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DEPARTMENT OF PUBLIC WORKS

STANDARD SPECIFICATION

FOR

REFRIGERATION SERVICES

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STANDARD SPECIFICATION

FOR

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SECTION 1

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STANDARD SPECIFICATION

FOR

REFRIGERATION SERVICES

SECTION 1

1.0 GENERAL REQUIREMENTS

1.1.0 NOTICE

1.1.1 This standard specification forms part of, and is to be read in conjunction with the Department's supplementary technical specifications for refrigeration services.

1.1.2 In so far as the conditions herein contained are at variance with anything contained in the supplementary specifications, the contract shall be in terms of the supplementary specification for each particular service.

1.1.3 Where reference is made to "Contractor" or "Sub-Contractor", it shall be read to mean the successful Tenderer appointed to execute the contract specified in the supplementary specification.

1.2.0 STANDARD MEASURES

1.2.1 The dimensions, weights, etc., shown on the drawings and mentioned in the specifications shall be taken as the Republic of South Africa's legal standard weights and measures.

1.3.0 MATERIALS AND WORKMANSHIP

1.3.1 All work is to be executed with materials of the best quality and in the most substantial manner under the inspection and to the entire satisfaction of the Department.

1.3.2 The entire installation shall be in accordance with the following:

a) The National Building Regulations and Building Standards Act No. 103 of 1977 as amended in 1984 and all amendments thereafter.

b) The latest revision of SABS 0400: The Applications of the National Building Regulations, as amended.

c) SABS Code of Practice for the Wiring of Premises No. 0142 of 1981, as amended.

d) The Machinery and Occupational Health and Safety Act No. 85 of 1993.

e) Any other relevant by-laws of local or other authorities.

1.3.3 All apparatus, components parts, fittings and materials supplied and/or installed whether especially specified herein or not shall conform in respect of quality, manufacture, tests and performance with the requirements of the appropriate current South African (SABS) or British Standard Specifications (BS) and Addenda thereto, except where otherwise required by this specification or permitted by approval of the Department in writing. All materials and workmanship which may, in the opinion of the Department, be inferior to that specified for the work will be condemned. All condemned material and workmanship must be replaced or rectified as the case may be, to the satisfaction of the Department.

1.3.4 No second hand equipment of any description may be offered for supply or installation.

1.3.5 If so required the Department may call for samples of material and equipment for approval. Such samples shall be submitted within 14 days of the request and if judged necessary by the Department may only be returned after completion of the installation in order to ensure that the quality of the installed product is the same as that of the approved sample.

1.3.6 Any fitting or item of equipment not specifically mentioned but obviously necessary for the successful completion of the installation is to be included so as to form a complete working installation.

1.4.0 DRAWINGS

1.4.1 The tender drawings issued with the supplementary technical specification are schematic and do not necessarily purport to show the exact position, size or details of construction of equipment.

1.4.2 Tenderers must satisfy themselves that the equipment offered by them can be accommodated in the available space and positioned in such a way that access for maintenance, repairs or removal is not obstructed.

1.4.3 Contractor's drawings

Where indicated in the Supplementary Specification these drawings are to be prepared by the Contractor at his expense in accordance with this document and shall be on a scale of not less than 1:50.

These drawings shall at least consist of:

a) Builder's work drawings

These shall indicate all work to be done by others (bases, foundations, holes in concrete and masonry, etc.) as well as the sizes, capacities and positions of service connections (electrical, water, drainage, etc) to be provided by others, all in accordance with the supplementary specification.

b) General arrangement drawings

These shall indicate all equipment, distribution systems, testing and inspection requirements as well as instrumentation positions and access requirements.

During their preparation, the Contractor shall take cognisance of all relevant architectural, structural, electrical and other services drawings in order to properly co-ordinate his layout. These drawings can be obtained via the Department. The drawings shall be amended as required during the contract period, and up to date copies kept on site for reference purposes.

1.4.4 Positions and sizes of air grilles, louvered openings through reinforced concrete beams and slabs, etc., as indicated on the tender drawings shall be adhered to as far as possible. Amendments will only be considered if absolutely unavoidable.

c) Shop drawings

These shall be based on the General Arrangement drawings, and shall show in detail the construction of all the parts of the works, method of assembly where applicable, erection and construction, materials and connections, welds, gaskets, sealants, fastenings, reinforcing and all other necessary detail.

d) Electrical drawings

Electrical drawings shall comprise complete control and power wiring diagrams, as well as

front and side elevations giving major dimensions of control panels as well as instrumentation and switch position layouts.

e) As-Built drawings and wiring diagrams

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

1.4.5 Submission of contractor's drawings

Drawings shall be submitted to the Department in orderly fashion commencing within the following time limits or as determined by the main contract programme (where applicable):

Builder's work drawings	:	within 2 weeks of tender acceptance.
General layout drawings	:	within 4 weeks of tender acceptance.
Shop drawings	:	within 6 weeks of tender acceptance.
Electrical drawings	:	within 6 weeks of tender acceptance.
As-built drawings	:	at completion before first hand-over.

By submitting drawings, the Contractor represents that he has determined and verified all site measurements, site instruction criteria, materials, catalogue numbers and similar data, or will do so, and that he has checked and co-ordinated each of his drawings with the requirements of the works and the contract documents, taking into account drawings of all other relevant disciplines.

At the time of submission the Contractor shall inform the Department in writing of any deviation in the Contractor's drawings from the requirements of the supplementary documents.

After scrutiny the Department may at it's discretion and depending on the number of discrepancies, require amendment and resubmittal prior to approval. Drawings shall be resubmitted until approved prior to any portion of the works related to the drawings being commenced.

Should the Contractor, during drawing amendment, alter any portion of his drawings not specifically required by the Department, he shall point this out in writing when resubmitting the drawing.

Approval of the Contractor's drawings in no way indemnifies him from being responsible for the correctness of the drawings and satisfactory operation of the installation.

1.4.6 If the Tenderer wishes to submit alternative proposals, differing from the Department's design, drawings indicating such proposals comprehensively shall be submitted with his tender.

1.5.0 SITE CONDITIONS

1.5.1 It is the responsibility of the Tenderer to visit the site during the tender phase and to familiarise himself with conditions related to it. If the location of the site is not indicated in the Supplementary Specification, it can be obtained from the Department. No claim for additional payment related to ignorance of site conditions will be accepted. By submitting a tender it is accepted that the Tenderer is fully aware of all site conditions as well as the access to it, and has allowed for this in his tender price.

1.6.0 DEVIATIONS FROM TENDER DOCUMENTS

1.6.1 No deviations or alterations from that of the specification, schedules or drawings shall be made without first obtaining the written approval of the Department.

1.7.0 PROGRAMMING OF WORK

1.7.1 The contract works shall proceed concurrently with the building construction or in accordance with an approved programme in all respects.

1.7.2 It is essential that the Contractor programmes his construction and all other work in conjunction with the Main Contractor and the main contract programme in order to avoid possible delays or clashes of trades.

1.7.3 For direct contracts the Contractor shall submit a detailed programme in the form of a bar chart based on the contract period and the various activities and components of the installation. This programme shall be submitted to the Department within two weeks of site hand-over.

1.8.0 MANUFACTURER'S RATINGS

1.8.1 All equipment such as fans, compressors, cooling towers, pumps, etc., shall be selected to operate well within the manufacturer's ratings. Equipment offered for use beyond these limits will not be considered.

1.8.2 Tenderers must submit manufacturer's ratings of all equipment offered. Ratings shall be given in the SI system.

1.9.0 NOTICES

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

1.10.0 GUARANTEE

1.10.1 The 12-month guarantee called for in the Supplementary Specification, shall apply to all items of plant such as compressor, condensing units, etc., delivered to site and/or erected. It is the responsibility of the Contractor to negotiate with his suppliers in order to secure their equipment guarantee on this basis.

1.10.2 The date of acceptance shall be that appearing in the acceptance certificate issued by the Department and shall define the start of the guarantee period and free maintenance period (where applicable).

1.10.3 No Claims for extended guarantee or otherwise from Suppliers, Principals etc., will be considered even if equipment is required on site long before acceptance date.

1.11.0 LUBRICATION

1.11.1 All bearings must be packed with approved grease or filled with the correct oil, and all gearboxes and sumps must be filled with the lubricant specified by the manufacturer. The Contractor will be responsible for the supply of all lubricants required for the initial fill. All lubricants must be new and supplied in sealed drums or containers.

1.12.0 COMMISSIONING AND TESTING

1.12.1 Commissioning Engineers

The Tenderer shall allow in his tender price for the services of approved and expert Commissioning Engineers, as may be appropriate for the individual specialised sections of his contract, as well as a competent Engineer in overall control of the installation. Testing and commissioning shall be carried out by these Engineers.

Should undue problems be encountered at any time, the Contractor may be requested by the Department to obtain the services of a representative of the manufacturer of specified items of equipment, at no cost to the Department.

1.12.2 Notice of Testing and Commissioning

The Department shall receive not less than two weeks advance notice of any tests to be witnessed by the Department.

1.12.3 Failure of Works, Site or Commissioning Tests

Should the Department be notified to attend official tests as laid down, and should the equipment fail the test for any reason whatsoever, such that the Department is required to re-witness the test, the time, transport and disbursement by the Department in so doing will be for the Contractor's account, which amount may be deducted, at the option of the Department, from monies due to the Contractor.

1.12.4 Quality Testing of Equipment

The Department reserves the right to arrange for testing of any piece of equipment at will, to check on compliance with the relevant specifications. Should the particular piece of equipment pass the test, the cost of such testing will be borne by the Department. However, should it fail the test, the cost of the test, rectification of the shortcomings, re-testing and repetition of the same test on the remaining like items will be for the Contractor's account.

1.12.5 Inspection during Manufacture

The Contractor will advise the Department when the items to be supplied are in the course of manufacture. The Department reserves the right to inspect any items during the course of manufacture, and witness any performance tests that may be required thereon. The Contractor shall give the Department at least two weeks advance notice of works tests.

1.12.6 Testing

The Contractor shall be responsible for carrying out all tests laid down in the specific sections elsewhere in this document, in addition to those listed hereafter and in the Supplementary Specification.

Testing and balancing shall not begin until the system has been completed and is in full working order.

The plant shall be tested and operated to meet the performance figures and duties specified.

All safety features and interlocks will be tested.

The Contractor will be responsible for all costs incurred in the testing, including the supply, calibration and use of all instruments and tools, but not the supply of water or power on site.

All instruments and test equipment used shall be provided by the Contractor, and shall be accurately calibrated and maintained in good working order. All test instruments used for tests to be witnessed by the Department's Representative shall be provided with calibration certificates, which must be available to the Department's Representative.

Specific attention is drawn to the fact that calibration certificates will be required for the following:

Watt meters, ammeters, voltmeters, frequency meters, pressure gauges, flow meters, orifices plates, temperature gauges and dynamometers.

All instruments shall be of above standard grade, and test pressure gauges shall not be less than 150mm in diameter. The maximum scale of the instrument shall not exceed 1,5 times the full test requirement.

It is essential that the Contractor inspects and tests all equipment before requesting the Department to inspect or witness acceptance tests thereon.

All acceptance tests, whether in the manufacturer's works or on site, must be carried out in the presence of the Department's Representative.

Should the Department wish to verify the calibration of any instruments, the Contractor shall make the necessary arrangements for the instrument to be re-calibrated by a recognised authority. Should the instrument prove to be correctly calibrated, the cost of the re-calibration test will be borne by the Department. Should the instrument prove to be in error, the cost of the tests will be borne by the Contractor.

Two copies of the complete test reports shall be submitted to the Department, prior to the first delivery of the project. Reports shall cover all tests carried out on individual sections, including such works tests as may have been conducted. All reports shall be neatly typed.

1.12.7 Commissioning

The Contractor shall carry out all tests and commissioning of the systems installed by him, in a co-ordinated and properly organised manner.

Refrigeration Services shall be commissioned in accordance with the following Codes or such other recognised commissioning procedure or code approved by the Department:

a) Refrigeration Systems:
CIBS : Commissioning Code : Series R : Refrigeration Systems.

b) Control Systems:
CIBS : Commissioning Code : Series C : Automatic Controls.

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

Should the tests be carried out over an area outside the range of normal speech, it is required that the Contractor make available at least four battery powered, two-way radio sets, to facilitate communications.

The testing procedures shall be sufficiently comprehensive to prove the correct functioning of each and every piece of equipment, and its suitability for the application.

After all systems and equipment have been tested and commissioned to the satisfaction of the Department, a detailed demonstration of all functions of the system shall be carried out in the presence of the Department's Representative, so as to allow him to become fully acquainted with the operation of the system.

The commissioning tests shall include the tests laid down under the specific sections hereafter, and a full operational test of all pumps, compressors, fans and control gear in all modes of operation.

The Contractor shall allow for the replacement and cost of any materials and fuel used for testing purposes, as part of the contract.

The demonstration to the users shall include a repeat of the operational tests above.

The planning of this demonstration shall take place in collaboration with the Department.

A certificate of completion will not be issued until all tests have been satisfactorily completed, and the plant has operated successfully, to the complete satisfaction of the Department.

1.13.0 PERFORMANCE TOLERANCE

1.13.1 All performance figures obtained during testing and commissioning must be within -5% and +5% of the specified performance figures given in the supplementary specification. Should the plant fail to comply with these figures after it has been tested and operated for a period of seven days, then the Contractor shall have a further four weeks to meet the requirements of the specification, after which the Department shall have the right to reject the plant and recover all monies paid to the Contractor for the rejected plant.

1.14.0 TEST CERTIFICATES

1.14.1 The Contractor shall ensure that copies of all relevant test certificates, inspection reports, materials analysis certificates and similar data as may be required under various sections of this specification, or by Government Licensing and Inspection Authorities or Local Authorities, shall be provided before handing over the plant. Acceptance of the plant will be delayed if such certificates are not available. In particular, attention is drawn to pressure vessel and boiler construction and materials test certificates.

1.15.0 APPLICATION FOR INSTALLATION

1.15.1 The Contractor shall allow for the submission of the necessary forms, fees and drawings to the Inspector of Machinery or other relevant Authorities to obtain permission to install equipment where this is required. He shall also, in co-operation with the Department make any arrangements that may be required for Government Inspectors or other relevant Inspectors to carry out prescribed tests.

1.16.0 POWER, WATER AND DRAIN CONNECTIONS

1.16.1 Power, water and drain points in the plant room will be provided by and at the expense of the Department.

1.16.2 All plumbing between equipment and water and drain points shall form part of the contract.

1.16.3 The exact details of terminal points will be set out in the Supplementary Specification.

1.17.0 QUALITY OF MATERIALS

1.17.1 Only new materials of high quality shall be used throughout and shall be subject to the approval of the Department.

1.17.2 All materials, where applicable, shall conform in respect of quality, manufacture, tests and performance, with the requirements of the SABS standards or, where no such standards exist, they shall conform with the appropriate current specification of the British Standard Institution. Materials manufactured in South Africa shall be used wherever possible.

1.17.3 Imported materials shall comply with the requirements of the relevant SABS or British Standard Specifications, although these materials need not necessarily bear the SABS mark.

1.17.4 All materials shall be suitable for the particular site conditions. These conditions shall include weather conditions as well as prevailing conditions during installation and subsequent permanent use.

1.17.5 Should the materials or components not be suitable for use under temporary site conditions, where applicable, the Contractor shall provide at his own cost, suitable protection until these unfavourable site conditions cease to exist.

1.18.0 SERVICE ACCESS

1.18.1 Where equipment such as fans, dampers, etc. are installed above ceiling the Contractor shall ensure that access will be possible for maintenance purposes after installation.

1.19.0 STANDARD SPECIFICATIONS

1.19.1 Unless otherwise specified in the supplementary specification, the following standard specifications (including amendments) of the organisations indicated shall form part of this specification.

a)	SABS 0140-1978;	Identification colour marking
b)	SABS 0139-1981;	The prevention, automatic detection and extinguishing of fire in buildings.
c)	SABS 0147-1992;	Refrigerating systems including plants associated with air conditioning systems.
d)	SABS 1530 - Part 1 : 1991;	Panels with two impervious facing sheets.
e)	CKS 336 : 1987;	Mortuary trolleys.

1.19.2 Tenderers shall indicate in their tender submission whether their tender and/or equipment as applicable complies with any of the above specifications or carries the SABS mark.

1.20.0 MONTREAL PROTOCOL

Tenders for equipment utilising chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) or hydrofluorocarbons (HFCs), to be supplied and installed shall be within the constraints and schedules of the Montreal Protocol and the Copenhagen Agreement and such amendments thereto as may be made by the international community.

Where tenders are submitted for equipment not complying with this Protocol it shall be clearly indicated, in writing, in the tender submission.

SECTION 2

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SECTION 2

2.0 MAINTENANCE AND SERVICING

2.1.0 GENERAL

2.1.1 Unless otherwise specified in the Supplementary Specification, the Contractor shall be responsible for all maintenance and servicing of the installation for the full 12-month guarantee period. During this period, the Contractor shall make good any defect due to inferior materials or workmanship and maintain all plant and equipment in perfect operating condition.

2.1.2 The Contractor shall be entirely responsible for carrying out regular inspections at intervals not greater than 2 months, unless otherwise specified, and for full servicing of all components of the installation in accordance with the manufacturer's instructions. For this purpose, the Contractor shall prepare a detailed inspection and service report in the form a checklist and log sheet showing all functions to be carried out at each inspection and service. Copies of these service reports shall be regularly submitted to the Department after each service.

The Contractor shall also maintain a plant log book on site in which he shall record, sign and date all work carried out at each inspection as well as log all temperatures and pressure readings etc.

2.1.3 The Contractor shall allow for all expendable materials necessary for servicing such as lubricating oils, grease, refrigerant and cleaning materials.

Replacement filters, if required, will be provided by and at the expense of the Department.

2.2.0 MAINTENANCE INSTRUCTION OF OWNER'S STAFF

2.2.1 Tenderers shall make proper allowance in their tender price for instruction of the Department's staff in the maintenance, repair and adjustment of all the equipment. Allowance must be made for the proper hands-on tuition of the owner's personnel at the appropriate time to enable them to take over operational duties.

2.3.0 SPARE PARTS AND AGENCIES

2.3.1 Where Tenderers offer plant embodying units of manufacture other than those of their principals and for which they are not accredited South African agents, and for which they do not stock spare parts, they should state in the tender the name of the accredited South African agents from whom spare parts for such units are obtainable.

2.3.2 In all cases, Tenderers should furnish an undertaking from agents to the effect that they are prepared to carry the necessary stock of spare parts for their particular units

2.3.3 Tenderers are also required to furnish the same undertakings as regards the spares for units manufactured by their own principals.

2.3.4 During adjudication of tenders, consideration may be given not only to the cost of the plant offered, but also to the cost of the spares.

2.4.0 TOOLS

2.4.1 All special tool required, i.e. tools specially designed for the particular equipment offered, must be supplied and listed in the tender offer and included in the unit price. In the case of a number of identical items of plant being supplied it will only be necessary to supply two sets of tools covering all units, and not one set for each unit.

2.4.2 It is the responsibility of the Contractor to ensure that all tools are handed over to the Department on completion of the contract, in brand new condition. No damaged tools will be accepted, and the contract will not be considered complete until such tools are satisfactorily received. Tools handed over shall be suitably mounted on a wallboard or supplied in a high quality metal box or other container as may be agreed to by the Department.

2.5.0 OPERATING, MAINTENANCE INSTRUCTIONS, WIRING AND CONTROL DIAGRAMS

2.5.1 The Contractor shall prepare and supply comprehensive manuals for the successful operation and maintenance of the installation. A draft of the manual shall be submitted to the Department after commissioning, for approval. The draft shall then be corrected, if required, and THREE sets of the manual shall be submitted before first acceptance of the plant will be considered.

2.5.2 Manuals shall be prepared in the same language as the contract document unless otherwise required by the Department. These manuals shall be bound in hard file covers with clear titles and indices and shall contain the following information as a minimum, in the sections indicated:

SECTION 1: System Description

A comprehensive description of the system, including schematic diagrams.

SECTION 2: Commissioning Data

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

SECTION 3: Operating Instructions

1. Plant running checklist and frequency of servicing.
2. Safety precautions to be taken.
3. Manual and automatic operation.
4. Operator's duties.
5. Lubricating oils and service instructions.
6. Pre-start checklist for each system.
7. Starting and stopping procedures.

SECTION 4: Mechanical Equipment

1. Description of all major items of equipment with the make, model number, names, addresses and telephone numbers of the Supplier, Manufacturer or their Agents.
2. Design capacities of all equipment including selection parameters,

selection curves, capacity tables, etc.

3. Manufacturer's brochures and pamphlets.

4. Schedule of spares with part numbers recommended to be held in stock by the Department.

SECTION 5: Maintenance Instructions

1. Schedule of maintenance particulars, frequency of service and replacements.

2. Troubleshooting guide.

3. Part number of all replacements items and spares.

4. Capacity curves of pumps, fans and compressors.

5. Serial number of main items of equipment.

SECTION 6: Electrical Equipment

1. Schedule of equipment indicating manufacturer, type, model number, capacity and address and telephone number of supplier.

2. Maintenance instructions.

3. Manufacturer's brochures and pamphlets.

4. Complete "as-built" circuit diagrams and diagrammatic representation of inter-connections of electrical equipment.

SECTION 7: Instrumentation and Control

1. Description of each control system.

2. Schedule of control equipment indicating make, type, model number, rating, capacity and name, address and telephone number of supplier.

3. Maintenance instructions.

4. Manufacturer's brochures and pamphlets.

SECTION 8: Drawings

1. Paper prints (reduced if so desired) of all "as-built" mechanical and electrical Contractor's drawings.

2. Wiring diagrams, framed behind glass shall be mounted adjacent to each relevant control panel.

SECTION 3

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SECTION 3

3.0 TECHNICAL REQUIREMENTS – GENERAL

3.1.0 ERECTION OF EQUIPMENT

3.1.1 Tenderers shall allow for a complete installation, including the provision of mobile cranes, air compressors, lifting tackle, measuring equipment, precision levels, and all other special or regular tools and equipment that may be needed to complete the entire installation in accordance with the specification, and to the satisfaction, of the Department.

3.1.2 The Contractor will be responsible for any damage caused to buildings, equipment, etc. during the course of the erection of his equipment.

3.2.0 EQUIPMENT PLINTHS

3.2.1 Plinths as specified hereunder shall not be confused with any form of inertia or anti-vibration base. Unless otherwise specified in the Supplementary Specification, equipment plinths shall form part of the refrigeration services contract.

3.2.2 Plinths shall be provided for all mechanical and electrical equipment. Plinths cast on concrete surfaces shall protrude at least 100mm above floor levels and depending on the position of the vibration mountings, shall be at least 300mm wider or longer than the inertia bases mounted on top. (Where applicable)

3.2.3 Plinths for equipment which do not need inertia bases or plinths for inertia bases with recessed vibration mountings, shall be of the same size as the equipment or bases mounted on top. Plinths shall consist of 1,6mm thick channel or angle iron formers with 10mm thick reinforcing bars located at 150mm pitch in each direction and filled with concrete. The top surface of the concrete shall be floated to an even and smooth finish to allow for not less than 25mm and not more than 50mm of suitable cement or epoxy grout under the equipment base frame. A 25mm 45? chamfer shall finish off all grout corners.

3.2.4 Plinths as specified above shall also be provided for field assembled as well as other equipment.

3.2.5 Where cooling towers are on the same floor level as condenser water pumps, the towers shall be mounted on concrete or masonry walls high enough to ensure a flooded suction at all times.

3.3.0 HOLDING DOWN BOLTS AND BOLTS FOR EQUIPMENT

3.3.1 The Contractor shall be responsible for the supply of all necessary holding down bolts for the machines supplied by him. He shall also supply all bolts necessary for assembling all the equipment supplied by him.

3.3.2 Holding down bolts shall preferably be cast into concrete bases when the bases are being cast. All bolts shall, in this instance, be provided with galvanised sheet metal sleeves approximately three times the diameter of the bolt, and projecting a minimum of four-bolt diameters below the surface of the concrete. This sleeve must be kept free of concrete until the final grouting takes place.

3.3.3 Under exceptional circumstances, the provision of suitably sized pockets for the holding down bolts will be permitted.

3.3.4 Where galvanised bolts are called for, they shall be fully galvanised all over. No re-cutting of threads will be permitted after galvanising. All nuts must run freely on the threads.

3.4.0 BEDPLATES

3.4.1 All bedplates shall be of fabricated mild steel with surfaces on which the pump, motor, gearbox, fan etc. is mounted.

3.4.2 All bedplates shall be stress relieved after welding but before machining. Each bedplate shall be provided with approximately eight horizontal jacking screws with locknuts for each unit mounted thereon to assist in aligning the pumps and motors, etc.

3.4.3 All bedplates shall be thoroughly cleaned, prepared and painted with one coat of Anodite red oxide primer to finishing coats being applied.

3.4.4 It will not be necessary to dowel equipment in place, provided the jacking screws specified above are fixed and locked.

3.5.0 COUPLING SHAFT AND VEE-BELT GUARDS

3.5.1 All couplings, vee-belts, shafts and moving parts and components shall be fitted with adequate guards which comply in all respects with the Machinery and Occupational Health and Safety Act. They shall be fabricated from sheet and flattened expanded metal, and be so arranged that the couplings or belts are completely visible through the guard.

3.5.2 All guards shall be painted as specified.

3.5.3 Guards for fluid couplings shall be so constructed as to completely enshroud the coupling, and completely contain 110% of the full volume of oil contained in the coupling. In the event of an oil discharge, no oil must be thrown about or leak onto the floor.

3.6.0 COUPLINGS

3.6.1 High speed (Above 750 r/min)

Couplings between motors and driven equipment shall be Fenaflex tyre type couplings or approved, and shall comply with the following requirements:

i) They should be designed and selected for severe duty and 24 hours per day operation. In no case shall a "service factor" of less than 25% above that given in the Fenner Catalogue be used.

ii) All tyre couplings must be fitted with taper lock bushes.

iii) All couplings shall be of synthetic oil resisting rubber.

3.6.2 Low speed (Below 750 r/min)

These couplings shall in general be of a flexible type, which shall be approved by the Department.

Couplings shall in all cases be designed and selected for severe duty and 24 hours per day operation. In no cases shall a "service factor" of less than 25% above that given in the maker's catalogue be used.

Where possible, all couplings shall be fitted with taper lock bushes.

3.6.3 Hydraulic Couplings

These shall be of the Crofts, Voith or Vulcan Sinclair manufacture or as approved.

Where possible, couplings shall be fitted with taper lock brushes for both input and output shafts.

All couplings shall be adequately rated for the full power and torque rating of the motor to which they are coupled, plus 15% safety margin.

All fluid couplings must be offered with a temperature safety device, which will safely release the oil in the event of the coupling overheating.

3.7.0 MECHANICAL DRIVES

3.7.1 Vee-belt drives

Where used vee-belts shall be standard sections and lengths conforming to the latest edition of CKS 332 - 1972, "Specifications for industrial vee-belts".

Belt drives shall be designed and selected assuming direct on line starting of a squirrel cage motor and heavy duty operation for 24 hours per day. Design and selection shall be in accordance with the Fenner Power Transmission design manual or equivalent. Design shall be based on at least 6 starts per hour for all refrigeration applications. The power rating of the drive shall be based on full rating of the drive motor.

Pulleys shall be fitted with taper lock bushes. No pulley shall have a diameter smaller than that recommended by the belt manufacturer with minimum diameter being 100mm, and no non-standard pulley will be accepted.

No drive above 1kw rating shall have less than two belts.

Pulley size and centre distance shall be designed to ensure a belt contact arc over the smaller pulley of not less than 120º.

Pulleys shall be manufactured from close-grained cast iron with grooves matching belt sections and properly machined with smooth edges and wear surfaces.

Inward and outward adjustment of the drive motor and pulley combination shall be possible with proper locking mechanisms to enable correct belt tensioning and ease of replacement of belts.

All belt tensions shall be checked within 24 hours of first delivery and again one week later and adjusted as necessary.

Belt speeds exceeding 15 m/s and speed ratios greater than 7:1 are not acceptable.

3.7.2 Chain Drives

To facilitate maintenance, spares inter-changeability and standardisation, chains where selected, shall be standard stock roller type precision drive chains of reputable manufacture.

The axial and angular alignment of wheels and chains shall be carefully checked to very close tolerances to ensure maximum life and trouble free operation.

The amount of adjustment possible to take up chain wear shall be not less than 2 pitches or 2 percent elongation above nominal chain length, whichever is the greater. Chains shall be lubricated in accordance with manufacturer's recommendations.

3.8.0 PACKING OF EQUIPMENT

3.8.1 All base plates and steel work shall be suitably packed with steel packs to ensure that they are true to level, line and grade. The thickness of packing shall be such as to allow for not less than 25mm, and not more than 50mm of grout under all base plates or steel work. Packings shall be of suitable size to support the base plates and one pack must be situated immediately on each side of each holding down bolt as well as in such other positions as may be directed by the Department in order to adequately support the base plates and its superimposed load.

3.8.2 All packs shall be as near as possible to the exact height in one thick piece. Thinner shims may be used for final adjustments, but large piles of thin shims will not be accepted. All packs must be of parallel shims. Taper packs or wedges will not be accepted. Packs must be bedded on a flat and smooth area on the surface of the concrete foundation. Packs resting on rough concrete will be rejected.

3.8.3 After final levelling and lining up, it is essential that all packs are tight. Loose packs will be rejected.

3.8.4 No shims will be permitted between a machine base and plate and the machine's feet except as mentioned hereinafter.

3.9.0 ALIGNMENT OF EQUIPMENT

3.9.1 Bedplates

Where equipment is delivered completely assembled on a bedplate, these items of equipment shall be removed from the bedplate prior to installation. The bedplates shall first be installed, levelled, lined up and packed to ensure that there is no twist or distortion therein. The machines shall then be installed on their bedplates and the final alignment carefully checked and adjusted until it is to the entire satisfaction of the Department.

Minor corrections to the alignment of machines may be carried out using thin shims between the machinery feet and the machined surface of the bedplate. This applies particularly to electric motors. A maximum level error of 20 seconds of arc, or as decided by the Department, will be allowed.

3.9.2 Couplings

The alignment of all couplings must be carefully checked for both the parallelism and eccentricity of their shafts. Alignment must be carried out to the maker's tolerance and to the entire satisfaction of the Department.

In any event, a misalignment of more than 0,05mm will not be permitted for either parallel or eccentric misalignment as measured at the periphery of the couplings. It is essential that a dial micrometer is used to set the final alignment, which must be witnessed by the Department.

3.9.3 Vee-belts and chain drives

The alignment of vee-belt drives and chain drives shall be carried out with a precision steel straight edge in the case of short centre drives, or by means of a nylon line in the case of long centre drives. The Contractor must ensure that all belts and chains are correctly tensioned in accordance with the maker's instructions.

3.9.4 Gearboxes

All gearboxes shall be carefully checked for level and twist. No twist in the gearbox casing will be permitted. After final levelling and bolting down, the gear teeth shall be marked with Engineer's blue, and the meshing and bearing of the teeth checked and corrected to the satisfaction of the Department.

3.10.0 ASSEMBLY OF COMPONENTS

3.10.1 It is essential that all mating components such as couplings, taper lock bushes, machined faces, etc., be thoroughly cleaned with a suitable solvent before assembly. All surfaces must be free from burrs or irregularities, which may prevent the correct mating of the surfaces.

3.10.2 A molybdenum-disulphide lubricant similar or equivalent to Mobil-grease Super shall be used on the threads of all bolts and between the mating surfaces of all parts closely fitted together, such as shafts and couplings, keys and base plates. PTFE tape shall be used in all screwed pipe connections.

3.11.0 WELDING

3.11.1 Welding shall be carried out in accordance with the current edition of SABS 044 Parts I to VII where applicable.

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

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

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

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

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

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

3.11.7 All welds must show proper fusion.

3.11.8 Where welding is contemplated in pipework systems, Tenderers shall allow for the removal and testing by an approved body of 5% of the welded joints in the system. These will be removed at random as indicated by the Department and tested. Should faulty welding be discovered, all other joints shall be X-ray tested by the SABS or an approved body, all at the expense of the Contractor.

3.12.0 GALVANISING

3.12.1 Unless otherwise specified in the Supplementary Specification the following items shall always be galvanised:

Fabricated mild steel sections exposed to the weather.

Steel grilles and louvers exposed to the weather.

3.12.2 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.

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

3.12.4 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.

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

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

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

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

3.12.9 The Department 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.

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

3.12.11 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.

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

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

3.12.14 The SABS requirement for uniformity shall apply.

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

3.13.0 PAINTING

3.13.1 The entire installation, other than aluminium or stainless steel pipe cladding, shall be painted, unless otherwise specified in the Supplementary Specification.

3.13.2 Painted items shall include plantroom floors, equipment plinths and bases.

3.13.3 Before any painting is applied, the surfaces shall be prepared according to SABS 064, Code for Preparation of Steel Surfaces for Painting. All surfaces shall be moisture free, clean and properly prepared.

3.13.4 During painting, the Contractor shall ensure that all the necessary fire prevention and fire fighting precautions have been taken.

3.13.5 Name plates, labels and notices on equipment shall not be painted.

3.13.6 Items which do not require painting such as light fittings and thermometers, shall only be installed after the paint work on the plant, ceiling or walls as applicable have been completed.

3.13.7 Painted surfaces on proprietary manufactured items shall be adequately protected. Equipment on which the paintwork has been damaged during installation shall be repainted before first delivery of the plant will be considered.

3.13.8 Unless otherwise specified in the Supplementary Specification the installation shall be painted in accordance with the SABS colour coding where applicable. Colour code bands and arrow

indicators shall be as per SABS 0140 of 1978, and the basic colour shall cover the full length and circumference of pipes and ducts.

3.13.9 Ferrous casings of cooling towers, evaporative condensers including galvanised iron casings, sumps, fans and ductwork connected to outlets of cooling towers or evaporative condensers, shall be internally painted with two coats of epoxy-tar paint to SABS 801, type II.

Angle iron framework shall be similarly painted with epoxy paint before side covers are fitted. All steel surfaces shall be cleaned and painted with a wash primer or zinc chromate primer (ungalvanised iron) before the epoxy paint is supplied.

3.13.10 Exposed and unlagged galvanised piping shall be painted with one coat wash primer (self etch primer) to SABS 723 followed by one undercoat to SABS 681, type II and one coat gloss enamel paint to SABS 630, Grade 1 as top coat.

3.13.11 Unlagged black piping, flat iron, angle iron, rods, etc, for supports, brackets, frames, duct stiffeners, etc, shall be painted on all sides with a zinc chromate primer to SABS 679 type 1, followed by one coat universal undercoat and one finishing coat of enamel paint to SABS 630 Grade 1.

3.13.12 Where specified in the supplementary specification, aluminium shall be painted with a wash primer to SABS 723 followed by a zinc chromate primer to SABS 679, type I and one coat universal undercoat to SABS 681-1972 type II and one final coat of enamel paint to SABS 630, Grade 1.

3.13.13 Where specified in the supplementary specification, steel surfaces shall be cleaned and then treated with the hot phosphate process to a minimum weight of 1,6 g/m? coating followed by two coats of backing enamel to SABS 783 type I.

3.13.14 All galvanised surfaces requiring painting other than those covered in 3.13.17 below shall be thoroughly degreased. In case a detergent is used, the surface shall be well rinsed and dried. It shall then be painted with one coat wash primer (self etch primer) to SABS 723. When dry, the surface shall be painted with one undercoat to SABS 681 type II and one coat universal undercoat and one coat high gloss enamel paint to SABS 630 Grade 1 as top coat.

3.13.15 All galvanised surfaces inside cold and freezer rooms and external within 50km of the coast, or as specified in the supplementary specification, shall be cleaned with a galvanised iron cleaner until a water break free surface is achieved. After drying one primer coat of "Galvo-Grip" or approved paint shall be applied followed by one coat of universal undercoat paint. A final coat of gloss enamel to SABS 630, Grade I shall then be applied.

3.13.16 For blower coil units the entire unit casings, including galvanised iron eliminators, sumps, drip pans, fans etc., shall be painted internally with two coats of epoxy-tar paint to SABS 801, type II. The white rust preventative compound on galvanised iron shall be removed as specified above before the paint is applied. Angle iron framework shall be similarly painted with epoxy paint before side covers are fitted.

3.13.17 Exposed piping with canvas covered insulation shall be painted two coats of bitumen aluminium paint to SABS 802 followed by the colour coding basic colour as per table 1.

3.14.0 BEARINGS

3.14.1 Anti-friction

Anti-friction bearings shall include all bearings, which provide rolling contact between one or more sets of hardened steel balls or rollers and hardened steel rings or raceways.

Anti-friction bearings shall be of approved manufacture and available throughout South Africa.

To facilitate maintenance, spares inter-changeability and standardisation, anti-friction bearings of

standard design and manufacture shall be employed. All anti-friction bearings shall be provided with greasing facilities in accordance with manufacturer's requirements.

3.14.2 Bushed bearings

Only where specifically stated in the Supplementary Specification and in the case of low velocities and light loads in moisture free conditions will bushed bearings be accepted. All bushed bearings shall be made of an approved bearing metal composition that has good anti-friction qualities and is capable of withstanding severe usage in the specific application.

All bushed bearings shall be provided with lubrication facilities to ensure adequate lubrication and shall be properly grooved to distribute the lubricant uniformly over the bearing surfaces. Grooves shall not be cut into the journal, but always into the surrounding bush. The edges of all chambers and grooves shall be rounded to avoid sharp corners and to facilitate the introduction of the oil or grease between the journal and the bearing metal.

3.14.3 Self-lubricating or oil-less bearings

Self-lubricating or oil-less bearings shall only be used on application of light and low velocities in moisture free and low humidity conditions and where access to bearings is difficult and likely to be neglected during servicing.

The type of bearing metal composition used shall have frictional and wear resistant properties akin to those of grease lubricated bushed bearings.

3.15.0 NOISE AND VIBRATION CONTROL

3.15.1 General

Unless otherwise specified in the Supplementary Specification the design, manufacture and installation of all the mechanical and electrical equipment shall be such as to ensure compliance with the relevant sections of SABS 0103 of 1983 "The Measurement and Rating of Environmental Noise with Respect to Annoyance and Speech Communications", as amended.

Any installation where the measured residual sound level exceeds the maximum desired residual sound level as per SABS 0103 shall be rectified to comply with SABS 0103 at the Contractor's own expense.

In all plantroom applications where airborne noise cannot be limited or comply with the set standards, provision shall be made for acoustical treatment of the equipment involved or, alternatively, total enclosure thereof with acoustical panelling to comply with requirements laid down in this specification.

Such provisions shall be included in the tender price and no claims for payment to comply with this requirement will be entertained.

3.15.2 Vibration Isolation

Proper provisions shall be made in the foundations and mountings of all equipment capable of transmitting vibration forces to its environment, whether local or remote, (As is the case with pipes) for vibration isolation.

Selection of vibration isolation equipment and in particular, mountings for equipment and machines, shall be done with due regard to the forcing frequency of the driven machinery and the mounted natural resonant frequency of the machine.

In the case of installation of equipment on upper floors, suspended floors, roofs etc. it is of prime importance that floor stiffness, floor, deflection and natural frequency of the floor be taken in to consideration to ensure that resonant conditions cannot occur.

Driven machinery and isolator deflections shall be carefully selected in these applications.

Equipment selection schedules shall be submitted to the Department for approval and shall contain full details regarding the forcing frequency, the natural mounting frequency, the static deflection and all other relevant information to evaluate vibration isolation equipment.

Should added mass inertia blocks be required to comply with these vibration isolation requirements, proper provision shall be made at tender stage for the provision of such.

3.15.3 Damping

Where static deflections in excess of 8mm are indicated, steel springs shall be employed incorporating acoustic sound pads in series with the spring.

The horizontal stiffness of the springs shall not exceed that in the vertical, in particular for systems mounted at vertical frequencies below 5Hz.

Low frequency mounts shall incorporate rubber snubbers to accommodate extreme horizontal or vertical motions such as can occur near resonance during start up.

The snubbers shall however not be relied upon to provide the necessary horizontal stability of the machine in normal operational conditions.

Spring layouts and inertia blocks shall be employed to avoid this situation.

For static deflections below 8mm, rubber in sheer mounts may be used provided the frequency is above 6Hz.

For small static deflections less than 4mm and particularly for high-speed machines and general acoustic isolation, ribbed rubber neoprene composite pads may be employed subject to the specified requirements.

No equipment shall be installed in critical areas without correct and approved vibration isolation.

Sufficient stability and damping shall be incorporated in the mountings to minimise the movement of the machine during start up or changes in the operating conditions.

The selection of mounts shall take proper cognisance of unequal distribution of the mounting weight of equipment and rotational and/or pressure forces acting thereon.

3.15.4 Cooling Towers

3.15.4.1 Indoor Applications

Anti-vibration requirements and noise transmission to surrounding areas shall comply with requirements as laid down (unless otherwise specified in the supplementary specification). No cooling tower shall be installed indoors unless it is mounted on anti-vibration spring mountings and should it be necessary, the required inertia mass.

3.15.4.2 Outdoor Applications

Cooling towers installed outdoors shall similarly comply with the laid down noise criteria for this application, particular care being paid to the selection of the fans and where applicable, the pumps for critical areas.

3.15.4.3 Cooling Tower Fans

Centrifugal fans shall generally be required for indoor application of cooling towers and for outdoor applications in critical areas.

In critical areas it will possibly be required that proper attenuation be applied to air inlets and air

discharge of cooling towers and, where so specified in the supplementary specification, the total cooling tower shall be installed inside acoustic panelling to prevent noise breakout.

Alternatively ejector type cooling towers may be offered, subject to the requirements of this specification.

3.15.5 Pumps

All pumps with their motors shall be mounted on a base frame, which shall be installed on concrete plinths.

In addition it is required that pumps installed indoors and in critical areas shall be installed on anti-vibration mountings with inertia mass bases with mountings selected for correct static deflection.

Bases for pumps in non-critical areas shall be installed on rubber in sheer mounts as a minimum, depending on the pump selection and locality of the pump.

Where required in the supplementary specification, pumps shall be totally enclosed in acoustic panelling to reduce noise breakout to the immediate vicinity and surrounding areas.

3.15.6 Fans

3.15.6.1 Centrifugal Fans

No centrifugal fan shall be selected in a class range other than Class 1 or 2 and the rotating speed of the fan at duty point shall not exceed 1 440 r/min.

Centrifugal fans in critical areas and fans above 7,5kW shall in all cases be mounted together with the drive motor on anti-vibration mountings together with the correct inertia mass.

3.15.6.2 Propeller Fans

Propeller fans shall comply with the criteria already laid down and shall be carefully selected for the highest possible efficiency with due regard for the noise criteria.

Propeller fans in excess of 0,5kW and of rotational speed higher than 800 r/min shall, in addition to the requirements already laid down, be mounted on correctly selected and installed anti-vibration mountings to reduce possible vibration transmission to surrounding structures.

3.15.6.3 Axial Flow Fans

Axial flow fans shall be selected for the highest possible efficiency and comply with the noise criteria specified. In critical areas no fan shall be installed without attenuators on inlet and outlet sides.

In addition it will be required that the fan as a whole be mounted on anti-vibration mountings and where specified in the supplementary specification, it may be required for the fan to be enclosed in acoustic panelling.

No axial flow fan may be installed without anti-vibration mountings to match the fan characteristics and in critical areas it may be required for the axial fan to be provided with inertia mass to match.

Fan rotational speeds specified in the supplementary specification shall not be exceeded.

3.15.6.4 General

No fan may be directly connected to ducting either on the inlet or outlet sides, approved flexible connections shall be provided between the fan and the ducting distributing the air.

Where fan noise characteristics cannot meet the requirements of this specification such fans shall be replaced or other approved steps taken by the contractor at his own expense until the installation meets the requirements.

3.15.7 Blower Coil Units

3.15.7.1 General Application

Blower coil units shall comply with the requirements already laid down for noise, vibration and noise criteria.

In the case of built-up air handling units, the fan and motor unit shall be mounted on anti-vibration mountings and in the case of critical areas, be provided with additional inertia mass to comply.

In the case of packaged factory-built units, it shall be necessary to mount the fan and motor unit on anti-vibration mountings internally to the unit and in addition, it will be required for the air handling unit as a whole to be mounted on anti-vibration mountings of the correct static deflection characteristic.

In critical areas, it will be necessary to provide additional inertia mass for the fan and motor combination in addition to the above.

3.15.8 Piping

3.15.8.1 General

Under no circumstances may any piping be directly connected to noise generating equipment such as pumps, chillers, cooling towers etc.

Connections to such equipment shall be made with correctly selected flexible rubber type connectors of the spherical type.

In critical areas double spherical rubber type isolators immediately adjacent to the noise generating machine will be required.

3.15.8.2 Pipe Penetrations Through Walls

Under no circumstances will pipe penetrations through walls be permitted where the pipe comes in direct contact with the surrounding wall or structure.

At such penetrations it is required that a sleeve of 25mm thick soft neoprene, or other approved material, be provided around the piping at the penetration and, where plastering is applied, plastering shall be cut back to the outer edge of this sleeve.

Rubber links similar to the LINK-SEAL bolted type are preferred.

3.15.8.3 Pipe Supports

In all critical applications and within the first ten metres of all equipment, it is required that pipe supports shall be of the flexible type, correctly selected for the application and with the correct static deflection.

Depending on the application spring mounting will in all probability be required.

Any other areas and applications at risk of noise or vibration transmission to the surrounding structure similarly require pipe mountings isolated from the structure.

Pipe supports fixed to sensitive building elements will not be permitted.

3.15.8.4 Refrigerant Piping

Refrigerant piping in critical applications shall similarly be supported on anti-vibration mountings and in addition, delivery and suction piping at compressors and air handling units shall be provided with at least two braided flexible connections installed at 90? to each other and in close proximity of each other.

3.15.9 Sound Attenuators

Where required, in order to comply with the noise and vibration criteria already laid down, or where specified in the supplementary specification, sound attenuators shall be provided for ventilation, air conditioning and all other plant (Duct mounted and/or unit mounted as applicable).

Primary sound attenuators shall be installed near or in the plantroom.

The attenuators selected shall match the specific fan or plant characteristics to ensure the correct insertion loss to meet the sound criteria laid down.

Unless otherwise specified, sound attenuators shall be installed with flexible connections at the inlet and outlet connections.

The sound attenuators shall in addition be selected to produce the minimum pressure loss across the attenuator coupled to the least re-generated noise level produced by the flow through the attenuator.

Unless otherwise specified, air path sound attenuators shall be manufactured from galvanised sheet steel with the sound absorption material moisture repellent and erosion resistant up to 20 m/s air speed, and preferably flange connected.

Wherever possible attenuators shall be proprietary type supplied by the same manufacturer as the plant manufacturer to ensure complete compatibility.

Where not clearly indicated on the drawings, attenuators shall in all cases be provided at points where supply and return air ducting leaves the plantroom and shall be installed to prevent noise breakout from the plantroom via the ductwork.

The internal free area of sound absorbers shall be not less than the cross sectional area of the connecting duct as indicated on the drawings.

Field fabricated type sound absorbers shall be made as follows:-

All sides of rectangular ducting shall be double walled with the inner walls perforated with 10mm holes at 25mm centres. The space between the two sidewalls shall be divided into 3 unequal sections by means of 25mm thick cement fibre panel strips and filled with glass wool. The lining thickness shall be at least 80mm.

Circular ducts shall be lined as specified above except that the lining thickness shall not be less than 100mm.

3.15.10 Air-Borne Noise

Selection and installation of all items such as grilles, diffusers, dampers, jet outlets, nozzle outlets, transformation pieces, take-offs etc. shall be carried out in such a manner to ensure compliance with the noise criteria laid down in this specification. Items shall be carefully selected to reduce generated noise levels to accepted levels and with minimum air pressure loss.

Items such as dampers, volume control items etc, shall be carefully selected with due consideration for noise regeneration in all possible positions of such dampers or items to ensure compliance in all positions.

All duct penetrations through walls and structures shall be provided with a 25mm thick soft neoprene or similar approved material sleeve surround to ensure that no direct contact between the duct and wall occurs. For plastered walls the plastering shall be cut back to the outer edge of

this sleeve.

3.15.11 Noise to the Exterior

Where specified in the supplementary specification, additional measures shall be taken to prevent or reduce noise breakout to the exterior from the plantrooms.

In critical areas it is essential that all possible steps be taken and be allowed for at tender stage to ensure compliance with the requirements laid down.

No allowance shall be made for screening or attenuation with distance in calculating requirements.

3.15.12 Electrical Connections

In critical areas no conduit or armoured cabling may be connected directly to equipment. Flexible connections shall be used in these applications.In other applications cabling shall be connected to equipment with long radius bends. No sharp corners or bends in cabling may be used.

Electrical connections shall not impede anti-vibration mountings and shall not convey vibrations or sound to the structure or building elements.

In critical areas cabling, trunking etc. shall be supported in a manner to ensure no vibrations are conveyed to the structure. Supporting from sensitive elements of the structure will not be permitted.

Where floating floors, acoustical separating elements etc. are used in a structure, flexible connections, conduit etc. shall be used at all crossover points.

3.15.13 Testing

When called upon to do so by the Department, the Contractor shall provide at his expense, all necessary equipment required to ascertain compliance with noise and vibration elimination in the installation.

The instruments provided shall be calibrated by an approved Authority and shall be capable of measuring sound and vibration levels integrated over a period of time.

The instrument to measure sound pressure levels must be capable of reading sound levels in dBA as well as the sound level at the international octave band centre frequencies of 31,5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz and 8000 Hz as a minimum.

The instrument to measure vibration levels shall be calibrated in nano m/s over the integration period.

In the event of such tests indicating insufficient provision for eliminating airborne noise and vibration transmission, the Contractor shall at his expense rectify the installation as necessary and the tests shall again be executed until satisfactory results are obtained.

Final approval of the noise and vibration levels shall be at the sole discretion of the Department.

3.16.0 ELECTRICAL EQUIPMENT AND INSTALLATION

3.16.1 Unless otherwise stated in the Supplementary Specification tenderers must allow in their price for the complete electrical installation and wiring.

3.16.2 All electrical equipment and wiring shall be in accordance with the current issue of the Department's Standard Specification for Electrical Equipment and Installation for Mechanical Services. Copies can be obtained from the Department, Private Bag X65, PRETORIA, 0001.

3.16.3 Power terminal points will be as specified in the Supplementary Specification.

3.16.4 Ammeters and pilot lights shall be provided for electric heaters, one of each for each step of heating.

3.16.5 All compressor motors over 5kW shall be provided with an approved electronic type motor protection unit in addition to the protection called for in the Standard Specification for Electrical Equipment and Installation for Mechanical Services.

3.16.6 Clause 1.2.1 (a) of the Standard Electrical Specification shall read "The South African Bureau of Standards Code of Practice for the Wiring of Premises as amended".

3.16.7 The fault level of the refrigeration services distribution board shall be as specified in the Supplementary Specification.

3.16.8 In the case of small wiring direct from busbars, e.g. voltmeter supply, suitable protection fuses shall be mounted directly onto the busbars.

3.16.9 The possibility of inadvertent contact with live terminals shall be avoided at all cost. All apparatus and wiring behind readily accessible hinged doors or panels shall be protected against finger contact by means of insulating panels (Perspex or similar approved material) or other approved method. Busbar mounted voltmeter fuses shall be mounted on insulated back plates to afford complete safety from hand contact with busbars or other conductors in the immediate vicinity.

3.17.0 SELECTION OF EQUIPMENT

3.17.1 All equipment shall be selected with due regard to the installation site conditions, particularly with respect to;

- altitude
- ambient temperatures
- atmospheric conditions

3.17.2 Equipment shall at all times be selected to operate within the limits recommended by the particular manufacturer.

3.17.3 Where equipment will be required to operate at conditions deviating from the manufacturer's standard selection tables, re-rating shall be done strictly in accordance with the manufacturer's methods.

SECTION 4

CONTENTS

STANDARD SPECIFICATION

FOR

REFRIGERATION SERVICES

SECTION 4

4.0 TECHNICAL REQUIREMENTS - EQUIPMENT AND MATERIALS

4.1.0 AIR-COOLED CONDENSING UNITS

4.1.1 Air-cooled condensing units shall be equipped with hermetic, semi-hermetic or open type compressors matching the specified requirements, load and refrigerant.

4.1.2 Condensing units shall be designed and selected to properly match ambient conditions, refrigerant, room temperature requirements, temperature differences, compressor operating hours and specified cooling capacity.

4.1.3 Each condensing unit shall be a complete unit with compressor and motor, air cooled condenser coil, receiver, cooling fan/s, controls, high- and low pressure protection, discharge- and suction valves on serviceable units and high- and low pressure indicating gauges complete with shut-off valves.

High-pressure protection shall be of the manual reset type.

4.1.4 Units shall be suitable for permanent outdoor use or indoor use as specified.

Units installed indoors shall be fitted with ducting or sheet metal cowls ensuring proper airflow and cooling without short-circuiting.

4.1.5 Condensing units, including outdoor package units shall be installed on proper bases as specified.

4.1.6 Compressors with nominal cooling capacity exceeding 7kW must start unloaded.

4.1.7 Open type compressors shall be directly coupled to the drive motors by means of flexible couplings and compressor and motor shall be mounted on a single robust bedplate of fabricated steel construction.

4.1.8 Initial charge of oil and refrigerant shall be provided.

4.1.9 Internal motor over-temperature protection shall be fitted to hermetically and semi-hermetically sealed compressors together with external over-current protection.

4.1.10 Units with ducted air discharge shall be fitted with centrifugal or axial flow fans.

4.1.11 Condensing coils shall be seamless copper tubing with copper or aluminium fins depending on the application.

4.1.12 Interlocks shall be provided between indoor and outdoor units.

4.1.13 Outdoor package units where specified shall be completely weatherproof and self-contained with only electrical and refrigerant line hook-up required.

Unit casing shall be stainless steel, aluminium or internally and externally powder coated steel.

Units designed on a modular basis with multiple unit stacking arrangement will be preferred.

All components, including controls shall be easily accessible for servicing.

Compressors shall be mounted internally with anti-vibration mountings and vibration eliminators on the refrigerant piping.

Control panels shall be mounted behind weatherproof see-through panels with status indication light clearly visible.

4.2.0 WATER-COOLED CONDENSING UNITS

4.2.1 Condensers for water-cooled condensing units shall be shell and tube or plate type.

4.2.2 Plate heat exchangers shall be manufactured entirely from stainless steel.

4.2.3 Shell and tube heat exchangers shall be manufactured form seamless copper tubing expanded in steel tube plating, each tube individually replaceable.

Tubes shall be accessible from both sides of the shell for tube replacement.

Tube plates shall be welded to the steel shells.

A plastic resin coating or equal for corrosion protection shall be applied after fabrication to the waterside of all steel tube plates and shell ends within each condenser.

Tube supports correctly spaced shall be provided between the end plates.

4.2.4 Safety pressure relief valves shall be fitted as standard.

4.2.5 Water and refrigerant pipe connections shall be sized according to the duty and shall preferably be flanged.

4.3.0 COOLING TOWERS

4.3.1 Cooling towers shall be factory assembled units, rigidly constructed of galvanised sheet steel, stainless steel, aluminium or moulded fibre glass suitably reinforced with galvanised steel angle iron.

Units shall be complete with fan/s and motor/s, spray nozzles, water distribution system, eliminators, pan section and casing.

4.3.2 Water level control shall be automatic with a quick-fill bypass valve and drain valve fitted to the sump.

4.3.3 Unless otherwise specified in the Supplementary Specification the unit shall be of the counter-flow blow-through arrangement type with centrifugal fans.

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

4.3.5 Access to all internal parts shall be provided by means of easily removable panels or watertight doors fitted with quick opening catches. Suitable handles or holding bars shall be fitted to removable panels and doors.

4.3.6 Fan wheels and housings shall be of hot dip galvanised steel or corrosion protected to the Department's approval.

4.3.7 All moving parts shall be protected with removable screens and panels, hot dip galvanised after manufacture.

4.3.8 Effective eliminator sections, corrosion proof shall be provided to prevent water carry-over.

4.3.9 The pan section shall be manufactured of heavy gauge hot dip galvanised steel.

Standard pan accessories shall include access doors, easily removable corrosion proof strainer for the pump suction, drain valve, overflow and large bore adjustable make-up ball valve.

The perforations of the strainer shall be smaller than the bore of the spray nozzles.

4.3.10 Automatic water treatment for corrosion protection with bleed control shall be fitted as standard equipment.

4.3.10 Re-circulating spray water shall be uniformly distributed over the heat transfer surfaces ensuring complete wetting of the wet deck areas at all times.

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

4.3.12 Cooling towers with ducted discharge shall be provided with access panels in the ducting, large enough to ensure proper access to nozzles and headers and to enable removal of eliminator sections for repairs or replacement.

4.3.13 A pressure gauge shall be fitted to the nozzle inlet piping from the pump.

4.3.14 Units for outdoor use shall be completely weatherproof including all electric components.

4.3.15 Units shall be assembled with compatible galvanised or polymer and cadmium coated fasteners.

4.3.16 Where specified in the Supplementary Specification protection against pan freezing shall be built in.

4.3.17 Where specified modulating damper control matching heat rejection and system load shall be provided.

4.3.18 All steel surfaces shall be painted as specified in Clause 3.13.9.

4.3.19 Cooling towers with forced draught propeller or axial flow fans are not acceptable.

4.3.20 Units with multiple fan sections shall be internally baffled to permit independent operation of the individual fan sections.

4.3.21 The wet deck shall consist of heavy hot dip galvanised steel, PVC or other plastic material impervious to rot or biological attack or decay, encased in removable hot dip galvanised steel panels or sections.

The wet deck surface shall be properly degreased.

4.3.22 Eliminators shall be manufactured from hot dip galvanised steel, stainless steel or moulded fibre glass UV stabilised where exposed to the sun with a minimum of three directional changes to the air path.

Plate spacing shall not exceed 30mm centre to centre.

4.3.23 Drain and overflow connections shall be piped to the nearest building drain point or gully.

4.3.24 Cooling tower and circulating pump levels shall be arranged to ensure a flooded pump suction with NPSH complying with the manufacturer's requirements.

4.3.25 Piping system and cooling tower shall be arranged to prevent the sump flooding when circulating pumps are stopped.

4.3.26 Interlocks for fans and pumps shall be provided between the indoor and outdoor units linked in the system, as specified.

4.3.27 Wiring shall be terminated in a weathertight junction box on the unit.

4.4.0 CLOSED CIRCUIT COOLING TOWERS

4.4.1 Closed circuit cooling towers shall generally comply with 4.3.0 as applicable.

The heat exchanger shall however be water/fluid to water and not refrigerant to water.

4.4.2 Each tower shall be served by two circulating pumps, one for the closed circuit to be cooled and one forming an integral part of the cooling tower for the spray circuit.

4.4.3 The closed circuit shall be fitted with the necessary air release valves, expansion tank with make-up, overflow and drain connections and provision for slug dosing of the closed circuit against corrosion.

4.5.0 DRY COOLERS

4.5.1 Dry coolers shall be factory assembled closed circuit water to air coolers, complete with heat exchanger, fan/s, screens and controls.

4.5.2 Heat rejection shall be based on ambient air to water or ambient air to glycol water solution where specified in the Supplementary Specification.

4.5.3 Dry cooler selection shall be based on specified ambient dry bulb temperature and maximum circuit heat rejection.

4.5.4 Dry coolers shall be factory assembled, tested, commissioned and guaranteed.

4.5.5 Dry cooler and circulating pumps shall be interlocked with the chiller/condenser with timer controlled delay starting of approximately 60 seconds (Adjustable 30 - 120 seconds).

4.5.6 The dry coolers shall be of the vertical or horizontal type with slow speed multiple fans of the direct drive type with horizontal or vertical air discharge as indicated on the drawing, suitable for permanent outdoor use.

4.5.7 The dry cooler heat exchanger shall be constructed of copper tubing with aluminium fins (copper fins for coastal applications). Design water pressure shall be not less than 1400kPa.

4.5.8 The casing shall be constructed of corrosion resistant steel, aluminium or stainless steel panels suitable for permanent outdoor application.

If not stainless steel the casing shall be epoxy powder coated finished all sides.

4.5.9 All sections of the casing shall be completely self-draining with no water collecting areas.

4.5.10 Support framework shall be hot dip galvanised after manufacture and epoxy powder coated.

4.5.11 The fans shall be direct drive type fitted with rigid protection screens on the discharge side and coils/fins similarly protected.

Fan and fan motor shall have permanently sealed and lubricated ball or roller bearings, designed and manufactured for continuous heavy duty application.

The dry coolers shall operate at minimum noise level with maximum fan speeds not exceeding 1 000r/min.

Fan blades shall be of aluminium or corrosion protected steel, including shaft.

4.5.12 Tube headers shall be fitted with automatic air vent valves and drain valves as well as suitable in/out water connections.

4.5.13 Solid state fan speed control and fan cycling control on multiple fan units is required to maintain a near constant water temperature.

4.5.14 Off-cycle fans shall be protected against windmilling.

4.5.15 Coil face air velocity shall not exceed 3m/s.

4.5.16 The dry cooler shall be mounted on a sturdy base frame and concrete plinth.

4.5.17 Internal wiring shall be terminated in a weather tight junction box mounted on the unit baseframe.

4.6.0 WATER CIRCUITS AND ACCESSORIES

4.6.1 Piping

4.6.1.1 Piping layouts and circuits shall be laid out as shown on the drawings, including schematic drawings issued with the service.

4.6.1.2 Unless otherwise specified open circuit condenser cooling water piping shall be heavy class steel piping to SABS 62: 1971, as amended, and galvanised to SABS 763 : 1988 for type B articles, heavy duty.

4.6.1.3 Unless otherwise specified closed circuit condenser water piping, primary and secondary chilled water piping shall be medium class black piping to SABS 62 : 1971, painted or coated as specified prior to insulation where applicable.

4.6.1.4 Where specified in the Supplementary Specification chilled and condenser water piping up to size 50mm may be copper piping or for condenser water entirely of uPVC piping of a class not less than class 6.

4.6.1.5 Pipe connections from main circuits to unitary equipment such as fan coils, humidifiers etc. shall be annealed copper class 2 to SABS 460 : 1985, as amended.

4.6.1.6 Fittings and accessories larger than 50mm nominal bore size shall be flanged with standard flanges to SABS 1123.

Compressed mineral fibre joint rings shall be used for flanged joint packings.

4.6.1.7 Fittings and accessories smaller than 50mm nominal bore may use screwed connections.

Screwed fittings shall be of malleable cast iron to SABS 509 : 1975, amended. Ordinary light type or black iron fittings shall not be used.

Screw thread shall be to BS21 or ISO R7.

PTFE sealing tape or other approved sealing compound shall be used on screwed connections.

4.6.1.8 Welding to galvanised piping or fittings will not be permitted.

Where welding for whatever purpose is unavoidable the complete section shall be hot dip galvanised after manufacture.

Cold galvanising will not be accepted.

4.6.1.9 Full radius bends and sweep fittings must be used wherever possible. Elbows may only be used under exceptional conditions and only with written permission of the Department.

Where it is necessary to reduce pipes in size, reducing sockets only shall be used and not bushes.
In horizontal runs of piping, where there is only a slight fall eccentric fittings are to be used.

4.6.1.10 Pressure relief valves shall be of Spirax or approved manufacture and shall be installed in the positions indicated on the drawings.

Pressure relief valve drains shall be taken to a suitable safe discharge point.

4.6.1.11 Where pipes pass through walls etc., sleeve pipes must be provided by the Contractor. Sleeve pipes should be made in such a manner that they will not foul against any piping due to the natural expansions and contraction of the piping.

4.6.1.11 All pipelines must be provided with 15mm drain cocks at all low points in the system so that the pipework can be drained of liquid without dismantling.

Sufficient drain points must be provided to drain the system completely.

4.6.1.12 Provision shall be made by tenderers in their tender price to have one in every twenty welded joints cutout for inspection and testing and for making good afterwards.

Should any of the test welds prove unsatisfactory the Contractor will be called upon to have all welds on the installation X-rayed and examined, at his own expense, by an approved Inspection Authority.

The Contractor will then be required to submit written test and inspection reports by the Inspection Authority before the installation will be considered for acceptance.

4.6.1.14 Horizontal pipes shall be installed with a slope of at least 1 in 500 to allow venting of air to the expansion tank wherever possible. Air pockets shall be avoided. High points shall be provided with automatic air vent valves or air bottles. Air vents or bottles shall be designed for pressures at least 1,5 times the working pressure of the system.

4.6.1.15 Piping in plant rooms shall be so arranged that normal inspection and servicing of equipment is not obstructed.

All pipes must be neatly fitted and shall be run in such a manner as to prevent the formation of air locks.

On all circuits, screwed unions or flanged joints are to be provided to allow for the easy dismantling of pipes. Unions or flanges must be provided at all Tee-offs and adjacent to all valves. Pipes up to 50mm nominal size may use unions but pipes larger than 50mm must be flanged. On straight or continuous runs of pipe, unions or flanges shall be provided at intervals not exceeding 20 metres.

4.6.1.16 Pipes which are not dimensioned on drawings shall be sized as follows:-

a) The velocity shall not exceed 3m/s.

b) The friction rate shall not exceed 140kPa per 100m length.

The pressure drop through all circuits shall be approximately the same. If this cannot be achieved by pipe sizing alone due to excessive velocities, throttling or balancing type valves shall be provided where required.

4.6.1.17 Pipe supports and the positions of anchors shall be such as to allow for movement due to pipe expansion and contraction or expansion joints in the building structure as applicable. Expansion joints, where required, shall be of the bellows type manufactured from stainless steel or may be of

the Viking Johnson pipe coupling or equal where moderate expansion movements are to be accommodated. Expansion joints shall be rated at not less than 1,5 times the maximum working pressure in the system. Expansion joints in hot water piping shall be suitable for water temperatures up to 120ºC.

4.6.1.18 Pipe hangers shall be of the spring, roller, chain or rod type. The maximum spacing of hangers and the minimum diameter of hanger rods shall be as follows:-

Nominal Pipe Size mm	Maximum Span m	Minimum Rod Diameter mm
25	2,2	10
40	2,8	10
50	3,1	10
80	3,7	14
90	4,0	14
100	4,3	16
125	4,9	16
150	5,2	20
200	5,8	22
250	6,7	22
300	7,0	22

4.6.1.19 High compression type thermal insulation such as hard wood timber of the same diameter as the required insulation shall be provided between hangers and chilled and hot water pipes.

4.6.2 Strainers

4.6.2.1 Water strainers shall be of the pot or angle type. Strainers shall be designed for not less than 1 000kPa or 1,5 times the maximum system working pressure whichever is the greatest. Strainer screens shall be of bronze, monel metal or stainless steel and shall have the following maximum perforation sizes:-

Strainer Size, mm	Perforation Size, mm
20 - 50	0,8
65 - 150	1,6
200 - 300	3,2
Over 300	6,4

4.6.2.2 The effective free area of the screen shall in all cases be not less than 3 times the cross sectional area of the inlet opening.

4.6.2.3 Strainers shall be installed in accessible positions where the screens can be easily removed and cleaned.

4.6.3 Pressure Gauges and Thermometers

4.6.3.1 Pressure gauges shall be of the "Bourdon" type to BS 1780 with at least 100mm dial and calibrated in kPa with the maximum range not exceeding 1,5 times the system working pressure. Forged brass or gunmetal gauge cocks must be fitted with each pressure gauge.

4.6.3.2 Thermometers shall be of the replaceable glass type with bronze casings, fitted into pockets for

removal without draining the system. The thermometers shall be calibrated in ºC and the scale length shall be at least 170mm. Pockets shall be of brass filled with oil and shall be installed vertically.

On pipes smaller than 50mm diameter, pipe sizes must be increased locally to install the sockets.

4.6.4 Air Release Valves

4.6.4.1 Automatic air release valves shall be provided where shown on the drawings, but shall in addition also be fitted to piping at all high points and other places where air may accumulate. As these points depend on the installation of the system, full responsibility for fitting these valves rests with the Contractor.

4.6.4.2 Valves shall be of the inverted float type similar or equal to Honeywell, Braukmann or Spirax. They shall have either integral shut-off valves or be preceded by a lock shield valve.

4.6.4.3 Connections to the service pipe shall be made at the highest point to ensure complete venting. Valves shall be mounted with the inlet connection exactly vertical.

4.6.5 Drain Cocks

4.6.5.1 Drain cocks shall be of copper alloy and be of the screw down pattern type to BS2879 : 1957, Type A. They shall be fitted to all low points in the installation to ensure full draining of the system.

4.6.6 Valves and Non-return Valves

4.6.6.1 Isolating valves, unless otherwise specified in the Supplementary Specification shall be Saunders Type A or Type KB diaphragm valves or equal fitted with suitable diaphragms and rated for at least 1 000kPa working pressure and the system temperature.

Diaphragm valves shall be provided with hand wheels. Valves of 80mm and larger which are installed higher than 2 500mm above floor level, shall be provided with chain wheels and chains.

4.6.6.2.1 Where isolating valves of the gate type are specified it shall be of the type with solid or flexible wedges in accordance with SABS 664 and SABS 776. Valves of 80mm nominal bore and smaller shall be of bronze or gunmetal.

In lieu of gate valves, other types of valves may also be offered provided that bodies, temperature and pressure ratings are generally as specified for gate valves and that the fluid pressure drop for wide open valves does not exceed that of 40 diameters of pipe of the same size.

4.6.6.3 Diaphragm type valves and gate valves shall not be used for balancing or throttling purposes.

4.6.6.4 Unless otherwise specified in the Supplementary Specification balancing valves shall be similar or equal to the STA-T shut-off/balancing valves. Valves shall be provided with drain cocks with hose connections and two pressure cocks across each valve to enable measuring the flow rate. A differential pressure gauge to measure the pressure drop across all the valves in the system and a flow chart for each valve size used shall be provided by the Contractor at first handover.

4.6.6.5 Throttling valves shall be either plug, globe, angle or "Y" valves. Provision shall be made to prevent opening and closing of throttling valves by unauthorised persons once they are set.

4.6.6.6 Check valves shall be of the swing or lift type with seats of neoprene, gunmetal or stainless steel, discs of bronze, gunmetal or stainless steel and bronze or cast iron bodies suitably rated for system pressure and temperatures.

4.6.7 General

4.6.7.1 Flexible connections shall be provided at all condenser, dry cooler, cooling tower and pump connections and where indicated on the drawings. These shall be of nylon reinforced moulded neoprene rubber with metal flanges at both ends. Metal reinforcing will not be accepted.

The flexible connections shall be of spherical or double spherical construction as per clause 3.15.0.

The flexible connections shall be installed strictly in accordance with the manufacturer's recommendations and shall be suitable for the system working pressures and temperatures.

4.6.7.2 Pressure gauges, thermometers and shut-off valves shall be provided in the following positions in each condenser water pipe circuit:

a) A pressure gauge, thermometer and shut-off valve before and after each condenser and self-contained air conditioning unit.

b) A shut-off valve at the in- and outlet of each cooling tower.

c) A strainer shall be provided at the suction side of each pump.

d) A pressure gauge before and after each strainer and at each pump discharge for pump units.

e) A shut-off valve before each strainer and at each pump discharge for pump units.

4.6.7.3 Pressure gauges, thermometers, unions and shut-off valves shall be provided at the inlet and outlet of chilled water and central heating coils.

4.6.7.4 Strainers shall be provided upstream of coils and control valves.

4.6.8 Expansion Tanks

4.6.8.1 Expansion tanks shall be fitted to all closed circuit piping installations. The tank capacities shall be as specified in the Supplementary Specification but generally not less than 50 litres water capacity.

4.6.8.2 The tank shall be manufactured from at least 2mm galvanised sheet steel or be hot dip galvanised after manufacture. The minimum water level in the tank shall be kept at approximately 300mm from the bottom by means of a 20mm nominal size ball valve.

The tank shall be provided with a separate quick filling connection, overflow, drain and a bolt-down lid with an air vent.

4.6.8.3 The expansion tank shall be installed at least 1 200mm above the highest point of the relevant water system.

4.6.9 Copper Piping

4.6.9.1 Where specified in the Supplementary Specification copper piping may be used for chilled water and/ or condenser water piping.

4.6.9.2 All piping shall be the best quality copper pipe of approved make, free from any defects. The sizes shall be indicated on the main drawings and no pipe of a smaller size than 15mm shall be used.

4.6.9.3.1 All piping shall comply with SABS 460 – 1985 as amended, either half hard Class 1, 2 or 3 piping as specified in the Supplementary Specification.

All piping shall be suitable for a working pressure of not less than 1 300kPa.

4.6.9.4 In general, Class 1 and 2 piping shall be used inside buildings while only Class 3 piping shall be used for underground services.

4.6.9.5 All fittings shall be of the best quality and shall and shall be correctly matched to the size of piping to which they are connected.

4.6.9.6 Capillary type copper bends, elbows, tees, reducers, etc. are preferred wherever possible. These must be silver soldered using hard solders complying with SABS 23 – 1992 as amended. The use of soft tin-lead is not permissible.

4.6.9.7 Where it is necessary to provide dismantled connections in the pipe work use may be made of brass "Flarex "or "Conex" type fittings.

4.3.9.8 "Conex" type fittings will not be permitted for use with Class 1 piping or in underground use.

4.3.9.9 Brass fittings must be made from a grade of brass or gunmetal, which will not be subject to dezincification.

4.6.9.10 Full radius bend and sweep fittings must be used wherever possible. Elbows may only be used under exceptional conditions and only with the express permission of the Department.

4.6.9.11.1 Where it is necessary to reduce pipes in size, reducing sockets and fittings only shall be used and not bushes.

In horizontal runs of piping, where there is only a slight fall, eccentric reducing fittings are to be used to prevent air locks.

4.6.9.12 Where practical copper pipes, particularly in sizes up to 28mm shall be bent or set around corners or obstacles. Where pipes are bent or set proper bending springs or pipe bends shall be used. No flattening of pipes at bends or sets will be permitted.

4.6.9.13 On all circuits, screwed "Flarex" or "Conex" unions o flanged joints are to be provided to allow for easy dismantling of pipes. Unions or flanges must be provided at all major tee offs and adjacent to all valves. Pipes up to 50mm may use unions but pipes above 50mm must be flanged. On straight or continuous runs of pipes, unions or flanges shall be provided at intervals not exceeding 20 meters.

4.6.9.14 Horizontal copper piping shall be supported unless otherwise indicated on the relevant drawings, as follows:

DIAMETER	MAXIMUM SUPPORT SPACING METERS
15mm	1,8
22 – 28mm	2,4
34 – 54mm	3,0
76 – 108mm	3,6

"Unistrut " copper piping shall be supported unless otherwise indicated on the drawings or in the specification. Pipe support hanger bolts and "U-bolts" shall in all cases be provided with lock nuts which shall be brass or galvanised and must be arranged so as to cause no electrolytic corrosion of the copper pipe.

Where small bare copper pipes are chased in to brick work or floors, they shall be first wrapped with suitable mineral fibre or glass fibre tape approximately 6mm thick.

4.6.10 uPVC Piping

4.6.10.1 Where applicable in the Supplementary Specification uPVC piping may be used for condenser water, above or below ground.

4.6.10.2 The class of piping to be used shall be as specified, but not less than class 6.

4.6.10.3 Piping, fittings and joints shall generally comply with SABS 956 – 1976 as amended.

4.6.10.4 Piping handling and installation shall generally be in accordance with Code of Practice SABS 0112 – 1992 as amended.

4.6.10.5 Only pipes and fittings bearing the SABS mark will be acceptable.

4.6.10.6 All horizontal pipework shall be adequately supported at intervals not exceeding those given in the table below which applies for ambient and water temperatures not exceeding 35ºC. For higher temperatures continuous support shall be provided.

Nominal diameter (mm)

10	1,25	20	25	30	40	50	60	75	100	150	200

Maximum distance between supports (m)

0,25	0,30	0,30	0,35	0,35	0,45	0,45	0,50	0,60	0,90	1,0	1,0

It is essential that where metal holder bats or other types of support are used that all rough edges that may damage the pipe surfaces are removed prior to installation. Pipes must be free to slide axially in the pipe supports to accommodate expansion and contraction.

Where pipes pass through walls or floors, suitable non-metallic sleeves must be provided to allow freedom of axial movement.

Unistrut pipe supports and hangers shall be used throughout unless otherwise indicated on the drawings or in the specification. Pipe support hangers and “U-bolts”, hall in all cases be provided with locknuts, which shall be securely locked. All brackets and pipe clamps shall be suitably galvanised, hot dipped to SABS 763 – 1977.

For vertical piping the above spacing may be doubled.

Expansion loops or telescopic expansion units shall be fitted in straight runs of pipe at intervals of not more than 50 meters, Pipes must be suitably anchored at appropriate places to ensure that expansion takes place in the desired direction so that it can be correctly taken up by the expansion devices, Anchors must be so designed as to render damage to or crushing of the pipe impossible.

Installation of expansion units on site must be done with due regard t the season and average ambient temperature prevailing when assembly takes place.

4.6.11 Testing of Piping Installations

4.6.11.1 Testing of the installation is to be carried out by the Contractor at his own expense in the presence of the Department's Representative. The following actions shall be carried out:

a) After the flushing and cleaning of the pipelines, all lines shall be completely filled with cold water and bled of all air.

b) The pipe system shall then be subjected to a test pressure of 1,5 times the working pressure by means of a test pump. This pressure shall be maintained for a minimum of 60 minutes.

c) Any leaks apparent during the test shall be made good and the test repeated until no further leaks exist.

d) Items not capable of withstanding this test pressure shall be isolated from the pipe system.

4.7.0 INSTALLATION OF PIPEWORK AND DUCTWORK

4.7.1 Pipework and ductwork shall be installed in accordance with the service drawings issued with the Supplementary Specification.

4.7.2 The tender drawings are schematic and do not purport to show exact positions of pipes or ducts or specific details of construction of the latter. All final dimensions must be checked on site before preparation of manufacturing drawings and the fabrication of ducting and piping.

4.7.3 Where beams, stanchions or other obstructions interfere with the straight running of pipes or ducts, suitable offsets shall be provided or alternatively changes in the section of the particular duct made, all in accordance with good engineering practice.

4.7.4 Sufficient offsets or alternatively expansion bellows shall be allowed in piping installations to allow for expansion and contraction.

4.7.5 It is required that tenderers make themselves conversant with all the drawings of the particular building in order to determine the number of such offsets or changes in section and the positions in which they will be required.

Due allowance shall be made in the tender price for such offsets and changes required.

A complete set of drawings of the building may be inspected at the office of the Regional Representative of the Department.

4.8.0 PUMPS

4.8.1 Pumps shall be of the centrifugal type with non-overloading characteristics and volute casings.

Pumps shall be selected for the maximum possible efficiency at the required duty point.

4.8.2 Pumps requiring an input power of less than 4,0kW may be end suction pumps, close coupled to flange mounted motors.

4.8.3 Pumps requiring an input power of more than 4,0kW may be end suction horizontally split casing pumps mounted on a common baseplate with the drive motor with their shafts coupled with an approved flexible coupling.

4.8.4 Unless otherwise specified in the Supplementary Specification pump speed shall not exceed 1 500r/min.

No pump shall be operated at a speed exceeding the maximum recommended by the manufacturer.

4.8.5 Pumps shall be selected to handle the specified water flow quantities at the required total system resistance.

Pump pressure and flow characteristics shall be selected to match the total system requirements under all control conditions.

4.8.6 The Contractor shall ensure that the minimum Nett Positive Suction Head as required by the pump manufacturer is maintained throughout the required operating pressure and flow range at

the pumped fluid temperature.

4.8.7 Renewable casing wearing rings shall be fitted on all pumps with discharge diameters of 80mm and larger and with delivery pressures in excess of 175kPa. Wearing rings shall be manufactured of bronze, chromium steel, nickel steel or an alloy suitable for the particular application.

4.8.8 Impellers shall be manufactured of bronze and shall be statically and dynamically balanced. Impellers of pumps having 40mm diameter and larger discharge connections, shall be fully enclosed and hydraulically balanced. 4.8.9 Pumps shall be provided with mechanical seals matching the duty, fluid and temperature requirements.

4.8.10 Pump casing design pressure shall match the total system working pressure or be 1,5 times the discharge pressure, whichever is the greater.

Pump casings shall be of close-grained cast iron.

4.8.11 Suction and discharge connections shall be flanged with machined flanges corresponding to the pressure rating of the casing.

4.8.12 Bearings shall be grease lubricated ball and roller bearings selected for long duty life and to accommodate radial and axial loads.

Grease gun lubrication shall be provided. The grease gun nipples shall be of an approved type and shall comply with BS 1486 and be of the hexagonal "hook-on" type 11 or 21.

4.8.13 A galvanised sheet metal drip tray with drain connection shall be provided underneath each pump. Drain connections shall be piped to the nearest drain or gully.

In coastal applications the drip tray shall be of stainless steel.

4.8.14 Pump shafts shall be of EN57 stainless steel with stainless steel mechanical seal holders.

4.8.15 Pumps with stuffing box type shaft seals will only be considered if:

a) The shaft is fitted with a replaceable stainless steel wearing sleeve,

b) A lantern ring is fitted,

c) A minimum of 4 standard packing rings can be fitted, and

d) Bronze thrust bushes are provided.

4.8.16 Drive motors shall be selected with at least 15% more power than the maximum pump requirements.

4.8.17 Pumps for water temperatures in excess of 90ºC shall be provided with water-cooled bearings and seals.

4.8.18 All pump casings shall be provided with plugged drain and vent trappings.
In addition pumps of 4,0kW or larger input power shall be provided with plugged tappings for suction and delivery pressure gauges and a filling point.

Trappings or internal drilling shall be provided for gland and bearing cooling water where necessary.

4.8.19 Pumps of design different from that specified above offered as integral parts of factory made equipment, will also be considered.

4.9.0 WATER TREATMENT

4.9.1 General

4.9.1.1 Water treatment shall be provided for all cooling towers, open and closed circuit type as well as evaporative condensers.

4.9.1.2 Water treatment and water quality control shall be provided to match the specific application and local site and water conditions.

4.9.1.3 Water treatment for evaporative cooling units shall be provided only where specifically called for in the Supplementary Specification.

4.9.2 Water Softener

4.9.2.1 Water softeners shall be installed in the make-up lines to evaporative condensers and cooling towers.

4.9.2.2 Where capacities are not specifically specified the softener shall have sufficient capacity to ensure that the make-up demand is met under all operating conditions and that the softener will be capable of operating for at least 48 hours without regeneration.

4.9.2.3 The softener shall function automatically and must be of the base exchange type, manufactured from corrosion resistant materials.

4.9.2.4 The softener and dosing plant (where specified) shall be of the same manufacture and provided by the same supplier.

4.9.2.5 The resin bed exchange rate must not be higher than 45kg/m³ during regeneration and the softened water shall not contain more than 10mg/ litre of total dissolved solids as $CaCO_3$.

4.9.2.6 The softener shall be complete with a Kent or equal flow recording meter, control wiring, brine tank etc. and a bypass valve arrangement.

4.9.2.7 Each water softener shall be equipped with a time control mechanism to automatically control the time lapse between regeneration cycles for any period between 24 hours and 7 days. Alternatively the regeneration cycle may be controlled volumetrically by means of a meter in the soft water outlet pipeline.

4.9.2.8 Each softener shall be equipped with an automatic diaphragm valve, salt solution tank, salt storage compartment, salt solution ball valve and the necessary connections for draw-off and refilling of salt solutions.

4.9.2.9 The brine tank shall hold at least one week's brine for summer conditions, and shall be manufactured from PVC, Polypropylene or similar material.

4.9.2.10 Drainage pipework must be piped to the nearest drainpipe.

4.9.2.11 The softener shall be installed to match the existing site water pressure. If the water pressure is too high a pressure reducing valve similar and equal to Glenfield & Kennedy or approved shall be installed. If the water pressure is too low a booster pump of sufficient capacity shall be installed.

4.9.3 Water Dosing Plant

4.9.3.1 Unless otherwise specified cooling tower/condenser water circuits shall be provided with automatic dosing plant including bleed control.

4.9.3.2 Where capacities are not specified the dosing plant shall have sufficient capacity for the application and local water quality.

4.9.3.3 Each evaporative condenser or cooling tower circuit must be provided with it's own independent dosing plant and bleed control.

The dosing system must be complete with all necessary chemicals, control valves and appliances.

4.9.3.4 The system shall comprise an automatic bleed-off valve controlled by an electronic measuring cell from the water conductivity and automatic measuring type dosing pump/s. The electronic measuring cell must continually measure the water conductivity and control the bleed-off valve and dosing pump/s accordingly.

4.9.3.5 The pre-set values of the water conductivity (TDS) must be adjustable. The TDS shall be controlled in the range of 600 - 800mg/litre.

4.9.3.6 The water treatment shall ensure that:

a) Scale forming and corrosion are prevented,

b) Algae and microbiological growth is controlled,

c) Sediment is controlled with low water consumption.

4.9.3.7 Chemicals provided shall be well known products, and approved dilution tanks as reservoirs for the metering pumps must be provided.

4.9.3.8 Sufficient chemicals and salt must be provided at first hand over for three months use.

4.9.3.9 When the plant is in effective operation, water samples shall be drawn after the softener and from the condenser sump. The samples must be analysed by a recognised laboratory suitably equipped and the report submitted to the Regional Office.

4.9.3.10 Service calls with water analysis and recognised corrosion tests must be carried out every three months during the maintenance period and reports sent to the Regional Office.

4.9.3.11 The chemicals used shall be stable over at least a 12-month period and shall not break down and cause clogging of the dosing apparatus.

4.9.3.12 Isolating valves shall be provided to allow all components of the water treatment plant to be removed for maintenance without affecting the operating of the cooling plant.

4.9.3.13 The water treatment plant shall be electrically interconnected with the recirculating water pump so that it cannot operate unless the pump is running.

4.10.0 REFRIGERANT PIPING

4.10.1 Refrigerant tubing shall generally be in accordance with SABS 1453 : 1988: Copper tubes for medical gas and vacuum services with preferred sizes in accordance with SABS : 460 class 2 and shall be de-oxidised and dehydrated.

4.10.2 The tubing shall be seamless cold drawn copper tubing with soldered copper capillary fittings.

4.10.3 Piping/tubes, up to and including 10mm diameter, may be jointed with the flaring method.

Other pipe line joints, shall be silver soldered or other approved hard solder. All soldered joints, on factory supplied equipment, shall be carefully checked before commissioning and remade if found damaged in transit. Silver solders shall be in accordance with SABS 23 : 1973 and revisions.

4.10.4 Pipe size selection shall be such as to produce moderately low velocities whilst, nevertheless,

ensuring;

a) proper oil return to the compressor and minimising lubricating oil being trapped in the system.

b) practical lines without excessive pressure drops and with proper feed to evaporators.

c) prevent liquid refrigerant from entering the compressor during operation and at shutdown.

4.10.5 All plant room piping shall be thoroughly cleaned and painted with a heat resistant clear lacquer.

4.10.6 Piping shall be supported (unless otherwise indicated on the drawings) as follows:

Pipe Size mm	Max. distance between supports in metres
10 (and smaller)	0,6
10 - 18	1,0
22	1,5
28 - 35	2,0
42	2,5
54	2,75
67	3,0

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

4.10.8 Flexible metal vibration absorbers shall be fitted at compressor discharge and suction connections. Absorbers shall be installed at right angles to the direction of vibration. Hangers and supports where piping penetrates through walls shall be designed to prevent transmission of vibration to the building.

4.10.9 A hot gas muffler shall be installed as close to the compressor as possible in positions to prevent oil trapping.

4.10.10 Flash gas at the expansion valve shall be prevented. On systems with large pressure drops due to line friction or static head, liquid line subcooling shall be accomplished by the use of either liquid-suction heat exchanges, or subcooling sections in evaporative, air, or water cooled condensers.

4.10.11 Receivers shall be provided in the liquid line between the condensing and subcooling coils.

4.10.12 Liquid-suction heat exchangers shall be of either the shell-and-tube or the tube-in-tube type. Liquid-suction heat exchangers shall not be used in systems using R-22 as refrigerant. A valved liquid bypass shall be provided around the heat exchanger.

4.10.13 Coils with more than one inlet or coils in which the individual circuits are not evenly loaded due to surface or air quantity variation shall be provided with separate expansion valves.

4.10.14 For evaporative or air cooled condensers each compressor circuit shall be equipped with a receiver with safety valve, isolating valves and purge cock, capable of holding the full volume of refrigerant in that circuit. Receivers shall be shaded from the sun.

Receivers with pressure/volume rating qualifying as pressure vessels in terms of the Regulations of the Machinery and Occupational Health and Safety Act shall comply with all requirements of the Act and Regulations and shall be fitted with safety valves, purge cock, isolating valves, manufacturer's plates etc. as required by the Regulations.

4.10.15 For water-cooled condensers where the condensers are not of sufficient capacity to hold the full refrigerant charge, a receiver shall be installed in each circuit to hold the balance of refrigerant.

4.10.16 The liquid piping from the condenser to the receiver shall allow free drainage of the liquid. The condenser to receiver piping shall be as short as possible and shall be pitched towards the receiver with a minimum slope of 20mm per metre.

4.10.17 Oil separators shall be used in systems where it is impossible to prevent substantial absorption of refrigerant in the crankcase oil during normal operation or during shutdown periods. Oil separators shall be insulated to prevent it from acting as a refrigerant condenser. Provision shall be made to prevent drainage of condensed refrigerant into the crankcase.

4.10.18 A quality refrigerant drier shall be provided in the liquid line on all systems. Driers shall be of the side inlet replaceable element type. Driers shall be installed with a three-valve bypass for servicing and to allow partial flow on open compressor systems in order to reduce pressure drop. All the refrigerant shall flow through the drier on hermetic compressor systems. A reliable moisture indicator shall be provided for positive indication when the drier cartridge should be replaced.

4.10.19 A quality strainer shall be provided on all systems in the liquid line. A suction strainer shall also be provided unless the compressor is equipped with a built-in suction strainer. Combined filter-driers are also acceptable. Strainers shall be adequately sized to assure adequate foreign material storage capacity without causing excessive pressure drop.

4.10.20 Sight glasses of double port seal cap type shall be installed in a vertical section of the liquid line after the receiver or condenser (if no receiver is used) to check the refrigerant charge and before the expansion valve to check the state of the refrigerant. Moisture indicators installed directly in the liquid line serving the dual purpose of liquid line sight glass and moisture indicator are also acceptable.

4.10.21 A refrigerant charging connection shall be provided between the receiver or shell and tube condenser and the refrigerant drier, in the liquid line. Before charging the system with refrigerant the circuit shall be tested as specified.

4.10.22 Solenoid valves shall have opening stems to continue operation of the system in case of solenoid coil failure.

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

4.10.24 Refrigerant suction lines shall be insulated by means of "Thermaflex" Type 40 QE cross-linked polyethylene foam tube insulation, neoprene rubber foam with quick zip fastener, or equal. The insulation material shall meet the following minimum requirements:

Temperature range	:	-80ºC to +120ºC
Thermal conductivity	:	0,038 W/mºK at 0ºC
Thickness	:	10mm
Density	:	35kg/m³
Odour properties	:	Neutral
Cellular structure	:	Totally closed
Fire properties	:	Self-extinguishing to SABS

The insulation shall be applied to form a continuous and homogeneous vapour barrier over bends, supports, etc.

Where these pipes are run in areas exposed to sunlight or mechanical damage, they shall be installed inside suitable galvanised mild steel or PVC trunking or other approved method of covering.

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

Suction and delivering lines may not be insulated grouped together as for a single line.

4.11.0 EVAPORATOR BLOWER COIL UNIT

4.11.1 Fan powered evaporator blower coil units of the number and capacity specified in the Supplementary Specification shall be provided in the rooms and positions and cabinets, where applicable indicated on the drawings.

4.11.2 The units shall be suitable for the room temperature specified and shall be complete with fan/s, cooling coil, drip tray, thermostatic expansion valve, heat exchangers, etc. as a matched unit with the condensing unit.

4.11.3 Cooling coils shall be suitable for direct expansion air to refrigerant heat transfer at the specified temperature and temperature difference.

Coils shall be of extended surface type constructed of seamless copper tube with mechanically bonded aluminium or copper fins.

4.11.4 For low temperature applications (freezer room and freezer cabinet) fin spacing shall be adjusted to suit.

4.11.5 Thermostatic expansion valves shall be fitted with external equalisers where required.

4.11.6 Coil construction and design shall ensure complete coil drainage from coil.

4.11.7 Fan motors shall be fitted with overload protection.

Motor and impeller protection screens shall be fitted as applicable.

4.11.8 Drain pans shall be fitted to all blower coil units to collect water condensing on the coil and defrost water.

The pan shall be constructed from galvanised sheet steel or stainless steel, at least 1,6mm thick.

The pan bottom shall slope from all sides towards the drain point.

The drain point shall be fitted with a screwed, 20mm diameter or larger outlet, depending on coil size and application.

The drain from the drippan shall be piped to the nearest building or plantroom drain with 22mm or larger copper tubing.

4.11.9 Automatic defrost control shall be fitted to all freezer rooms and freezer cabinets.

Unless otherwise specified in the Supplementary Specification defrost shall be by means of hot gas by-pass control or electric heater elements.
Where electric heater elements are to be used, these shall be three-phase type balanced across the phases.
Drain pans shall be fitted with electric heater elements for defrosting and drain piping shall be fitted with heater tape to prevent freezing up.

4.11.10 Unless otherwise specified systems with R22 refrigerant shall be fitted with thermostatic, solenoid and pressure-stat control.

4.11.11 Unless otherwise specified in the Supplementary Specification all cold and freezer rooms and freezer cabinets shall be fitted with thermostatic control.

4.11.12 Blower coil casings shall be all aluminium construction, preferably embossed.

4.12.0 DRAIN PIPING

4.12.1 Cold rooms, body cabinets and body freezer cabinet blower coil drain pans shall be fitted with copper drain piping at least 22mm in diameter.

4.12.2 Freezer room blower coil drain pans shall be fitted with copper drain piping at least 35mm in diameter.

4.12.3 Drain piping shall be taken to the nearest drain point.

4.12.4 Drain pipes from drain pans for freezer rooms and body freezer cabinets shall be wrapped with heater tape over it's entire length inside the room or cabinet to prevent freezing up.
"Non-drip" tape or equal insulation shall be provided over the heater tape and piping.

4.12.5 Heater tape shall remain switched on while cooling is in use.

4.13.0 PREFABRICATED COLD/FREEZER ROOMS

4.13.1 General

4.13.1.1 Prefabricated cold/freezer rooms shall be installed in the positions indicated on the main drawings.

4.13.1.2 Unless otherwise specified in the Supplementary Specification wall insulation thickness shall not be less than specified herein.

4.13.1.3.1 Minimum internal dimensions of room sizes required are indicated in the Supplementary Specification or on the main drawings.

Actual dimensions must be determined on site before manufacture of panels.

4.13.1.4 External dimensions of rooms shall be planned to utilise available space to the maximum.

4.13.1.5 Pressure/vacuum relief valves shall be installed in all freezer rooms.

4.13.1.6 Each cold/freezer room shall be fitted with a 100mm diameter dial type thermometer above the door.

The capillary tube for the thermometer shall be taken through the wall in a 20mm diameter sleeve pipe sealed with silicone sealant on both sides.

The bulb shall be installed 25mm off the wall in a top corner of the room as high as possible but not directly in the air stream of the blower coil unit.

Thermometer range shall match the application.

4.13.2 Walls and Roofs

4.13.2.1 Factory fabricated modular panels securely fastened together shall be used in the construction of free standing cold and freezer rooms and where required for internal lining of rooms of conventional construction.

4.13.2.2 Panels shall form a continuous vapour barrier on both the inner and outer skins of the total cold/freezer room envelope, including floor insulation where specified.

4.13.2.3 Panels for walls and ceilings shall be composite panels composed of insulation material clad on

two sides with sheet metal to form a stressed metal skin securely bonded to the insulation.

4.13.2.4 Insulation material shall be fire retardant with minimum thickness and density as set out hereunder; (unless otherwise specified in the Supplementary Specification)

a) Cold rooms (0ºC and higher)

MATERIAL	MIN. THICKNESS (mm)	DENSITY (kg/m³)
Polystyrene	100	24
Polyurethane	70	40

b) Freezer rooms (below 0ºC)

MATERIAL	MIN. THICKNESS (mm)	DENSITY (kg/m³)
Polystyrene	150	24
Polyurethane	100	40

4.13.2.5 Panel skins shall be of galvanised sheet steel at least 0,6mm thick, surfaces prepared to match the finishing materials to be applied.

The skin side to be bonded to the insulation shall be prepared and coated with epoxy or vinyl primer compatible with the adhesive and insulation to be used.

The visible side of the metal skin shall be coated with baked silicone polyester or vinyl in an off-white colour.

4.13.2.6 Panels shall be protected with removable protective plastic coating during transport and erection and to be stripped at the appropriate time.

Damaged panels will be rejected.

4.13.2.7 No horizontal joints will be accepted in wall panels and no timber may be used in the construction of any of the panels.

4.13.2.8 Panelling and framework around the door opening shall be reinforced to ensure that no warping of walls or cladding occurs.

4.13.2.9 All wall to wall, wall to floor, roof to roof and roof to wall joints shall be extruded aluminium or PVC sections designed and shaped for the application.

The extrusions shall be sealed and riveted to the panels at intervals not exceeding 500mm.

All panels shall be fully factory pre-finished complete with necessary joint and spline grooves, mitred corners and step edges ready for erection on site with the jointing system.

4.13.2.10 All joints external to the room shall be sealed with a non-hardening butyl rubber or silicone mastic sealant applied through the cartridge method.

All joints internal to the room shall similarly be sealed with silicone sealant.

4.13.2.11 Vertical joints in wall panels and horizontal joints in ceiling panels shall be covered with 38mm wide extruded aluminium "Tee" sections riveted to the panels at intervals not exceeding 500mm and sealed with silicone sealant.

4.13.2.11 Corner joints internal and external to the room shall be covered by 38mm x 38mm x 4mm thick extruded aluminium angle riveted to the panels at intervals not exceeding 500mm.

Silicone sealant shall be applied to prevent the ingress of moisture between the angles and panels and floors.

4.13.2.13 Alternative jointing methods to be approved by the Department prior to manufacture.

4.13.3 Doors

4.13.3.1 Doors shall be of sliding or hinged type as specified in the Supplementary Specification and/or main drawings.

4.13.3.2 Unless otherwise specified doors shall provide a clear opening of at least 815mm with the door opening reinforced and finished in PVC or aluminium sections.

4.13.3.3 Door insulation, finishes and cladding shall be as specified for the wall panels.

Door corners shall be neatly reinforced.

4.13.3.4 Provision shall be made for an external padlock.

The locking mechanism shall be such that it shall be possible to open the door from inside the room under all circumstances, including when locked.

4.13.3.5 Swing type hinged doors for freezer rooms shall not be fitted flush with the wall panels but shall fit "slam-on".

4.13.3.5 Doors fitted to rooms with room floor on the same level as the exterior floor shall be provided with cam type (hinged) and drop in, drop down (sliding) hinges to seal properly on the floor.

Drag type seals or gaskets will be rejected.

4.13.3.7 Rubber back stops shall be fitted to all doors to prevent damage to doors and walls on opening.

4.13.3.8 Sliding door tracks shall be manufactured from heavy duty extruded aluminium sections at least 75mm x 80mm x 4mm thick.

The rails shall be fixed solidly and firmly to the wall panels by means of heavy aluminium or galvanised steel sections.

Each door shall be provided with at least two sets of rollers, bolted to galvanised steel brackets at each end of the door.

Rollers shall be fitted with sealed and lubricated ball bearings, each roller set individually adjustable to ensure proper alignment of the door.

4.13.3.9 All doors shall be fitted with chromium plated pull handles.

4.13.3.10 Hinged doors shall be fitted with robust heavy duty hinges capable of handling the door weight and frequent use.

4.13.3.11 Wall panels shall be suitably reinforced internally to ensure solid and robust fixing of door fixtures.

4.13.3.12 Doors shall be fitted with rubber or neoprene balloon type gaskets sealing properly and tightly with the door in the closed position.

Gaskets shall be removable to enable replacement.

Gasket systems fitted to the door shall be rejected.

4.13.3.13 Doors and/or frames for freezer rooms and freezer cabinets shall be fitted with double trace wire heater elements at least 22W/m around the full opening, ensuring that gaskets do not freeze to

wall elements.

Heater elements shall remain switched on while cooling is in use.

4.13.4 Floor Finishes

4.13.4.1 Where specified in the Supplementary Specification floor finishes forming part of the cold room installation shall be as set out hereunder.

4.13.4.2 Granolithic finish to floors, thresholds and similar horizontal surfaces shall not be less than 25mm thick, composed of 2 parts granite, or other approved hard stone chipping, or approved hard coarse sharp washed granitic or quartzitic sand, graded up to a maximum size of 5mm, half part clean pit sand screened through a 2,4mm mesh sieve and 1 part of cement, and hand or mechanically steel trowelled to a true and smooth surface.

4.13.4.3 No dry cement powder or grout shall be applied to the surface.

4.13.4.4 The granolithic shall be laid before the concrete sub-floor has matured otherwise the exposed surface of concrete shall be thoroughly cleaned with a wire brush, and a coat of neat cement grout applied immediately before the granolithic is laid.

4.13.4.5 Where granolithic is to be tinted it shall be laid in two thicknesses in one operation, the lower thickness brought up to within 6mm of the finished level, and the upper thickness then laid into which the requisite quantity of approved colouring material shall have been mixed. NO DUSTING OF COLOURING MATERIAL WILL BE ALLOWED.

4.13.4.6 Exposed salient angles of granolithic shall be neatly rounded to approximately 20mm radius.

4.13.4.7 All granolithic work shall be done by experienced workmen, and shall be protected from injury caused by rain or other extreme weather for 24 hours after being laid, and against too rapid drying whilst hardening, by being covered with wet sacks, or other suitable material, and shall be protected from injury and discoloration during the progress of the remaining work.

4.13.4.8 Edges of granolithic floors butting against different floor finishings, and edges of margins, etc., shall be true and sharp, and shall be protected by fixing temporary wood strips, which shall remain in position until the commencement of the laying of the adjoining floor material.

4.13.5 Floor Insulation

4.13.5.1 Cold room floors shall only be provided with insulation where specified in the Supplementary Specification.

Insulation shall be as specified for freezer rooms.

4.13.5.2 All freezer room floors shall be fitted with insulation.

4.13.5.2 The concrete base (provided by the Builder, unless otherwise specified) shall be thoroughly cleaned and free of loose materials etc.

Where necessary it shall be brought to a fair finish with a cement and sand plaster.

4.13.5.3 An underfloor vapour barrier of 0,25mm thick polyethylene membrane to SABS 952, type C, forming a continuous envelope with the wall structure shall be provided on the prepared concrete base.

The vapour barrier shall be totally pin hole free and shall have lapped joints at least 150mm wide, sealed with a minimum of two runs of non-hardening butyl rubber sealant.

4.13.5.5 Insulation shall be laid on the vapour barrier in a single layer with tightly butted joints.

4.13.5.6 Insulation material shall be fire retardant with minimum thickness and density as set out hereunder; (unless otherwise specified in the Supplementary Specification)

MATERIAL	MIN. THICKNESS (mm)	DENSITY (kg/m³)
Polystyrene	100	32
Polyurethane	100	40

4.13.5.7 Floor insulation shall be covered with reinforced concrete at least 75mm thick.

Floors shall be capable of withstanding distributed loads of not less than 10kPa and concentrated loads such as at rack feet of 10MPa.

4.13.5.8 Unless otherwise specified in the Supplementary Specification floors shall be finished with a 25mm thick granolithic screed floated to a smooth finish.

Where a tile finish is specified the concrete topping shall be finished with a wood float.

4.14.0 SHELVING

4.14.1 Shelving where specified in the Supplementary Specification or on the main drawings shall be constructed as set out hereunder, entirely from stainless steel 304.

4.14.2 Framework for shelves shall be constructed of rectangular stainless steel tubing not smaller than 25mm x 25mm, 2mm thick.

Legs shall be fitted with load spreading stainless steel feet plates not less than 80mm diameter (or equivalent area if square) and 4mm thick.

4.14.3 Shelves shall be manufactured from 1,2mm thick stainless steel sheet with a 2B finish and fixed to the framework with cleats and brackets to form a robust freestanding unit.

4.14.4 No sharp edges or corners will be accepted.

4.14.5 The top surface of a shelve shall be smooth and flat to enable containers to be slid on and off.

4.14.6 Shelving shall be properly stiffened and braced and capable of supporting a mass of 150kg/m² on all shelves simultaneously.

4.14.7 Shelve units shall be at least 550mm deep and 1,8mm high with four shelves spaced at 450mm vertically.

4.14.8 Shelve lengths shall be provided to allow maximum storage space as indicated on the main drawings.

4.15.0 MEAT RAILS

4.15.1 Meat rails where specified in the Supplementary Specification or on the main drawings shall be constructed as set out hereunder.

4.15.2 Meat rails shall be floor standing and firmly bolted to the floor.

4.15.3 The stanchions shall be not less than 80mm diameter medium class piping with 300mm diameter x 12mm thick welded baseplates and four 12mm diameter holding down stainless steel bolts per baseplate.

4.15.4 The stanchions complete with baseplates shall be hot dip galvanised after manufacture.

4.15.5 The rail shall be manufactured from not less than 50mm x 12mm thick stainless steel flat bar.

4.15.6 The rails shall be suspended from a crossbeam not less than 150mm x 50mm x 6mm thick mild steel channel which in turn is bolted to and supported on the stanchions.

4.15.7 The crossbeam shall be hot dip galvanised after manufacture.

4.15.8 Suspension supports for the rail from the crossbeam shall be not less than 50mm x 12mm thick stainless steel flat bar.

4.15.9 The entire meat rail unit shall be bolted together with stainless steel bolts and nuts not less than 12mm diameter.

4.15.10 Top of meat rail height shall be not less than 2000mm above finished floor level.

4.15.11 Rails shall be designed to safely support up to 500kg/m length.

4.15.12 Rails shall be equipped with not less than four stainless steel hooks per metre rail length or as specified in the Supplementary Specification.

4.16.0 LIGHTS

4.16.1 Cold/freezer rooms shall be equipped with lights generally at not less than 1 light per 10m².

No room shall however have less than two lights fitted.

4.16.2 Lights shall be wired from the refrigeration control panel with a separate circuit breaker.

4.16.3 A combined light with indicator pilot light for control of the lights shall be next to the door for each room.

The light switch shall be finished in neat baked enamel to blend in with the panel finish and shall be to the manufacturer's standard.

4.16.4 Lights must be symmetrically spaced with regards to the shelves and rails to ensure maximum light in passages and all parts of the rooms.

4.16.5 The lights and fittings complete with wiring must be entirely moisture proof and suitable for cold/freezer room applications.

4.17.0 MORTUARY BODY CABINETS

4.17.1 General

4.17.1.1 Generally three types of body cabinets may be required, namely:-

- ? Standard three body cabinet
- ? Standard six body cabinet
- ? Standard three body freezer cabinet

4.17.1.2 Standard Three Body Cabinets

The external dimensions of each three body cabinet shall be 2,665m long x 0,822m wide x 1,929m high, and shall be manufactured strictly according to all dimensions shown on drawings ME 800R/13/1 and -/13/2.

4.17.1.3 Standard Six Body Cabinets

The external dimensions of each six body cabinet shall be 2,815m long x 1,520m wide x 1,929m high, and shall be manufactured strictly according to all dimensions shown on drawings ME 800R/14/1, -/14/2 and -/14/3.

4.17.1.4 Three Body Freezer Cabinets

The external dimensions of the three-body freezer cabinet shall be 2,665m long x 0,822m wide x 1,929m high, and shall be manufactured strictly according to all dimensions shown on drawings ME 800R/15/1 and -/15/2.

4.17.2 Construction of all Body Cabinets

4.17.2.1 The framework of the cabinet shall be manufactured from well-seasoned Meranti or specially selected, steam treated and aged clear S A Pine, mortised and tenoned together and rendered waterproof with a bituminous solution.

4.17.2.2 Cabinet external surfaces and doors all-round shall be clad with 0,9mm thick stainless steel sheetmetal with a satin finish.

4.17.2.3 No galvanised sheetmetal may be used anywhere in the construction of the cabinet.

4.17.2.4 All corners shall be neatly rounded.

4.17.2.5 All internal surfaces of the cabinet shall be clad with 0,8mm thick, type AISI Grade 304 stainless steel with a satin finish. All seams shall be rendered watertight.

4.17.2.6 The space between the interior and exterior double skin cladding of standard body cabinets shall be insulated with 100mm thick polystyrene insulation material with a density of 24kg/m³ or alternatively polyurethane with a density of 40kg/m³.

4.17.2.7 For freezer body cabinets the insulation shall be 100mm thick polyurethane with a density of 40kg/m³.

4.17.2.8 Doors shall be insulated as for freezer body cabinets or alternatively the void between the interior and exterior cladding shall be filled with foamed-in-place polyurethane insulation material.

4.17.2.9 The reveals of cabinet door openings shall be fitted with gloss black "Perspex" breaker strips of approximately 100mm wide x 4mm thick, glued to all four sides of each door opening.

4.17.2.10 As an alternative to the wooden frame construction, use may be made of the method where prefabricated panels, double skin as for cold rooms but with sheet metal lining and insulation as above is used for the top, sides and bottom panels. This method may however only be applied for the top, sides and bottom of the cabinet, the door frames and rear of the cabinet are to be reinforced with timber as shown on the drawings.

4.17.2.11 Each door shall be hung on two robust hinges and fitted with a lockable latch and strike of approved manufacture. The swing shall match the layout as indicated on the main drawings.

4.17.2.12 Freezer cabinet doors shall be provided with double trace wire heater elements as specified for prefabricated freezer room doors.

4.17.2.13 The removable rear panel shall be reinforced with timber as shown, to carry the air-cooling, blower coil, and condensing units. The service panel shall serve to connect the entire refrigeration system on a slide in slide out basis and shall be accurately manufactured to ensure that it will be interchangeable on any other cabinet manufactured to this specification.

4.17.2.14 The removable rear service panel shall seal neatly and tightly against the face of the rear wall and shall be held in place by four clamps, as shown on drawing ME 800R/14/3.

4.17.2.15 All doors shall be fitted with airtight rubber gaskets all-round, which can be easily replace when necessary.

4.17.2.16 All door hardware shall be of highly polished chromium plated finish, fixed with stainless steel screws/bolts.

4.17.2.17 The cabinet shall be mounted on four adjustable feet.

4.17.2.18 Freezer cabinets shall be provided with pressure/vacuum valves.

4.17.2.19 A 32mm brass chromium plated waste fitting with screwed outlet and rubber or vulcanite plug shall be provided and positioned near the front end of each cabinet. The flange of the waste fitting shall be flush with the bottom plate of the cabinet to ensure complete drainage. Tenderers shall allow for 4 metres of 32mm rigid PVC drainpipe plus fittings to be piped to the nearest drain point.

4.17.3 Body Trays (All Cabinets)

4.17.3.1 Each body compartment shall be provided with a dished body tray, manufactured in accordance with drawings ME 800R/13/3 and -/13/4.

4.17.3.2 The body tray shall be manufactured from 1,25mm thick type AISI Grade 304 stainless steel sheet with a satin finish, folded form a single sheet to the details shown on the drawings. The tray shall be welded on the corners and to the tubular frame. The tubular frame shall be manufactured form 25mm outside diameter stainless steel tube with a wall thickness of at least 2mm.

4.17.4 Internal Fittings (All Cabinets)

4.17.4.1 The body trays shall slide into the cabinet on four sets of rollers each, as shown on drawings ME 800R/13/1, -/13/2 and -/13/5.

4.17.4.2 The rollers shall be manufactured from nylon to the details shown on the drawings.

4.17.4.3 The rollers shall run on 16mm diameter stainless steel 304 shafts.

4.17.4.4 The roller assemblies shall be held in place in the cabinet by means of folded stainless steel 304 supports of 1,25mm thick stainless steel sheet, as shown on the drawing.

4.17.4.5 Folded stainless steel 304 guides shall be provided between each first and second roller assembly as shown.

4.17.4.6 End stops shall be provided across the rear of the cabinet to prevent the trays sliding past the rear limit indicated on the drawing. End stops shall be robustly constructed from stainless steel 304 square tubing, and fitted with 20mm x 20mm solid rubber bumper strips to cover the full width of body trays.

4.17.4.7 All equipment shall be secured by means of rivets.

4.17.4.8 All dimensions indicated shall be strictly adhered to in manufacture and assembly in order to ensure uniformity and interchangeability of components.

4.17.5 Refrigeration System (All Cabinets)

4.17.5.1 The condensing and air cooling units shall be mounted on the rear service panel as shown on the drawings to form a complete, self-contained unit to enable slide in, slide out interchangeability.

4.17.5.2 A neat stainless steel instrument panel in which the isolators and pressure switch shall be mounted, shall be provided and fixed to the rear service panel of each cabinet. The isolators and pressure switch shall not be mounted on the service panel.

All wiring and cabling shall be fixed to the panel and equipment with proper cable glands.

4.17.5.3 Pressure switches shall be of the dual type with high and low pressure cutouts. No pressure gauges are required.

4.17.5.4 The refrigerant tubing, instrument panel, electrical wiring etc., shall be factory mounted on the service panel.

4.17.5.5 The refrigeration unit shall be run and thoroughly tested in the factory and shall be delivered to site, ready for operation.

4.17.5.6 The minimum cooling capacity of the combined refrigeration unit for each type of cabinet, at 35ºC ambient air temperature, shall be as follows:

Type	Cabinet temperature	Number of		Minimum capacity		Suction temperature	Temperature difference
		Condensing units	Air cooling units	of each condensing unit	of each air cooling unit		
Standard Three body	1ºC	1	1	850W	850W	minus 7ºC	8ºC
Standard Six body	1ºC	1	1	1 500W	1 500W	minus 7ºC	8ºC
Freezer Three body	minus 12ºC	1	2	1 100W	550W	minus 18ºC	6ºC

4.17.5.7 Blower coil cooling units shall be constructed with casings entirely from aluminium sheeting, preferably embossed.

4.17.5.8 Air cooling units shall be mounted directly onto the service panel. Should a support frame be necessary, the support frame shall be manufactured entirely from AISI grade 304 stainless steel.

4.17.5.9 Support frames and supporting slides for condensing units shall also be manufactured from AISI grade 304 stainless steel.

4.17.5.10 Where more than one body cabinet is installed side by side, proper baffle plates manufactured from 1,2mm thick galvanised sheet metal and square tubing shall be provided and fixed to the condensing units in such a manner that hot air from one unit is not drawn in by the next unit.

4.17.6 Inspection of Mortuary Body Cabinets

4.17.6.1 All body cabinets shall be inspected by the Department's representative during the course of construction and immediately prior to the application of the outer cladding.

4.17.6.2 The inspection will be carried out by an official of the Regional Representative's office of the Department in whose area the cabinets are being constructed.

4.17.6.3 The Contractor will be required to inform the above office within a reasonable time, when such an inspection may be carried out.

4.18.0 ELECTRICAL EQUIPMENT AND INSTALLATION

4.18.1 Unless otherwise stated in the Supplementary Specification tenderers must allow in their price for the complete electrical installation and wiring.

4.18.2 All electrical equipment and wiring shall be in accordance with the current issue of the Department's Standard Specification for Electrical Equipment and Installation for Mechanical Services. Copies can be obtained form the Department, Private Bag X65, Pretoria, 0001.

4.18.3 Power will be provided at the switchboard for cold rooms and at the under counter refrigerator or body cabinet by others.

4.18.4 All compressor motors over 5kW shall be provided with an approved electronic type motor protection unit in addition to the protection called for in the Standard Specification for Electrical Equipment and Installation for Mechanical Services.

4.18.5 Clause 1.2.1(a) of the Standard Electrical Specification shall read "The South African Bureau of Standards Code of Practice for the Wiring of Premises as amended".

4.18.6 Prefabricated cold rooms shall be provided with 100W watertight bulkhead light fittings.

4.18.7 Prefabricated freezer rooms shall be provided with water and vapour proof fluorescent type lights suitable for low temperature conditions.

4.18.8 Lights and fittings shall be wired and sealed to ensure that no vapour or moisture can penetrate the fittings, especially when cooling down when switched off.

4.18.9 All electrical equipment shall be suitable for the supply voltage specified in the Supplementary Specification.

4.18.10 Switchboards shall be in accordance with drawing ME700A/20 Type 2 (wall mounted type) which is attached to the above mentioned Standard Electrical Specification.

4.18.11 A plug socket outlet point will be supplied for each under counter refrigerator or body cabinet by others.

4.18.12 A 30 amp, 2 pole isolator mounted in a 100 x 50mm extension box complete with coverplate must be provided and fixed to the instrument panel on the rear service panel of each body cabinet.

4.18.13 Each mortuary body cabinet shall be supplied completely wired with 6m of heavy duty, 3 core rubber insulated and sheathed flexible cord and a 15 amp plug top.

4.19.0 CONTROLS

4.19.1 The temperature in cold rooms, body cabinets, freezer rooms and freezer cabinets shall be controlled by an electronic thermostat, which controls a solenoid valve in the liquid line. The compressors shall be controlled by a low-pressure switch.

4.19.2 Thermostats shall be of the electronic remote sensor type having a differential of not more than 2ºC (± 1ºC). The sensor of the thermostat shall be located inside the room or cabinet behind the air-cooling unit in the return air stream. The sensor shall be protected by means of a perforated metal or wire screen cover.

4.19.3 Defrosting of the air cooling units in the freezer rooms and freezer cabinets shall be controlled by an electronic time switch. The time switch shall switch the unit into the hot gas bypass mode or electric element defrost mode, as specified in the Supplementary Specification, for the required defrost time period and then switch back to normal cooling mode.

4.20.0 STANDARD EQUIPMENT

Maker's nearest standard equipment will be considered where the quality, capacity and engineering is acceptable to the Department.

4.21.0 PLANT ROOMS

4.21.1 Plant rooms where called for, complete with doors and louvers as shown on the drawings will be provided by the building contractor.

4.21.2 Any additional work called for in the Refrigeration contract shall be detailed on the main drawings

and specified in the Supplementary Specification.

4.22.0 UNDER COUNTER REFRIGERATOR

4.22.1 Cabinet framework shall be constructed as specified above for body cabinets.

Cabinets manufactured entirely from stainless steel will be acceptable.

4.22.2 All exterior surfaces of the cabinet shall be clad with grade 304 stainless steel, 0,9mm thick with a no. 4 finish.

All corners shall be neatly rounded and smooth.

4.22.3 All interior surfaces, including doors both sides, shall be clad with grade 304 stainless steel, 0,8mm thick with a no. 4 finish.

All seams shall be rendered waterproof.

4.22.4 The cavity or space between the inner and outer sheet metal cladding shall be insulated with 75mm thick polystyrene insulation with a density of not less than 24kg/m³.

4.22.5 Doors shall be of the overlap type and not flush type with the seal fixed to the door.

The cavity between the inner and outer cladding shall not be less than 50mm and shall be insulated with foamed-in polyurethane insulation with a density not less than 40kg/m³.

4.22.6 The reveals of the cabinet door openings shall be fitted with gloss black "Perspex" breaker strip 76mm wide, 4mm thick glued to all four sides of each door opening.

4.22.7 Door gaskets shall be solid rubber type ensuring a positive seal against the cabinet sides.

4.22.8 Each door shall be hung on two robust hinges and be fitted with a lockable heavy-duty latch and strike of approved manufacture.

All door hardware shall be chromium plated.

4.22.9 Cabinets shall generally be required to be installed in underbar counters in positions indicated on the main drawings.

4.22.10 Each cabinet shall be divided in to three compartments, each compartment fitted with it's own lockable door.

4.22.11 The condensing unit shall be fitted in the lower portion of one of the compartments to suit the particular installation.

4.22.12 The condensing unit enclosure shall be provided with two stainless steel louvered panels, one on the front and the second one on the side or back ensuring proper ventilation and heat rejection.

The louver panels shall be removable to allow for access to the condensing unit.

4.22.13 The space above the condensing unit shall also be refrigerated and provided with it's own door.

4.22.13 Alternatively the condensing unit may be housed on the side of the cabinet in a full height compartment, again allowing for ventilation and access.

Overall dimensions of the cabinet shall however remain unchanged.

4.22.15 Outside dimensions and cooling capacity of cabinets shall generally be as follows;

Height mm	Width mm	Depth mm	Cooling Capacity W
940	2 400	650	960

The cabinets shall be capable of passing through a door opening not more than 830mm wide.

4.22.16 Each cabinet shall be provided with two heavy duty stainless steel shelves for each compartment of the wire grid or expanded metal type.

Shelves shall be individually adjustable and removable.

4.22.17 Vertical dividers of the same material as the shelves shall be fitted behind the door stiles to divide the cabinet in to three compartments.

4.22.18 Each cabinet shall be mounted on 150mm high stainless steel legs with zinc, die cast adjustable foot pieces of the "bullet" type.

4.22.19 Suitable wooden duckboards covering the entire floor area of the cabinet shall be provided.

4.22.20 The condensing unit shall be of the hermetically sealed air-cooled type with capacity as specified, selected at -7ºC suction temperature and 35ºC ambient air temperature.

4.22.21 The condensing unit shall be charged and ready for use, complete with all necessary controls and 3 metre, 3 core cabtyre type flexible cable with 15 amp plug top fitted.

4.22.22 The indoor cooling unit shall be of the fan driven forced draught type with minimum cooling capacity as specified as a matching unit with the condensing unit at a temperature difference of 8ºC.

4.22.23 A suitable stainless steel drip tray shall be fitted beneath the cooling coil with a 22mm copper drainpipe.

The drain pipe shall be taken to the outside rear of the cabinet, approximately 300mm above floor level and on the side of the cabinet housing the condensing unit.

4.22.24 Temperature control in the cabinet shall be by means of suction pressure switch controlling compressor cycling.

4.22.25 Compressor motor shall be fitted with overload protection.