained after submission of tenders.
- It is a requirement that the entire installation shall function, prior to the beneficial use stage having been reached, in order to facilitate the commissioning of the entire plant prior to that stage.
- Beneficial use of the installation shall be deemed to have commenced when all installations have been fully commissioned and all the requirements of this specification and drawings complied with, for the installation as a whole.
- Tenderers shall make due allowances for the proper maintenance and guarantee, in terms of this specification, of the entire installation from the time of the first operation of individual components up to the beneficial use stage.
- Thereafter, a full 12 months free monthly maintenance and guarantee period shall commence from the date of approval by the Engineer of beneficial use of the entire installation.
- No combustible materials will be permitted in the ceiling and/or floor void or any other air plenums.
- Although certain items are required to be affected by others, i.e. marked thus (*) on the drawings, it shall still be the responsibility of the Contractor to co-ordinate and ensure that this work is carried out by the other trades.
- Where difficulty may be experienced in sealing gaps (openings) between underside of slabs and the top of ducts etc. where they go through walls and structure, the Contractor shall install Compri-band, Sondor, or an equally approved product, before the duct etc. is placed in position.
- Where switched socket outlets are provided in the ceiling void for either 220 Volt or 24 Volt connections to HVAC equipment, the cable connection between the local isolator and the equipment served shall be exposed PVC insulated cable not greater than 2 000 mm in length.
- It is hereby pertinently brought to the Tenderers notice that once this contract has been awarded, should

it in the opinion of the Consulting Engineer, be found at any stage during the course of the project that the Engineer's involvement in the project is in excess of what is considered to be reasonable in terms of his conditions of Employment, due to the non-performance of the Contractor (or his/her Subcontractors), then the Contractor shall be accordingly advised and be liable for such additional costs as identified and incurred by the Engineer.

- The tender period is fixed and no extension shall be entertained.
- Making off of the main incoming power cables reticulated by the Site Electrician, shall be the responsibility of the appointed Contractor.
- All equipment base formers, brackets and accessories to complete the installation as required.
- As-built drawings – hard copy and magnetic DXF/DWG format of all drawings.
- Operating and Maintenance Manuals – 3 sets.
- Spares and tools as specified and where applicable, as provided with the equipment.
- The Contractor shall allow for two days training of the Client's Maintenance and Technical Staff in the use and operation of all systems/ equipment.
- Painting of all equipment and ducting in accordance with the Specification. All exposed piping, ducting and equipment shall be painted i.e. Roof Plant / Piping and in Plant Rooms, including the ducting exposed in the Roof plant rooms. All bare steel surfaces shall be painted with primer and where exposed, with 2 coats of enamel.
- Directional airflow arrow shall be label on the ducting
- The contractor shall ensure that all joint is tightly sealed with bubble wrap along the duct to prevent any leaks

3.1.4 Piping

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

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

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

The piping network shall be connected using refrigerant branch joints, complete with the necessary reducers with the matching insulation as supplied by the system manufacturer.

Heat recovery shall be achieved by heat recovery units, complete with the necessary reducers with the matching insulation as specified and supplied by the system manufacturer.

Suction, discharge and liquid pipes are to be insulated separately and not grouped together as for a single line. Approved pipe insulation shall be used.

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

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

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

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

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

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

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

Provision shall be made for the drainage of condensate to the outside or to dedicated drain points by means of PVC piping of the sizes as indicated on the drawing.

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

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

Refrigerant Piping

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

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

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

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

- Part 2 specifications.

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

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

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

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

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

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

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

Refrigerant piping shall be arranged so that normal inspection and servicing of the compressor and other equipment is not hindered. Locations where copper tubing will be exposed to mechanical damage shall be avoided.

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

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

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

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

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

Inside the building piping shall be installed on approved medium-duty galvanised cable tray wide enough to accommodate both refrigerant pipes and the drain piping.

Outside the building piping shall be installed on approved medium-duty galvanised cable tray wide enough to accommodate both refrigerant pipes and the drain piping, including galvanised sheet metal covers painted to colour match the walls. Rung spacing shall be at 300mm intervals.

All cable trays shall be supported on approved 41x41x1.5mm galvanised channels including galvanised hold down saddles, bolts, nuts, washers and screws. The channel shall be supported from 8mm diameter hanger rods including washers and nuts. Channels to be spaced at intervals not exceeding 1500mm. Cable trays are to be installed to a fall of 1 in 100.

All cable ladders shall be supported on approved 41x41x2.5mm galvanised channels including galvanised hold down cup, bolts, nuts, washers and screws. The channel shall be rawl bolted directly to external walls or slabs. Channels to be spaced at intervals not exceeding 1500mm. Cable ladders to be installed to a fall of 1 in 100.

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

Strappings and cable ties will not be permitted. Hangers and supports where piping penetrates through walls shall be designed to prevent transmission of vibration to the building. Supports must be installed near to joints and fittings. Pipe clamps shall be installed at the following centre to centre distances.

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

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

Pipe Insulation (Sans 1445 & Sans 1508 As Applicable)

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

The insulation material shall meet the following minimum requirements:

Temperature range	:	-80°C + 120°C
Thermal conductivity	:	0,038 W/m K at 0°C
Thickness	:	15 mm
Density	:	35kg/m ³
Odour Properties	:	Neutral
Cellular Structure	:	Totally closed
Fire Properties	:	Self-extinguishing

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

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

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

Pressure Testing on Piping

All new copper refrigerant piping shall be hydraulically pressure tested to 1,5 times the working pressure or 1000 kPa, whichever is the largest. The test shall be carried out in the presence of the Engineer and Client.

All piping shall be subjected to the test pressure for a period of one (1) hour during which time the system shall retain the pressure with no leaks or losses.

Controls Individual control unit

The contractor shall supply and install approved hard-wired remote controllers in the positions indicated on the drawings.

The controller shall perform the following functions:

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

3.1.5 Ventilation Fans

Only good quality fans, from recognized manufacturers and suppliers with established local representation, and of the types as specified hereafter, shall be acceptable.

Alternative types of fans, suitable for the application and with dimensions to suit the allocated equipment spaces, may be offered to provide the most economical solution.

The fans offered shall nevertheless meet the specified air flow rates at the indicated system resistance. Fan efficiencies shall under no circumstances be less than 60 [%].

Fresh air supply systems shall be complete with washable primary air filters. Tenderers are to note that the fan total/static pressures indicated in the equipment schedules are to be used as a guideline at tender stage only.

The required pressures are to be re-calculated by the Contractor to allow for the equipment, as well as any modifications to the duct sizes and routes, etc., offered by the Contractor. If the Contractor is unable to calculate the new system resistance, the Engineer will do so, provided all the required information is made available by the Contractor. It shall nevertheless be the Contractor's responsibility to ensure that the system resistance of the new/altered duct layout is calculated and allowed for.

Fans with motors larger than 1 kW shall be internally sprung within their casings, or shall be fitted with anti- vibration mountings. The fans and their associated equipment offered shall meet the sound levels specified herein.

Tenderers or their suppliers shall calculate the noise levels generated by the offered fans, prior to close of tenders, and, if necessary, provide proprietary made attenuators down- and/or upstream of the fans, whether shown on the drawings or not.

3.1.6 Painting

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

Iron and steel surfaces shall be properly cleaned by removing all dirt, oil, scale and rust by brushing and sanding until a clean shiny surface is obtained. Hereafter a metal primer must be applied.

Galvanized surfaces shall be cleaned with a galvanizing cleaning agent and then washed with clean water to remove the factory-applied protection against white rust. Hereafter a calcium plumbate primer shall be applied, followed by an undercoat between 24 and 72 hours after application of the primer.

Other surfaces shall be cleaned by removing all dirt and a primer as specified by the paint suppliers for the particular surface must be applied.

Metal surfaces shall be painted as follows:

Surfaces shall be thoroughly cleaned in accordance with SABS 064. A zinc chromate primer complying with SANS 679 type 1 shall then be applied. Finally, two coats of paint complying with Grade 1 of SANS 630 shall be applied.

The primer coat shall be followed by a matt undercoat and a final top coat of high gloss enamel of a colour approved by the Engineer/ Client.

Each layer of paint shall be clearly distinguishable from each other by means of different colours and each layer shall be properly sanded before the following coat is applied.

All paint shall be at least SANS quality for industrial use and shall be approved by the Engineer, both regarding

quality and colour. Colour coding shall be according to SANS 10140 Part IV.

The following SANS codes shall apply:

SANS 10064	PREPARATION OF STEEL SURFACES FOR PAINTING
SANS 10140	IDENTIFICATION COLOUR CODING (ALL PARTS)
SANS 630	HIGH GLOSS ENAMEL ART PAINT
SANS 678	BASE PAINT FOR WOOD (INTERIOR AND EXTERIOR)
SANS 679	SINC-CHROMATE BASED BASE PAINT FOR STEEL
SANS 681	UNDERCOATS FOR PAINTWORK
SANS 682	ALUMINIUM BODY COLOUR PAINT
SANS 723	ETCHING PAINT
SANS 912	CALCIUM PLUMBATE BASE PAINT
SANS 1091	NATIONAL COLOUR STANDARD FOR PAINT
SANS 1186	SAFETY SYMBOL SIGNS

3.1.7 Condensate Drains

The Contractor shall supply and install all condensate drain piping required for the works.

Others shall only provide a trapped connection point in the relevant ceilings directly above the connection to the buildings waste drainage system, unless otherwise indicated on the drawings. The internal condensate lines shall have a minimum fall of 1:100.

The drain lines from individual air-conditioning units shall be trapped and have a minimum internal diameter of 15 [mm] (pipe diameter to match respective indoor and outdoor units).

Internal condensate drain lines shall be in PVC piping insulated with neoprene in order to prevent condensate dripping on ceiling tiles

3.1.8 Testing

On completion, the installation shall be balanced, set and tested to establish the capacity and performance of the plant. All such tests shall be recorded and typed copies of all test recordings shall be included within the operating manuals later specified herein. The test reports shall set out the procedure, data and instrument readings obtained as compared with the required capacities and the manufacturer's name plate rating where applicable.

3.1.9 Operating and Maintenance Instructions

The Contractor shall prepare and supply manuals for the successful installation, operation and maintenance of the equipment. A draft of the manual shall be submitted after pre-testing for approval. Three instruction manuals shall be provided for the new equipment. Each manual shall comprise of the following sections, bound in a vinyl plastic covered folder with the name of the project typewritten on a card inserted into a clear plastic covered cardholder on the front cover and spine and shall be handed to the Manager on completion of the installation.

- **Index**
- **Description of plant** (as installed)
- **Operation of plant** (as installed)
- **Plant and equipment** (a schedule list of all major plants to include description, make, model number and supplier's name and address).
- **Test Report**
- **Maintenance Instructions** (in schedule form setting out each item of the plant, the description and frequency of maintenance operations required).
- **Spare Parts** (list of spare parts to be supplied, as later specified herein, with detailed description of each part, make, model and part number and supplier's name and address)
- **Descriptive literature** (for all items of plant and equipment)
- **Record drawings** (of plant as installed to include plant layout drawings, control and wiring

diagrams and schematic piping diagrams).

- **Building Management System (BMS)** (Trouble shooting guide, Maintenance schedules for all equipment and Maintenance data and record books.

The operating maintenance instructions specified above shall preferably be obtained from the equipment manufacturer and where no such manuals exist, they shall be compiled by the Contractor to the best of his ability and approved by the Engineer.

The contract shall be considered incomplete until all test and commissioning results and certificates have been conducted to the satisfaction of the Client and all drawings and manuals have been handed over to the Engineer and Employer.

3.1.10 Training of Employers Representatives

The Contractor shall be responsible for the training of the Employer's staff during the commissioning period and after the installation and maintenance manuals have been completed. The staff shall receive enough instructions to ensure that they are fully conversant with the equipment concerned. Site staff shall be instructed on:

- a) The full installation, commissioning, testing and operating methods of the equipment.
- b) All instructions and problem solving of equipment.
- c) Stopping the equipment in emergency and warning against restarting after an emergency.
- d) Positions and settings of all control equipment.
- e) Operating temperatures, pressures, etc.
- f) All safety measures including electrical.
- g) Name, address and telephone number of the equipment suppliers and contractor that can be contacted during installation and maintenance of the equipment.

The operating and maintenance manual shall be available during the training of the staff. Staff shall also be made conversant with the contents of the manuals.

All instruments such as thermometers, pressure gauges, indicators, etc. shall be marked at the operating point under normal conditions. Such markings shall be neatly done on the scale itself and not on the protecting glass cover.

3.2 SPECIFIC EQUIPMENT DETAILS

3.2.1 Ducting

Ductwork

Ductwork shall be carried out in accordance with the details shown on the Drawings and shall be fabricated from prime quality galvanised sheet and stainless steel. All duct sizes indicated on the drawings are metal sizes and include the necessary allowances for any internal insulation, which may be specified.

Ductwork shall be fabricated and installed in accordance with the following specification, which shall be read in conjunction with the standards set by the Sheet Metal and Air Conditioning Contractors National Association of America (SMACNA), which shall be adhered to in detail except only as hereinafter specified.

Rectangular ductwork sheet thickness and cross breaking shall be as follows: -

Duct Size Long side mm	Duct Joint	Sheet Steel thickness mm	Sheet Steel gauge	Cross Breaking Length mm	Type of Stiffener	Intermediate
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Up to 750	Slip & Drive	0,6	24	2400	None
Up to 760	Mez	0,6	24	2400	None
751 to 1250	Mez	0,8	22	2400	None
1250 to 2400	Mez	1,0	20	1200	Tie-Rods
Above 2400	Mez	1,2	18	1200	Tie-Rods & Flat V Top hat

Longitudinal seams shall be Pittsburgh lock on all duct sizes. Cross joints on concealed ductwork having a semi-perimeter not exceeding 1150mm shall be as follows: -

Duct Size Long side mm	Long Side	Short Side
Up to 450	'S' slip	Drive Slip
451 to 760	25 mm Bar slip	Drive Slip

Cross joints on concealed ductwork having a semi perimeter in excess of 1150mm shall be of Mez or equal flange type, installed in accordance with the manufacturer's recommendations. As an alternative to the Mez or equal flange joints, 40mm x 3mm angle flange joints may be used.

Cross-joints on all exposed ductwork shall be of Mez or equal flange type.

Panel stiffening shall either be cross breaking, beading or pleating of longest side of all ducting.

Ductwork supports shall be of rod and angle type, sheet metal straps not being permitted. The size and spacing of these supports shall be as follows: -

Duct Size long side mm	Angles mm	Rods dia mm	Spacing max - mm
Up to 750	40 x 3	6	3000
751 to 1250	40 x 3	8	3000
1251 to 2400	40 x 6	10	2400
Above 2400	50 x 6	12	2400

Rectangular ductwork shall be regarded as medium velocity medium-pressure ductwork suitable for pressures up to 500 Pa and velocities up to 10 m/s. It shall accordingly be fabricated and installed to comply with the above requirements and the "Medium Velocity Duct Construction Standards" manual published by SMACNA. The contractor shall submit a testing methodology to the Engineer/Client for approval.

All cross-joints in ductwork shall be sealed with a liberal coating of 3M or equal Duct Sealer and Bubble wrap. Longitudinal joints/seams exposed to weather shall be made waterproof.

All duct connections to vibrating equipment shall consist of a flanged joint, followed by a flexible connector consisting of a neoprene covered fibreglass cloth fixed on either side of the joint in a double lock seam to form an airtight flexible joint with a minimum of 50mm separation between metal edges. Ducting at flexible joints shall be so supported that the ductwork is held square with the adjoining duct and no stress is imposed upon the flexible joint. Copper earthing straps shall be fitted over all flexible duct connections and be carried out in accordance with the standard wiring regulations.

Flexible ducts shall be equal to INSULATED EUROFLEX, comprising glass fibre fabric. P.V.C. coated with spirally wound metal inserts. Where flexible ducts connect to normal sheet metal or stainless steel ductwork or other equipment, a liberal coating of 3M or equal Duct Sealer shall be used, the joint then sealed with DURO - DYNE or equal 75 mm wide duct tape and finished with an approved clamp or metal strap to ensure an airtight joint.

Circular flexible ducting connected to supply air diffusers shall not exceed 1,5m in length.

All supply and exhaust air ducting shall be pressure tested with a maximum permissible leakage of less than 5% at a test pressure of twice the working pressure.

The maximum permissible leakage rate for return and ventilation air systems shall not exceed 5%.

All insulated ducting in storage or in position shall be adequately protected at all times

All ducting joints exposed to weather shall be waterproof and corrosion free.

Ductwork Insulation

Ductwork shall be insulated according to the requirements noted on the Drawings and in accordance with the following specifications.

Where noted on the Drawings, the supply air ducting shall be internally insulated with 25 mm thick "sonic liner" or equal, glued to the inside surface of the ducting with a fire retardant adhesive. In addition the insulation shall be further mechanically secured with Grip Nails or "Spotter Pins" at 450mm centres and not more than 75 mm from the edges of each panel. The insulation ends shall be covered with 0,8mm thick galvanised metal strips riveted to the duct panels to prevent erosion of particles of the insulation into the air stream.

External supply and return air ducting shall be internally insulated with 50 mm thick "sonic liner" or equal, glued to the inside surface of the ducting and mechanically secured.

Ducting installed in open roof spaces above insulated ceilings shall, in addition to being insulated internally with 25mm thick "sonic liner" or equal in accordance with clause 16.2, be wrapped externally with 50mm thick "foil faced" or equal fibreglass insulation, unless otherwise noted on the Drawings. This external insulation shall be strapped around the ducting with strapping bands fixed at 1200 mm centres, and joints sealed with foil duct tape.

Ventilation ducting only installed above ceilings and below concrete slabs shall be un-insulated unless otherwise noted on the Drawings.

Diffuser, Grilles and Louvres

Air distribution shall be affected by means of ceiling diffusers or grilles of the sizes, types and having the discharge patterns as indicated on the Drawings.

Ceiling Diffusers and grilles shall be fixed to spigots extending not less than 100 mm from the ducting, unless otherwise indicated on the Drawings, and shall be securely fixed so that no screws or other fixing devices are visible. Supply air diffusers shall be of steel construction and shall consist of an inner core which shall be easily removable from the outer section to facilitate access to the volume control damper located behind the diffuser. The inner core shall consist of concentric rectangular collars and the outer section shall consist of a single rectangular or bevel collar provided with a concealed spigot for attaching the diffuser to the supply ductwork.

Supply air diffusers shall be equal to RICKARD model CCD and CRD complete with dampers, and shall be finished in an epoxy powder coating in a colour to suit Architects requirements. Alternatively, fibreglass or aluminium diffuser casings will be acceptable.

Supply air grilles shall be of the double deflection type consisting of two rows of individually adjustable aerofoil section vanes, the front vanes being horizontal and the rear vanes vertical. The vanes shall be housed in a surrounding fixing flange with neat mitred joints at the corners. The entire grille assembly shall be of extruded aluminium unless otherwise noted on the Drawings.

Supply air grilles shall be equal to Europair type DD complete with factory fitted opposed blade dampers.

The multivane opposed blade dampers provided with supply air diffusers and grilles shall be finished in matt black lacquer. The dampers shall be attached to the rear of the grilles and fitted into the spigot connections or the diffusers and shall be adjustable, by means of a key or a lever, from the front of the installed diffusers and grilles.

Return air grilles shall consist of aluminium grid core housed in an extruded aluminium-fixing flange with neat mitred corners and finished in plain anodised aluminium unless otherwise noted on the Drawings.

Return air Grilles shall be equal to Europair type RA.

Door grilles shall be extruded aluminium construction equal to Europair type DG suitable for fitting into doors of varying thickness and shall be finished in a colour to suit Architects requirements. Door grilles shall be fixed to doors by means of countersunk screws with a colour to match the door grille.

Outside air intake weather louvres shall be of the extruded aluminium fixed vane type fitted with a vermin proof screen on the rear side as well as an opposed blade damper.

Dampers shall be provided with a locking device so that once has been set for the correct airflow they can be

permanently locked in position. Louvres shall be finished in plain anodised aluminium.

Where indicated on the Drawings the outside air intake louvres assembly shall be fitted with firmly fixed foam rubber gaskets and spring clips for the attachment of the fresh air filters, as later specified herein. The frames shall be fixed to the weather louvres so as to prevent any air by-passing the filters.

Rubber gaskets shall be glued to the rear of the fixing flanges of all diffusers, grilles and louvres to ensure airtight seals and prevent smudging.

Dampers

Dampers shall be provided where shown on the Drawings for shut-off, bypass or volume control purposes or where required to comply with local fire codes.

Volume control dampers shall consist of multiple blades acting in opposed blade manner, the blades being robustly linked together to operate in complete unison. Individual blades shall be hooked-edge construction, so bent for rigidity. The blades shall have steel trunnions mounted in bronze sleeve bearings or ball bearings. Permanently set dampers shall be provided with suitable devices to facilitate locking them in position with "Open" and "Shut" position indication.

Motorised dampers shall include suitable fastenings and supports for motor actuators.

Damper hardware shall be the product of an accredited manufacturer of such items, equal to DURO-DYNE. Dampers sections shall be housed in flanges steel metal casings of 1,6mm thick galvanised steel. Damper blades shall not exceed 200 mm in width and 1000 mm in length. Dampers over 1000 mm in length shall be sectionalised into separate cells each with its own shaft and bearings to ensure that the blade length of each section does not exceed 1000 mm.

Fire dampers shall be equal to BLENDAIR or TROX and manufactures to a recognised fire code with a two-hour fire rating. Damper casings shall have flanged ends and damper blades shall not exceed 300 mm in width. The fire dampers shall comply in all respects with the requirements of the local municipal fire authorities in the area where they are to be installed.

Damper blades shall be closed by the operation of approved fusible links located where they would be immediately affected by an abnormal rise in temperature of the air stream. When called for on the Drawings the blades shall also be actuated by solenoid operators, which shall be provided by the damper manufacturer. When closed in the blades shall be held by a catch arrangement so as to provide a positive seal against the air stream.

Duct mounted air volume control dampers and fire dampers installed in ducts shall be provided with a minimum 300 x 300mm inspection opening so that the dampers may be checked, maintained and reset when required. These inspection openings shall be covered with suitably sealed access panels.

3.2.2 Filtration

Fresh air supply

Pleated washable filters, of the standard panel type, with zinc passivated mild steel frames shall be installed on all outdoor air intakes and upstream of all cooling or heating systems.

Filters shall have a minimum resistance of 95% at 5 micron.

Filters shall be contained in a purpose made filter bank. Where filters are to be incorporated in a duct, the panels shall be suitable for side access.

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

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

One full set of filters shall be installed after expiry of the 12 months free warranty period.

While the air-conditioning plant is in operation up to and possibly after the premises opening, (depending on site

conditions), temporary filter media must be installed over the panel filters to protect them from excessive dust.

Exhaust air

The exhaust air housings will comprise of 3 stage filtration. the air will be exhausted at roof level from the various exhaust duct risers.

There will be a pre filter and secondary filter to protect the molecular filtration from blocking with particulate.

3rd stage if carbon (molecular) specifically for the absorption of formaldehyde fumes.

The molecular filters are "cartridge type" this are fitted with specifically designed holding frames and housings.

As the exhaust has the 3 stages of filters there is a need for 2 camcube housings per filter section, housing 1 if for the primary and the secondary filter and the 2nd housing for the molecular filters.

3.2.3 Motors

All motors used in the air conditioning installation shall be of the latest type and in accordance with all relevant SABS standards. All necessary overload protection must be provided.

3.2.4 Sound Attenuation

Sound attenuators shall be provided and installed in the positions indicated on the Drawings and shall be selected to provide the Noise Criteria levels specifies in Part 4 hereof. Sound attenuators shall be of factory fabricated type equal to those manufactured by SOUND ATTENUATORS LIMITED or DONKIN.

The sound absorbing lining material shall impart no odour to the air, shall not delaminated readily, shall have no loose material or any exposed surface that may be detached by the air stream either during installation or under regular operating conditions. The material shall also be non-combustible.

All lining material shall be in good condition at the time of final inspection. Material that has been damaged in shipment by rough handling vibration or exposure shall be rejected. Material that has been damaged prior to final inspection shall be replaced or coated to prevent detachment of loose material as directed by the Engineer.

Sound absorbing lining material generally shall have a density of not less than 16 kg per m³, a thickness of not less than 25mm and sound absorbing efficiency at each frequency of not less than the following: -

Frequency cycles per second	250	500	1000	2000
Percent absorption	45	65	70	80

The factory fabricated sound attenuators shall be complete units consisting of an outer casing, sound absorbing material and internal baffles and supports. Casings shall be made of zinc-coated steel, not lighter than that specified herein for ducts of the same outside dimensions.

3.2.5 Vibration insulation

Unless otherwise noted on the equipment schedules hereafter, all mechanical equipment, i.e. machinery, piping, ducting, etc., shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure

3.2.6 Corrosion precautions and finishes

All materials such as brackets, hangers, etc., shall be shot blasted, pre-painted, galvanized or treated against corrosion prior to their delivery to site. Any work that will require site cutting, etc., i.e. exposure of the bare steel to the atmosphere, shall immediately be treated by cold galvanizing, painting, etc.

The method of treatment for the above shall depend on the particular environment and type of surface to be coated. The surface preparation, primer coats, finishing coats, etc. shall therefore be in accordance with those specified by reputable paint manufacturers.

Each application shall be allowed to dry completely before the next coat is applied. The only exception to these stipulations shall be in the case of subcontracts, where the Contractor shall only apply the primer coats and the Principal Agent the finishing coats.

Color coding shall follow the coding currently used on site. If no color coding is in use, or in the case of new installations, the latest SANS 10173 (clause 6) and SANS 10140 Standards shall be used.

Plant and equipment, pre painted or pre primed at the factory shall be examined to ensure that the paint finishes are in a good condition. If not satisfactory, priming paint or finishing coats shall be removed where necessary, the surface cleaned to remove rust, and all such surfaces re-primed and finished in two coats of high quality paintwork to match the original.

The contractor shall fix black on white ivory labels to all items of equipment (machinery, fans, pumps, electric heater batteries, humidifiers, air handling units, outdoor condensers, etc.), as well as to all active valves (motorized and solenoid) and major isolating valves.

The labels shall be screwed or pop-riveted to the equipment and attached to the valves with steel cables. The lettering shall not be less than 10 mm in height and the wording shall be approved by the Engineer. The wording and tag numbers shall be the same as those used in this specification and indicated on the drawings

3.3 AIR DISTRIBUTION

3.3.1 Supply Air

Conditioned air is to be diffused into the spaces via supply air diffusers. The spacing and selection of outlets shall provide optimum airflow patterns, which shall be adjusted to avoid drafts and shall provide optimum air distribution for comfort.

All disc and grilles shall be finished in natural anodised aluminium, white baked enamel, or epoxy finish in a colour agreed with the Architect/ Internal Designer. Grilles occurring in bulkheads must be finished in baked enamel or epoxy finish in a colour to match the internal decor.

All outlets and supply air grilles are to be selected with a maximum face velocity whilst still complying with the noise level specification.

3.3.2 Return Air

No return air grilles shall be installed in accordance with the design issued.

NB: The bill of Quantities is by no means a list of equipment but rather a measure of the costs, therefore the contractor shall install whatever is necessary to make the systems work as intended as per engineers' drawings.

3.3.3 Air Filters

Air filters shall be installed before the coils in the packaged air conditioning units and the air- handling units and shall be equal to FIBATRON WP 77 minimum 50mm thick high performance washable pleated panel filters.

Long life air filters installed in independent air filter banks in Plant Rooms or before the coils in packaged air conditioning units and air handling units, where indicated on the Drawings, shall be equal to BRANDT EXPO 3000 extended surface air filters with VILEDON type PSB 290 filter media having an arrestance of 90% (ASHRAE). Each filter cell shall be suitable for the manufacturer's recommended air flow of O, 833 m³/s at an initial resistance of 20 Pa. Manometers to be used in conjunction with these filters shall be set for a final resistance of 150 Pa.

Fresh air filters shall be of the same make, type and size as the return air filters fitted in the units and shall be fitted into the holding frames installed on the rear of the outside air intake weather louvre so as to be easily removable from inside the plant room area.

Air filters shall be fitted into holding frames, which shall be designed to allow negligible quantity of air to bypass the filters.

All filter banks shall be mounted in easily accessible positions and shall be reachable with a normal 1.8m long ladder.

3.3.4 Refrigerant Gasses

Units must be fully compatible for replacement with applicable drop in replacement gases.

- **R22 shall not be used.**
- **R11 shall not be used.**

Refrigerant gasses shall ideally be pure gasses however blends shall be considered.

Global warming potential and ozone depletion potential shall be limited as far as possible.

Piping shall be flushed with inert gasses, refrigerant flushing of pipework may not be performed.

All piping systems shall be pressure tested and vacuum tested to the approval of the engineer prior to the introduction of refrigerant gasses.

Refrigerant gasses shall be weighed into systems to ensure adequate filling charge.

Condenser

All coils shall be suitable protected during shipment and installation so that the fins and casing flanges are not damaged. If fins are damaged they may be combed so as to restore them to the original shape and/or spacing. If however, in the opinion of the Engineer the coils have loose or damaged fins at the time of final inspection they will be rejected and shall be replaced with new coils.

Large surface area coils manufactured from copper tubes. Coils shall have aluminium fins (unless otherwise specified) mechanically bonded to seamless copper tubes. Aluminium fins treated with hydrophilic resins for corrosion resistance shall be used.

A low pressure drop is preferred. Face velocities shall not exceed 2,6 m/s.

The fins shall be spaced not closer than 12 per 25mm.

The pressure parts of coils shall be constructed and tested to a pressure of not less than 1 700 kPa or 1,5x operating pressure whichever is higher.

Headers shall be copper and fitted with approved distributors to maintain equal distribution to all circuits.

Coils shall offer a ten year design life installed outdoors noting the site locality.

Each coil section shall be securely mounted on appropriate frames.

After testing coils shall be charged with a Nitrogen holding charge and sealed.

Speed controlled; low noise fans including low ambient protection will be provided. EC fans are preferred, VSD driven fans may be accepted.

Materials supplied shall be suitable for the site location.

Alternative prices including estimated service life and guarantee durations must be offered for condenser corrosion protection as below;

- Factory applied corrosion protection,
- Bluchem corrosion protection to a full marinising specification, all fasteners exposed to the elements to be hot dip galvanised or stainless steel, PC boards to be sprayed with low conductivity polyresin anti-corrosion product suitable

for electronics corrosion protection, coils fully sprayed with proprietary product, unit casings protected with PU resin.

Condenser corrosion protection shall include but not be limited to casings, fasteners, printed circuit boards and coils.

Serviceability

Routine maintenance (lubrication, filtration cleaning etc) shall be possible while the equipment is in operation. Separation of accessible maintenance areas from rotating parts and circuitry is required.

Clear maintenance access shall be provided to all equipment requiring regular adjustment, maintenance or calibration.

Refrigerant Circuits

Refrigeration systems shall be shipped with nitrogen holding charge to prevent corrosion.

The following shall be included in the refrigerant circuit (this is not an exhaustive list);

Discharge shutoff valve
Liquid receiver with outlet service valve
Filter drier with moisture sight glass
Liquid line solenoid valve
Safety valve
Thermostatic or electronic expansion valve
Compressor
Evaporator coil
Condenser coil
Hot gas heating section

The following safeties shall be provided as a minimum;

High pressure switch
Low pressure switch

4.1 OTHER SERVICES

4.1.1 Fire Protection

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

4.1.2 Smoke Control

In the event of a fire alarm, all air conditioning units will be stopped by means of a fire relay provided by the Contractor.

The Electrical / Smoke Detection Contractor shall allow for bringing the necessary wiring into the Air-Conditioning contractors electrical panels, and connecting to potential free contacts.

4.1.3 Electrical

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

All material and equipment supplied for this contract shall be new and the best of their respective kind.

All new materials and equipment supplied, shall comply fully with the requirements laid down in the specification. The whole of the works shall be executed in accordance with best practice and to approval of the engineer. The equipment shall comply with the latest issues of the following standard specifications:

- a. SABS 150: Insulated wire
- b. SANS 1091: Colour standards for paint
- c. SANS 0142: Wiring code of practice

Apart from any other authority, which the engineer may have in terms of the contract, he shall have the right to set the standard and to accept or reject part of the specified equipment depending on the quality of material and workmanship offered.

The contractor shall be notified if the quality of such materials and/or workmanship is not acceptable.

In such an event, the contractor shall replace the specific part or repair it to the satisfaction of the engineer, all at the cost of the contractor. Such an instruction shall not exempt the contractor from any of his obligations in terms of the contract.

In addition the contractor shall at his cost issue all notices in respect of the installation to the local authorities, and shall exempt the client from all losses, costs or expenditures which may arise as a result of the contractor's failure to comply with the requirements of the regulations enumerated above.

It shall be assumed that the contractor is conversant with the above-mentioned requirements. Should any requirements, by law or regulation, which contradicts the requirements of this document, apply or become applicable during erection of the installation, the contractor shall immediately inform the engineer of such a contradiction. Under no circumstances shall the contractor carry out variations to the installation in terms of such contradictions without obtaining the written permission to do so from the engineer.

The AC Contractor will be responsible for:

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

The Electrical Contractor will be responsible for:

- i. The supply and installation of the main incoming supply cable/s to each air conditioning board, and for making off of these cables to the incoming side of the main isolator.
- i. The provision of a separately protected electrical supply to each independent split system AC unit.
- ii. For the provision of specific conduits to be cast into concrete columns or slabs (needed for the AC installation). These are to be detailed by the AC Contractor on his Builders Work drawings and given to the Electrical Consultant so that they may all be indicated on the electrical drawings.

5.1 COMPLETION

5.1.1 Testing and Acceptance

The Contractor shall test all equipment to be supplied in accordance to any recognized testing procedure or code approved by the Engineer/Client. The contractor shall submit, at least two weeks prior to the commencement of the testing, a testing program and check lists to the Engineer/Client and at the same time notify the Engineer/Client of the code or procedure to which all equipment to be supplied will be tested. The results of all checks and measurements shall be recorded in writing during the testing period and the Engineer and Employer representative must witness these tests. Certified testing records shall be handed to the Engineer and Employer. The following equipment shall be tested.

- Air-Conditioning Systems
- Fresh Air Systems
- Extraction Air Systems
- Ducting System

The equipment shall be tested in accordance with the following codes, standards or any other recognized commissioning procedure or code approved by the Engineer/Client before testing commences:

- i) Control systems - CIBS: Commissioning Code: Series C: Automatic Controls.
- ii) Air distribution systems may as an alternative be commissioned in accordance with CIBS: Commissioning Code: Series A: Air Distribution.

Air quantities as specified in the specification and drawings are quantities required when filters are approximately 75% dirty (75% between initial clean filter resistance and recommended final resistance not to be exceeded in accordance with the. Fan speeds and blade settings shall be selected at a static pressure loss of 180 Pa through each stage of filtration (360 Pa for primary and secondary filters). Clean filters shall be partially blanked off until the above pressures are reached before fans are adjusted. The pressure must be maintained at the initially set value, as indicated, throughout the complete process of adjustment.

Testing, balancing and commissioning shall consist of the following:

- Checking of all safeties by means of simulated overload conditions.
- Checking and setting of protection devices to stop the operation of equipment at overload or abnormal conditions.
- Balancing of water systems including all existing secondary and tertiary systems connected to the new system.
- Checking the performance criteria by plotting it on the original selection curve of all fans and pumps.
- Marking operating values (temperatures, pressures, amps, etc.) on gauges and thermometers as appropriate.
- Rectangular ductwork shall be tested as medium velocity medium-pressure ductwork suitable for pressures up to 500 Pa and velocities up to 10 m/s.
- Compile a field test report of the above tests for inclusion in the operating and maintenance manual.
- The testing, balancing and commissioning report shall be submitted to the Engineer for approval prior to application for final hand-over.

NOTE:

All testing operations shall be witnessed and approved by the Engineer.

Commissioning Programme

The Contractor shall adhere to the program for the installation, but shall ensure that his commissioning program makes allowance for the following requirements:

- i. The blow-out of all supply air ducts for the various air conditioning and ventilation systems, shall be completed not later than 1 (one) week before Beneficial Occupation Date.
- ii. At the date of Beneficial Occupation, **ALL** systems shall be operating and the air conditioning system be fully operational, balanced, tested, commissioned and handed over by that date.

Each task in these schedules shall be countersigned by the Contractors Commissioning Engineer to ensure that any discrepancies between site and commissioning conditions/data can be clarified.

The minimum commissioning requirements are:

Initial Visual Check

- Correct models, types, etc. provided.
- Equipment located in correct positions and parallel to building lines unless otherwise specified.
- Shipping fasteners, clamps, etc. removed or released.
- Joints tight and correctly fitted.
- All fasteners in position and tight.
- Coil piping correct configuration. (Counter flow, IN at the bottom, OUT at the top, etc.).
- Existence of sufficient and where applicable correctly fitted bleed off, vent valves, drains, etc., as specified. (Both at components and in pipework.)
- Thermal expansion and contraction allowances.
- Access panels provided and are hinged complete with handles, patches, locks, etc..

- Natural free movement of rotary/moving equipment.
- Proper isolation of rotary/moving equipment (check canvas collars anti vibration mounts, flexible couplings/rubber mounts, etc.).
- Soundness and alignment of general supports.
- Grommets provided against chaffing at all pipe cables, etc. penetrations through housings, etc.
- Installation workmanship and finish

Pre-Switch ON Checks

- Merge all electrical circuits for correct continuity, etc.
- Check oil levels and lubricate where applicable.
- Run fan impellers by hand to see that they are free of obstructions.

Post First Switch ON Checks

- Listen for unusual noises from equipment items.
- Check for unbalanced rotary items.
- Vibration transmitted to fixed elements, such as ducts, structure, pipework, etc. (Antivibration mountings, flexible canvas collars, to be checked for isolation.)
- Moving/rotary equipment smooth operation, i.e. free of excessive vibration, drumming, rumbling, etc.
- Excessive air and other fluid leaks (prime suspects: Evaporator units joints and canvas collars).

Air Filters

- Cell media correct.
- Satisfactory filter bedding.
- By pass air around cells and frames.
- Easy removal of filter cells.
- Positive locking devices.

Coils

- Coil materials.
- Cooling coil drip tray material.
- Cooling coils drip tray, front and rear extensions.
- Coiling coil drip tray piping integrity (fall, slope, trap, etc.).

Insulation

- Securement.
- Type and thickness.
- Soundness/integrity of joints.
- Vapour barrier, where applicable.
- Wooden rings or other approved thermal break, at supports.

Electrics

- Check motor sizes.
- Check motor types.
- Check amperage against motor nameplate ratings.
- Motor direction of rotation.
- Electrical wiring.
- Starters overload settings.
- Interlocks.
- Check soundness of all wiring connections (particularly ammeters.).

General

- Lubrication.
- General noises.
- Colour coding provision.
- Space cleanliness.
- Spare parts/operating manuals handed over.

Air Systems

- Measure and record air flow at air registers.
- Measure fans static pressure rise and motor draw (amperage)
- Measure excessive noises if any.

It is hereby recorded that the checking, testing, adjusting, measuring, setting, confirming, reporting, etc., of the

foregoing items are the minimum requirements. Additional tasks which are necessary for the proper commissioning of the works shall be conducted by the Contractor / Supplier as required

5.1.2 Guarantee and Maintenance

The entire air conditioning and ventilation installation shall be subject to a guarantee of **12 months from the Beneficial Occupation date**, or the date of final acceptance by the Consultants, whichever is the later.

The Contractor shall maintain the installation from Beneficial Occupation and the costs associated with this maintenance shall be calculated on maintaining the entire AC System for the period of 12 months from the day of start-up, or the date of final acceptance by the Consultants, whichever is the later.

Expendables such as filters and water treatment chemicals for the maintenance period must be included in the contract price. Oils and other such minor expendables shall also be included.

A service log book is to be kept on site for all service activity and must be countersigned by the Manager.

5.1.3 Noise Control Standards

Local Authority Requirements

The maximum noise level at the site boundary is not to be more than 4db higher than ambient at its quietest time.

If the adjoining property is a residential dwelling, the design of the sound attenuation must be such that noise at the boundary falls well within the legal maximum rating. No nuisance is to be noted by a neighbour, especially at night when background masking noise is non-existent.

If the adjoining property is undeveloped then it must be established the nature of the zoning and the likelihood of the area becoming noise sensitive i.e. residential, hospital, etc.

If the area is likely to become noise sensitive the design of the plant must be such that this is accommodated at initial design stage.

* Note – Overload protection to be provided by the Air-conditioning sub-contractor to all fans.

5.2 Health and Safety Specification

Tenderers shall allow in their costing for the preparation of a Health and Safety Plan in accordance with the OHS Act 85/1993, as amended, Construction Regulations (July 2003), and all other relevant legislation that may relate to their activities directly or indirectly. This H&S plan is to be discussed with, and approved by, the Principal Agent, on award of the Contract.

The Contractor shall be registered with the Workman's Compensation Commissioner. The Contractor's H&S Plan shall be implemented and maintained and include, amongst others, at least monthly audits.

The Tenderers shall, in costing their H&S Plan, prepare a risk assessment specific to their operations, such as amongst others, but not restricted to, demolition work, edge protection and penetrations, stacking of materials, speed restriction and protection, construction plant, fire extinguishers and firefighting equipment, hired plant and machinery, scaffolding, working on heights, lifting machine and tackle, ladders and ladder work, general machinery, portable electrical tools, explosive power tools, public health and safety and night work.

The Principal Agent and all Contractors shall submit an organogram, outlining the Health and Safety Site Management Structure including the relevant appointments/competent persons. In cases where appointments have not been made, the organogram shall reflect the intended positions. The organogram shall be updated when there are any changes in the Site Management Structure.

The Principal Agent and all Contractors shall ensure that Health and Safety Representative(s) are appointed under consultation and trained to carry out their functions.

The appointment must be in writing. The Health and Safety Representative shall carry out regular inspections, keep records and report all findings to the Responsible Person forthwith and at health & safety meetings.

The Principal Agent and all Contractors shall keep and maintain Health and Safety records to demonstrate compliance with this Specification, with the OHS Act 85/1993, as amended and with the Construction Regulations (July 2014).

The Principal Agent shall ensure that all records of incidents/accidents, training, inspections, audits, etc. are kept in a health & safety file held in the site office. The Principal Agent must ensure that every Contractor opens its own health & safety file, maintains the file and makes it available on request