

PART: 3

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PART 1 – HVAC INSTALLATION CONDITIONS OF CONTRACT

**CONDITIONS OF CONTRACT SHALL BE AS PER THE
JBCC 2005 JULY EDITION FOR NOMINATED /
SELECTED SUB CONTRACTORS.**

**THE TENDERERS ARE INSTRUCTED TO REVIEW THE
PRELIMINARIES AND GENERAL CONDITIONS
PERTAINING TO THE MAIN CONTRACTORS
DOCUMENTATION.**

**THE TENDERERS SHALL IN ADDITION FAMILIARIZE
THEMSELVES WITH THE JBCC CONDITIONS
PERTAINING TO THIS PROJECT BY REQUEST TO THE
MAIN CONTRACTOR.**

**NO EXTRA'S OR ALTERNATE CONDITIONS WILL BE
CONSIDERED FOR TENDERERS LACK OF
KNOWLEDGE OF THE CONDITIONS OF CONTRACT.**

PART 2 - GENERAL REQUIREMENTS

2.1 Introduction

The project, more fully described in these documents and drawings, comprises of the supply, installation, commissioning, handing over and maintenance/guarantee for one year of the air conditioning/ventilation systems to serve.

2.2 Definition of Terms

In these Conditions, Agreement, Specification, Bills of Quantities (if any), Schedules and Drawings, the following terms and expressions shall, unless the context otherwise requires, have the meanings hereby assigned to them:

- “EMPLOYER” shall mean that party with whom the Principal contractor for this contract work has entered into a building contract for the carrying out of the specified works by him in terms of this contract. The term Employer shall also include his or their duly appointed representatives or any other official, duly authorised to act on his/their behalf for the purpose of the said Contract. The appointment of such official for such purpose shall be notified to the Sub-contractor in writing.
- “ARCHITECT” shall mean that registered Architect who has been appointed as the principal agent of the Employer and whose name shall appear as the appointed Architect in the contract document between the Employer and the Principal contractor for these contract works.
- “QUANTITY SURVEYOR” shall mean that party responsible for the quantity surveying and whose name shall appear as such in the “Agreement” and “Schedule of Conditions of Building Contract” signed between the Employer and the Sub-Contractor.
- “ENGINEER” shall mean Mekan Engineering Services. The Engineer has been appointed to act as Engineer for the project described in these documents and who is the delegated representative of the architect for the purposes of this sub-contract.
- “RESIDENT ENGINEER” shall mean that person duly appointed by the Engineer to control and administer the sub-contract works on site.
- “PRINCIPAL CONTRACTOR” shall mean that person, firm or company who shall be appointed as the contractor by the Employer to carry out the contract works and the Principal Contractor shall include his or their legal personal representatives, administrators, successors and/or assigns.
- “SUB-CONTRACTOR” shall mean that person, firm or company who shall be selected as Sub-Contractor to carry out the sub-contract works described in this specification and accompanying documents and shall include his or their legal personal representatives, administrators, successors and/or assigns.
- “PRINCIPAL CONTRACT” shall be the contract entered into between the Employer and the Principal Contractor to which this selected sub-contract forms a supplement.
- “SUB-CONTRACT” shall mean the sub-contract agreement entered into between the Principal Contractor and the selected Sub-Contractor, together with the documents referred to herein, including these Conditions of Sub-Contract, Specifications, Bill of Quantities, (if any) Schedule of Price (if any) and Drawings. All these documents taken

together shall form one sub-contract and be considered complementary to one another and shall be ready jointly.

- "WORKS" shall be the construction project for which the Principal Contractor has entered into agreement with the Employer to construct, erect or otherwise proceed with to the requirements of the Employer.
- "SUB-CONTRACT WORKS" shall mean the engineering works described in the specification and/or bills of quantities and/or as shown on the drawings and shall include all modified extra or additional work and obligations to be performed and shall include all plant and materials to be provided and work to be done by the Sub-Contractor in terms of this sub-contract.
- "INSPECTOR OF WORKS" shall mean any person appointed as such whose duties shall be to act as inspector or supervisor of the sub-contract works on behalf of the Employer and under the direction of the architect or, if so delegated, the Engineer. The Sub-Contractor shall afford him every facility for the performance of that duty. The inspector of works shall have no authority to relieve the Sub-Contractor in any way of his duties or obligations under the sub-contract, nor shall he have authority to order any work involving delays or extras.
- "SITE" shall mean the land and/or building placed at the disposal of the Principal Contractor from time to time for the purpose of executing the contract work.
- "MONTH" shall mean one calendar month.
- "WRITING" shall include any manuscript, typewritten or printed statement undersigned by a person properly authorised to sign such statement on behalf of the issuing party.
- "APPROVED" shall mean prior approval to the work given in writing by the Architect or, if so delegated, by the Engineer.
- Words supporting the singular shall be deemed to include plural and vice versa where the text requires and works purporting persons shall include bodies, firms and corporations.
- "ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS" shall mean the manufacturer's instructions at the time of tender.
- "APPROVAL" shall mean the approval by the architect or, if so delegated by the Engineer in writing and is limited to visual appearance of the work, material or components. Approval does not relieve the Contractor from compliance with the specification.
- "B.S" shall mean British Standard.
- "DRAWINGS" shall mean drawings forming part of the contract documents and any modification thereof or additions thereto delivered by the Engineer to the contractor during the execution of the works.
- "NBR" shall mean National Building Regulations.
- "PARTICULAR SPECIFICATION" shall mean a specification that is drawn up as a supplement to the Project Specification to specify items for a particular contract not covered by the Project Specification.
- "STANDARD SPECIFICATION" shall mean the latest edition (as revised) of the standard quality specification of the Engineer.
- "SANS" shall mean South African National Standards.
- "SABS" shall mean South African Bureau of Standards.
- "SABS-CKS" shall mean specifications prepared by the SABS mainly for the procurement of products for the use of government departments.

- “Specified” shall mean as specified in the Project Specification, Particular Specification, drawings, Bill of Quantities or in any other contract document.
- “Hepa” shall mean high efficiency particulate filters.
- “NPSH” shall mean Nett Positive Suction Height.
- “TEFC” shall mean Totally Enclosed Fan Cooled.
- “UL” shall mean Underwriters laboratory
- “SMACNA” shall mean Sheet Metal and Air Conditioning Contractors National Association.

2.3 *Sub-Contractor’s Drawings*

The preparation and submission of working drawings, and co-ordination drawings in respect of certain services will form part of this sub-contract as follows:

Working drawings, drawn to a scale of not less than 1: 50 shall be produced by the Sub-Contractor and submitted for approval to the Engineer or Employer’s representative for approval (nine hard copies & soft copies dwgs”and pdfs). Such drawing must be based on and co-ordinated with the latest available architectural, structural, roof truss and services drawings and dimensions shall be verified on site prior to installation. The tender price schedule of section 6 shall include for all necessary variations of duct and pipe layouts for co-ordination and to clear other services and obstacles.

The attention of the Engineer shall be drawn to any deviation from the Specification by the Sub-Contractor at the time of submission.

Builder’s work drawings showing masonry work, openings for ducts, pipes, cables and other services through concrete sub-structures, slabs, walls, partitions etc. are to be supplied to the Engineer (three hard copies & soft copies dwgs”and pdfs). This provision applies similarly to builders’ work requirements related to equipment foundations, and the provision of fresh water, drainage, and electrical mains provisions.

Three sets of “as installed” drawings of the system, including wiring diagrams and control diagrams are to be supplied to the Engineer for the eventual retention by the Employer.

The Engineers drawings for the contract shall be those issued at the time of tender together with any others issued to cover the variations to the contract.

As part of this contract the HVAC Contractor shall provide the following drawings:

- Manufacturing and Installation Drawings:
- Builder’s work drawings showing all penetrations required.

The manufacturing and installation drawings (“shop drawings”) shall provide all details of the plant area, plinths etc. necessary for the manufacture and installation of the complete system in accordance with this specification and drawings.

2.3.1 Wiring Diagrams:

The wiring diagrams shall provide details of all the electrical wiring associated with the Air Conditioning and Ventilation Installation. The same drawing symbols and system shall be used as used in the Engineers drawings.

2.3.2 Builder's Work Drawings:

All necessary builders work drawings as described elsewhere in this specification shall be provided as part of this Contract.

2.3.3 Record Drawings:

On completion of the installation but before the plant is handed over, the Contractor shall provide a complete set of drawings showing the completed installation including wiring.

In addition to the drawings listed above the Contractor shall provide all drawings necessary for the execution of the Contract and shall submit such general and detailed drawings of the plant and apparatus as the Engineer may require approving construction of the plant.

Details and drawings of all major items of equipment made by the Contractor or his suppliers shall be submitted for approval without specific request from the Engineer.

All required drawings shall be submitted to an agreed programme to suit the construction of the plant.

All drawings shall be clearly numbered or marked with the equipment item numbers, area references, etc.

2.3.4 Approval of Drawings:

The Contractor shall submit for approval, in principle, copies of all above mentioned drawings prior to starting work or issue to other parties. Any work started (off site or on site) prior to receiving the Engineers approval of drawings shall be at the Contractors own risk and cost.

The Engineer may require from the Contractor further detailed drawings and/or calculations which clarify features not adequately shown on the layout drawings. The request for additional details shall not be construed as extending the scope of this contract or altering the programme.

The Contractor shall submit two copies of each drawing to the Engineer for approval.

The Engineer will return to the Contractor within ten working days of their receipt by him, once copy of each drawing marked "APPROVED IN PRINCIPLE" or marked with any changes which are necessary.

The Contractor shall modify the details and drawings as required by the Engineer. The nature and date of each modification and a distinguishing symbol shall be added and the drawings submitted again for approval.

Alterations to drawings by the Engineer are not intended to change the scope of work unless explicitly stated as doing so. Should any alterations, in the opinion of the Contractor, change the scope of work, the Contractor shall notify the Engineer immediately on receipt of the altered drawings before any further drawing work or fabrication is carried out. Claims for a change of scope, made after performance of the work, constituting the claimed change of scope, will not be considered.

The approval in principle of drawings by the Engineer shall not relieve the Contractor of any responsibility in terms of the contract. The Engineer will check the drawings for design only and approval of the drawings, schedules and catalogues shall not be construed as a complete check.

The contractor shall be responsible for any discrepancies, errors or omissions in the drawings other particulars supplied by him whether such drawings or particulars have been approved by the Engineer or not, provided that such discrepancies, errors or omissions are not due to inaccurate information or particulars furnished in writing to the Contractor.

Five copies of the Final Manufacturing and Installation Drawings shall be issued to the Engineer by the Contractor within ten days of receipt of approval in principle. Further copies shall be provided as may be required by the Engineer either before or after final approval.

The Contractor shall provide at his own expense, all copies of drawings by him in the execution of the work and shall also, at his own expense, supply to the Engineer, such drawings and copies thereof as are provided for in the specification.

2.3.5 Record Drawings:

On completion of the installation, but before final handover, the Contractor shall provide an electronic copy plus the necessary prints of each of the following drawings showing the services as fixed:

1. Complete 1:50 scale layout of pipework inside plantrooms.
2. Large scale (at least 1:50) details of plantrooms.
3. Complete 1: 50 scale drawings of the whole installation.
4. Detailed drawings of all items of plant.
5. Electrical layouts and wiring diagrams.
6. Details of any other items requested by the Engineer.

7. The drawings shall be sufficient in detail to enable the Employers staff to maintain, dismantle, reassemble and adjust all parts of the works.
8. The layouts shall show the location of all manual and automatic valves, controls, control panels, outlets, etc.
9. A copy of the wiring diagram shall be mounted in the Plantroom in a glass fronted frame. The diagrams shall be printed by a non-fading process.

2.4 Materials and Equipment Submittals

The Sub-Contractor shall submit to the Engineer for his approval comprehensive Manufacturer's technical data (submittals) of major equipment and materials which he proposes to use. Applicable model numbers, operation points, capacities and applicable options shall be highlighted or marked up in order to demonstrate compliance with the specification. Optional items not applicable should be crossed out to avoid any doubts with regard to what is proposed.

The Sub-Contractor shall ensure that the technical data is submitted in good time to avoid the risk of delays. Within 7 days after being awarded the sub-contract or letter of intent, (whichever occurs first) the Sub-Contractor shall submit to the Engineer for his approval a Schedule of items of equipment and materials which he intends to submit complete with scheduled submittal and latest approval dates in co-ordination with the "agreed installation programme" as detailed in paragraph INSTALLATION PROGRAMME AND PROGRESS.

All material shall be new of high quality and suitable for the conditions on site. Should the materials not be suitable for use under temporary site conditions then the Contractor shall at his own cost provide suitable protection until these unfavourable site conditions cease to exist. All materials and workmanship shall comply with the relevant SABS or BS standards.

The Contractor shall where requested to do so, submit samples of equipment and material to the Engineer for his approval prior to installation. Samples may be retained in the Engineer's possession until the contract is completed after which they will be returned and no charge will be made for such samples.

Locally manufactured equipment shall be used where possible and practical in preference to imported equipment. The owner in no way binds himself to assist the Contractor in obtaining import permit for imported equipment.

The works shall be designed to provide ease of inspections, cleaning and maintenance.

All artisans employed on site shall be competent in terms of the Regulations and Acts.

The contract shall be executed to a high standard and to the satisfaction of the Engineer. Should any workmanship, equipment or material not be to the satisfaction of the Engineer, it shall be rectified at the cost of the Contractor and all rejected materials shall be removed from site.

If, in the opinion of the Engineer, any member of the Contractor's staff is not competent to carry out the work to the required standard, then that person shall be removed from the project if so instructed by the Engineer.

2.5 Commissioning and Testing Prior to Completion

As part of the commissioning procedures the Sub-Contractor shall carry out all necessary tests and submit the test results recorded on approved forms for approval by the Engineer of each item of equipment as demonstration that the relevant items of equipment operate in accordance with or exceeds the minimum requirements of the Specification and approved manufacturer's technical data.

The Sub-Contractor shall give the Engineer notice in writing when any portion of the plant is ready for test and if the Engineer does not himself or through his representative attend to witness the test within seven (7) days from the receipt by him of such notice, then the Sub-Contractor may proceed with the test, duly forwarding to the Engineer, certified copies of the results thereof. In such case, the test shall be deemed to have been made in the Engineer's presence.

If, in the discretion of the Engineer test results are insufficient or not acceptable, the Contractor shall carry out necessary remedial work and repeat the necessary tests at his own expense.

2.6 Design Conditions

Where, in terms of this specification, air conditioning systems are installed, these systems have been designed on and shall be commissioned (subject only to the limitations of their design), on the basis of the following climatic, temperature, humidity, and sound level data unless specified differently in the technical schedules in Section 3 of the Specification.

2.6.1 Ambient Design Conditions

Summer |36°C db 20°C wb

Winter |1°C db

The above conditions are the mean average maximum and minimum temperatures recorded in the area and which are normally not exceeded on more than ten days in a year.

2.6.2 Inside Controlled Conditions

Summer |22°C db at ± 50% Relative Humidity. Humidity will not be actively controlled.

Winter |23° C db

The above temperatures are those at which the majority of people are considered to be comfortable, as indicated on a Comfort Chart.

The temperature would be controlled within a tolerance of $\pm 1.5^{\circ}\text{C}$.

The relative humidity would not be positively controlled but would be indirectly controlled within the comfort range as a result of the design and selection of the cooling plant.

The winter temperature would be maintained via heat pump cycle from the reverse cycle split type AC units.

2.6.3 Noise Levels

The air conditioning and ventilation installations must be designed not to exceed the rating levels of ambient noise for the relevant indoor dwelling spaces based on the South African National Standard (SANS) 10103.

Refer to table below for design and maximum rating levels of ambient noise for indoor dwelling spaces as per SANS 10103:

SPACE	DESIGN $L_{\text{Req. T, DBA}}$	MAXIMUM $L_{\text{Req. T, DBA}}$
Offices	35	40
Police	35	40
Court Room	25	30
Library	35	40

Project Altitude: 1243 m

Whilst considering required duties and capacity data of plant items, with regard to the selection of such items the project altitude of 1243 meters must be taken into account.

In this respect it should be noted that the capacity data in the Specification and specification drawings is based on the project altitude.

MEASURES TO REDUCE NOISE AND VIBRATION

- Where attenuators are fixed into walls, canvas collars are to be placed on noise sensitive side.
- Where piping and ducting pass through walls, they are to be wrapped with high density ($64 - 103 \text{ kg/m}^3$) preformed, resin-bonded glass wool of 25mm

thickness and then with thick Builder's plastic. Grouting is then to be done hard-up to the plastic.

2.6.4 Outside Air Ventilation

Computer labs, group rooms and office zones where applicable would be supplied with mechanical ventilation systems as per SANS 10400 Part O.

2.7 Tools and Equipment: Acceptable Manufacturers, Types and Model Numbers

Where, in these documents, requirements are stated in terms of the acceptability of manufacturers, installation firms, of types/model numbers of systems or equipment, these requirements are to be strictly adhered to unless the Engineer has, in writing, authorised, at his sole discretion, further and alternative names before the tender date.

Unless otherwise specified, the Contractor shall provide all tools, materials, scaffolding, power, water, etc. necessary for the proper and efficient execution of the work covered by this specification.

No extra payment will be made for plant equipment, materials required by the contractor to complete the work.

The Contractor shall provide all rigging, cranes, lifting equipment, etc., necessary to execute the works.

2.8 Definition of System

The word "system" where used in these documents shall mean not only the major terms of plant and equipment covered by the Specification, but all work and the incidental sundry components (including hoisting, rigging, scaffolding, etc.) necessary for complete execution of the works in an efficient and workmanlike manner and for the proper operation of the installation, with their labour charges, whether or not these sundry components and/or charges are mentioned in detail in the documents.

2.9 Maintenance and Maintenance Tools

During the [12] months guarantee period specified in Part 3 of these documents, the Sub-Contractor, will at no extra charge, service and maintain the installation on a monthly basis, totalling twelve such visits. Such maintenance/service operations shall include inspection and lubrication where required on all moving parts; checking and adjusting where necessary of v-belt drives, cleaning of filters, checking and cleaning and adjusting where necessary of refrigeration systems and their associated controls, checking and adjusting where necessary of temperature control systems, and any other maintenance required in terms of manufacturers' instructions.

The Sub-Contractor is to arrange for twelve service record sheets to be signed by a representative of the Employer, and these twelve signed record sheets are to be

furnished to the Engineer as documentary proof that the requirements of this maintenance clause have been met.

The Contractor shall provide one set of all special tools, gland keys, valve keys, etc. required for testing, maintaining and operating of all items of equipment.

Duplicate keys shall be provided for all control panels, instrument locks, safety valve locks, etc.

All special tools etc. referred to above shall be handed to the client when the system handover is done.

2.10 Guarantee

Without limiting the requirements and obligations of the sub-contractor in respect to the Latent Defects Liability Period contained in Clauses 27, 36 and 39 of the sub-contract agreement, the sub-contractor shall provide a guarantee to the Employer for the material, apparatus and workmanship delivered by him. The guarantee must be valid for a period ending twelve months from the date when the sub-contract is accepted by the Engineer as completed and in working condition. The complete installation must be guaranteed against defects as a result of patent and latent defects of the design and apparatus, save design defects made or specified by the Engineer, as well as against faulty materials and workmanship. Fair wear and tear is excluded from the guarantee.

The guarantee must provide that all parts, spares and appurtenances that become defective during the guarantee period be replaced free of charge of any nature to the Principal Contractor, the Employer or the Engineer.

The costs of labour and transportation required to replace such part of a defective installation shall be borne by the Sub-Contractor and shall be included in his guarantee. The Sub-Contractor shall cede to the Employer the remainder of any equipment guarantee (s) which he has received from his suppliers and which extend (s) beyond the period of twelve months mentioned herein.

2.11 Operating and Maintenance Instructions

The Sub-Contractor, as a pre-condition to acceptance by the Engineer of the system as practically completed and ready for beneficial occupation by the Employer, will prepare and submit three sets of operating/maintenance/fault finding instructions pertaining to the operation and maintenance of all major items of equipment.

These operating instructions are to include:

- 1 Detailed plant description
- 2 Detailed daily plant operation description
- 3 Description of overall plant operation
- 4 Details of main items of equipment, each containing:
 - 4.1 Design capacity details
 - 4.2 Tested performance details
 - 4.3 Manufacturers; data sheets with operating points highlighted
 - 4.4 Manufacturers' commissioning and maintenance instructions
 - 4.5 List of recommend spare parts (for two year period)
 - 4.6 Details of local suppliers
- 5 Schedule of set points (for controls and safety devices)
- 6 "Troubleshooting List"
 - 6.1 Step-by-step procedures for unspecialised fault finding
 - 6.2 What remedial action to take
 - 6.3 When to call for specialised assistance
- 7 Maintenance Schedule
- 8 One complete set of "as built" drawings as described in Para OPERATING AND MAINTENANCE INSTRUCTIONS.

2.12 Training of Personnel

The Sub-Contractor must explain and demonstrate the following to person (s) nominated by the Employer or Engineer:

1. Stopping and starting of equipment.
2. Repair of minor defects
3. Adjustment of controls
4. Routine maintenance inspection
5. Routine maintenance

Two man-days, to be arranged in conjunction with the Engineer, must be allocated for this exercise, and a pre-requisite being that the operating and maintenance manuals and "on site" wiring diagrams have been compiled and supplied before that day.

2.13 Completeness of Contract Documentation and Drawings

Part 6 and the Engineer's drawings forming part of these documents are described as follows, and the Sub-Contractor is deemed to have satisfied himself of the completeness of these documents.

2.14 Legal Requirements

The installation shall be erected and carried out in compliance with:

1. SABS 0142, 1982, as amended: Code of Wiring of premises.
2. Machinery and Occupational Safety Act No. 6-1983 as amended.
3. The Mines and Works Regulations, Government Notice No. R10609 of the 28 September 1952.
4. The local Municipal by-laws and Regulations as well as the regulations of the local Supply Authority.
5. SABS 0103, 1983, Code of Practice for environmental noise.
6. SABS 0400, 1990.
7. The Factories, Machinery and Building Work Act of 191 as amended.
8. The regulations of the local Gas Board.
9. The SABS Code for the Wiring of premises. – SABS 0142-1987 as amended as well as SABS 0180-1974 as amended.
10. The local Fire Regulations.
11. The Building regulations as described in SANS 10400 (current edition).
12. The Occupation Health and Safety Act (current edition).
13. The Specifications of the applicable Public Works Department.

In addition, the Contractor shall issue all notices and pay all the required fees in respect of the installation to the Local Authorities; and shall exempt the Principal Agents and Employer from all losses, cost or expenditures which may arise as a result of the Contractor's negligence to comply with the requirements of the regulations enumerated in this paragraph.

Should any requirement, by-law or regulation, which contradicts this Specification, apply or become applicable during erection of the Installation, such requirement, by-law or regulation shall overrule the Specification; and the Contractor shall immediately inform the Engineer of such a contradiction.

Under no circumstances shall the Contractor carry out any variations to the installation in terms of such contradiction without obtaining written permission to do so from the Engineer.

It shall be assumed that the Contractor is conversant with the above mentioned requirements. Should any requirements, bye-laws or regulations, which contradict the requirements of this document, apply or become applicable during erection of the installation, such requirement, by-law or regulation shall overrule this Document and the Contractor shall immediately inform the Engineer of such contradiction. Under no

circumstances shall the Contractor carry out any variation to the installation in terms of such contradictions without obtaining written permission to do so from the Engineer.

2.15 Sub-Contracted Work

Under no circumstances shall the Sub-Contractor subcontract work or part of works out to other parties other than as shown in the completed questionnaires of Section 6 without the prior approval of the Engineer.

2.16 Installation Programme and Progress

An “agreed” installation programme produced by the Sub-Contractor in close consultation with and approved by the Principal Contractor shall be submitted to the Engineer for approval within 7 days of awarding of the Sub-Contractor issuance of Letter of Intent whichever occurs first.

The programme for the carrying out of the works shall be submitted in detailed form covering all significant operations and shall be in the form of a bar chart.

The Contractor shall liaise with all necessary parties (other contractors, sub-contractors, consultants, equipment suppliers, etc.) to ensure that the programme is as accurate and as realistic as possible.

The Contractor shall submit the programme in a format agreed with the Principal Contractor and the Engineer.

The programme shall list each scheduled item of equipment in the contract and shall indicated periods for:

1. Preparation, approval and finalisation of manufacturing drawings.
2. Ordering
3. Manufacturing
4. Inspection and testing during manufacture.
5. Delivery
6. Installation
7. Testing
8. Commissioning

The Contractor shall build into the programme a period of two weeks for approval of drawings by the Engineer.

The Contractor shall allocate to a senior member of his staff the duties of studying and evaluating the works in relation to the approved programme, of devising methods to overcome or prevent delays and of co-operating with the Engineer and other contractors working on site. He shall report to the Engineer and draw his attention timeously to anything, which may cause a delay in the execution of the works.

The programme shall be updated as and when necessary to take account of changed circumstances.

2.17 Work by Others

The following work is excluded from this subcontract:

1. Openings in walls, partitions, and other structures to accommodate ducting, piping, electrical cables and other services. These openings to be made good and air tight sealed by the Sub-Contractor. See also sleeve wall detail.
2. Timber linings for duct penetrations through masonry walls.
3. Roof penetrations, providing suitable roof curbs for roof fans, flashing off and waterproofing where necessary. Sub-Contractor to provide counter flashing.
4. Holes in ceilings and bulkheads where shown on drawings and to accommodate air terminals, diffusers and grilles.
5. Provision of suitable access panels in ceilings, bulkheads and walls for servicing/commissioning of air conditioning equipment.
6. Concrete bases and up stands (150mm high) to support air conditioning equipment and air handling units where shown on the drawings, as well as masonry supports under cooling towers where shown on the drawings.
7. Concrete for the inertia blocks for major items of equipment. However, the steel trays for inertia blocks to be supplied by the Sub-Contractor.
8. The Sub-Contractor will be responsible for providing angle framework around corners of base plinths for casting in by the Principal Contractor.
9. The provision of full bore condensate drain points with P-traps to sewer pipes near air handling plants and cooling towers where shown on the drawings.
10. The provision of suitable mains water supply points with valves where shown on the drawings. Mains water supply points are required to cooling towers and feed and expansion tanks.
11. Unless specifically stated differently in this Specification, the supply, installation of the main electrical supply cables to the air conditioning/ventilation switchboards. The Sub-Contractor shall be responsible for the termination and connection of all such cables to the switchboards supplied under these contracts.
12. The electrical supply, switching arrangements and connecting up to local isolators of all small fans where indicated "By Others" in the technical schedules of Section 3 of this Specification, or where shown on the drawings. The Sub-Contractor to wire from these local isolators to the referred fans.
13. Waterproofing of plantroom floors with 150mm high up stands or steel sleeves around holes in floor under doors and waterproof floor sealing.
14. Undercutting of doors and supply and installation of louvred doors where shown on the drawings.
15. The installation of door grilles and cutting of holes in door, as shown on the drawings. The door grilles to be supplied by the Sub-Contractor.
16. Roof insulation, solar shielding and solar shading louvres or windows where required.
17. Holes in window glass for the window mounted fans where shown on the drawings.

18. Exterior painting of exposed ducting by the Principal Contractor or his painting subcontractors.
19. Where applicable, smoke detection system including low voltage wiring and connecting up to terminals in the air conditioning switchboards to be carried out by the electrical subcontractor.
20. Electrical conduits with draw boxes from sub control panels to main air conditioning panels, as details in Sections 2 and 4 and the drawings, to be provided by the electrical subcontractor.
21. Supply and installation of console and window/wall a/c units and associated outside wall sleeves and louvres, unless specified in detail in Sections 2 and 3 of the Specification.
22. Electrical conduits (dia. 25mm) to above ceiling level with 100mm x 100mm draw boxes at 1800 AFFL for wall mounted thermostats and control consoles marked
23. "T" on the drawings to be supplied and installed by the electrical subcontractor.

2.18 Compliance with Standards

When so requested by the Engineer, provide evidence in the form of delivery slips, certificates, test reports or other written proof that material or components comply with the standards laid down in this specification.

Products that are specified as mark-bearing must bear the mark of the relevant standards body.

2.19 Summary of SANS Specifications Application to the Standard Quality Specification for Air Conditioning Installation

1. SANS 10064: The preparation of steel surfaces for coating.
2. SANS 1200 HC: Corrosion protection of structural steelwork.
3. SANS 1091: National colour standards for paint.
4. SANS 12944-4: Paints and Varnishes – Corrosion protection of steel structures by protective paint system Part 4 Types of surface and surface preparation.
5. SANS 460: Copper and copper alloy tubing.
6. SANS 455: Covered electrodes for the manual Arc welding of carbon and carbon manganese steels.
7. SANS 10044: Welding: Parts I to VII
8. SANS 10238: Welding and thermal cutting processes – Health and safety
9. SANS 121: Hot-dip (galvanised) zinc coatings (other than on continuously zinc-coated sheet and wire).
10. SANS 3575: Continuous hot-dip zinc-coated carbon steel sheet of commercial, lock forming and drawing qualities.
11. SABS 0214: The design, fabrication and inspection of articles for hot-dip galvanising.
12. SANS 1186-1: Symbolic Safety Signs Part 1:
13. Standard signs and general requirements.

14. SANS 62-1: Steel Pipes Part 1: Steel pipes of NB Not exceeding 150mm.
15. SANS 62-2: Steel Pipes Part 2: Pipes and pipe fittings of nominal bore not exceeding 150mm, made from steel pipe.
16. SANS 10147: Refrigeration System including plants associated with air-conditioning systems.
17. SANS 1125: Room air conditioners and heat pumps.
18. SANS 719: electric welded low carbon steel pipes for aqueous fluids (ordinary duties)
19. SABS 23: Brazing alloys containing silver
20. SANS 193: Fire Dampers
21. SANS 10173: The installation, testing and balancing of air conditioning duct work.
22. BS 10: Specification for flanges and bolting For piping, valves and fittings.
23. BS 3601-22: Specification for carbon steel pipes and tubes with specified room temperature properties for pressure purposes.
24. BS 4504: Circular flanges for pipes, valves and Fittings (PN designated), Specification for steel flanges, Specification for copper alloy and Composite flanges.
25. BS 5000-99: Machines for miscellaneous applications.
26. BS EN 1561: Founding, Grey cast irons.
27. BS EN 1563: Founding, Spheroidal graphite cast iron.
28. BS EN 1982: Copper and copper alloys, ingots and castings.
29. BS EN 10213-1: Technical delivery conditions for steel castings for pressure purposes.
30. BS EN 10213-2: Technical delivery conditions for steel castings for pressure purposes. Steel grades for use at room temperature and at elevated temperatures.
31. BS 1486
32. BS 848 Part 1 & 3
33. BS 970
34. BS 21
35. BS 1387
36. BS 1740
37. ASTM B61: Standard Specification for Steam or Valve Bronze castings.
38. ASTM B 62: Standard Specification for Composition Bronze or Ounce Metal Castings.
39. ASTM A 126: Standard Specification, for Gray Iron For Valves, Flanges, and Pipe Fittings.
40. ASTM A 216/A 216M: Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service.
41. ASTM A 389/A 389M: Standard Specification for Steel Castings, Alloy, Specially Heat-Treated for Pressure-Containing Parts, Suitable for High - Temperature Service.
42. ASTM A 395/A 395M: Standard Specification for Ferritic Ductile Iron Pressure – Retaining Castings for use at Elevated Temperatures.
43. ASTM F 1369: Standard Specification for Heaters, Convection, Steam and Hot Water.
44. ASTM F 1508: Standard specification for Angle Style, Pressure Relief Valves for Steam, Gas and Liquid Services.

- 45. API 5L: Specification for line pipe.
- 46. IP 44
- 47. IP 55:
- 48. SO 1940: Mechanical vibration
- 49. ISO 2372
- 50. OHS Act: The Occupational Health and Safety Act, Act 85 of 1993.

2.20 Site Conditions

Tenderers are instructed to visit the site and acquaint themselves with all local conditions pertaining to the execution of the installation before tender closing date. No claims from the contractor which may arise from insufficient knowledge of site access, type of site, labour conditions, establishment space, transport and loading/unloading facilities power, water, supply, etc. will be considered after submission of tenders. For services where prior permission is required before contractor can visit the site, a visit will be arranged for all interested parties at their request.

2.21 Arrangements with the Supply Authority

The Contractor shall give all notices required by and pay all necessary fees, including any inspection fees, which may be required by the local supply Authority unless otherwise specified.

On production of the official account, only the net amount of the fee charged by the Supply Authority for connection of the installation to the supply mains will be refunded to the Contractor by the Owner.

It shall be the responsibility of the Contractor to make the necessary arrangements at his own cost with the local supply authority and to supply the labour, equipment and means to inspect, test and commission the installation to the requirement of the local and supply authorities.

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

2.22 Storage of Equipment and Materials

The Contractor shall ensure that all stored material and equipment are safely stacked and that they are not damaged by stacking.

The Contractor shall ensure that stored materials and equipment do not overload the structure of floor construction.

The storage of combustible materials on site shall be kept to a minimum.

The Contractor shall be responsible for ensuring that such combustible materials are safely stored. Suitable firefighting equipment shall be provided by the Contractor who shall further ensure that staff capable of using the equipment is at hand.

2.23 Location of Equipment

The Contractor shall check on doorways, passages, openings, lifts, etc, provided and shall ensure that all equipment offered can be moved through them to its final position. If necessary, equipment shall be ordered in a partially dismantled condition so that is suitable for moving through the restricted openings or areas of restricted height or areas of restricted load.

2.24 Co-operation with Other Trades

The Contractor shall ascertain the extent of the work of other trades on site.

The Contractor shall give all necessary assistance to other trades to ensure that the work of all trades can be installed satisfactorily and without delay.

The Contractor shall liaise with other trades working in close proximity to the work covered by this specification and shall assist in working out equipment and material positions to ensure that all trades can complete their work satisfactorily.

2.25 Builder's Work

The successful tenderer shall, within 30 days, or any shorter period which may be necessitated by the construction programme, submit two sets of all drawings showing all builders works required for the project.

The drawings shall provide the builder with all the dimensions, details, etc., for the work to be carried out correctly.

The Engineer will scrutinise the drawings and request changes and adjustments as required. After such changes are satisfactorily made the Engineer will fix his stamp; of approval to the drawings.

The successful tenderer shall provide all the necessary copies of the drawings to the Engineer to issue to all parties.

It is the responsibility of the Contractor to check the builder's work as it is completed to ensure that the work has been correctly carried out in accordance with the drawings. The Contractor shall point out any problem areas as soon as possible to the builder so that they can be rectified. No claims shall be considered for delays or other additional costs which arise of the contractor's failure to check the builders work in good time.

The builder's work drawings shall be fully dimensioned and shall include the following:

1. Details of all plant bases required.
2. Positions of all drain points.
3. Details of all openings in walls and concrete work.
4. Details and positions of all equipment to be built into walls.
5. Any other work required.

The contractor and builder to the approval of the Engineer and Architect shall carefully detail all areas where the Air Conditioning and Ventilation Installation pierces waterproofing. All necessary sleeves, caulking and flashing as required to make the installation waterproof shall be provided as part of this contract.

2.26 Supervision and Site Organisation

For the full duration of this Contract the Sub-Contractor shall employ at least one good and competent Supervisor careful and skilled in all aspects of the trades and skills required by this Contract. This supervisor shall be on site whenever work associated with this contract is being carried out and shall at all times be available to attend to queries by the Principal Contractor or Engineer.

The Supervisor shall be the contractor's authorised representative for the project on site and shall be available to attend progress meetings when called upon to do so by the Principal Contractor, Engineer or Architect, whether or not these take place prior to work actually starting on site.

The supervisor shall be empowered to make all decisions necessary for the execution of the contract.

The supervisor shall not be transferred from his position unless on the express instructions of the Engineer.

The sub-contractor shall at all times have on site copies of all relevant drawings as well as a copy of the specification and an unpriced BOQ. The sub-contractor shall institute the necessary procedures to ensure the drawings on site are the latest drawings and that all superseded drawings are removed from site.

PART 3 – GENERAL TECHNICAL SPECIFICATION

3.1 General Information Regarding Equipment

This section of the tender documents represents the combined functions of statements and schedules of technical requirements relating to equipment, and of schedules to be filled out, in part by the tenderer at tender stage, and in full by the successful sub-contractor.

It is to be carefully noted that only the items of information in the Schedules marked with an asterisk (*) are required to be completed by the tenderer at tender stage. All other information will require to be completed by the successful tenderer before the subcontract is entered into with the principal contractor.

To facilitate the process of tendering for this project in view of the fact that exact pumping heads and fan resistance characteristics cannot be determined at this stage, as such characteristics could vary depending on the finally accepted major items of equipment, estimated figures have been entered in the schedules, and tenderers are to base the selection of their fans and pumps on this data.

Should the actual pumping head and fan resistance figures, at the time of selection of equipment, be different from the corresponding figures appearing in these Schedules, corresponding subcontract price adjustments, approved to the satisfaction of the Engineer, will be made.

Attention is drawn to paragraph 4.8. Tenders who do not comply with this paragraph shall be disqualified.

3.2 General Equipment Protection

3.2.1 Protection against Damage

All equipment delivered to site shall be adequately protected against damage that can be expected on a building site.

Protection against weather is the responsibility of the sub-contractor carrying out the work detailed in this specification.

3.2.2 General Machinery Protection

All high speed couplings, projecting shaft ends and every dangerous moving parts of machinery which is within normal reach of a person shall be protected by a guard manufactured from not less than 1, 6 mm mild steel plate.

The coupling guards shall be neatly formed and securely fixed in position.

All belt or rope drives within normal reach shall be adequately protected by a belt guard.

The belt or rope guard shall be manufactured from wire mesh or open type expanded metal, securely braced and stiffened with light rolled steel section and bolted in position.

All chain drives shall be fitted with sheet steel chain cases and lubrication facilities to chain manufacturers' recommendations. All joints shall be dust tight and arranged for convenient installation and dismantling.

Each chain case shall be fitted with a hinged inspection door, drain hole and plug.

All guards shall be finished in a light orange colour too B.5 381. C.

3.3 Quality Assurance

3.3.1 General

The following general points shall be noted:

The Air Conditioning and Ventilation Contractor shall be responsible for implementing a full quality assurance plan covering all activities included in this contract.

Contractors and suppliers with ISO 9000 certification will be considered favourably in the adjudication process.

Contractors who do not have ISO 9000 certification shall provide a comprehensive quality assurance plan in accordance with ISO 9000 provisions at the time their tender is accepted.

The quality plan shall cover design activities, procurement, storage, construction, handover, maintenance and guarantee.

3.3.2 Quality Management Plan

A Quality Management Plan shall be prepared by the successful Air Conditioning and Ventilation contractor and this plan shall be submitted to the Engineer for approval within 14 days of receiving an advice of the appointment. The QMP shall include at least the following:

A responsibility matrix identifying all parties in the contractors organisation who will be involved in the project or who are responsible for aspects of the project. The specific activities shall be identified with the responsible individual.

A list of all applicable specifications and third party inspections required.

A list of all inspection holds points with actions and responsibilities to ensure that these are timeously inspected.

A list of all inputs required from the Engineer or the client with actions and responsibilities to ensure that the proper persons are advised in good time.

3.4 Testing and Commissioning

3.4.1 General

The Engineer or his representative shall be advised of all testing and commissioning and shall be given the opportunity to witness all tests. However, the Engineer will only be on site to witness the tests and takes no responsibility for the acceptance of test results.

The testing and commissioning procedure shall form part of the Quality Verification Plan submitted by the Contractor and shall be the subject to the same prior approval by the Engineer. The testing and commissioning procedure shall embody the following principles:

All plant shall be tested off site prior to delivery. No plant or equipment will be accepted and paid for if it is not accompanied by the manufacturer/supplier certificate verifying that it has been tested.

All plant and systems on site shall be tested as early as possible after installation to verify that the plant/system/sub-system is operating correctly.

No testing or commissioning shall take place without an approved written procedure.

The responsibility for the proper testing and commissioning of the system rests fully with the Contractor. This includes the provision of all necessary test equipment, measuring and test points, valves and dampers, etc. to test and commission the system.

At the time of submitting equipment for approval, full details of the commissioning requirements shall be provided.

3.4.2 Testing and Commissioning Program

At least four weeks before commencing any testing and commissioning the contractor shall submit a complete program for such work so that the Engineer can arrange to be on site at the appropriate time. The programme shall embody the agreed testing and commissioning procedure.

The programme shall include –

A bar chart covering all activities.

Names and addresses of companies involved in each activity.

The way in which each test will be carried out complete with pro forma forms for tabulating results.

3.4.3 Equipment and Procedure

The equipment supplied under the Contract shall be subject to inspection by the Engineer or his Selected Agent at all stages of manufacture.

The tests and commissioning procedure as laid down and such additional tests as the Engineer may reasonably require to prove compliance with the Specification shall be carried out at the Contractor's Works and at Site.

The Contractor shall give reasonable notice of time and place in writing to enable the Engineer to inspect and witness tests of materials and equipment. He shall provide the Engineer with facilities for witnessing the tests and for any additional tests or inspection of any portion of the works required by the Engineer.

The Contractor shall at his own cost render all assistance and supply all labour, appliances and any other materials, as the Engineer may require to check the setting out, measure up and inspect any portions of the works at any stage during fabrication, construction, erection or painting. During such operations, the Contractor shall if required, suspend any or all of the Works, without having claim for loss or damage as a result thereof.

The testing of the plant (or any part thereof) supplied under this contract shall be carried out through its full operating range (or part thereof) as required by the Engineer.

All such tests and inspections and the necessary inspection facilities shall be provided as part of the Tendered price for the Contract.

At the commencement of and during the whole of the Commissioning and Testing Periods, the Contractor shall have available on site all essential spares and tools considered necessary to enable repair work of defective parts to be carried out immediately in the event of a breakdown or adjustments being necessary.

The Contractor shall be responsible for the proper operation and maintenance of the plant throughout the period of the tests and until the operator training period is complete.

Acceptance by the Engineer of any plant item, following such inspection or tests, shall not relieve the Contractor of any obligations under this Contract.

All pumps shall be lined up and tested as a complete set. Test Certificates shall be supplied before dispatch.

All rotors and motor/impeller combinations shall be statically and dynamically balanced. Test Certificates shall be supplied before dispatch.

All such other tests as required by the Engineer to prove compliance with the specification shall be carried out.

3.4.4 Test Certificates

The Contractor shall provide three copies of test certificates in respect of all materials and equipment, further copies are to be bound into the operating and maintenance manuals.

3.4.5 Insulation Tests

All electrical wiring and equipment shall be subjected to insulation tests. All instruments and other equipment for the tests shall be provided by the Contractor.

3.4.6 Draining and Cleaning

On completion of the pressure test on a section of pipework the water used for testing shall be drained away as quickly as possible to remove as much dirt and dross as possible. After completion of a pipework circuit the circuit shall be flushed through to remove all pipe scale, dross and similar materials.

The Contractor shall provide all necessary connections, by-pass pipes, temporary strainers, and temporary make-up pieces, to enable the systems to be drained and cleaned.

Additionally, on boiler commissioning, steam lines are to be charged with steam to full operating pressure and allowed to cool. This procedure is to be carried out three times over a period of two days. Following the third cycle the pipes are to be open ended and blown through.

These procedures are to be supervised by the Engineer.

3.4.7 Plant Commissioning

The Contractor shall arrange at his cost for the manufacturer's representatives to check over and fully commission all major items of equipment. This work is to be carried out by skilled engineers preferably employed by the manufacturers, who are completely familiar with the equipment involved and shall be capable of training the operating and maintenance staff in the duties they are to perform.

On completion of the plant commissioning the Contractor shall obtain written confirmation from the various manufacturers that they have completed all commissioning work and are satisfied that the items of plant for which they are responsible are functioning satisfactorily.

Copies of the manufacturer's written confirmation shall be sent to the Engineer.

3.4.8 Tests on Completion

On completion of the balancing and commissioning of equipment the plant shall be put into normal operation and the final adjustments of the equipment shall be made.

Thereafter the Test on Completion shall be carried out to ensure that the plant meets the specification.

Such tests shall include the following:

Simulated tests for all alarm and safety cut out equipment to prove the operation of the equipment.

Simulated tests on automatic controls to prove the ability of the controls to correct conditions which are outside the required design conditions.

The tests shall be carried out by manually changing the desired values to produce an incorrect condition and then re-setting the controls to the design conditions and checking the operation of valves, etc. to restore the design conditions.

Operational tests on the Plant to demonstrate that it is giving the rated output and efficiency.

The Contractor shall provide all necessary temporary measuring and recording equipment. The equipment shall be of a type generally used for this type of testing and shall be to the approval of the Engineer. All instruments shall be accurately calibrated before the tests begin.

On completion of the whole of the tests and when the Contractor is satisfied that the entire plant is operating satisfactorily and will fulfil the function for which it has been supplied, he shall submit to the engineer triplicate copies of all test records and charts together with reports on all the tests required in terms of the approved Quality Verification Plan. The Engineer shall reserve the right to ask for any reasonable additional tests or for the repetition of previous tests in order to prove that the operation of the plant is satisfactory and in accordance with the Performance Specification.

3.5 Electric Wiring

Electrical mains supply cables will be brought to the air conditioning switchboards by others unless otherwise stated, but will require to be terminated by the air conditioning sub-contractor.

Electrical connections and associated conduit work and cable ducting between the switchboards and all air conditioning, ventilation and associated plant shall be provided by the air conditioning sub-contractor.

All electric wiring and earthing shall be executed in accordance with the relevant local authority regulations.

Horizontal distribution of cables to equipment shall be by means of suitable trays using UNISTRUT type cable trays and accessory fittings. Cables installed on the cable trays must be neatly arranged in parallel and adjacent to each other and clamped at disturbances not exceeding 600 mm.

Isolator switches shall be fitted to equipment remote from the Electrical switchboards where required to meet local wiring regulations and where safety of operation demands such isolators.

Please refer to the schedules where all electrical power points to be provided by the main electrical sub-contractor.

The wiring to and the connections to the power points are to be undertaken by the main air conditioning contractor. Details and final power selections are to be confirmed timeously by the air conditioning contractor.

All miscellaneous fans to have suitable connection box on side of fan or duct for easy connection. Before fans are switched on the air conditioning sub-contractor is to test wiring installation for connection.

All wiring to electrical heater banks shall be heat resistant in accordance with the acceptable standards and local regulations.

Low voltage wiring and low voltage control wiring shall be of grey colour and have terminals physically separated from the usual 220V terminals for easy identification and to avoid confusion.

Low voltage wiring shall be properly "screened" where necessary to prevent the risk of "ghost" signals resulting from induction.

Whereas the supply and installation of the mains electrical supply to the air conditioning equipment is part of the electrical sub-contract, the air conditioning contractor shall ensure that suitable connections are made available to cable sizes as advised.

The mechanical distribution board(s) shall be rendered moisture, dust and vermin proof. During erection of the installation, the distribution board(s) shall be protected against damage and penetration of moisture, dust and vermin.

Care shall be taken to ensure that all equipment is fully labelled and that accurate descriptions appear. Engraved plastic or ivory sandwiched strips shall be used

throughout. The strips shall bear either white lettering on black background or black lettering on white background.

Letters shall at least 5mm high.

3.6 Variable Refrigerant Type DX Systems

3.6.1 After Sales Support

To ensure long term support and given the specific nature of variable refrigerant system spares, the system offered shall be from a worldwide recognised brand only, with branch offices on all continents. The South African branch office shall offer full technical and local spares support. The mother company shall guarantee full spares availability for at least 10 years after the model that is installed, has been discontinued for replacement with a later model.

3.6.2 Outdoor Units

The variable refrigerant system shall be of the heat recovery type, using either a 2-pipe or 3-pipe configuration and run on R-410A refrigerant. Outdoor units shall be air-cooled.

The compressors shall be of the inverter driven scroll type. Digital scroll type compressors shall not be accepted.

In order to make up the required total cooling capacity for the building, outdoor units may be grouped in parallel, but interlocked to work as a single system.

The mechanical design shall be such, that should a compressor fail on any of the outdoor units, acid contaminated oil will be effectively contained in the unit of failure so that it does not cause failure of the remaining units.

The outdoor units shall run from a 400V 3-phase, 50 Hz power supply, with a tolerance of at least 10% in supply voltage. VRF units shall come standard fitted with voltage protection in the case of any electrical surges or power dips to protect PC boards and compressors.

Should it be needed to install the outdoor units in an enclosed space where the discharge air needs to be ducted to the outside, the standard outdoor fan shall have suitable capacity to provide maximum required flow at an additional 50 Pa static pressure.

The outdoor units shall be fitted with hail guards over and above the original protection provided by the suppliers.

3.6.3 System Design

The complete system design to shall be done by the supplier of the product, with supplier specific software, based on the capacities and layout in this specifications and the drawings. To effectively make use of the heat recovery function, the units shall be grouped per level as indicated on the drawings. It shall be possible to connect more than one unit on a port of a Branch Selector or Branch Control unit, where the indoor units shall be configured for master/slave operation.

The design report shall include the following on a schematic diagram:

1. Pipe sizing and junction types
2. Bus cable diagram
3. Remote controller connection of single units, or Master / Slave configuration
4. Component addressing if addressing is done manually

3.6.4 Communication Bus and Master Controller

Indoor and outdoor unit controllers shall be interconnected via a communication bus. A master control panel shall be supplied for central control with the following functions:

1. Programmable to suit the specific building setup.
 2. Reading of all measured parameters of indoor and outdoor units.
 3. Adjusting of temperature set points of all units on the system.
 4. Support addressable logic for all controllers connected to the system.
1. Support Lonworks and BACnet BMS protocols for integration with other BMS systems.

Regardless of the fact that the system shall be provided with a master control panel, all parameters and fault codes of all the units connected to the system, shall be readable from the controller of the outdoor unit.

3.6.5 Refrigerant Piping

All refrigerant piping shall be rated for use with R-410A refrigerant.

Hard drawn pipes shall be ordered with specific mention to have end caps on both ends, to prevent dirt and moisture from accumulating inside the pipes. Pipes that arrive

on site without end caps, or pipes that lays open ended on site during assembly, shall be confiscated during routine and surprise inspections and the contractor shall be ordered to cut any pipes of the engineer's choice for inspection, at his cost.

During sweat on assembly of hard drawn pipes, the contractor shall pressurise the pipeline with Nitrogen from the end of which assembly has started. The flow of nitrogen shall be sufficient to prevent any carbon build-up on the inside of the pipes, during assembly. Whenever assembly needs to be discontinued, both ends of the pipes shall be sealed off with insulation tape.

Should it be revealed on any inspection, or during commissioning that due care was not taken to prevent dirt from entering the pipe system, or that nitrogen pressurisation was not used during assembly causing a carbon build up, the engineer has the right to reject the entire pipe installation and all damaged or blocked components will be replaced on the cost of the contractor.

3.6.6 Training Certificates

It is a specific condition of this specification, that the contractor is certified by the supplier of the product as an approved installer. Proof of successful completion of the specific supplier's installation training course, shall be submitted for each technician that does the physical installation.

3.6.7 Commissioning

It is a specific condition, that commissioning of the variable refrigerant system, shall be done by technical representatives of the local supplier. During commissioning, the contractor shall make any changes or reparations required by the commissioning technician, at his cost.

3.7 Ductwork

3.7.1 Sheet metal Ductwork

Construct air ducts according to "Low Velocity Duct Construction Standards" and "High Velocity Duct Construction Standards" (SMACNA) or SABS 1238 – 1979 as amended.

Install ductwork as indicated on the project drawings.

All duct dimensions, (including internally insulated ducts), refer to the clear internal cross-sectional area.

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

Ducts must be airtight, not drum or vibrate when the internal static pressure varies and must be so constructed that airflow is even without excessive static pressure drop. Construction must be sturdy.

Ducts must be thermally insulated in accordance to Section 4.3.19. Apply internal or external insulation according to requirements shown on the Engineer's drawings.

Avoid aspect ratios in excess of 4:1 in rectangular ductwork. Internal duct dimensions of less than 200mm in rectangular ducting are not acceptable in low and medium velocity ductwork.

Provide adjustable opposed blade dampers, sound attenuators, duct splitters and turning vanes where shown on the drawings.

Unless otherwise specified ductwork must be manufactured of galvanised sheet steel using thickness as recommended by SMACNA.

Paint ductwork as specified.

Isolate all ducts passing through concrete or brick walls from the walls by means of a high density glass fibre collar at least 20mm thick to prevent transmission of vibration to the building structure. Seal all openings where ducts pass through plant room walls by means of polysulphide mastic.

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

Flexible connections must be made of fireproof fabric reinforced air-tight material attached both sides with approved galvanised steel collars or frames.

Overhead hangers for horizontal ducts must be of the "Trapeze" type (SMACNA page 45). Support vertical ducts in accordance with SMACNA page 43, Fig B.

Ductwork connected to equipment such as cooling towers, evaporative condensers, plenum chambers etc., must be provided with flanged removable sections to allow for removal and access to eliminators, etc.

3.7.2 Low Velocity Ducts

This refers to ducts with velocity up to and including 10 m/s and static pressure up to and including 500 Pa.

Refer to "Low Velocity Duct Construction Standards". (SMACNA) for all constructional requirements. Alternative methods applicable are specified hereafter.

Galvanised sheet steel must be used with thickness as recommended in SMACNA ("Table 1, page 11). Either cross-breaking or beading is acceptable. Longitudinal seams must be of the "Pittsburg Lock" or Acme Lock" type. Transverse joints must be as follows: (SMACNA – Table 1, page 11):

Dimensions of Longest side if duct	Transverse joints		Reinforcing Angle
	Long Side	Short Side	
Up to 450mm	B	A	SMACNA – P11
475 to 750mm	E	A	SMACNA – P11
775 to 1500mm	L	L	SMACNA – P11
1525 and larger	M	M	SMACNA – P11

Reinforcing the angle irons must be galvanised. Rivets, screws, bolts and other fastening equipment must be completely corrosion proof.

Elbows must be in accordance with SMACNA page 61. Use standard radius elbows generally. Install short radius elbow pieces as shown on the project drawings.

Provide square elbows with galvanised turning vanes, SMACNA Fig. A, Page 53.

3.7.3 High Velocity, Medium Pressure Ducts

Refer to "High Velocity Duct Construction Standards" (SMACNA) for all constructional requirements. Ducts with velocities higher than 10 m/s and a static pressure between 500 Pa and 1 500 Pa apply.

Galvanised sheet metal must be used with thickness as recommended in SMACNA fig 3 – 1, pages 14 and 15. Construction must be in accordance with (1), (2), (4) and (12) of Fig 3-1.

Use standard radius generally. Install short radius square elbows as shown on the project drawings. Provide short radius elbows with splitters and square elbows with double thickness type turning vanes.

(SMACNA pages 42,43 and 44).

Flexible ducts must be of the spiral wire reinforced glass fabric type (SMACNA page 63).

Overhead hangers for horizontal ducts must be of the "Trapeze" type (SMACNA page 56). Support vertical ducts as indicated in SMACNA page 57.

3.7.4 High Velocity, High Pressure Ducts

This refers to ducts with velocities above 10 m/s and static pressure above 1 500 Pa. Refer to "High Velocity Duct Construction Standards" (SMACNA) for all constructional requirements. Alternative methods applicable are specified hereafter.

Use galvanised sheet steel with construction in accordance with SMACNA Fig 3-2 Pages 16 and 17, Tables (1), (2), (4) and (11).

Use standard radius elbows generally. Install short radius square elbows as shown on the project drawings. Provide short radius elbows with splitters and square elbows with double thickness type turning vanes. (SMACNA) Pages 42,43 and 44.

Flexible ducts must be of the spiral wire reinforced glass fabric type (SMACNA Page 63).

Overhead hangers for horizontal ducts must be of the "Trapeze" type (SMACNA Page 56). Support vertical ducts as indicated in SMACNA Page 57.

3.7.5 Flexible Ductwork

Where indicated on the project drawings, ductwork must be connected to mixing boxes and integrally mounted ceiling diffusers by means of flexible ducting.

Flexible ducts must be either of the flexible aluminium foil metal type or of the spiral reinforced fabric type, in accordance with SMACNA Page 106, all flexible ducts must be insulated externally.

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

Flexible ducts connected to diffusers or mixing boxes must, unless otherwise shown or approved, not exceed 1,2m in length nor have more than the equivalent of one 90 ° bends. Bends must be of the maximum possible radius without flattening or distorting the flexible ducting.

Support flexible ducting with sufficient and correct brackets that will maintain its shape.



3.7.6 Duct Access Doors

Access doors must be of the insulated hinged type as shown in SMACNA Fig. B, page 17 (“Low Velocity Duct Construction Standards”).

Access doors must be of sizes as shown on the project drawing.

3.7.7 PVC Ductwork

PVC Ductwork where specified on the layout drawings must be of unplasticized polyvinyl chloride (uPVC) manufactured and installed in accordance with SMACNA – “The Thermoplastic Duct Construction Manual”.

The class of ducting used must be as specified.

Provide for expansion and contraction of the ductwork.

Flexible connections must be made of plasticized polyvinyl chloride (PVC).

Duct joints must be welded flanges or male/female socket type welded around. Test all welded joints and seams by high frequency spark test at 40 kV.

3.7.8 Manual Air Dampers for Volume Control

Provide each branch duct leading to a single air outlet with a damper unless the outlet diffuser is of the variable volume type. Provide each branch duct leading to a group of air outlets with a damper at the point where the branch leaves the main air duct. Splitters may be used in lieu of dampers where the estimated pressure drop does not exceed 30 Pa. Install dampers and splitters so that they can be adjusted at any time after the completion of the work. Provide access panels where the adjusting mechanism is concealed by suspended ceilings, furring, etc. Front and back bars or vanes of directional grilles are not to be used for adjustment of air quantities.

Butterfly dampers must be of the balanced type with opposed blades and must be constructed in accordance with SMACNA Pages 64,65,66 and 67.

(“Low Velocity Duct Construction Standards”).

Dampers shall not be used to create artificial resistance in the system in order to reduce fan air flow capacity.

Reduction of air flow shall be accomplished by reduced fan speed or by changing the fan blade angle.

3.7.9 Testing

Unless otherwise specified, test the total ductwork installation for leakage as per SANS 10173.

Leakage rates must not exceed 5% of the required air flow quantity in any section of ductwork or exceed the SABS permissible leakage, whichever is the smaller.

3.7.10 Duct Installations

Install ductwork in accordance with the layout drawings issued with the Project Specification.

The tender drawings are diagrammatic and do not purport to show exact positions of ducts or specific details of construction of the latter. Check all final dimensions on site before preparation of manufacturing drawings and the fabrication of ducting.

Where beams, stanchions or other obstructions interfere with the straight running of ducts, provide suitable offsets or alternatively make changes in the section of the particular duct.

Study all the drawings of the particular building in order to determine the number of such offsets or changes in section and the positions in which they will be required. Allow for such offsets. A complete set of drawings of the building may be inspected at the office of the Architect.

3.7.11 General

Unless specified, type 316 stainless steel shall be used for stainless steel ducting.

All exhaust air ducting for moisture producing equipment such as cooling towers or where air is drawing through or over water shall have sealed longitudinal and cross joints and shall be painted on the inside with corrosion protection paint to the satisfaction of the Engineer. Corrosion protection shall be selected to give a minimum protection life of five years.

Black mild steel of a minimum thickness 1,6mm thickness, shall be used for grease contaminated exhaust systems. All joints shall be welded.

3.7.12 Duct Hangers

Duct Hangers shall be as follows:

Longest duct dimensions (mm)	Round hangers (mm)	Galvanized Strap Hangers (mm)	Shelf Angles	Maximum Spacing (mm)
Up to 760	6	25 x 1.6	25 x 25 x 3	3.0
761 to 1000	10	25 x 1.6	38 x 38 x 3	3.0
1001 to 1200	10	25 x 1.6	50 x 50 x 3	2.4
2101 to 2400	10	25 x 1.6	50 x 50 x 6	2.4
2401 and over	12	25 x 1.6	50 x 50 x 6	2.4

Hangers shall not protrude below the lowest part of the shelf angles.

3.8 Fans

3.8.1 General

The combination fan and silencer selection must be such as to satisfy the specified noise levels.

Requirements under the above heading apply to fans which are not integral parts of cooling towers, air handling units or similar equipment designed as standard units by the manufacturer.

Fan duties are specified in the Equipment Schedules.

Where no pressure requirements are indicated, estimate the fan static pressure requirements from the system lay-out drawings and equipment.

The total fan system's design resistance, as specified must be finally checked when all information on selected system elements are available.

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

Flexible connections must be fitted between fan inlet/discharge and ducting or equipment as appropriate.

Matching flanges to be supplied with all fans.

Fit fans with manufacturer's nameplates permanently fixed to the casing in a prominent position clearly indicating manufacturer, model number, maximum operating speed, maximum power absorbed, size and serial number.

Protect fan in/outlets which are not connected to ducting or equipment with removable screens.

Provide indicating arrows for direction of rotation and direction of air flow on fan casings.

Fans for special applications such as corrosive gases, explosive atmospheres, etc., must be selected for the particular medium mentioned.

Fans for proprietary and package units although not specifically covered in this specification must however comply with the general requirements of this specification.

Mount all fans on anti-vibration mountings or support from anti-vibration hangers. All anti-vibration mountings must be to the approval of the Engineer.

Bearings must be ball or roller type, and quiet in operation. They must be sized to give a long life (not less than 100 000 hours) at the loads imposed by the application.

Belt guards must be arranged to permit lubrication and use of speed counters with the guard in position. Belt guards must have adequate ventilation for belt cooling.

Fans must be painted in the factory with one primer coat and two coats of high gloss corrosion resistant paint.

Where stated in the technical schedules under Electrical power from: "By Principal Contractor" or "By Others", the electrical contractor shall provide and connect the electrical supply wiring with local isolator near each fan wired to the fan via an interlocking ON/OFF switch where necessary as indicated in the technical schedules. For 380 volt 3 phase fans the electrical contractor shall provide a 3 phase local isolator wired up to a 380 volt 3 phase supply with interlocking starter contactor with suitable overload protection.

The air conditioning sub-contractor shall wire and connect from the isolator to the fan.

3.8.2 Centrifugal Fans

Centrifugal fans must be of the forward or backward curved, multi-vane type with single or double inlet and arrangement as specified in the Equipment Schedules.

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

The fan casing must be of the volute type manufactured from sheet steel with lock forming or continuously welded seams, suitable reinforced and adequately supported by means of a steel superstructure. Fans with a wheel diameter above 1000mm must be provided with access doors fitted to the fan casing.

Fan wheel and shaft assembly must be statically and dynamically balanced to ISO 1940 within grade G6,3.

Fan drives shall be by means of standard V-belt and grooved pulley configuration or direct drive.

Fans and motors must be rigidly bolted to a common prefabricated steel frame with the motor mounted on slide rails for normal belt drive adjustment or replacement. The complete frame must be mounted on anti-vibration mountings.

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

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

Shafts must be fully machined steel shafting conforming to BS 970.

Provide a drain socket with plug at the lowest point in the fan casing (except if discharge is at lowest point).

Fans used in variable volume applications must have stable characteristics throughout the operating range to suit the particular application.

All fans must be tested in the factory and checked for vibration to ISO 2372.

Bearings must be checked using a shock impulse meter. All measurements and observations made during this test run must be recorded and made available to the Engineer on request.

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

Shafts for variable inlet vane control must be supported by pre-lubricated sealed bearings. Both sets of variable inlet vanes on double inlet fans must be controlled simultaneously and equally.

3.8.3 Axial Flow Fans

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

Axial fans must be selected for the highest possible efficiency with the lowest possible blade tip speed. All fans must be of the adjustable pitch impeller type.

The complete fan unit must be statically and dynamically balanced in accordance with ISO 1940 within Grade G6,3.

Fan performance must be based on tests carried out in accordance with BS 848: Part 1.

Fan casings must be manufactured from reinforced mild steel with pre-drilled flanges at both ends. Casing access panels must be provided where specified in the Equipment Schedules.

Fan motors must be totally enclosed squirrel cage induction type with protection to IP55 unless for a special application as set out in the Equipment Schedules.

Motor connections must be in an external weatherproof terminal box forming part of the casing except for flameproof and special applications which are specified in the Equipment Schedules

Lubrication points must be extended to the outside of the casing and inspection doors of ample size must be provided in the casing.

In the case of aerofoil bladed fans, fan impellers shall be manufactured from aluminium or rigid PVC and shall be fitted in machined hubs featuring individual blade angle adjustment.

Fans mounted in ducts shall be provided with access panels for inspection and shall be easily removable for maintenance purposes.

Vibration isolation equipment to axial fans shall be provided in accordance with the Specification.

Axial flow fans, where not mounted in ducting, shall be protected with suitable wire-guards.

3.8.4 Roof Extract Fan

Roof extract units must be of the vertical jet or mushroom type unless prior approval for an alternative type is given by the Engineer in writing.

Install fans in accordance with the manufacturer's recommendations.

Outlet cowls and shutters must be the standard product of the fan unit manufacturer.

Outlet grilles must protect the fan from birds.

Provide single phase fan motors only where specified in the Equipment Schedules.

Flow and rotation direction arrows on fan casings must be easily visible from the plant room or from the access to the fan.

Where specified, units must be suitable for upstand and curb mounting, complete with weather skirting and flashing as required.

3.8.5 Propeller Fans

Propeller fans must be suitable for mounting with or without mounting plate (diaphragm) as specified in the Equipment Schedules.

Wall cowls, wire guards, diaphragm plates and louvre shutters must be standard products supplied with the fans.

Mounting plates (diaphragm) where required must be of pressed steel or fibreglass reinforced polyester with integral bell mount orifice.

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

Fan motors must be three phase totally enclosed squirrel cage induction type with protection to IP 44 unless otherwise specified in the Equipment Schedules.

Mount fans resiliently.

Balancing and testing must be as set out as for axial flow fans.

Fit motor and impeller protection screens as applicable.

Where applicable, fit fans on exterior walls with weather proof galvanised louvre shutters and where specified with wall cowls.

Fans are essentially to be manufactured from corrosion resistant material, chemically treated and painted in a high gloss enamel.

3.8.6 Window / Wall Extract Fans

Fit window / wall type fans with automatic shutters and with finger protection guards.

Where specified provide speed control. Fit motors with thermal overload protection.

Where remote control is specified wiring between fan, control point and power supply point must be flush mounted with conduit and draw boxes.

Fans shall be supplied complete with mounting accessories.

3.9 Sound Attenuators

3.9.1 General

Sound attenuators shall be generally manufactured, selected and supplied by the fan manufacturer.

Sound attenuators shall be factory made units of a make approved by the Engineer, and consist of a casing, internal baffles and sound absorbing lining material.

Sound attenuators shall be suitable for the system working pressure, velocity and for an air temperature up to 80 ° C.

Casings shall be constructed of galvanised sheet metal, of which the minimum thickness is in accordance with requirements laid down elsewhere in the specification.

The sound absorbing lining material shall be odourless, non-flammable, rot proof and shall not tear loose as a result of the air stream flowing over it.

Sound attenuators shall be provided complete with mating flanges.

(Duct mounted) sound attenuators shall be of the rectangular or circular type to achieve the noise criteria ratings stated in the Specification.

Sound attenuators of the rectangular type shall be flanged heavy metal duct sections containing built-in silencer baffles. Baffles shall be installed in order to achieve the required attenuation rate.

Sound attenuators of the circular type shall be complete with flanges, and shall comprise of a heavy gauge circular duct section with internal sound absorption lining, complete with centre pod, (if the centre pod is required to achieve the sound attenuation rate stated in the schedule).

Sound absorbent material shall be manufactured from non-flammable, odourless, rat proof, fire resistant, non-combustible, damp-resistant material edged with galvanised sheet steel and covered with fireproof erosion resistant material. The finished product shall not tear loose as a result of the air stream flowing over it.

Sound absorbent material for sound attenuators serving kitchen canopy exhaust system, shall be "MALINEX" covered and sealed to prevent the impregnation of kitchen greases.

Sound attenuators shall be factory manufactured by recognised specialist manufacturers in this field, accepted manufacturers being TROX, HOWDEN AIR, WOODS, AIR MOVEMENT SUPPLIES or equally approved.

The attenuators shall be selected with a maximum air pressure drop of 50 Pa.

The tenderer to note the sound attenuator properties on the "Sound Attenuator Technical Schedule".

3.9.2 Air conditioning applications

In the case of normal air conditioning applications, sound attenuator panels shall be covered with perforated metal sheet.

Sound attenuators shall be provided complete with mating flanges. The size of the flanges shall be at least as that specified for ducting of the same duty and dimension.

3.9.3 Special applications

Sound attenuators in the air flow of kitchen extraction systems shall have a sound absorbing lining which shall not absorb any grease or fat.

In the case of corrosive airflow applications, the sound attenuator materials shall be suitable for the application.

Note: Should fibre glass be used as a sound absorbent material, the exposed internal lining shall be protected with MALINEX and perforated metal sheet.

3.10 Grilles, Diffusers, louvers and Dampers

3.10.1 Grilles

Supply and return air grilles must be provided as indicated on the drawings.

Each grille must be selected in accordance with the manufacturer's recommendation to be capable of passing the specified air quantity without creating excessive resistance, noise or local draughts.

Grilles must be manufactured of stamped, extruded or rolled aluminium or steel sections, finished as specified and mounted in a neat frame.

Provide supply air grilles with double deflection aerofoil vanes adjustable from the front of the grille.

Vanes must be spaced at not more than 20mm centres.

Exhaust and return air grilles in the same installation must be similar in general appearance and construction to the supply air grilles but with a single set of fixed vanes.

Provide supply air grilles with opposed blade volume control dampers adjustable from the front of the grille.

Provide return air grilles with opposed blade dampers for volume control. Grilles shall be furnished in a natural anodised finish to the Architect's requirements. Dampers must be adjustable from the front of the grille.

Grilles must in all cases be selected with free air passage areas not less than that indicated on the drawings.

Grilles shall be finished in natural anodized. Finished to Architect's requirements.

3.10.2 Weather Louvres

Weather louvers must be manufactured of extruded aluminium sections or ferrous metal hot dip galvanised after manufacture, as specified.

Weather Louvers must be constructed with drip edges to blades and rigid frame to enable building in.

Weather louvers must be finished in natural anodised aluminium, powder coated or painted as specified.

Weather louvers must be watertight even with nominal air velocity up to 3,0m/s.

Weather louvers must be fitted with 12mm opening size galvanised expanded metal or wire mesh screen.

Top and bottom blades must be fitted flush with the frame and smooth without grooves, channels or recess where dirt or water can collect.

3.10.3 Ceiling Diffusers

Ceiling diffusers shall be manufactured of steel or aluminium and shall be finished in high quality white baked enamel or epoxy coated in a colour matching the ceiling to the Architect's requirements.

Ceiling diffusers throughout the building project shall be of similar appearance.

The Sub-Contractor shall, prior to placing orders for ceiling diffusers, submit a sample unit to the Architect in the colour format required by the Architect.

Diffusers must be square, round or rectangular with face plates matching the ceiling grid as specified.

Each diffuser must be selected in accordance with the manufacturer's recommendations to be capable of passing the specified air quantity without creating excessive resistance, noise or local draughts.

Each diffuser must be provided with an opposed blade volume control damper or alternatively, an adjustable disk type throttling mechanism.

Dampers must be selected and installed so as not to disturb the supply air distribution pattern or induction ratio of the diffuser.

Diffuser cores must be removable for cleaning and access purposes.

3.10.4 Variable Volume Outlets

Variable volume outlets with controls and re-heaters must be provided where indicated on the drawings.

Only well catalogued and proven products will be considered.

Minimum air volume must be factory set and site checked for each outlet.

Outlets must be selected and installed to ensure that no dumping or coning of supply air streams occurs, particularly at low air flow rates.

Variable volume control must be achieved with pneumatic or electric drives as specified. Low noise levels during operation are essential.

Re-heaters must be protected against overheat and must be switched with an adequately rated and reliable micro-switch.

Easy access to all parts possibly requiring servicing, removal or setting must be provided.

3.10.5 Dampers

Dampers for positive volume control purposes must be manual or electric actuator driven as specified and provided where indicated on the drawings.

Damper blades, links and damper frames must be of rigid construction galvanised steel generally as per SANS 1238, and of the opposed blade type.

Manually adjusted dampers must be provided with adjusting levers in accessible positions with provision for positive locking in any position from fully open to fully closed.

Dampers must be of the link or gear type as specified.

Damper blade shaft bearings shall be brass.

3.10.6 Non Return Outlet Louvers

Non return outlet louvers must be installed where indicated on the project drawings.

3.10.7 Door Grilles

Door grilles shall be supplied where shown on the drawings. Such door grilles shall be delivered to the Principal Contractor in good time for fitting by him in the relevant doors/frames.

Door grilles shall of the “no vision” type incorporating flanges on both sides of the door and horizontal blades of the v - type spaced in order to limit air friction loss.

Door grilles shall be finished in natural anodised finish to the Architect’s requirements.

3.11 Painting

311.1 General

The clauses which appear under this heading shall be considered as forming part of each of the following paint specifications.

Paint shall not be applied over any surface containing traces of grit, grease, oil etc. loose mill scale or corrosion products of any kind.

All metal surfaces to which paint is applied shall be moisture dry. Paint surfaces which are to be over coated shall be hard dry before over coating, unless the specification states otherwise.

All traces of soluble salts and corrosive air-borne contaminants shall be thoroughly washed from the surface prior to painting, dried and painted immediately thereafter.

Unless otherwise stated, no paint shall be applied within 50mm of areas which are to be welded.

Welds and adjacent parent metal shall be deslagged, inspected and approved and all spatters shall be removed prior to painting.

The weld area shall be wire brushed and all contaminants shall be removed prior to painting. The weld area shall then be flushed with fresh water and allowed to dry. In the case of rust formation, the weld area should again be wire brushed.

Surfaces which are to rest on concrete or other floors shall receive the full paint system prior to erection.

Areas where the paint coating has been damaged during transportation, erection or by any means whatever shall be repaired.

Rust spots shall be removed by means of a wire brush or emery paper and the surrounding paint which is still intact shall be feathered for a distance of 20mm beyond the damaged area.

Spot priming shall consist of all the coats previously applied and shall overlap the undamaged area by 20 mm.

Where the shop coat has been allowed to age for a few months before painting, it shall be light sanded or rubbed with steel wool or scrubbed with Polycell Sugar Soap Solution, using a bristle brush. The surface shall then be rinsed with drinking water.

Mating or contact surfaces shall be brought together by ensuring that the two surfaces brought into contact with each other are prepared and primed in accordance with the specification.

Areas which will be inaccessible after erection shall receive the full specified coating system, before erection or assembly.

Unless otherwise specified, steel embedded within concrete shall not be painted except to within 50 mm below the concrete / air interface.

All sharp edges and cut ends shall be filed smooth and shall then receive the specified dry film thickness of paint.

When blast-cleaning, a satisfactory blast profile (i.e. anchor pattern) shall be achieved. If the abrasive used for blast cleaning is sand, then it shall be free of clay. Alternatively, an approved grit shall be used.

The Contractor shall ensure that the final finishing coat obscures the previous coat.

The Contractor shall ensure that the manufacturer's recommended thinners are used for any particular paint.

The Contractor shall ensure that primed steelwork, piping etc. which is to be delivered to site is stacked on bearers and is clear of the ground. Wherever possible channels, angles, etc. shall be stacked so that water cannot collect on the steel.

Surfaces which are to be friction bolted shall be prepared in accordance with the specification (i.e. wire brushed) but shall receive no paint coating.

The painted dry film thickness shall be measured using a non-destructive thickness gauge such as the Mikrotest or equivalent.

All the mixing of paints shall be done using either a flat-sided paddle or by means of a mechanical mixer.

Where a specified volume ratio of components must be mixed together, provision shall be made on-site for a practical yet accurate method of volume measurement.

All air used for abrasive blast-cleaning or for spraying shall be free from all traces of oil, water and other contaminants.

The paint manufacturer's instructions shall be strictly adhered to.

3.11.2 Painting of Chequer Plate or Egg-crat Flooring and Supporting Frames

This paint specification will be referred to as Class "C" painting. Chequer plate and egg-crate flooring shall not be delivered to site with a bituminous coating.

Finishing

Three coats of HYSHEEN EPOXY TAR (SAR 681-BROWN, SAR 682-BLACK) to SABS 801-1973, Type II, shall be applied, at a dry film thickness of 70-80- micrometres per coat. Overcoats shall be applied within a minimum of 16 hrs, and a maximum of 48 hrs.

3.11.3 Steelworks

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

Surface preparation

All surfaces shall be thoroughly degreased with AQUASOLV DEGREASER (Code AR), then rinsed with fresh water and allowed to dry. The surfaces shall then be wire brushed to remove loose rust and loose mill scale to a St 3 finish to Swedish Standard 515 05/59/00-1967.

Priming:

One coat NAMELCOAT PRIMER (U 53) shall be applied to a dry film thickness of 30-40 micrometres.

Undercoat

One coat of MERIT UNIVERSAL UNDERCOAT (UC1) shall be applied to a dry film thickness of 30-40 micrometres.

Finishing

One coat of UNIVERSAL HIGH GLOSS colour shall be applied, to a dry film thickness of 30-40 micrometres.

The total dry film thickness to be less than 90 micrometres.

3.11.4 Motors, Gear-Boxes Pumps and Other Equipment

Surface Preparation

The surfaces to be painted shall be abrasive blast cleaned to Grade C 5a 2 ½ of the Swedish Standard SIS 055900-1967.

Priming

One coat of EPIMIDE EPOXY PRIMER ZINC/CHROMATE IRON OXIDE (EPD 41) shall be applied to form a uniform coat and to fill all porosities in the castings.

Undercoat

One coat of EPIDUCT CHEMICAL RESISTANT EPOXY ENAMEL (EPD 700/699 series), tinted to a shade just lighter than the finishing colour with UNIVERSAL STAINERS (X 14-20), shall be applied.

Finishing

One coat of EPIDUCT CHEMICAL RESISTANT EPOXY ENAMEL (EPD 700/699 series) in the specified colour shall be applied.

The blast profile for this system shall be between 25 and 40 micrometres.

If over coating the primer after two weeks, abrades to a matt surface with 220-350 grit waterproof paper and rinse with fresh water.

3.11.5 Piping (Other than Steam Piping)

Piping which is not galvanized is to be protected as follows after installation.

Above Ground

Surface Preparation

The surfaces shall be wire brushed to remove loose rust and loose mill scale to an St 3 finish to Swedish Standard SIS 05/59/00-1967.

Priming

One coat of NAMELCOAT PRIMER (UC 53) film thickness of 30-40 micrometres.

Undercoat

One coat of MERIT UNIVERSAL UNDERCOAT (UCI) shall be applied to a dry film thickness of 30-40 micrometres.

Finishing

One coat of UNIVERSAL HIGH GLOSS ENAMEL (G) in the specified colour shall be applied to a dry film thickness of 30-40 micrometres.

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

Underground or in trenches.

Piping installed underground or in trenches shall be painted with bitumastic paint whether the pipe is insulated or not.

3.11.6 Galvanised Iron

Surface Preparation (General)

All grease and other deposits shall be removed from all surfaces with galvanised iron cleaner (Code G.I.C.). The surface shall then be rinsed with clean water to give a water break-free surface.

All surfaces must be thoroughly clean and dry prior to the application of any materials. Should this state not be achieved, the cleaning process must be repeated.

3.11.7 Galvanised Cladding Inside Buildings

Priming

One coat CALCIUM PLUMBATE PRIMER to a dry film thickness of 25 – 35 micrometres.

Intermediate coat

One coat UNIVERSAL UNDERCOAT (UC 1) to a dry film thickness of 25 – 35 micrometres.

The total dry film thickness shall not be less than 75 micrometres.

3.11.8 Galvanised Cladding Exposed to Atmosphere

Priming

One coat CALCIUM PLUMBATE PRIMER to a dry film thickness of 25 – 35 micrometres.

Intermediate coat and finishing

Two coats of IRONGUARD MIO MICACEOUS IRON ORE ROOF PAINT to a dry film thickness of 50 – 70 micrometers.

The total dry film thickness shall not be less than 75 micrometres.

3.11.9 Galvanised Cladding Moist Conditions

Priming

One coat CHEMICOTE HIGH BUILD CHEMICAL RESISTANT PRIMER (CHC 1) to a dry film thickness of 60 – 80 micrometres.

Intermediate coat

One coat CHEMCOTE HIGH BUILD CHEMICAL RESISTANT INTERMEDIATE COAT (CHC 101) to a dry film thickness of 60 – 80 micrometres.

3.11.10 All Galvanised Pipes

Finishing

One coat CHEMCOAT ENAMEL (CHC 3000) to 25 – 35 micrometres.

The total dry film thickness shall not be less than 145 micrometres.

PART 4 – DETAILED TECHNICAL SPECIFICATION

4.1 General Description of the Project

This specification covers the supply, delivery, installation and commissioning of all equipment related to the HVAC services for the De Aar Magistrate Court in De Aar, Northern Cape Province.

4.2 Scope of Work

The works shall include the following:

1. Supply, delivery, and installation of 2 (two) Air Cooled R410 split type Roof Top units complete as indicated on drawings.
2. Supply, delivery, and installation of 8 (eight) VRV Type R410 split type high/mid-wall type units complete as indicated on drawings.
3. Supply, delivery and installation of 5 (five) VRV Type R410 split type 4-Way cassette type unit complete as indicated on drawings.
4. Supply, delivery and installation of three (3) fresh air fan systems.
5. Supply, delivery and installation of two (2) extraction air fan systems.
6. Supply, delivery and installation of one (1) extraction wall air fan systems.

4.3 Detail specification

4.3.1 Applicable Drawings

The followings drawings are applicable to all items under chapter 6.3:

K5020-MV-200 GROUND FLOOR HVAC LAYOUT REV A

K5020-MV-201 FIRST FLOOR HVAC LAYOUT REV A

4.3.2 Indoor Condition

Room indoor conditions shall be maintained at maximum 22°C DB in summer and at 23°C DB in winter.

4.3.3 Ambient Conditions

Outdoor DB temperature: 33°C
Outdoor WB temperature: 20°C
Winter DB temperature: -1.0°C

4.3.4 Ceiling Cassette Room Air conditioners

The room air conditioners shall be of ceiling cassette type and be rated as specified in the bill of quantities. Pipe runs shall be installed in PVC trunking on inside walls, and galvanised trunking on exterior walls and painted a matching colour to the surface it is fixed to. All drain pipes to run in ceiling void with refrigerant piping in cable rack were indicated schematically (see HVAC drawings). All Ceiling cassette units shall be equipped with wall mounted hard wired remote controls that shall be positioned next to the light switch. Where there are more than one unit in one zone it is indicated on the drawings the loop for the controls. An electrical isolator shall be provided by others at the indoor units and the main supply isolator at the outdoor units, the AC contractor shall do the connection from the isolator within 1 meter from the outdoor units and a the indoor units.

4.3.5 High/Mid Wall Split Type Units

The units shall be of the heat pump constant speed (R410) type.

The air-conditioning units shall be standard factory assembled, piped and wired. The units shall be thoroughly tested for all operating conditions. Spares shall be freely available in South Africa. On request, the Contractor shall provide the Engineer with performance test certificates.

The air-conditioning units and installation in general shall be in accordance with the high / mid wall unit's supplier's recommendations. Any discrepancies between this specification and the supplier's recommendations that may influence the unit's performance or guarantee shall be clarified with the Engineer during tender stage.

The indoor unit and condensing unit shall be interconnected with refrigerant piping, electrical wiring and interlocking control cabling. The pipe and cable connections shall be made in accordance with the unit supplier's recommendations. The refrigerant shall be of the R410 type.

Each condensing unit with connected evaporator unit shall be clearly labelled to identify different split units.

All units shall be of Daikin / Carrier / Mitsubishi or other approved make. "Other approved" means approved by the Engineer during the tender stage.

4.3.6 Refrigerant Circuit

Refrigerant piping shall be in accordance with the following standards:

- SABS 1453: Copper tubes for medical gas and vacuum services
- SABS 0147: Refrigerating systems including plants associated with air-conditioning systems

Fittings shall be copper based capillary solder fittings in accordance with SABS 1067. All soldered joints on proprietary manufactured units shall be carefully checked and remade if found damaged in transit.

Pipe size selections shall be such as to produce moderately low velocities whilst, nevertheless:

- Ensuring proper oil return to the compressor and minimizing lubricating oil being trapped in the system.
- Ensuring practical lines without excessive pressure drops and with proper feed to evaporators.
- Preventing liquid refrigerant from entering the compressor during operation and at shutdown.

Refrigerant piping shall be sized and fitted with the necessary oil traps strictly in accordance with the unit manufacturer's requirements.

All refrigerant pipelines shall be insulated with the "Armaflex" type, lightweight, elastomeric nitrile rubber tube insulation. Insulation thickness shall be 13 mm.

Suction and liquid pipelines shall be insulated separately and joints on insulation shall be glued with the insulation manufacturer's recommended adhesive to create a vapour barrier.

The installation of trunking and trays shall form part of this mechanical contract.

4.3.7 *Installation of Refrigerant Piping*

Refrigerant piping shall be arranged so that normal inspection and servicing of the compressor and other equipment is not hindered. Locations where copper tubing will be exposed to mechanical damage shall be avoided. Hangers and supports where piping goes through walls shall be installed to prevent transmission of vibration to the building.

Refrigerant piping in ceiling voids and mounted internally against walls shall be installed in 101 mm wide galvanised steel Cabstrut light duty cable trays (per unit). Pipes shall be strapped over insulation to cable trays at 500 mm intervals with suitably sized cable ties. Cable trays shall be 152 mm wide where drain pipes run together with refrigerant piping (per unit).

Externally mounted refrigeration pipes and drain pipes shall be mounted in Cabstrut P9000 cable trunking (127 mm x 76.2 mm). Cable trunking shall be complete with clip on covers. Pipes and cables shall be strapped together every 500 mm with suitably sized cable ties and loosely fitted in the trunking. The trunking shall be manufactured from galvanised steel and epoxy powder coated to a colour as specified by the Engineer.

Any insulation material not covered by the trunking and exposed to the elements shall be neatly strapped with cable ties to minimise the possibility of dirt and water entering between the insulation and refrigeration pipes.

4.3.8 *Installation of Indoor and Outdoor Units*

During installation, care shall be taken to ensure that no vibrations are carried over to structures to which the indoor and outdoor unit is fixed.

Outdoor condensing units shall be installed on wall mounted brackets and / or a concrete slab as indicated on the project drawings.

Where installed on wall mounted brackets, the condensing unit shall be securely bolted to the mounting bracket with adequately sized fasteners.

Where installed on a concrete slab, the condensing unit shall be fitted on top of neoprene vibration isolating pads and 450 mm square concrete paving slabs.

4.3.9 *Installation of Condensate Drain Pipes*

If an outdoor unit (heat pump type) is mounted against a wall more than 1 m above ground / floor level, the unit shall be fitted with an uPVC drain pipe neatly saddled to the wall. Drain pipe sizes for outdoor condensing units shall be to the supplier's specification.

Condensate drain pipes shall always run together with refrigerant pipes and shall always be installed in the same trunking and on the same cable trays for as far as the installation permits. Surface mounted drain piping shall only be allowed where condensate drain pipes run in a different direction to either a service duct, waste water pipe or any other location as indicated on the project drawings. Surface mounted drain piping shall be secured to the wall by means of galvanised steel saddles at no more than 1 m intervals.

Where units are mounted on the inside of exterior walls on wall-mounted brackets, the mechanical contractor shall drill sufficiently sized holes through which refrigerant pipes, drain pipes and cable wires shall penetrate the walls/windows of the indoor unit. Drain pipes running from the indoor unit through the wall/windows shall be adequately sloped to ensure positive drainage.

All condensate pipes running from indoor units to waste water pipes, outlet gullies or open waste water points shall be fitted with a U-trap at a location as indicated on the project drawings.

uPVC pipes shall be used for drain piping from indoor units. Drain pipe sizes for indoor units shall be Ø 32 mm for all unit sizes.

The first 5m of drain piping shall be insulated with "Armaflex" type, lightweight, elastomeric nitrile rubber tube insulation. Insulation thickness shall be 13 mm.

Where drainage piping or control cabling is required to be installed flush mounted, positioning and chasing shall be done in good time to meet construction programs.

4.3.10 Fresh Air Supply System

The fresh air supply system will consist of primary and secondary filters with a forward curved blade centrifugal fan purpose build from a reliable supplier in RSA. The fresh air system will need to be approved at tender stage to avoid any variations at construction stage.

The system is to be mounted on appropriate vibration spring mounts to suit the weight accordingly. Flexible connections between ducts and the FAF system is to be installed to avoid any vibrations carried over to the building.

PART 5- SCHEDULE OF CAPACITIES

5.1 General

The following points shall be noted with respect to the Schedule of Capacities below:

1. All capacities are minimum and the Bidders offer must meet or exceed the specified capacities.
2. Where equipment performance is dependent on the selection of other equipment, The Bidder shall offer compatible equipment. No claims for additional cost will be considered for equipment not correctly selected.
3. Capacities should be corrected for altitude.
4. Failure to complete these schedules will invalidate the Bid.

5.1.1 VRV Heat Recovery – Indoor & Outdoor Units

AC1		
	SPECIFIED	OFFERED
Type	Wall Mounted Unit	
Make		
Model		
Cooling/Heating Capacity	3.6 kW /4.0 kW	
Air Flow	- l/s	
Air Temp. On Cooling Coil	23°C db @ 50% RH	

AC 2		
	SPECIFIED	OFFERED
Type	4-Way Ceiling Cassette	
Make		
Model		
Cooling Capacity	5.6 kW/ 6.3 kW	
Air Flow	- 1/s	
Air Temp. On Cooling Coil	23°C db @ 50% RH	

AC 3		
	SPECIFIED	OFFERED
Type	Wall Mounted Unit	
Make		
Model		
Cooling/Heating Capacity	5.6 kW /6.3 kW	
Air Flow	- 1/s	
Air Temp. On Cooling Coil	23°C db @ 50% RH	

AC 4		
	SPECIFIED	OFFERED
Type	Wall Mounted Unit	
Make		
Model		
Cooling/Heating Capacity	5.6 kW /6.3 kW	
Air Flow	- l/s	
Air Temp. On Cooling Coil	23°C db @ 50% RH	

5.1.2 R410 Air Cooled Rooftop Packaged Units

RTP		
	SPECIFIED	OFFERED
Type	Roof Top Packaged Unit	
Make		
Model		
Cooling/Heating Capacity	16.27 kW /15.24 kW	
Air Flow	830 l/s	
Air Temp. On Cooling Coil	23°C db @ 50% RH	

5.1.3 Ventilation Fans

FAF1		
	SPECIFIED	OFFERED
Type	In-line fresh air fan c/w primary 50mm filter bank	
Size		
Air Volume	315l/s	
Static Pressure	200 Pa	
Sound Attenuation	c/w product	
Make	Actom/AMS/Donkin or equally approved	

FAF2		
	SPECIFIED	OFFERED
Type	In-line fresh air fan c/w primary 50mm filter bank	
Size		
Air Volume	224l/s	
Static Pressure	200 Pa	
Sound Attenuation	c/w product	
Make	Actom/AMS/Donkin or equally approved	

FAF3		
	SPECIFIED	OFFERED
Type	In-line fresh air fan c/w primary 50mm filter bank	
Size		
Air Volume	341l/s	
Static Pressure	180 Pa	
Sound Attenuation	c/w product	
Make	Actom/AMS/Donkin or equally approved	

EAF1		
	SPECIFIED	OFFERED
Type	In-line duct extract air fan	
Size		
Air Volume	530 l/s	
Static Pressure	150 Pa	
Sound Attenuation	1.5 D Complete With PODS	
Make	Actom/AMS/Donkin or equally approved	

WF1		
	SPECIFIED	OFFERED
Type	Window / Wall Fan	
Size	315mm Diameter	
Air Volume	50l/s	
Static Pressure	30 Pa	
Sound Attenuation	N/A	
Make	Expelair/Actom/AMS/Donkin or equally approved	



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REPUBLIC OF SOUTH AFRICA

**DEPARTMENT PUBLIC WORKS
AND INFRASTRUCTURE**

**WCS 055677
DE AAR MAGISTRATES COURT
REPAIRS TO FIRE DAMAGE**

**SPECIFICATION FOR THE
ELECTRICAL INSTALLATION**

PROJECT NO : 3010
DATE : NOVEMBER 2023

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DEPARTMENT PUBLIC WORKS AND INFRASTRUCTURE

**WCS 055677: DE AAR MAGISTRATES COURT
REPAIRS TO FIRE DAMAGE**

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DEPARTMENT PUBLIC WORKS AND INFRASTRUCTURE

**WCS 055677: DE AAR MAGISTRATES COURT
REPAIRS TO FIRE DAMAGE**

PART 1: GENERAL CONDITIONS OF CONTRACT

NOT INCLUDED IN THIS DOCUMENT

**This entire Specification & Bills of Quantities
shall be read in conjunction with the Quality Specifications of
The Department of Public Works, which is available on request.**

C

PART 2: SPECIFICATIONS

DEPARTMENT PUBLIC WORKS AND INFRASTRUCTURE

WCS 055677: DE AAR MAGISTRATES COURT REPAIRS TO FIRE DAMAGE

SECTION A: SPECIFICATION FOR THE ELECTRICAL INSTALLATION

A.1. GENERAL TECHNICAL SPECIFICATION

1.1 TESTS

After completion of the works and before first delivery is taken, a full test will be carried out on the installation for a period of sufficient duration to determine the satisfactory working thereof. During this period, the installations will be inspected, and the Contractor shall make good, to the satisfaction of the Representative/Agent, any defects which may arise.

The Contractor shall provide all instruments and equipment required for testing and any water, power and fuel required for the commissioning and testing of the installations at completion.

1.2 MAINTENANCE OF INSTALLATIONS

With effect from the date of the First Delivery Certificate the Contractor shall at his own expense undertake the regular servicing of the installation during the maintenance period and shall make all adjustments necessary for the correct operation thereof.

The maintenance period is 3 months.

If during the said period the installations is not in working order for any reason for which the Contractor is responsible, or if the installations develop defects, he shall immediately upon being notified thereof take steps to remedy the defects and make any necessary adjustments.

Should such stoppages however be so frequent as to become troublesome, or should the installations otherwise prove unsatisfactory during the said period the Contractor shall, if called upon by the Representative/Agent or the Director-General, at his own expense replace the whole of the installations or such parts thereof as the Representative or the Director-General may deem necessary with apparatus specified by the Representative/Agent or the Director-General.

1.3 REGULATIONS

The installation shall be erected and tested in accordance with the following Acts and regulations:

- (a) the latest issue of SANS 0142: 'Code of Practice for the Wiring of Premises'.
- (b) the Occupational Health and Safety Act 1993 (Act 85 of 1993) as amended.
- (c) the Local Government Act 1998 (Act 10 of 1998 (Gauteng)) as amended and the municipal by-laws and any special requirements of the local supply authority.

- (d) the Fire Brigade Services Act 1993, Act 2000 (Act 14 of 2000) as amended.
- (e) the National Building Regulations and Building Standards, Act 1996 (Act 29 of 1996) as amended.
- (f) the Post Office Act 1998 (Act 124 of 1998) as amended.
- (g) the Electricity Act 1996 (Act 88 of 1996) as amended; and
- (h) the Regulations of the Local Gas Board, where applicable.
- (i) The PW 379: "Standard Conditions in respect of the Supply-, Delivery and Installation of Electrical-, Mechanical-, Pneumatic- and Vacuum Operated Equipment, Control Systems, Plant and Materials."

1.4 NOTICES & FEES

The contractor shall give all notices required by and pay all necessary fees, including any inspection fees, which may be due to the local Supply Authority.

On production of the official account, only the net amount of the fee charged by the Supply Authority for connection of the installation to the supply mains, will be refunded to the contractor by the Department.

1.5 SCHEDULE OF FITTINGS

In all instances where schedule of light, socket outlet and power points are attached or included on the drawings, these schedules are to be regarded as forming part of the specification.

1.6 QUALITY OF MATERIALS

Only materials of first-class quality shall be used and all materials shall be subject to the approval of the Department. Departmental specifications for various materials to be used on this contract are attached to and form part of this specification.

Where applicable the material is to comply with the relevant South African Bureau of Standards specifications, or to British Standard Specifications., where no SABS Specifications exist.

Materials wherever possible, must be of South African manufacture.

1.7 CONDUIT & ACCESSORIES

The type of conduit and accessories required for the service, i.e. whether the conduit and accessories shall be of the screwed type, plain-end type or of the non-metallic type and whether metallic conduit shall be black enamelled or galvanised, is specified in Section 2 of this specification. Unless other methods of installation are specified for certain circuits, the installation shall be in conduit throughout. No open wiring in roof spaces or elsewhere will be permitted.

The conduit and conduit accessories shall comply fully with the applicable SABS specifications as set out below and the conduit shall bear the mark of approval of the South African Bureau of Standards.

- (a) Screwed metallic conduit and accessories: SANS 162
- (b) Plain-end metallic conduit and accessories: SANS 1065 Parts 1 and 2
- (c) Non-metallic conduit and accessories: SANS 950

All conduit fittings except couplings, shall be of the inspection type. Where cast metal conduit accessories are used, these shall be of malleable iron. Zinc base fittings will not be allowed.

Bushes used for metallic conduit shall be brass and shall be provided in addition to locknuts at all points where the conduit terminates at switchboards, switchboxes, draw-boxes, etc.

Draw-boxes are to be provided in accordance with the "Wiring Code" and wherever necessary to facilitate easy wiring.

For light and socket outlet circuits, the conduit used shall have an external diameter of 20 mm. In all other instances the sizes of conduit shall be in accordance with the "Wiring Code" for the specific number and size of conductors, unless otherwise directed in Section 3 of this specification or indicated on the drawings.

Only one manufacture of conduit and conduit accessories will be permitted throughout the installation.

Running joints in screwed conduit are to be avoided as far as possible and all conduit systems shall be set or bent to the required angles. The use of normal bends must be kept to a minimum with exception of larger diameter conduits where the use of such bends is essential.

All metallic conduits shall be manufactured of mild steel with a minimum thickness of 1.2 mm for plain-end conduit and 1,6 mm in respect of crewed conduit.

NOTE: Under no circumstances will conduit having a wall thickness of less than 1.6 mm be allowed in screeding laid on top of concrete slabs

Bending and setting of conduits must be done with special bending apparatus manufactured for the purpose and which are obtainable from the manufacturers of the conduit systems. Damage to conduit resulting from the use of incorrect bending apparatus or methods applied must on indication by the Department's inspectorate staff, be completely removed and rectified and any wiring already drawn into such damaged conduits must be completely renewed at the contractor's expense.

Conduit and conduit accessories used for flame-proof or explosion proof installations and for the suspension of luminaires as well as all load bearing conduit shall in all instances be of the metallic screwed type.

All conduit and accessories used in areas within 50 km of the coast shall be galvanised to SABS 763.

Tenderers must ensure that general approval of the proposed conduit system to be used is obtained from the local electricity supply authority prior to the submission of their tender. Under no circumstances will consideration be given by the Department to any claim submitted by the contractor, which may result from a lack of knowledge in regard to the supply authority's requirements.

1.8

CONDUIT IN ROOF SPACES

Conduit in roof spaces shall be installed parallel or at right angles to the roof members and shall be secured at intervals not exceeding 1,5 m by means of saddles screwed to the roof timbers.

Nail or crampets will not be allowed.

Where non-metallic conduit has been specified for a particular service, the conduit shall be supported and fixed with saddles with a maximum spacing of 450 mm throughout the installation. The contractor shall supply and install all additional supporting timbers in the roof spaces as required.

Under the flat roofs, in false ceilings or where there is less than 0,9 m of clearance, or should the ceilings be insulated with glass wool or other insulating material, the conduit shall be installed in such a manner as to allow for all wiring to be executed from below the ceilings.

Conduit runs from distribution boards shall, where possible, terminate in fabricated sheet steel draw-boxes installed directly above or near the boards.

1.9

SURFACE MOUNTED CONDUIT

Wherever possible, the conduit installation is to be concealed in the building work; however, where unavoidable or otherwise specified under Section 3 of the specification, conduit installed on the surface must be plumbed or levelled and only straight lengths shall be used.

The use of inspection bends is to be avoided and instead the conduit shall be set uniformly, and inspection coupling used where necessary.

No threads will be permitted to show when the conduit installation is complete, except where running couplings have been employed.

Running couplings are only to be used where unavoidable and shall be fitted with a sliced couplings as a locknut.

Conduit is to be run on approved spaced saddles rigidly secured to the walls.

Alternatively, fittings, tees, boxes, couplings, etcetera, are to be cut into the surface to allow the conduit to fit flush against the surface. Conduit is to be bedded into any wall irregularities to avoid gaps between the surface and the conduit.

Crossing of conduits is to be avoided, however, should it be necessary purpose-made metal boxes are to be provided at the junction. The finish of the boxes and positioning shall be keeping with the general layout.

Where several conduits are installed side by side, they shall be evenly spaced and grouped under one purpose-made saddle.

Distribution boards, draw-boxes, industrial switches, and socket outlets etcetera, shall be neatly recessed into the surface to avoid double sets.

In situations where there are no ceilings the conduits are to be run along the wall plates and tie beams.

In buildings where building operations are to be carried out, all surface conduits will be painted by the building contractor.

In all other instances the electrical contractor shall allow for painting of surface conduit with two coats of good quality enamel paint, and the colour shall match the surrounding building finish.

Only approved plugging materials such as aluminium inserts, fibre plugs, plastic plugs, etcetera, and round-head screws shall be used for fixing saddles, switches, socket outlets, etcetera, to walls, wood plugs and the plugging in joints in brick walls are not acceptable.

1.10 CONDUIT IN CONCRETE SLABS

In order not to delay building operations the contractor must ensure that all conduits and other electrical equipment which are to be cast in the concrete columns and slabs are installed in good time.

The contractor shall always have a representative in attendance when the casting of concrete takes place.

Draw-boxes, expansion joint boxes and round conduit boxes are to be provided where necessary. Sharp bends of any nature will not be allowed in concrete slabs.

Draw and/or inspection boxes shall be grouped under one common cover plate and must preferably be installed in passages or male toilets.

All boxes, etcetera, are to be securely fixed to the shuttering to prevent displacement when concrete is cast. The conduit shall be supported and secured at regular intervals and installed as close as possible to the neutral axis of concrete slabs and/or beams.

Before any concrete slabs are cast, all conduit droppers to switchboards shall be neatly spaced and rigidly fixed.

1.11 FLEXIBLE CONNECTIONS FOR CONNECTING UP OF STOVES, MACHINES, ETC.

Flexible tubing connections shall be of galvanised steel construction, and in damp situations of the plastic sheathed galvanised steel type. Other types may only be used subject to the prior approval of the Department's site electrical representative.

Connectors for coupling onto the flexible tubing shall be of the gland or screw-in types, manufactured of either brass or cadmium or zinc plated mild steel, and the connectors after having been fixed onto the tubing, shall be durable and mechanically sound.

NOTE: Aluminium and zinc alloy connectors will not be acceptable.

1.12 WIRING

Except where otherwise specified in Section 3 of the specification, wiring shall be carried out in conduit throughout. Only one circuit per conduit will be permitted.

No wiring shall be drawn into conduit until the conduit installation has been completed and all conduit ends provided with bushes. All conduit to be clear of moisture and debris before wiring is commenced.

Unless otherwise specified in Section 3 of this specification or indicated on the service drawings, the wiring of the installation shall be carried out in accordance with the "Wiring Code". Further to the requirements concerning the installation of earth conductors to certain light points as set out in the "Wiring Code", it is a specific requirement of this document that where plain-end metallic conduit or non-metallic conduit has been used, earth conductors must be provided and drawn into the conduit with the main conductors to all points, including all luminaires and switches throughout the installation.

Wiring for lighting circuits is to be carried out with 2.5 mm² conductors and a 2.5 mm² earth conductor. For socket outlet circuits the wiring shall comprise 4 mm² conductors and a 4 mm² earth conductor. In certain instances, as will be directed in Section 3 of this specification, the sizes of the conductors may be increased for specified circuits. Sizes of conductors to be drawn into conduits in all other instances, such as feeders to distribution boards, power points etcetera, shall be as specified elsewhere in this specification or indicated on the drawings. Sizes of conductors not specified must be determined in accordance with the "Wiring Code".

The loop-in system shall be followed throughout, and no joints of any description will be permitted.

The wiring shall be done in PVC insulated 600/1,000 V grade cable to SANS 150.

Where cable ends connect onto switches, luminaires etcetera, the end strands must be neatly and tightly twisted together and firmly secured. Cutting away of wire strands of any cable will not be allowed.

1.13 SWITCHES & SOCKET OUTLETS

All switches and switch-socket outlet combination units shall conform to the Department Quality Specifications, which form part of this specification.

No other than 16 A 3-pin sockets are to be used unless other special purpose types are distinctly specified or shown on the drawings.

All light switches shall be installed at 1.4 m above finished floor level and all socket outlets are directed in the Schedule of Fittings which forms part of this specification or alternatively the height of socket outlets may be indicated on the drawings.

1.14 SWITCHGEAR

Switchgear, which includes circuit breakers, iron-clad switches, interlocked switch-socket outlet units, contactors, time switches, etcetera, is to be in accordance with the Departmental Quality Specifications which form part of this specification and shall be equal and similar in quality to such brands as may be specified.

For uniform appearance of switchboards, only one approved make of each of the different classes of switchgear mentioned in the Quality Specifications shall be used throughout the installations.

1.15 **SWITCHBOARDS**

All boards shall be in accordance with the types as specified, be constructed according to the detail or type drawings and must be approved by the Department before installation.

In all instances where provision is to be made on boards for the supply authority's main switch and/or metering equipment the contractor must ensure that all requirements of the authorities concerned in this respect are met.

Any construction or standard type board proposed as an alternative to that specified, must have the prior approval of the Department.

All busbars, wiring, terminals, etcetera, are to be adequately insulated and all wiring is to enter the switchgear from the back of the board. The switchgear shall be mounted within the boards to give a flush front panel. Cable and boxes and other ancillary equipment must be provided where required.

Clearly engraved labels are to be mounted on or below every switch. The wording of the labels in both official languages, is to be according to the layout drawings or as directed by the Department's representative and must be confirmed on site. Flush mounted boards to be installed with the top of the board 2,0 m above the finished floor level.

1.16 **WORKMANSHIP & STAFF**

Except in the case of electrical installations supplied by a single-phase electricity supply at the point of supply, an accredited person shall exercise general control over all electrical installation work being carried out.

The workmanship shall be of the highest grade and to the satisfaction of the Department.

All inferior work shall, on indication by the Department's inspecting officers, immediately be removed and rectified by and at the expense of the electrical contractor.

1.17 **CERTIFICATE OF COMPLIANCE**

On completion of the service, a certificate of compliance must be issued to the Department's representative/agent in terms of the Occupational Health and Safety Act, 1994 (Act 85 of 1993).

1.18 **EARTHING OF INSTALLATION**

1.18.1 **Main Earthing**

The type of main earthing must be as required by the supply authority if other than the Departments, and in any event as directed by the Department's representative, who may require additional earthing to meet test standards.

Where required an earth mat shall be provided, the minimum size, unless otherwise specified, being 1.0 m x 1.0 m and consisting of 4 mm diameter hard-drawn bare copper wires at 250 mm centres, brazed at all intersections.

Alternatively, or additionally earth rods or trench earths may be required as specified or directed by the Department's authorised representative.

Installations shall be effectively earthed in accordance with the "Wiring Code" and to the requirements of the supply authority. All earth conductors shall be stranded copper with or without green PVC insulation.

Connection from the main earth bar on the main board must be made to the cold water main, the incoming service earth conductor, if any and the earth mat or other local electrode by means of 12 mm x 1.60 mm solid copper strapping or 16 mm² stranded (not solid) bare copper wire or such conductor as the Department's representative may direct. Where main earth copper strapping is installed below 3 m from ground level must be run in 20 mm diameter conduit securely fixed to the walls.

All other hot and cold-water pipes shall be connected with 12 mm x 0.8 mm perforated or solid copper strapping (not conductors) to the nearest switchboard. The strapping shall be fixed to the pipework with brass nuts and bolts and against walls with brass screws at 150 mm centres. In all cases where metal water pipes, down pipes, flues, etcetera, are positioned within 1,6 m of switchboards an earth connection consisting of copper strapping shall be installed between the pipework and the board. In vertical building ducts accommodating both metal water pipes and electrical cables, all the pipes shall be earthed at each distribution board.

1.18.2 Roofs, Gutters and Down Pipes

Where service connections consist of overhead conductors, all metal parts of roofs, gutters and down pipes shall be earthed. One bare 10 mm² copper conductor shall be installed over the full length of the ceiling void, fixed to the top purlin and connected to the main earth conductor and each switchboard. The roof and gutters shall be connected at 15 m intervals to this conductor by means of 12 mm x 0.8 mm copper strapping (not conductors) and galvanised bolts and nuts. Self-tapping screws are not acceptable. Where service connections consist of underground supplies, the above requirements are not applicable.

1.18.3 Sub-distribution boards

A separate earth connection shall be supplied between the earth busbar in each sub-distribution board and the earth busbar in the Main Switchboard. These connections shall consist of bare or insulated stranded copper conductors installed along the same routes as the supply cables or in the same conduit as the supply conductors. Alternatively armoured cables with earth continuity conductors included in the armouring may be utilised where specified or approved.

1.18.4 Sub-circuits

The earth conductors of all sub-circuits shall be connected to the earth busbar in the supply board in accordance with SANS 0142.

1.18.5 Ring Mains

Common earth conductors may be used where various circuits are installed in the same wire-way in accordance with SANS 0142. In such instances the sizes of earth conductors shall be equivalent to that of the largest current carrying conductor installed in the wire-way, alternatively the size of the conductor shall be as directed by the Engineer. Earth conductors for individual circuits branching from the ring main shall be connected to the common earth conductor with T-ferrules or soldered. The common earth shall not be broken.

1.18.6 Non-metallic Conduit

Where non-metallic conduit is specified or allowed, the installation shall comply with the Department's standard quality specification for "conduit and conduit accessories". Standard copper earth conductors shall be installed in the conduits and fixed securely to all metal appliances and equipment, including metal switch boxes, socket-outlet boxes, draw-boxes, switchboards, luminaires, etc. The securing of earth conductors by means of self-threading screws will not be permitted.

1.18.7 Flexible Conduit

An earth conductor shall be installed in all non-metals flexible conduit. This earth conductor shall not be installed externally to the flexible conduit but within the conduit with the other conductors. The earth conductor shall be connected to the earth terminals at both ends of the circuit.

1.18.8 Connection

Under no circumstances shall any connection points, bolts, screws, etcetera, be used for earthing utilised for any other purpose. It will be the responsibility of the Contractor to supply and fit earth terminals or clamps on equipment and materials that must be earthed where these are not provided. Unless earth conductors are connected to proper terminals, the end shall be tinned and lugged.

1.19 MOUNTING & POSITIONING OF LUMINAIRES

The electrical contractor is to note that in the case of board and acoustic tile ceilings, ie as opposed to concrete slabs, close co-operation with the building and mechanical contractor is necessary to ensure that as far as possible the luminaires are symmetrically positioned with regard to the ceiling pattern, as well as air conditioning units.

The lay-out of the luminaires shall be agreed upon on site and must be adhered to as far as possible and must be confirmed with the Department's representative.

Fluorescent luminaires installed against concrete ceilings shall be screwed to the outlet boxes and in addition 2 x 6 mm expansion or other approved type fixing bolts are to be provided. The bolts are to be $\frac{3}{4}$ of the length of the luminaires apart.

Fluorescent luminaires to be mounted on board ceilings shall be secured by means of two 40 mm x Number 19 round head screws and washers. The luminaires shall also be bonded to the circuit conduit by means of locknuts and brass bushes. The fixing screws are to be placed $\frac{3}{4}$ of the length of the fitting apart.

Earth conductors must be drawn in with the circuit wiring and connected to the earthing terminal of all fluorescent luminaires as well as other luminaires exposed to the weather in accordance with the "Wiring Code".

Incandescent luminaires are to be screwed directly to outlet boxes in concrete slabs. Against board ceilings the luminaires shall be secured to the bracing or joists by means of two 40 mm x Number 8 round head screws.

1.20 **DEPARTMENTAL MATERIAL**

When certain materials are supplied by the Department to the contractor for installation, the contractor must arrange for taking delivery and providing safe storage for these materials.

The contractor will be held responsible for all damage to or loss of such material while it is in his custody.

1.21 **DELAY**

If the electrical contractor's work should cause any delay to the building operations, he will be held responsible for any claims arising out of such delay.

A.2. PROJECT SPECIFICATION

2.1. CABLE SLEEVE PIPES

Where cables cross under roadways, other services and where cables enter buildings, the cables shall be installed in asbestos-cement pipes, earthenware, or high-density polyethylene pipes.

The ends of all sleeves shall be sealed with a non-hardening watertight compound after the installation of cables. All sleeves intended for future use shall likewise be sealed.

2.2. NOTICES

The Contractor shall issue all notices and make the necessary arrangements with Supply Authorities, the Postmaster-General, SA Transport Services, Provincial or National Road Authorities and other authorities as may be required with respect to the installation.

2.3. ELECTRICAL EQUIPMENT

All equipment and fittings supplied must be in accordance with the attached quality specification (Part 5 of this document), suitable for the relevant supply voltage, and frequency and must be approved by the Department's representative.

2.4. DRAWINGS

The drawings generally show the scope and extent of the proposed work and shall not be held as showing every minute detail of the work to be executed.

The position of power points, switches and light points that may be influenced by built-in furniture must be established on site, prior to these items being built in.

2.5. BALANCING OF LOAD

The Contractor is required to balance the load as equally as possible over the multiphase supply.

2.6. SERVICE CONDITIONS

All plant shall be designed for the climatic conditions appertaining to the service.

2.7. SWITCHES & SOCKET OUTLETS

The installation of switches and socket outlets must conform to clause 13 of Section 1 of this specification.

2.8. LIGHT FITTINGS & LAMPS

The installation and mounting of luminaires must conform to clause 19 of Section 1 of this specification.

All fittings to be supplied by the Contractor shall have the approval of the Department.

The light fittings must be of the type specified in the Schedule of Light Fittings.

The contractor shall allow for the supply, delivery, and installation of all light luminaires as specified, and indicated on the drawings and in the schedules. Please see ITEMS FOR APPROVAL clause.

NB: All LED luminaires shall bear the Safety Requirements Mark, SANS 60598 and Performance Requirements Mark, SANS 475 and be fitted with high-frequency drivers (LG, Osram, Tridonic, TCI/DC JOLLY) with a frequency greater than 100HZ.

Luminaires fed from emergency power outlet points shall have red indication of emergency power supply.

Tenderers shall allow for all luminaires listed in the Schedules and shown on the drawings.

All Light luminaires installed on lowered ceilings or recessed in ceilings shall relate to 5A, 3-Pin socket outlets and a 5A, 3-Pin Plug by means of a 3m, 5A, and three-core PVC insulated cable.

Reference must be made to the Schedule of luminaires for a detail description of the light fittings.

Whenever the term "equal and approved" is not used in the specification, Tenderers shall have no choice but shall install the specific luminaires as specified.

All luminaries shall be complete with lamps, indicator lamps, control gear and all other accessories required to make the luminaires fully operative.

All luminaires shall be equipped with an earth terminal and shall be properly earthed.

The Contractor shall be responsible for the purchasing, taking delivery, storing, installation, aiming, adjustment, testing and commissioning of all specified luminaires specified including all necessary mounting accessories, brackets, poles, stirrups, base plates, etc. and including any necessary excavations and backfilling.

The internal wiring of luminaires shall consist of flexible stranded copper conductors of not less than 0.5 mm² with suitable heat-resisting insulation to SABS 529. A terminal block shall be fitted to each luminaire.

Luminaires shall not cause radio or television interference in accordance with Posts and Telecommunications requirements.

Luminaires shall be designed to prevent excessive temperatures and components and materials shall be selected so that they are not adversely affected by the operating temperature.

The voltage rating and lamp wattage shall be clearly and indelibly marked on control gear. If applicable, ballasts shall be power factor corrected to at least 0,95 lagging and shall have a minimum circuit efficiency of 0,95. Capacitors shall comply with SABS 1250: 1979.

The wattage and type of lamp suitable for use in the luminaire shall be clearly marked on the base of the luminaire close to the lamp holder.

The contractor shall submit details of the luminaires, including photometric data, to the Engineer for approval on request.

The contractor is to note that in the case of board and acoustic tile ceilings, i.e. as opposed to concrete slabs, close co-operation with the Building Contractor is necessary to ensure that as far as possible, the luminaires are symmetrically positioned with regard to the ceiling pattern.

Where luminaires are mounted on ceilings consisting of panes, care has to be taken that the work is performed symmetrically. Conduit work above false ceilings shall be fully co-ordinated in level, plan and sequence of installation with the Building and Ceilings Contractor, the Air Conditioning Contractor and any other Contractor installing services in the false ceilings.

Luminaires installed against concrete shall be screwed to the outlet boxes and in addition, 2 x 6.35 mm expansion or other approved type fixing bolts are to be provided. The bolts are to be spaced 75% of the length of the fitting part.

Luminaires to be mounted on board ceilings shall be secured to brandering (additional to that used for ceiling construction if necessary) using two wood screws with round heads of a size that will provide secure fixing. The fittings shall also be bonded to the circuit conduit by means of locknuts and brass bushes. The fixing screws are to be placed $\frac{3}{4}$ of the length of the fitting apart.

Surface mounted ceiling luminaires narrower than 225mm shall be fixed at the outlet point and at two further positions. Luminaires wider than 225mm shall have four fixings exclusive of the outlet point.

Where necessary, luminaires shall be fixed together with brass bushes and lock nuts.

Conduits shall be screwed directly into all weatherproof luminaires and other outside lights. No outlet boxes are permitted. The conduit shall be installed in such a way that it falls from the wall to the luminaires at an angle.

The bases of all luminaires shall be installed after the first coat of paint has been applied. The Luminaires shall then be left until the painting has been finished, after which the Contractor shall complete the installation and adjusting of the luminaires.

All luminaires shall be fixed and suspended in accordance with the manufacturer's requirements and as specified.

2.9. EARTHING & BONDING

The Contractor will be responsible for all earthing and bonding of the building and installation. The earthing and bonding is to be carried out strictly as described in clause 18 of Section 1 of this specification and to the satisfaction of the Department's representative.

2.9.1. Earthing Of Distribution Boards

- a) Lightning arrestors shall conform to SABS 171, shall bear the SABS mark, and shall be solidly earthed directly onto the main earth bar by means of a copper strap.
- b) Boards must be earthed by way of suitable cable clamps or glands and where clamps are used, the armouring strands must be ferruled and bolted to the earth bar.

2.9.2. Earth Conductors

As is evident from the schedules of cables a separate copper earth conductor shall be installed with each length of LT cable.

This conductor is to be connected to the distribution boards at the earth bar as stated in the Clause above.

2.9.3. Earthing Of Metal Power Skirting

All metal power skirting shall be bonded to the earth conductor and to another where the continuity is broken.

2.10. MAINTENANCE OF ELECTRICAL SUPPLY

All interruptions of the electrical supply that may be necessary for the execution of the work, will be subject to prior arrangement between the Contractor and the user Department and the Department's representative.

2.11. EXTENT OF WORK

The work covered by this contract comprises the complete electrical installation, in working order, as shown on the drawings and as per this specification, including the supply and installation of all fittings and the installation of such equipment supplied by the Department.

2.12. SUPPLY & CONNECTION

The Supply Authority is the Emthanjeni Local Municipality. The supply to the site is from an existing low voltage connection.

2.13. CONDUIT & WIRING

Conduit and conduit accessories shall be black enamelled/galvanised screwed conduit or black enamelled/galvanised plain end conduit in accordance with SANS 162, 763 and 1007, respectively.

All conduits, regardless of the system employed, shall be installed strictly as described in the applicable paragraphs of clauses 4 to 8 of Section 1 of the specification. Wiring of the installation shall be carried out as directed in clause 9 Section 1 of this specification.

Where plain end conduit is offered all switches and light fittings must be supplied with a permanent earth terminal for the connection of the earth wire.

Lugs held by switch fixing screws or self-tapping screws will not be acceptable.

2.13.1. Telephone Installation

The Contractor shall allow for the installation of all conduits, outlet boxes, TELKOM Distribution boards, sleeve pipes, etc., required for the telephone system as shown on the drawings. The Electrical Contractor will not be responsible for the Telkom cabling and installation. The IT & Telecomms system will be installed by the IT & Telecomms specialist contractor.

The sizes of all telephone conduits shall be of 25mm diameter and must be installed in the floor slab and ceiling voids. Galvanised steel draw-wires shall be installed in all conduits.

End boxes must consist of a 50mm x100mm x 100mm outlet box fitted with suitable blank cover plates, flush mounted 0,4m above floor level.

2.13.2. Data Installation

The Contractor shall allow for the installation of all conduits, outlet boxes, Data Distribution boards, sleeve pipes, etc., required for the data system as shown on the drawings. The Electrical Contractor will not be responsible for the Data cabling and installation. The IT & Telecomms system will be installed by the IT & Telecomms specialist contractor.

The sizes of all data conduits shall be of 25mm diameter and must be installed in the floor slab and ceiling voids. Galvanised steel draw-wires shall be installed in all conduits.

End boxes must consist of a 50mm x100mm x 100mm outlet box fitted with suitable blank cover plates, flush mounted 0,4m above floor level.

2.14. POWER TRUNKING

The Contractor shall be responsible for the supply and installation of all power trunking complete with corner pieces, end pieces, junction pieces, supply conduits, cover plates and power outlets as specified and indicated on the drawings.

The power trunking must comply with SANS 1197. The Contractor must ensure that the power trunking is installed to satisfaction of the Department's representative before commencing with the wiring of the power trunking.

The power trunking shall be installed onto the bottom horizontal truss of the roof structure at the positions as indicated on the drawings.

2.15. POWER SKIRTING

A three-compartment metal powder coated power skirting shall be supplied and installed. The multi-skirt shall be as supplied by O-Line series OL 803. The power skirting will facilitate wiring and installation for the following services.

- (a) Socket outlets – Main power & 2 pin socket
- (b) Dedicated computer socket outlets
- (c) Computer data cables and outlet points
- (d) Telephone / data cables and telephone / data outlet points.

The power skirting must be supplied complete with standard clip-in type metal covers, T-offs, end pieces and outlets with independent front covers as specified.

2.16. POWER POINTS

All special purpose points shall be wired according to the schedules. Solid conduit shall be used and where necessary, ended off with "Kopex" or other approved flexible tubing. Special precautions shall be taken to ensure good earth continuity throughout the whole installation and connection of electrical equipment.

2.17. CABLES

The Contractor shall supply and completely install all distribution cables as indicated on the drawings and listed in the Schedule of Cables.

The storage, transportation, handling and laying of the cables shall be according to first class practice, and the contractor shall have adequate and suitable equipment and labour to ensure that no damage is done to cables during such operations.

The cable-trenches shall be excavated to a depth of 0,9m deep below ground level and shall be 450mm wide for one to three cables, and the width shall be increased where more than three cables are laid together so that the cables may be placed at least two cable diameters apart throughout the run. The bottom of the trench shall be level and clean and the bottom and sites free from rocks or stones liable to cause damage to the cable.

The Contractor must take all necessary precautions to prevent the trenching work being in any way a hazard to the personnel and public and to safeguard all structures, roads, sewage works or other property on the site from any risk of subsidence and damage.

In the trenches the cables shall be laid on a 75mm thick bed of earth and be covered with a 150mm layer of earth before the trench is filled in.

All joints in underground cables and terminations shall be made either by means of compound filled boxes according to the best-established practise by competent cable jointers using first class materials or by means of approved epoxy-resin pressure type jointing kits such as "Scotchcast". Epoxy-resin joints must be made entirely in accordance with the manufacturer's instructions and with materials stipulated in such instructions. Low tension PVC cables are to be made off with sealing glands and materials designed for this purpose which must be of an approved make. Where cables are cut and not immediately made off, the ends are to be sealed without delay.

The laying of cables shall not be commenced until the trenches have been inspected and approved. The cable shall be removed from the drum in such a way that no twisting, tension, or mechanical damage is caused and must be adequately supported at intervals during the whole operation. Care must be exercised where it is necessary to draw cables through pipes and ducts to avoid abrasion, elongation, or distortion of any kind. The ends of such pipes and ducts shall be sealed to approval after drawing in of the cables.

Backfilling (after bedding) of the trenches is to be carried out with a proper grading of the material to ensure settling without voids, and the material is to be tamped down after the addition of every 150mm. The surface is to be made good as required.

On each completed section of the laid and jointed cable, the insulation resistance shall be tested to approval with an approved "Megger" type instrument of not less than 500V for low tension cables.

Earth continuity conductors are to be run with all underground cables constituting part of a low-tension distribution system. Such continuity conductors are to be stranded bare copper of a cross-sectional area equal to at least half that of one live conductor of the cable but shall not be less than 4mm² or more than 70mm². A single earth wire may be used as earth continuity conductor for two or more cables run together, branch earth wires being brazed on where required.

2.18. LAYING, JOINTING & MAKING OFF OF ELECTRICAL CABLES

[The requirements specified hereafter, are aimed essentially at high tension cable but are also valid for low tension cable, where applicable.]

- 2.18.1.** The use of the term "Inspector" includes the engineer or inspector of the Department or an empowered person of the concerned supervising consulting engineer's firm.
- 2.18.2.** No cable is to be laid before the cable trench is approved and the soil qualification of the excavation is agreed upon by the Contractor and inspector.
- 2.18.3.** After the cable has been laid and before the cable trench is back-filled the inspector must ensure that the cable is properly bedded and that there is no undesirable material included in the bedding layer.
- 2.18.4.** All cable jointing and the making off the cables must only be carried out by qualified experienced cable jointers. Helpers of the jointers may not saw, strip, cut, solder, etc. The cable and other work undertaken by them must be carried out under the strict and constant supervision of the jointer.
- 2.18.5.** Before the Contractor allows the jointer to commence with the jointing work or making-off of the cable (making off is recognized as half a joint) he must take care and ensure:
 - 2.18.5.1. That he has adequate and suitable material available to complete the joint properly and efficiently. Special attention must be given to ensure the cable ferrules and cable lugs are of tinned copper and of sufficient size. The length of the jointing lugs must be at least six times the diameter of the conductor,
 - 2.18.5.2. that the joint pit is dry and that all loose stones and material are removed,
 - 2.18.5.3. that the walls and banks of the joint pit are reasonable firm and free from loose material which can fall into the pit,
 - 2.18.5.4. that the necessary cofferdams or retaining walls are made to stop the flow of water into the joint pit,
 - 2.18.5.5. that the joint pit is provided with suitable groundsheets so that the jointing work is carried out in clean conditions,
 - 2.18.5.6. that the necessary tents or sails are installed over the joint pit to effectively avert unexpected rainfall and that sufficient light or lighting is provided,
 - 2.18.5.7. that the necessary means are available to efficiently seal the jointing or cable end when an unexpected storm or cloudburst occurs, regardless of how far the work has progressed,
 - 2.18.5.8. that the cables and other materials are dry, undamaged and in all respects are suitable for the joint work or making off,
 - 2.18.5.9. that the heating of cable oil, cable compound, plumbers' metal and solder is arranged that they are at the correct temperature when required so that the cable is not

unnecessary exposed to the atmosphere and consequently the ingress of moisture (care must be taken of overheating).

Flow temperatures of cable oil and compound must be determined with suitable thermometers.

Cable oil and compound must not be heated to exceed the temperatures given on the containers and precaution must be taken to ensure that the tin is not overheated in one position. The whole mass must be evenly and proportionally heated.

(Temperatures of solder and plumbers' metal may be tested with brown paper (testing time: 3 seconds.) The paper must colour slightly – not black or burnt).

2.18.6. Before the paper-insulated cables are joined, they must be tested for the presence of moisture by the cable jointers test. This consists of the insertion of a piece of unhandled insulated impregnated paper tape in warm cable oil heated to a temperature of 130 +/- 5°C.

Froth on the surface of the oil is an indication that moisture is present in the impregnated insulation and the amount of the froth gives an indication of the moisture present.

2.18.7. If the cable contains moisture or is found to be otherwise unsuitable for jointing or making of the inspector is to be notified immediately and he will issue the necessary instruction to cope with the situation.

2.18.8. The joint or making-off of paper insulated cables must not be commenced during rainy weather.

2.18.9. Once a joint is in progress the jointer must proceed with the joint until it is complete and before he leaves the site.

2.18.10. The jointer must ensure that the material and his tools are always dry, reasonably clean and absolutely free from soil.

2.18.11. Relating to the jointing of the cable the following requirements apply:

2.18.11.1. All jointing must be carried out in accordance with recognized and tried techniques and comply strictly with the instructions given by the supplier of the jointing kit.

2.18.11.2. The cables must be twisted by hand so that the cores can be joined according to the core numbers. If necessary, the cable is to be exposed for a short distance to accomplish this. Under no circumstances may the cores in a joint be crossed to enable cores to be joined according to the core numbers. If it is not possible to twist the cables so that the preceding requirements can be met, then cores are to be joined in the normal way without any consideration of the core numbers.

2.18.11.3. Normally the cables will have profile conductors. The conductors shall be pinched with gas pliers to form a circular section, bound with binding wire so that they do not spread, and then tinned before jointing.

2.18.11.4. Jointing ferrules, the length of which are at least 6 times the diameter of the conductors, must be slid over the conductor ends to be joined and pinched tightly. Then they are soldered by means of the ladle process whilst being pinched further closed.

Use resin only as a flux. The slot opening in the ferrule must be filled, including all depressions.

Remove all superfluous metal with a cloth dipped in tallow. Work during the soldering process must be from top to bottom. Rub the ferrule smooth and clean with aluminium oxide tape after it has cooled down to ensure that there are not any sharp points or edges.

NB: The spaces between the conductor strands must be filled by soldering process and must be carried out quick enough to prevent the paper insulation from burning or drying out unnecessarily.

- 2.18.11.5. After the ferrules have been rubbed smooth and clean, they and the exposed cores must be treated with hot cable oil (110°C) to remove all dust and moisture. These parts are to be thoroughly basted with the oil.
- 2.18.11.6. The joiner must take care that his hands are dry and clean before the joint is insulated. Also, the insulating tape which is to be used must first be immersed in warm cable oil (110°C) for a sufficient period to ensure that no moisture is present.
- 2.18.11.7. After the individual cores have been installed, they must be well basted with hot cable oil and again after the applicable separator and/or belt insulation tape is applied before the lead joint sleeve is placed in position.
- 2.18.11.8. The lead joint sleeve must be thoroughly cleaned and prepared before it is placed on the cable and must be kept clean during the whole jointing process. Seal the filling apertures of the sleeve with tape until the sleeve is ready for compound filling.
- 2.18.11.9. The plumbing joints employed to solder the joint sleeve to the cable sheath, must be cooled off with tallow and the joint sleeve is to be filled with compound while it is still warm. Top up continuously until the joint is filled to compensate for the compound shrinkage.
- 2.18.11.10. The outer joint box must be clean and free from corrosion. After it has been placed in position it must be slightly heated before being filled with compound. Top up until completely full.
- 2.18.12.** As far as cable end boxes are concerned the requirements as set out above are valid where applicable.

2.19. DISTRIBUTION BOARDS

In addition to clause 14 and clause 15 of Section 1 of this specification the following shall also be applicable to switchboards required for this service.

The Contractor shall supply and install the distribution boards as indicated on the drawings. All distribution boards shall comply with the quality specification in Section 3 of this specification and be approved by the Department's representative.

2.19.1. General

2.19.1.1. Scope

The scope of this portion of the works shall be the supply, delivery, off-loading, possible storage, placing into position, erecting, testing and commissioning of all low voltage distribution boards required for the project. The majority of the boards have been detailed on the attached drawings and Tenderers should price in accordance with the requirements. Before any board is manufactured, the manufacturer shall obtain approval from the Engineer to proceed with manufacture of that particular board.

All distribution boards shall be installed in the positions indicated on the drawings, and as finally agreed upon with the Engineer.

One spare 25 mm dia and three spare 20 mm dia conduits must be installed from all distribution boards to roof spaces.

Three sets of factory drawings of all distribution boards must be submitted to the Electrical Engineer for approval within four weeks after award of tender (in order to confirm that the space being allowed for the DB's are adequate) and before manufacture of the distribution boards commence.

2.19.2. Size

All switchboards shall be of ample size to accommodate the specified switchgear and provide space for future switchgear. For every 4 (or part of 4) 5 kA circuit-breakers on a switchboard, space for an additional 5 kA circuit breaker shall be allowed unless future space requirements are clearly specified. For circuit breakers above 5 kA, this factor shall be 15 %. The clearance between adjoining switchgear openings shall be as specified in paragraph 7.4.2.

2.19.2.1. External Dimensions

The maximum allowable height of free standing switchboards is 2.2 metre. Cubicle type boards may be up to 2.4 metre high if they can be fully dismantled into individual cubicles. Where, due to space restrictions, a board exceeds 2.4 metre in height, equipment not normally requiring access, shall be installed in the top section, enabling equipment normally requiring access to be installed lower down in the board. All other specified external dimensions for switchboards shall be strictly adhered to. If the clearances specified in paragraph 7.4.2 cannot be adhered to as a result of restricting external dimensions, the Contractor shall obtain the approval of the Department before manufacturing the switchboards.

2.19.3. Moisture and Vermin

All switchboards shall be rendered moisture proof and vermin proof and shall be adequately ventilated.

2.19.3.1. Ventilation

Switchboards shall be properly ventilated, especially cubicles containing contactors, transformers, motor starters, lighting dimmers and other heat producing equipment. Louvers shall be fitted to provide adequate upward or cross ventilation. All louvers shall be vermin proofed with 1.5 mm brass mesh or perforated steel plate internally spot welded over the louvers. The internal ambient temperature shall not exceed 40°C.

2.19.3.2. Vermin Proofing

Free standing boards shall be protected against vermin, especially from below- Where cables have to pass through the gland plate, rubber grommets shall be provided and enough non-hardening compound shall be delivered with the board so that these holes can be sealed properly after installation of the cables.

2.19.4. Load Balance

The load shall be balanced as equally as possible across multiphase supplies.

2.19.5. Construction Of Flush Mounted Switchboards

2.19.5.1. Standard

Flush mounted switchboards shall comply fully with SABS 1180. part I. Unless the depths of the switchboards are specified, the depths shall be determined in accordance with paragraph 7.4.

2.19.5.2. Expanded Metal

Where switchboards are to be built into 115 mm thick walls, expanded metal shall be spot-welded to the rear of the bonding trays. The expanded metal shall protrude at least 75 mm on each tray side to prevent plaster from cracking.

2.19.5.3. Knock-outs

Knock-outs shall be provided in the top and bottom ends of each switchboard tray to allow for the installation of conduits for the specified and future circuits. Knock-outs shall be provided for an equal number of 20 mm and 25 mm dia. conduits.

2.19.5.4. Panel

Front panels shall have machine punched slots for housing the specified and future flush mounted switchgear. The distance between the inside of the closed doors and the panel shall not be less than 20 mm. No equipment may be mounted on the panel unless the panel is permanently hinged to the switchboard frame.

2.19.5.5. Fixing of Front Panels

The front panel shall be secured to the architrave frame by means of 6 mm studs and chromium-plated hexagonal domed nuts, hank nuts or captive fasteners. Alternatively, the panel may be secured to the architrave frame by means of two pins at the bottom and a latch or lock at the top of the panel. Self-tapping screws will not be allowed. All front panels shall be provided with a minimum of one chrome plated handle.

2.19.5.6. Door Handles and Catches

Switchboard doors shall be equipped with handles and catches. Locks shall only be provided when specified. In all cases where lockable doors are required and, in all cases, where the switchboard doors are higher or wider than 450 mm, handles consisting of a push-button-and-handle combination with spring loaded catch or rotary handle-and-catch combination shall be installed. Switchboard doors smaller than 450 mm in height and width may be equipped with spring loaded flush mounted ring type latches. Square key operated catches are not acceptable unless specified.

2.19.6. Construction of Surface Mounted Switchboards

2.19.6.1. Standard

Surface mounted switchboards shall comply with SABS 1180, Part II.

2.19.6.2. Switchboard Tray

Surface mounted switchboards shall be equipped with a 1.6 mm minimum sheet steel reinforced tray, suitably braced and stiffened to carry the chassis, door and equipment. Lugs to secure the switchboard to a vertical surface shall be provided.

2.19.6.3. Construction

All joints shall be welded or securely bolted. The tray shall be square and neatly finished without protrusions. The front tray sides shall be rounded with an edge of at least 20 mm to accommodate flush doors.

2.19.6.4. Chassis

A sheet steel chassis for the mounting of equipment shall be bolted to the tray and shall comply with the requirements of paragraph 7.4.1 and 7.4.3.

2.19.6.5. Front Panel and Door

The front panel and door shall comply with paragraph 7.2.4 to 7.2.6 above. Doors shall fit flush in the tray when closed.

2.19.6.6. Dimensions

Unless the depth of the switchboards is specified, the dimensions shall be determined in accordance with the requirements of paragraph 7.4.2 and 7.4.3.

2.19.7. Mounting of Equipment

The mounting of equipment shall comply with SABS 1180 where applicable. Equipment to be mounted on the chassis shall be mounted by bolts, washers, and nuts or by bolts screwed into tapped holes in the chassis plate. In the latter case the minimum thickness of the chassis plate shall be 2.5 mm. The latter method shall not be used where boards will be subject to vibration or mechanical shocks. Self-tapping screws will not be accepted.

2.19.7.1. Space Requirements

In designing the switchboards, the following requirements shall be strictly adhered to:-

- a) A minimum of 50 mm between any piece of equipment and the frame or internal partitioning. This minimum space is required on all sides of the equipment. In the case of a single row of single-pole circuit-breakers the spacing on one side of the row may be reduced to 25 mm if the incoming side of the circuit-breakers is busbar connected.
- b) A minimum of 75 mm between horizontal rows of equipment. The maximum outside dimensions of equipment shall be considered.
- c) Circuit-breakers up to a fault rating of 10 kA may be installed adjacent to each other. For higher ratings a minimum of 40 mm shall be allowed between circuit-breakers or isolators.
- d) Sufficient space shall be provided for wiring allowing for the appropriate bending radius.
- e) Space for future equipment shall be allowed as described in paragraph 7.1.2.

2.19.7.2. Mounting of Chassis

The chassis of flush mounted and smaller surface mounted boards shall be mounted in accordance with SABS 1180. For all free-standing switchboards and surface mounted switchboards where the main switch rating exceeds 100 A (triple-pole), space for wiring shall be provided between the chassis and tray. This space shall be adequate to install the supply cable behind the chassis and terminate on the main switch without sharp bends in the cable cores.

2.19.7.3. Grouping of Equipment

- a) Equipment shall be arranged and grouped in logical fashion as follows:
 - i. Main switch - to be installed either at the top or bottom of the board.
 - ii. Short circuit protection equipment - fuse gear or fuse-switches.
 - iii. Change-over contactors or other contactors controlling the supply.
 - iv. Motor supplies.
 - v. Fuse-switches for outgoing circuits.
 - vi. Other circuits and equipment.
- b) Where a portion of the equipment on the switchboard is supplied from a standby power source, the change-over contactor and the associated equipment shall be grouped in a separate compartment.
- c) Where earth leakage units are required, the associated circuit-breakers shall be installed adjacent to the unit.

2.19.7.4. Mounting of Circuit-Breakers

All moulded-case circuit-breakers shall be flush mounted with only the toggles protruding. Miniature circuit-breakers may be installed in clip-in trays mounted on the frame. All other circuit-breakers shall be bolted to the chassis. Special provision shall be made for large main switches when designing the framework. Care shall be exercised that the rear studs of circuit-breakers are properly insulated from the steel chassis. Where necessary, insulating material shall be installed between the rear studs and the chassis. Circuit-breakers shall be installed so that the toggles are in the up position when "ON" and down when "OFF".

2.19.7.5. Instrumentation

All metering instruments shall be flush mounted in the front panel or door. The rear terminals of instruments mounted on doors shall be covered with an insulating material to prevent accidental contact. Current transformers for metering shall be mounted so that the rating plate is clearly visible. Fuses for instrumentation shall be mounted in an easily accessible position and clearly marked.

2.19.7.6. Mounting of Fuses

- a) Fuse holders shall be mounted semi-recessed in the front panel so that fuses can readily be changed without removing the front panel. Busbar mounted fuses for instrumentation shall be used as far as possible.
- b) Where equipment requiring fuses is specified on a board (fuse switches etc), a ruling shall be obtained from the Department on the quantity of spare fuses to be provided.

2.19.7.7. Equipment in Main Boards

Equipment in main low-tension switchboards and sub-main boards shall be grouped in individual compartments. Equipment shall be installed as follows:

- a) Rack-out type air circuit-breakers shall be mounted in the bottom section, flush behind the panel with the handle only protruding. If this is not possible, the panel shall be omitted and the air circuit-breakers installed behind a door.

- b) If the main switch is a moulded-case circuit-breaker or isolator it shall be flush mounted.
- c) Contactors controlling the supply shall be installed behind separate front panels.
- d) All metering, protection and indicating equipment shall be clearly visible from the front of the board. Current transformer ratios and multiplication factors shall be clearly marked. Where doors are specified, the equipment shall be installed flush in the doors and covered as described in paragraph 7.4.6.
- e) All circuit-breakers and fuses (with the exception of fuse-switches) may be grouped together behind one or more panels.

The switchgear shall be logically arranged and grouped as described in paragraph 7.4. Depending upon the number and size of components, a common front panel may be installed over one or more groups of equipment. All equipment shall be installed in accordance with the requirements of paragraph 7.4.

- f) Fuses or fuse-switches providing back-up protection for circuit breakers, shall be grouped with the associated circuit-breakers. Exposed surfaces of fuse-switches shall be of the same finish and colour as the rest of the board where practical.

2.19.7.8. Standby Supplies

- a) Where standby power from a diesel-generator set or other sources is available and has to be connected to some of the equipment on a switchboard, the switchboard shall be divided into separate sections with sheet metal divisions to isolate standby power and mains power sections.
- b) Standby and normal supply shall each have its own incoming isolator or circuit-breaker.
- c) The two sections of the switchboard shall be labelled "ESSENTIAL" and "NON-ESSENTIAL" respectively.
- d) The front panels of standby and no-break supply sections shall be painted in distinctive colours as follows:
 - i. Normal supply "LIGHT ORANGE", colour B26 of SABS 1091
 - ii. Standby power "SIGNAL RED", colour All of SABS 1091
 - iii. No-break supply "DARK VIOLET", colour F06 or "OLIVE GREEN", colour H05 of SABS 1091

2.19.8. Busbars in Switchboards

2.19.8.1. Application

- a) Busbars shall be manufactured of solid drawn high conductivity copper with a rectangular cross-section in accordance with SABS 784, SABS 1195 and BS 159 and BS 1433. where applicable.
- b) Although SABS 784 refers only to overhead or rising busbars, busbars in switchboards shall comply with applicable sections of this specification especially as far as insulation and clearance values, creepage distance, joints, insulation resistance, dielectric strength, deflection test, absorption resistance and rated short time withstand current are concerned.

Heat shrink, PVC sheets shall be fitted over the busbars to indicate the phase colours. Insulation tape is not acceptable.

c) Busbars shall be supplied for the following applications:

- iv. Distribution of supply voltage.
- v. Connection of equipment with ratings exceeding the current rating of 70 mm² conductors (paragraph 8.6).
- vi. Connection of outgoing circuits with current ratings in excess of that allowed for 70 mm² conductors (paragraph 7.8).
- vii. Collector bars for parallel cables (paragraph 8.1).
- viii. Connection bars for neutral conductors (paragraph 7.9).
- ix. Earth busbars (paragraph 7.10).
- x. Connections to miniature circuit-breakers (paragraph 8.6).

2.19.9. Wiring

2.19.9.1. Cabling

Cables connected to incoming or outgoing circuits shall be terminated on the gland plate supplied for this purpose. Power cables up to and including 70 mm² may terminate on clamp type terminals where the clamping screws are not in direct contact with the conductor. Connection to the equipment can then be made with cables that are similarly connected to the clamp terminal. All power cables larger than 70 mm² terminate on busbars that are connected to the associated equipment. Parallel incoming or outgoing cables shall be connected to a collector busbar without crossing the conductors.

2.19.9.2. Terminal Strips

External wiring for low voltage, control, interlocking, alarm, measuring and DC circuits shall terminate on numbered wiring terminals complying with the Department's standard specification for "WIRING TERMINALS", Section C9. The correct terminal size as recommended by the manufacturer for each conductor to be connected shall be used throughout. The terminal numbers shall appear on the wiring diagrams of the switchboard. Terminals for power wiring shall be separated from other terminals. Terminals for internal wiring shall not be interposed with terminals for external circuits. All connections to terminals shall be identified as described in paragraph 7.6.8. Where switchboards consist of separate sections, the control wiring passing between sections shall be terminated on strips in each section so that control wiring can be readily re-instated when reassembling the board.

2.19.9.3. Current Ratings

The current rating of conductors for the internal wiring shall be sufficient for the maximum continuous current that can occur in the circuit. This value shall be determined from the circuit-breaker or fuse protection of the circuit.

Table 9.1: Current Rating for Internal Wiring

Nominal cross-section mm ²	CONDUCTOR RATING (A)				
	NUMBER OF CONDUCTORS IN BUNCH				
	1	2 - 3	4 - 5	6 - 9	10 and more
2.5	28	25	22	19	16
4.0	37	33	30	26	22
6.0	47	42	38	33	28
10.0	64	54	51	44	38
16.0	85	76	68	59	51
25.0	112	101	89	78	67
35.0	138	124	110	96	88
50.0	172	154	137	120	103
70.0	213	191	170	149	127

The above table shall be applied for ambient temperatures up to 30 C. (Refer to table 41.2 in VDE 0100). For higher ambient temperatures the values shall be de-rated as prescribed by SABS 0142, Table 10.

2.19.9.4. Internal Wiring

- (a) Standard 600/1 000 V grade PVC-insulated stranded annealed copper conductors to SABS 150 shall be employed for the internal power wiring of switchboards. The smallest conductor size to be used for power wiring in switchboards shall be 2.5 mm². Flexible cord of minimum size 1.0 mm² may be used for control wiring.
- (b) Where heat generating equipment is present and the internal temperature of the board is likely to exceed 50°C, silicon-rubber insulated stranded conductors shall be used.
- (c) Wiring shall be arranged in horizontal and vertical rows and shall be bound with suitable plastic straps or installed in PVC wiring channels. Under no circumstances may PVC adhesive tape be used for the bunching of conductors or for the colour identification of conductors.
- (d) Bunched conductors shall be neatly formed to present a uniform appearance without twisting or crossing the conductors. Conductors leaving the harnesses shall be so arranged that they are adjacent to the chassis.
- (e) Conductors to hinged panels and doors shall be secured on both the door and the frame and shall be looped between the two points. The loop shall be arranged to produce a twisting motion when the door is opened or closed. A flexible protection sleeve shall be installed over the conductors.
- (f) Where wiring channels are used, they shall be installed horizontally and vertically. Under no circumstances may power and control circuit wiring be installed in the same wiring channels. Channel shall not be more than 40% full.
- (g) All wiring between different Panels within the same switchboard shall be installed in wiring channels.
- (h) Grommets shall be installed in each hole in the metalwork through which conductors pass.
- (i) All wiring shall be installed away from terminals, clamps or other current carrying parts. Wiring shall also be kept away from exposed metal edges or shall be protected where they cross metal edges.

- (j) Conductors may be jointed at equipment terminals or numbered terminal strips only. No other connections are allowed.
- (k) Where conductors change direction, smooth bends shall be formed with a radius of at least 5 times the outside diameter of the conductor or harness.
- (l) Where screened cables are specified, the screening shall be earthed in the switchboard or control board only unless clearly specified to the contrary, screened cables entering control boxes through pressed knockouts, shall terminate in compression glands. Conductors shall as far as possible remain inside the screening at terminations. Where conductors must separate from the screen, the braiding shall be separated, and the conductors drawn through the braid without damaging the braiding. The conductors shall then be connected to their respective terminals and the screening smoothed and connected to the earth terminal.
- (m) Where neutral connections are looped between the terminals of instruments, it is essential that the two conductor ends be inserted into a common lug or ferrule and are crimped or soldered together in order that the neutral connection is not broken when the conductors are removed from one of the instruments.
- (n) Wiring should as far as possible be confined to the front portions of switchboards for ease of access. This requirement is important for wiring between smaller circuit-breakers and the associated main circuit-breaker as well as the wiring from circuit-breakers to lighting and socket-outlet circuits.
- (o) A maximum of two conductors will be allowed per equipment terminal. Where more conductors must be connected to the same equipment terminal (for example a main circuit-breaker feeding other circuit-breakers), stub busbars shall be provided for the various conductors. Refer also to paragraph 7.6.6.

2.19.9.5. Load End Connections

The supply end connections to all equipment shall under all circumstances be at the top and the load end connections at the bottom.

2.19.9.6. Wiring to Circuit-breakers

Equipment with a rating exceeding the current rating of 70 mm² conductors shall be connected by means of busbars to the main busbars. Looped connections may only be installed for a maximum of two outgoing circuits. Where there are more than two outgoing circuits, busbars shall be used and equipment connected individually to the busbars. Where miniature circuit-breakers are mounted in continuous rows and supplied by busbars connected to each MCB, each busbar shall be supplied by a separate conductor. This conductor shall be connected to the busbar by means of a separate lug and not via an MCB terminal.

2.19.9.7. Conductor Terminations

Conductors connected to terminals complying with the Department's standard specification for "WIRING TERMINALS", Section C9, need not be soldered or ferruled. Connections to circuit-breakers, isolators or contactors shall be made by one of the following methods:

- (a) A ferrule of the correct size,
- (b) Soldering the end of the conductor, or
- (c) Winding a conductor strand tightly around the end to totally cover the end.

All conductors terminating on meters, fuse holders and other equipment with screwed

terminals shall be fitted with lugs. The lugs shall be soldered or crimped to the end of the conductor. The correct amount of insulation shall be stripped from the end to fit into the terminal. Strands may not be cut from the end of the conductor.

2.19.9.8. Identification

- a) The colour of the conductors for all 220/250 V circuits shall correspond to the colour of the supply phase for that circuit. Neutral conductors shall be black.
- b) All other conductors in the board, supplying control circuits, etcetera shall be coded in colours other than those specified above. A colour code shall be devised for each board and the colour code shall be shown on the wiring diagrams.
- c) All conductors that terminate at wiring terminals and all conductors used for the internal wiring of the switchboard, shall further be identified at both ends by means of durable cable marking ferrules. PVC or other tape is not acceptable.
- d) The numbers on the markers shall be shown on the wiring diagrams.

2.19.10. Paint Finish

Metal components of the framework, panels and chassis shall be painted in accordance with the Department's "STANDARD PAINT SPECIFICATION", Section C39.

2.19.11. Labelling

Care shall be taken to ensure that all equipment is fully labelled and that accurate descriptions and safety warning notices appear in both official languages.

2.19.11.1. Material

Engraved plastic or ivory sandwiched strips shall be used throughout. The strips shall bear white lettering on a black background for normal labels and red letters on a white or yellow background for danger notices.

2.19.11.2. Main Switchboards

Main switchboards and sub-main switchboards shall be supplied with the following bilingual labels:

- (a) Number and allocation of switchboard.
Example:

CONTROL BOARD A4
BEHEERBORD A4

Lettering: at least 10 mm high. prominent position. Label on the outside in a prominent position.

- (b) Designation of busbar sections.
Example:

BUSBAR SECTION 2
GELEISTAMSEKSIE 2

Lettering: at least 10 mm high. Label on the outside in a prominent position.

- (c) Designation of all switchgear including circuit-breakers, isolators, contactors, etcetera. If the current rating of circuit-breakers is not clearly marked on the equipment, the value shall be indicated on the engraved label.

Example:

SUPPLY TO BOARD C3
TOEVOER NA BORD C3

PUMP SUPPLY
POMPTOEVOER

Letters at least 5 mm high. Label on the outside of the switchboard.

- (d) All other equipment including meters, instruments, indicator lights, switches, pushbuttons, circuit-breakers, fuses, contactors, control relays, protection relays, etcetera shall be identified. The function of the equipment and circuits shall be clearly indicated. The main switch shall be labelled as such and designated :

"SWITCH OFF IN CASE OF EMERGENCY"
"SKAKEL AF IN NOODGEVAL"

Flush mounted equipment within doors or front panels shall be identified with labels fixed to the doors or front panels respectively. The labels for equipment installed behind panels, shall be fixed to the chassis close to the equipment. If this equipment is positioned too close together to accommodate descriptive engraved labels, the equipment may be identified by a code or number on an engraved label which shall be fixed close to the equipment. The code number shall be identified on a legend card which shall be installed on the switchboard behind a plastic or other protective cover.

2.19.11.3. Other Switchboards

All equipment on switchboards shall be identified with the necessary bilingual labels. The circuit numbers shall appear at grouped single-pole circuit-breakers. The circuit numbers shall correspond to the circuit numbers on the final installation drawings. The above-mentioned circuits shall be identified on a legend card, which shall be installed on the inside of the switchboard door, or in any other position where it can conveniently be observed. All fuses, including instrument fuses, shall have labels stating function, fuse rating and duty or type where applicable. All other equipment shall be identified separately, and their functions shall be clearly indicated.

2.19.11.4. Fixing of Labels

- a) Labels shall not be fixed to components or trunking but to doors, panels, chassis or other permanent structures of the switchboard.
- b) Engraved strips shall be secured to facilitate a neat alteration of the designation of the labels. Sufficient fixing points shall be provided to prevent labels from warping. Labels in slotted holders shall be secured in position to prevent unauthorised removal. Labels may be secured by the use of brass bolts and nuts, self-tapping screws, slotted label holders or pop-rivets.

2.19.12. Tests

- 2.19.12.1. The Department shall be notified when the mechanical construction of the switchboard, ie frame, panels and base frame, is complete in order that it may be inspected at the factory.
- 2.19.12.2. Function tests of all equipment, control and interlocking circuits shall be conducted to the satisfaction of the Department. Testing equipment and facilities including instruments, dummy loads and additional switchgear and cables shall be provided by the Contractor at no extra cost. The Department shall be notified in writing two weeks

in advance of any test to be conducted, to allow its representative to be present at such tests. A complete report on the tests shall be handed to the Department.

2.19.13. Drawings

2.19.13.1. Drawings for Approval

A set of three prints of the shop drawings for the switchboards shall be submitted to the Department for approval before the boards are manufactured. The following information shall be presented:

- (a) A complete wiring diagram of the equipment on the boards.
- (b) A complete layout of the arrangement of the switchboards indicating all equipment dimensions and the construction of the boards. The positions and method of fixing and sizes of busbars shall be shown.
- (c) All labelling information in both the official languages on a separate sheet.
- (d) The make, catalogue number and capacity of all equipment such as isolators, circuit-breakers, fuses, contactors, etcetera

The approval of drawings shall not relieve the Contractor of his responsibility to the Department to supply the switchboards according to the requirements of this Specification.

2.19.13.2. Final Drawings

A complete set of "as-built" transparent drawings of all switchboards shall be submitted to the Department within two weeks after delivery of the boards. The following information shall be presented:

- (a) Item (a) to (d) of the previous paragraph.
- (b) Terminal strip numbers, numbers and colours of conductors connected to the terminal strips and numbers and colours of the conductors utilised for the internal wiring.
- (c) A separate schedule of all equipment.

2.19.13.3. Manuals

Three sets of manuals for all specified main and sub-main switchboards shall be supplied to the Department at no extra cost. These manuals shall include the following information :

- (a) Complete information on the operation of the equipment.
- (b) Complete information for maintenance of the equipment.
- (c) Brochures and ordering information.
- (d) A complete equipment list indicating quantities and relevant catalogue numbers.

2.19.13.4. Completion

The supply contract shall be regarded as incomplete until all tests have been conducted successfully and all drawings and manuals have been handed to the Department.

2.20. LIGHTNING PROTECTION & EARTHING

This item covers the extension of a complete lightning conductor system and shall comply in all aspects with the requirements set in the SANS Users' Code 03 of 1985 (as amended).

IT IS A SPECIFIC REQUIREMENT OF THIS CONTRACT THAT THIS PART OF THE INSTALLATION SHALL BE DONE BY SPECIALISTS WHO ARE CONVERSANT WITH THIS TYPE OF WORK. TEST CERTIFICATES OF THE LIGHTNING INSTALLATION IS A FURTHER REQUIREMENT.

2.20.1. General Protection

The terms Contract Works, Works, or Installation shall mean the Sub-contract works as specified in this section.

The Sub-contractor shall carry out the complete sub-contract works as indicated in and in accordance with the specification and drawings and shall provide and install all items necessary for the proper functioning of the installation, even though such items may not specifically be referred to in the specification and drawings. The terminology in this section has the same meaning as in SANS 03 (as amended).

All materials and equipment used in the installation shall be of recent design and manufacture and of the best quality available and shall, wherever possible, carry the latest mark of the South African Bureau of Standards.

2.20.2. Drawings

2.20.2.1. Contract Drawings

The drawings accompanying this specification are as stipulated in the Notes to Tenderers. The working drawings of the contract shall, however, consist of:

- (a) the Electrical drawings,
- (b) the Architect's drawings,
- (c) the Structural Engineers' drawings, as applicable,
- (d) the Engineer's drawings of other disciplines, as applicable,
- (e) And the installation drawings of other sub-contractors, where applicable.

All drawings and layouts shall be regarded as diagrammatic, and all positions and dimensions shown on drawings shall be verified on site. The Sub-contractor shall check with the Builder before putting work in hand on any section of the work, that he is in possession of the latest drawings and should any discrepancy be found between the Sub-contractor's drawings as issued by the Engineer and those in possession of the Builder, the matter shall be referred to the Engineer for clarification. No extra will be allowed for alterations or making good resulting from lack of verification.

2.20.2.2. Shop Drawings for Approval

A complete set of all shop drawings shall be submitted to the Engineer for approval and to demonstrate compliance with the sub-contract specification.

These drawings shall indicate the complete design of the proposed installation, including the method and materials employed in effecting earth terminations, down conductor systems, air terminations, etc.

Approval of shop drawings by the Engineer does not relieve the Sub-contractor of his responsibility for compliance with the specification, nor does it relieve him of his responsibility for errors or omissions in shop drawings.

2.20.3. Site Survey

The Sub-contractor shall survey the premises prior to submitting his tender to establish, in particular, the soil resistivity and, in general, any other prevailing conditions so as to include in his tender for the entire installation.

2.20.4. Tests & Inspections

- 2.20.4.1. The Sub-contractor shall arrange for all necessary installation tests and inspections required.
- 2.20.4.2. The Sub-contractor shall attend on the Engineer during all site/equipment inspections and tests and shall advise the Engineer in good time of the proposed completion of works in order that these may be inspected prior to installation.
- 2.20.4.3. A permanent testing point shall be provided between each down conductor and its associated earth conductor, consisting of a recessed 100 x 100mm conduit box and cover plate engraved "Lightning Protection Test Point".
- 2.20.4.4. The following test records shall be submitted to the Engineer:
 - (a) Earth resistance at each test point, duly recorded on as-built drawings,
 - (b) Continuity of each trench earth.
 - (c) Earth resistance of main substation earth bar and clean earth bar also recorded on as-built drawings.
 - (d) Final test certificate.

2.20.5. Components

2.20.5.1. Conductors

The Sub-contractor shall arrange for all necessary installation tests and inspections required.

2.20.5.2. Earthing Electrodes

The Sub-contractor shall attend on the Engineer during all site/equipment inspections and tests and shall advise the Engineer in good time of the proposed completion of works in order that these may be inspected prior to installation.

2.20.5.3. Alternative Conductor Material

A permanent testing point shall be provided between each down conductor and its associated earth conductor, consisting of a recessed 100 x 100mm conduit box and cover plate engraved "Lightning Protection Test Point".

2.21. TRENCHING

2.21.1. General

The provision of trenches for the laying of cables and the installation of telephone, data, fire detection, access control and cable sleeves forms part of this contract. All cables and sleeves shall be laid at a depth of 600 mm except that sleeves below the building may be laid at a lesser depth provided that the Electrical Engineer is satisfied that no damage to the sleeves can occur.

The bottom of the trenches shall be of smooth contour and shall have not sharp dips or rises, which may cause tensile forces in the cable during backfilling.

Prior to cable laying, the trench shall be inspected thoroughly and all objects likely to cause damage to the cables either during or after laying shall be removed.

Where ground conditions are likely to reduce maximum current carrying capacities of cables or where the cables are likely to be subject to chemical or other damage or electrolytic action, the Electrical Engineer shall be notified before installing the cables and will then advise on the course of action to be taken.

2.21.2. Dimensions of Trenches

Cable trenches for one or two cables or sleeves shall not be less than 300 mm wide and need not be more than 450 mm wide. This dimension shall be valid for the total trench depth.

Where trenches change direction or where cable slack is to be accommodated, the contractor shall ensure that the requirements of the relevant SANS specification regarding the bending radii of cables are met when determining trench widths.

Trench depths shall be determined in accordance with cable laying depths and bedding thickness.

2.21.3. Bedding

The bottom of the trench shall be filled across the full width with a 150 mm layer of suitable soil sifted through a 6 mm mesh and levelled off.

Only sandy clay or loam soil with a satisfactory thermal resistivity (not exceeding 1.5 Cm/W) may be used for this purpose. Sea or river sand, ash, chalk, peat, clinker or clayey soil shall not be used. The use of crusher sand is acceptable.

Where no suitable soil is available on site, the contractor shall import fill from elsewhere and make all the necessary arrangements to do so. The cost of importing soil for bedding purposes shall be included in the unit rates for excavations.

After cable laying, a further layer of bedding shall be provided to extend to 150 mm above the cables.

2.21.4. Backfilling

The contractor shall not commence with the backfilling of trenches without prior notification to the Electrical Engineer so that the cable installation may be checked. Should the contractor fail to give a timeous notification, the trenches shall be re-opened at the contractor's cost. Such an inspection will not be unreasonably delayed.

Backfilling shall be undertaken with soil suitable to ensure settling without voids. The maximum allowable diameter of stones present in the backfill materials is 75 mm.

The contractor shall have allowed in his tender for the importation of suitable backfill material if required and such costs shall be included in the unit rates for excavations.

The backfill shall be compacted in layers of 150 mm and sufficient allowances shall be made for final settlement. The contractor shall maintain the refilled trench at his expense for the duration of the contract. Surplus material shall be removed from site and suitably disposed of.

On completion of the contract, the surface shall be made good to match the surrounding area.

In the case of roadways or paved areas the excavations shall be consolidated to the original density of the surrounding material and the surface finish reinstated.

2.21.5. Measurement

Trench excavations shall be measured and paid for as per the unit rate included by Tenderers for excavations. In all cases, the cost of excavations shall include the total cost of excavating, bedding, backfilling, and making good.

Definitions for the different type of excavations are as follows:

1. Earth: Excavations which can be performed with pick and shovel.
2. Hard rock: Hard rock will be measured. Where compressor operated jack hammers are required to remove the rock and includes for areas where large boulders which must be mechanically moved occur as well as, where excavations can only be performed by means of earth moving equipment and/or blasting.

2.22. SCHEDULE OF LIGHT FITTINGS

All the LED luminaires as detailed on the lighting schedule shall be suitable for operation between the minimum and maximum ambient temperatures found on site. Refer the lighting schedule as detailed on the Lighting Layout drawings

The light fittings and accessories are to be according to the quality specifications in Section A and shall be approved by the Engineer prior to ordering.

A.3. TENDERERS SCHEDULES

3.1. GENERAL

This section of the specification forms part of, and must be read in conjunction with, sections A1, A2, A3 as well as the drawings.

3.2. SCHEDULE OF ADDITIONAL LABOUR (RAND/HOUR)

These tariffs shall be used for the charging of labour costs not included in other tariffs. P & G amounts are excluded. These tariffs will be subject to negotiation by the Engineer or his representative during the installation phase.

	SUPERVISOR	FOREMAN	ARTISAN	REGISTERED APPRENTICE	LABOURER
NORMAL TIME	R _____ /h	R _____ /h	R _____ /h	R _____ /h	R _____ /h
WEEKLY OVERTIME	R _____ /h	R _____ /h	R _____ /h	R _____ /h	R _____ /h
SUNDAY TIME	R _____ /h	R _____ /h	R _____ /h	R _____ /h	R _____ /h

3.3. SCHEDULE OF ADDITIONAL TRANSPORT (TRAVELLING COSTS)

Should the contractor be successful in tendering, the following costs per kilometre shall pertain to the cost of all additional travelling.

VEHICLE GROSS MASS	COST PER KILOMETER	
	TARRED SURFACE ROAD	GRAVEL SURFACE ROAD
CAR	R _____ /km	R _____ /km
1,000 kg	R _____ /km	R _____ /km
3,000 kg	R _____ /km	R _____ /km

3.4. SCHEDULE OF PROFIT FOR METERIAL FOR VARIATIONS

The following profit percentage is applicable to all materials not included in other tariffs, P & G items excluded, and will be subject to negotiation by the Engineer or his representative during the installation phase.

If the tender is successful, the following percentage profit shall be applicable on the cost of all materials specified for variation order purposes for which unit prices have not been included in this tender document.

The stated percentage profit is not fixed, and the Engineer may negotiate for a lower percentage during variation.

The Engineer shall be at liberty to call for adjustment of individual prices, as considered necessary, based on the average ruling prices as determined by the Engineer for similar work in the industry, in the area in which the work is being carried out.

VARIATIONS	PERSENTAGE PROFIT
Additions	%

3.5. SCHEDULE OF EQUIPMENT

Should the tender be successful, the following material/equipment will be used.

The Contractor shall submit full details regarding the information required when submitting the tender.

This includes equipment that was not specified in this document but may form part of the installation.

Failure to include full details regarding the information required will invalidate the tender.

ITEM	MATERIAL	MAKE	COUNTRY OF ORIGIN
1	Distribution boards		
2	Circuit breakers 1P, 2P, 3P		
3	On load isolators without trips		
4	Contactors 1P, 2P, 3P		
5	Earth leakage relays 1 & 3 phase		
6	Surge arrestors		
7	Current transformers		
8	Voltmeter		
9	Maximum demand ammeter		
10	Daylight sensitive switch		
11	Time switch		
12	Conduit		

ITEM	MATERIAL	MAKE	COUNTRY OF ORIGIN
13	Conduit boxes		
14	Power skirting / trunking		
15	Surface switches		
16	Watertight switches		
17	16 A inductive type dimmer – 200W		
18	Telephone sockets in power skirting		
19	Telephone sockets in 100 x 50 grid plates		
20	Data sockets in power skirting		
21	Date sockets in 100 x 50 grid plates		
22	16 A flush socket outlets		
23	16 A socket outlets in power skirting		
24	16 A surface socket outlets		
25	16 A watertight socket outlets		
26	3gang cluster unit		
27	16 A dedicated socket outlets in power skirting		
28	<u>Luminaires:</u>		
28.1	Type A		
28.2	Type Ae		
28.3	Type B		
28.4	Type Be		
28.5	Type C		
28.6	Type C1		
28.7	Type Ce		
28.8	Type D		
28.9	Type E		
28.10	Type F		
28.11	Type Fe		
28.12	Type G		
28.13	Type H		

ITEM	MATERIAL	MAKE	COUNTRY OF ORIGIN
28.14	Type He		
28.15	Type I		
28.16	Type Ie		
28.17	Type J		
28.18	Type J1		
28.19	Type K		
28.20	Type M		
28.21	Type P		
28.22	Type R		

NOTE:

Tenderers are to note that under no circumstances may materials be installed other than that offered in the above material schedule, which has been approved and accepted by the Engineer.

Should the successful Tenderer wish to supply materials other than that originally offered, prior written approval must be obtained from the Electrical Engineer before any orders are placed.

3.6. SCHEDULE OF WORK COMPLETED BY TENERER

3.6.1. Previous Projects

The Tenderer must, in the space below, supply a list of at least three customers/ contracts of a similar/comparable nature (reference sites) that were completed by him or where similar systems have been installed by him within the last three years.

Arrangements will be made with the Contractor during the evaluation period, to visit at least one of the sites, where a successful installation of a similar/comparable nature has been made.

CLIENT NAME & TEL	CONSULTING ENGINEER NAME & TEL	SCOPE OF WORK	VALUE OF WORK (EXCL. VAT)	YEAR COMPLETED

3.6.2. **Current Projects**

The Tenderer must, in the space below, supply a list of at least three customers/ contracts of a similar/comparable nature (reference sites) that are currently being completed by him or where similar systems are being installed by him.

CLIENT NAME & TEL	CONSULTIN G ENGINEER NAME & TEL	SCOPE OF WORK	VALUE OF WORK (EXCL. VAT)	YEAR TO BE COMPLETED

3.7. **SCHEDULE OF SUB-CONTRACTORS**

The Contractor shall state in the schedule below the names of all sub-contractors he wishes to employ for the works and shall define their duties and outline their experience.

Acceptance of this tender should not be seen as acceptance of all or any of the sub-contractors. If any of the sub-contractors is not approved after acceptance of the tender it will not invalidate the tender and the tender tariff for the various items will remain final and binding, even should the engineer approve a sub-contractor who was not mentioned in the tender document.

NAME OF SUB- CONTRACTOR	PROPOSED DUTIES	EXPERIENCE

3.8. SCHEDULE OF PROPOSED PERSONNEL & LABOUR

Tenderers must here under indicate the personnel and labour that will be utilised for the completion of the contract

PERSONNEL & LABOUR	NUMBER
Technical Personnel	
Clerical Personnel	
Artisan	
Skilled Labour	
Unskilled Labour	
TOTAL PERSONNEL & LABOUR	

3.9. LIST OF RETURNABLE SCHEDULES

This is a list of all other returnable documentation, apart from what is already included in the specification. Please tick off and attach the required documents to this tender.

2.1	Company Profile	
2.2	Valid CIDB Grading Certificate	
2.3	Certified ECA Certificate	
2.4	Valid Workman's Compensation Insurance / Letter of Good Standing	
2.5	Annexure A: Form of Reference (for 2 different relevant projects, currently in progress or completed in the last 3 years)	

Name of Tenderer

Contact Details

Tel No. _____

Email _____

Physical Address

Date _____

Tenderer Signature _____

Company Stamp

ELECTRICAL CONTRACTORS' ASSOCIATION (ECA) REGISTRATION NUMBER

PART 3: DRAWING SCHEDULE

DRAWING NUMBER	DESCRIPTION
E10812-001	GROUND & FIRST FLOOR - SMALL POWER LAYOUT [REV B]
E10812-002	GROUND & FIRST FLOOR - LIGHTING LAYOUT [REV C]
E10812-003	SINGLE LINE DIAGRAM [REV C]
E10812-006	GROUND & FIRST FLOOR - LIGHTING LAYOUT [REV A]

PG-03.2 (EC) SITE INFORMATION – JBCC 2000 PRINCIPAL BUILDING AGREEMENT (EDITION 6.2 OF MAY 2018)

Project title:	<i>DE AAR MAGISTRATE COURT</i>				
Tender no:	<i>KIM15/2023</i>	WCS no:	<i>055667</i>	Reference no:	<i>19/2/4/2/2/2373/86</i>

C4 Site Information

THE SITE IS LOCATED AT DE AAR MAGISTRATE COURT.

