DEPARTMENT OF PUBLIC WORKS

STANDARD SPECIFICATION

FOR

CENTRAL HEATING INSTALLATIONS

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STANDARD SPECIFICATION

FOR

CENTRAL HEATING INSTALLATIONS

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SECTION 1

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STANDARD SPECIFICATION

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SECTION 1

1. GENERAL REQUIREMENTS

1.1. 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 Central Heating Installations.

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. 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. 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 and amendments.

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 shall 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. 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 shall 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 Technical 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 Technical 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 sleeved and other 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 transparent copy 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.

1.4.4 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. 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 Technical 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. 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. 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 for approval within two weeks of site hand-over.

1.8. MANUFACTURER'S RATINGS

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

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

1.9. 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. GUARANTEE

1.10.1 The 12-month guarantee called for in the Supplementary Technical Specification, shall apply to all items of plant such as boilers, pumps, 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. LUBRICATION

1.11.1 All bearings shall be packed with approved grease or filled with the correct oil, and all gearboxes and sumps shall 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 shall be new and supplied in sealed drums or containers.

1.12. 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 Technical 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 shall 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, shall 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.

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

a) Control Systems:

CIBS : Commissioning Code : Series C : Automatic Controls.

b) Hot Water and Steam Boilers:

CIBS : Commissioning Code : Series B : Boiler Plant.

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, boilers, fans, etc. 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. PERFORMANCE TOLERANCE

1.13.1 All performance figures obtained during testing and commissioning shall be within -5% and +5% of the specified performance figures given in the Supplementary Technical 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. 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. 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. 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 Technical Specification.

1.17. 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. 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. 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) CKS 130 – 1922 Hot water radiators (for central heating)

d) BS 855 Specification for Welded Steel Boilers for Central Heating and Indirect Hot Water Supply (rated output 44kW to 3MW), 1990 edition

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 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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CENTRAL HEATING INSTALLATIONS

SECTION 2

2. MAINTENANCE AND SERVICING

2.1. GENERAL

2.1.1 Unless otherwise specified in the Supplementary Technical 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 1 month, 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 of a check list 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 logbook 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. 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 shall 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. 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. TOOLS

2.4.1 All special tools required, i.e. tools specially designed for the particular equipment offered, shall 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. 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

i) Plant running checklist and frequency of servicing.

ii) Safety precautions to be taken.

iii) Manual and automatic operation.

iv) Operator's duties.

v) Lubricating oils and service instructions.

vi) Pre-start checklist for each system.

vii) Starting and stopping procedures.

SECTION 4: Mechanical Equipment

i) Description of all major items of equipment with the make, model number, names, addresses and telephone numbers of the Supplier, Manufacturer or their Agents.

ii) Design capacities of all equipment including selection parameters, selection curves, capacity tables, etc.

iii) Manufacturer's brochures and pamphlets.

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

SECTION 5: Maintenance Instructions

i) Schedule of maintenance particulars, frequency of service and replacements.

ii) Troubleshooting guide.

iii) Part numbers of all replacements items and spares.

iv) Capacity curves of pumps, fans and compressors, etc.

v) Serial numbers of main items of equipment.

SECTION 6: Electrical Equipment

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

ii) Maintenance instructions.

iii) Manufacturer's brochures and pamphlets.

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

SECTION 7: Instrumentation and Control

i) Description of each control system.

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

iii) Maintenance instructions.

iv) Manufacturer's brochures and pamphlets.

SECTION 8: Drawings

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

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

SECTION 3

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SECTION 3

3. TECHNICAL REQUIREMENTS – GENERAL

3.1. 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. 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 Technical Specification, equipment plinths shall form part of the central heating installation 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 45º chamfer shall finish off all grout corners.

3.2.4 Plinths as specified above shall also be provided for field assembled plenum chambers, pumps, and other equipment.

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

3.2.6 Pumps for water systems shall be installed to ensure an acceptable NPSH with due regard for fluid temperature and vapour pressure to ensure cavitation free operation.

3.3. 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 shall 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 shall run freely on the threads.

3.4. 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 prior 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. 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 shall be thrown about or leak onto the floor.

3.6. 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 shall 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 shall be offered with a temperature safety device, which will safely release the oil in the event of the coupling overheating.

3.7. 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 8 starts per hour for all 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. 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 shall 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 shall be of parallel shims. Taper packs or wedges will not be accepted. Packs shall 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. 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 shall be carefully checked for both the parallelism and eccentricity of their shafts. Alignment shall 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 shall 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 shall 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. 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 shall 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. 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 recommenced, 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 shall 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. GALVANISING

3.12.1 Unless otherwise specified in the Supplementary Technical Specification the following items shall always be galvanised:
Fabricated mild steel sections exposed to the weather.

Steel grilles and louvres 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. PAINTING

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

Hot surfaces shall be painted with appropriate heat resisting paints.

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 diffusers and grilles, shall only be installed after the paintwork on the plant, ceiling or walls 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 SABS 0140, 1978 as amended. Colour code bands and arrow indicators as indicated 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 Plastered surfaces inside plenums shall be painted with a suitable alkali resistant primer to SABS 1414-1987 followed by a universal undercoat with a final coat of high gloss enamel paint to SABS 630, Grade I. The colour of the final coat shall be white.

3.13.10 Lagged and plastered ductwork and plastered surfaces outside plenums shall be painted with a suitable alkali resistant primer to SABS 1414 of 1987 followed by one undercoat to SABS 681, type II and one coat high gloss enamel paint to SABS 630, Grade 1 or PVA exterior type emulsion paint to SABS 634 of 1974 as top coat.

3.13.11 Ferrous casings of cooling towers, evaporative condensers and sprayed coils 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.

3.13.12 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.

3.13.13 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.

3.13.14 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.

3.13.15 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.

3.13.16 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.

3.13.17 All galvanised surfaces inside air handling plenums 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.

3.13.18 For air handling units the entire unit casing, 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.

3.13.19 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. 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 interchangeability 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 Technical 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, which 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 oilless bearings

Self-lubricating or oilless 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. 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.

The following table of recommended isolation efficiencies for critical areas applicable to heavy mass concrete floor slabs serve as a guide only:

CRITICAL AREAS		TRANSMISSIBILITY	ISOLATION EFFICIENCY
1.	Centrifugal compressors	0,5%	99,5%
2.	a) Centrifugal fans larger than 15kW b) Reciprocating compressors larger than 40kW c) Pumps larger than 4kW	1%	99%
3.	a) Axial flow fans larger than 20kW b) Centrifugal fans up to 15kW c) Reciprocating compressors up to 40kW d) Pumps up to 4kW e) Heat pumps f) Fan coil units	3%	97%
4.	a) Axial flow fans up to 20kW b) Air handling units	4%	96%
5.	a) Pipes b) Electrical connections, conduit cabling etc.	8%	92%
6.	Boilers, steam and central heating, larger than 20kW		4 to 7Hz

The following table of recommended isolation efficiencies for general areas applicable to heavy mass concrete floor slabs serve as a guide only:

CRITICAL AREAS		TRANSMISSIBILITY	ISOLATION EFFICIENCY
1.	Centrifugal compressors	5%	95%
2.	a) Centrifugal fans larger than 15kW b) Reciprocating compressors larger than 40kW c) Pumps larger than 4kW	8%	92%
3.	a) Axial flow fans larger than 20kW b) Centrifugal fans up to 15kW c) Reciprocating compressors up to 40kW d) Pumps up to 4kW e) Heat pumps f) Fan coil units	10%	90%
4.	a) Axial flow fans up to 20kW b) Air handling units	15%	85%
5.	a) Pipes b) Electrical connections, conduit cabling etc.	20%	80%
6.	Boilers, steam and central heating, larger than 20kW		8 to 15Hz

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 Pumps

All pumps with their motors shall be mounted on a baseframe, 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.

3.15.5 Fans

3.15.5.1 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.

3.15.5.2 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.

3.15.5.3 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.

3.15.5.4 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.

3.15.6 Piping

3.15.6.1 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.

3.15.6.2 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.

Proper sleeves of approved materials shall be fitted at wall penetrations.

3.15.6.3 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.

3.15.7 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

and all other plant (Duct mounted and/or 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 repellant 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.

3.15.8 Air-Borne Noise

Selection and installation of all items such as valves, traps, 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 pipe 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.

3.15.9 Room Units

Where room units such as fan coil units are used, it is essential that the acoustical characteristics of such units are considered during selection and that they are installed to ensure compliance with the noise criteria laid down.

The sound pressure level from these machines shall be within the set criteria throughout the frequency range.

3.15.10 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.

3.15.11 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.

3.15.12 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 shall 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. ELECTRICAL EQUIPMENT AND INSTALLATION

3.16.1 Unless otherwise stated in the Supplementary Specification tenderers shall 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 Technical Specification.

3.16.4 All 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.

3.16.5 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".

3.16.6 The fault level of the central heating installation distribution board shall be as specified in the Supplementary Technical Specification.

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

3.16.8 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. 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

CENTRAL HEATING INSTALLATIONS

SECTION 4

4. TECHNICAL REQUIREMENTS – EQUIPMENT AND MATERIALS

4.1 GENERAL

4.1.1 Heating Systems

Unless otherwise specified the central heating system shall be a low pressure re-circulating hot water system heated by one of the following heat sources;

- coal fired boiler
- fuel oil fired boiler
- gas fired boiler
- electric heated, direct or storage type system
- heat pump, air to water, water to water
- steam calorifier, non-storage type

4.1.2 Boilers

The design, manufacture, installation and operation of the equipment shall comply fully with all the relevant requirements of the Atmospheric Pollution Prevention Act 45 of 1965, as amended, and any regulations promulgated thereunder.

4.1.2.1 Written permission shall be obtained from the local authority Chief Air Pollution Control Officer for the area where any new boiler is to be installed.

4.1.2.2 The Contractor shall supply and install all notices and warning signs that are required as set out in the relevant Regulations and Acts, and/or by these documents.

4.1.2.3 Where applicable the Contractor shall apply in good time to the Department of Labour for permission to erect the boiler/s on behalf of the Department.

4.2.1.4 Boiler rating shall be based on the particular fuel and quality specified in the Supplementary Technical Specification.

Tenderers shall submit written guarantees with their tenders stating maximum specified fuel consumption of the boiler as tendered at specified MCR.

4.2 COAL FIRED BOILERS

4.2.1 Boilers

4.2.1.1 Welded steel or cast iron sectional central heating boilers of approved make and of the sizes and heating capacity specified in the Supplementary Technical Specification, complete with all control dampers and access doors shall be provided and installed in the boiler room where shown on the main drawing.

Boilers shall comply in every respect with BSS 855.

4.2.1.2 Boiler capacity shall not be based on heat transfer rate in excess of 14kW/ m^2 at maximum continuous rating.

4.2.1.3 Each boiler shall be fitted with a copper plate in a clearly visible position indicating;

- ? hydraulic test pressure
- ? heating capacity, kW
- ? Make
- ? Model number
- ? Date of manufacture

4.2.1.4 The hydraulic working pressure shall be as stated in the Supplementary Technical Specification.

4.2.1.5 Each boiler is to be provided with the following as a minimum;

a) A pressure gauge of not less than 100mm diameter fitted to the top of the front section

b) A hot water flow connection as recommended by the boiler manufacturer

c) Two return flow connections

d) Drain cock and plug (min. size 50mm)

e) Heavy cast iron gate bars for boilers where automatic stokers are not fitted

f) A complete set of cleaning and stoking tools consisting of clinker tool, slice bar, scraper, flue brush and shovel, which are to be suspended from steel brackets mounted on a rack fixed to the wall of the boiler room.

g) A brass case angle type, mercury in glass or coloured alcohol thermometer fixed in each of the flow and return pipes immediately above the connection to the boiler.

h) The boiler is to be raised and mounted on a base not less than 250mm above floor level so as to provide an additional 250mm space for ash and possible future automatic stoker if not specified.

The base is to be either a cast iron distance piece or hard firebrick and is to be provided with a suitable ash cleaning opening in front of the boiler.

The base at the back of the ash door and sides to be tapered down for the easy raking out of ash.

i) Where indicated on the main drawing a connecting pipe from the boiler to the chimney shall be provided. The flue gas pipe is to be constructed of not less than 2.65mm sheet steel with flanged joints and any deviation from the straight shall be by means of long radius bends.

For brick chimneys a steel register plate shall be fitted at the flue pipe entry to the chimney.

Suitable doors for cleaning purposes shall be provided at the flue bases.

Long lengths of horizontal flue gas pipe shall be supported by means of heavy metal brackets fixed to the boiler room ceiling at intervals not greater than 2.5m. Joints shall be flanged and cleaning doors shall be provided at intervals not exceeding 3m. All bends shall also be provided with cleaning doors.

j) Where specified in the Supplementary Technical Specification a steel stack shall be provided where no brick chimney is available, generally as per this specification with diameter as specified, but not less than the manufacturer's recommendation.

4.2.1.6 The external surface of all smoke pipes inside the boiler room shall be insulated and covered with galvanised sheet metal cladding.

4.2.1.7 The boiler shall be suitable for manual stoking, de-scaling and operation, or semi-manual with automatic underfeed stoker as specified in the Supplementary Technical Specification.

4.2.2 Automatic Stokers and Controls

4.2.2.1 Automatic Storker

Each stoker shall be complete with controls, infinitely variable hydraulic gearbox, hopper, burner, fan, motor, starter and safety devices.

The coal hopper shall be constructed of sheet steel and shall hold at least 5 hours of fuel. The coal feed screw shall be of alloy steel to resist the effects of abrasion, cohesion and heat and shall run in a thick steel tube with joints provided between hopper and burner, for easy removal and replacement of the coal screw.

The retort section shall be made up of heat resisting cast iron tuyeres and manufactured in sections for easy replacement.

The entire area surrounding the burners and retort shall be bricked up with matching refactory brickwork.

The coal feed tube shall be pressurised with damper adjustable forced draught air.

The stoker speed control shall be arranged to give infinitely adjustable feed control over its full range of rates of coal feed. The rate of air supply and coal feed shall be mechanically interlocked and arranged for both manual and automatic control.

A shear pin shall be fitted to the final worm shaft. The pin shall be readily accessible for replacement.

Drive mechanism shall be easily removable and provision shall be made for screw removal.

The stoker shall be the standard unit normally supplied by the particular boiler manufacturer.

The following items shall be provided for each boiler;

a) One removable 6mm thick steel clinker tray below the ash door, mounted on 38mm x 38mm x 6mm angle iron legs suitably stiffened.

b) One ash rake

c) One slice bar
d) One set of spanners

4.2.2.2 Controls

For each boiler/ stoker combination the following controls shall be provided.

Control Thermostat

The stoker shall be automatically controlled on a continuous basis from a control thermostat located in the main outflow pipe from the boiler.

The thermostat control shall maintain the outflow water temperature at 80ºC ± 2ºC or such set point as specified in the Supplementary Technical Specification by controlling the stoker feed rate and fuel-to-air ratio.

Safety Thermostat

A safety thermostat shall be provided in the outflow pipe at the top of the boiler. The safety thermostat shall be set to stop the stoker operation and boiler fans (where applicable) should the temperature rise above 85ºC or such temperature as specified in the Supplementary Technical Specification.

Interlocking

Boiler controls shall be interlocked with the main circulating pump to prevent stoker and fan (where applicable) operation should the circulating pump not be in use. A flow switch with time delay built into the main out flow pipe from the boiler and the pump motor contactor shall be used for this purpose.

4.3 FUEL OIL FIRED BOILERS

4.3.1 General

Fuel oil fired boilers shall only be provided where specifically specified in the Supplementary Technical Specification.

4.3.2 Boilers

Boilers shall generally comply with clause 4.2 above with temperature controls, over-riding thermostat protection and circulating pump interlocks.

4.3.3 Fuel Oil Burners

4.3.3.1 Burners shall be capable of burning all currently available fuel oils, from heavy duty oil to light fuel oil such as diesel, needing only minor adjustments to match the specific fuel requirements specified in the Supplementary Technical Specification.

Burners of the rotary cup type are preferred.

4.4.3.2 Fully automatic modulating control over a wide range of turndown on all possible fuels shall be provided, controlling from the leaving water temperature.

4.4.3.3 Combustion air shall be provided by centrifugal fan with integral damper control and proper air distribution throughout the burner operating range.

4.4.3.4 Heavy fuel oils needing assisted ignition shall be provided with either a LP gas or diesel igniter with integral ignition flame monitor.

The igniter fuel shall be as specified in the Supplementary Technical Specification.

4.4.3.5 Fuel oil flow shall be automatically controlled with metered modulating control in response to the boiler load demand and provided with a safety cut-off valve.

4.4.3.6 All burners shall be equipped with an automatic ignition and main flame (as applicable) proving system.

4.4.3.7 Automatic sequencing, supervisory and modulating controls shall be housed in a robust steel cabinet and shall incorporate all necessary safety circuits, relay logic and programmable logic control based controls with electrical/ electronic modulating control.

4.4.3.8 Combustion emissions shall comply with the Atmospheric Pollution Prevention Act with the fuel specified for the particular application.

4.43.9 Automatic controls shall incorporate safe light-up and shutdown sequence control with pre-purge, pre-ignition and lock out safety timed intervals.

Controls shall be configured fail-safe.

4.3.3.10 Fuel oil storage and piping shall be provided as set out in the Supplementary Technical Specification.

4.3.3.11 Hot flue gas exhaust piping and stack/ chimney generally as per 4.2 above.

4.4 GAS FIRED BOILERS

4.4.1 General

Gas fired boilers and type of gas fuels to be used shall be provided as specified in the Supplementary Technical Specification.

4.4.2 Gas Boilers

4.4.2.1 The boiler/ s shall be of the naturally aspirated compact modular type suitable for use in banks to match the specified heating requirements.

4.4.2.2 Boilers shall be of cast iron construction with integral heat exchanger and series water flow.

4.4.2.3 Each modular boiler shall be a fully packaged and factory listed unit.

4.4.2.4 Each boiler shall be complete with;

- naturally aspirated burners
- venturi type mixer tube
- gas jet
- adjustable primary air shutter
- gas manifold
- combination gas control valve
- internally piped safety type pilot gas flame unit with thermo-couple controls
- flue pipe

4.4.2.5 Boiler control shall be either individual control thermostats, step sequence control or programmable logic controller as specified in the Supplementary Technical Specification.

4.4.2.6 Safety thermostats and circulating pump interlocks shall be provided generally as per 4.2 above with all controls fail-safe.

4.4.2.7 Hot gas flue pipes generally as per clause 4.2 above.

4.4.2.8 Unless otherwise specified in the Supplementary Technical Specification an exhaust stack or chimney will not be required. Hot gas discharge to be piped to a safe and convenient point outside boiler room.

4.4.2.9 Provision shall be made for adequate replacement air inlet to the boiler room for boiler aspiration.

4.5 DIRECT ELECTRIC HEATED STORAGE TYPE SYSTEMS

4.5.1 General

Where specified in the Supplementary Technical Specification the heating for the central heating system shall be provided by direct electric heating with hot water storage tanks and associated piping, controls and circulating pumps.

4.5.2 Hot Water Storage Tanks (Calorifiers)

4.5.2.1 Hot water storage tanks shall be supplied and installed where shown on the main drawings. Each hot water storage tank shall have a nett storage volume as specified in the Supplementary Technical Specification.

4.5.2.2. Tanks shall be of mild steel, all welded construction type having a horizontal or vertical configuration, with outward dished ends and supported on integral steel bases.

4.5.2.3 All piping connections shall be flanged irrespective of size. A manhole shall be provided with a 500 mm diameter clear entrance and shall be flanged with a bolted cover fitted with handles for ease of maintenance.

4.5.2.4 The tank's shell shall be circular and the internal diameter and shell length shall enable it to fit within the plant rooms available.

4.5.2.5 The calorifier shall comply with A.S.M.E. 8 and / or B.S.S. 857, and shall be suitable for the design pressures and temperatures. Testing in accordance with the above specifications shall be carried out by an approved inspection authority during manufacture and the appropriate test certificates shall be submitted to the Department's Representative.

4.5.2.6 Final pressure testing shall be carried out with the heating elements installed and shall be witnessed by the Department's representative.

Design pressure shall be not less that specified in the Supplementary Technical Specification with a design temperature of 90ºC.

The corrosion factor can be assumed to be the equivalent of 1 mm material thickness.

4.5.2.7 The responsibility for the design strength of the tank rests solely with the contractor.

However, under no circumstances shall the tank's shell be formed from plating of less than 6,0 mm thickness. The tank shall be supported off the ground by means of two steel bases raised high enough off the floor to accommodate, when insulated, a bend in the piping from the drain connection. A concrete levelling foundation not less than 150 mm above the finished floor shall be provided to rest the steel bases on.

4.5.2.8 The tanks shall be complete with insulation supporting cleats, welded to the shell exterior at radii of say 300 and 60 mm, spaced approximately 300 mm apart, and any other hook or pin that may be required on the shell in order to retain the insulation in place. (see appropriate clause herein after).

4.5.2.9 An earthing plate shall be welded to one of the steel bases and a maker's plate to the shell, the latter to protrude past the insulation stating the manufacturer's name, material used, capacity of tank, working and test pressure, date, etc.

4.5.2.10 The tanks shall undergo a hydraulic test on site at a pressure of not less than the design pressure measured with a gauge at the top of the vessel. This pressure shall be maintained for at least 6 hours without the tank leaking or undergoing any excessive distortion. Test results, etc., shall be submitted to the Department for their records as well as entered in the Operating & Maintenance Manuals.

The Certificate of Compliance and test certificate required to be issued by a government authorised inspection company such as AVCO Inspection cc shall be submitted for approval before the tanks are delivered to site. The certificate shall state that the tank materials, their parts, thickness, the welding procedure, etc., are acceptable and/or are in full compliance with the specification as well as stating that the Pressure Test has been witnessed by said Company and found to be in order.

4.5.2.11 Externally the tank's surface shall be wire brushed and two coats of Apexior or two coats of approved suitable heat resisting aluminium paint shall be applied. The first coat shall be applied not later than four hours after wire brushing. The second coat shall be applied in the times laid down by the manufacturers of the paint.

A third coat of heat resisting aluminium paint or Apexior shall be applied on site, after touching up all damaged areas, immediately before the lagging is installed.

No internal coating is required.

4.5.2.12 Pipe take-offs and connections shall be similarly treated, and shall be extended to the inside of the boltholes.

4.5.2.13 On completion of the application of the coating product the coating manufacturer shall submit a certificate clearly stating that these coatings were applied under his supervision and completely in accordance with his recommendation.

It is to be noted that notwithstanding the foregoing the coatings offered shall be suitable for the design temperature and application.

4.5.2.14 The tanks shall be delivered to site with all their connections blanked off with plywood or PVC boards/plates, these seals shall be in position until piping is connected. The tanks themselves shall also be kept protected while on site from damage by mortar, dirt, etc., by means of a tarpaulin or a similar approved method. Prior to insulation being applied the tank's external surfaces shall be re-examined and if found dirty, etc., insulation shall not be applied without the Department's representative firstly having examined the tank's surface, and the damage being satisfactorily repaired.

4.5.2.15 All pipes connected to the tank shall be supported independently from the tank so that the minimum of stress is applied to the tank itself.

4.5.2.16 The calorifier shall be provided with the following connections located in approximately the positions indicated in the drawings.

a) One flanged water inlet at low level.
b) One flanged hot water outlet at high level.
c) One flanged spare inlet/ outlet.
d) One flanged safety valve connection at high level.
e) Two flanged thermometer pockets.
f) One flanged control thermostat pocket for each independent heater bank.
g) One flanged high limit thermostat pocket at high level.
h) One flanged drain connection.
i) One flanged pressure gauge connection.
j) One access manhole of sufficient size to enable a man to enter the calorifier.
k) Suitable flanged mountings for the heating element clusters as indicated on the drawings.
l) One flanged air vent/ vacuum break pipe connection.

4.5.2.17 All pipe connections shall be in the form of flanged stubs.

Flanged connections shall be provided with welded-on steel flanges complying with B.S.S. 4504 Table 16, and/ or with S.A.B.S. 1123, Table 16.

4.5.2.18 All connections and pockets shall project sufficiently to allow for the specified insulation thickness. All connections and pockets shall be fully accessible outside the calorifier lagging. All bolts, flanges and pockets shall be at least 50mm clear of the outside of the lagging.

The thickness of the insulation shall be as set out herein.

4.5.2.19 All cladding shall be neatly finished off with all edges being properly beaded and secured with nickel-plated self-tapping screws or pop rivets.

4.5.2.20 All cut outs for pockets or pipe connections to the calorifier shall be neatly finished with

concentrically cutout coverplates with properly beaded edges.

4.5.3 Heating Elements

4.5.3.1 Each hot water storage tank (calorifier) shall have not less than two (2) heating element banks with independent power supply to each bank.

4.5.3.2 The control system shall automatically switch the heating element banks on and off consecutively as needed.

4.5.3.3 Heater elements shall be of the water heating immersion type suitable for the power supply.

The elements in each cluster shall be suitable for operation from a 3-phase, 4-wire supply, with voltage as specified in the Supplementary Technical Specification and shall be so arranged as to form a balanced 3-phase load.

4.5.3.4 Each calorifier heater bank shall be provided with electrical control thermostats for the control of each electric heater cluster. Furthermore, a high limit safety thermostat shall be provided to switch off all the calorifiers' heater clusters.

4.5.3.4 All thermostats shall be adjustable over a range of temperature from 15ºC to 90ºC and shall have a temperature differential of not greater than 3ºC. The setpoint shall be lockable.

Thermostats shall be provided with suitable pockets welded into the calorifier shell so that should it be required, the thermostats can be withdrawn from the calorifier pocket without having to drain the calorifier. The heat sensitive part of the thermostat shall project not less than 75mm into the controlling fluid.

Electronic type thermostats shall be used.

4.5.3.6 Elements shall be designed for a low emission density to avoid excessive element temperatures. All elements shall be provided with heavy-duty brass terminal studs and lock nuts for the electrical connections.

4.5.3.7 Brass or copper plate interconnecting straps shall be provided between elements of each phase group. Wire jumpers will not be accepted. Separate incoming terminal studs and locknuts shall be provided to accommodate the power supply wiring. The element terminals may not be used for this purpose.

Each calorifier shall have heating banks arranged as specified in the Supplementary Technical Specification.

4.5.4 Electrical Installation

Electrical installation requirements shall be set out in the Supplementary Technical Specification including fault level distribution board, circuit breakers, contactors, relays, overloads, etc.

4.5.5 Demand Control Systems

4.5.5.1 General

Where specified in the Supplementary Technical Specification the electric heating control of the storage water heaters shall be kVA-demand controlled, where each heater bank is to form one step of heating.

kVA-demand measuring shall be done on the HT electrical supply side or as specified.

In the heating mode the maximum kVA demand is to be set at the specified value (adjustable). Should the measured building kVA-demand drop sufficiently the first step of heating is to be switched on, increasing the measured building kVA to approximately the specified maximum value. This saw-tooth demand profile is to be repeated until all heater banks are switched on.

Should the measured building kVA-demand remain persistently and sufficiently below the specified value with sufficient positive load adjustment available, the maximum demand controller shall allow (via internal timers/load priorities etc.) the remaining heater banks to be switched on at three minute intervals until all heater banks are switched on.

However should the predicted maximum building kVA-demand exceed the specified maximum value the connected loads shall be reduced via their priorities at three-minute intervals to ensure that the instantaneous maximum demand does not exceed the user definable value.

The adjustable target maximum demand required shall be set by the contractor, and will depend on the prevailing building energy demand at the time of installation. The load value's operational properties and on/off timer values shall be user definable, and front of panel programmable. A key switch is to be provided to lock out unwanted program changes on the maximum demand controller.

The maximum demand controller shall offer a visual display of instantaneous kVA loading, target maximum demand, predicted maximum demand, the time remaining in each 30/60 minute block interval, real time and the load adjust value. The display of this information is to be in the form of LED’s. Information with respect to the number of loads shed and whether the maximum demand sensor is in either shed or restore condition is to be displayed.

4.5.5.2 Controller Construction

The maximum demand controller shall be of modular construction to allow for ease of maintenance. Any of the control cards shall be easily removable. The controller shall be wall mounted or panel mounted and shall have a minimum of eight relay outputs for load control.

4.5.5.3 Controller Operation

The maximum demand controller shall accept energy weighted inputs and shall be able to accept two feeders i.e. two pulsing inputs of kVA/hr. These will be summated by the maximum demand controller. In the event of more than two feeders the maximum demand controller shall be upgradeable to a maximum of eight feeders.

The energy weighing of each input pulse shall be user configurable for separate values per feeder. The maximum demand controller shall operate in a block interval.

The maximum demand controller shall have a memory support for all set-up parameters, and a minimum of the last six months, month end resets. The controller shall also allow for both external month end reset and block interval reset via third party devices with modem connections.

4.5.5.4 Front-End

In order to connect the maximum demand controller to the power supply, C.T. secondaries as specified and a three wire V V.T output as specified shall be provided. These outputs shall be connected directly to the front-end device, which shall be front panel programmable for both C.T. primary values and V.T. ratio. The device shall operate on an internal timer to allow for 30/60 minutes block intervals, and shall display Voltage, current, maximum demand in both kW and kVA, kVA.hr, kVAR.hr and instantaneous kW and kVA. The device shall also feature both ASCII and MODBUS protocols as standard.

Upon a power outage the device shall store (in non-volatile memory) all set-up parameters and energy and maximum demands for kW/kVA and line currents. The device shall be fitted with pulsing contacts for both kW.hr and kVA.hr, which shall be front of panel programmable for their energy weights.

4.5.5.5 Interconnection

The maximum demand controller shall, via the on board power supply provide a signal which is to be used for the pulsing outputs on the Front end, and this signal shall in turn feed back to the maximum demand controller as energy pulses.

A 3-day battery back-up annually programmable overriding time switch is to be provided to override the kVA-demand controller. This timer shall be programmed to allow the heater banks to be switched on and off by the kVA demand sensor between the 15th of May and 15th of August of each year. Outside of these dates the entire central heating system shall be at rest. Overriding of the kVA demand sensor is also to be affected during the weekends falling between the above dates. A weekend shall start at 16:00 on a Friday and terminate at 16:00 on the following Sunday. The hot water storage reservoirs shall not be heated on weekends.

A temperature sensor mounted at the bottom of the hot water storage reservoir shall override both the building kVA- demand sensor and the time switch. All heater banks of the hot water storage reservoir on which the temperature sensor is mounted shall be controlled simultaneously from the temperature sensor. When the hot water temperature is sensed at 85 C, both heater banks shall be switched off. When the sensed temperature drops to 75 C or below, heater banks are to be switch-controlled from the building kVA-demand sensor and associated timer unit until the sensed temperature again reaches 85 C.

4.5.6 Building Circulation

Unless otherwise specified in the Supplementary Technical Specification the central heating of the building shall be time switch controlled, by switching the circulating pumps on and off. The circulating pump shall be switched on each morning Mondays to Fridays at 05:00 and switched off Mondays to Fridays at 16:00 between the 15th of May and the 15th of August of each year. Outside of these dates the circulating pump shall not be switched on or off, when the central heating system shall be at rest.

The supply water temperature to the building's central heating system shall be automatically controlled by means of a three way modulating mixing valve. The supply water temperature to the central heating system shall be maintained at a temperature (adjustable) as specified in the Supplementary Technical Specification. The supply water temperature shall be sensed by a modulating controller, which is to activate an actuator driven three way mixing valve. When the circulating pump is switched off, the mixing valve shall return to a rest position where make-up hot water flow from the storage tanks to the building hot water heating pipes is closed off.

The mixing valve shall operate in a bypass arrangement form the circulating pump to the building, blending bypass water and water from the storage tanks.

4.6 HEAT PUMPS FOR CENTRAL HEATING

4.6.1 Heat pumps shall be of the air-to-water, water-to-water or air-to-air or as specified in the Supplementary Technical Specification.

4.6.2 Refrigerant to water heat exchangers shall be corrosion resistant and suitable for use with the local water at high temperature and flow velocities.

4.6.3 Shell and tube condensers are preferred for air to water applications.

4.6.4 Heat pumps shall be completely self contained units with stainless steel or epoxy powder coated casings and cladding, suitable for permanent outdoor use where required.

4.6.5 Condenser and condenser piping circuits shall be properly insulated.

4.6.6 A condensate drippan of stainless steel 430 shall be fitted and piped to the nearest building drain, allowing for defrost cycles.

4.6.7 Heat pumps shall be selected for a maximum compressor running operation of 20 hours per day.

4.6.8 Reverse cycle automatically controlled defrost shall be provided as standard. Defrost shall be demand controlled and not timer controlled.

4.6.9 The heat pump shall be suitable for operating with ambient wet bulb temperatures as low as -10ºC and as high as 35ºC.

4.6.10 Heat pumps for central heating hot water shall heat the water to 60ºC (or as specified) and shall be selected to ensure correct functioning with water inlet temperature as low as 40ºC and as high as 50ºC.

4.6.11 Heat pumps with a coefficient of performance (COP) of less than 3.0 at ambient wet bulb temperature of 10ºC with secondary circuit inlet temperature 40ºC will not be acceptable.

4.6.12 Each heat pump shall be fitted with a control and fault indication panel to provide status indication on fault occurrence and operation mode.

4.6.13 A flow switch shall be fitted to the water or air secondary circuit and the heat pump control interlocked with the flow switch.

4.6.14 Heat pumps shall be fitted with head pressure control set at ensuring constant 60ºC water supply temperature at all possible water inlet temperatures and flows.

4.6.15 Compressors shall be well known products of an approved manufacturer.

Motor windings shall be suitable for the temperatures experienced in heat pump applications, particularly hermetically sealed units.

Operating pressures and temperatures shall comply with the manufacturer's recommendations.

4.6.16 Provision shall be made in the refrigerant circuits for liquid collection during periods of not being in use.

4.6.17 The compressor shall be interlocked with the evaporator fan/s and the flow switch to prevent operation unless these elements are functional.

4.6.18 Each refrigerant circuit shall be fitted with a sight glass, replaceable filter drier, manual liquid shut-off valve, high- and low-pressure switches and pressure gauges.

4.6.19 Controls shall be fitted to prevent compressor short cycling on low demand.

4.6.20 Crankcase heaters shall be fitted where application and unit size warrants the use thereof.

4.6.21 Where a standby heater is required with a heat pump application the standby heater shall be switched on automatically on heat pump failure with heating called for.

4.6.22 Suction- and discharge pressure gauges shall be provided on the instrument panel.

4.6.23 Noise levels shall comply with clause 3.15.0.

4.6.24 Easily detachable/ openable panels of rigid construction giving access to all working parts of the unit shall be provided.

4.7 STEEL STACKS

4.7.1 General

Steel stacks shall be provided for boilers as indicated on the drawings.

The stack diameters and heights shall be as specified in the Supplementary Technical Specification. Where no such dimensions are specified, they shall be in accordance with the requirements of the boiler manufacturer and the Local Authority, generally not lower than 20m above boiler room floor level.

Stacks shall be either self-supporting or supported off the boiler, as specified in the Supplementary Technical Specification.

The stack shall be manufactured to it’s full height from stainless steel 3CR12 or 304, thickness not less than 4,0mm, or as specified in the Supplementary Technical Specification.

Stacks and supports/stays shall be designed for a wind velocity of at least 260km/h.

Base design, stack support and stack shall be based on site soil conditions and wind forces and design details shall be certified by a registered professional structural engineer. Contractor to submit engineer’s design and report for approval before construction commences.

4.7.2 Boiler Supported Stacks

Each coal fired boiler shall be provided with it's own independent stack.

The stack shall be constructed in sections from welded plates, the lower half to be at least 4,0mm thick. The entire mass of the stack shall be carried by the boiler. Where stacks pass through the boiler house roof, the necessary flashing and weatherproofing shall form part of the boiler contract.

A flanged connection shall be provided between the boiler and stack. Each stack shall be provided with a damper of the butterfly type of at least 6mm thick stainless steel plate, arranged for operation from the floor of the boiler house. Dampers shall be accessible for repairs or replacement by means of bolted inspection doors.

A collar with guy ropes and stays shall be fixed to the stack. Stays shall be firmly fixed to the building and ground anchors to the satisfaction of the Regional Representative. Brackets and ground anchors for stays shall form part of the boiler contract.

4.7.3 Self-Supporting Stacks

The stacks shall be of the welded and flanged stainless steel self-supporting type consisting of a conical bottom section and cylindrical top section. The plate thickness of the bottom section shall be at least 10mm and the top section at least 6mm.

The necessary reinforcing or bracing shall be provided where flues enter the stack.

A cleaning door shall be provided at the base of each stack.

An amply reinforced concrete base shall be included in the contract for each stack. The base shall be at least 2000mm deep.

4.8 GRIT ARRESTORS

Each coal-fired boiler shall be fitted with a suitable grit arrestor as detailed in the Supplementary Technical Specification.

Grit arrestors shall be of the multi-cell or integral cyclone type, and shall conform in all respects with the requirements of the Atmospheric Pollution Prevention Act of 1965, and their efficiencies shall be well above the limit allowed in the Act.

Tenderers shall allow for gas sampling downstream of grit arrestors with the boiler operating at or close to MCR by an independent authority such as the CSIR who shall submit a written report indicating compliance or not with the Air Pollution Act.

Multi-cell grit arrestors shall be vertical high efficiency type.

Integral type grit arrestors shall be of the low resistance type, using natural draught.

The arrestor shall be installed between the boiler and the induced draught fan or the boiler and stack as applicable and shall be accessible for cleaning and maintenance.

The grit arrestor shall be supported off the floor with a structural steel framework.

The grit arrestor shall be manufactured from 6mm mild steel plate or thicker.

Walls of the collector or shells shall preferably be of cast iron with the bottom of the cone section and other erosion susceptible parts to be replaceable.

The arrestor shall be provided with a grit-collecting chute at the bottom with an automatic plate

shutter. A matching grit collecting bin on wheels shall be provided for each boiler. The grit trolley shall fit under the discharge chute to collect the grit when the shutter is opened without upsetting draught balance.

4.9 INDUCED DRAUGHT FANS

4.9.1 Induced draught fans shall be provided where necessary due to stack and flue arrangements or where specified in the Supplementary Technical Specification. The fans shall be of the multi-vane, centrifugal type, with radially tipped blades. Fans shall be statically and dynamically balanced, and shall be quiet in operation.

4.9.2 The fan casing shall be robustly constructed of steel plate and a cleaning door shall be provided in the casing.

4.9.3 The impeller shaft shall be carried in ball or roller bearings with cooling arrangements to provide satisfactory operation with gas temperatures over the full range of the application.

4.9.4 The induced draught fan shall be mounted on the boiler within the support framework of the stack with access to all service points and ease of removal of motor, bearings and fan shaft and impeller.

4.9.5 The fan shall be of the single inlet centrifugal type, self-cleaning impeller.

4.9.6 The fan capacity shall be for the full flue gas flow at MCR at site conditions with sufficient margin to allow for expected foul up between annual services of flue gas passes through the boiler.

4.9.7 The fan casing shall enable removal of the impeller and shaft without removal of any duct work or support structure.

4.9.8 The fan and motor shall be the standard units normally supplied by the boiler manufacturer with the boiler model offered.

The motor shall be of the T.E.F.C. squirrel cage type with speed not exceeding 1450 r/min.

4.9.9 A control damper functioning off the normal boiler controls shall be built into the ductwork between the fan section and the grit collector.

4.9.10 All ducting between boiler, grit collector, stack and induced draught fan shall be of 6mm mild steel welded construction and flanged with sufficient bolted inspection and cleaning openings.

Duct sizing shall be based on a gas velocity of not higher than 7,5m/s and ample provision shall be made for expansion and contraction in the ducting.

4.10 STEAM HEATED CALORIFIERS

4.10.1 General

4.10.1.1 Unless otherwise specified in the Supplementary Technical Specification steam heated calorifiers for central heating use shall be of the non-storage vertical type.

4.10.1.2 Capacities of calorifiers, traps, etc. shall as indicated on the main drawings.

4.10.1.3 Water, steam, power and condensate connections shall be provided as specified.

4.10.2 Non -storage Calorifiers

Steam calorifiers shall be similar or equal to those of the mild steel type manufactured by Royles.

All water spaces and exterior mild steel shall be galvanised.

For rating purposes capacities shall be taken with the steam at 700 kPa gauge when raising the water temperature from 72ºC to 82ºC at a water pressure of 500 kPa gauge.

The calorifiers supplied shall have steam spaces tested to 1 700 kPa gauge pressure and water spaces tested to 800 kPa gauge pressure minimum or twice the working pressure on site, if higher.

The thermostat controls shall be set at 82ºC or as specified. The thermostats shall be fitted as shown on the drawings and shall be of the Horne's type or equal. The "Bowstring" type will not be accepted. The control valve shall be protected by a steam strainer.

A steam gauge with a 100mm-diameter dial shall be fitted complete with siphon tube to the steam space. The steam battery shall be composed of indented copper 1,6mm thick tubes, and fitted with a 80mm x 15mm diameter magnesium rod in a removable plug, for corrosion protection.

A pressure relief valve shall be fitted on top of the water space and set at 70kPa above working water pressure.

The calorifier shall be provided with 100mm diameter dial thermometers, fixed to the water flow and return outlets. Flow, return, cold water outlets and drain valves shall be provided. Connections to these valves from the calorifier body shall be of the flanged or screw type. Drain valves shall be fitted with nipples for hose connections.

Special care shall be given to correct choice of condensate trap and pipe sizes.

A condensate trap shall be provided immediately upstream of the control valve.

Caloifier exterior surface shall be cleaned and painted prior to insulating.

Name plate, calorifier inspection test plate, etc., shall be unlagged with metal beading framing these areas.

Calorifiers shall be mounted on cast iron or fabricated steel supports fixed to the calorifier, so that the lowest point of the calorifier is not less than 300mm above the floor level and then mounted on a concrete plinth not less than 75mm thick.

A brass plate shall be fixed to the calorifier in accordance with the MOSH Act. Calorifiers shall comply with BSS 855. Sufficient space shall be left in front or top of the calorifier to allow for easy withdrawal of the heater battery.

4.10.3 Condensate Tanks

Condensate tanks where specified shall be constructed of 6mm thick mild steel plate. Capacities of tanks shall be indicated on the main drawing. The tanks shall be fitted with flanges or unions. The valve drains and overflows shall be piped to the nearest gully or storm water channel. A 50mm diameter vent pipe shall be taken to vent to atmosphere outside the building. The tanks shall be supported on steel cradles on the floor. The tanks shall be prepared, internally cleaned and given two coats of "Apexior" or equal corrosion resistant paint. The outside of the tank shall be given a

finishing of two coats of high quality heat resistant aluminium paint.

The tanks shall be so mounted that the pumps always have flooded suctions.

4.10.4 Condensate Pumps

The pumps shall be of the self-priming centrifugal type. The pump shall be capable of delivering the capacity at the total head with flooded suction as specified on the main drawings.

The pump impeller may be fitted to the extended shaft of the motor or a flexible coupling may be used. Short-shafted units (impeller mounted on motor shaft) will not be accepted as it is desirable to affect cooling of the shaft to prevent heat transmission into the motor.

The shafting between pump and motor shall be exposed and fitted with a water slinger to prevent water ingress into the motor.

The gland shall be fully accessible without having to remove the motor. An adequate stuffing box shall be provided and the packing shall be re-packable PTFE packing.

The pump shall have a shrouded impeller with replaceable wear ring. The impeller shall be bronze or stainless steel and the pump shaft shall be of type 410 or 415 stainless steel.

The pump and motor unit shall be mounted on a rigid cast iron or fabricated steel base plate suitable for bolting down on a concrete plinth.

The drive shall be protected and the whole unit shall comply with the requirements of the MOSH Act, 1983.

If the pump is of the back pull out type the common base plate or coupling shall be of such design that removal of the pump base with shaft, without disturbing the motor or sliding of the motor, is possible. Dowels for relocating the pump and motor in alignment shall be provided.

The whole unit shall be quiet in operation and the pump shall run at maximum efficiency. The pump shall be capable of performing the duty required and shall be provided with a name and indication plate giving particulars such as:

a) Litres/sec
b) Head in metres
c) Impeller size
d) Model
e) Make

The pump housing shall have an arrow indicating direction of rotation either cast in or fixed to it.

The condensate pump shall be suitable for permanently pumping condensate having a temperature 2ºC below boiling at atmospheric pressure at site.

The gland, construction and bearings and bearing housings shall be suitable for these high temperatures.

4.11 EXPANSION TANK

4.11.1 A combination feed and expansion tank/s of capacity and dimensions indicated in the Supplementary Technical Specification shall be provided and installed in the highest possible position where indicated on the main drawings.

4.11.2 The tank shall be a welded construction from plate steel not less than 3,0mm thick and hot dip galvanised after manufacture.

4.11.3 A 20mm or 25mm galvanised supply shall be connected to the feed tank through a suitable 20mm or 25mm gunmetal stop valve from the cold water main provided as specified in the Supplementary Technical Specification. A full-way ball valve shall be provided and fixed in the tank for level control.

4.11.4 The ball valve shall be of brass, and shall be so adjusted that a minimum of water is in the tank when the system is filled with cold water.

4.11.5 The overflow pipe and drainpipe shall be piped to a safe and acceptable point.

4.11.6 The tank shall be provided with a separate quick filling connection, a bolted down lid for access to the ball valve and an air vent.

4.11.7 The expansion tank shall be installed at least 1 500mm above the highest point of the relevant water system.

4.12 HEADERS

4.12.1 For multiple boiler and multiple return pipe arrangements or where indicated on the main drawing, header pipes shall be provided of welded construction with flanged outlets.

4.12.2 Spare outlets (supply and return side) properly sealed off shall be provided.

4.12.3 Unless otherwise detailed main return branch pipes shall not be connected together before entering the boiler room, each main return shall be carried back in to the boiler room and connected to the main return header.

Each main return shall be provided with a clearly visible thermometer in the boiler room.

14.13 PIPING

4.13.1 All central heating piping shall be best quality and shall comply with SB 1387 “medium grade” or ASA Schedule 40.

4.13.2 All piping shall be entirely free from defects, rust or millscale and shall be coated with a suitable red oxide primer. All piping shall be suitable for a working pressure of 1000kPa.

4.13.3 Piping up to 50mm nominal bore may be screwed while piping larger than 50mm nominal bore shall be flanged and welded. It is however preferred that piping larger than 20mm be welded. All piping to be welded shall be suitably prepared and bevelled for welding. Run outs to radiators, fan convectors, and similar small-bore connections shall be screwed.

4.14 PIPE FITTINGS

4.14.1 General

All pipefittings shall be of the highest quality ungalvanised steam quality fittings.

4.14.2 Screwed Fittings

Where screwed fittings are used these shall be wrought steel fittings which shall comply with BS 1740 and shall be threaded to BS 21. Malleable iron fittings may not be used.

4.14.3 Welding Fittings

These shall be seamless carbon steel butt welding fittings, and shall comply with BS 1640 or ASA B16.5 Schedule 40.

4.14.4 Bends

All bends shall be of the long radius type. Elbows may only be used on small pipe sizes where the requirements are such as to render the use of bends impractical. All bends shall comply with BS1387 medium grade or BS1640 Schedule 40 as appropriate. Elbows shall comply with BS1740.

4.14.5 Reducers

Where reducers are used these shall be either eccentric or concentric as appropriate. It is essential that, where reducers are used in horizontal piping the top of the pipe is straight and free from any trapped air pockets. or places which could accumulate vapour or air. The fittings shall comply with BS 1640 or ASA B16.5 Schedule 40 for welding fittings or BS1740 for screwed fittings.

4.14.6 Tee Pieces

Where these are screwed they shall comply with BS1740. Where these are welded they shall comply with BS 1640 Schedule 40. Tee pieces may be equal or reducing. The latter are preferred where a smaller branch is taken from a main.

4.14.7 Nipples

Only tapered thread nipples made from medium grade pipe to BS1387 may be used. Nipples may be long, short or hexagonal.

4.14.8 Unions

All unions shall be of the wrought steel conical bronze seat type of steam union and shall comply with BS1740. Malleable iron or flat face unions will not be accepted.

4.14.9 Gaskets

For temperatures of 100ºC and above all gaskets shall either be metallic joint rings equal to Taylor metal joint rings, or they shall be made from graphited compressed mineral fibre with a minimum thickness of 1.6mm. For temperatures below 100ºC, compressed mineral fibre joints rings may be used.

4.15 VALVES NON-RETURN VALVES AND STRAINERS

4.15.1 General

All valves and fittings shall be suitable for a minimum working pressure of 1000 kPa and a working temperature of 100ºC unless otherwise specified in the Supplementary Technical Specification.

4.15.2 Valve

Valves shall be of gunmetal and shall be the full way gate type unless otherwise specified.

Main shut-off valves shall be rated for a minimum working pressure of 1000 kPa. Valves of 50mm and larger shall be flanged. Smaller valves may be screwed. Valves of 80mm nominal bore and larger shall be rising stem gate valves.

4.15.3 Pressure Reducing Valves

Pressure reducing valves shall be as specified on the main drawing and shall be installed with suitable isolating valves.

4.15.4 Non Return Valves

Non return valves shall be screwed or flanged and suitable for a working pressure of not less than 1300kPa, Valves larger than 50mm shall be flanged.

All non return valves shall be bronze trimmed and shall seal drop tight. Non-return valves shall be suitable for horizontal or vertical mounting.

4.15.5 Pressure Relief Valves

Pressure relief valves be of the spring-loaded diaphragm guided type. The body shall be bronze and suitable for a working pressure of 1 000 kPa. The valve seat shall be bronze, resilient material or stainless steel. The spring shall be cadmium-plated steel, with spindle and spring plate being bronze. The valve shall be selected for the maximum required flow allowing for a 15 kPa pressure drop across the valve. The valve shall not require a variation of more than 10% of the controlled pressure to cause it to open fully. The final pressure setting shall be locked by means of a padlock . The safety valve shall discharge to a safe position outside the building.

4.15.6 Strainers

Strainers shall be of the Y-leg type with bronze body up to and including 50mm diameter, and cast iron body above 50mm. Strainers shall be fitted with a stainless steel or monel metal screen mesh size 100 with a screw on or bolted cap. The total free area of the screen shall be equivalent to at least twice the area at the entering port. All strainers larger than 50mm shall be fitted with a blow down cock.

4.15.7 Air Vent Valves

Air vent valves shall be installed at all points in the piping system where air may accumulate.

These valves shall be float operated vent valves and shall be similar or equal to Spirax AE 600 air eliminators.

Discharge connections from air eliminators shall be taken by means of 20mm piping (either galvanised or copper) to the nearest drain point.

All air eliminators shall be fitted with a suitable isolating valve to enable it to be removed for maintenance while the system is under pressure.

It is essential that a suitable strainer be fitted immediately up-stream of each vent valve.

4.16 DRAIN COCKS

4.16.1 At the lowest point of return pipes, and where indicated on the drawings, 15 mm drain cocks fitted with hose connections shall be provided and installed.

14.16.2 Drain cocks shall be of gunmetal of approved make. Drain cocks shall be installed as close as possible to walls with enough clearance to connect hosepipes.

14.16.3 Two loose keys shall be provided to the Department for operating drain cocks.

14.17 CHECKERS

14.17.1 Checkers for balancing flows shall be provided and installed on return branch pipes in the positions indicated on the drawings.

14.17.2 Checkers shall be iron or gunmetal tees, of approved pattern, with adjustable plugs, suitably designed to regulate the amount of water passing through the pipes.

14.17.3 The spindles of plugs shall have squared heads with lock nuts. When fully open, checkers shall be capable of passing the same quantity of water as the pipes on which they are fitted. Two loose keys for each size checker shall be provided to the Department.

14.18 PRESSURE GAUGES AND THERMOMETERS

14.18.1 Pressure Gauges

Pressure gauges shall not be less than 100mm diameter Bourdon Tube dial type gauges. All gauges shall be supplied with syphon, cock and hydraulic snubber to suit the pipe to which they are fitted.

Gauges shall have an error of not greater than + 2% as calibrated against a dead weight tester over the complete range of operation.

Gauges shall be of the same manufacture and shall be calibrated in standard metric units and shall be graduated to 50% above the working pressure.

All gauges shall comply fully with BS 1780.

14.18.2 Thermometers

Dial type thermometers shall be provided in the positions indicated. All thermometers shall have not less than 100mm diameter dials, and shall be calibrated from 0ºC to 120ºC.

Thermometers shall be of Rototherm or Budenberg or equal and approved manufacture.

All thermometers shall be calibrated on site and shall not have and error of more than ±1ºC at any point on the scale.

Thermometers shall be installed in suitable pockets so that they can be withdrawn without emptying the water system. Temperatures indicated shall accurately represent the water temperature measured.

4. 19 PIPE JOINTS

4.19.1 General

The ends of all pipes are to be free from burrs and rough edges before jointing.

All pipes in boiler, calorifier and pump rooms shall be provided with flanged joints.

Pipes outside boiler, calorifier and pump rooms may have screwed or welded joints as per this specification. A sufficient number of unions or flanged connections shall be provided to permit easy removal of equipment.

Pipes in ducts shall have welded or flanged joints.

4.19.2 Threaded Joints

All pipe threads shall be right handed, Whitworth Standard taper pipe threads and shall comply with BS 21 or ISO R7. Threaded pipe joints shall be made with either an approved steam pipe jointing compound or PTFE Tape.

All surplus compound or tape shall be cleaned off the joints before painting or finishing off.

4.19.3 Welded Joints

All welded pipe joints shall be of a high standard and carefully prepared for welding.

All edges and holes shall be correctly bevelled and shaped. Where flame cutting is carried out the surfaces shall be thoroughly cleaned by grinding, and all slag and oxidised material removed before welding commences.

Welded joints shall be thoroughly cleaned after welding and all slag and other foreign material removed.
All welding shall comply with relevant SABS specifications, BS2971 or BS2640 Class I Welding.

When pipes are welded, Tenders shall allow for one in ten welded pipe joints (chosen by the Department) to be cut out for examination purposes. Tests of specimen welds are to be carried out in accordance with the test procedures of the above specifications. After the removal of these joints, the piping shall be made good by the Contractor. Should any of the welds prove unsatisfactory the Contractor will be called upon at his own expense to have all welds examined by X-ray and to have the X-ray plates examined by the SABS or other approved Authority and to make good.

All flanges shall be welded both internally and externally.

4.20 RUNNING OF PIPES

4.20.1 All pipes shall be installed with a fall away from air vents of not less than 1 in 400. Pipes shall be so arranged that the piping can drain and no pockets of air shall be formed at points other than the vent points.

4.20.2 Offsets shown on the drawings should be strictly adhered to as the complete layout is designed to take up the natural expansion in the offsets instead of expansion loops etc. Where it is necessary to install devices to take up pipe expansion, expansion loops of the “Lyre-” or U-type are preferred.

4.20.3 All main and branch flow and return pipes shall be provided 'with valves where required and as indicated on the drawings.

Checker tees shall be provided in all return lines to enable the system to be correctly balanced.

4.20.4 Where piping passes through walls, slabs etc. pipe sleeves shall be provided. The size of the pipe sleeve shall be at least two sizes larger than the diameter of the insulated pipe, and shall extend the full depth of the construction including the final finishes.

Sleeves passing through firewalls shall be packed with fibreglass or fire retarding material in accordance with the local fire regulations. Sleeves passing through floors shall extend 50mm above the finished floor level.

Sleeves passing through exterior walls shall be rendered water tight by means of suitable caulking, flashing and counter flashing.

4.20.5 All pipes shall be provided with sufficient unions and flanges to permit the easy dismantling of equipment, and unions or flanges shall be provided adjacent to every branch connection and at all valves.

Valves shall be installed so as to be easily removable for replacement or repair.

4.20.6 Piping shall be so arranged that it will not obstruct other equipment.

Piping shall be connected to equipment in such a way as to permit the easy removal of the equipment with the minimum of dismantling of pipe work.

4.20.7 On straight pipe runs, flanges or unions shall be provided at intervals not exceeding 20 meters.

Unions may only be used in pipe sizes up to and including 50mm diameter.

4.20.8 All pipe lines shall be provided with adequate drain and vent points Drain points shall be provided with a l5mm bronze gate valve, while vent points shall be provided with an automatic air vent.

4.20.9 All pipes shall follow the line of walls both vertically and horizontally and shall be kept not less than 50 mm away from walls and 150 mm away from electric lighting or trunking and cables. Mains running side by side shall be kept a sufficient distance apart to permit of easy disconnecting. Under no circumstances will joints be allowed within the thickness of walls or in floors.

4.20.10 Pipes shall be run along walls or stanchions behind radiators or as directed.

4.20.11 Where beams, stanchions etc. interfere with the straight running of pipes suitable offsets shall be provided so that pipes may follow the line of walls both vertically and horizontally.

Tenderers should make themselves familiar with complete drawings of the building in order to ascertain the number and positions where such offsets will be required.

4.20.12 Air vents or air bottles are to be provided at the highest points or as indicated on the main drawings.

Air release pipes from the bottles shall be brought down below the ceiling and provided with screw down air release valves fixed at 2.10m above floor level, preferably in the boiler room or on an

exterior wall.

4.21 PIPE SUPPORTS

4.21.1 Support shall be provided as indicated on the drawings. Details of pipe loads and stresses due to expansion and anchor loads shall be submitted for approval by the Department where called for in the Supplementary Technical Specification.

4.21.2 Additional support shall be provided at places where concentrated loads occur due to valves, control valves, strainers, etc.

4.21.3 For prefabricated supports only supports, hangers and anchors of approved quality backed up by manufacturer's recommendations and experience will be accepted. "Unistrut" or equal supports are preferred. Alternatively supports shall be manufactured as detailed on the main drawings.

4.21.4 Where called for overhead pole supports shall be constructed as shown on the main drawings. The poles shall be made of mild steel and painted as described herein. A minimum clearance of 4300mm between finished ground level and lowest point of pipe shall be maintained.

4.21.5 Vertical piping on the exterior walls of buildings shall be supported at each floor level and at intervals not exceeding 2m.

4.21.6 Horizontal piping in trenches shall be supported as detailed on the main drawings.

4.21.7 Vertical and horizontal piping within roof spaces shall be supported as detailed on the main drawings.

4.21.8 Generally horizontal piping shall be supported at intervals as listed below, unless otherwise indicated on the relevant drawings.

Diameter of Pipes mm	Max. Span Supports m
15 to 20	2,5
25 to 32	3,0
40 to 50	3,5
65 to 80	4,5
100 to 125	6
150 to 200	7.5

4.21.9 All supports and support hangers shall permit free expansion and contraction of pipes.

4.21.10 Suitable pipe anchors shall be provided to allow for free movement of the pipe.

4.21.11 Expansion joints shall be of the multiple walled stainless steel bellows type with outer steel sleeve to protect the bellows portion. Suitable sliding pipes guides shall be provided to ensure that only

axial loads are applied to the expansion joints.

4.21.12 All expansion bends and joints shall be provided with unions or flanges to allow for easy replacement.

4.21.13 Pipes passing through ceilings or floors shall be offset from the wall to the front of the cornice or skirting with sufficient clearance to allow for the clear fixing of a ceiling plate. Pipes passed directly through the cornice will not be allowed. In multi-storey buildings where wall thickness vary, the same applies.

All offsets shall be evenly and symmetrically set, the off-sets are to be as high and as near the ceiling as possible.

4.21.14 Pipes passing through walls and concrete floors are to be provided with suitable mild steel pipe sleeves extending 10 mm above finished floor or wall surfaces. All pipe fixings and throughways shall be free to allow movement for expansion and contraction.

4.21.14 Pipes installed at or near floor levels are to be perfectly horizontal and to be secured by approved steel type holder bats securely fixed at distances not exceeding 1,5 m and to be not more than 20 mm away from the face of the skirting board. Where possible, such fixings shall be fixed between the radiators and near the bends. Pipes shall where possible be secured into the brick work above the skirting boards. Pipes shall be free to move in the holder bats.

Each separate return pipe to the boiler room shall be connected to a common header fixed in the boiler room which in turn is to be connected to the suction side of the circulating pump.

Each separate branch return pipe is to be provided immediately before entry into the header with a thermometer, a checker valve and a drain cock.

4.22 THERMAL INSULATION

4.22.1 Insulation shall be applied after the erection of equipment and pipe work and after all joints have been completed and tested.

All piping not inside spaces to be heated shall be insulated.

Unless otherwise specified in the Supplementary Technical Specification central heating piping in spaces to be heated shall not be insulated.

4.22.2 Insulation materials shall be chemically inert in their wet or dry state and shall comply with BS1588 and BS3708. The mechanical strength of the insulation together with its finish and supports shall be such that sagging or other deformation under the conditions of use is prevented.

4.22.3 All pipes to be insulated shall be insulated with pre-formed insulation units, Valves, unions, and flanges are to be provided with removable muffs and the adjacent insulation to be weatherproofed where exposed to the weather. The thickness of insulation shall be based on heat losses in watts per lineal metre and shall not be less than that stated for economical thickness as set out in BS1988/ 1949.

4.22.4 Guide to Thickness of Insulation

SIZE OF PIPE	THICKNESS OF PRE-FORMED SECTIONS
Up to 50mm diameter	25mm
65mm to 150mm diameter	40mm
Over 150mm diameter	50mm

Recommended thickness based on the above shall be stated by the Tenderer. Heat losses and thermal conductivities of the proposed material shall be given by the Tenderer so that the merits of insulating material can be assessed. Surface temperatures of insulation shall not exceed 35ºC.

Mineral wool shall be at least 224kg/m³ density and fibreglass 95kg/m³.

Mineral fibre insulation shall not contain more than 3% by mass of phenolic resin binder.

NOTE: Pre-formed fibreglass sections are preferred.

4.22.5 These pre-formed units shall be suitable for application to hot surfaces and the sectional insulation shall be strapped in position with 10mm wide galvanised sheet metal bands and prior to applying sheet metal cladding, where sheet metal cladding is required.

4.22.6 Where specified in the Supplementary Technical Specification flanged joints, valves, reducing valves, strainers etc. shall be separately covered by pre-formed insulation flange boxes, “muff covers” held in position by removable metal bands and finished similarly to the lagging on the length of pipe.

Where valves etc. are not insulated, the adjacent insulation shall have it's ends properly sealed and weatherproofed as applicable.

The insulation boxes shall be capable of removal without damage to any other portion of the insulation.

4.22.7 Generally all pipes exposed to the weather or where the insulation is likely to be damaged or where visible inside buildings and plant rooms, are to be provided with a covering of 0,8 mm galvanised sheet metal over the insulation and adequately secured by means of 10mm wide stainless steel metal bands at intervals of not more than 500mm. Sheet metal covering shall painted as specified.

The sheet metal covering shall be applied with the longitudinal overlap joints in a continuous straight line and automatically water shedding. Butt overlapping shall be at least 40mm.

Piping not sheet metal covered, may be insulated with plain pre-formed sections strapped as above for the cladding. 200mm wide pre-formed cladding shall however be applied at intervals of approximately 15 metres generally and both sides of wall penetrations, etc. to enable direction of flow arrows and colour coding to be applied.

4.22.8 Pipes exposed to the weather shall be insulated and clad in such a manner that no moisture or rainwater may penetrate the insulation.

Support brackets, hangers, etc. shall be external to the insulation and cladding and no cut-outs will be permitted.

4.22.9 All insulation to be of the same manufacture.

4.22.10 Where pre-formed insulation sections for bends are not available, bends are to be insulated with plastered hard setting moulded plastic fibrous lagging strengthened with galvanised wire netting and trowelled to a smooth finish of the same diameter as the sheet metal covering. The insulation shall be finished with 4 coats silicated soda and then neatly bound with black scotch tape and painted as specified. Weather-tight sheet steel lobster back-insulated bends may also be tendered.

4.22.11 Boiler and Vessel Insulation

1. Boilers, calorifiers and hot water vessels shall be insulated with insulating mattresses and covered with cladding of galvanised and stainless sheet steel (as specified).

   The mattresses shall be made up in sections to suit the area to be covered. They shall be cut accurately to ensure even coverage. Loose in-fill pieces will not be acceptable.

2. Each boiler or vessel shall be insulated with 50mm thick insulation with density not less than 120kg/m³. Insulation shall be neatly fixed to the vessel shell and held in position with galvanised steel straps or wire mesh. Insulation shall be clad with 0.6mm thick stainless steel 430 sheeting with at least 40mm overlapping for boilers and 0.8mm thick galvanised steel for other vessels. The insulation and cladding shall be fixed in a workmanlike manner and any sign of irregularity in or damage to the surface will cause same to be rejected and to be replaced at Contractor's expense. No pop riveting will be allowed.

   Exposed hot surfaces of ducting, grit collectors and stacks inside the boiler house shall be similarly insulated with 40mm thick insulation protected with 0.8mm galvanised sheet metal cladding.

   The sheet steel covering shall be neatly formed to the shape of the area to be covered. All inspection openings or places where fittings protrude from boilers and vessels, shall be fitted with neat surrounds and beading to completely cover the mattresses.

3. All joints in the sheet steel cover shall be fitted with steel bands of the same material. The bands shall be at least 59mm wide and fixed to the cover plates by means of self-tapping screws to allow easy removal of any plate.

4. All rivet seams on boilers etc. as applicable, shall be separately lagged to facilitate inspections.

5. On externally installed vessels, the seams of all sheet steel covers shall be rendered watertight by design or with an approved sealant.

4.23 RADIATOR VALVES

4.23.1 On each radiator flow a 15 mm chromium plated valve with hand control wheel and on each radiator return a 15 mm chromium plated shrouded or lockshield radiator valve shall be provided and installed.

Valves shall be of an approved make.

Two loose keys shall be provided for operating the shrouded valves.

Valves shall be selected for a working pressure of 100kPa and temperature of 120ºC.

Valve design shall be such as to permit maintenance to the spindle while in service.

4.24 PANEL RADIATORS

4.24.1 Panel radiators of the heating capacity and size as indicated on the drawings shall be of welded pressed steel construction, manufactured from good quality steel sheets. Radiators shall be of approved make and suitable for a working pressure of 700 kPa.

4.24.2 Panel radiators shall be supported by means of adjustable bottom brackets and top stays built or fixed into the wall. The minimum clearance at the back shall be 40 mm and the clearance at the bottom shall be not less than 100 mm.

4.24.3 Air vents shall be fitted to each panel radiator and two operating keys shall be provided.

4.24.4 Panel radiators shall have the capacity specified at a mean water temperature of 74ºC, water temperature drop of 11ºC and surrounding room temperature of 21ºC.

4.24.5 Where multiple sections of panel radiators are selected to match the capacity requirements top grilles and end cover panels shall be provided to ensure a neater finish.

4.25 CONVECTOR HEATERS

4.25.1 Convector heaters of the number, sizes and capacities shall be provided and erected in the positions indicated on the main drawings.

4.25.2 Convectors shall have the capacities specified at a mean water temperature of 74ºC, a water temperature drop of 11ºC and an entering air temperature of 21ºC.

4.25.3 Convector elements shall be constructed of copper tubes with non-ferrous fins mechanically bonded to the tubes and designed for a working pressure of 700 kPa. Each element shall be provided with an air vent.

4.25.4 Recessed convectors shall be built into recesses, which will be provided by the Building Contractor complete with timber framing and insulation at the back. The elements shall be so installed that air does not bypass the element. The front plate shall be not less than 1,25 mm thick and of rigid design. The front plate shall be firmly held in position by means of concealed clips or quick opening fasteners so that it can be easily removed for access to the valves and air vents. Air inlet and outlet grilles of the punched louvre type shall be formed in the front plate.

4.25.5 Cabinet convectors shall be of the floor standing or wall mounted type of approved make. The cabinets shall be robustly constructed of sheet steel with rounded corners. The front plate shall be easily removable for access to the air vent etc. Cabinet convectors shall be mounted as shown on the drawings.

4.25.6 Unless otherwise specified all convectors shall be provided with dampers capable of being operated from the front of the convector. Each convector shall be provided with two valves, one in the flow and one in the return. The valve in the return shall be shrouded.

4.25.7 Convectors shall be supplied in an attractive finish subject to the approval of the Department.

4.26 BASE BOARD HEATERS (Finned Type)

4.26.1 Where shown on the main drawings convection type baseboard heaters with capacities as indicated on the drawing shall be provided and installed.

4.26.2 Finned tubes shall have the heating capacities specified at a mean water temperature of 74ºC, a water temperature drop of 11ºC and an entering air temperature of 21ºC.

4.26.3 The cabinet shall be manufactured from high-grade sheet metal, suitably stiffened. The heaters shall consist of modules of approximately 1,5 in length, assembled to form a continuous run. Removable front panels of the same length shall be provided on each module.

4.26.4 Discharge grilles shall be of the punched louvre type. Dampers shall be provided behind the outer grille and shall be manually operated by means of an insulated control knob situated on the front panel.

4.26.5 Finned heating tubes shall consist of either steel or copper tubing with aluminium or copper fins mechanically bonded to the tubes. The tubes shall be supported on brackets at regular intervals with provision for vertical adjustment. The tubes shall be properly pitched to allow for natural venting of air. Drains shall be provided in suitable positions. Allowance shall be made for expansion and contraction of tubes and pipes. Tubes shall be designed for a working pressure of at least 700 kPa.

4.26.6 Where heaters are mounted on outside walls, glass fibre insulation (or equal) at least 12 mm thick, shall be provided between the backplate of the cabinet and the wall.

4.26.7 The cabinet shall be effectively sealed off against the wall to prevent streaking.

4.26.8 Cabinets shall have an attractive powder coated finish which shall be subject to the approval of the Department.

4.27 FAN CONVECTORS

4.27.1 Fan convectors of the number, sizes and capacities specified in the Supplementary Technical Specification shall be provided and erected in the positions indicated on the main drawings.

4.27.2 Fan convectors shall be of the freestanding vertical cabinet or wall mounted type with discharge grille on top or front or ceiling mounted horizontal cabinet type with discharge grille at front. Each unit shall be complete with hot water coil, fan(s), filters and on/ off control as well as thermostat.

4.27.3 Cabinets shall be constructed of not less than 1,25 mm sheet metal. Front panels of cabinets shall be removable for access to working parts. The casing shall be lined internally with glass fibre for sound absorption.

4.27.4 Hot water coils shall be of copper tubes with copper or aluminium fins mechanically bonded to the tubes, and shall be not less than 2 rows deep. Each coil shall be provided with a drain and air vent.

4.27.5 Hot water coils shall have the capacities specified at a mean water temperature of 74ºC a water temperature drop of 11ºC and an entering air temperature of 21ºC. The coils shall be designed for a working pressure of 700kPa.

4.27.6 Fans shall be of the centrifugal type directly connected to extended motor shafts. The fans shall be statically and dynamically balanced. Fans and motors shall be quiet in operation.

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

4.27.8 The minimum heating capacities, based on high fan speed, shall be as indicated on the drawings.

4.27.9 Each unit shall be controlled by a two-position thermostat which shall operate a two-way solenoid valve in the flow pipe to the coil.

For free standing vertical cabinet type units, the thermostat shall be provided within the cabinet, with the set point adjusting knob next to the fan speed adjusting knob, mounted behind an access panel in the top or front panel.

For ceiling mounted units, the thermostat and fan speed control shall be mounted together in an easily accessible position at normal light switch level.

4.27.10 Fan convectors shall be provided with an automatic thermostat to switch the fan motor off when the supply water temperature drops below approximately 38ºC and to switch the fan motor on again when the water temperature reaches 50ºC.

4.27.11 All valves, drains and checkers shall be contained within the cabinet.

4.27.12 The mean sound pressure levels generated by the unit shall not exceed the 35dBA value when measured at a distance of 2 m from the unit.

4.27.13 The unit shall be supplied in an attractive powder coated finish, which shall be subject to the approval of the Regional Representative of the Department.

4.28 UNIT HEATERS (Water Heated)

4.28.1 Unit heaters of the number, type and capacity specified in the Supplementary Technical Specification shall be provided and erected where shown on the drawings.

4.28.2 Heating capacity shall be based on a mean water temperature of 74ºC, a water temperature drop of 11ºC and an entering air temperature of 21ºC.

4.28.3 Heating elements shall be of the finned tubular type with fins mechanically bonded to the tubes and designed for a working pressure of 700 kPa. Provision shall be made for contraction and expansion to be absorbed without strain.

4.28.4 Each unit heater shall be provided with a silent running propeller fan having the minimum capacity specified on the drawings. Fans and motors shall be properly balanced and shall be resiliently mounted on rubber supports.

4.28.5 Casings shall be rigidly constructed of sheet steel with rounded corners. Horizontal discharge unit heaters shall be provided with adjustable horizontal louvres. Vertical discharge heaters shall be

provided with adjustable, louvred, circular diffusers.

4.28.6 Each unit heater shall be provided with two valves, one in the flow and one in the return. The valve in the return shall be shrouded. Air release and drain cocks shall be provided on each unit heater.

4.28.7 Unit heaters shall be controlled by room thermostats, which shall stop and start the fan motors. Thermostats shall be of the mercury switch type with a support range of 10 to 40ºC or maker's nearest standard and a differential of 2ºC (± 1ºC).

4.28.9 Temperature control shall be by means of regulating water flow as specified in the Supplementary Technical Specification.

4.29 PET COCKS

4.29.1 Brass Pet Cocks

Brass pet cocks shall be provided on each main flow and return pipe at the boiler or heating source.

4.30 CIRCULATING PUMPS

4.30.1 Centrifugal type circulating pumps shall be provided and installed for the central heating as indicated on the main drawing.

4.30.2 Where two pumps are provided one pump shall be the duty pump and the other standby with automatic changeover on a timed and sequence control to equalise running hours and maximise availability.

4.30.3 The pumps shall be provided and installed in the plant room to suit the manifold system as indicated on the main drawing.

4.30.4 The pumps shall be suitable in all respect for the application and continuous operation as well as standing idle for long periods of time with closed circuit domestic potable water with temperatures ranging from 8ºC to 98ºC, design static pressure 700 kPa and static cold water test pressure up to 800 kPa.

4.30.5 For in-line pumps the pump connections shall be flanged.

4.30.6 Where necessary suitable drip receptacle(s) or trays with drain pipes shall be provided.

4.30.7 The pumps shall be provided with a control facility for selection of automatic or manual operation.

4.30.8 Pumps and motors shall be silent in operation.

4.30.9 A by-pass with valves shall be provided for each pump to allow natural circulation in case of pump breakdown. In-line pumps with built in by-pass will also be acceptable.

4.30.10 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.

4.30.11 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.

4.30.11 Unless otherwise specified in the Supplementary Technical Specification pump speed shall not exceed 1450 r/ min.

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

4.30.12 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.

4.30.14 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.

4.30.15 Renewable casing wearing rings shall be fitted on all pumps with discharge diameters of 80mm and larger and with delivery pressures in excess of 200kPa. Wearing rings shall be manufactured of bronze, chromium steel, nickel steel or an alloy suitable for the particular application.

4.30.16 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.

4.30.17 Pumps shall be provided with mechanical seals matching the duty, fluid and temperature requirements.

4.30.18 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.

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

4.30.19 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 30 21 A galvanised sheet metal dip tray with drain connection shall be provided underneath each pump. Drain connections shall be piped to the nearest drain or gulley.

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

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

4.30.23 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.

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

4.30.25 Pumps for water temperatures in excess of 90'C shall be provided with water-cooled bearings and seals.

4.30.26 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.

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

4.31 TRAINING OF EMPLOYER'S STAFF

4.31.1 Construction Phase

Where called for in the Supplementary Technical Specification the Department may decide to have two employees (future plant operators) nominated for working with the Contractor's staff during the construction phase on site to enable them to gain a working knowledge of the installation as well as familiarise them with the various sections and elements.

It will be expected of the Contractor to utilise and develop their skills and instruct them from day to day as if they were his own employees. Salaries of the two employees will be paid by the Department.

4.31.2 Commissioning Phase

The Contractor shall within reason involve and train the operating and maintenance staff of the Department during the commissioning phase to enable them to do commissioning after future maintenance shut downs.

4.31.3 Training in Operation

After the successful commissioning of the plant and it being used on a regular basis it is required that a suitably qualified employee of the Contractor shall spend 7 consecutive working days of 9 hours each in full attendance training the Department's staff in the day-to-day operation and attendance and minor adjustments necessary to operate the installation successfully and efficiently.

4.32 PERFORMANCE TESTING

4.32.1 General

The testing of all equipment forming part of this installation forms part of this contract. All testing shall be done by the Contractor at his expense in the presence of the Department's Representative. The Contractor shall supply all materials, equipment, labour, instruments etc. to facilitate the full and comprehensive testing required.

Before the completion certificate is issued a full load test will be carried out on the complete plant for a period of sufficient duration to determine the satisfactory working of the plant. During this period the whole of the works will be inspected and the Contractor shall make good to the satisfaction of the Department any deficiencies which may arise.

4.32.2 Boilers and Ancillary Plant

The following tests will have to be carried out on each boiler:

a) Hydraulic pressure test and internal inspection as required and arranged with the Inspector of Machinery (where applicable).

b) Testing of all automatic and safety apparatus and equipment.

c) Hydraulic pressure test on all pipe lines in the presence of the Department's Representative Tests to be conducted at 150% of maximum working pressure and the whole system inspected for leaks.

d) All controls and valves for proper functioning.

e) Proper functioning of combustion controls with special regard to efficient burning in the range 40% to 100% of continuous rating.

4.32.3 Piping

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 1000 kPa 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.

4.32.3 Commissioning

When the pipe work is complete, the mains and all branch lines shall be blown clear.

After the cleaning of all strainers and the checking of non-return valves, the lines shall be brought up to working pressure and temperature and inspected by the Department.

Only when the mains are to the satisfaction of the Department may the Contractor proceed with the lagging thereof.

All strainers shall be given a final cleaning, two months after the mains are in full operation.

4.33 COPPER PIPING

4.33.1 Where specified in the Supplementary Technical Specification copper piping may be used for central heating, insulated as specified.

4.33.2 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.

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

All piping shall be suitable for a working pressure of not less than 1300kPa.

4.33.4 In general, Class 1 and 2 piping shall be used.

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

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

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

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

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

4.33.10 Full radius bend and sweep fittings shall be used wherever possible. Elbows may only be used under exceptional conditions and only with the written approval of the Department.

4.33.11 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.

4.33.12 Where practical copper pipes, particularly in sizes up to 28mm shall be bent or set around comers

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.

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

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

DIAMETER	MAXIMUM SUPPORT SPACING METERS
l5mm	1,8
22-28mm	2,4
34-54mm	3,0
76-108mm	3,6

"Unistrut" pipe support and hangers shall be used throughout 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 securely locked. All brackets and pipe clamps shall be brass or galvanised and shall be arranged so as to cause no electrolytic corrosion of the copper pipe.

Where small bare copper pipes are chased in to brickwork8 or floors, they shall be first wrapped with suitable mineral fibre or glass fibre tape approximately 6mm thick.