PART C3: SCOPE OF WORKS

PART C3

SCOPE OF WORKS

INDEX

PART C3

SCOPE OF WORKS

INDEX

PART C3

Section 1

DESCRIPTION OF THE WORK

INDEX

PART C3

Section 1

DESCRIPTION OF THE WORKS

1.1 Employer's Objective

1.1.1 Transnet Freight Rail has embarked on an office space optimization initiative, based on an open plan design philosophy for all office buildings. This initiative will be implemented over the next 3-years and nationally approximately 50 000m² of office space will be converted to open plan. The project entails the refurbishment of office buildings to an open plan environment, refurbishment of air-conditioning to suit open plan and installation of public address systems and early warning fire detection.

One of the buildings identified for refurbishment is Loliwe House, 151 South Coast Road, Bayhead.

1.1.2 The Tenderers are required to check the number of pages and should any be found to be missing or in duplicate or the figures or writing to be indistinct or should there be any doubt or obscurity as to the meaning of any particular word or phrase or descriptions or should Tenderers consider that any item is incorrectly or inadequately described they must inform the Manager, Johan Basson, 3rd Floor, Table 7, Inyanda House 2, 15 Girton Road, Parktown, 2193 at once in writing under reference and have the matter rectified or explained as the case may be as no liability whatsoever will be admitted by Transnet in respect of errors in a tender due to the foregoing.

No alterations, erasures or additions of any kind shall be made by the Tenderers in, from or to any part of this specification unless expressly required to be made by written notice and should any unauthorised alterations, erasures or additions be made they will not be recognised by Transnet.

1.2 Overview of the Works

1.2.1 The contract consists of the demolishing/dismantling of existing brick walls, partitions, ceilings, electrical work and floor/wall finishes etc., and the construction/fitting of new brick walls/partitions, ceilings, electrical/plumbing work, plastering painting and the laying of new floor finishes, refurbishment of the existing air-conditioning system, installation of a fire detection system and a public address system.

1.3 Extent of the Works

1.3.1. The main contractor shall do the work on a turn-key basis as detailed in the various specifications and drawings as per attached drawing register

1.4 Location of the Works

1.4.1 The site is situated in Rossborough, 151 South Coast Road

1.5 Temporary Work

Not Applicable

Part C3

Section 2

ENGINEERING

INDEX

PART C3

Section 2

ENGINEERING

2.1 Design services and activity matrix

Not Applicable

2.2 Employer's design

2.2.1 Employer will issue floor layouts for the proposed refurbishment.

2.3 Design brief

2.3.1 Designs to be as per guidelines in the particular specifications, referred to standard and generic specifications.

2.4 Drawings

2.4.1 Drawings of the refurbishment of floors layouts:

AIR-CON

DRAWING NUMBER	REVISION NO.	TITLE
C077-AC-01	0	GROUND FLOOR AIR-CONDITIONING LAYOUT
C077-AC-02	0	1st FLOOR AIR-CONDITIONING LAYOUT
C077-AC-03	0	2nd FLOOR AIR-CONDITIONING LAYOUT
C077-AC-04	0	3rd FLOOR AIR-CONDITIONING LAYOUT
C077-AC-05	0	4thFLOOR AIR-CONDITIONING LAYOUT
None		DETAIL OM MCW CONNECTIONS
None		SECTION A-A
None		DETAIL - INTERIA BASE AND AXIAL FAN

CIVIL WORKS

TI 001B-GRDFL-400	0	SMOKE DETECTION - GROUND FLOOR
TI 001B-GRDFL-400	0	DEMOLISION LAYOUT - GROUND FLOOR
TI 001B-GRDFL-400	0	STRUCTURE LAYOUT - GROUND FLOOR
TI 001B-GRDFL-400	0	ELECTRICAL_ FIRE LAYOUT - GROUND FLOOR
TI 001B-GRDFL-400	0	CEILING_LIGHT LAYOUT - GROUND FLOOR
TI 001B-GRDFL-400	0	WALL/WINDOW FINISHES - GROUND FLOOR
TI 001B-GRDFL-400	0	FLOOR FINISHES LAYOUT - GROUND FLOOR
TI 001B-GRDFL-400	0	CEILING_DEMOLISION LAYOUT - GROUND FLOOR
TI 001B-1STFL-400	0	SMOKE DETECTION - 1ST FLOOR
TI 001B-1STFL-400	0	DEMOLISION LAYOUT - 1ST FLOOR
TI 001B-1STFL-400	0	STRUCTURE LAYOUT - 1ST FLOOR
TI 001B-1STFL-400	0	ELECTRICAL_ FIRE LAYOUT - 1ST FLOOR
TI 001B-1STFL-400	0	CEILING_LIGHT LAYOUT - 1ST FLOOR
TI 001B-1STFL-400	0	WALL/WINDOW FINISHES - 1ST FLOOR
TI 001B-1STFL-400	0	FLOOR FINISHES LAYOUT - 1ST FLOOR
TI 001B-1STFL-400	0	CEILING_DEMOLISION LAYOUT - 1ST FLOOR
TI 001B-2NDFL-400	0	SMOKE DETECTION - 2ND FLOOR
TI 001B-2NDFL-400	0	DEMOLISION LAYOUT - 2ND FLOOR
TI 001B-2NDFL-400	0	STRUCTURE LAYOUT - 2ND FLOOR
TI 001B-2NDFL-400	0	ELECTRICAL_ FIRE LAYOUT - 2ND FLOOR
TI 001B-2NDFL-400	0	CEILING_LIGHT LAYOUT - 2ND FLOOR
TI 001B-2NDFL-400	0	WALL/WINDOW FINISHES - 2ND FLOOR
TI 001B-2NDFL-400	0	FLOOR FINISHES LAYOUT - 2ND FLOOR
TI 001B-2NDFL-400	0	CEILING_DEMOLISION LAYOUT - 2ND FLOOR
TI 001B-3RDFL-400	0	SMOKE DETECTION - 3RD FLOOR
TI 001B-3RDFL-400	0	DEMOLISION LAYOUT - 3RD FLOOR
TI 001B-3RDFL-400	0	STRUCTURE LAYOUT - 3RD FLOOR

TI 001B-3RDFL-400	0	ELECTRICAL_ FIRE LAYOUT - 3RD FLOOR
TI 001B-3RDFL-400	0	CEILING_LIGHT LAYOUT - 3RD FLOOR
TI 001B-3RDFL-400	0	WALL/WINDOW FINISHES - 3RD FLOOR
TI 001B-3RDFL-400	0	FLOOR FINISHES LAYOUT - 3RD FLOOR
TI 001B-3RDFL-400	0	CEILING_DEMOLISION LAYOUT - 3RD FLOOR
TI 001B-4THFL-400	0	SMOKE DETECTION - 4TH FLOOR
TI 001B-4THFL-400	0	DEMOLISION LAYOUT - 4TH FLOOR
TI 001B-4THFL-400	0	STRUCTURE LAYOUT - 4TH FLOOR
TI 001B-4THFL-400	0	ELECTRICAL_ FIRE LAYOUT - 4TH FLOOR
TI 001B-4THFL-400	0	CEILING_LIGHT LAYOUT - 4TH FLOOR
TI 001B-4THFL-400	0	WALL/WINDOW FINISHES - 4TH FLOOR
TI 001B-4THFL-400	0	FLOOR FINISHES LAYOUT - 4TH FLOOR
TI 001B-4THFL-400	0	CEILING_DEMOLISION LAYOUT - 4TH FLOOR

2.5 ALTERNATIVE EQUIPMENT AND DRAWINGS

2.5.1 CHILLED WATER PUMPS

Item		Alternative Offered.
System	CHILLED WATER	
Quantity	2	
Make	KSB	
Model No.	ETA 80-250	
Flow rate	20.8 l/s	
Head	20m	
NPSH Pump	2.3m	
Efficiency	76%	
Nominal Speed	1450	
Motor Make	WEG	
Motor Rating	9.2 kW	
Power Required	5.4 kW	
Electrical Supply	400V 3 phase 50 Hz	
Shaft Seal	Mechanical	
Bearings/Lubrication	Ball/Oil	
Casing	Cast Iron	
Impellor	Bronze	
Shaft	Chrome Steel	
Shaft Protection Sleeve	316 S/ Steel	
Coupling	Tyre Spacer	
Base plate Material	Hot Dip Galvanised	
Drip Tray	304 S/ Steel	
Estimated Mass	311 kg	

2.5.2 COOLING COIL

Item		Alternative Offered.
Make	Heating Centre	
Model No.	4-CWC-33 x 3050 x 6r x 10f x 44c	
Quantity	2	
Type	Serpentine	
Total Cooling Capacity	205.3 kW	
Sensible Cooling Capacity	130.9 kW	
Supply Air Quantity	6.510 m³/s	
On-Coil	26.7ºC db/19.4 ºC wb	
Off-Coil	9.9 ºC db /9.5 ºC wb	
Inlet Water Temperature	6 ºC	
Outlet Water Temperature	11 ºC	
Water Temp. Difference	5 ºC	
Water Quantity	9.79 kg/s	
Water Pressure Drop	39.5 kPa	
Coil Height	838.2 mm (33”)	
Coil Length	3050 mm	
Coil Velocity	2.55 m/s	
Air Pressure Drop	213.8 Pa	
Rows	6 Rows	
Fins	10 fins per inch	
Circuits	44.0	
Casing Material	Stainless Steel	
Fins Material	Aluminium Fins	
Tube Material	Copper Tube	
Drain Pan	304 Stainless Steel	

2.5.3 CONDENSER WATER PUMPS

Item		Alternative Offered.
System	CONDENSER WATER	
Quantity	2	
Make	KSB	
Model No.	ETA 100-250	
Flow rate	28.8 l/s	
Head	20 m	
NPSH Pump	3.4 m	
Efficiency	79 %	
Nominal Speed	1450 r.p.m.	
Motor Make	WEG	
Motor Rating	9.2 kW	
Power Required	6.8 kW	
Electrical Supply	400V 3 phase 50 Hz	
Shaft Seal	Mechanical	
Bearings/Lubrication	Ball/Oil	
Casing	Cast Iron	
Impellor	Bronze	
Shaft	Chrome Steel	
Shaft Protection Sleeve	316 S/ Steel	
Coupling	Tyre Spacer	
Base plate Material	Hot Dip Galvanised	
Drip Tray	Not Required	
Estimated Mass	320 kg	

2.5.4 COOLING TOWERS

Item		Alternative Offered.
Ref.		
Make / Model No.	EVAPCO	
Location	ROOF	
Quantity	2	
Heat Rejection	471.29 kW	
Flow Rate	20.05 l/s	
Warm Water temperature	35.0 ºC	
Cold Water temperature	29.5 ºC	
Wet Bulb Temperature	26.5 ºC	
Fill Material	PVC	
Nozzle Type	Poly Prop Evap jet	
Nozzle Pressure	30 kPa	
Fan Motor	7.5 kW	
Fan Type	Axial	
Fan Motor Protection	IP56	
Fan Support Structure	Stainless Steel	
Access Ladder	Galvanised Steel Access Ladder c/w Safety Hoops	
Operating Weight	2358 kg	
Length	2963	
Width	2530	
Height	4130	

2.5.5 AXIAL FLOW FAN SCHEDULE

REF	Specified	Alternative Offered
SERVICE	Air-conditioning Supply Air Fan	
LOCATION	Plant room	
QUANTITY	2	
MAKE	Donkin	
Fan Type	Guide Vane Axial	
MODEL No.	1000.D.1/1	
Impellor Type	Broad Axial	
AIRFLOW	6.51 m³/s	
STATIC PRESSURE	800 Pa	
PITCH	9º	
SPEED	1440 rpm	
MOTOR POWER	7.5 kW	
Full Load Current	14.5 A	
EFFICIENCY	76%	
MOTOR SPEED	1440 rpm	
ELECTRICAL SUPPLY VOLTAGE	400 Volts 3 phase 50 Hz	
SOUND PRESSURE LEVEL	94 dB	

2.5.6 RA AXIAL FLOW FAN SCHEDULE

REF	Specified	Alternative Offered
SERVICE	Air-conditioning Return Air Fan	
LOCATION	Plant room	
QUANTITY	2	
MAKE	Donkin	
Fan Type	Guide Vane Axial	
MODEL No.	1000.D.1/1	
Impellor Type	Broad Axial	
AIRFLOW	6.51 m³/s	
STATIC PRESSURE	800 Pa	
PITCH	9º	
SPEED	1440 rpm	
MOTOR POWER	7.5 kW	
Full Load Current	14.5 A	
EFFICIENCY	76%	
MOTOR SPEED	1440 rpm	
ELECTRICAL SUPPLY VOLTAGE	400 Volts 3 phase 50 Hz	
SOUND PRESSURE LEVEL	94 dB	

2.5.7 DRAWING SCHEDULE

The following drawings form part of this specification

DRG. No.	Title	Date	Revision
C077-AC-01	Ground floor Air-conditioning layout	March 2009	0
C077-AC-02	First floor Air-conditioning layout	March 2009	0
C077-AC-03	Second floor Air-conditioning layout	March 2009	0
C077-AC-04	Third floor Air-conditioning layout	March 2009	0
C077-AC-05	Fourth floor Air-conditioning layout	March 2009	0
C077-AC-06	Air-conditioning Plant room	March 2009	0
C077-AC-07	Air-conditioning sections	March 2009	0
C077-AC-08	Details of connections to cooling towers	March 2009	0

2.6 Design procedures

2.6.2 Not Applicable

Part C3

Section 3

PROCUREMENT

INDEX

PART C3

Section 3

PROCUREMENT

3.1 Subcontracting

3.1.1 Tenders are required to provide a list of work, which they intend carrying out on a subcontract basis, and that which they intend carrying out with own permanent employees.

3.1.2 Tenders shall outline their policy with regard to the employment of local “previously marginalized” subcontractors, and the estimated proportion of the work in the various trades that will be sublet to such subcontractors.

3.1.3 The successful Tenderer will be responsible for the supervision and quality control of the work undertaken by the subcontractors.

3.1.4 The successful Tenderer shall not take advantage of the lack of pricing skills of emerging subcontractors, and obvious errors in pricing shall be pointed out and rectified to reflect the reasonable prices for the work.

3.1.5 Any subcontractors in which the main Contractor considers using shall be submitted to Transnet Freight Rail for approval.

Part C3

Section 4

GENERAL CONSTRUCTION ASPECTS

INDEX

PART C3

Section 4

GENERAL CONSTRUCTION ASPECTS

4.1 Works Specifications

4.1.1 Standard Specification

In so far as they can be applied and where they are not inconsistent with the terms of this specification, the following specifications shall be regarded as being embodied in this specification.

4.1.1.1 SABS Specifications (To be obtained by the contenders)

National Building Regulations	SABS 0400 - 1990
General Structural	SABS 1200AH - 1986
Electrical Code of Practice	SABS 0142

4.1.1.2 Standard Airconditioning Specification

4.1.1.2.1 Supplementary Airconditioning Specification

4.1.1.2.3 Drawings

Applicable specifications referred to as secondary specifications

4.2 Construction Equipment

The Contractor shall supply all equipment necessary to perform the work.

4.3 Existing Services

4.3.1 The Contractor shall be responsible for locating and protecting existing services. The position of existing services (if) shown on the drawings are only approximate. Services other than that shown on the drawings may be pointed out to the Contractor by the Transnet Freight Rail Supervisor and the Contractor shall take responsibility to protect them in the same way as those shown on the drawings. Damage to any service shown on the drawings or pointed out to the Contractor shall immediately be reported to the Transnet Freight Rail Supervisor who will arrange for its repair.

4.3.2 The Contractor shall reinstate the services and structures damaged during construction.

4.3.3 Any damages caused by the Contractor to Transnet property and services shall be rectified by the Contractor at his own costs and to the full satisfaction of the Supervisor.

4.3.4 Permission to connect to any existing Transnet Freight Rail service, on a temporary basis, must be obtained from the Transnet Freight Rail Supervisor.

4.4 Site Establishment

4.4.1 Not Applicable

4.6 Site Usage

4.5.1 The establishment of a site is the responsibility of the successful tenderer and this must be provided for in the quotation. Fixed assets such as fencing, carports etc. shall be removed or demolished after completion of the Works.

4.5.2 The Contractor shall provide an office for the Transnet Freight Rail Supervisor on site upon request.

4.5.3 Housing of Contractor's staff on any Transnet property will not be permitted.

4.5.4 The Contractor is to make his own arrangements for the distribution of electrical power for his own use on the site. Transnet Freight Rail will not be responsible for any claims whatsoever brought about by any disruption or fluctuations in the supply of any such electrical power to the Contractor.

4.5.5 The Contractor is to apply to the network provider for a telephone if required.

4.5.9 Contractor's own and supervised site store

4.5.9.1 The Contractor must provide adequate storage, at his own expense to the satisfaction of the Transnet Freight Rail Supervisor. All material must, in addition, be stored or stacked in position that will not interfere with other work in progress in the area.

4.5.9.2 Sites for storage facilities on property of Transnet Freight Rail, if available, must be arranged in conjunction with the parties concerned. Where no sites are available, the Contractor must make his own arrangements at his expense.

4.5.9.3 The Transnet Freight Rail Contract Supervisor shall be advised as early as possible where storage sites will be located.

4.5.9.4 The cost of this store shall be shown separately as an item in the quotation for installation.

4.5.9.5 On completion of the contract, the Contractor shall dismantle and remove the store entirely from the property of Transnet Freight Rail.

4.5.9.6 Off-loading, storage and distribution

- The Contractor shall be responsible for off-loading all material, the storage and safe custody thereof and for the distribution on the Works.
- The Contractor shall maintain records, to the satisfaction of the Transnet Freight Rail Contract Supervisor, concerning the receipt and issue of all material.
- All material must be stored or stacked in positions that will not interfere with other work in progress in the area.

4.5.10 The Contractor shall, on completion of the Works, clear the site of all leftover items of material, such as empty cable drums, cable off-cuts, empty tins, etc., to the satisfaction of the Transnet Freight Rail Supervisor. Off-cuts of all material of a valuable nature which is the property of Transnet, such as copper or aluminium wire or cable, shall be returned to a site to be directed by Transnet Freight Rail Supervisor.

4.6 Alterations, additions, extensions, and modifications to existing works

4.6.1 Contractor shall use the given drawings as a guideline or proposal by Transnet Freight Rail, and should the Contractor deem it necessary/appropriate to deviate from the above, he shall inform the Project Manager/Transnet Freight Rail Supervisor for approval.

4.6.2 Only Transnet Freight Rail Contract Supervisor or his appointed designate shall be allowed to enter Site Instructions. Any instruction that might result in a change in scope or has cost implications, shall only be carried out once a Compensation Event has been approved by Transnet Freight Rail, otherwise the client may refuse to pay for such work.

4.7 Inspections of adjoining properties

4.8.1 Not Applicable.

4.9 Water for construction purposes

4.9.1 The Contractor shall use existing water connections in the building for construction purposes.

4.10 Survey control and setting out the Works

Not Applicable

Part C3

Section 5

MANAGEMENT OF THE WORKS

INDEX

PART C3

Section 5

MANAGEMENT OF THE WORKS

5.1 SABS Specifications

The following SABS Specifications and associated specification data are applicable:-

5.1.1 SABS 0400 - 1990: NATIONAL BUILDING REGULATIONS

5.1.2 SABS 1200AH - 1986: GENERAL STRUCTURAL.

5.1.3 SABS 0142: ELECTRICAL CODE OF PRACTICE.

5.2 Particular/generic specification

5.2.1 Refer to Section 7

5.3 SITE RECORDS:

5.3.1 Site Diary

The Contractor shall provide a diary, in triplicate to record all day-to-day incidents that could occur during the contract period. This includes weather, name & number of workers on the site, material that has been delivered, material that has been loaded and disposed off, incidences that have occurred, what work is to be done on that day, etc.

5.4 SITE INSTRUCTION BOOK:

5.4.1 The Contractor shall supply and have available ON SITE at all times three A4 size triplicate carbon copy books.

5.4.2 In one book, site instructions will be recorded. Only the Project Manager and the Supervisor or their delegated representative will have the authority to issue site instructions to the Contractor. Any instruction that might result in a change in scope or has cost implications, shall only be carried out once a Compensation Event has been approved by Transnet Freight Rail, otherwise the client may refuse to pay for such work.

5.4.3 The second book will be used as the Risk Register required by the Contract for Engineering and Construction Work, NEC3.

5.4.4 The third book will be a site diary. Site diaries shall be forwarded to the Transnet Freight Rail Supervisor during monthly progress meetings. Site activities and information (including weather conditions) shall be entered in a site diary on a daily basis. Amongst others the safety talks shall be entered, and all visitors on site shall sign the Site Diary. Working hours are to be aligned with the Depot working hours, any work to be done outside normal Depot working hours to be discussed with the relevant Depot.

5.4.5 The original sheet of each set of three pages will be removed from the books and retained by the Project Manager. The Contractor may remove the second sheet but the third sheet shall be retained on the site until completion of the Works when it shall be handed to the Project Manager.

5.4.6 All important communication shall be in writing.

5.5 PROGRAMME & PLANNING OF THE WORK

5.5.1 The contractor shall provide to the Project Manager a detail plan of how he intends to do the work and this plan must be to the requirements of the operation of Transnet Freight Rail with minor disruptions as no delays must be allowed in this regard.

5.5.2 The programme must be agreed to (in the site instruction book) before any work will be allowed to commence. The programme can be in a form of a pert (bar) chart and will be used as a guide to measure progress of the work.

5.6 WATER SUPPLY:

5.6.1 Water will be made available for the purpose of construction of the works only. The water shall be used conservatively and if not, this privilege shall be removed and the water shall be metered, and the cost of the metered water shall be borne by the Contractor as well as all charges as entertained by Transnet. The Contractor must supply all connections, hoses, etc., as necessary.

5.7 ELECTRICITY SUPPLY:

5.7.1 Electricity will be made available to the Contractor. The contractor must adhere to the safety standards as per the General Safety Regulations, Electrical Machine Regulations, Electrical Installation Regulations of the Health and Safety Act, (Act 85 of 1993) and SABS 0142.

5.8 ACCESS TO SITE:

5.8.1 The premises will not be occupied during the execution of the contracts.

5.8.2 The building has security control system at the main entrance. The Transnet Freight Rail Supervisor on site will arrange for the issue of temporary permits to the contractor and his workmen. A list stating name permanent residential address and copy of ID Book of the workmen who require permits must be handed over timeously to Transnet Freight Rail Supervisor, 48 Hours minimum notice is necessary for the processing these permits. All permits issued remain the property of Transnet Freight Rail and shall be handed in at completion of the contract, by the contractor or whenever so requested by the Transnet Freight Rail Supervisor. Permits shall at all time be displayed by the holder in the building. Replacement of lost or missing permits shall be for the contractors

5.8.3 Contractor and his workmen are not to enter any area (Floors) not in the construction designated area.

5.8.4 Only goods lift is to be used for the transport of material, tools and equipment. The Floor and sides of goods lift is to be protected during the transporting of material and equipment. Lifts are to be kept clean and clear when not transporting material or equipment.

The contractor is to keep the main entrance to lift area clean and clear at all times to allow residents free passage to floors above.

5.8.5 **ACCESS POINTS TO SITE (SECURITY) CHECKS AT CLOSE OF DAY**

5.8.5.1 Inspect all windows, doors, gates etc. to ensure security against any unauthorised entry, to all floors under construction.

5.9 MATERIALS FOUND ON SITE:

The Contractor shall not use on the works any materials found on the site without the prior written consent of the Project Manager. No material that is lying on the site (other then that from this contract) or on Transnet's property, may be removed (even if deemed as scrap) by the contractor.

5.10 CLEARING OF SITE:

The Contractor shall provide for cleaning up and sorting all rubbish and debris of whatever kind throughout the duration of the contract. Upon completion the Contractor shall clear away and remove all rubbish, unused material, plant and debris and leave the site and the whole of the works clean and tidy to the satisfaction of the Project Manager. The contractor is to see that there is no build-up rubble, both on site, service lift, main lifts, passages foyers or parking areas.

Existing carports/parking area is not to be used to store materials or for the use of construction vehicles.

5.11 WORKING OUTSIDE NORMAL WORKING HOURS:

The normal working hours are between 07:30 and 16:00 Mondays to Fridays. If it is required to work outside the stated normal working hours the Contractor must obtain written permission at least 24 hours before such work needs to be undertaken. Transnet will not unreasonably withhold permission; however the Contractor may have to pay for Transnet's supervisory personnel.

5.12 ENVIRONMENT

5.12.1 Refer to section 6

5.13 ACCOMMODATION OF TRAFFIC ON PUBLIC ROADS OCCUPIED BY THE CONTRACTOR

5.13.1 Not Applicable

5.14 OTHER CONTRACTORS ON SITE

Not Applicable

5.15 TESTING, COMPLETION, COMMISSIONING AND CORRECTION OF DEFECTS

5.15.1 When, in the opinion of the Supervisor, any part of the work done or any items of material used is not in accordance with the requirements of the Contract, whether or not payment for such work or material has been made, he may order the Contractor in writing to remove any objectionable part, item or component thereof, to replace it with an acceptable part, item or component and to rectify or reconstruct the Works without cost to Transnet.

5.15.2 The Works will not be accepted by Transnet as complete until all defects of every kind have been made good to the satisfaction of the Supervisor.

5.15.3 Within a reasonable time after receipt of written instructions from the Project Manager/Supervisor, the Contractor shall make good to the satisfaction of the Supervisor all the defective material and workmanship which are not in accordance with the contract and which may appear within a period of 12 months, or such other period as stipulated in the Contract Data, after the date stated in the CERTIFICATE OF COMPLETION, and shall repair all damage caused thereby.

5.15.4 Should the Contractor fail to comply with the above provisions, Transnet may cause the required work to be carried out at the expense of the Contractor and may recover the cost thereof from the Contractor.

5.15.5 Testing and commissioning shall be done in accordance with applicable standards, generic and particular specifications.

5.16 RECORDING OF WEATHER

5.16.1 The requirements are covered in the contract data.

5.17 KEY PERSONNEL

5.17.1 The Contractor shall provide an Organigram of his key personnel on site, including all relevant contact details within two weeks from the start date.

5.18 MANAGEMENT MEETING

5.18.1 Risk reduction meetings: These meetings can form part of the regular site meetings or be held as separate meetings. At these meetings the following issues will be discussed:

(i) Compensation events
(ii) Early warnings
(iii) Contractual claims
(iv) Risk register

5.18.2 The Contractor shall attend site meetings when convened by the Transnet Freight Rail Supervisor (normally once a month). Such meetings will be for the purpose of discussing progress, delays, materials, conditions and the co-ordination of site activities. The meetings will be chaired by the Project Manager or his deputy and the proceedings shall be minuted and circulated by the Transnet Freight Rail Supervisor.

5.18.3 The Contractor shall attend ad hoc site meetings when convened by the Transnet Freight Rail Supervisor. Such meetings will be for the purpose of discussing specific issues or problems relating to specifications and adherence thereto, quality and contractual matters.

5.18.4 Contractor's representatives at these meetings shall have the necessary delegated authority in respect of aspects such as planning, change management, health and safety.

5.19 PAYMENT

5.19.1 Payments shall be made at an agreed date once a month only, for work satisfactory completed, (minus retention money), as per Contract Data and in accordance with the Bill of Quantities. This will be a part payment for the work completed on the date of measurement.

5.19.2 Payment will be paid within 30 days from date of receipt of the approved Invoice been received in the financial office in Johannesburg.

5.20 INSURANCE PROVIDED BY THE EMPLOYER

5.20.1 Details of these are covered in the Contract Data.

5.21 HEALTH AND SAFETY REQUIREMENTS AND PROCEDURES

5.21.1 Health and safety requirements are covered in Transnet Specifications E4E (August 2006).

Part C3

Section 6

ENVIRONMENTAL REQUIREMENTS

INDEX

PART C3

Section 6

ENVIRONMENTAL REQUIREMENTS

6.1 Works specification

6.1.1 All work shall be done in accordance with the Environmental Management Plans and applicable specifications below:

6.1.1.1 Specification E4B: November 1996): Minimum Communal Health Requirements in areas outside the jurisdiction of Local Authority.

6.1.1.2 National Environment Management Act, 107/1998

6.1.1.3 Environmental Conservation Act, 73/1989

6.1.1.4 National Water Act, 36/1998

6.2 Environment

The Contractor shall, at all times, comply with the statutes that prohibit pollution of any kind. These statutes are enacted in the following legislation.

6.2.1 The National Environmental Management Act, 107/1998;

6.2.2 The Environmental Conservation Act, 73/1989; and

6.2.3 The National Water Act, 36/1998.

6.2.4 The Contractor shall appoint a responsible person to ensure that no incident shall occur on site that could cause pollution. Where the Contractor was negligent and caused any form of pollution the damage shall be rectified at the Contractors cost.

6.3 ADDITIONAL DOCUMENTS AND NUMBERS TO BE SUPPLIED

6.3.1 Compensation for Occupational Injuries and Diseases Act, 1993

6.3.2 Registration number: _____

6.3.3 District Council Number: _____

6.3.4 VAT Registration Number: _____

A certified copy of the Compensation form, VAT, relevant District Council Registration form as well as the ID document must be submitted with tender documents.

PART C3

SECTION 7

PARTICULAR SPECIFICATIONS

PART C3

SECTION 7

PARTICULAR SPECIFICATIONS

PROJECT SPECIFICATIONS - CIVIL

NOTE:

1. *For further descriptions of materials to be used and methods to be adopted, the Contractor is referred to the various Drawings, Codes and Standards, where relevant, and this shall be deemed to form part of the descriptions of any items in the following Specification. Except where any specification provision in a description in this specification is at variance with the above, in which case the specific provision in this Specification description shall apply.*

2. *Where trade names and catalogue references have been used in these Specifications to specify a product, Tenderers must tender on that particular product specified. In addition, Tenderers must tender on the design specified. The accepted tenderer (i.e. Contractor) may, after obtaining written authority from Transnet, use an alternative product or design.*

   Where Transnet gives such a written authority at the request of the Contractor, for the Contractor's convenience, all additional costs involved will be done to the Contractor's account. In the event of a less expensive product or design being used, a variation order reflecting the saving in cost will be issued.

1. GENERAL

This section must be read in conjunction with the drawings, and appropriate document to derive at a contract price as asked for in the Bill of Quantities which is further transferred to Part C1.1 (FORM O OFFER AND ACCEPTANCE (ECC3)).

1.2 Standard Specification

In so far as they can be applied and where they are not inconsistent with the terms of this specification, the following specifications shall be regarded as being embodied in this specification.

1.3 SABS Specifications (To be obtained by the contenders)

National Building Regulations	SABS 0400 – 1990
General Structural	SABS 1200AH- 1986
Electrical Code of Practice	SABS 0142

2. STARTING/COMPLETION DATES FOR PROJECT

The contract will commence on the commencement date and continue for a period of 5 (five) months. This period of shall be inclusive of weekends, public holidays statutory holidays. Starting and completion dates will be communicated on award of project.

WORK EXCLUDED FROM CONTRACT

Communications/computer/Lan installations and Furnishings.

3. DRAWINGS

All drawings schedules of finishes, Bill of Quantities is to be fully studied and understood by main contractor and his sub-contractors. Any queries regarding above, to be made to Project Manager immediately

4. GENERAL INFORMATION

4.1 PARKING

Contractor to arrange with Transnet Freight Rail Supervisor on site for parking of his vehicles, his staff and subcontractors vehicles in the building area.

4.2 TOILET FACILITIES

The contractor and his sub-contractors staff will be allowed the use of the toilet facilities within the construction area. These toilet facilities shall be maintained in a clean and approved manner at all times during construction/project.

4.3 SMOKING

No smoking rule in construction area 30 minutes before close of working day.

A general check to be carried out for smouldering cigarette ends at end of working day.

4.4 SUPERVISION

Full on site supervision by contractor (or his appointed representative) must be approved at all times during all aspects of the upgrading at ground floor, First Floor, Second Floor, Third Floor and Fourth floor. Name and telephone number/cellular phone is to be provided to Project Manager and Transnet Freight Rail Supervisor when project commences.

4.6 WORK QUALITY ASSURANCE AND CONTROL

The Tenderer shall submit with his tender his work quality assurance plan and procedures, indicating how the necessary work quality assurance and control will be carried out in order to meet the specification requirement during project.

4.7 LOCAL AUTHORITIES

The contractor shall make all arrangements with and obtain the necessary permission from local authorities that may be required, for the placing of bins (rubble removal) on public property and for the execution and proper completion of the works. The contractor shall at all times comply with relevant by-laws. All rubble shall be removed and dumped at a registered municipal dumping site.

4.8 HOT WORK PERMIT

A hot work permit will be provided to the contractor and sub-contractors. Permit is to be read and fully understood by contractors, before any welding, gas welding and cutting with angle grinder is allowed. Permit is to be signed and returned to Transnet Freight Rail supervisor/Fire officer.

4.9 CLOSE-DOWN PROCEDURES

This procedure and checks are to be used at end of a working day. Contractor and his workmen to take note:-

4.10 ELECTRICITY

Isolate all non-essential electrical circuits at main and distribution switchboards. Switch-off large machines, eg. Welding cutting machines etc. small appliances to have wall sockets switched off and plug tops withdrawn.
Check that electrical equipment, which requires to be powered overnight, is operating correctly and all combustible material are at a safe distance.

4.11 OPEN FIRES

No open fires will be permitted in any area of building/construction area.

4.12 FLAMMABLE LIQUIDS AND SUBSTANCES

Return all flammable liquids and other hazardous materials eg. (Paint) to suitable lockable storage areas.

Remove from building (site) all refuse bins containing oily and solvent rags and cleaning material and place in designated safe location out of doors (away from site).

4.13 DAMAGE TO TRANSNET FREIGHT RAIL PROPERTY

Any damages caused by the contractor to the building (PX) or existing services shall be rectified by the contractor at his own cost and to the full satisfaction of the Project Manager and Transnet Freight Rail Supervisor.

4.14 MAKING GOOD

Where any item is specified and no specific mention is made of preparatory work making good existing surfaces and items to accommodate the specified item that these items to be considered as being required, and the cost of these items shall be allowed for in the tendered price.

4.15. EXTRAS / ALTERATIONS

Transnet Freight Rail may request alterations, extras, additions to, or omissions from the works. The contractor shall carry out or give effect to such orders from Transnet Freight Rail. The rates for such works shall be agreed between the contractor and Transnet Freight Rail, and where possible rates quoted in the schedule of works and prices shall form the basis as far as may be reasonable, of such agreement.

4.16. GENERAL

- An updated Safety file will be on site at all times.
- An Induction course will be presented to all the Workers before the start of the contract. This will be done by a Transnet representative.
- An approved municipal dump site will be used for all building rubble.
- Contractor to note that some offices might be occupied during the construction period.
- A workable, realistic construction plan (bar chart) will be presented before work commences

STANDARD AIRCONDITIONING SPECIFICATION

CONTENTS

SCOPE OF THE STANDARD SPECIFICATION

This Standard Specification applies and is to be read in conjunction with the detailed project specification and the tender drawings.

This Standard Specification describes the equipment materials and operational methods generally required to carry out the work detailed in the project specification.

Should any variance be found between the Standard Specification and the Project Specification and Tender Drawings, the Project Specification and Tender Drawings are to take preference.

General

All workmanship and materials used in this project shall be of the highest quality and where not fully covered by this specification shall conform to the latest SABS standard, Engineering Manual or Publication or best practice as may be determined by the Engineer.

SABS Code of Practice for the wiring of Premises No. 0142 pf 1981 as amended.

The entire installation is to conform to all relevant SABS Standards.

The entire Project is to conform to the Machinery and Occupational Safety Act of 1983, as amended.

The entire Project must conform to the National Building Regulations SABS 0400.

All electrical work is to conform to the Local Authority Byelaws and Regulations.

No alternative Equipment, materials or methods will be accepted without a written concession by the Engineer.

All alternatives offered at tender stage must be clearly defined and detailed with the tender submission.

1. VENTILATION FANS

1.1 General

1.1.1 Ventilation fans shall be in accordance with the Schedule of Fans and as detailed on the tender drawings. Fans shall deliver the specified air quantities against the system resistance. Where no pressure requirements are indicated Tenderers shall estimate the fan static pressure requirements for the system layout and equipment as offered by them and tender accordingly.

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

1.1.3 Flexible connections shall be fitted between fan inlet/discharge and ducting or equipment as appropriate. Flanges are required with flexible connections.

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

1.1.5 Air in/outlets not connected to ducting or equipment shall be properly protected with removable screens as per SABS 0400. Indicating arrows for both direction of rotation and direction of airflow shall be provided on fan casings.

1.1.6 Fan motors shall be suitable for single-phase 230 volt or 3 phase, 400 volt, 50 cycle electrical supply.

1.1.7 Fan motors shall be totally enclosed fan cooled and shall be suitable for star-delta starting if larger than 7,5kw The motors shall have nameplate ratings of not less than 20%, or otherwise specified, above the actual fan power required at specified capacities and system resistance.

1.2 Centrifugal Fans

1.2.1 Centrifugal fans shall be of the forward or backward curved, multi-vane type with single or double inlet arrangement as specified in the Supplementary Specification.

1.2.2 Fan performance shall be based on tests carried out in accordance with BS 848 : Part 1 or Part 3 (as applicable) and as amended.

1.2.3 The fan casing shall be of the volute type manufactured from sheet steel with lock forming or continuously welded seams, suitably reinforced and adequately supported by means of a steel superstructure.

1.2.4 Fan wheel and shaft assembly shall be statically and dynamically balanced to ISO 1940 – 1973 within grade G6,3.

1.2.5 Fan drives shall be by means of standard V-belt and grooved pulley configuration. Drive motors mounted on the fan casings are not acceptable. A lockable isolator to be mounted within 1m of fan.

1.2.6 Larger fans shall be manufactured with split casings in sections to permit installation through available openings in new and existing buildings.

1.2.7 Shaft bearings shall be grease lubricated, self-aligning ball or roller bearings in accordance with the fan manufacturer's standard practice. For bearings located in the air stream, precautions shall be taken to prevent loss of lubricant.

1.2.8 Shafts shall be fully machined steel shafting conforming to BS 970 grade 070M20.

1.2.9 A drain socket with plug shall be provided at the lowest point in the fan casing (except if discharge is at lowest point). Fans used in variable volume applications shall have stable characteristics throughout the operating range.

1.2.10 All fans shall be tested in the factory and checked for vibration to ISO 2372, smooth running, mechanical interference. Bearings shall be checked using a shock impulse meter.

1.2.11 Fan motors in the air stream in draw-through applications with spray coolers or sprayed coils shall be TEFC and protected to IP44 or better.

1.2.12 Casing access panels shall be fitted to fans 630mm and larger and all fans used in draw-through applications with spray coolers or sprayed coils.

1.3 Axial Flow Fans

1.3.1 All fans shall be manufactured from heavy gauge mild sheet steel. The casings shall be roll formed and welded before being hot dipped galvanised to BS729.

1.3.2 All axial fans shall be long case axial flow fans. Each fan shall be complete with matching flanges and feet.

1.3.3 The fan blades shall be manufactured from die cast aluminium to BS1490

1.3.4 All fan Hubs shall be manufactured from a die cast aluminium alloy.

1.3.5 Axial fans shall be installed with a suitable flexible connection between each side of the fan and the connecting ductwork.

1.3.6 Axial flow fans shall be supported on anti-vibration mountings to the written recommendation of the manufacturer. Suspended units shall generally be supported from hangers Type 30N as manufactured by Mason Industries Inc. or equal and approved.

1.3.7 Axial flow fans shall be of the aerofoil type with non-overloading characteristic with peak power requirements occurring in normal operating pressure range and motor rating exceeding this requirement.

1.3.8 Axial fans shall be selected for the highest possible efficiency with the lowest possible blade tip speed.

1.3.9 The complete fan unit shall be statically and dynamically balanced in accordance with ISO 1940 – 1973 within grade G6,3. A lockable isolator to be mounted within 1m of fan.

1.3.10 Fan performance shall be based on tests carried out in accordance with BS 848 : Part 1 as amended.

1.3.11 Fan motors shall be totally enclosed squirrel cage induction type with protection to IP 55 unless for a special application as set out in the Supplementary Specification.

1.3.12 Motor connections shall be in an external weather proof terminal box forming part of the casing. (Except for flameproof and special applications.)

1.4 Propeller Fans

1.4.1 Propeller fans shall be suitable for plate mounting. A lockable isolator to be fitted 1m from fan.

1.4.2 Mounting plates (diaphragm) shall be of pressed steel or reinforced laminated fibreglass with integral bell mouth orifice.

1.4.3 Impellers shall be of heavy gauge contoured pressed steel blades or reinforced polypropylene or fibreglass ultra-violet stabilised, mounted on cast aluminium or steel hubs.

1.4.4 Fan motors shall be three-phase totally enclosed squirrel cage induction type with protection to IP44.

1.4.5 Fans shall be resiliently mounted.

1.4.6 Motor and impeller protection screens shall be fitted as applicable.

1.4.7 Fans on exterior walls shall be fitted with weather tight galvanised wall cowls.

1.5 Window/Wall Extract Fans

1.5.1 Window/wall type fans shall be fitted with automatic shutters.

1.5.2 Fans shall be fitted with finger protection guards.

1.5.3 Where specified, speed control shall be provided.

1.6 Roof Extract Fans

1.6.1 Roof extract fans shall be the mixed flow or propeller type as specified in the Supplementary Specification with non-overloading characteristic.

1.6.2 Where specified, units shall be suitable for upstand or curb mounting complete with weather skirt and flashing as required.

1.6.3 Vertical discharge fans shall be fitted with shutters to prevent rain ingress.

1.6.4 Roof extract units shall be suitable for mounting on the roof pitch.

1.6.5 Roof extract units shall be manufactured from reinforced fibreglass and painted as specified.

1.6.6 Fans shall be directly driven by totally enclosed airstream rated motors protected to IP44.

1.6.7 Fan performance shall be based on tests carried out in accordance with BS 848 : Part 1 (as amended).

1.6.8 Impellers shall be statically and dynamically balanced.

2. FILTERS

2.1 General

2.1.1 Filters shall be of the type, size and quantity as specified in the Supplementary Specification.

2.2 Primary Filters

2.2.1 Primary Filters shall be of the washable panel type with an efficiency of 30 - 35% on the ASHRAE 52-76-test standard and an average dust arrestance rating of 92%. (Type F4)

2.2.2 The approach velocity shall not exceed 2,5 m/sec.

2.2.3 Panel filters shall be of the pleated type and not less than 50mm thick. The filter shall be washable or disposable as specified. Synthetic media shall be used bounded together with galvanised wire for reinforcing and bonded in the frame ensuring no air bypass. The frame shall be galvanised steel or a distortion and corrosion free moulding.

2.3 The Secondary Filters

2.3.1 The secondary filters shall be of the compact type F9 with an efficiency of 90% on the ASHRAE 52.1-1992 test standard and an average dust arrestance rating of 98%.

2.3.2 Filter housing units shall be proprietary brand, flanged and mounted after the supply air fan. Access shall be side or bottom withdrawal, depending on the plant layout. The housing shall be equipped with an adequate mechanism to provide a positive filter to casing and filter-to-filter seal.

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

2.3.4 Sufficient space shall be allowed in front or behind filters, as applicable, to enable inspection and servicing. The approach velocity shall not exceed 2,5 m/sec.

2.4 Spare Filters

2.4.1 One complete set of spare filter cells is to be supplied to the client prior to acceptance of the plant.

2.5 Manometers

2.5.1 An inclined manometer is to be fitted on the outside of the air-handling unit where secondary or HEPA filters are used. A separate manometer shall be fitted for each filter stage (except primary filters).

3. GRILLES AND DIFFUSERS

3.1 General

3.1.1 All grilles and diffusers sizes and quantities shall be as detailed in the equipment schedule.

3.2 Ceiling Diffusers

3.2.1 All ceiling diffusers shall be the same proprietary make i.e. Ventline, Rickard, Trox etc.

3.2.2 All ceiling diffusers shall suit the size of the ceiling grid. The diffusers shall provide an even 360-degree air pattern with a constant discharge velocity. The diffusers shall be manufactured from pressed steel construction with flat surfaces to facilitate cleaning. The inlet to each diffuser shall be with a round spigot for easy connection onto a circular duct. Each diffuser shall be complete with an adjustable plate for air balancing.

3.2.3 The Colour finish shall be as detailed in the Supplementary Specification.

3.2.4 All diffusers and grilles shall be left in a new clean condition with all marks or scratches repaired to make item as new.

3.3.1 Variable Volume Diffusers

3.3.1 Variable volume diffusers shall be complete with integral electric actuators and be selected to suit the ceiling grid. All electrics to the diffusers shall be 230 volt unless otherwise specified. A separate power point is to be provided adjacent each master diffuser. The diffusers shall provide an even 360-degree air pattern with a constant discharge velocity ensuring maximum entrainment from 100% to 33% capacity. The minimum air quantity will be preset to 33%. The diffusers shall be manufactured from pressed steel construction with flat surfaces to facilitate cleaning. The inlet to each diffuser shall be with a round spigot for easy connection onto a circular duct. The Colour finish shall be as detailed in the Project Specification. Supply air grilles

3.3.2 Grilles shall be manufactured of stamped, extruded or rolled aluminium or steel sections, finished as specified and mounted in a neat frame. Supply air grilles shall be provided with double deflection aerofoil vanes adjustable from the front of the grille.

3.3.3 Vanes shall be spaced at not more than 20mm centres. Exhaust and return air grilles in the same installation shall be similar in general appearance and construction to the supply air grilles but with a single set of fixed vanes. Supply air grilles shall be provided with opposed blade volume control dampers adjustable from the front of the grille.

3.4 Return and Exhaust Air Grilles

3.4.1 Return air grilles shall be aluminium with front section horizontal fixed profile blades for ceiling installation, or alternatively aluminium egg crate as scheduled. Return air grilles shall be provided with opposed blade dampers for volume control only where called for on the drawings. Dampers shall be adjustable from the front of the grille.

3.4.2 RAEC Type grilles will be complete with a flange and spigot, and have an opposed blade damper. The grilles will suit a ceiling tee if required.

3.4.3 RAFF return air grilles shall be Europair type. These grilles shall be manufactured from extruded type 50S anodised grade aluminium. These grilles shall consist of a 30mm fixed outer frame and a hinged inner frame with a fixed blade grille core having a 20 mm spacing. The grilles are to be complete with a 6 mm thick washable filter media positioned inside the outer frame behind the hinged grille section. The grille section is to be securely held closed by hidden clips and shall be opened by an aluminium handle finished in the same colour as the grille.

3.4.4 The Colour finish shall be as detailed in the Supplementary Specification.

3.4.5 All diffusers and grilles shall be left in a new clean condition with all marks or scratches repaired to make item as new.

3.4.6 All return air and exhaust air grilles shall be complete with an opposed blade damper volume control.

3.5 External Louvres

3.5.1 External weatherproof louvres shall be constructed from extruded aluminium. A galvanised steel vermin proof wire mesh screen is to be fitted to the rear face of each louvre.

3.5.2 All external weather louvres will be complete with an adjustable OBD and have a Natural Anodised finish.

3.5.3 All external weather louvres shall be Europair Model WL. The louvres shall be manufactured from extruded type 50S anodised grade aluminium. These grilles shall consist of a 50mm frame

with a fixed blade grille core having a maximum spacing of 50mm. The louvres shall be complete with a galvanised steel wire mesh screen. The grilles shall have a Natural Anodised finish or colour anodised finish as detailed in the project specification.

3.6 Door Grilles

3.6.1 Door grilles where shown on the drawings shall be supplied to the builder for installation. They shall be of the inverted V-blade type, manufactured from natural anodised aluminium and flanged on both sides of the door. Colour finish shall be confirmed in the Project Specification.

4. PIPEWORK

4.1 General

4.1.1 The Contractor shall supply, deliver and install all interconnecting pipework complete with all brackets, fittings, flanges, unions, valves, etc., necessary for the operation of the plant as indicated on the drawings and in accordance with this and the Supplementary specification.

4.1.2 Piping shall be so arranged to ensure unobstructed access so that normal inspection, maintenance and adjustment of all equipment can be readily carried out.

4.1.3 The pipework and fittings shall conform to the current relevant SABS specifications and where applicable installed to the relevant Code of Practice.

4.1.4 The contractor is to allow for sufficient flanges to ensure the pipework can be manhandled into position on site.

4.1.5 All pipework runs shall be properly spaced from walls, floors, ceilings and each other to ensure a neat and tidy installation.

4.1.6 All valve, flanges sensors and valves on flow and return connections to units shall be installed at the same heights.

4.2 Pipework Quality

4.2.1 All pipework used shall comply to the following standards:

- Black mild steel pipework shall comply to SABS 62/SABS 1182/B.S.1387;
- Screwed and flanged fittings shall be manufactured in accordance with ABS509/SABS 1123/B.S.143;
- Galvanised mild steel pipework shall comply with SABS 763/ B.S.1387;
- Screwed and flanged fittings shall be manufactured in accordance with SABS509/SABS 1123/B.S.143;
- Medium gauge copper tube shall be manufactured to the requirements of SABS 460, or B.S.2871, Part I, Table X, by Yorkshire Imperial Metals Ltd.

4.2 Piping Installation

4.3.1 The following material shall be used for the relevant Airconditioning Services unless otherwise specified in the supplementary specification:

- Chilled Water - Black Medium Mild Steel
- Condenser Water Open System - Galvanised Medium Mild Steel or Black Medium Mild Steel and Hot Dipped Galvanised
- Condenser Water Closed Circuit - Black Medium Mild Steel
- Condensate Drains in Plantrooms - Class 1 hard drawn Copper with Capillary fittings
- Overflows - Class 1 hard drawn Copper with Capillary fittings
- MCW - Class 1 hard drawn Copper with Capillary fittings

4.3.2 All steel pipework and fittings of 50 mm nominal bore and below may have screwed connections. All screwed pipework shall be galvanised medium class steel to BS 1387. All screwed fittings shall be manufactured of malleable cast iron in accordance with SABS 509 or BS 143.

4.3.3 Short Radiused elbows are only permissible where there is limited space and only with the written approval of the Engineer.

4.3.4 All steel piping 65 mm Diameter and above will be welded and flanged. Flanges shall be in accordance with SABS 1123. Flange jointing packings shall be of suitable joint rings.

4.3.5 All fittings and accessories shall generally be flanged and shall be in accordance with SABS 1123. Flanges shall be rated at not less than 1000 kPa or 1.5 times the maximum working pressure which ever is the greatest.

4.3.6 All screwed pipework connections to equipment shall be made with flanges. NO unions shall be used.

4.3.7 All exposed threads shall be painted with Corrocote 3, AECI product Code D184-1054 or equal. All grease, thread etc. shall be removed before paint is applied.

4.3.8 All condensate drains shall be installed using hard drawn copper with soldered capillary fittings. UPVC pipework or fittings will not be accepted in plantrooms.

4.3.9 Bends on black mild steel, and galvanised pipework, shall not be bent without a bending machine. Fittings shall be used throughout the installation in these instances. Copper bends may be formed from pipe lengths by an appropriate bending machine when this is the accepted practice. The internal radius of the bend shall not be less than two pipe diameters. Alterations to the cross sectional area of the pipe or rippling of the throat of a bend will make such a bend unacceptable for installation.

4.3.10 All galvanised mild steel pipework shall be protected against damage and corrosion prior to and during installation.

4.3.11 All horizontal services shall be laid to a slight fall so that the system is self-draining to all low points, drain cocks and drain plugs.

4.3.12 Where screwed joints are used, bushings or long screw connections and back nuts will not be accepted. The amount of flux and paste used in jointing shall be kept to a minimum and all excess shall be removed.

4.3.13 Care shall be taken to ensure fittings are not excessively tool marked. If in the opinion of the Engineer any fitting or pipe length is unacceptably marked, the Contractor shall replace the condemned section with new material.

4.3.14 Piping when cut, shall be carefully reamed out to restore the bore and the Sub-contractor shall allow for disconnecting and prefixing any joint the Engineer may select to demonstrate that this has been done.

4.3.15 Before any part of the installation is commissioned, the pipework shall be cleaned of any

accumulated dirt and debris by washing or blowing through the pipework at least twice. The Contractor shall allow for dismantling the pipework at the bottom of each riser to ensure that all debris is removed from the system.

4.3.16 All screwed joints shall be clean threaded and pulled up tightly. No caulking shall be permitted.

4.3.17 Vertical lines shall be dropped plumb; all multiple lines shall be parallel and must be spaced to permit coverings as specified under the insulation clause of this specification.

4.3.18 All black pipework and all welded joints shall be painted with two coats of red oxide after tests have been completed.

4.3.19 All black mild steel pipework in floor duct, chases, ceiling void and service shafts shall be welded. Flanged or screwed connections shall be made at valves, items of plant and elsewhere as specified.

4.3.20 The Contractor shall provide between all galvanised and copper pipework, connectors that will minimise electrolytic reaction between the materials.

4.4 Welding of Pipework

4.4.1 All welding is to be carried out in accordance with recommendations contained in the latest recommended practices and to SABS 044 as amended.

4.5 Pipe Fitter Welders

4.5.1 Only welders holding a Certificate of Competency shall be permitted to perform any welding on site. The names of such welders shall be submitted to the Engineer before any welding is executed on site and the appropriate certificates must be submitted for the approval of the Engineer at the time. Their certificates will be renewed after inspection. Each welder having completed a weld shall stamp the number of his Certificate of Competency on the pipe adjacent to the weld.

4.5.2 Any welding which is found to have been performed by the welder whose name has not been previously approved, shall be removed and the pipeline re-welded by an approved welder at the expense of the Contractor.

4.6 X-RAY Examination

4.6.1 If for any reason the Engineer should see fit to request that any or all welds are to be X-Ray examined this will be done at the contractors cost.

4.7 Pipe Supports and Anchors

4.7.1 The contractor shall supply and install all necessary anchors and brackets to support and control the movement of the pipes. Where there are two or more pipes installed together the contractor shall manufacture and erect a purpose made channel iron bracket with suitable sized “U” bolts. Pipe brackets shall be designed to accommodate movement caused by either expansion and contraction or building movement.

4.7.2 Detailed drawings for the pipework supports shall be approved by the Engineer prior to fabrication.

4.7.3 Pipe brackets shall be complete with rubber inserts for anti-vibration purposes.

4.7.4 The maximum spacing of hangers and the minimum spacing of hanger rods shall be as follows:

Nominal Pipe Size mm	Maximum Span	Minimum Rod Diameter
20 mm	2.2m	10 mm
25-40 mm	2.8m	10 mm
50 mm	3m	10 mm
80 mm	3m	12 mm
90 mm	3m	12 mm
100 mm	3m	16 mm
125 mm	3m	16 mm
150 mm and above	3m	22 mm

4.7.5 All vertical water pipes shall be additionally supported at the lowest point of all risers to ensure no movement of pipework.

4.7.6 The Structural Engineer shall approve all fixings and brackets prior to their installation onto the concrete slab.

4.7.7 Any piping installed onto a concrete roof shall be supported by floor-mounted brackets. The floor brackets shall be positioned on purpose made concrete bases so as not to penetrate the waterproofing. No fixings will be allowed to penetrate the waterproofing of the roof without the Architects and Structural Engineers written approval. Any such penetration through the waterproofing shall be sealed with chemical anchors or as otherwise instructed by the Engineer.

4.8 Sleeves and floor plates

4.8.1 Where pipes pass through walls, floors, partitions or ceilings, the Contractor shall supply and hand to the Builder sleeve pipes of suitable size and material for building in. After installation of the pipework, the Contractor shall caulk the sleeve with fibre cement rope, or alternatively, fire retardant foam in the space around the pipe. Pipes shall pass concentrically through wall sleeves to maintain an even thickness of insulation. Each sleeve shall project beyond the furnished surface sufficient enough to allow the application of a continuous vapour seal where required. Any pipe passing through a waterproofing retaining wall or slab shall pass through a sealed puddle flange.

4.9 Pipework Anti Vibration

4.9.1 Piping supported from the roof trusses or concrete slab are to incorporate Mason type spring hangers to avoid any vibration being transmitted through the building.

4.9.2 The first four hangers located adjacent to mechanical equipment shall be capable of supporting the piping at a fixed elevation during installation, regardless of load changes. The mountings shall consist of a steel spring in combination with a neoprene in shear element. The minimum static

deflection shall be 32mm. The hanger shall also incorporate an adjusting device to transfer the load to the spring.

4.9.3 Ceiling suspended piping shall be isolated by a combination spring and neoprene in shear element having a minimum static deflection of 32mm.

4.9.4 Floor supported piping shall be isolated by mountings free standing, laterally stable without housings or guides, and complete with 6mm ribbed acoustical neoprene pad cold bonded to the underside of the base plate. All mountings shall have boltholes in the base plate and be provided with adjusting bolts for levelling and attachment to the equipment. Horizontal and vertical spring constants shall be equal so as to ensure the same protection from horizontal disturbances as from vertical. Mountings shall have an additional 50% capacity beyond the rated load.

4.9.5 Floor supported piping in the main plantroom and condenser water piping shall be supported by mountings as described above except that mountings shall incorporate a resilient vertical limit stop to prevent spring extensions during weight changes. A minimum clearance of l3 mm shall be maintained between the steel springs and the limit stop housings and around the restraining bolts so as not to interfere with normal spring performances.

4.9.6 When piping passes through walls or floors, furring sleeves, which contain isolating material, should be used.

4.10 Valves

4.10.1 The Contractor shall install valves as detailed in the project specification and on the tender drawings, on the flow and return connections to each branch circuit and at each item of apparatus.

4.10.2 In addition to the isolating valves, regulating valves shall be provided on the return connection of each branch circuit.

4.10.3 All valves up to and including 50mm shall be screwed to BSPT. Valves 65mm and above shall be flanged to SABS 1123/B.S. Table 10

4.11 Gate Valves

4.11.1 The gate valves up to 50mm diameter Nominal Bore shall be Hattersley 33x bronze gate valves OR EQUAL and approved by the Engineer prior to installation. All valves must have cast metal hand wheels - pressed metal wheels must not be used.

4.11.2 The valves shall have a Bronze Body, screwed bonnet, internal screw and yoke, non-rising spindle bronze wedges.

4.11.3 Gate Valves 65mm diameter Nominal Bore must have Cast iron body, bolted bonnet, flanged ends, external screw and yoke, bronze trim, rising spindle and shall be Newman Hattersley - Fig. 552E. or equal and approved.

4.12 Globe Valves

4.12.1 Globe Valves Up to and including 50mm Nominal Bore shall have a Bronze Body, screwed BSP ends, rising stem screwed bonnet, renewable stainless steel disc and seat similar or equal to Newman Hattersley - Fig. 16.

4.12.2 Globe Valves 65 mm Nominal Bore and above, Bronze Body, flanged ends, Table H, outside screw and yoke, renewable stainless steel disc and seat, rising spindle similar or equal to Hattersley - Fig. 18fl.

4.13 Butterfly Valves

4.13.1 All butterfly valves shall be Hattersley Model 950 semi lugged type OR EQUAL and approved by the Engineer prior to installation.

4.14 Check Valves

4.14.1 Check Valves or Non Return Valves Up to and including 50mm Nominal Bore, shall be complete with a Bronze Body, screwed bonnet, screwed ends BSP, spring loaded, renewable composition fibre disc and bronze seat air check valve similar or equal to Newman Hattersley - Fig. 1213 up to 5Omm.

4.14.2 Check Valves of 65mm nominal bore and above shall be Hattersley Model 850 Cast Iron wafer check valves OR EQUAL and approved by the Engineer prior to installation.

4.15 Commissioning / Balancing Valves

4.15.1 Commissioning Valves shall be STA-D/F Balancing valves. The valves shall be installed on the return from each air-handling unit to regulate the flow rate. The valve shall be provided with drain cocks to facilitate the use of a manometer.

4.16 Strainers

4.16.1 Strainers shall be Y type cast Iron flanged complete with a bolted cover with blow down plug and stainless steel screen to be fitted with extraction handle.

4.16.2 Strainers of 50mm size and smaller may have bronze or iron bodies, with screwed connections.

4.16.3 Strainers shall be designed for not less than 1035 KPa working pressure.

4.16.4 Screens shall be bronze Monel metal or stainless steel with perforations as follows:

4.16.5 **Strainer Size** **Perforation Size**

- 20mm to 50 mm inclusive (NH807) 0,8mm
- 55mm to 150mm inclusive (NH810-E) 1,6mm
- 200mm to 300mm inclusive (NH810-E) 3,2mm
- Over 300mm 6,4mm

4.16.6 The free area of each screen shall be not less than three times the area of the strainer inlet pipe.

4.16.7 Each strainer shall be provided with 20mm valved drain, with hose connection and unless the strainer design is devoid of air pockets, a l5 mm vent cock.

4.17 Ball Valves

4.17.1 Ball valves up to 50mm nominal bore where permitted shall be chromium steel with stainless steel ball fitting. All ball valves installed on chilled water systems shall have extended shafts to protrude through the insulation.

4.18 Automatic Air Vents

4.18.1 Automatic air vents shall be bronze body, brass ball, stainless steel valve and seat. They will be installed at all high points in the water systems as shown on the drawings (BRAUMANN EA122).

4.19 Pressure Gauges

4.19.1 Pressure gauges shall be installed where required and where indicated on the drawings. All pressure gauges shall be of the glycerine filled dial type with a diameter not smaller than 100mm. All pressure gauges shall be complete with stopcock and syphon pipe and shall be graduated to 50% above the working pressure. The accuracy of all gauges shall be 2%.

4.20 Thermometers

4.20.1 All thermometers shall be stem type. They shall be alcohol in glass with an aluminium or brass casing. Scale range of the thermometers shall be selected so that the nominal operating temperature falls at or near midscale.

4.20.2 Thermometer wells shall be made of heavy brass with portions surrounding the bulbs not over 1,6mm thick. They shall be approximately 150mm long, shall project a minimum of 50mm into the pipe. Pipes smaller than 65mm in size shall be enlarged at the points where the wells are installed. Wells shall be set vertically or at an angle, so as to retain oil.

4.21 Vacuum Breakers

4.21.1 Vacuum breakers shall be installed on all liquid storage vessels. They shall be constructed of a brass body with stainless steel valve disc and seat with a stainless steel enclosed operating spring. Minimum size to be 25 mm.

4.22 Binder Fittings

4.22.1 Binder fittings shall be installed in positions indicated on the drawings. All binder fittings shall be installed on the top of the pipe where possible.

4.23 Expansion Tank

4.23.1 Expansion tanks are to be installed where indicated on the drawing or at the highest point in the system.

4.23.1 The tank is to be manufactured from 3 mm mild steel and shall be hot dip galvanised after manufacture. The tank is to be complete with a lid and air vent.

4.23.2 The tank will have a minimum water level of 300 mm from the bottom of the tank.

4.23.3 A 20 mm diameter MCW supply will be supplied by others within 2m of the tank. The isolating valve and ball valve will be installed as part of this contract.

4.23.4 The tank shall be provided with separate quick fill connection, overflow, and valved drain connection.

4.23.5 A 25 mm cold feed shall be taken from the tank 100 mm from the bottom and run to the suction side of the pump.

4.23.6 All pipe connections to the tank are to be complete with unions.

4.23.7 The size of the expansion tank is to be calculated as 0.6% of the total water quantity of the whole system. The expansion tank is then sized to handle the increase in water plus the minimum amount required in the tank. (i.e. 300 mm from the bottom of the tank).

4.23.8 The base of the feed and expansion tank shall not be below the highest point of the system.

4.23.9 The contractor is to allow for a suitable hot dip galvanised bracket to support the tank, which must be approved by the Structural Engineer before manufacture.

4.24 Pipeline Identification

4.24.1 Pipeline identification banding shall be used to identify all pipelines (insulated and uninsulated), concealed in ducts, voids and spaces above false ceilings. It shall be self-adhesive cellulose tape laminated with a layer of transparent ethyl cellulose tape.

4.24.2 The contents of the pipeline shall be readily identified by an adhesive band of the appropriate ground colour detailed in B.S. 1710/SABS 0140(111) with an explanatory text approved by the Engineer, printed upon it in a contrasting colour detailing the contents of the pipe.

4.24.3 All colour bands shall be 3OOmm wide and spread at approximately 5m centres. Where pipes are installed in under floor ducts, colour bands etc., shall only be provided where access covers occur.

4.25 Valve Labels

4.25.1 The Contractor shall provide chain and brass labels for all valves, stopcocks, etc., with engraved lettering to indicate their purpose, as directed by the Engineer.

4.25.2 Provide approved ceiling tile markers in areas where removable ceilings or access panels occur to indicate location of valves or other devices.

4.26 Flushing the System

4.26.1 The completed pipework system shall be filled with water and then run to waste until the system is free of dirt, oil, cuttings, and weld splatter. On steam Systems remove all steam traps and strainers and provide temporary connections as required prior to flushing out. Replace all traps on completion.

4.27 Pressure Test

4.27.1 On completion of the installation the piping is to be pressure tested to one and a half times the working pressure or 8 bar whichever is the greater. In the case of chilled water systems this must be carried out before any insulation is applied. All equipment must be isolated during this test.

5. DUCTING

5.1 General

5.1.1 All ducting shall be low velocity low-pressure ductwork and be manufactured from galvanised sheet metal to SABS 1238-1979 as amended.

5.2 Site Dimensions

5.2.1 The Mechanical Contractor is required to check all dimensions on site before preparing drawings for the manufacture of ductwork and will be held responsible for ensuring that all ductwork conforms to the building structure.

5.2.2 All ducting will be installed neatly and all duct joints and seams shall be airtight.

5.2.3 The types of longitudinal seams, transverse joints, and duct stiffening shall be in accordance with the relevant tables and sub-sections of the SABS specification. Ductwork is to be true in section. No distortion shall be permitted.

5.2.4 Ductwork supports are to be galvanised, adjustable, of adequate strength and in accordance with SABS 10173. Pop rivets, etc. penetrating into vapour sealed insulation will not be allowed.

5.2.5 All ducting having a semi-perimeter of 1150 mm or more shall be flanged using Ductlok flanges and fasteners incorporating a permanent non-hardening sealant. Should Mezz Flanges be used, then sufficient sealant and fasteners shall be used to ensure that no air leakage occurs.

5.2.6 All material thickness SHALL be in accordance with the specification. The cost of replacing any defective ductwork and any associated builders work will be for the contractors account if lighter gauge material is used.

5.2.7 All ducting will be sufficiently supported to ensure no stress or strain is imposed on the ducting joints and seams. The cutting of drive slips or flanges to accommodate branch ducts is not acceptable.

5.3 Insulation

5.3.1 All airconditioning ducting is to be insulated as detailed in the Project Specification. No ducting shall be accepted with torn insulation.

5.3.2 Ventilation ducting need not be insulated.

5.3.3 Allowance must be made for a flexible connection on each connection to equipment. A minimum of 50 mm separation between metal edges shall be maintained.

5.3.4 All bends installed on the main supply air duct connections from the units shall have double thickness turning vanes.

5.3.5 Where changes in duct sizes indicated are necessitated on site, duct sizes shall be determined using equivalent diameters (hydraulic diameter) and not cross-sectional area.

5.3.6 Flexible joints shall be provided between all fans, airhandlers, vibration inducing equipment, etc. and ducting.

5.3.7 Flexible joints exposed to weather shall be provided with protecting galvanised sheet steel cover strips.

5.3.8 Flexible connections shall be made of fireproof fabric reinforced airtight material attached both sides with approved galvanised steel collars or frames.

5.4 Flexible Ducting

5.4.1 Flexible ducting shall be Euroflex type Isodec 25A aluminium/polyester/aluminium laminate with a heavy-duty steel helix core. The flexible duct shall be insulated with fibreglass insulation having a density of 16 kg / cubic meter. The outer jacket vapour barrier shall be made of spirally reinforced multiple layer aluminium laminated construction. No tight turns with the flexible ducting will be accepted and the maximum length of any flexible duct will be 1500 mm.

5.4.2 Should the engineer not be satisfied with the installation of the ducting he shall reserve the right to call for an air leakage test. The test shall be in accordance with SABS 10173 and the contractor shall supply all necessary measuring apparatus, and conduct the test in the presence of the engineer. The contractor will carry out any remedial work deemed necessary by the engineer to meet the necessary air leakage standards free of charge.

5.4.3 Care is to be taken with the installation of any second fix ducting through ceiling grids. Any damage caused to the ceiling grid or tiles shall be rectified free of charge by the contractor.

5.4.4 All ducting is to be kept dust free during and after installation. The contractor is to allow for sufficient plastic sheeting covering all openings, attenuators, and grilles to avoid dust getting into the ducting prior to commissioning.

5.4.5 All hangers are to be level and perpendicular to the ceiling and ducting. All marks writing etc are to be removed by the contractor prior to handover.

5.4.6 Flexible ducting shall comply with local fire codes, NFPA Bulletin 90A and SABS 0400 fire resistance requirements.

5.5 Test Holes

5.5.1 Test holes shall have galvanised steel cover plates secured with stainless steel screws. Any cut edges around holes etc, and wherever galvanising is broken shall be painted with 'Galvanite'.

5.6 Exposed Ducts

5.6.1 Ductwork exposed to the weather shall not be less than 1mm material thickness and shall be painted to an approved colour.

5.7 Balancing Dampers

5.7.1 All balancing dampers shall be gear driven opposed aerofoil blade dampers mounted between two flanges and be complete with a lockable quadrant. Dampers shall be manufactured from galvanised sheet metal which shall have a thickness not less than the duct gauge fixed to each side. Dampers shall be Similar or equal to Europair DMP.

5.8 Fire Dampers

5.8.1 Fire dampers shall be provided at all positions where ducts pass through a firebreak barrier. These shall have a fire resistance equal to that of the barrier, and shall be equipped with fusible links to operate at 59 degrees Celsius. Access traps shall be provided in the ductwork to permit inspection and replacement of the link.

6. CONTROLS

6.1 General

6.1.1 The automatic electrical control system for each project will be specified in detail in the Supplementary Specification

6.1.2 Controls shall be electric or electronic or a combination thereof. Controls shall be analogue or direct digital as specified.

6.1.3 The performance of sensors, controllers and outputs shall be such that stability is ensured under all operating conditions.

6.1.4 Provision shall be made on controllers to enable adjusting control loop stability such as adjustable proportional bands, adjustable reset rates etc.

6.1.5 Controllers shall be designed for minimum time lag around the control loop.

6.1.6 Non-adjustable controllers or controllers with inadequate adjustment facility will not be accepted.

6.1.7 Electric heaters shall be controlled in steps as specified in the Supplementary Specification.

6.1.8 The control circuit shall be interlocked with the supply air fan and shall only be in operation if the fan is running.

6.1.9 The following interlocks shall be provided for electric heaters where used;

- Heater shall not be on unless the fan is on;
- A fire protection high temperature thermostat shall be provided in the supply air duct to stop the fan if the air temperature exceeds 50ºC and to switch all heaters off;
- A pressure switch or flap type mercury switch shall be fitted in the supply air duct to ensure that the heaters cannot be on unless air flow is established
- Provision to ensure that heating and cooling cannot be on simultaneously.

6.1.10 All Compressors shall have interlocks preventing operation unless heat rejection equipment is functioning.

6.1.11 Air-cooled condensers shall be provided with head pressure control to maintain condensing temperatures within the limits recommended by the compressor manufacturer.

6.1.12 Damper actuators shall be selected to suit the specified control requirements and with sufficient torque output to drive the dampers smoothly without straining or overloading. Damper actuators shall be mounted in accessible positions for maintenance and setting purposes. Linkages between actuators and dampers shall be adjustable.

6.1.13 Thermostatic expansion valves shall be of the gas charged type with external superheat adjustment and solder joint or flanged pipe connections. On coils where the refrigerant pressure drop through the coils exceeds 15 kPa, the expansion valve shall be provided with an external equaliser to the suction line at a point beyond the remote bulb. Valves shall be able to move from fully open to fully closed on not more than 3ºC change in superheat. The superheat setting shall be between 4 and 8ºC and shall be as recommended by the coil manufacturer.

7. HUMIDIFIERS

7.1 General

7.1.1 Steam humidifiers are to be an immersed electrode type equal or similar to the Carel SD range.

7.1.2 The humidifier is to be fully automatic and is to modulate the steam production by control of the water level to the production cylinder.

7.1.3 The contractor is to allow for pipework connections, cold-water and drainage, and electrical connections, power and control wiring, to and from the humidifier.

7.1.4 The humidifier is to be complete with a stainless steel linear distributor.

7.1.5 Should the humidifier be controlled by an automatic control system similar to Johnson, the Carel SD humidifier must be fitted with the CDP controller, which will be enabled by the airflow relay.

8. HEATER BANKS

8.1 General

8.1.1 Electrical Heater Banks must be downstream of the cooling coil. The elements shall be Incalloy black heating elements. The electrical load of the heater elements must be evenly distributed over the three phases.

8.1.2 Overheat thermostats and flow switches shall be connected in series with the heater banks.

8.1.3 Heater banks must be step or proportionally controlled. The electrical supply must be 230v/400v.

8.1.4 Heaters built into ductwork shall be installed in a pre-fabricated section internally lined with fibre cement paneling.

8.1.5 Heaters shall be so constructed so that all elements can be easily inspected and replaced if and when necessary.

8.1.6 All elements shall be wired to a terminal box mounted on the outside of the duct.

9. SOUND ATTENUATORS

9.1 General

9.1.1 Sound Attenuators shall be installed in the supply and return air ducts where shown on the tender drawing and as further detailed in the equipment schedule.

9.1.2 The sound attenuators shall be designed for an insertion loss large enough to limit the total sound pressure level of the noise at a distance of 1.5m directly in front of the first air outlet in the duct system to the following NC Levels detailed in the project specification.

9.1.3 The absorption material shall be moisture repellent non-inflammable and shall not support combustion and shall be abrasion proof up to air speeds of 20m/s.

9.1.4 Sound Attenuators shall be of the proprietary manufactured type. Field fabricated sound attenuators will not be accepted.

9.1.5 The sound attenuators detailed in the equipment schedule are for tender purposes only and all sound pressure levels shall be recalculated by the contractor and submitted to the engineer before manufacture.

10. WATER TREATMENT

10.1 General

10.1.1 Water treatment shall be provided for all cooling towers and closed circuit cooling systems. The water treatment and water quality control shall be matched to suit the local site and water conditions.

10.2 Water Treatment for Closed Circuit Systems

10.2.1 The closed water system is to be chemically dosed on completion of the commissioning. The system is to be flushed once the pressure test is complete and the chemicals introduced when refilling the system.

10.2.2 Chemicals shall be selected to prevent formation of scale, sludge, control microbiological growth and inhibit corrosion.

10.2.3 The chemicals shall be capable of remaining stable over a 12-month period, and the quantity calculated to treat the total volume of water of the whole system.

10.2.4 Care is to be taken that the chemicals selected do not adversely react with any item of equipment.

10.2.5 Once commissioning is complete a water sample is to be taken and the contractor is to supply the engineer with a laboratory report proving that the water is satisfactorily treated.

10.2.6 The chemicals for this project shall be

- Microbiological - Broad spectrum biocide SK shall be added at 150 ppm
- Sludge - Dispersant BL at 50 ppm
- Corrosion - Nitrate based corrosion and scale inhibitor at 700-1000 ppm.

10.2.7 Water Treatment for Open Condenser Water Systems.
The open condenser water system is to have an automatic water treatment system incorporating an automatic dosing plant and bleed control. The system is to include an electronic conductivity display.

10.2.8 Isolating valves shall be provided to ensure that any maintenance can be carried out without the interruption of the operation of the airconditioning system.

10.2.9 The contractor is to carry out a monthly service where a water analysis and recognised corrosion tests must be carried out and a detailed report submitted to the Engineer.

10.2.10 The contractor is to allow for all necessary chemicals for the 12-month guarantee period. The chemicals used shall be stable and not breakdown and cause clogging of the dosing equipment.

10.2.11 The system shall comprise an automatic bleed-off valve, which is to be controlled by an electronic measuring cell from the water conductivity and automatic measuring type dosing pumps. The electronic measuring cell must continually measure the water conductivity and control the bleed off valve and dosing pump accordingly.

10.2.12 The TDS is to be controlled in the range of 600-800 mg/litre.

10.2.13 The water treatment system is to ensure that:

- Scale formation and corrosion are prevented,
- Algae and microbiological growth is controlled,
- Legionella Pnuemophila is prevented,
- Sediment is controlled with low water consumption,

11. COOLING TOWERS

11.1 General

11.1.1 Cooling Towers shall be selected to match the design duty at the selected wet bulb temperatures specified in the project Specification.

11.1.2 Cooling towers shall be induced draught type of a proprietary manufacturer Sulzer, Evapco or Baltimore Air Coil.

11.1.3 Preference will be given to cooling towers manufactured from anti corrosion materials.

11.1.4 Fibreglass cooling towers shall carry a warranty on the casing of at least 10 years.

11.1.5 Fans shall either be axial or centrifugal.

11.1.6 All fan motors shall not exceed 1500 rpm and shall have TEFC squirrel cage type motors. A lockable isolator to be provided on tower; mounted within 1m from fan.

11.1.7 Each cooling tower shall have sufficient access panels to carry out all necessary maintenance and visual inspections.

11.1.8 The cooling tower pack or fill is to be manufactured from an inert polyvinyl chloride.

11.1.9 Cooling Towers shall be complete with all necessary eliminators to reduce carry over.

11.1.10 Each cooling tower shall be fitted with an automatic water level control, a quick-fill bypass valve and a drain valve fitting to the sump.

11.1.11 All steel sections shall be manufactured from galvanised steel with edges protected against corrosion.

11.1.12 Recirculating spray water shall be uniformly distributed over the cooling tower pack or fill ensuring complete wetting of the pack or fill area at all times.

11.1.13 Spray nozzles shall be of the non-clogging type. Nozzles and branch piping shall be easily removable for cleaning and flushing purposes.

11.1.14 Piping systems are to be so arranged to prevent the sump flooding when the circulating pump stops.

12. ELECTRICAL INSTALLATION

12.1 Electrical Panels

12.1.1 Boards are to be made of galvanised or zintex sheet metal, minimum thickness 2 mm.

12.1.2 After all door cutouts have been made, the board is to be coated with an epoxy wash primer, and then electrostatically powder coated.

12.1.3 Any door that has to be cut after painting must be either repainted or professionally touched up.

12.1.4 Floor mounted boards are to have a substantial channel iron base. This base is to be hot-dip galvanised.

12.1.5 All switchgear is to be mounted on a backing plate. This plate is to be drilled and tapped to accept the fasteners. Plastic slotted trunking, terminal rail, and DIN rail may be pop-riveted. No self-tapping screws may be used.

12.1.6 The backing plate is to be white.

12.1.7 Fasteners on copper or brass conductors are to be machine screws. Fasteners up to 5 mm are to be brass. Fasteners 6 mm and over are to be cadmium plated steel. Galvanised fasteners are not to be used. All fasteners are to have washers and spring washers. Structural fasteners are to be cadmium plated steel or galvanised steel. Galvanised fasteners are not to be used on copper or brass components. All fasteners are to have washers and spring washers.

12.1.8 Completed boards are to be IP42 or better.

12.1.9 Switchboard doors are to be earthed with 4 mm^2 copper braid.

12.1.10 Doors are to be hinged, and secured with standard 6.35 mm square catches. One catch on each switchboard door is to be able to accept a padlock to prevent it being opened.

12.1.11 Large unhinged access panels are to be doweled at the bottom, and secured with standard 6.35 mm catches.

12.1.12 Small access panels, bus bar extension panels, and gland plates are to be secured with chrome-plated setscrews or with studs and chrome plated dome nuts.

12.1.13 All board wiring is to be done in slotted PVC trunking. This trunking must have 30% spare space.

12.1.14 In switchboards with a fault level of 10 kA or greater wires from the bus bars to components may not be smaller than 16 mm².

12.1.15 Power and control wiring within the switchboard are to be sized strictly in accordance with SABS 0147 method 1, taking into account overload and short circuit protection, grouping, and temperature.

12.1.16 Door wires are to be properly secured (sticky patches and other adhesives are not acceptable) and protected by spiral binding.

12.1.17 Outgoing terminals and incoming isolators are to be arranged so that top-entry boards have the terminals and/or isolator at the top and vice-versa.

12.1.18 Sufficient space must be allowed between the enclosure and the terminals so that the site electrician has plenty of space in which to make off his cables.

12.1.19 All boards are to have gland plates with gaskets.

12.1.20 All site-made holes for glands must be done with a chassis punch. Hole saws are not to be used.

12.1.21 Current transformers are to have individual pairs of conductors wired back to the instrument. Instrument common terminals are NOT to be looped at the instrument.

12.1.22 All transformers are to have one side of the secondary winding earthed, unless specifically noted otherwise.

12.1.23 All pilot lamps are to be 22 mm in diameter, multiple LED.

12.1.24 Exposed isolator terminals are to be shrouded.

12.1.25 All live bus bars are to be covered with tufnel or perspex and labeled

“DANGER LIVE BUS BARS BEHIND THIS COVER”

12.1.26 All equipment, including fuses and circuit breakers, is to be labeled. All labels, inside and outside of the board, are to be engraved plastic, white letters on black background except for danger labels, which are to be white letters on red background. Fuse labels are to include fuse ratings. Labels are to be fastened with machine screws and may not be fixed to trunking lids.

12.1.27 All terminals are to be Wieland WK or similar rail mounted terminals. All terminals are to have numbers on both sides.

12.1.28 No more than two lugs or two conductors without lugs are permitted in any terminal.

12.1.29 All wires are to be numbered as shown on the wiring diagrams. Where wires are connected to numbered terminals, the wire and the terminal are to have the same number. Neutral wires are not numbered unless numbers are shown on the wiring diagram. Wire numbers are to be Haley Partex type PA.

12.1.30 Wire Colours :

Power	Live	Phase colours
	Neutral	Black
Control		
220 VAC	Live	Red
	Neutral	Black
24 VAC	Live	Brown
	Neutral	Grey
DC	Positive	Orange
	Negative	White
Other		Pink

12.1.31 All wires except as noted below are to have lugs crimped to the ends. Lugs on wires 6 mm^2 and under are to be insulated. Insulated bootlace ferrules are acceptable when the terminal is designed to accept them. The correct type of crimper is to be used. Ratchet crimpers only are to be used on insulated terminals. No exposed conductors are to be visible on wires that have insulated lugs.

12.1.32 Single core conductors are not to have crimped lugs, but are to have insulated bootlace ferrules. Wires 10 mm^2 and over which are secured into saddle or screw terminals are to be twisted and bound.

12.1.33 Live, earth and neutral bars are to be copper, with nuts, bolts, and washers and spring washers to connect conductors. Drilled and tapped bars are not acceptable.

12.1.34 Other types of earth and neutral bars may be offered, but systems in which a screw bears down directly on the conductor or lug are not acceptable.

12.1.35 Small switchboards with incoming cables 10 mm^2 or less, which require a control neutral only, may have a black standoff insulator in lieu of a neutral bar. No more than two conductors may be made off to this insulator.

12.1.36 All switchboards are to be inspected and tested before being dispatched to site.

12.1.37 Wall mounted switchboards are to be supplied with brackets to space the board away from the wall 20 mm.

12.1.38 All copper bus bars will be rated to suit the fault level of the incoming supply. Current ratings will not exceed 1,3 Amps per square millimeter. Should the bus bars be taped adhesive tape should not be used of the correct phase coloring as specified or heat shrink PVC tubing of the correct colour.

12.1.39 Clip on type terminals similar to Pratley manufacture rated at least 50% in excess of the contactor rating for outgoing motor connection or control cables up to 70 millimeters squared or 100 kW motor ratings shall be provided at the top or bottom of the enclosure, as specified. The terminal blocks shall be fixed to the removable base plate of the panel not on to the framework, and shall have ample space above or below them for making off the cable terminations. Allowance must be made on the terminal block to accommodate 25% for spare ways

12.1.40 The wiring between all starter components, isolators, Fuses, overload relays etc., terminal strips are to be rated to suit the maximum capacity of the starter and or the rupturing capacity of the board whichever is the larger and all wiring will be completed at the factory and will not be done on site. All panel wiring will be encased in PVC cable trunking of Hellerman manufacture. A running hour meter (type HK 46 or similar) to be included in the panel. Where there is no phase monitor provided in the electronics, a phase failure relay is to be provided.

12.1.41 For motors exceeding 100kw rating, bolted terminals or bus bar stubs will be permitted. All phase wiring will be done in red, white and blue PVC insulated conductors.

12.1.42 If control and supervisory wiring is required to equipment installed on the doors of the panel the wiring shall be bunched together and suitably strapped with Hellerman spiral binding in the form of a vertical "U" loop between the door and panel, to ensure that there is no torsion on the wiring, when the door is rotated along the longitudinal axis of the conductors. Wiring supports shall be fixed onto the hinged panels, to relieve the weight of the cables off the equipment terminals.

12.1.43 All installations and wiring are to conform to the following:

- The latest revision of SABS 0142 Code of practice for the wiring of premises
- The latest revision of SABS 1765
- Machinery and occupational safety regulations
- Local authority regulations
- The specification issued by the Consulting Engineer

12.1.44 All Indoor units, their electrical panels, outdoor units and isolators to be labeled with engraved labels fixed to the items so that all matching components can be identified. The main supply circuit breakers in the main electrical panel to be clearly marked in the panel legend (Labels: see 12.1.26).

- Laminated wiring diagrams to be displayed either on the wall adjacent to the panel or inside the electrical panel door.
- Controller instructions to be available inside the electrical panel.
- If after hour timers are installed, laminated operating instructions to be fixed next to the switches.

The switchboard manufacturer is to provide a release certificate for each switchboard as required in terms of SABS 1765, and any other certificate as required by SABS 0142.

DO NOT alter wiring diagrams, switchgear selections, and cable sizes, cable types, equipment positions etc. without permission.

12.2 Gland Plates

12.2.1 The galvanised gland plates will be 300 mm above the bottom of the board and will be machine punched in the factory to suit each and every cable gland required and under no circumstances will any filling be allowed on site.

12.3 Fuses

12.3.1 The rating and selection of the Fuses shall ensure that they remain intact and shall provide satisfactory operation for starting the motors under all normal short circuit conditions.

12.4 Earth Bars

12.4.1 Boards, panels and pillars are to be provided with suitable arranged tinned copper earth bars mounted on glass fibre insulators, at least 40mm high, having sufficient accommodation for separate earth wire for each circuit requiring one. The earth bar shall have a cross-sectional area equal to that of the phase bus bar, with a maximum area of 240 m^2. Provision for connections to earth electrode and all ECC must be allowed for and all nuts, bolts and washers shall be supplied on earth bar accordingly.

12.5 Provision for Incoming Cable

12.5.1 Suitable and proper provision is to be made in all boards and panels to allow space between incoming cables and switchgear terminals, bus bars and other equipment. Only if the size of the incoming cable exceeds 70 m^2 it shall be terminated directly onto the isolator and not via the terminal block.

12.6 Instruments

12.6.1 Indicating instruments such as Volt, Ampere and Power Factor Meters, etc., shall be of the moving iron flush pattern type with physical dimension of not less than 72 mm x 72 mm, having a 90 degree quadrature scale with pointer filcrum in lower right hand corner and calibrated as specified in the detailed specification or as indicated on drawings. PCI or equivalent instruments are preferred.

12.7 Current Transformers

12.7.1 Current transformers are to have ratios as specified in the detailed specification or on drawings, and have suitable burdens for the particular application; current transformers are to be installed on the load side of each phase and to be wired back to a suitable selector switch or instrument as specified.

12.7.2 Phase colour coding must be provided where possible for all wiring to current transformers. Numbered ferrules, or other suitable identification at both ends and wiring connections to current transformers and instruments, shall be provided

12.8 Lightning Surge Arrestors

12.8.1 All boards and panels are to be equipped with lightning arrestors or surge diverters of approved manufacture and bearing the SABS mark, type "AEI" LV 280W, where voltage does not exceed 400 volts, unless the incoming line is protected by a previous board containing such arrestors.

12.8.2 The arrestors or diverters shall be mounted inside the panel on the incoming unit. The supply side connections shall be made in the factory to neutral and phase bus bars, and earth side connections to earth bar of the board.

12.9 Spare Fuse Cartridges

12.9.1 Where HRC or other cartridge type Fuses are specified, the board or panel shall be suitably equipped with a compartment or other approved facility for housing at least one third of every type of Fuse cartridge specified, having a minimum of one set (i.e. 3 Fuses) of each rating specified and all such spare fuses shall be provided inside this compartment on handing over. The compartment shall be clearly labeled.

"SPARE FUSE CARTRIDGE: REPLACE USED-UP FUSES"

12.10 Phase Distribution and Balancing of Load

12.10.1 Where multi-phase boards or panels are specified, single-phase circuits shall be wired in such a manner as to ensure that the electrical loads are evenly distributed over the three phases.

12.11 Cable Trays and Cable Ladder

12.11.1 All references to cable trays in this document also refer to cable ladders.

12.11.2 All cables are to be on cable tray or cable ladder, except where otherwise noted. The type of cable tray or cable ladder used must be approved in advance.

12.11.3 Cable trays are to be hot-dip galvanised unless otherwise specified.

12.11.4 Should the project specification require cable trays to be painted they are to be painted as follows:

Clean with Spick & Span galvanised iron cleaner:

- Cold galvanise any cut edges
- Prime with calcium plumbate paint
- Paint orange

12.11.5 Cable tray brackets are to be hot dip galvanised, and painted in the same way as cable tray, except that they are to be black.

12.11.6 As an alternative galvanised cable trays and brackets may be plastic coated.

12.11.7 Cable trays are not to be cut to form bends. Elbows and tees are to be factory-made items. Ascenders and descenders are to be beaten round a former.

12.11.8 Cable trays may be horizontal or vertical unless the drawing is marked to the contrary.

12.11.9 All take-offs from cable tray runs must be done using tees or bends.

12.11.10 Cables must not be bunched on cable tray.

12.11.11 Only one layer of cables is permitted on cable trays.

12.11.12 Cables may not cross over on cable trays

12.11.13 Where changes of size occur on a cable tray run, this must be done using bends and tees. Abrupt changes of size are not allowed.

12.11.14 Cable trays must be spaced off the surface that they are fastened to. Unistrut must be used for cable tray over 100 mm.

12.11.15 Do not short-circuit vibration isolators on machinery with cable tray.

12.11.16 Cable tray brackets and supports must be of sufficient strength to prevent sagging, twisting etc. particularly in the case of large cables.

12.11.17 Cable trays and conduits are to be properly earthed to the switchboard earth bar.

12.12 Earthing

12.12.1 All equipment is to be earthed.

12.12.2 All earths are to be made off to the switchboard earth bar.

12.12.3 The earthing strands in ECC cable, surfix, etc. are to be made off to the proper earthing points at both ends of the cable.

12.13 Making Off and Terminating Wires and Cables

12.13.1 All site made holes in switchboards for glands etc. must be done with a chassis punch. Hole saws are not to be used. In the case of switchboards mounted outside, or in damp conditions, the cut edges of these holes must be treated with cold galvanising, and touched up with the correct colour paint.

12.13.2 Where cables are made off into boards, this must be done carefully, offsetting the cables neatly and evenly, without crossovers.

12.13.3 All cable tails must have sufficient slack to allow tong testers to be used.

12.13.4 Allow sufficient slack when making cables off to allow for adjustment of pulleys, removal of actuators etc.

12.13.5 No more than two lugs or two conductors without lugs are permitted in any terminal.

12.13.6 Wires connected to numbered terminals are to bear the same number. Wire numbers are to be Haley Partex type PA.

12.13.7 Where cable numbers are shown on cable schedules, then the cables are too marked on both ends, directly above the gland shroud, with copper, brass or stainless steel bands or strips with the number embossed or punched on the strip or band.

12.13.8 All wires except as noted below are to have lugs crimped to the ends. Lugs on wires 6 mm^2 and under are to be insulated. Insulated bootlace ferrules are acceptable when the terminal is designed to accept them. The correct type of crimper is to be used. Ratchet crimpers only are to be used on insulated terminals. No exposed conductors are to be visible on wires, which have insulated lugs.

12.13.9 Single core conductors are not to have crimped lugs, but are to have insulated bootlace ferrules. Wires 10 mm^2 and over which are secured into saddle or screw terminals are to be twisted and bound.

12.14 Conduits

12.14.1 All conduits are to bear the relevant SABS mark.

12.14.2 Conduits are to be run neatly and parallel to each other.

12.14.3 Conduits are to be bent and offset with the correct tool. Wrinkling of the inside of bends will not be accepted.

12.14.4 Through boxes, end boxes and fittings are to be made of the same material as the conduit, except that galvanised boxes and fittings may be used with black conduit.

12.14.5 Inspection bends, tees, or couplings may not be used.

12.14.6 All unwired conduits are to have draw-wires installed.

12.14.7 Open conduit ends and boxes are to be sealed to prevent the ingress of debris.

12.14.8 Cut conduit ends are to be properly reamed.

12.14.9 Conduits must be made off to switchboards, boxes, trunking etc using a coupling and male bush.

12.14.10 Solid brass bushes must be used on iron conduit, plastic bushes on aluminium conduit, and brass, or plastic bushes on plastic conduit.

12.14.11 Where the enameling or galvanising of conduit has been removed by threading or tools, then the bare metal is to be painted with cold galvanising paint.

12.14.12 Conduit fixings are to be manufacturers items designed for the fixing of conduit. The method of fixing is to be approved before construction commences.

12.14.13 Metal conduit is to be fixed at minimum 2.0m, and plastic conduit 0.75m. In addition conduit is to be fixed 150 mm before and after each bend, offset and box. Sagging between fixings will not be accepted.

12.14.14 Draw boxes are to be installed after two right-angle bends, or after 10.0m of straight conduit.

12.14.15 All plastic conduit joints and fittings are to be glued.

12.15 Trunking

12.15.1 Trunking may not to be cut to form bends. Distribution outlets, elbows, tees, ascenders, and descenders are to be factory-made items and must be radiused.

12.15.2 Internal splices are to be used for joints.

12.15.3 Sharp fastenings are not to protrude into trunking.

12.15.4 All cut edges are to be smoothed, and no sharp edges are to be left inside trunking.

12.15.5 All brackets are to be galvanised.

12.16 General

12.16.1 All wiring to fire dampers is to be done using silicon insulated wire in steel conduit, capable of withstanding 180°C continuously.

12.16.2 All cable trays, ladders, conduits, surface mounted cables, trunking etc. is to be run parallel to or at right angles to walls and other surfaces, and may not be solid over expansion joints.

12.16.3 Wall mounted switchboards are to be spaced away from the wall 20 mm.

12.16.4 All cut ends of galvanised material are to be painted with cold galvanising paint.

12.16.5 All iron or steel material and fastenings exposed to damp conditions must be hot dip galvanised. Electro-galvanised or cadmium plated material will not be accepted unless suitably painted.

12.16.6 All switchboards, isolators, terminal boxes etc. located outside, or in any area subject to dampness, must be bottom entry only.

12.16.7 All installations and wiring are to conform to the following:

- The latest revision of SABS 0142 code of practice for the wiring of premises
- Machinery and occupational safety regulations
- Local authority regulations

12.16.8 Electrical Compliance Certificates as required by the latest revision of SABS 0142 are to be produced before power is applied to the installation.

12.16.9 All cable and cable tray routes, wiring methods etc. must be approved in advance.

12.16.10 **DO NOT** alter wiring diagrams, switchgear selections, and cable sizes, cable types, equipment positions etc. without permission.

12.17 Motor Starters and motor protection

12.17.1 Motor starters to comprise of two element control comprising motor starter (ABB MS 116 up to 16 amps MS 325 up to 25 amps MS 450 to 495 up to 100 amps or similar) to suit the motor current on top of a suitable contactor (ABB A9-A110 or similar) and a suitable isolator (ABB OT/OETL or similar) for motors up to 50kw. For large motors confirm with engineer.

13. PUMPS

13.1 General

13.1.1 Pumps shall be mounted only a common Baseplate with the drive motor, shafts, flexible coupling, coupling guard and drip tray.

13.1.2 Lock out arrangement – Direct on line start
Remote isolator to be provided and installed within 1m from motor. Interlocked to prevent the pomp from starting while being worked on. The isolator to have a locking facility. (ABB: OTP type or similar).

13.2 Pump Types

13.2.1 Pumps shall be single entry volute casing pump with an end suction nozzle and a radial discharge nozzle.

13.2.2 All pumps having a suction not exceeding 100 mm diameter the pump casing may be overhung and flange mounted onto the bearing bracket or pedestal.

13.2.3 All pumps having a suction above 100 mm diameter shall be additionally supported by two heavy feet.

13.2.4 Pumps generally shall not operate at over 1500 r.p.m.

13.3 Pump Casings.

13.3.1 Casings of horizontally split pumps shall be designed for a working pressure of 8,5 bar or 1,5 times the actual discharge pressure, whichever is greater. Casings of vertically split pumps shall be designed for working pressures of 5 bars or 1,5 times the actual discharge pressure whichever is greater. Pressure classification of flange connections shall correspond to casing working pressures.

13.2.2 High points of pump casings shall be provided with air vent cocks. Cocks shall be extended outside of any insulation specified. Low points of casings shall be provided with valved drains and inlet and outlet connections shall be provided with properly located gauge tapings. Each removable casing weighing over 23 kg shall be provided with a lifting eye or lugs of ample strength. Casing brackets of vertically split pumps equipped with stuffing boxes shall be arranged to have drip pockets. A drip pipe shall be run from each drip pocket and terminate with an approved air gap over the nearest drip funnel or floor drain.

13.4 Pump Impellers

13.4.1 Impellers shall be cast iron or bronze as further detailed in the Supplementary specification. All impellors shall be dynamically balanced.

13.4.2 Impellers of pumps having 38mm and larger discharge connections shall be fully enclosed and hydraulically balanced. Actual impeller size selected shall not exceed 85% of maximum impeller size possible in casing.

13.5 Pump Shafts

13.5.1 Pump Shafts shall be 316 stainless steel. Where shafts pass through stuffing boxes they shall be provided with a 316 stainless steel shaft protecting sleeves.

13.5.2 The shaft is to be sealed by a soft packed stuffing box or mechanical seal.

13.5.3 The shaft is to be supported on two oil lubricated deep groove ball bearings.

13.6 Pump bearings

13.6.1 Bearings for close-coupled pumps shall be of the ball type. Bearings for all other pumps shall be either ball or roller bearings or ring oiled or wool packed sleeve bearings with ample oil reservoirs. Thrust bearings shall be either the ball or Kingsbury type. Bearings shall be effectively sealed to prevent ion of oil and entrance of dirt or water.

13.7 Mechanical Seals

13.7.1 All Chilled Water and Condenser water pumps shall be fitted with a Mechanical seal. The mechanical seal is to be as recommended and guaranteed by the pump manufacturer for the particular service involved.

13.7.2 Stuffing boxes shall not be used if practically possible.

13.8 Flexible Couplings

13.8.1 All pumps, other than close-coupled pumps, shall be provided with suitable flexible couplings, which shall impose no restriction on normal endplay and expansion.

13.8.2 Each flexible coupled pump shall be provided with a fabricated steel bedplate of ample size to hold both pump and motor in correct alignment. Pump and motor shall be accurately aligned when running at normal temperature.

13.8.3 A metal coupling guard is to be fitted over the coupling for protection.

13.9 Pump Efficiency

13.9.1 the efficiency of each pump shall not be less than 70% and not more than 3% below the peak of the efficiency curve for the impeller furnished.

13.9.2 Catalogue data submitted for approval shall include characteristic curves.

13.10 Pump Motors

13.10.1 Each pump shall be equipped with an electric motor. The name plate rating of the electric motor shall be not less than the maximum brake horse power required by the pump at any operating head characteristic from zero to shut-off or as otherwise specified.

13.10.2 Electric motors shall be suitable for Star-Delta starting, if larger than 7,5 kW, and shall be totally enclosed fan-cooled.

13.10.3 The maximum speed of the motor shall be 1500 r.p.m.

13.11 Alignment

13.11.1 All pumps shall be correctly aligned after installation. The pump shall be aligned so that a straight edge placed over the two coupling halves, parallel to the shaft, maintains the same distance from the shaft at all points around its periphery. Furthermore the gap between the two coupling halves must remain the same at all points around the periphery.

14. INSULATION

14.1 Chilled Water Pipework Insulation

14.1.1 All chilled water piping will be insulated with pre-formed sections of fire retardant closed cell rigid polystyrene having a minimum density of 24 kg/m3.

14.1.2 The thickness of insulation shall be as follows:

- Chilled water piping >50 mm Diameter 30 mm Thick
- Chilled water piping 50 -150 mm Diameter 40 mm Thick

14.1.3 All piping shall be cleaned, dry, and free of grease loose rust and scale before any insulation is applied.

14.1.4 All piping is to be painted with PA10 before application of insulation.

14.1.5 A coat of Flintcote type 3 bitumen sealer is to be applied to all piping and onto the inside of the insulation.

14.1.6 The pre-formed insulation sections are to be applied in two layers, staggered to avoid air bridges. Coat the wire brushed pipework with one layer of Flintcote 5, synthetic cold bitumen adhesive and wait until this is tacky. Apply a coat of Flintcote 5 to the inside of styrene shells taking care to fill all air bubbles and depressions and when tacky place upon the metal surface. Allow setting firmly and repeating for second layer.

14.1.7 When dry, apply final coat of Foster 30-36 or Chemseal 4 onto the outside of the styrene sections and cover with a fibre glass scrim cloth taking care to smooth out all bubbles and wrinkles. When firmly in place apply two further coats of Foster or Chemseal until a smooth finish is achieved. All bends and joints to be purpose made, either moulded or segmented. Round off segmented sections to a neat workmanlike appearance before applying sealer.

14.1.8 20 mm pressure sensitive tape is to be applied every 300 mm.

14.1.9 A fiberglass scrim is then to be applied with two coats of Fosters 30/36 to give an adequate vapour barrier.

14.1.10 All exposed chilled water insulation will be clad with 0.6 mm galvanised sheet metal. All bends shall be formed using full-segmented lobster back sections.

14.1.11 Care is to be taken that no rivets or fasteners pierce the vapour barrier. Self-tapping screws shall not be used.

14.1.12 High density foam blocks will be installed with all pipe hangers and pipe supports are to be removed to allow vapour barrier to run through. Silicon sealant shall be used to seal off any gaps between material interfaces.

14.1.13 Any drain piping producing condensation is to be insulated with Armaflex type insulation.

14.1.14 After completion of the insulation suitable markers to indicate the direction of water flow shall be applied at 10m intervals.

14.2 Valves and Strainers

14.2.1 Valves and strainers shall be insulated using the minimum thickness specified for relevant pipe size.

14.2.2 All fittings as specified above shall be enclosed in minimum, 0,29 mm thick aluminium fabricated valve box-hinged lid for access to valve body for maintenance.

14.2.3 Hinges are to be heavy-duty chrome plated. Provide also a sponge gasket for lid to seat on.

14.2.4 The purpose of valve boxes is to permit access to valves and strainer baskets for maintenance, without having to re-insulate valve each time. Care and thought should therefore be given to see that the valve box fulfils this task.

14.3 Refrigeration Pipework

14.3.1 All refrigeration pipework shall be insulated using ⅝" seamless Armaflex type insulation.

14.3.2 Joints are to be securely taped to ensure no dripping of condensation occurs.

14.3.3 Damaged or torn insulation will not be accepted.

14.3.4 Cable ties that are tightly pulled around the insulation causing indentations to the insulation will not be accepted.

14.3.5 Hot gas lines shall not be insulated.

14.4 Internally Insulated Ductwork

14.4.1 Generally, all sheet metal ductwork carrying chilled air at velocities up to 10 m/sec shall be insulated. Internally with 25mm Sonic Liner, securely held with angles and cover strips on all corners and joints streamlined to suit airflow. On circular ducts, hold in position with an inner sleeve of expanded metal having at least 16 divisions per 25mm. Expanded metal to be flat faced not raised, to prevent any whistling. All split pins and plates etc., shall be manufactured from a rust proof material.

14.5 Externally Insulated Ductwork and Fittings

14.6 Exposed in Plantroom

14.6.1 Insulate externally with 50mm fibreglass slabs or lags secured by straps every metre. Wrap 25mm galvanised chicken wire around fibreglass and apply nominal 12mm plaster finish. Cut expansion joints through plaster finish every l.5mm both longitudinally and vertically. Seal all joints with mastic or suitable foam seal. Finally prime and then epoxy paint all plastered finish to provide a suitable vapour seal.

14.7 Concealed

14.7.1 Insulate with 50mm foil backed fibreglass in accordance with Manufacturers written instructions.

14.8 Duct Fittings

14.8.1 Whether detailed or not, all plenum boxes and diffuser connections shall be insulated as above.

15. CHILLED WATER GENERATOR

15.1 General

15.1.1 The Chiller Water Generator shall be selected to meet the design capacities as specified in the Project Specification.

15.1.2 Compressors shall comply in all respects with the requirements of the Machinery and Occupational Safety Act, Act No. 6 of 1993 as amended and with the latest edition of the ASHRAE Safety Code for Mechanical Refrigeration.

15.1.3 Preference shall be given to equipment with either semi-hermetic reciprocating or screw compressors specifically designed for medium pressure refrigerant gas. Preference shall be given to equipment with more than one refrigeration circuit.

15.1.4 The chiller will have the minimum number of capacity steps as specified in the Supplementary Specification and be controlled by an electronic Controller.

15.1.5 Each compressor shall be complete with an automatically reversible oil pump, operating oil charge; suction and discharge shut off valves and crankcase heater.

15.1.6 Each compressor shall be mounted on anti-vibration mounts. The unloading of the compressors will be by pilot operated solenoid valves.

15.1.7 The chilled water generator will use a flooded evaporator with two independent circuits. The evaporator will be a shell and tube construction and be complete with removable heads. The tubes are to be manufactured from enhanced seamless copper type rolled into tube sheets.

15.1.8 Evaporators and condensers shall be mechanically cleanable shell and tube type with removable heads. Tubes shall be internally enhanced, seamless copper type and shall be rolled into sheets.

15.1.9 Evaporator shells are to be externally insulated to ensure no condensation forms on the outer surface of the machine.

15.1.10 Each evaporator unit shall be provided with a chilled water low temperature safety switch.

15.1.11 Compressors shall be interlocked with the chilled water system flow switch to prevent the unit operating when there is no water flow.

15.1.12 Screw type compressors shall be provided with an efficient oil separator.

15.1.13 Drive motors shall be cooled by the refrigerant.

15.1.14 Chilled water generators are to be supplied with an initial charge of oil and refrigerant.

15.1.15 The chilled water generator is to be supplied with all necessary operating and safety controls. These items shall include all controls specified in the project specification.

15.1.16 The chiller will be complete with an externally mounted pre-lubricating oil pump per circuit. Operation of this pump will be part of the start up circuit.

15.1.17 The chiller controller must have fault diagnostic capability and be capable of controlling the chilled water pump.

15.1.18 The controller shall be complete with an automatic lead-lag feature to automatically alternate the lead circuit to ensure even compressor wear.

15.1.19 The expansion device will be electronic and be controlled by a microprocessor.

15.1.20 The controller will be mounted in the chiller electrical panel, which must be complete with mains breaker and all necessary switchgear. The cabinet shall be capable of withstanding 500 hours salt spray test in accordance with the ASTM B-117 Standard (USA) and conform to IP45 standards.

15.1.21 Air Cooled Chillers shall be complete with low noise axial type condenser fans and shall be manufactured from a non-corrosive material.

15.1.22 Air Cooled Chillers condenser coils will be copper with aluminium fins and will be factory treated with Heresite Durable epoxy coated or similar coil treatment.

16. REFRIGERATION SYSTEMS

16.1 General

16.1.1 All refrigeration piping shall be in accordance with SABS 0147 Code of Practice for Refrigeration and Airconditioning Installations.

16.1.2 All personnel involved in the operation and maintenance of refrigeration installations shall have been trained on the functioning of the installation, to ensure that they are fully conversant with the equipment concerned.

16.1.3 The contractor shall ensure that all workers shall have received appropriate training in :

- Dangers to the environment because of leakage of CFC's and HCFC's to the atmosphere;
- Servicing refrigeration and airconditioning equipment; and
- The operation of the recovery equipment.

16.2 Materials

All materials used in the construction of refrigerating systems shall be suitable for conveying the refrigerant used. Some refrigerants are corrosive to certain materials in the presence of moisture or air or both. Materials that will deteriorate in the presence of moisture or air because of the refrigerant or oil or their combination shall not be used. The material shall also be resistant to possible impurities and contaminants and to any heat transferring liquids that could be present.

16.3 Refrigeration piping, valves fittings.

16.3.1 All refrigeration piping, valves, fittings and related parts shall comply with ANSI/ASME B31.5 where applicable.

16.3.2 Refrigeration piping shall be so installed that it cannot be accidentally damaged.

16.3.3 Piping up to 22 mm diameter may be soft drawn copper. All other pipework shall be run using hard drawn copper.

16.3.4 All refrigeration piping shall be NEATLY and securely run on galvanised cable tray. All corners shall be mitred.

16.3.5 The maximum pacing between pipe brackets shall be 2m.

16.3.6 All piping going through walls shall be sleeved, and the sleeve filled with polyurethane foam and made good.

16.3.7 All fittings and joints shall be carried out using soldered fittings.

16.3.8 All copper capillary fittings shall be soldered using a copper eutectic such as coppertech. Brass and copper fittings shall be jointed using a hard silver solder. Soft silver or tin solder is not acceptable.

16.3.9 All components of the refrigeration system that require servicing shall be easily and safely accessible.

16.3.10 All systems shall have provision for handling the refrigeration charge safely for servicing purposes.

16.3.11 All suction lines on cooling only equipment and all suction and liquid lines on heat pumps shall be suitably insulated with seamless Armaflex type insulation.

16.3.12 The minimum thickness of the insulation is to be 13 mm.

16.3.13 No condensation will be permitted from pipework or machinery.

16.3.14 All components or fittings shall apply to their approved standard. The component or fitting is to withstand a hydrostatic pressure of not less than 1.5 times the design pressure applicable to the component or fitting as detailed in SABS 0147.

16.3.15 Suction line accumulators to be installed on all Package units and units above 600000BTU, where the condensers are mounted remote. Lines to and leaving the accumulators to be insulated but not so the accumulator. If accumulator cannot be fitted in the enclosure then, this must be fitted remote, as near as possible to the compressor and suitable arrangements made to lead the condensate from the accumulator to a drain point.

16.3.16 Where a compressor is not supplied with discharge and suction shut off, suitable weld-on valves of the ball type, to be welded into the discharge and suction lines as close to the compressor as possible so as to enable the compressor to be isolated from the system where a Hermetic compressor is installed, a burnout drier must be installed in the suction line with isolating valves on the inlet and outlet to enable the core to be changed when necessary.

16.3.17 Condensate drains shall be trapped and run to nearest down pipe or gulley. All internal condensate drain piping shall be insulated. NO condensation shall drip from drain piping onto ceilings.

16.3.18 The minimum condensate drainpipe size shall be 25mm diameter.

16.3.19 The contractor is to ensure that all Pressure Gauges used have been checked for accuracy at full scale reading either by comparison with master gauges or by setting the pointer as determined by a dead-weight pressure tester.

16.4 Evacuating the system.

16.4.1 All copper pipes and fittings shall be oxygen free or de-oxidised.

16.4.2 Before charging the system with refrigerant the whole system is to be evacuated by means of a suitable vacuum pump to ensure the removal of all moisture. Once evacuated the vacuum is to be broken with oil pumped dry nitrogen. Then the system is to be re-evacuated to ensure that all vapour is removed. The system is to stand under vacuum for a minimum of twelve hours. If no noticeable rise in pressure has taken place at the end of this period the system may be charged.

16.4.3 The piping shall be leak tested by maintaining a vacuum for a minimum of 12 hours.

16.5 Charging and discharging refrigerants

16.5.1 When refrigerant is added to a system, except to a packaged unit that requires less than 3 kg of refrigerant, the refrigerant shall be charged into the low-pressure side of the system. Any point on the downstream side of the main liquid line stop valve shall be considered as part of the low pressure side when the system is operating with the stop valve in the closed position. NO service container shall be left connected to a system except when refrigerant is being charged or discharged.

16.5.2 Refrigerants discharged from refrigerating systems shall be transferred to approved containers only. No refrigerant shall be discharged to sewer, river, steam or lake or into the atmosphere.

16.6 Refrigeration Equipment

16.6.1 All equipment shall carry a nameplate marked with the following:

- The manufacturers name, trade name or trademark,
- The identification number of the part,
- The design pressures;
- The refrigerant which is currently in use;

16.6.2 Fans and any moving item of machinery shall have a suitable guard in accordance with the said Occupational Health and safety act.

16.6.3 Reasonable access, including ladders, platforms and clear space adequate for inspection and servicing of all machinery is to be provided in accordance with the said Occupational Health and safety act.

16.6.4 All foundations supports and brackets for condensing units shall be manufactured from a non-combustible construction.

16.7 Pressure Containers

16.7.1 Refrigerant containers shall be designed in accordance with relevant regulations framed under the Occupational Health and Safety Act 1993. The contractor is to ensure that all equipment is suitable to operate at the maximum temperature and pressures obtainable using the specified refrigerant.

16.7.2 All pressure containers shall have a pressure relief device, on the high-pressure side of the vessel, to open when the system temperature or pressure exceeds the maximum working temperature or pressure specified by the manufacturer.

16.7.3 The pressure relief device is to discharge to atmosphere. The device may discharge to the low-pressure side of the system providing that the low-pressure side is fitted with a pressure relief valve or bursting disc. Should an Ozone depleting substance be used it must be discharged to the low-pressure side of the system.

17. CHILLED WATER AIR HANDLING UNITS

17.1 General

17.1.1 The contractor shall supply erect and install all chilled water air handling units shall be as detailed in the project specification.

17.1.2 Each air-handling unit shall be complete with separate fan coil; filter and mixing box sections.

17.1.3 The units shall have an attractive casing manufactured from galvanised sheet metal and be finished with an epoxy coating. The unit frame shall be constructed from extruded aluminium profiles and be assembled with die cast aluminium corners to give an accurate and corrosion free structure.

17.1.4 The panels shall be double skin sandwich type with 25mm thick high-density fibreglass insulation. Rubber seal gaskets shall be used on all joints to eliminate any condensation on the external casing. The external sheet metal face shall be manufactured from 1mm thick galvanised sheet metal steel and be finished with an epoxy powder coating. The internal face shall be manufactured from 0.8mm thick galvanised sheet metal and shall remain unpainted.

17.1.5 All fixings shall be by plated screws inserted in nylon sleeves.

17.1.6 Access doors shall be constructed from the same sandwich panels with aluminium hinges and closed with progressive CAM type handles. All doors shall be complete with suitable rubber seals and will be airtight.

17.1.7 Fans shall be forward curve centrifugal type and shall have an outlet velocity not exceeding 9m/s. The fans and motors shall be mounted on a common frame through suitable anti-vibration mounts. The fan discharge shall be connected to the casing by means of a flexible sleeve to ensure silent and vibration free operation.

17.1.8 The Centrifugal fans shall be double width, double inlet, multi blade centrifugal type. Fan wheels shall be designed for continuous operation at the maximum rated fan speed and motor kilowatt. Fan wheels and shafts shall be selected to operate at least 25% below the first critical speed. The fan wheel and shaft shall be statically and dynamically balanced as an assembly.

THE FAN OUTLET AIR VELOCITY SHALL NOT EXCEED 10,0 M/SEC

17.1.9 Motor and drive shall be sized to deliver the required air quantity against the system resistance. Motors are to be air-cooled, 380 volts, 4 pole, 50 Hz.

17.1.10 The chilled water coil will be manufactured with 12.7mm diameter copper tubes, which shall be expanded into aluminium fins.

17.1.11 The filter section will be complete with 50mm washable side withdrawal filters, which shall be of a standard size i.e. 600x600mm or 600x300mm.

17.1.12 The mixing box will be supplied with a return air and fresh air connections each having a gear driven damper with lockable quadrant.

17.1.13 All sections shall be complete with access doors large enough to carry out any maintenance on the unit.

17.1.14 The unit shall be assembled on site under the supervision of the supplier. Any damage to the paintwork will be rectified by the contractor prior to handover.

17.1.15 The drain pans shall be provided under the complete coil section with drain connections on both sides. The drain pan shall be of stainless steel construction with 32 mm diameter drain connections.

17.1.16 The units shall be mounted on anti-vibration pads to the written recommendation of the manufacture

17.2 Cooling Coils

17.2.1 Coil casings shall be fabricated from 304 Stainless Steel and Passivated.

17.2.2 Coil section shall include a condensate drain pan. All coils shall be arranged within the coil section for horizontal airflow. Where multiple cooling coils is used in single units, intermediate drain pans shall be provided. Coil headers and refrigerant distributors shall be completely enclosed within the insulated casing with only connections extended through the cabinet. Coils shall be copper tube aluminium finned with a maximum of 312 fins per meter and maximum face velocity of 2,5m/sec.

17.2.3 Drain pans shall be constructed of stainless steel with drain connection to outside unit.

17.3 Filters

17.3.1 **Primary Filters**

These shall be of the washable panel type with an efficiency of 30 - 35% on the ASHRAE 52-76 test standard and an average dust arrestance rating of 92%. (Type F4)
The approach velocity shall not exceed 2,5 m/sec.

17.3.2 **Secondary Filters**

These shall be of the compact type F9 with an efficiency of 90% on the ASHRAE 52.1-1992 test standard and an average dust arrestance rating of 98%.
Filter housing units shall be proprietary brand, flanged and mounted after the supply air fan. Access shall be side or bottom withdrawal, depending on the plant layout. The housing shall be equipped with an adequate mechanism to provide a positive filter to casing and filter-to-filter seal.
The approach velocity shall not exceed 2,0 m/sec.

17.3.3 **Spare Filters**

One complete set of spare filter cells is to be supplied to the client prior to acceptance of the plant.

17.3.4 **Manometers**

Secondary Filters shall be equipped with a measuring device for indication of Pressure via an electrical transmission to provide remote indication of pressure drop and high and low alarm conditions. Refer Controls Installation.

17.4 Heater Banks

17.4.1 Electrical Heater Banks must be downstream of the cooling coil.

17.4.2 The elements shall be Incalloy black heating elements.

17.4.3 The electrical load of the heater elements must be evenly distributed over the three phases.

17.4.4 Overheat thermostats and flow switches shall be connected in series with the heater banks.

17.4.5 Heater banks must be proportionally controlled. The electrical supply must be 380v

18. CHILLED WATER FAN COIL UNITS AND CASSETTE UNITS

18.1 The contractor is to supply and install the number and make of chilled water fan coil units and cassettes as specified in the Supplementary Specification and as shown on the tender drawings.

18.2 The sizes and quantities will be as detailed in the equipment schedules.

18.3 The units are to be selected for the duty, water temperatures and ambient wet bulb temperatures specified in the Supplementary specification.

18.4 Coils shall comprise solid drawn copper tubes expanded into close metallic contact with aluminium fins. Coil connections shall be fitted with air vents.

18.5 The fan will be a direct driven backward curved with a three-speed permanent split capacitor motor with built in thermal protection. The fan will be installed on spring anti-vibration mounts.

18.6 Fan motors shall be shaded pole or permanent split capacitor type with built in overload protection. Motors shall have three speed windings and be factory wired to a junction box.

18.7 Fans and motors will be quiet in operation and the mean sound pressure level generated by the unit shall not exceed NC40.

18.8 The coil shall be copper tubes with aluminium fins and have brass coil connections. The upper pipe to the coil will be complete with an air vent while the lower connection will be complete with a drain cock.

18.9 The unit will be complete with a condensate pump capable of removing all condensate from the drain pan into the drainpipe.

18.10 Each fan coil unit will be complete with a 20mm electrically operated 3 way-diverting valve and two 20mm stainless steel ball valves for isolating purposes.

18.11 Each unit will be complete with an Eberle type controller with temperature selector, three-speed fan selection and on-off function.

18.12 Each fan coil unit will have a trapped drain of 25mm minimum Dia. As per the standard specification. The drain will be run to the nearest storm water down pipe.

18.13 Each cassette unit will be suspended with threaded rods, each having a suitable anti-vibration mount similar or equal to Mason type 30. The type of mounting is to be approved by the Engineer before installation.

18.14 Chilled water Cassette units will have external dimensions to suit a standard 600x600 mm ceiling tee and a maximum height of 295mm.

18.15 The ceiling diffuser shall be 4-way blow and have a maximum depth of 25mm. The ceiling diffuser shall be so designed to direct air evenly across the ceiling and not dump air directly below.

18.16 The return air shall enter the cassette through the center of the diffuser. This fascia will be easily accessible so that the filter may be removed and cleaned. The filter shall be manufactured from a washable synthetic fabric. The unit shall be internally insulated for sound absorption and to ensure that no condensation forms on the external casing.

19. WATER COOLED PACKAGE EQUIPMENT

19.1 All water-cooled package airconditioning units shall be similar or equal to Daikin.

19.2 All water-cooled package units shall be fully internally factory wired.

19.3 The refrigeration circuits shall be fully charged with R22 refrigerant.

19.4 All units are to be fully tested within the factory prior to delivery.

19.5 Compressors shall be either scroll or reciprocating hermetically sealed and be mounted on rubber isolation pads.

19.6 Units up to 35 kW shall have one refrigeration circuit. All units above 35 kW shall have a minimum of two refrigeration circuits.

19.7 Each unit complete with pressure gauge or Schrader valves fitted so gauges can be attached to record pressure. The evaporator shall be copper tube aluminum finned cross fin coil. The fins be waffle type louvers.

19.8 The condenser shall be a tube in tube with a corrugated and wire or needle shaped inner tube.

19.9 The unit must be able to accept condenser water pipe connections on either side.

19.10 Each unit will be complete with a dual suction multi-blade centrifugal fan driven through a V belt drive.

19.11 All smaller units shall be complete with a variable pitch pulley.

19.12 All units above 85 kW must have block type bearings that must be complete with grease nipple and be fully serviceable.

19.13 Each unit is to be complete with an internal air thermostat.

19.14 The unit is to be complete with a centrally controlled operation panel on the front face of the unit.

19.15 Each control panel must have facility to switch to OFF/FAN/COOL/HEAT

19.16 Each unit must be complete with indicating lights to show normal and abnormal operating conditions.

19.17 Each unit must be complete with a Resin washable filter. The filter frame must be deep enough to accept a du-trap washable filter.

20. AIR-COOLED DUCTED SPLITS

20.1 The contractor is to supply and install the number and make of air-cooled ducted splits as specified in the Project Specification and as shown on the tender drawings.

20.2 The sizes and quantities will be as detailed in the equipment schedules.

20.3 The air-handling units shall be complete with fan, fan motor and drive, direct expansion cooling coil, expansion device filters and mixing box. The air-handling unit shall be a vertical single skin unit and shall be internally insulated with 25mm thick closed cell foam insulation.

20.4 The units will have a mixing box manufactured from the same type of construction as the unit and will be complete with fresh air connection and return air grille.

20.5 The centrifugal fan will be forward curve belt driven with adjustable pulley.

20.6 The evaporator coil will be copper tube with aluminium fins. All coils will be pressure tested to 2700kPa before installation and be provided with Schrader valves to attach gauges.

20.7 All electrics for the air-handling unit will be mounted in the control panel.

20.8 These units are to be on the essential power supply and will be fed from the standby generator set during ESCOM power failures.

20.9 The condensing unit will be complete with an epoxy coated galvanised sheet casing. The condenser coil will be a wraparound type with aluminium finned copper coils. The fins will be post treated with Heresite before operation. Schrader valves to accept gauges shall be provided to record pressure.

20.10 The compressors will be Hermetic type and comply with all respects with the requirements of the Machinery and Occupational Safety Act No. 6 1983 as amended and with the latest edition of the ANSI/ASHRAE safety code for Mechanical Refrigeration. If no shut off valves supplied, ball type shut off valves provided as close to compressor as possible.

20.11 The compressor will be complete with crankcase heaters for protection from failure caused by dilution or migration of compressor oil. Schrader valves provided to record discharge and suction pressures.

20.12 The condensing unit shall be complete with both High (HP) and Low (LP) switches to protect the compressor from excessive condensing pressures and loss of gas charge.

20.13 The condenser fans shall be direct drive axial type and be controlled by head pressure control.

20.14 The unit shall be complete with an anti re-cycle timer to prevent short cycling of the machine

21. ROOM AIR-CONDITIONING UNITS

21.1 General

21.1.1 Room type air conditioners shall be self-contained units of the direct expansion unitary or air covered split type design. Schrader valves provided in discharge and suction lines to record pressure.

21.1.2 The airconditioners shall generally be in accordance with SABS 1125-1977 with sound levels not exceeding the values specified in the project specification.

21.2 Console Units

21.2.1 The Contractor shall supply and install room air conditioners as indicated on the drawings and in the schedules. Schrader valves to be provided on suction and discharge line to record pressure.

21.2.2 Each unit is to be of a current catalogued modern design.

21.2.3 All external parts exposed to the weather shall be coated with Tectyl or equal and approved.

21.2.4 Console units shall be supplied with natural anodised external aluminium weather grilles.

21.2.5 Cabinets are to be fully insulated to prevent excessive noise being transmitted and surface condensation occurring.

21.2.6 Capacities shall be as indicated on the drawings, at the design conditions.

21.2.7 Each unit shall be supplied with a permanent type washable filter.

21.2.8 Each unit will be equipped with a variable position thermostat, high, low and medium speed fan control and damper control or room and fresh air quantities.

21.2.9 Power supply will be 230 volts, 50 hertz, and single phase. A double pole 15amp isolator will be provided within 2 metres of the position of the units by others. The successful tenderer shall carry out the wiring between each unit and it's respective isolator.

21.2.10 Tenderer's are to state clearly any discrepancies between the guarantee of these units and those required under the general conditions of contract

21.2.11 Units shall be provided with suitable cradles, sleeves, sealing strips and brackets in order to support the units and prevent undue vibration.

21.2.12 Units shall be installed so that they may be easily removed for maintenance purposes and installation is to be completely weatherproof.

21.2.13 Units shall be mounted using maker's mounting points and using materials to ensure that galvanic action does not take place. Close fitting, knot-free, wooden varnished architraves are to be fitted on the outside of each unit to ensure a neat finish. Architraves are to be fitted on the outside of each unit to ensure a neat finish. Architraves shall be 75 mm x 20 mm meranti timber.

21.3 Ceiling Cassette Split Units

21.3.1 Each unit shall consist of an air-handling unit with a separate matching condensing unit from the same manufacturer. Schrader valve to be provided in suction and discharge lines.

21.3.2 All ceiling cassettes shall be similar or equal to Daikin Model FHYC.

21.3.3 Each machine is to be complete with a hard-wired type remote controllers.

21.3.4 The unit is to incorporate a high efficiency filter, which is to be easily accessible for cleaning and maintenance purposes.

21.3.5 The indoor unit is to incorporate an aerodynamically designed impellor and is to have an exceptionally quiet operation with a maximum of 42db sound power level.

21.3.6 Each evaporator is to be complete with a 4-way uniform decorative panel to ensure even air distribution.

21.3.7 Each machine is to be complete with a temperature controller with a self-diagnostic microcomputer that continuously monitors the operating status of the indoor and outdoor units. The controller is to include for a low gas charge detector, be able to select high and low Fan speeds have a Filter cleaning icon displayed on the remote controller when its time to clean filters. The angle of the discharge blades is to be electronically controllable.

21.3.8 The machine is to be provided with Auto restart that automatically restarts the unit in the previous mode after power is restored following a power failure.

21.3.9 Each machine is to be provided with a high lift water drain pump.

21.3.10 The condensing unit is to be complete with scroll compressors and incorporate High static pressure fans. Where no shut off valves provided, ball type shut-off valves to be installed close to compressor.

21.3.11 The coils are to be copper tubes with aluminium fins and are to be treated with a special acryl coating. (PE fin)

21.4 Air Cooled Ducted Splits (<17.5kw)

21.4.1 Each unit shall consist of an air-handling unit with a separate matching condensing unit from the same manufacturer.

21.4.2 Each machine is to be complete with hard-wired type remote controllers.

21.4.3 Each machine is to be complete with a temperature controller with a self-diagnostic microcomputer that continuously monitors the operating status of the indoor and outdoor units. The controller is to be complete with the following functions:

- Auto Operation Mode
- Fan Operation Mode Change
- Emergency Operation Function
- Auto Restart Function
- Anti –Ice Function on Indoor Coil
- Low Voltage Detection Function
- Random Start Function
- Filter Alarm Function
- Sensor Fail Function
- Cycle Fail Detection Function

21.4.4 The condensing unit is to have an extremely quiet operation and high efficiency compressors and incorporate High static pressure fans.

21.4.5 The coils are to be copper tubes with aluminium fins and are to be treated with a special anti corrosive coating.

21.4.6 All condensing unit coils shall be pre treated with an anti-corrosion treatment similar or equal to Heresite or Coil guard and the whole casing is to be treated with tectyl before installation. Schrader valves installed. Ball type isolating valves to be provided to isolate compressor.

21.5 Under Ceiling Split Type Units

21.5.1 Each unit shall consist of a direct expansion indoor fan coil unit and a separate remote externally located air cooled condensing unit.

21.5.2 The indoor fan coil unit shall be under ceiling mounted. When the unit is installed below a false ceiling the unit is to be recessed into the ceiling tiles.

21.5.3 Remote controls shall be either hard wired in conduit and mounted at the same height as the light switches or be of the infra-red type remote.

21.5.4 All refrigeration piping shall be installed as elsewhere detailed in this specification.

21.5.5 The external condensing units are to be mounted either on galvanised wall brackets or onto a concrete base.

21.5.6 Condensing units positions on concrete bases must be seated on rubber anti-vibration mounts. Where no shut off valves provided Ball type shut-off valves to be installed close to compressor. Schrader valves to be provided to attach gauges for pressure recording.

22. EQUIPMENT BASES AND VIBRATION ISOLATION.

22.1 All equipment is to be positioned onto a concrete base as shown on the tender drawings.

22.2 The concrete base will be large enough for the equipment and necessary access space between them.

22.3 Should electrical control panels be floor mounted they must be positioned on a concrete base.

22.4 The concrete base will be the responsibility of the main contractor however full builders work details are to be submitted by the AC Contractor.

22.5 All chillers, air handling units will be positioned on rubber and cork mounts.

22.6 Centrifugal chilled water pumps are to be mounted on an inertia base. The base is to be constructed from 1.6mm channel and angle iron formers with 10mm thick reinforcing bars located at 150mm pitch in each direction and filled with concrete.

22.7 The top surface of the concrete is to be floated to an even and smooth finish. The sand stone and cement mixture by volume shall be 6:3:1.

22.8 The inertia base is to be supported above the concrete base on suitable sized Mason spring mounts.

23. DRAWINGS

23.1 Tender Drawings

The Drawings accompanying this specification shall be deemed to indicate the general layout of the systems and are not to be used as shop drawings. All dimensions are to be checked on site before manufacture.

23.2 Drawings to be supplied by Contractor

23.2.1 The successful contractor shall within two weeks of notification of award of this contract submit all necessary builders work drawings showing all necessary holes, chases etc. to the engineer for approval. The Contractor shall supply plant foundation drawings showing the position and dimensions of plinths required together with details of anti-vibration material, foundation bolt holes, to allow the Builder to have this work prepared in time to receive the plant.

23.2.2 The contractor will then proceed to produce and co-ordinate all necessary working drawings of all the services included in this contract.

23.2.3 Three copies of all drawings shall be submitted by the contractor to the engineer for approval before ordering any plant or machinery required for the contract or before any work commences.

23.2.4 Prior to the preparation of the co-coordinated working drawings, the Contractor shall liaise with other Contractors as directed by the Builder to ensure that due consideration of other services is taken into account.

23.2.5 The Contractor shall allow for preparing such drawings sufficiently in advance to give the respective parties adequate time for approval of drawings, and to suit the Builder's programme.

23.2.6 The Engineer's approval of drawings submitted by the Contractor shall not in any way relieve the Contractor from his responsibility in respect of the accuracy of all such drawings or from his responsibility to provide equipment suitable in dimension, construction and finish for the location in which it is to be installed.

23.2.7 Any modification or amendments to these drawings requested by the Engineer in order to ensure that they fulfill the contract conditions shall not involve the employer in extra expenditure.

23.2.8 All alterations to working drawings, whether due to co-ordination or otherwise, shall be carried out by the Contractor and, after final approval has been obtained, the Contractor shall make final issue to all parties concerned with 3 copies to the Engineer.

23.2.9 Any work caused by inaccuracy of marking out or other default of the Contractor shall be paid for by the Contractor, Such unnecessary work may include repairing, replacing, making good, taking down and rebuilding of any part of the building plant and other as may be effected by such work.

23.2.10 Any unnecessary work carried out by the Builder adjudged by the Engineer or Architect to be caused by inaccuracy of marking out or other default of the contractor, shall be paid for by the contractor.

23.2.11 All detailed drawings submitted for approval shall be produced to be compatible with AutoCAD or equivalent computing package. Drawings are to be drawn to a reasonable scale, and the Engineers decision as to what constitutes a reasonable scale shall be final.

23.2.12 Detailed drawings shall be regarded as correct where they differ from the general arrangement drawings. A graphical scale shall be incorporated on all drawings.

23.3 Untimely Submission of Drawings

23.3.1 Any extra expense incurred due to any addition and/or amendment made by the Contractor after the drawings mentioned above have been submitted or due to the untimely submission of drawings, shall be for the Contractor's account.

23.3.2 It shall be binding upon the Contractor to establish with or obtain from the builder the scheduled time of commencement and programming of all building work affecting the Contractor in respect of this clause.

23.4 Final Drawings

23.4.1 The Contractor shall furnish the Engineer (for onward transmission to the Employer) with two sets of drawings of the plant as finally completed, incorporating all variations made during the course of construction. Such drawings shall be submitted no later than two weeks after the completion of the contract works. Once accepted the contractor shall furnish an electronic copy of all drawings for record purposes. The electronic copies shall conform to SABS 0400 and shall be compatible to the latest AutoCAD computing package.

24. MAINTENANCE AND SERVICING

24.1 The contractor shall be responsible for all maintenance and servicing of the Installation for the full 12-month maintenance and guarantee period following the hand over date. During this period, the contractor shall make good any defects due to inferior materials and workmanship and maintain all plant and equipment in perfect operating condition.

24.2 During the twelve-month maintenance period the contractor is to carry out the specified number of services and at the end of the warranty period he is to rectify all defects and bring the equipment to an as new level.

24.3 The contractor shall be responsible for the servicing of all components of the Installation in Accordance with the manufacturer's instructions at the end of the one years guarantee and Maintenance period.

24.4 For this purpose, the contractor shall prepare a detailed inspection and service report in the form of a checklist showing all functions to be carried out at each service. Copies of this service report are to be submitted to the Company's authorised representative after the service. The detailed service report shall be signed by the officer in charge of the installation. Unsigned service reports will not be accepted.

24.5 Breakdowns or complaints about any malfunctioning of the installation will be reported to the Contractor. It is the responsibility of the contractor to respond promptly on all such call outs, to repair the installation in the shortest possible time and to submit a signed breakdown report to the Company's authorized representative.

24.6 The contractor shall allow for all expendable materials necessary for servicing such as lubricating oils, grease, cleaning materials, etc.

24.7 Should the contractor fail to maintain the installation in a satisfactory working condition during The guarantee period, the Client may decide to extend the guarantee period and the requirements of this specification shall apply to such an extended guarantee period or may alternatively decide to call in the services of another contractor for this maintenance and servicing at the expense of the original contractor to the end of effective servicing period.

24.8 No worker shall service a refrigeration or airconditioning appliance that uses CFC's or HCFC's refrigerant if such a worker does not make use of recovery equipment for the recovery of the refrigerant for recycling purposes.

24.9 Should a different refrigerant be substituted for that provided by the manufacturer, all name plates, drawings, and operating manuals shall be amended to show the new refrigerant name.

24.10 The contractor shall ensure that he complies with SABS 0147 and the Montreal Protocol when working on any Refrigerant or air-conditioning appliances that use CFC or HCFC refrigerant or that use refrigerant mixtures that contain CFC or HCFC. Any refrigeration equipment, which is to be serviced or repaired shall first be checked for refrigerant leaks and shall not be charged with new or recycled refrigerant that contains CFC or HCFC until all leaks have been repaired. Upon completion of the repair or service that equipment shall be rechecked for refrigerant leaks and should any be found the procedure should be repeated until no leaks can be detected.

25. COMMISSIONING AND TESTING

25.1 General

25.1.1 Following completion of the work the contractor shall carry out all necessary commissioning and testing as required by the Engineer.

25.1.2 The contractor shall submit a commissioning programme to the Engineer at least two weeks prior to commencement of commissioning and at the same time notify the Engineer of the code or procedure to which the plant will be commissioned.

25.1.3 The commissioning shall be carried out in accordance with the latest SABS and CIBSE Codes.

25.1.4 The results of all checks and measurements as recorded during the commissioning period shall be included and shall be compiled in such a manner that every check and measurement is clearly defined.

25.1.5 The installation shall run continuously for a minimum period of ten days after commissioning to the satisfaction of the Engineer.

25.1.6 The Engineer reserves the right to inspect any item of plant during manufacture or before delivery to site.

25.1.7 Calibration certificates shall be given for all items of instrumentation before commissioning.

25.1.8 Further to the above requirements, the Contractor shall perform at appropriate times all tests required by Government and Local Authorities who may from time to time have jurisdiction over the works and shall obtain all necessary certificates of approval. These certificates and details of the tests carried out shall be lodged with the Engineer upon the completion of the works.

25.2 Abortive Tests

25.2.1 Should the Contractor notify the Engineer that tests are ready for his inspection and the tests prove faulty or fail to take place through default by the Contractor, the cost of the Engineers wasted time and expense in attending the aborted inspection will be charged to the Contractors account at the rates laid down by the SA Association of Consulting Engineers

25.3 Refrigeration Systems.

25.3.1 Field assembled refrigerant piping and apparatus, other than centrifugal refrigerating machines, shall be tested with dry carbon dioxide or nitrogen plus a small amount of refrigerant. Test pressures shall be in accordance with the latest edition of SABS 0147. Field assembled refrigerating equipment, including centrifugal machines and absorption machines, shall be tested under vacuum and shall show no evidence of leakage with an absolute pressure of 0,68 KPa mercury gauge, sustained for a period of one hour without pumping.

25.3.2 Leaks in pipe joints shall be corrected by remaking the joints. Caulking will not be permitted. The vacuum test shall follow the pressure test. Charging the equipment with refrigerant shall follow the vacuum test as closely as is practicable to minimise the possibility of air or moisture being returned to the system. After charging and prior to capacity tests, joints in refrigerant piping and apparatus shall be checked with a halide torch or other equally sensitive leak detector. If leaks are found, the system shall be pumped down and the leaks corrected as specified above.

25.4 Water Piping Systems

25.4.1 Water piping shall be tested with water pressure of not less than eight bars or one and a half times the maximum working pressure, whichever is greater, at the lowest point in the system.

25.4.2 Care shall be taken to avoid putting excessive pressures on mechanical seals, safety devices, etc. The system shall be filled and all air vented at least 24 hours before the actual test pressure is applied. Test pressure shall be applied when water and average ambient temperatures are approximately equal and constant. Test pressure shall be maintained for not less than 30 minutes without appreciable drop after the force pump has been disconnected. Leaks in screwed fittings shall be corrected by remaking the joint. Leaks in welded joints shall be cut out and re-welded. Caulking of leaks will not be permitted.

25.5 Balancing Water Systems

25.5.1 Water circulating systems shall be adjusted, cleaned and balanced so that water quantities circulated through heat exchangers, condensers, coils and similar equipment are as specified. The adjustment of individual coil circuits may be based on return water temperature, provided air or other primary flow adjustment has first been satisfactorily completed.

25.5.2 Temperature Control valves shall be fully open during balancing. Regulating valves shall be set so that those on the longest circuits will be nearly frilly open and those on shorter circuits closed only enough to balance the longer circuits. If this results in excessive total flow then limited final adjustment may be made by partial closing of pump discharge valves. The Contractor shall allow for adjustments to pump impeller sizes as appropriate. Final settings of all regulating valves shall be permanently marked.

25.5.3 Water quantities shall be measured with calibrated orifice meters.

25.5.4 Water quantities read from pump curves may not be used for determining capacities.

25.6 Balancing Air Systems

25.6.1 Airflow systems shall be adjusted and balanced so that air quantities at outlets are as directed and the distribution from supply outlets is free from draughts and uniform over the face of each outlet. These adjustments shall be made in such a manner that volume controls close to air outlets will have the least pressure drop consistent with flow requirements.

25.6.2 Additional pressure drop required for balancing of shorter runs shall be obtained by adjustment of dampers at branch take-off points. Adjustable fan drives shall be used for making final adjustments of total air quantities.

25.6.3 Direct reading velocity meters may be used for comparative adjustment of individual outlets but air quantities in all ducts having velocities 8 m/s or more, shall be measured by means of Pitot tubes which shall be inserted through small test holes with metal covers (see section 7) provided in the ductwork in positions which shall give at least two traverses of the cross section of the duct.

25.6.4 Final settings of all regulating dampers and other volume adjusting devices shall be permanently marked.

25.6.5 Total diffuser volume for low pressure duct systems, measured by means of a velometer, shall be at least 95% of actual fan supply.

26. OPERATING INSTRUCTIONS

26.1 The contractor shall prepare and supply Operating and Maintenance Manuals for the successful operation and maintenance of the installation. A draft copy of the manual shall be submitted after commissioning for approval. The draft copy shall then be corrected and two sets of the manual shall be submitted before first acceptance of the plant will be taken.

26.2 These manuals shall contain the following information:

Section 1: System Description
Section 2: Operating Instructions
Section 3: Design Data
Section 4: Equipment Technical Information and Data
Section 5: Equipment Catalogues
Section 6: Maintenance Instructions
Section 7: Commissioning Data
Section 8: Drawings
Section 9: Acceptance Certificates

27. HANDOVER

27.1 After completion of the commissioning the contractor is to submit all test results to the Engineer for checking and approval. The Engineer will check all commissioning figures and prepare a final defect list for completion. Once the snag list is completed to the Engineers satisfaction the system will be accepted and the maintenance period commence.

28. STAFF TRAINING

The contractor shall be responsible for the training of the Company's site staff after the commissioning has been completed. The site staff must receive enough instructions to ensure that they are fully conversant with the equipment concerned. Site staff shall be instructed on

- The general operating method of the plant
- Starting and stopping instructions
- Stopping the plant or unit in emergency and warning against restarting after an emergency unless a competent person is present
- Positions and normal settings of control equipment

29. PAINTING

29.1 The Contractor shall paint with first quality materials all parts of the installation covered by the work of this contract to the approval of the Engineer, except where such painting is specified as being of others. All work shall be sealed (as appropriate) primed and given two full finishing coats.

29.2 Ductwork, which is exposed to view, shall be fully painted externally.

29.3 External ductwork shall be given two coats of bituminous paint after the primer, internally and externally.

29.4 All non-aluminium cowl and grilles etc. shall be manufactured from galvanised sheet metal and shall be degreased primed and painted.

29.5 All plantroom equipment shall be fully painted. Equipment supplied in finished condition will be acceptable provided the finish is of high standard, acceptable in colour and is not damaged in any way.

29.6 All piping and fittings shall be painted with the exception of operating components (and copper piping and trays).

29.7 All pipework and equipment shall be colour coded in accordance with the relevant SABS Standard (SABS 1091-1975)

29.8 All mild steel pipework fittings and hangers shall be painted before being brought to site.

29.9 Turned parts of valves, controls and fittings, exposed copper and bright metalwork, shall be cleaned and polished to approval.

29.10 All piping shall have approved identification bands fitted after final painting to denote the type of service and the direction of flow. (Refer also section identification).

29.11 Galvanised metal parts supplied shall be degreased with galvanised iron cleaner. One coat of primer shall then be applied from the following: Calcium plumbate: etch primer plus zinc chromate, or zinc oxide primer. One overcoat and one finishing coat of exterior alkyd gloss to an approved colour shall then be applied or bituminous paint as approved. Ungalvanised components primed before delivery and erection on site shall be examined when received. Wire brush any areas where the paint is damaged or where rust has appeared and touch up with a suitable primer, paying special attention to all angles, edge rivets and bolt heads. All steel shall be finished complete with two priming coats being red lead, metallic lead, zinc phosphate or calcium plumbate and finished with one undercoat and one finishing coat of exterior alkyd gloss to an approved colour.

All ductwork shall be readily identified by an adhesive band of the appropriate ground colour detailed in B.S. 1710/SABS 0140 with an explanatory text approved by the Engineer, printed upon it in a contrasting colour detailing the contents of the duct.

29.12 Name plates, labels and notices on equipment shall be left clean, clear and unpainted.

29.13 Unlagged black piping, supporting steelwork shall be painted on all sides with a zinc chromate primer to SABS 679 Type 1, followed by one coat of universal undercoat and one finishing coat of enamel paint to SABS 630 Grade 1.

30. GALVANISING

30.1 Where hot dip galvanising is called for, items to be galvanised shall be entirely pre-fabricated and then dismantled in sections for galvanising. No cutting of threads or welding will be accepted after galvanising.

30.2 All hot dip galvanising shall be carried out in accordance with SABS 934 and SABS 763 where applicable, including preparation for galvanising.

30.3 Mild steel plate and sections shall be of good commercial quality, or higher grades, best suited for galvanising. The materials shall be free from slag or coarse laminations, fine fissures and rolled-in impurities.

30.4 Castings shall be sound, dense and clean, and free from distortion, porosity, carbon and slag enclosures, blowholes and other injurious conditions.

30.5 Welding flux shall be chipped away and all welds wire brushed before galvanising.

30.6 The surface to be galvanised shall be free from paint, oil, grease and similar impurities.

30.7 All exposed surfaces including welds shall be thoroughly sand blasted prior to galvanising.

30.8 The Engineer reserves the right to inspect all steel components before galvanising, and shall have the right to reject or ask for remedial treatment of any material which is considered to be unsuitable. This applies particularly to welds.

30.9 The galvanising coating shall be smooth, adherent, continuous and free from black spots or flux stains.

30.10 Globular extra-heavy deposits of zinc, which interfere with the intended use of the material, will not be acceptable. Excessively protuberant lumps and nodules shall be removed by hot wiping or by the skilful application of mechanical means; however there shall remain a sufficient minimum thickness of unbroken zinc coating. Flaws on small parts and working surfaces shall be repaired only by stripping and re-dipping.

30.11 Repairs to galvanised coatings will not be accepted. Items damaged will need to be re-galvanised.

30.12 Coating thickness shall be as per Table 1 of SABS 763 unless otherwise specified in the supplementary specification.

30.13 The SABS requirement for uniformity shall apply.

30.14 Galvanised surfaces specified with paint finishing shall not be passivated.

SUPPLEMANTARY AIRCONDITIONING SPECIFICATION

INDEX

1. DESCRIPTION

The specification is for the upgrade of the airconditioning system serving the Loliwe House (formerly known as the CX Administration building) in Bayhead, Durban.

The existing building is presently airconditioned by a central cold air system. The system consists of a single large airhandling unit that is positioned in the main airconditioning plantroom on the roof of the building. The airhandling unit supplies the conditioned air through a range of externally insulated galvanised sheet metal ductwork. The ductwork drops down two masonry shafts and runs through a bulkhead on each floor. The air is dispersed to each office through pneumatically operated variable volume wall grilles.

The return air is drawn through a return air grille on each floor and drawn up a masonry shaft back to the airhandling unit by two return air fans.

The airhandling unit consists of a fresh air inlet damper, a filter section with washable filters, a coil section with chilled water coil and a discharge plenum from which the two supply air axial flow fans draw the air.

The cooling coil is served by a chilled water system consisting of a Trane TRVA chilled water generator. The chilled water is circulated around the pipework reticulation system by a single centrifugal pump.

A Marley stainless steel cooling tower is positioned within the plantroom.

The system is controlled by a mixture of electronic and pneumatic controls.

2. SCOPE OF WORKS

This contract is for the refurbishment of the airconditioning system. The existing chilled water generator, existing airhandling units and existing airconditioning ductwork is to be reused.

The Contractor is to allow for the supply and installation of the two fiberglass cooling towers. These towers are to be positioned on the roof of the building outside the plantroom.

The Contractor is to allow for the supply and installation of two new chilled water centrifugal pumps, one run, one standby and for two new condenser water pumps, one run and one standby.

The Contractor is to allow for the replacement of the two axial supply air fans and the two axial return air fans. The supply air fans are to be driven through a variable speed drive.

The Contractor is to allow to replace the fresh air weather louvre and wire mesh screen on the inlet to the airhandling unit. A new gear driven opposed blade damper is to be installed behind this louvre.

The Contractor is to allow for the replacement of a new chilled water cooling coil complete with all necessary supports.

The Contractor is to allow for a new stainless steel filter frame and two sets of washable filters for the airhandling unit.

The Contractor is to allow to remove all rust from the existing airhandling unit and repair, paint and leave as new. The Contractor is to allow to replace the TROX doors on the air handling unit with new ones.

The Contractor is to allow for the removal of all redundant equipment from site. Any item containing semi-precious metal must be removed and transported to Transnet scraping yard in Edwin Swales Drive.

The Contractor is to allow for the removal of existing electric control panel and all pneumatic controls. A new electrical control panel is to be provided which is to include all new switchgear and new electronic controls.

The contractor is to allow for the whole system to be controlled by a web based Building Management System. To operate this on site the Contractor is to allow for a new computer workstation and LCD screen.

The Contractor is to make provision for all necessary builders work. This work is to include all new concrete bases, inertia base openings through walls as well as there making good and the closing of all existing holes in the plantroom that become redundant.

The Contractor is to allow for all necessary painting. This includes painting of equipment and piping. The Contractor is to allow for the painting of all walls and for the painting of the plantroom floor with an epoxy paint when the construction work is complete.

The Contractor is to allow for the repositioning of the plantroom door leading to the roof area. The Contractor is to make good the existing opening.

The Contractor is to allow for the supply and installation of all new variable volume diffusers, static pressure dampers, gear driven opposed blade dampers and access panels on each floor. Each ceiling diffuser shall be complete with a reheater.

The Contractor is to allow for all necessary modifications to the airconditioning ductwork.

The Contractor is to allow for the internal cleaning of all airconditioning and ventilation ductwork.

The Contractor is to allow for all necessary commissioning of the airconditioning system.

The Contractor is to allow for the local supplier Service First to carry out a major service on the existing chilled water generator.

The Contractor is to allow for the replacement of all damaged external insulation on the airconditioning ductwork.

The Contractor is to allow for the external insulation of the new fans guide vanes and sound attenuators.

The Contractor is to allow for the production of three copies of the Operating and Maintenance manuals. The Contractor is to allow for a full set of electrical wiring diagrams to be framed and mounted on the plantroom wall adjacent to the new electrical control panel.

The Contractor is to allow for the supply and installation of the new electrically operated fire dampers in the airconditioning ducting and behind the return air grilles on each floor.

The Contractor is to allow for all wiring and power supplies to each ceiling diffuser. The Contractor is to allow for a distribution board on each floor to server the diffusers.

The Contractor is to allow for all necessary wiring power and control to each fire damper. The fire dampers are to be linked to the Building Management System.

3. DESIGN CONDITIONS

EXTERNAL SUMMER CONDITIONS	30.0 ºC db 26.0 ºC wb
INTERNAL SUMMER CONDITIONS	22.5 ºC db 55% RH
EXTERNAL WINTER CONDITIONS	10ºC db
INTERNAL WINTER CONDITIONS	20.0 ºC db
ALTITUDE	Sea Level

THERE WILL BE NO HUMIDITY CONTROL USED ON THIS PROJECT.

4. CHILLED WATER GENERATOR

4.1 The existing chilled water generator is a Trane Model RTWA 212.

The chiller has been selected to cool 20.8 l/s of water from 11°C to 5°C.

The total cooling capacity of the chiller is 436 kW.

4.2 The Contractor is to make allowance for the local supplier of the chiller to carry out a major service on the machine.

The chiller shall be brought up to as new a standard as possible.

4.3 All rust and scratches are to be removed from the chiller and then unit is to be re painted with a corrosion preventative substance such as DULTEC or similar and be primed and repainted with two coats of an approved paint as per SANS 1091 complete as new colour to match the existing.

4.4 The Contractor is to allow for Service First to upgrade the controller so that it can be connected to the Building Management System.

5. CHILLED WATER PUMPS

5.1 The Contractor is to allow for the supply and installation of two new chilled water circulating pumps.

5.2 The pumps shall be centrifugal with non-overloading characteristics and be complete with a cast iron casing.

5.3 The pumps shall be capable of the following duty:

- Duty 49.55 l/s @ System Resistance

5.4 The final system resistance will be calculated by the successful Contractor and submitted to the Engineer for approval before ordering the pump.

5.5 The pump will be complete with a 400-Volt motor not exceeding 1500 rpm. Motors shall be IP55 and shall have a cast iron frame.

5.6 The pump casing and motor are to be fitted onto a mild steel base plate that is to be hot dipped galvanised after manufacture.

5.7 The pump is to be complete with a stainless steel drip tray, which is to be adequately sized to collect all condensation and any drips from the seals. The drip tray is to have a 25 mm diameter drain outlet, which is to be piped to the nearest full bore.

5.8 Casings shall be designed for a working pressure of 10 bars.

5.9 High points of pumps shall be provided with air vent cocks.

5.10 Impellers shall be bronze and shall be statically and dynamically balanced.

5.11 Shafts shall be chrome steel and shall have a 316 Stainless steel protecting sleeve.

5.12 All shafts shall be fitted with a mechanical seal.

5.13 The pump is to have a tyre spacer coupling and a coupling guard.

5.14 Each pump shall be with a Grade 304 stainless steel drip tray which is to have a condensate drain piped to the nearest drain.

5.15 The pump is to be mounted on an inertia base, which is to be supported by suitably sized spring mounts.

5.16 Each pump is to have an isolating valve on the suction and discharge pipes.

5.17 Each pump is to have a Cast Iron Y Type Strainer on the suction to each pump.

5.18 Each Pump is to have a Cast iron NRV on the discharge of each pump.

5.19 Each pump is to have a flexible coupling on the discharge and suction side of each pump.

5.20 Each pump is to have a binder fitting on either side of the strainer and on the discharge side of each pump.

6. CONDENSER WATER PUMPS

6.1 Two new centrifugal type pumps (one standby) with non-overloading characteristics and volute casing shall be supplied to each perform the following duty:

- Duty 28.8 l/s @ System Resistance.

6.2 The final system resistance will be calculated by the successful Contractor and submitted to the Engineer for approval before ordering the pump.

6.3 The pump will be complete with a 400-Volt motor not exceeding 1500 rpm. Motors shall be IP55 and shall have a cast iron frame.

6.4 The pump casing and motor are to be fitted onto a mild steel base plate that is to be hot dipped galvanised after manufacture.

6.5 Casings shall be designed for a working pressure of 10 bars.

6.6 High points of pumps shall be provided with air vent cocks.

6.7 Impellers shall be bronze and shall be statically and dynamically balanced.

6.8 Shafts shall be chrome steel and shall have a 316 stainless steel protecting sleeve.

6.9 All shafts shall be fitted with a mechanical seal.

6.10 The pump is to have a tyre spacer coupling and a coupling guard.

6.11 The pump is to be mounted on an inertia base and is to have suitable spring mounts.

6.12 Each pump is to have an isolating valve on the suction and discharge pipes.

6.13 Each pump is to have a Cast Iron Y Type Strainer on the suction to each pump.

6.14 Each Pump is to have a Cast iron NRV on the discharge of each pump.

6.15 Each pump is to have a flexible coupling on the discharge and suction side of each pump.

6.16 Each pump is to have a binder fitting on either side of the strainer and on the discharge side of each pump.

7. COOLING TOWERS

7.1 The Contractor is to supply and install two fiberglass induced draught cooling towers. The towers shall be certified to cool a total of 28.8 l/s of water from a temperature of 35°C to 29.5°C dry bulb and at 26°C wet bulb.

7.2 The towers will be manufactured from reinforced fiberglass. The housing shall have to be guaranteed for a minimum of ten years by the supplier. This guarantee is to be vested in writing to the client after completion of the project.

7.3 The fan support ring, bracket and fan guard is to be manufactured from 304 Stainless Steel.

7.4 The circulating water is to be distributed onto the heat exchanger material by means of fixed, non-clogging design spray nozzles. The nozzles are to be connected to a PVC distribution pipe system within the tower.

7.5 The fan motor shall be totally enclosed fan cooled and be complete with a cast iron frame. The motor shall be suitable for a 400 Volts, three phase 50 cycle electrical supply. The motor is to be externally mounted with an adjustable self-tensioning base.

7.6 Axial flow fans shall be heavy duty axial propeller type, statically balanced. The fans shall be constructed with aluminum alloy blades and installed in a closely fitted fiberglass cowl. The air inlet shall be designed for maximum fan efficiency. Each blade shall be individually adjustable.

7.7 The eliminators shall be constructed entirely of inert polyvinyl chloride (PVC) in easily handled sections, and are to be completely separate from the fill section, for maximum efficiency. The eliminator design shall incorporate three changes in air direction, to assure complete removal of all entrained moisture from the discharge of the air stream. Maximum drift rate shall be less than 0.001% of the circulating water rate.

7.8 The air inlet louvres shall be constructed from UV inhibited polyvinyl chloride (PVC) and incorporate a frameless interlocking design that allows for easy removal of louvres for access to the entire basin area, for maintenance.

The louvres are to have a minimum of two changes in direction and be a non-planar design to prevent splash out, block direct sunlight and debris from entering the basin. All fasteners shall be 304 Stainless Steel and to be of the wing nut type.

7.9 The strainer is to be a basket type, manufactured from stainless steel. The strainer is to fit neatly on the inside of the tower and is to be easily removable. The strainer is to fit tightly against the side of the tower; no water shall bypass the strainer. The strainer is to be manufactured from 304 stainless steel.

7.10 The Contractor is to allow for a hot dipped galvanised ladder with safety hoops on each tower for access to the cooling tower fans.

7.11 The cooling tower fans are to be driven by a variable speed drive.

7.12 The cooling tower fan motors shall be WEG or equal.

8. CHILLED WATER AIR HANDLING UNIT

8.1 The chilled water airhandling unit is a horizontal modular double skin unit. The airhandling unit has been designed to supply 13.02m^3/s of air at the following condition:

- ON COIL 26.7°C db / 19.4°C wb
- OFF COIL 9.9°C db / 9.5°C wb

8.2 The airhandling unit is to be refurbished in its entirety. The cooling coil, filter bank, fresh air inlet louvre, fresh air gear driven opposed blade damper, TROX access doors are all to be replaced.

8.3 The airhandling unit is to have all its rust removed and the whole unit is to be painted as new. Al bare metal on the airhandling unit is to be painted with a corrosion preventative substance such as DULTEC or similar and be primed and repainted with two coats of an approved paint as per SANS 1091 complete, new colour to match the existing

8.4 The airhandling unit is to have all its joints sealed so that there is no air leakage or water leaks.

9. CHILLED WATER COOLING COIL

9.1 The Contractor is to supply and install two new chilled water cooling coils into the existing airhandling unit.

9.2 Each cooling coil shall be capable of cooling 6.51m^3/s of air from 26.7°C db / 19.4°C wb to 9.9°C db / 9.5°C wb.

9.3 Each cooling coil will be provided with 10.4 l/s of chilled water at 6°C. The design leaving chilled water temperature is 11°C.

9.4 The coil shall be manufactured with 12.7 mm diameter copper tubes which shall be expanded into Copper fins with a maximum of 10 fins per 25.4mm of coil.

9.5 The coil casing shall be of 304 stainless steel construction.

9.6 Each coil is to be complete with a 304 stainless steel drip tray which is to be piped to the nearest outlet. (Take suction pressure of fans into consideration when calculating size of the drain pipe)

9.7 The chilled water coil shall have a maximum face velocity of 2.56m/s.

9.8 The bottom of each drip tray is to be insulated with a thermaflex type insulation to prevent the formation of condensation.

9.9 All mounting fasteners for the cooling coils are to be manufactured from 304 Stainless Steel.

10. FILTERS

10.1 The Contractor is to allow to replace the existing filter frame with a new front withdrawal 304 stainless steel housing. The Contractor is to include to supply all new 304 Stainless Steel Filter Clips.

10.2 The Contractor is to allow for TWO sets of washable panel filters. The filters shall be 50mm thick washable filters, which shall be of a standard size i.e.
600 x 600mm or 600 x 300mm.

10.3 The filters shall have an average duct arrestance rating of 92%.

11. FRESH AIR LOUVRE AND DAMPER

11.1 The Contractor is to allow for a new fresh air inlet weather louvre. The louvre shall be manufactured from extruded aluminium.

11.2 The louvre shall be complete with a 304 Stainless steel vermin proof wire mesh screen.

11.3 The louvre is to have a Natural Anodised finish.

11.4 The louvre shall consist of a 50mm frame with a fixed blade grille core having a maximum spacing of 50mm.

11.5 The louver shall be complete with a gear driven opposed blade damper. The damper shall be similar to the Europair DMP damper.

12. TROX DOORS

12.1 The Contractor is to allow to replace the three existing TROX doors with new.

12.2 The TROX doors shall be Model ST.

12.3 The doors shall be low leakage steel doors.

12.4 The doors shall have double skinned door in formed galvanised sheet steel to DIN EN 10142, with insulation of non-flammable Rockwool to DIN 4102.

12.5 The doors shall have new installation frame with welded hinges and galvanised steel builders cleats shall be supplied.

12.6 Each door shall have a double lever locking devices enables operation from both sides, in diecast aluminium.

12.7 Each door shall have a peripheral profiled rubber seal of APT, temperature resistant up to 90 °C.

12.8 Each door is to be painted with a corrosion preventative substance such as DULTEC or similar and be primed and painted with two coats of an approved paint as per SANS 1091 complete, new colour to match the existing.

13. AIRCONDITIONING SUPPLY AIR FANS

13.1 The Contractor is to allow for the supply and installation of the two guide vane axial supply air fans.

13.2 The fans shall be capable of supplying 6.51m^3/s of air against the system resistance.

13.3 General

13.3.1 Ventilation fans shall be in accordance with the Schedule of Fans and drawings.

13.3.2 Fans shall deliver the specified air quantities against the system resistance.

13.3.3 Fan motors shall be suitable for single-phase 230 volt or 3 phase, 400 volt, 50 cycle electrical supply.

13.3.4 All fans will be complete with support brackets and shall be able to be removed without disturbing the ducting.

13.3.5 Fan motors shall be totally enclosed fan cooled and shall be suitable for star-delta starting if larger than 7.5kW. The motors shall have nameplate ratings of not less than 20%, or otherwise specified, above the actual fan power required at specified capacities and system resistance.

13.3.6 The system resistances detailed in this specification and on other tender drawings are for tender purposes only. The system pressure drops are to be recalculated by the successful contractor once drawings are issued for construction. Fans are not to be ordered until the Engineer approves the revised pressure drops.

13.4 Supply Air Fans

13.4.1 The supply air fans are to be Donkin guide vane axial flow fans.

13.4.2 Each fan shall be capable of supplying 6.51 l/s against the system resistance.

13.4.3 A new Pod type cylindrical sound attenuator shall be provided on the inlet and outlet of each fan. The attenuators shall be as manufactured by mess's Donkin and shall conform to the catalogue sound attenuation data.

13.4.4 A suitable flexible connection shall be installed on both sides of the fan.

13.4.5 Axial flow fans shall be supported on anti-vibration mountings to the written recommendation of the manufacturer. Suspended units shall generally be supported from hangers using a Type 30N anti-vibration mount as manufactured by Mason Industries Inc. or equal and approved.

13.4.6 The supply air fans are to have a WEG or equivalent motor.

13.4.7 The supply air fans are to be driven by a variable speed drive.

14. AIRCONDITIONING RETURN AIR FANS

14.1 The Contractor is to allow for the supply and installation of the two return air fans.

14.2 The fans shall be capable of supplying 6.51m^3/s of air against the system resistance.

14.3 A new Pod type cylindrical sound attenuator is to be provided on the inlet and outlet of each fan. The attenuators shall be as manufactured by Donkin and shall conform to the catalogue sound attenuation data.

14.4 A suitable flexible connection is to be installed on both sides of the fan.

14.5 Axial fans shall be supported on anti-vibrating mountings to the written recommendation of the manufacturer. Superseded units shall generally be supported from hangers using a Type 30N anti-vibration mount as manufactured by Mason Industries Inc. or equal and approved.

15. PIPEWORK

15.1 The Contractor is to allow for the supply and installation of all new chilled water, condenser water, mains cold water, overflow and condensate drain pipework.

15.2 The existing condenser water pipework is to be removed and scrapped.

15.3 The existing chilled water pipework between the chiller and the airhandling unit is to be checked and if of good quality retained.

15.4 The chilled water pipework between the circulating pumps and the chiller and airhandling unit is to be replaced with new.

15.5 Quality Assurance Control.

15.5.1 A quality assurance / quality control system is to be implemented by the Contractor.

15.5.2 The system shall cater for both factory and site work and shall ensure that all aspects of the contract are incorporated.

15.5.3 The Contractor is to submit details of his proposed system before commencing the fabrication of any pipework. The information shall include but not be limited to:

- Joint Number,
- Operators Name

15.6 General

15.6.1 The Contractor shall supply, deliver and install all interconnecting pipework, complete with all brackets, fittings, flanges, unions, valves, etc., necessary for the operation of the plant as indicated on the drawings and in accordance with this and the Standard Specification.

15.6.2 Piping shall be so arranged to ensure unobstructed access, so that that the normal inspection, maintenance and adjustment of all equipment can be readily carried out.

15.6.3 The pipework and fittings shall conform to the current relevant SANS Specifications and where applicable, installed to the relevant Code of Practice.

15.6.4 The Contractor is to allow for sufficient flanges to ensure the pipework can be manhandled into position on site.

15.6.5 All pipework runs shall be properly spaced from walls, floors, ceilings and each other to ensure a neat and tidy installation.

15.6.6 All valve, flanges sensors and valves on the flow and return connections to the units shall be installed at the same heights.

15.7 Pipework Quality

15.7.1 All pipework used shall comply with the following standards:

- Black mild steel pipework shall comply to SANS 62-1 & 2/SANS 1182/B.S. 1387;
- Screwed and flanged fittings shall be manufactured in accordance with SANS 62-1 & 2, SANS 1123, and B.S. 143;
- Galvanised mild steel pipework shall comply with SABS 763/ B.S. 1378;
- Galvanised Screwed and flanged fittings shall be manufactured in accordance with SANS 14:1994/ ISO 49:1994 , SANS 1123 and B.S. 143
- Medium gauge copper tube shall be manufactured to the requirements of SANS 460: 2009, or B.S.2871, Part I, Table X, by Yorkshire Imperial Metals Ltd

15.8 Piping Installation

15.8.1 The following material shall be used for the relevant airconditioning services unless otherwise specified in the supplementary specification:

Chilled Water	Black Medium Mild Steel
Condenser Water Open System	Galvanised Heavy Mild Steel or Dipped Galvanised Black Heavy Mild Steel.
Condenser Water Closed Circuit	Black Medium Mild Steel
Condensate Drains	Class 1 hard drawn Copper with Capillary fittings
Overflows	Class 1 hard drawn Copper with Capillary fittings
MCW	Class 1 hard drawn Copper with Capillary fittings

15.9 Chilled Water Piping

15.9.1 The chilled water piping will be as detailed on the tender drawings.

15.9.2 All water circuit piping will fully comply with the Standard Specification.

15.9.3 All chilled water piping will be black medium mild steel to SANS 62-1:2003 & SANS 62-2:2009.

15.9.4 All piping above 50 mm diameter will be welded and flanged with BS10 Table “E” flanges.

15.9.5 All connections to the chillers and air-handling units shall be made with flanges. Unions will not be accepted.

15.9.6 Isolating valves shall be installed on the supply and return connections to the chiller, chilled water circulating pump and air handling units as detailed on the tender drawings.

15.9.7 A cast iron strainer complete with stainless steel screen, is to be installed on the suction to each water-circulating pump.

15.9.8 A flow switch is to be installed on the outlet of each chilled water generator.

15.9.9 Flexible connections must be installed on all connections to the chilled water pumps and the chilled water generators.

15.9.10 Pressure gauges shall be installed either side of the chiller, on the suction and discharge of the pump and on the inlet side of the strainer. All instrumentation is to comply with the Standard Specification.

15.9.11 Binder fittings are to be installed on the supply and return pipes to each air-handling unit, chiller and pump.

15.9.12 Balancing valves shall be installed on the flow pipe serving each air handling unit to regulate the flow rate. The valves shall be provided with drain cocks to facilitate the use of a manometer.

15.9.13 Air vents are to be installed at all high points of the system. Each air vent is to have a drain pipe which is to discharge into the nearest full bore.

15.9.14 Drain cocks and dirt pockets are to be installed at the bottom of each riser. The drain cock is to be suitable for the connection of a hosepipe, to facilitate drainage to the nearest full bore.

15.10 Condenser Water Pipework

15.10.1 The condenser water pipework system shall be installed as generally indicated on the tender drawings.

15.10.2 All piping is to be installed neatly, level and perpendicular to all walls and slabs.

15.10.3 All valves and flanges in plant rooms, on the condenser water flow and return risers or headers are to be level.

15.10.4 All condenser water piping shall be BLACK HEAVY class mild steel to SANS 62-1 & 2 and be hot dipped galvanised inside and out after manufacture. The thickness of zinc coatings shall be as specified in SANS 1461

15.10.5 Piping larger than 150 mm diameter shall be in accordance with SANS 719:2008 with wall thickness not less than 5 mm.

15.10.6 All galvanised mild steel pipework shall be protected against damage and corrosion prior to and during installation.

15.10.7 All steel piping above 65 mm diameter and above will be welded and flanged with B.S.10 Flanges Table “E”.

15.10.8 All pipework and fittings of 50 mm nominal bore and below may have screwed connections.

15.10.9 All screwed pipework shall be galvanised medium class steel to BS 1387.

15.10.10 All connections to the condensers and cooling towers shall be made with flanges. Unions will not be accepted.

15.10.11 Isolating valves shall be installed on the supply and return connections to the condenser and condenser water circulating pumps as detailed on the tender drawings.

15.10.12 A cast iron strainer, complete with stainless steel screen, is to be installed on the suction to each water-circulating pump.

15.10.13 A flow switch is to be installed on the outlet of each chilled water generator condenser.

15.10.14 Flexible connections must be installed on all connections to the condenser water pumps and the condensers.

15.10.15 Pressure gauges shall be installed either side of the condenser, on the suction and discharge of the pump on the inlet side of the strainer. All instrumentation is to comply with the Standard Specification.

15.10.16 Drain cocks and dirt pockets are to be installed at the suction to each pump. The drain cock is to be suitable for the connection of a hosepipe to facilitate drainage to the nearest full bore.

15.11 Welding of Pipework

All welding is to be carried out in accordance with recommendations contained in the latest recommended practices and to SANS 10044-1 & 2 as amended.

15.12 Pipe Fitter Welders

15.12.1 Only welders holding a Certificate of Competency shall be permitted to perform any welding on site. The names of such welders shall be submitted to the Engineer before any welding is executed on site and the appropriate certificates must be submitted for the approval of the Engineer at the time. Their certificates will be renewed after inspection. Each welder having completed a weld, shall stamp the number of his Certificate of Competency on the pipe adjacent to the weld.

15.12.2 Any welding which is found to have been performed by the welder whose name has not been previously approved, shall be removed and the pipeline re-welded by an approved welder at the expense of the Contractor.

15.13 X-RAY Examination

15.13.1 If for any reason the Engineer should see fit to request that any or all welds are to be X-Ray examined, this will be done at the Contractors cost.

15.13.2 Piping when cut shall be carefully reamed out to restore the bore and the Sub-Contractor shall allow for disconnecting and prefixing any joint the Engineer may select, to demonstrate that this has been done.

15.13.3 No welding will be allowed on galvanised pipe. The Contractor shall ensure that the piping with all fittings, sockets etc. for instrumentation and control equipment has been installed and properly checked before galvanising.

15.13.4 Care shall be taken to ensure fittings are not excessively tool marked. If in the opinion of the Engineer, any fitting or pipe length is unacceptably marked, the Contractor shall replace the condemned section with new material.

15.14 Flanges and Fittings

15.14.1 The Contractor is to allow for sufficient flanges to ensure the pipework can be man handled into position on site.

15.14.2 All piping shall be arranged so that normal inspection and servicing of all equipment can be readily carried out.

15.14.3 Flanges shall be in accordance with SANS 1123. Flange jointing packing's shall be of suitable joint rings.

15.14.4 All fittings and accessories shall generally be flanged and shall be in accordance with SANS 1123. Flanges shall be rated at not less than 1000 kPa or 1.5 times the maximum working pressure, which ever is the greatest.

15.14.5 Short radiused elbows are only permissible where there is limited space, and only with the written approval of the Engineer.

15.14.6 All screwed fittings shall be manufactured of malleable cast iron in accordance with SANS 62-2:2009 or BS 143.

15.14.7 All screwed pipework connections to equipment shall be made with flanges. NO unions shall be used.

15.14.8 Where screwed joints are used, bushings or long screw connections and back nuts will not be accepted. All screwed joints shall be clean threaded and pulled up tightly. No caulking shall be permitted.

15.14.9 All exposed threads shall be painted with Corrocote 3, AECI product Code D184-1054 or equal and approved. All grease, thread etc. shall be removed before paint is applied.

15.15 Pipe Supports and Brackets

15.15.1 The Contractor shall supply and install all necessary anchors and brackets to support and control the movement of the pipes.

15.15.2 All pipe brackets shall be purpose made from black mild steel channel iron and the pipes secured with suitably sized "U" bolts. The brackets are to be hot dipped galvanised after manufacture and all "U" bolts shall be made from galvanised threaded bar.

15.15.3 Pipe brackets shall be designed to accommodate movement caused by either expansion or contraction or building movement.

15.15.4 The maximum spacing of hangers and the minimum diameter of hanger rods shall be as follows:

Nominal Pipe Size mm	Maximum Span	Minimum Rod Diameter
20 mm	2.2m	10 mm
25-40 mm	2.8m	10 mm
50 mm	3m	10 mm
80 mm	3m	12 mm
90 mm	3m	12 mm
100 mm	3m	16 mm
125 mm	3m	16 mm
150 mm and above	3m	22 mm

The vertical water pipes shall be additionally supported at the lowest point of all risers, to ensure no movement of pipework.

15.15.5 Floor-mounted brackets shall support the water piping on the roof. The floor brackets shall be positioned on purpose made concrete bases, so as not to penetrate the waterproofing.

15.15.6 The Structural Engineer shall approve all fixings and brackets prior to their installation onto the concrete slab.

15.15.7 No fixings will be allowed to penetrate the waterproofing of the roof without the Architect's and Structural Engineer's written approval. Any such penetration through the waterproofing shall be sealed with chemical anchors, or as otherwise instructed by the Engineer.

15.16 Pipeline Identification

Pipeline identification is required.

15.17 Flushing the System

Before any part of the installation is commissioned, the pipework shall be cleaned of any accumulated dirt and debris, by washing or blowing through the pipework at least twice.

The completed pipework system shall be filled with water and then run to waste, until the system is free of dirt, oil, cuttings, and weld splatter.

The Contractor shall allow for dismantling the pipework at the bottom of each riser, to ensure that all debris is removed from the system.

15.18 Pressure Test

On completion of the installation, the piping is to be pressure tested to one and a half times the working pressure or 8 bar whichever is the greater. The system shall hold this pressure for a 24-hour period.

All equipment and the pump will be isolated during this test, so as not to damage the mechanical seal or heat exchangers.

The Engineer is to be given sufficient prior notification, so that he may witness the test.

15.19 Condensate Drains, Overflows and Mains Cold Water Connection.

15.19.1 Condensate water piping shall be provided from each airhandling unit to the nearest full bore drain provided in each plantroom.

15.19.2 All condensate drains shall be installed using hard drawn copper with soldered capillary fittings. UPVC pipework or fittings will not be accepted in plantrooms. Copper bends may **NOT** be formed from pipe lengths by an appropriate bending machine.

15.19.3 The piping sub-Contractor is to allow for the insulation of all condensate piping in the airconditioning plantrooms with ⅝" thick Armaflex insulation, to ensure no condensation forms on outside of pipe.

15.19.4 The Contractor is to allow for all overflow piping from the cooling towers to the nearest full bore. Coupled to the overflow pipe shall be a valved drain connection. Overflows and drain piping shall be run in hard drawn copper, with soldered capillary fittings.

15.19.5 The Contractor shall allow for the supply and installation of a mains cold-water connection to the condenser water system from the building mains. The mains cold water supply shall be run in hard drawn copper with soldered capillary fittings.

15.20 Chemical Dosing Pot

The Contractor is to allow for the supply, manufacture and installation of a chemical dosing pot. The chemical dosing pot is to consist of a 300 mm length of 150 mm diameter pipe with a welded cap on either end. The section of pipe is to have two 15 mm sockets welded on, to allow for connection to the chilled water flow and return pipes. The dosing pot is to have a 15 mm diameter drain point at the bottom of the pipe.

At the top of dosing pot, will be a 15 mm diameter connection with a steel tundish, to allow chemicals to be added to the system.

15.21 Rigging and Erection of Equipment

The Contractor is to make allowance for the offloading, rigging and positioning of all airconditioning equipment onto their respective bases. The Contractor will be responsible for any damage to the equipment caused during this operation.

15.22 Painting

The Contractor shall paint all mild steel pipework fittings and hangers before being brought to site, with two coats of a zinc chromate primer to SANS 1319.

15.23 Galvanising

15.23.1 Where hot dip galvanising is called for, items to be galvanised shall be entirely pre-fabricated and then dismantled in section for galvanising. No cutting of threads or welding will be accepted after galvanising.

15.23.2 All hot dip galvanising shall be carried out in accordance with SANS 935-2007 where applicable, including preparation for galvanising.

15.23.3 Mild steel plate and sections shall be of good commercial quality, or higher grades, best suited for galvanising. The materials shall be free from slag or coarse laminations, fine fissures and rolled-in impurities.

15.23.4 Castings shall be sound, dense and clean, and free from distortion, porosity, carbon and slag enclosures, blowholes and other injurious conditions.

15.23.5 Welding flux shall be chipped away and all welds wire brushed before galvanising.

15.23.6 The surface to be galvanised shall be free from paint, oil, grease and similar impurities.

15.23.7 All exposed surfaces including welds shall be thoroughly sand blasted prior to galvanising.

15.23.8 The Engineer reserves the right to inspect all steel components before galvanising, and shall have the right to reject or ask for remedial treatment of any material which is considered to be unsuitable, This applies particularly to welds.

15.23.9 The galvanising coating shall be smooth, adherent, continuous and free from black spots or flux stains.

15.23.10 Globular extra-heavy deposits of zinc, which interfere with the intended use of the material, will not be acceptable. Excessive protuberant lumps and nodules shall be removed by hot wiping or by the skilful application of mechanical means; however there shall remain a sufficient minimum of thickness of unbroken zinc coating. Flaws on small parts and working surfaces shall be repaired only by stripping and re-dipping.

15.23.11 Repairs to galvanised coatings shall not be accepted. Items damaged will need to be re-galvanised.

15.23.12 Coating thickness shall be as per SANS 1461, unless otherwise specified in the Supplementary Specification.

15.23.13 The SANS requirement for uniformity shall apply.

15.23.14 Galvanised surfaces specified with paint finishing shall not be passivated

16. VALVES

16.1 General
All valves up to and including 50mm shall be screwed to BSPT. Valves 65mm and above shall be flanged to SANS 1123 or BS 10 Table 'E'.

16.2 The Chilled water connections to the airhandling unit shall remain as is. The valves shall be removed, serviced, cleaned of all rust and reinstalled.

16.3 The chilled water and condenser water pump connections to the chilled water generator shall be complete with the following items:

- Butterfly isolating valves,
- Flexible connections,
- Flow switch (Condenser and evaporator),
- Pressure gauges, gauge cocks and siphon tubes,
- Binder fittings,
- Drain cocks

16.4 The chilled water and condenser water pumps shall be complete with the following items:

- Isolating valves,
- Non return valves,
- Strainers,
- Flexible connections,
- Pressure gauges and gauge cocks,
- Flow switch on each pump, (six off)
- Drain cocks

16.5 The condenser water pipe connections to each cooling tower shall be complete with the following items:

- Butterfly isolating valves on inlet and outlet of each tower,
- Binder fittings on each inlet
- Butterfly valves on the equalisation line between each tower
- Ball valve on the MCW connection to each tower
- Ball valve on each drain connection to each tower

16.6 Gate Valves

The gate valves up to 50 mm diameter nominal bore shall be bronze gate valves. All valves must have cast metal hand wheels - pressed metal wheels must not be used.
The valves shall have a bronze body, screwed bonnet, internal screw and yoke, non-rising spindle bronze wedges.

Gate valves 65 mm diameter nominal bore must have cast iron body, bolted bonnet, flanged ends, external screw and yoke, bronze trim, rising spindle.

16.7 Butterfly Valves

All butterfly valves shall be semi lugged type.

The bypass valve shall be a two port motorised valve, complete with a proportional motor.

16.8 Check Valves

Check valves or non return valves up to and including 50 mm nominal bore, shall be complete with a bronze body, screwed bonnet, screwed ends BSP, spring loaded, renewable composition fibre disc and bronze seat air check valve.

Check valves of 65 mm nominal bore and above shall be cast iron wafer check valves.

The non-return valves shall be cast Iron wafer check valves.

16.9 Strainers

Strainers shall be Y type cast iron flanged complete with a bolted cover, with blow down plug and stainless steel screen to be fitted with extraction handle.
Strainers of 50 mm size and smaller may have bronze or iron bodies, with screwed connections.
Strainers shall be designed for not less than 1035 KPa working pressure.

Screens shall be bronze Monel metal or stainless steel with perforations as follows:

Strainer Size	Perforation Size
20 mm to 50 mm inclusive	0,8 mm
55 mm to 150 mm inclusive	1,6 mm
200 mm to 300 mm inclusive	3,2 mm
Over 300 mm	6,4 mm

The free area of each screen shall not be less than three times the area of the strainer inlet pipe. Each strainer shall be provided with 20 mm valved drain, with hose connection, and unless the strainer design is devoid of air pockets, l5 mm vent cock.

The strainers on the condenser water piping shall be Y type cast iron flanged, complete with a bolted cover, with blow down plug and stainless steel screen to be fitted with extraction handle. The screen perforations for a 200 mm diameter strainer shall be 3.5 mm diameter.

16.10 Ball Valves

Ball valves up to 50 mm nominal bore where permitted, shall be chromium steel with stainless steel ball fitting.

16.11 Automatic Air Vents

Automatic air vents shall be bronze body, brass ball, stainless steel valve and seat. They shall be installed at all high points in the water systems as shown on the drawings.
Each air vent shall be complete with ball valves for isolation and maintenance purposes.

16.12 Flow Switch's

All flow switches installed on the chilled water system shall be suitably vapour sealed. The water flow switches shall be filled into the pipework where shown. The flow switches shall be single pole double throw (signal contact). The flow switch shall incorporate a dust protected micro switch, which shall have adjustable settings.

16.13 Binder Fittings

Binder fittings shall be installed in positions indicated on the drawings. All binder fittings shall be installed on the top of the pipe where possible.

16.14 Flexible Connections

Mason Vibreflex flexible connections shall be installed either side of each pump.

16.15 Pressure Gauges

Pressure gauges shall be installed where required and where indicated on the drawings. All pressure gauges shall be of the glycerine filled dial type with a diameter not smaller than 100 mm. All pressure gauges shall be complete with stopcock and syphon pipe and shall be graduated to 50% above the working pressure. The accuracy of all gauges shall be 2%.

16.16 Thermometers

16.16.1 All thermometers shall be stem type. They shall be alcohol in glass with an aluminium or brass casing. Scale range of the thermometers shall be selected, so that the nominal operating temperature falls at or near midscale.

16.16.2 Thermometer wells shall be made of heavy brass with portions surrounding the bulbs not over 1.6 mm thick. They shall be approximately 150 mm long, shall project a minimum of 50 mm into the pipe. Pipes that are smaller than 65 mm in size, shall be enlarged at the points where the wells are installed. Wells shall be set vertically or at an angle, so as to retain oil.

16.17 Test Kit

Binder test kit comprising the pressure gauge and thermometer shall be handed to the Engineer after completion.

16.18 Valve Labels

Valve labels are not required

17. CHILLED WATER PIPEWORK INSULATION

17.1.1 The Contractor is to allow to insulate all new chilled water pipework and to repair all existing chilled water pipework as new.

17.1.2 All chilled water pipework insulation shall conform to the latest SANS Specifications.

17.1.3 All chilled water pipework insulation shall be insulated in a workmanlike manner to modern practice.

17.1.4 All chilled water piping shall be insulated with pre-formed sections of fire retardant closed cell, rigid polystyrene having a minimum density of 24 kg/m³. The polystyrene shall have a thermal conductivity not exceeding 0.022 W/m°K.

17.1.5 The thickness of the insulation shall be as follows:

Chilled water pipework less than 50 mm diameter shall be a minimum of 30 mm thick,
Chilled water pipework between 65 mm diameter and 150 mm diameter shall be a minimum of 40 mm thick,
Chilled water pipework 200 mm diameter and above shall be a minimum of 50 mm thick,

17.1.6 All pipework and fittings shall be cleaned dry and free of grease, loose rust and scale before insulation is applied.

17.1.7 All pipework and fittings shall be painted with PA10 before application of insulation.

17.1.8 A coat of Pekay RK-T570 sealer is to be applied to all piping and onto the inside of the polystyrene insulation.

17.1.9 The pre-formed sections are to be staggered and joined with Pekay RK-T570 sealer.

17.1.10 The Pekay RK-T570 sealer is to be applied to the ends of all sections of insulation when butting them together.

17.1.11 The polystyrene is to be wrapped with a piece of pressure sensitive tape every 300 mm.

17.1.12 The polystyrene is to be covered with a reinforced foil kraft composite covering having nil permeability.

17.1.13 The foil kraft is to be joined to the polystyrene insulation using a solvent free adhesive.

17.1.14 The foil kraft composite covering is to be sealed using a pressure sensitive, self adhesive aluminium tape, 48 mm wide.

17.1.15 The Insulation is to be painted with a Pekay 835 acrylic waterproofing material. The colour of the waterproofing material is to be as detailed in SANS Standard Specification.

17.1.16 The chilled water pipework insulation, is to be clad with 0.6 mm thick aluminium sheetmetal cladding to match the existing cladding.

17.1.17 Cladding that has been compressed or damaged in any way is to be replaced and the vapour barrier re-instated before handover.

17.1.18 All insulation and cladding is to be painted after completion as detailed in the Standard Specification. Should no particular colours be specified, the Contractor is to paint the insulation in accordance with the colours specified in the latest SANS Specification.

17.1.19 All bends shall be formed using full segmented lobster back sections. Sondor type self adhesive tape is to be installed on the inside of the bends to protect against any penetrations caused by fixings.

17.1.20 Lobster back bends on pipes up to 50 mm diameter shall have a minimum of three segments. Lobster back bends on chilled water pipework 65 mm and above shall have a full segmented bend.

17.1.21 The Contractor is to ensure that the vapour barrier is not pierced by any rivets or fasteners. Self tapping screws shall not be used.

17.1.22 Polystyrene sections manufactured from High Density Polystyrene, having a density of 32 kg/m³ shall be installed around pipes where pipe hangers, supports and brackets are installed. The length of the polystyrene sections shall be as detailed in the Standard Specification.

17.1.23 The polystyrene sections are to be clad with a section of galvanised sheetmetal cladding 0.8 mm thickness to prevent the pipe bracket from compressing the insulation. The cladding is to be strapped at either end.

17.1.24 The pipe bracket is to have a shoe manufactured from 1.2 mm thick galvanised sheet metal to support the insulated pipe.

17.1.25 The length of the polystyrene sections, cladding and shoes are to be as detailed on the tender.

17.2 Colour Bands and Directional Arrows

Colour Bands and directional arrows shall be installed on all piping as detailed in SANS10140-1 to 5 as per latest amendments

17.3 Pressure Test

17.3.1 No chilled water pipework insulation is to be applied until the pipework pressure test is approved by the Engineer.

17.3.2 On completion of the installation, the piping is to be pressure tested to one and a half times the working pressure or 8 bar whichever is the greater. The system shall hold this pressure for a 24-hour period.

17.3.3 All equipment and the pump will be isolated during this test, so as not to damage the mechanical seal or heat exchangers.

17.3.4 The Engineer is to be given sufficient prior notification, so that he may witness the test.

18. EQUIPMENT BASES AND VIBRATION ISOLATION

18.1.1 The Contractor shall provide all necessary concrete plinths for the all the equipment and condenser water pipes.

18.1.2 The Contractor is to allow for the spring mounts for all circulating pumps and for all necessary Teco pads for the cooling towers.

18.1.3 The Contractor is to allow for the supply and manufacture four of hot dipped galvanized steel inertia bases for the circulating pumps.

19. DUCTWORK

19.1.1 The Contractor is to allow for the removal of all second fix variable volume grilles and their associated spigots.

19.1.2 The Contractor is to replace these grilles with new TROX variable volume diffusers. The Contractor is to allow for new spigots to be installed over the existing holes in the main ducting and for all circular second fix ducting and associated flexible ducts.

19.1.3 The Contractor is to allow for the installation of new static pressure damper, access panel and gear driven opposed blade balancing damper in each branch as shown on the tender drawings.

19.1.4 Should there be any existing spigots hat are not being re-used in the new system the Contractor is to blank the openings off with a suitable stop end.

19.1.5 The Contractor is to allow for the replacement of all existing fire dampers with new. The contractor is to allow for all necessary duct alterations to accommodate the new fire dampers.

19.1.6 All ducting shall be low velocity, low-pressure ductwork and be manufactured to SANS 1238-2005 as amended and as detailed in the Standard Airconditioning Specification.

19.1.7 The Contractor is required to check all dimensions on site before manufacture of ductwork and will be held responsible for ensuring that all ductwork conforms to the building structure.

19.1.8 All ducting will be installed neatly, with all duct joints and seams shall be airtight.

19.1.9 The types of longitudinal seams, transverse joints, and duct stiffening shall be in accordance with the relevant tables and sub-sections of the SABS Specification.

19.1.10 Ductwork is to be true in section. No distortion shall be permitted.

19.1.11 Ductwork supports are to be galvanised, adjustable, of adequate strength and in accordance with SANS 1238-2005 and DW/121.

19.1.12 All ducting having a semi-perimeter of 1100 mm or more shall be flanged using Ductlok flanges and fasteners, incorporating a permanent non-hardening sealant. Should Mezz Flanges be used, then sufficient sealant and fasteners shall be used to ensure that no air leakage occurs.

19.1.13 All material thickness shall be in accordance with the Specification. The cost of replacing any defective ductwork and any associated builders work will be for the Contractors account if lighter gauge material is used.

19.1.14 All ducting will be sufficiently supported to ensure no stress or strain is imposed on the ducting joints and seams.

19.1.15 All bends installed on the main supply air duct connections from the units shall have double thickness turning vanes.

19.1.16 Should the Engineer not be satisfied with the installation of the ducting, he shall reserve the right to call for an air leakage test. The test shall be in accordance with SANS 10173 - 2003 and the Contractor shall supply all necessary measuring apparatus, and conduct the test in the presence of the Engineer. The Contractor will carry out any remedial work deemed necessary by the Engineer to meet the necessary air leakage standards, free of charge.

19.1.17 The ducting is to be level to the underside of the ceiling slab and its centre line perpendicular to the external walls. All hangers are to be level and perpendicular to the ceiling and ducting.

19.1.18 All marks, writing etc is to be removed by the Contractor prior to handover.

19.1.19 All balancing dampers shall be gear driven opposed aerofoil blade dampers mounted between two Mezz flanges, and be complete with a thickness not less than the duct gauge, fixed to each side of a square spindle, having brass end bearings, which have means of lubrication. Dampers shall be similar or equal to Europair DMP. Dampers on circular ducts below 350 mm diameter, may be single blade type dampers.

19.1.20 The Contractor is reminded that it is his responsibility to ensure that his ducting and equipment is adequately protected prior to handover. All ducting is to be kept dust free during and after installation. The Contractor is to allow for sufficient plastic sheeting covering all openings, attenuators, and grilles to avoid dust getting into the ducting prior to commissioning.

19.1.21 Care is to be taken with the installation of any second fix ducting through ceiling grids. Any damage caused to the ceiling grid or tiles shall be rectified free of charge by the Contractor.

19.1.22 All external ducting and fans, fittings and hangers are to be painted. The Contractor is to include for the washing of the galvanised ducting prior to painting with a corrosion preventative substance such as DULTEC or similar and be primed and painted with two coats of an approved enamel paint as per SANS 1091 complete. The Architect will specify the colour of paint.

19.1.23 Structural openings through concrete beams, walls, slabs, etc have been provided where deemed necessary. It shall be the responsibility of the Contractor to timeously request any additional builders work requirements from the Main Contractor.

19.2 Duct Insulation

19.2.1 All airconditioning ducting shall be externally insulated to comply with the relevant SANS Specifications.

19.2.2 All ducting that is to be externally insulated, is to be satisfactorily leak tested before the insulation is fixed.

19.2.3 Insulating materials and their finishes shall be completely free of any form of asbestos, shall not contain chlorofluorocarbons, and shall be resistant to ozone and ultraviolet.

19.2.4 All insulating materials, adhesives, straps and finishes shall comply with the stated fire index for the surface spread of flame, heat contribution and smoke.

19.2.5 All airconditioning ductwork is to be externally insulated with 25mm foil faced fiberglass, similar or equal to Ductwrap. The insulation is to be non-combustible and shall have a Class 1 fire index all as detailed in tested to SANS 10177. The insulation is to be a thermal blanket type insulation, manufactured from inorganic glass fiber, bonded with thermo setting resin and faced with reinforced Kraft/Aluminium foil laminate. The insulation is to have a density of 18 kg/m³ and a thermal resistance of 0.66 m²k/W.

19.2.6 Where brackets and hangers occur, a suitable high-density non-compressible material shall be used between the duct and the supporting member, to prevent thermal bridging.

19.2.7 Sufficient adhesive shall be applied to all sides of the duct to ensure bonding of the insulating material to the sheet metal.

19.2.8 The insulation is to be secured by suitable straps. There is to be no damage to the insulation or the vapour barrier when the straps are fixed.

19.2.9 Furthermore, the insulation shall be secured by mechanical fasteners on the bottom and sides of all ducts wider or deeper than 600 mm. All holes caused by the fixing of the fasteners are to be sealed by the use of a suitable aluminium foil tape. All fasteners to be of stainless steel construction.

19.2.10 All insulation is to be securely fastened with edges being correctly butted.

19.2.11 No ducting shall be accepted with torn insulation.

19.2.12 All joints in the insulation shall be sealed by means of an aluminium tape of the same quality as the foil facing, with a minimum overlap of 50 mm.

19.2.13 The insulation material shall fit tightly to the outer perimeter of the duct.

19.2.14 Ventilation ducting need not be insulated.

19.3 Flexible Ducting.

19.3.1 The fire rating of the flexible ducting shall comply with SANS 10177-3

19.3.2 Flexible ducting shall be Euroflex type Isodec 25A aluminium/polyester/aluminium laminate with a heavy-duty steel helix core. The flexible duct shall be insulated with fiberglass insulation, having a density of 16 kg /cubic meter. The outer jacket vapour barrier shall be made of spirally reinforced multiple layer aluminium laminated construction.

19.3.3 The maximum length of any flexible duct will be 1500 mm.

19.3.4 All flexible ducts are to be fixed to the sheet metal ducting with metal clamps and the flexible duct insulation is to be secured with aluminium tape. The fixing of flexible ducting with brown tape is not acceptable.

19.3.5 Flexible ducting shall not be compressed, twisted or kinked.

19.3.6 Flexible ducting shall not be installed on top of light fittings or hot water and steam pipes.
19.3.7 All bends made with flexible ducting shall have a minimum internal turning radius of at least one diameter. No tight turns with the flexible ducting will be accepted.

20. DUCTWORK - CLEANING

20.1 The Contractor is to allow for a specialized company to clean the inside of all airconditioning and ventilation ductwork.

20.2 This contract is to be carried out by firms who specialize in the cleaning and decontamination of air conditioning ducting.

20.3 The specialist tendering on this contract must be from a reputable company operating from a fully equipped registered premises.

20.4 No wet method of cleaning shall be allowed.

20.5 Procedure

20.5.1 Prior to commencement with the cleaning of the ducting a video recording shall be taken showing the condition of the interior of the ducting. Once the cleaning has been completed a further video recording shall be taken so as to ensure that the ducts have been cleaned.

20.5.2 The method of cleaning shall be by means of high –powered vacuum cleaners that have been fitted with high efficiency filters.

20.5.3 All supply and return air diffusers are to be removed, cleaned and sanitized before re-installation thereof.

20.5.4 All chemicals that are used must be **EPA** registered specifically for the sanitation and deodorization of HVAC systems and ductwork.

20.5.5 All contaminants removed from the ducting shall be placed in sealed containers and disposed of by successful contractor.

20.5.6 All work to take place with the minimum disruption to the tenant.

20.5.7 The cleaning process shall be carried out in strict accordance with the OHSA act.

20.5.8 If any defects are detected in the ducting during the cleaning process such defects are to be brought to the client's attention.

20.5.9 Once the cleaning of the ductwork has been completed, all access panel shall be made good by means of galvanized sheet metal plate held in position by silicone sealant and self drilling screws.

20.5.10 All ductwork and air conditioning units are to be treated with an **E.P.A**. registered biocide to eliminate microbial population present in air distribution systems.

20.5.11 All section of ducting that is internally insulated shall be treated with a duct sealant to arrest any remaining particles.

21. GRILLES, DIFFUSERS AND DAMPERS

21.1 All grilles and diffusers sizes and quantities shall be as detailed in the equipment schedule on the drawing.

21.2 The ceiling diffusers shall be TROX and shall be Model DVV.

21.3 Ceiling diffusers in solid ceilings shall be TROX type RVV constant volume diffusers. These diffusers will be fitted into a flush plastered ceiling. The holes are to be marked by the airconditioning sub-contractor and will be cut by the ceiling contractor.

21.4 The diffusers shall provide an even 360-degree air pattern with a constant discharge velocity ensuring maximum entrainment from 100% to 33% capacity. The minimum air quantity will be preset to 33%. The diffusers shall be manufactured from pressed steel construction with flat surfaces to facilitate cleaning. The inlet to each diffuser shall be with a round spigot for easy connection onto a circular duct. All diffusers will be finished in Baked Enamel White. Blanking sections shall be provided on diffusers as detailed on the drawing.

21.4.1 TROX Doors

21.4.2 The TROX doors shall be Model ST.

21.4.3 The doors shall be low leakage steel doors.

21.4.4 The doors shall have double skinned door in formed galvanised sheet steel to DIN EN 10142, with insulation of non-flammable Rockwool to DIN 4102.

21.4.5 The doors shall have new installation frame with welded hinges and galvanised steel builders cleats shall be supplied.

21.4.6 Each door shall have a double lever locking devices enables operation from both sides, in diecast aluminium.

21.4.7 Each door shall have a peripheral profiled rubber seal of APT, temperature resistant up to 90 °C.

21.4.8 Each door is to be painted with a corrosion preventative substance such as DULTEC or similar and be primed and painted with two coats of an approved paint as per SANS 1091 complete, new colour to match the existing.

21.5 Ceiling Diffusers

21.5.1 The diffusers are to be an electronically operated unit incorporating rate aided proportional air volume and heater control. Automatically regulate the room temperature which is measured with a sensor either in the diffuser or in the wall mounted unit. According to the thermal demands in the room the controller moves the damper by means of a push / pull actuator and stainless steel spindle or cycles the heater until the room temperature reaches the set point adjusted on the controller by the user (if wall mounted).

21.5.2 Electronics and electrical parts shall not be exposed but covered with a corner box.

21.5.3 The heater is to be protected against over-heating (in case there is too little air flow) via an automatic thermal switch (Klixon). This ensures that the surface temperature stays within the safe range required by the SABS.

21.5.4 Each diffuser with heater (main & sub) is to have a 220V connection cable and a cable of suitable length to connect the diffusers with each other and with the controller (if wall mounted).

21.5.5 Each controller shall be capable of controlling up to 5 diffusers. Each diffuser needs to be connected to the power supply either 24V or 220V. The master diffuser is the one with the sensor (if the sensor is required to be in the diffuser). All diffusers are to be supplied with modular sockets – these are used to connect the diffuser via the supplied cables.

21.5.6 The diffuser body and faceplate are constructed from cold rolled black steel which is all phosphate treated and powder-coated textured white VEP 1595. This process will provide corrosion resistance protection to the product based on a 500-hour salt-spray test.

21.6 All return air grilles in the ceiling shall be Europair type ECP complete with plastic cores.

21.7 Toilet extract grilles in the ceilings shall be white PVC extract discs.

21.8 All door grilles shall be Europair Model DG and shall incorporate a concealed fixing. Door grilles shall be ordered to suite the appropriate door thickness and shall have a Natural Anodised finish.

21.9 All static pressure dampers shall be TROX model JN-B and be complete with reversible motor. The pressure sensor will be as detailed in the control section.

21.10 Dampers

Multileaf dampers designed for volume flow and pressure control or to isolate sections of ducting in ventilation systems, basically consisting of a channel shaped casing, aerofoil blades, connected by external linkage. All manufactured from galvanised sheet steel. Suitable for manual or motorised operation.

21.11 All duct and fresh air inlet dampers shall be Europair Model DMP gear driven type with lockable quadrants.

21.12 All diffusers and grilles shall be left in a new clean condition with all marks or scratches repaired to make item as new.

21.13 The Engineer shall approve a sample of the anodised louvre before ordering.

21.14 Fire Dampers

21.14.1 New fire dampers will be required for in the airconditioning ducting and any return air opening in fire walls within the ceiling space. The fire dampers are shown on the tender drawings and as detailed in the equipment schedule.

21.14.2 All fire dampers shall be TROX Model FDF combination air / smoke/fire damper. The dampers shall be installed within a duct spigot so that they can be positioned where the duct penetrates a firewall and that the locking quadrant is easily accessible for resetting.

21.14.3 All fire dampers shall be in accordance with SANS 193:2004, as amended. Fire damping markings shall be set out in Clause 4 of SANS 193:2004 as follows:

a) Manufacturers name or trade name or trademark
b) Fire-resistance rating, in hours
c) Vital instructions regarding installation, e.g. direction of flow, mounting positions.

The opened and closed positions shall be clearly marked.

21.14.4 The fire dampers are to be fitted with electric motors with a spring return option. Each fire damper is to be fitted with limit switches to signal blade position to the Building Management System.

21.14.5 The thermal holding device arranged within the casing shall have a release temperature of 72°C.

21.14.6 All fire dampers installed within the airconditioning ductwork shall be externally insulated with Thermo flex insulation or be installed within an internally lined sheetmetal casing. No sweating is to occur from these dampers.

21.14.7 Fire dampers positioned in the firewalls shall have the opening around the damper casing securely sealed.

21.14.8 Fire dampers shall be installed so that the operation of the quadrant is not fouled by the smoke partition.

22. ELECTRICAL

22.1 The Contractor is to remove and scrap the existing electrical control panel, the control wiring and all the existing controls.

22.2 The Contractor is to allow for the design, manufacture, supply and installation of a new electrical control panel

22.3 The Contractor is to allow for the supply and installation of all necessary new switchgear, electronic controls, wiring, cable trays, conduits etc. and all other necessary items required for the correct operation of the airconditioning system.

22.4 The new electrical control panel is to be sized to house the new switchgear, new electronic controls and the variable speed drives for the supply air fans and the cooling towers.

22.5 In addition the new electrical control panel will have a section for a mimic panel which will show a separate digital read out of the following items:

- Air on-coil dry bulb temperature
- Air off-coil dry bulb temperature
- Chilled water supply temperature
- Chilled water return temperature
- Condenser water supply temperature
- Condenser water return temperature

22.6 Each of these digital read outs shall be clearly labeled.

22.7 Each section of the electrical control panel shall be suitably ventilated.

22.8 The Contractor is to allow for the supply and installation of all necessary electronic controls as specified.

22.9 Chiller

22.9.1 The Contractor is to allow for a new power supply to the existing chilled water generator.

22.9.2 The Contractor is to allow for the installation of a flow switch on the chilled water supply pipe and the condenser water leaving pipe.

22.9.3 The chiller will be controlled by its own controls.

22.9.4 The Contractor is to allow to upgrade the chiller controller so that it can be connected to the Building Management System.

22.10 Cooling Towers

22.10.1 The Contractor is to allow for separate switchgear for each cooling tower and for one variable speed drive to control the fan speed of the two fans.

22.10.2 The Contractor is to allow for a new power supply to each cooling tower fan.

22.10.3 The Contractor is to make allowance for a weather proof isolator adjacent each cooling tower, which is to be clearly marked.

22.10.4 In addition to the mains isolator to each cooling tower, the Contractor is to allow for a weatherproof lockable emergency stop on top of each cooling tower. The emergency stop shall be a lockable on load isolator which breaks the lines to the motor to be installed next to the cooling tower fans. The isolator must be in reach when working on any part of the fan.

22.10.5 The Contractor is to allow for all necessary wiring to the motorized by pass valve.

22.11 Centrifugal pumps

22.11.1 The Contractor is to allow for all necessary power supplies and separate switchgear to each pump from the main electrical panel.

22.11.2 Each pump is to have a weatherproof lockable emergency stop installed next to each pump. The emergency stop shall have a lockable on load isolator which breaks the lines to the motor to be installed next to each pump. The isolator must be in reach when working on any part of the pump.

22.11.3 The Contractor is to allow for the wiring of a separate flow switch on each pump.

22.12 Supply Air Fans

22.12.1 The Contractor is to allow for all necessary power supplies and separate switchgear to each fan from the main electrical control panel.

22.12.2 Each supply air fan is to be driven through a separate variable speed drive.

22.12.3 Each fan is to have a weatherproof lockable emergency stop installed adjacent each fan. The emergency stop shall have a lockable on load isolator which breaks the lines to the motor to be installed next to each fan.

22.13 Return Air Fans

22.13.1 The Contractor is to allow for all necessary power supplies and separate switchgear to each fan from the main electrical control panel.

22.13.2 Each fan is to have a weatherproof lockable emergency stop installed adjacent each fan. The emergency stop shall have a lockable on load isolator which breaks the lines to the motor to be installed next to each fan.

22.14 Water Treatment

22.14.1 The Contractor is to provide a power supply from the new electrical control panel to feed the water treatment which is to be installed adjacent the cooling tower.

22.15 Toilet Extract Fans

22.15.1 The Contractor is to provide a power supply and all necessary new switchgear for each toilet extract fan from the main electrical panel.

22.16 General

22.16.1 The main electrical feed to the main electrical panel and sub-panel is existing.

22.16.2 All switches, except the voltmeter selector switch on all panels are to be key operated.

22.16.3 All three phase motors larger than 7.5 kW shall be wired star delta.

22.16.4 The Electrical installation shall comprise but not be limited to the following items:

- Supply, manufacture and installation of new electrical control panel.
- Install all switchgear and all interconnecting wiring as necessary.
- Install the mains electrical power feed to the chiller electrical control panel
- Power supply to each item of equipment from the main airconditioning electrical control panel.
- Supply and install all necessary controls and sensors.
- Supply and install all necessary wiring to the water flow switches.
- Mains supply to each chilled water generator.
- Mains supply to the chilled water pumps.
- Mains supply to the cooling towers.
- Mains supply to the condenser water pumps.
- All interlocks between the air handling units and the airconditioning electrical control panels.
- All interconnecting wiring to the cooling tower bypass valve.
- Supply and installation of all mains supply and interconnecting wiring to the water treatment system.
- Electrical Compliance Certificates.
- New circuit breakers and isolator for the supply to the chiller.
- New isolator, motor control breakers and contactors for each pump.
- New volt meters for each panel cubicle.
- New selector switches and control transformer for each ammeter.
- New motor control breaker and contactor for each cooling tower fan.
- One only isolator for all the cooling towers.
- Selector switches to control lead / lag secondary chilled water pumps (These pumps are to change over daily automatically).

- Selector switch to control lead / lag condenser water pump (these pumps are to change over daily automatically).
- All necessary wiring to BMS.
- New personal computer, 17" LCD screen, hardware and software for the BMS.
- New isolator, motor control breaker and contactors for each fan.
- Power supply to each fan.
- Electrical power supply to each fire damper.
- Electrical interlock from each fire damper to the main electrical control panel and BMS.
- Electrical power supply to each ceiling diffuser.

22.17 Electrical Panels

22.17.1 All modifications and new works to the existing airconditioning electrical control panels shall conform to the following:

The current revision of SANS 10142-1
The current revision of SANS 1765 (for boards <10 kA)
The current revision of SANS 1473 (for board's ≥10 kA)
Machinery and Occupational Safety Regulations
Local Authority Regulations

22.17.2 The pumps are to be started with Star Delta starters; all other starters below 7.5 kW shall be DOL.

22.17.3 After all door cut outs have been made, the board is to be coated with an epoxy wash primer and then electrostatically powder coated.

22.17.4 The board colour is to be grey. Any door that has to be cut after painting must be either repainted or professionally touched up.

22.17.5 All internally mounted electrical panels shall be manufactured from galvanised or zintex sheet metal having a minimum thickness of 2 mm. After all door cut outs have been made, the board is to be coated with an epoxy wash primer and then electrostatically powder coated

22.17.6 No isolator, switch or control is to be more than 2000 mm above floor level, except on the cooling tower fans.

22.17.7 All modifications to the existing electrical control panels are to be designed on the same system fault level. This should be confirmed with the Electrical Engineer before manufacture. All equipment in the panels shall be rated accordingly.

The Contractor is to ensure correct fault level before manufacture.

22.17.8 All electrical panels shall be adequately ventilated and if required, have weather proof and vermin proof openings.

22.17.9 All internally mounted switchboards and control panels shall be the product of a specialised manufacturer to a minimum of Class IP54 of I.E.C. 144.

22.17.10 All electrical control panels are to be fitted with a mains isolator to turn the incoming mains supply on and off. The operating handle of the mains isolator shall protrude through the panel and shall be interlocked, to ensure that the panel cannot be opened when the isolator is on.

22.17.11 Ammeters and voltmeters are required on the main electrical control only.

22.17.12 Each panel is to be designed to have a minimum of 30% spare space for later additions.

22.17.13 All switchgear is to be mounted on a backing plate. This plate is to be drilled and tapped to accept the fasteners. Plastic slotted trunking, terminal rail, and DIN rail may be pop-riveted. No self-tapping screws may be used.

22.17.14 The backing plate is to be white.

22.17.15 Fasteners on copper or brass conductors are to be machine screws. Fasteners up to 5 mm are to be brass. Fasteners 6 mm and over are to be cadmium plated steel. Galvanised fasteners are not to be used. All fasteners are to have washers and spring washers.

22.17.16 Structural fasteners are to be cadmium plated steel or galvanised steel. Galvanised fasteners are not to be used on copper or brass components. All fasteners are to have washers and spring washers.

22.17.17 All boards are to have gland plates with gaskets.

22.17.18 Switchboard doors are to be earthed with 4 mm^2 copper braid or flexible wires.

22.17.19 Doors are to be hinged, and secured with standard 6.35 mm square catches. One catch on each switchboard or cubicle door which is able to accept a padlock to prevent it being opened.

22.17.20 Large unhinged access panels are to be doweled at the bottom, and secured with standard 6.35 mm catches. Large access panels are not to be secured by dome nuts or other removable fasteners.

22.17.21 Small access panels less than 200 x 200 mm, busbar extension panels, and gland plates may be secured with chrome-plated setscrews or with studs and chrome plated dome nuts.

22.18 Busbars

22.18.1 All live busbars are to be covered with tufnel or perspex and labeled:

“DANGER LIVE BUSBARS BEHIND THIS COVER”.

22.18.2 Busbars must be supported to withstand the physical stresses imposed upon them during short circuit conditions.

22.18.3 Live, earth and neutral bars are to be tinned copper, with nuts, bolts, washers and spring washers to connect conductors. Drilled and tapped bars are not acceptable.

22.18.4 Other types of earth and neutral bars may be offered, but systems in which a screw bears down directly on the conductor or lug are not acceptable.

22.18.5 Neutral and earth bars must be sized for the loads carried, but must be at least half the size of the live busbars.

22.18.6 Small switchboards with incoming cables 10 mm^2 or less, and which require a control neutral only, may have a black standoff insulator in lieu of a neutral bar. No more than two conductors may be made off to this insulator.

22.18.7 Each switchboard is to have an earth bar, at least half the size of the live busbars, with one connection for each incoming or outgoing cable.

22.18.8 The earth bar on a floor-mounted switchboard is to run the full length of the switchboard.

22.19 Switchboard Wiring

22.19.1 The minimum size for power wiring is 2.5 mm^2 and for control wiring is 1.0 mm^2.

22.19.2 The maximum conductor temperature inside a switchboard is not to be more than 10K above ambient temperature.

22.19.3 Welding cable may not be used for power wiring inside switchboards.

22.19.4 Board wiring is to be done in slotted PVC trunking. This trunking must have 30% spare space.

22.19.5 In switchboards with a fault level of 10 kA or greater, wires from the busbars to components may not be smaller than 16 mm².

22.19.6 Power and control wiring within the switchboard is to be sized strictly in accordance with SANS 10142-1 method 1, taking into account overload and short circuit protection, grouping, and temperature.

22.19.7 Door wires are to be properly secured (sticky patches and other adhesives are not acceptable) and protected by spiral binding.

22.19.8 Outgoing terminals and incoming isolators are to be arranged so that top-entry boards have the terminals and/or isolator at the top and vice-versa.

22.19.9 Sufficient space must be allowed between the enclosure and the terminals so that the site electrician has plenty of space in which to make off his cables.

22.19.10 All site-made holes for glands must be done with a chassis punch. Hole saws are not to be used.

22.19.11 Current transformers are to have individual pairs of conductors wired back to the instrument. Instrument common terminals are NOT to be looped at the instrument.

22.19.12 All transformers are to have one side, the secondary winding earthed, unless specifically noted otherwise. No more than two lugs or two conductors without lugs are permitted in any terminal.

22.19.13 All wires are to be numbered as shown on the wiring diagrams. Where wires are connected to numbered terminals, the wire and the terminal are to have the same number. Neutral wires are not numbered unless numbers are shown on the wiring diagram.

22.19.14 Wire numbers are to be Haley Partex type PA.

22.19.15 Wire colours:

Power Live			**Phase colours**
Neutral			Black
Control	220 vac	Live	Red
		Neutral	Black
	24 vac Live		Brown
	Neutral		Grey
	DC	Positive	Orange
		Negative	White
		Other	Pink

22.19.16 All wires, except as noted below are to have lugs crimped to the ends. Lugs on wires 6 mm^2 and under are to be insulated. Insulated bootlace ferrules are acceptable when the terminal is designed to accept them. The correct type of crimper is to be used. Ratchet crimpers only are to be used on insulated terminals. No exposed conductors are to be visible on wires that have insulated lugs.

22.19.17 A copy of the wire colour chart must be printed out laminated and permanently mounted on the inside of all switchboard panels.

22.19.18 Single core conductors are not to have crimped lugs, but are to have insulated bootlace ferrules. Wires 10 mm^2 and over which are secured into saddle or screw terminals, are to be twisted and bound.

22.20 Switchgear

22.20.1 All switchgear is to conform to the relevant South African standard. A list of these standards is given in SANS 10142-1.

22.20.2 Contactors and circuit breakers are to be selected for protection co-ordination to IEC 947-4 Class 2.

22.20.3 All handles for incoming and cubicle isolators, fuse switches and circuit breakers are to be of the rotary handle type, capable of being padlocked in the off position.

22.20.4 All pilot lamps are to be 22 mm in diameter, multiple LED.

22.20.5 All exposed incoming or cubicle isolator, fuse switch or circuit breaker terminals are to be shrouded.

22.20.6 All terminals are to be rail mounted. All terminals are to have numbers on both sides.

22.20.7 Time switches are to have at least 72 hours reserve, and are to be mounted inside the switchboard.

22.20.8 All three-phase switchboards are to have protection against phase loss or phase reversal.

22.20.9 All three phase motors are to be protected against single phasing.

22.20.10 Pneumatic timers are not to be used.

22.20.11 All ammeters, voltmeters, hour meters, kilowatt-hour meters and the like are to be flush mounted on the door of the switchboard, at not more than 2000 mm above floor level.

22.21 Motors, Starters and Motor Protection

Motors

22.21.1 All electric motors shall comply fully with the relevant Standard Specifications SABS 948: Standard Specification for three phase induction motors. SABS. IEC 34: Rotating Electrical Machinery

22.21.2 Standard Squirrel Cage Motors shall be three phase (or single phase up to 3 kW) continuously rated, screen protected, drip proof, suitable for direct on line or Star-Delta starting.

22.21.3 Fractional KW motors shall be continuously rated, totally enclosed single phase capacitor start induction run type, shaded pole or three phase squirrel cage where required.

22.21.4 Motors with a speed in excess of 1500 r/min except in the case of centrifugal compressors and close-coupled pumps will not be accepted unless it is agreed by the Engineer.

22.21.5 When determining motor rating, the following shall be taken into account:
All motors shall be rated for continuous full load duty.

22.21.6 The Continuous Maximum Rating (CMR) of the motor shall be 20% in excess of the full load running duty in order to withstand the tolerance of 105% -120% in the tripping characteristics of the overload protection devices allowed in BS 4941 Part 1.

22.21.7 All motors shall be capable of a minimum of three consecutive starts per hour with the load connected by the method of starting installed without exceeding the temperature limits of the insulation. In addition, the motor shall be capable of the number of starts per hour for the particular load as may be specified or may be experienced under normal operating conditions.

22.21.8 Unduly over-rated motors resulting in low power factor and efficiency are not acceptable.

22.22 Motor Starters

22.22.6 Starters shall be provided for all electrical driven mechanical equipment and shall be as specified or otherwise required by local supply authorities or system requirements.

22.22.2 All Contractors and starters shall comply with SANS 60947-4-1:2004. BS 587 BS4941 and BS 5856 as applicable. Where floats are used in the ON/OFF control circuit, inherent time delays or other protection shall be built into the control circuit to prevent hunting or chatter of the starter contactor at, or near the switching point

22.22.3 All electrically driven mechanical equipment shall be provided with a means of isolating the electrical supply in the panel by one of the following methods:

- An isolator on the equipment.
- A motor starter with positive manual stop control and isolating characteristics, mounted within 2m of the panel.
- A separately mounted lockable on load isolator which breaks the lines to the motor, to ensure the motor cannot be started from the panel by pushing in the Contractor. In the case of star-delta motor, the isolator must be 6 pole type and lockable. Fans on cooling towers mounted max of 1m from the fan for other machinery mounted max 2m from machine. All devices shall have “locked rotor” breaking capacity in the case of motor circuits.
- If Variable Speed drives are used, an auxiliary must be provided as an early brake to remove start signal from the drive.

22.22.4 The method of starting shall in all cases comply with the requirements of the local supply authority.

22.22.5 The following schedule of starting requirements will apply unless the supply authority prescribes more stringent requirements or unless written permission to contrary has been obtained from the Engineer:

Note: Reduced voltage starting includes

- Star Delta starters.
- Auto transformer starters
- Part wind starters.
- Liquid starters.
- Variable speed drives.
- Soft start Drives.

22.22.6 The method of starting motors shall in all cases be the two-element type comprising a motor control circuit breaker (ABB MS 375 up to 25 amps and MS 450 – MS 495 up to 100 amps or similar) and a suitable contactor (ABB A9 to A110-30 or similar),

22.22.7 Starters comprising circuit breaker, contactor and thermal overload (No three element) shall not be used without the written permission of the Engineer.

22.23 Labels

22.23.1 All switchboards are to be labelled in compliance with SANS 10142-1

22.23.2 All equipment, including fuses and circuit breakers, is to be labeled.

22.23.3 All labels inside and outside of the board, are to be engraved plastic, white letters on black background except for danger labels, which are to be white letters on red background.

22.23.4 Fuse labels are to include fuse ratings.

22.23.5 Labels are to be fastened to the device plate with machine screws and must be clearly visible after the switchboard has been wired.

22.23.6 Labels may not be fixed to trunking lids, busbars, or switchgear.

22.24 Site Wiring

General

22.24.1 Cable trays shall be installed as per the Standard Specification enclosed within this document.

22.24.2 All cables are to be on a galvanised cable tray except where otherwise noted.

22.24.3 Cable trays and support brackets are to be hot-dip galvanised. Cut edges are to be treated with cold galvanising paint.

22.24.4 Cable trays are not to be cut to form bends. Elbows and tees are to be factory-made items. Ascenders and descenders are to be beaten round a former.

22.24.5 Cable trays may be horizontal or vertical, unless the drawing is marked to the contrary.

22.24.6 All take-offs from cable tray runs must be done using tees or bends.

22.24.7 Cables must not be bunched on the cable tray.

22.24.8 Only one layer of cables is permitted on the cable trays. Cables are to be spaced as required to avoid de-rating

22.24.9 Cables may not cross over on cable trays

22.24.10 Where changes of size occur on a cable tray run, this must be done using bends and tees. Abrupt changes of size are not allowed.

22.24.11 Cable trays must be spaced off the surface that they are fastened to. Unistrut must be used for a cable tray over 100 mm.

22.24.12 Cable tray brackets and supports must be of sufficient strength to prevent sagging, twisting etc. particularly in the case of large cables.

22.24.13 Cable trays and conduits are to be properly earthed to the switchboard earth bar.

22.24.14 Local weatherproof isolators are to be provided and installed on all items of equipment.

22.24.15 All electrical control wiring, except the daisy chains of the diffusers, shall be run in conduits.

22.25 Earthing

Refer to the Standard Specification enclosed within this document.

22.26 Making off and terminating wires and cables

Refer to the Standard Specification enclosed within this document.

22.27 Conduits

Refer to the Standard Specification enclosed within this document.

22.28 Trunking

22.28.1 Refer to the Standard Specification enclosed within this document.

22.28.2 Trunking systems must be approved before installation.

22.28.3 Trunking and support brackets are to be galvanised. Cut edges are to be treated with cold galvanising paint. Trunking lids are to be PVC.

22.29 Documentation and Inspection

22.29.1 The following documentation must be submitted and approval obtained before commencing manufacture of the switchboard:

- Wiring diagrams
- Physical layout drawings
- Schedule of components and switchgear

22.29.2 Original certificates and documentation required to prove compliance with above standards is to be submitted before the switchboard is inspected.

22.29.3 All switchboards are to be tested, inspected and approved before being dispatched to site

22.29.4 Prior to the inspection, the following documentation must be submitted:

- The as-built wiring diagrams.
- A schedule of all components and switchgear used.
- Original certificates and documentation listed above.

23. CONTROLS

23.1.1 General

23.1.1.1 The Contractor is to allow for field controls to accomplish the control sequence as described below for the chilled water generator, cooling towers, air handling units, and fresh airhandling units.

23.1.1.2 The controls shall be either Johnson, Satchwell or Honeywell. All controls shall be capable of communicating with the BMS system. The whole control system shall be of the same manufacture, mixing of products is not acceptable.

23.1.1.3 All controllers shall have an integrated alpha numeric display with password protection.

23.1.1.4 All controls shall be based on a standard open communication protocol i.e. LON Works BACNet or N2.

23.1.2 Chilled Water Generators

23.1.2.1 The chilled water temperature is to be controlled by the chilled water generator's own electronic controller. The controller is to be upgraded so that it can be connected to the BMS.

23.1.2.2 The chilled water and the condenser water standby pump's are to be automatically changed over daily by a time switch. If either pump develops a fault or pump fails, it will change over automatically.

23.1.2.3 The chiller is to have a water flow switch installed in the chilled water supply pipe.

23.1.2.4 The chiller is to have a water flow switch installed in the condenser water-leaving pipe.

23.2 Condenser Water Plant

23.2.1 The condenser water temperature from the cooling towers shall be controlled by a temperature sensor in the water entering the condenser and modulating a Butterfly type bypass valve.

23.2.2 In addition, the condenser water shall also be controlled by a variable speed drive that is to control the speed of the cooling tower fans. Each fan requires overload protection.

23.2.3 The condenser water system will require the following controls:

- Variable speed drive
- Electronic Programmable Temperature Controller,
- Condenser Water pipe sensor,
- Bypass Valve and Motor (128 l/s against a max. pressure drop of *20* kPa.)

23.3 Main Air handling Unit

23.3.1 The contractor is to allow for all necessary controls wiring and switchgear for each system to operate as specified.

23.3.2 The plant will be started by a time clock positioned in the electrical control panel.

23.3.3 The panel will have a selector switch to turn on the AHU. The unit will be operated normally when left in the "auto" position, and control is automatic. In the "manual" position the unit will run continuously, and in the "off" position it will not run at all.

23.3.4 The off coil temperature is to be controlled by a new 3 way diverting valve on each coil. The 3 way valves are to be controlled by a programmable electronic temperature controller.

23.3.4 The unit serves five separate floors. Each floor will have two static pressure dampers. The unit will supply a variable volume of air at a constant temperature monitored by a supply air sensor. Each floor will have two averaging temperature sensors.

23.3.5 As the space temperature varies the TROX variable volume diffusers will open and close varying the amount of air to the space. The static pressure dampers are to be controlled by the programmable temperature controller.

23.3.6. A variable speed drive will vary its amount of air dependant on the start pressure with the main supply duct. The variable speed drives and static pressure dampers are to be set with a minimum setting of 33%.

23.3.6 A temperature sensor will be installed within the common return air space to reset the supply temperature should the return air temperature increase or decrease from the required setting.

23.3.7 The space temperature is to be adjustable by + / - 3ºC in one degree increments by a remote set point positioned on the front of each electrical control panel.

23.3.8 All temperature and pressure set points are to be readable, set and adjusted directly into the programmable electronic temperature controller.

23.3.9 A remote after hours switch is to be installed on each floor to enable the tenant to switch the unit on after hours. The after hours switch is to bring on the unit for a period of two hours and then will switch back to its automatic.

23.3.10 The toilet extract fans and the fresh air fans are to be bought on by the 7 day 24 hr electronic time clock within the electrical control panel.

23.3.11 The return air fans are to be constant volume. Each return air fan is to have a bypass damper adjacent the AHU. When the supply fan variable speed drive slows down the supply fan it will proportionally open the bypass damper.

23.3.12 All Variable air terminals, electrically operated dampers, pressure sensors and associated thermostats shall be manufactured by TROX.

23.3.13 The air handling unit will require the following controls:

- Programmable Electronic Temperature Controller
- 3 way diverting valve (2 off)
- Supply Air Temperature Sensor
- Return Air / Reset Temperature Sensor
- Two averaging temperature sensors for each floor
- Variable Speed Drive and static pressure sensor
- Remote set point
- Air Flow Switch
- After Hours Switch
- Smoke Detector (two per floor)
- 7 day 24 hour Electronic Time Clock
- Return air bypass dampers and actuators

23.4 Building Management System.

23.4.1 A Building Management System (BMS) shall be installed and commissioned which would be capable of monitoring and controlling all the connected parameters of the units or plant controllers.

23.4.2 The system shall include for the software to accommodate the mapping of all the system points and a graphic for each AHU and the Main Chiller Plant, Cooling Towers, Centrifugal Pumps and variable speed drive's.

23.4.3 The Contractor to supply a PC Workstation, all necessary hardware and all necessary software for the BMS System to be viewed in the Main Airconditioning Plantroom. An ADSL Line will be provided by the client to a local point. Provision must also be made for a local Network Connection.

23.4.4 Contractor to connect all the air-conditioning plant and all associated equipment to the BMS, including all controls starting gear and panels for the chiller, pumps, AHU, ducting, dampers, cooling tower's, fans and etc.

23.4.5 The BMS is to have web based remote access.

23.4.6 The BMS must be on stand alone UPS power. The Contractor is to allow for the supply and installation of the UPS in each panel to supply the whole control circuit.

23.4.7 The BMS operator shall be able to access the connected parameters via multiple level password access and be able to generate hard copy printouts on an inkjet printer and view the following: -

- Scheduled Start/Stop Times,
- Trend and Log Temperatures,
- Alarms,
- Duty – Standby selection of equipment,
- Plant or Unit Graphics,

23.4.7 All available points of each variable speed drive are to be available on the B.M.S.

23.4.8 The BMS System shall have the following input and outputs:

	Digital Inputs	**Description**	**Sensor**
DI 1	Chiller Run Status	Running/Stopped	Network
DI 2	Chiller Fault Status	Normal/Fault	Network
DI 3	Chilled Water Pump 1 Run Status	Running/Stopped	N/O Contact
DI 4	Chilled Water Pump 1 Fault Status	Normal/Fault	N/C Contact
DI 5	Chilled Water Pump 2 Run Status	Running/Stopped	N/O Contact
DI 6	Chilled Water Pump 2 Fault Status	Normal/Fault	N/C Contact
DI 7	Condenser Water Pump 1 Run Status	Running/Stopped	N/O Contact
DI 8	Condenser Water Pump 1 Fault Status	Normal/Fault	N/C Contact
DI 9	Condenser Water Pump 2 Run Status	Running/Stopped	N/C Contact
DI 10	Condenser Water Pump 2 Fault Status	Normal/Fault	N/C Contact
DI 11	Cooling Tower VSD Run Status	Running/Stopped	N/O Contact
DI 12	Cooling Tower VSD Fault Status	Normal/Fault	N/C Contact
DI 13	Cooling Tower 1 Fault	Normal/Fault	N/O Contact
DI 14	Cooling Tower 2 Fault	Normal/Fault	N/C Contact
DI 15	Supply Fan 1 Run Status	Running/Stopped	N/O Contact
DI 16	Supply Fan 1 Fault Status	Normal/Fault	N/C Contact
DI 17	Supply Fan 2 Run Status	Running/Stopped	N/O Contact
DI 18	Supply Fan 2 Fault Status	Normal/Fault	N/C Contact
DI 19	Return Fan 1 Run Status	Running/Stopped	N/O Contact
DI 20	Return Fan 1 Fault Status	Normal/Fault	N/O Contact
DI 21	Return Fan 2 Run Status	Running/Stopped	N/O Contact
DI 22	Return Fan 2 Fault Status	Normal/Fault	N/O Contact
DI 23	Chilled Water Flow 1	Flow/No Flow	N/O Contact
DI 24	Chilled Water Flow 2	Flow/No Flow	N/O Contact

DI 25	Condenser Water Flow 1	Flow/No Flow	N/O Contact
DI 26	Condenser Water Flow 2	Flow/No Flow	N/O Contact
DI 27	Air Flow Switch	Flow/No Flow	N/O Contact
DI 28	After Hours Switch	On/Off	Pushbutton
DI 29	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 30	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 31	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 32	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 33	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 34	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 35	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 36	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 37	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 38	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 39	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 40	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 41	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 42	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 43	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 44	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 45	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 46	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 47	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 48	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 49	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 50	Fire Damper Closed Signal	Open/Closed	N/O Contact
DI 51	Condenser Water Pump Call to Run	Run/Stop	Network
	Digital Outputs		
DO 1	Chiller Start Signal	Started/Stopped	Relay
DO 2	Chilled Water Pump 1 Start Signal	Started/Stopped	Relay
DO 3	Chilled Water Pump 2 Start Signal	Started/Stopped	Relay
DO 4	Condenser Water Pump 1 Start Signal	Started/Stopped	Relay
DO 5	Condenser Water Pump 2 Start Signal	Started/Stopped	Relay
DO 6	Cooling Tower Start Signal	Started/Stopped	Relay
DO 7	Supply Fan 1 Start Signal	Started/Stopped	Relay
DO 8	Supply Fan 2 Start Signal	Started/Stopped	Relay
DO 9	Return Fan 1 Start Signal	Started/Stopped	Relay
DO 10	Return Fan 2 Start Signal	Started/Stopped	Relay
DO 11	Fire Damper Test Signal Level 1	Auto/Test	Internal Relay
DO 12	Fire Damper Test Signal Level 1	Auto/Test	Internal Relay
DO 13	Fire Damper Test Signal Level 2	Auto/Test	Internal Relay
DO 14	Fire Damper Test Signal Level 2	Auto/Test	Internal Relay
DO 15	Fire Damper Test Signal Level 3	Auto/Test	Internal Relay
DO 16	Fire Damper Test Signal Level 3	Auto/Test	Internal Relay
DO 17	Fire Damper Test Signal Level 4	Auto/Test	Internal Relay
DO 18	Fire Damper Test Signal Level 4	Auto/Test	Internal Relay
DO 19	Fire Damper Test Signal Level 5	Auto/Test	Internal Relay
DO 20	Fire Damper Test Signal Level 5	Auto/Test	Internal Relay
	Analog Inputs		
AI 1	Air On Coil temperature	ºC	LF20
AI 2	Air Off Coil Temperature	ºC	LF20

AI 3	Return Air Temperature Sensor	ºC	LF20
AI 4	Supply Air Temperature Sensor	ºC	LF20
AI 5	Main Duct 1 Static Pressure	Pa	DPT250
AI 6	Main Duct 1 Static Pressure	Pa	DPT250
AI 7	Static Pressure 1 Level 1	Pa	DPT250
AI 8	Static Pressure 2 Level 1	Pa	DPT250
AI 9	Static Pressure 3 Level 1	Pa	DPT250
AI 10	Static Pressure 4 Level 1	Pa	DPT250
AI 11	Static Pressure 1 Level 2	Pa	DPT250
AI 12	Static Pressure 2 Level 2	Pa	DPT250
AI 13	Static Pressure 3 Level 2	Pa	DPT250
AI 14	Static Pressure 4 Level 2	Pa	DPT250
AI 15	Static Pressure 1 Level 3	Pa	DPT250
AI 16	Static Pressure 2 Level 3	Pa	DPT250
AI 17	Static Pressure 3 Level 3	Pa	DPT250
AI 18	Static Pressure 4 Level 3	Pa	DPT250
AI 19	Static Pressure 1 Level 4	Pa	DPT250
AI 20	Static Pressure 2 Level 4	Pa	DPT250
AI 21	Static Pressure 3 Level 4	Pa	DPT250
AI 22	Static Pressure 4 Level 4	Pa	DPT250
AI 23	Static Pressure 1 Level 5	Pa	DPT250
AI 24	Static Pressure 2 Level 5	Pa	DPT250
AI 25	Static Pressure 3 Level 5	Pa	DPT250
AI 26	Static Pressure 4 Level 5	Pa	DPT250
AI 27	Space Temperature 1 Level 1	ºC	RF20
AI 28	Space Temperature 2 Level 1	ºC	RF20
AI 29	Space Temperature 3 Level 1	ºC	RF20
AI 30	Space Temperature 4 Level 1	ºC	RF20
AI 31	Space Temperature 1 Level 2	ºC	RF20
AI 32	Space Temperature 2 Level 2	ºC	RF20
AI 33	Space Temperature 3 Level 2	ºC	RF20
AI 34	Space Temperature 4 Level 2	ºC	RF20
AI 35	Space Temperature 1 Level 3	ºC	RF20
AI 36	Space Temperature 2 Level 3	ºC	RF20
AI 37	Space Temperature 3 Level 3	ºC	RF20
AI 38	Space Temperature 4 Level 3	ºC	RF20
AI 39	Space Temperature 1 Level 4	ºC	RF20
AI 40	Space Temperature 2 Level 4	ºC	RF20
AI 41	Space Temperature 3 Level 4	ºC	RF20
AI 42	Space Temperature 4 Level 4	ºC	RF20
AI 43	Space Temperature 1 Level 5	ºC	RF20
AI 44	Space Temperature 2 Level 5	ºC	RF20
AI 45	Space Temperature 3 Level 5	ºC	RF20
AI 46	Space Temperature 4 Level 5	ºC	RF20
AI 47	Chiller Active Capacity	%	Network
AI 48	Suction Pressure	kPa	Network
AI 49	Discharge Pressure	kPa	Network
AI 50	Chiller Current 3 ph	Amps	Network
AI 51	Chilled Water Entering Temperature	ºC	Network
AI 52	Chilled Water Leaving Temperature	ºC	Network
AI 53	Condenser Water Entering Temperature	ºC	Network
AI 54	Condenser Water Leaving Temperature	ºC	Network
	Analog Outputs		
AO 1	Chilled Water Valve	%	0-10 Vdc Signal

AO 2	Chilled Water Valve 2	%	0-10 Vdc Signal
AO 3	Supply Fan Speed	%	0-10 Vdc Signal
AO 4	Supply Fan Speed	%	0-10 Vdc Signal
AO 5	Cooling Tower Fan Speed	%	0-10 Vdc Signal
AO 6	Bypass Valve	%	0-10 Vdc Signal
AO 7	Static Pressure Damper 1 Level 1	%	AF24
AO 8	Static Pressure Damper 2 Level 1	%	AF24
AO 9	Static Pressure Damper 3 Level 1	%	AF24
AO 10	Static Pressure Damper 4 Level 1	%	AF24
AO 11	Static Pressure Damper 1 Level 2	%	AF24
AO 12	Static Pressure Damper 2 Level 2	%	AF24
AO 13	Static Pressure Damper 3 Level 2	%	AF24
AO 14	Static Pressure Damper 4 Level 2	%	AF24
AO 15	Static Pressure Damper 1 Level 3	%	AF24
AO 16	Static Pressure Damper 2 Level 3	%	AF24
AO 17	Static Pressure Damper 3 Level 3	%	AF24
AO 18	Static Pressure Damper 4 Level 3	%	AF24
AO 19	Static Pressure Damper 1 Level 4	%	AF24
AO 20	Static Pressure Damper 2 Level 4	%	AF24
AO 21	Static Pressure Damper 3 Level 4	%	AF24
AO 22	Static Pressure Damper 4 Level 4	%	AF24
AO 23	Static Pressure Damper 1 Level 5	%	AF24
AO 24	Static Pressure Damper 2 Level 5	%	AF24
AO 25	Static Pressure Damper 3 Level 5	%	AF24
AO 26	Static Pressure Damper 4 Level 5	%	AF24
	Set points		
SP 1	Chilled Water Leaving Set point	ºC	Network
SP 2	Main Duct 1 Static Set point	Pa	Internal
SP 3	Main Duct 1 Static Set point	Pa	Internal
SP 4	AHU Return Air Set point	ºC	Internal
SP 5	AHU Return Air Set point	ºC	Internal
SP 6	Condenser Water Set Point	ºC	Internal
SP 7	Static Set Point 1 Level 1	Pa	Internal
SP 8	Static Set Point 2 Level 1	Pa	Internal
SP 9	Static Set Point 1 Level 2	Pa	Internal
SP 10	Static Set Point 2 Level 2	Pa	Internal
SP 11	Static Set Point 1 Level 3	Pa	Internal
SP 12	Static Set Point 2 Level 3	Pa	Internal
SP 13	Static Set Point 1 Level 4	Pa	Internal
SP 14	Static Set Point 2 Level 4	Pa	Internal
SP 15	Static Set Point 1 Level 5	Pa	Internal
SP 16	Static Set Point 2 Level 5	Pa	Internal
	Mimic Panel		
		ºC	
	On Coil Temperature	ºC	
	Off Coil Temperature	ºC	
	Chilled Water Supply Temperature	ºC	
	Chilled Water Return Temperature	ºC	
	Condenser Water Supply Temperature	ºC	
	Condenser Water Return Temperature	ºC	

24. PLANT OPERATION

24.1.1 The chilled water system will be started by an input from the AHU's which is started. This interlock shall be a hard wired interlock. The chilled water pump will start first and after a short delay, request the chiller to start. Once the chiller is started and its condenser water pump, the controls will respond to meet the chilled water temperature.

24.1.2 The supply air fans will respond to the load demands by varying the speed of the fan in accordance with the differential pressure.

24.1.3 The standby and run condenser pumps will be alternated on a daily basis.

24.1.4 The standby and run chilled water pumps will be alternated on a daily basis.

24.1.5 Whenever a chiller is operating, the condenser water pump and cooling towers will be started.

24.1.6 The condenser water temperature will be controlled by varying the speeds of the cooling tower fans simultaneously and then by operating the bypass valve. The tower fans are to be PID controlled.

24.1.7 The circulating pump's, fan's and airhandling unit is to have a manual-off-auto switch located on the switchboard door. These are normally left in the "auto" position, and control is automatic. In the "manual" position the item of equipment will run continuously and the "off" position with not run at all.

24.1.8 The two cooling towers are to be operated from a common switch. Each pump is to have a flow switch that will disable the pump in the event of "No Flow".

24.1.9 The chilled water generator requires a separate flow switch on the evaporator and condenser.

24.1.10 The contractor is to allow for separate weatherproof emergency lockable lock out stops for each cooling tower fan.

25. VARIABLE SPEED DRIVES

25.1.1 Variable speed drives are to control the speed of the motor by varying the frequency and are to be ABB, Danfoss, Varispeed or other approved.

25.1.2 Variable speed drives and motors are to be rated at 400 volt 3 phase.

25.1.3 Each variable speed drive is to be mounted in a new cubicle within the main electrical control panel, labeled in compliance with SANS10142-1, and shall be ventilated.

25.1.4 The temperature inside the switchboard or enclosure is not to exceed 40°C, and the variable speed drives are to be rated for this temperature.

25.1.5 The enclosures are to be vermin proof, and the air intakes are to have filters.

25.1.6 If variable speed drives are mounted on walls inside plantroom, then they are to be dustproof and hose proof to IP54.

25.1.7 Variable speed drives are to have RFI filters and chokes.

25.1.8 A control panel is to be provided with each drive, which is to display motor current, motor speed in rpm, motor power in kW, DC bus voltage, output voltage, cumulative running time in hours, analogue input status, analogue output status, digital input status, output relay status, drive temperature and a fault log showing at least three faults with date stamps.

25.1.9 Drives and motors are to be selected so that there is no objectionable noise from the motor during operation.

25.1.10 Drives are to be commissioned by the manufacturer or manufacturer's agent.

25.1.11 All wiring, in particular earthing arrangements, is to be approved by the manufacturer or manufacturer's agent in writing.

25.1.12 All available points of each variable speed drive is to be available on the B.M.S.

26. DRAWINGS

26.1 Tender Drawings

26.1.1 The Drawings accompanying this specification shall be deemed to indicate the general layout of the systems and are not to be used as shop drawings. All dimensions are to be checked on site before manufacture.

26.2 Drawings to be supplied by Contractor

26.2.1 The successful Contractor shall within two weeks of notification of award of this contract, submit all necessary builders work drawings, showing all panel construction details, necessary fixing details, structural requirements and hanging details etc. to the Engineer for approval. The Contractor shall supply drawings showing the position and dimensions of all concrete bases required, together with details of builders work requirements, to allow the Builder to have this work prepared in time to receive the plant.

26.2.2 The Contractor will then proceed to produce and co-ordinate all necessary working drawings of all the services included in this contract.

26.2.3 Two copies of all drawings shall be submitted by the Contractor to the Engineer for approval before ordering any plant or machinery required for the contract, or before any work commences.

26.2.4 Prior to the preparation of the co-coordinated working drawings, the Contractor shall liaise with his Contractors to ensure that due consideration of other services is taken into account.

26.2.5 The Contractor shall allow for preparing such drawings sufficiently in advance, to give the respective parties adequate time for approval of drawings, and to suit the program.

26.2.6 The Engineer's approval of drawings submitted by the Contractor shall not in any way relieve the Contractor from his responsibility in respect of the accuracy of all such drawings, or from his responsibility to provide equipment suitable in dimension, construction and finish for the location in which it is to be installed.

26.2.7 Any modification or amendments to these drawings requested by the Engineer in order to ensure that they fulfil the contract conditions, shall not involve the employer in extra expenditure.

26.2.8 All alterations to working drawings, whether due to co-ordination or otherwise, shall be carried out by the Contractor, and after final approval has been obtained, the Contractor shall make final issue to all parties concerned, with 3 copies to the Engineer.

26.2.9 Any work caused by inaccuracy of marking out, or other default of the Contractor, shall be paid for by the Contractor, Such unnecessary work may include repairing, replacing, making good, taking down and rebuilding of any part of the building plant and other as may be effected by such work.

26.2.10 All detailed drawings submitted for approval, shall be produced to be compatible with AutoCAD. Drawings are to be drawn to a reasonable scale and the Engineers decision as to what constitutes a reasonable scale shall be final.

26.2.11 Detailed drawings shall be regarded as correct where they differ from the general arrangement drawings. A graphical scale shall be incorporated on all drawings.

26.3 Untimely Submission of Drawings

26.3.1 Any extra expense incurred due to any addition and/or amendment made by the Contractor after the drawings mentioned above have been submitted, or due to the untimely submission of drawings, shall be for the Contractor's account.

26.3.2 It shall be binding upon the Contractor to establish with, or obtain from the Engineer, the scheduled time of commencement and programming of all building work affecting the Contractor in respect of this clause.

26.4 Final Drawings

26.4.1 The Contractor shall furnish the Engineer (for onward transmission to the Employer) with three sets of drawings of the plant as finally completed, incorporating all variations made during the course of construction. Such drawings shall be submitted no later than two weeks after the completion of the contract works.

26.4.2 A full set of electrical wiring diagrams are to be framed and mounted on the plantroom wall. The drawings shall be clear and legible. No annotation shall be smaller than 3mm when printed.

26.4.3 The contractor is to supply a full set of AS built Drawings in AutoCAD Electronic Format.

27. COMMISSIONING

27.1 Following completion of the work, the Contractor shall carry out all necessary commissioning and testing as required by the Engineer.

27.2 The Contractor is to make allowance to carry out a water balance to each airhandling unit and fan coil unit.

27.3 The Contractor is to make allowance to carry out an air balancing to the mezzanine offices where eight in-ceiling ducted fan coil units are to be replaced and to the customs hall where the two fan coil units are to be replaced.

27.4 The Contractor shall submit a commissioning programme to the Engineer at least two weeks prior to commencement of commissioning and at the same time notify the engineer of the code or procedure to which the plant will be commissioned.

27.5 The commissioning shall be carried out in accordance with the applicable SABS or CIBSE Codes as detailed in the Standard Specification.

27.6 The results of all checks and measurements as recorded during the commissioning period shall be included and shall be compiled in such a manner that every check and measurement is clearly defined.

27.7 The installation shall run continuously for a minimum period of ten days after commissioning to the satisfaction of the engineer. A first delivery certificate will only be issued after ten days test run is satisfactory.

27.8 The Engineer reserves the right to inspect any item of plant during manufacture or before delivery to site.

27.9 Calibration certificates shall be given for all items of instrumentation before commissioning.

27.10 The Contractor is to include, for the commissioning of the chilled water generators, to be carried out by the suppliers local agent. A full set of the commissioning results and a letter detailing the agent's satisfaction with the installation, are to be included in the Operating and Maintenance Manual.

27.11 Further to above requirements, the Contractor shall perform at appropriate times, all tests required by Government and Local Authorities, who may from time to time have jurisdiction over the works, and shall obtain all necessary certificates of approval. These certificates and details of the tests carried out shall be lodged with the Engineer upon the completion of the works.

28. OPERATING INSTRUCTIONS

28.1 The Contractor shall prepare and supply Operating and Maintenance Manuals for the successful operation and maintenance of the installation. A draft copy of the manual shall be submitted after commissioning, for approval. The draft copy shall then be corrected and three sets of the manual shall be submitted before first acceptance of the plant will be taken.

28.2 The manuals are to include an electronic copy of the final drawings of the project.

28.3 A full set of electrical wiring diagrams are to be framed and mounted in the plant rooms.

28.4 These manuals will be produced in a hardbound cover and will include all information as generally detailed in the Standard Specification.

28.5 These manuals shall contain the following information:

Section 1: System Description
Section 2: Operating Instructions
Section 3: Design Data
Section 4: Equipment Technical Information and Data
Section 5: Equipment Catalogues
Section 6: Maintenance Instructions
Section 7: Commissioning Data
Section 8: Drawings
Section 9: Acceptance Certificates

28.6 The Contractor is to also supply a full electronic copy of the O&M Manual.

29. MAINTENANCE AND SERVICING

29.1 The Contractor shall be responsible for all maintenance and servicing of the entire installation for the full 12-month maintenance and guarantee period, following the hand over date. During this period, the Contractor shall make good any defects, due to inferior materials and workmanship, and maintain all plant and equipment in perfect operating condition.

29.2 The Contractor shall be responsible for the servicing of all components of the installation in accordance with the manufacturer's instructions, at regular intervals of not more than one month. For this purpose, the Contractor shall prepare a detailed inspection and service report in the form of a checklist, showing all functions to be carried out at each service. Copies of these service reports shall be regularly submitted to the Company's authorized representative after each service. The detailed service report shall be signed by the officer in charge of the installation. Unsigned service reports will not be accepted.

29.3 Breakdowns or complaints about any malfunctioning of the installation will be reported to the Contractor. It is the responsibility of the Contractor to respond promptly on all such call outs, to repair the installation in the shortest possible time and to submit a signed breakdown report to the Company's authorized representative.

29.4 The Contractor shall further maintain a plant logbook on site, in which he shall record, sign and date all work carried out at each service, as well as log all pressures, temperatures, ammeter, voltmeter and run-hour meter readings. This logbook shall include all information required for pressure vessels, regulation C7 1 -C76 6 of the Machinery and Occupational Safety Act of 1983 as amended. Regulation C.75 states that: "Every user of a pressure vessel shall keep on the premises, a record or log book which shall be open to inspection by an inspector and in which shall be entered a written record of all tests, internal and external examinations, cleanings and repairs and signed by the carrying out such tests, examinations, cleanings and repairs".

29.5 The Contractor shall allow for all expendable materials necessary for servicing, such as lubricating oils, grease, cleaning materials, etc.

29.6 Should the Contractor fail to maintain the installation in a satisfactory working condition during the guarantee period, the Client may decide to extend the guarantee period, and the requirements of this specification shall apply to such an extended guarantee period, or may alternatively decide to call in the services of another Contractor for this maintenance and servicing, at the expense of the original Contractor, to the end of effective servicing period.

29.7 The Contractor is to make allowance for the agent to service the chilled water generators throughout the extended service contract.

29.8 The Contractor is to conform to all the requirements of the main tender document when carrying out this extended maintenance contract.

29.9 All works carried out shall conform to the Standard Specifications, fully detailed in the main tender document.

29.10 Should the Contractor fail to maintain the installation in a satisfactory working condition during the contract period, the Client may decide to call in the services of another Contractor for this maintenance and servicing at the expense of the original Contractor, to the end of the effective servicing period

30. STAFF TRAINING

30.1 The Contractor shall be responsible for the training of the Company's site staff after the commissioning has been completed. The site staff must receive enough instructions to ensure that they are fully conversant with the equipment concerned. Site staff shall be instructed on:

- The general operating method of the plant,
- Starting and stopping instructions,
- Stopping the plant or unit in emergency and warning against restarting after an emergency unless a competent person is present,
- Positions and normal settings of control equipment,
- Positions and settings of fire and volume control dampers,
- Normal operating temperatures, pressures, differential pressures etc.
- Safety measures, especially against high voltages,
- Normal liquid levels in sumps, expansion tanks etc.
- Operational checks on sight glasses, water treatment dosing equipment, bleed off, dirty filters, running amperages etc.,
- Name, address and telephone number of the competent person responsible for the maintenance of the plant or unit.
- BMS operation including recalibration of controllers, changing of set points, fault finding, resetting or cancellation of faults, downloading of fault reports and etc.

30.2 The operating and maintenance manual must be available during the training of site staff who must also be made conversant with the contents of the manuals.

30.3 All instruments such as thermometers, pressure gauges, humidity indicators, manometer 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.

31. PAINTING

Painting of the installation shall be in accordance with the Standard Specification.

32. REMOVAL OF EXISTING AIRCONDITIONING EQUIPMENT.

The Contractor is to make allowance to strip out and remove all the redundant, existing airconditioning system from the building.

The Contractor is to make allowance to deliver all redundant equipment containing precious metals to the Transnet Scrap Bank Technical Area at 311 Edwin Swales Drive, Durban.

33. BUILDERS WORK

33.1 The Contractor is to allow for all necessary builders work.

33.2 The Contractor is to allow for the removal of the existing cooling tower and the bricking up and making good of the existing opening. The external brickwork is to match the existing. The internal facebrick is to be plastered and painted to match the existing. The walls shall be painted with one coat of primer and two coats of high quality P.V.A.

33.3 The Contractor is to allow for the repositioning of the single door at the near of the plantroom. The existing opening is to be bricked up and made good to match existing.

33.4 The Contractor is to allow for a new full bore outlet to be installed in the plantroom. The drain will be run through the fourth floor ceiling to the nearest soil pipe. The coring of the hole forms part of this contract.

33.5 The Contractor is to allow for all new concrete bases for the cooling towers and pumps.

33.6 The contractor is to allow for the concrete in the interior bases.

33.7 The Contractor is to allow to extend the mains cold water supply to the new cooling towers. The mains water supply is to be metered and the meter is to be connected to the BMS.

33.8 After completion of all works the plantroom walls are to be painted with two coats of high quality P.V.A.

33.9 The Contractor is then to allow for the whole plantroom floor to be painted with a grey epoxy paint.

33.10 All Face Brick surfaces in the plantroom must be cleaned.

34. PROGRAM

The tenderer is requested to submit an outline program detailing the overall time frame he requires for the installation of this new airconditioning system.

35. ERECTION, DELIVERY AND CRANEAGE.

The tenderer is to make allowance for all erection expenses, scaffold, delivery costs and for any craneage or lifting equipment that is or may be required.

36. HANDOVER

After completion of the commissioning, the Contractor is to submit all test results to the Engineer for checking and approval. The Engineer will check all commissioning figures and prepare a final defect list for completion. Once the defects list is completed to the Engineers satisfaction, the system will be accepted and the maintenance period will commence.

PART C3

SECTION 8

GENERAL SPECIFICATIONS

8. GENERAL SPECIFICATIONS
8.1 General specifications

8.1.1 E.4E (August 2006) – Safety arrangements and procedural compliance with the occupational health and safety act (Act 85 of 1993) and applicable regulations.

8.1.2 E7/1 (July 1998) – Specification for works on, over, under or adjacent to railway lines and near high voltage equipment.