REQUEST FOR BID
PROFESSIONAL SERVICES

National Department of Health

THE CONTRACT

BID NUMBER: NDoHF 07/2015-16

DESCRIPTION: APPOINTMENT OF A CONTRACTOR FOR CONSTRUCTION AND COMMISSIONING OF NEW SMALL CLINIC AT MAGWEDZA CLINIC – VHEMBE DISTRICT (LIMPOPO PROVINCE)

ELECTRICAL & MECHANICAL SPECIFICATIONS

Procurement process administered by Deloitte Consulting (Pty) Ltd
General Technical Specification

December 2015

National Department of Health
Issue and revision record

<table>
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<th>Date</th>
<th>Originator</th>
<th>Checker</th>
<th>Approver</th>
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<td>2015/12/10</td>
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**Information class:** Standard

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# General Technical Specification

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## Part 1: General Technical Specification

### 1.1 General

The General Technical Specification is to be read in conjunction with the Detailed Technical Specification.

Where the Detailed Technical Specification differs from the General Technical Specification, the former shall apply to this contract.

### 1.2 Compliance with regulations

The total installation shall conform to the Occupational Health and Safety Act 85 of 1993 and to SANS 10142-1 of 2003, the Wiring of Premises-Low Voltage Installations, as well as all the regulations and by laws of the Local and Supply Authority

### 1.3 Arrangement with the supply authority

The Electrical Sub-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. The connection cost will be paid directly by the client to the supply authority. However, the electrical contractor shall allow for the liaison with the electrical supply authority in this respect.

It shall be the responsibility of the Sub-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, commission and to hand over the installation.

The Sub-Contractor shall supply and install all notices and warning signs that are required by the appropriate laws, regulations and/or by this document.

### 1.4 Fixing and Supporting of Equipment and Materials

It is the responsibility of the Electrical Sub-Contractor to position and securely fix conduits, ducts, cables with cable channels, switchboards, fittings, and all other equipment or accessories as required for the installation. The Electrical Sub-Contractor shall provide and fix all supports, clamps, brackets, hangers and other fixing materials.

All supporting steelwork shall be wire-brushed and given one coat of rust resisting primer, followed by one coat of high quality enamel paint before any other equipment is fixed.
Supports, brackets, hangers, etc. may only be welded to steel structural members where prior permission has been obtained.

Supports shall preferably be proprietary products such as UNISTRUT, or failing this, shall be of mild steel sections, purpose fabricated for their application. Under no circumstances whatsoever will sheet metal straps be accepted as a supporting method. All supports shall cradle the item to be supported and shall not be riveted or welded to the equipment. Rod hangers shall not exceed 3000mm in length and will be of minimum diameter 12mm. For longer suspensions mild steel angles are to be used. Angle iron supports shall be of 38 x 5mm minimum section.

REDHEAD or RAWLBOLT anchor bolts, or their equivalent, shall be used for fixing supports to the building structure. It is not permissible to utilise gunpowder shot-driven bolts for this purpose unless prior permission has been obtained.

Brass screws, bolts and nuts shall be used to fix galvanised equipment.

Materials as sheet metal cable ducts, or channels, may be fixed against walls and concrete slabs by means of the shot-fired method designed for this purpose.

1.5 Electrical Conduit Installation

1.5.1 Galvanised Conduit

Galvanised conduit and accessories shall be used in the following circumstances:

a) For surface mounted conduit installations
b) In conduit used for future extensions where 'free ends' exist.

Conduit & accessories for the above applications shall be hot-dipped galvanised to SABS SANS 60614-2-1of 1982.

1.5.2 PVC Conduit

The use of PVC conduit is permitted in all cases except for those indicated in clause 1.5.2. It shall be the PVC type bearing the SANS mark of approval, and shall conform to SANS 950 of 2008.
1.5.3 General

Where conduits are to be installed in concrete, this shall be done while the building work is still in progress. Surface mounted conduit shall only be installed after the concrete has cured sufficiently.

Conduits may not be installed closer than 150mm to pipes containing gas, steam, hot water or other materials which may damage the conduits. Metal conduits may not touch pipes or other service installations in order to prevent electrolytic corrosion. Where this is unavoidable, cathodic protection shall be provided.

1.5.3.1 Debris

Care shall be taken to prevent any debris or moisture from entering the conduit during and after installation of the conduits. All conduit ends shall be sealed by means of a solid plug which shall be screwed to the conduit end. All conduits shall be cleaned to remove all oil, moisture or other debris that may be present, before conductors are installed.

1.5.3.2 Defects

Each length of conduit shall be inspected for defects and all burrs shall be removed. All conduits that are split, dented, have sharp internal edges, or are otherwise damaged, shall be removed from site. The Sub-Contractor shall ensure that conduits are not blocked.

1.5.3.3 Conduit Ends

Conduit ends shall be cut at right angles to ensure that ends butt squarely at joints. Threads shall not be visible at joints and connections, except at running joints for steel conduits.

1.5.3.4 Joints

All metal conduit ends shall be reamed and all joints tightly screwed. All PVC conduits shall be joined using joint couplings and PVC weld. Only approved couplings shall be used. Running joints with long threads shall be kept to a minimum, and locknuts shall be provided to ensure a strong mechanical and a continuous electrical joint for steel conduits.
1.5.3.5 Finish (Steel)

All joints shall be painted with red lead to prevent them from rusting in damp areas, areas within 50km of the coast, and in cases where the installation is exposed to the weather for any length of time. In spaces where the galvanising or black paint has been damaged, the area shall first be cleaned and a coat of zinc base paint applied subsequently. Additional coats of paint shall only be applied after the undercoat has been completed.

1.5.3.6 Continuity (Steel)

Mechanical and electrical continuity shall be maintained throughout the conduit installation. Conduits may not be relied upon for earth continuity.

1.5.3.7 Position of Outlets

All accessories such as socket outlets, switches, lights, etc., shall be accurately positioned. It is the responsibility of the Sub-Contractor to ensure that all accessories are installed level and square at the correct height from the floor, ceiling or roof level as specified. It shall be the responsibility of the Sub-Contractor to determine the correct final floor, ceiling and roof levels in conjunction with the Main Contractor. Draw boxes shall not be installed in positions where they will be inaccessible after completion of the installation. Draw boxes will be installed in inconspicuous positions to the approval of the Engineer. All installed draw boxes shall be pointed out to the Engineer. The positions of all draw boxes shall be indicated on the 'record' drawings.

1.5.3.8 Draw Wires

Nylon draw wires shall be installed in all unwired conduits, e.g. conduits for future extensions, telephone installations and other services.

1.5.3.9 Bends

A maximum of two 90° bends or the equivalent displacement will be allowed between outlets and/or draw boxes. Draw boxes shall be installed at maximum intervals of 12m in straight conduit runs. All bends shall be made without heating the conduit or without reducing the diameter of the conduit. The inside diameter of a bend shall not be less than three times the outside diameter of the conduit.
1.5.3.10 Wall Sockets

Where more than one socket outlet is connected to the same circuit, the conduit shall be looped from one outlet box to the following on the same circuit. Where a metal channel is used, the conduit may be installed from the channel directly to the outlet box on condition that the conductors can be looped from one outlet to the next without the jointing of wires.

1.5.3.11 Luminaires

Conduit end may not be used to solely support luminaires. Where luminaires are specified to be fixed directly to the pendant box, the pendant box shall be fixed independently of the conduit installation except where the pendant box is cast into concrete.

1.5.3.12 Temperature Differences (steel conduits)

Should the conduit installation be subject to temperature gradients at the same time, an expansion joint shall be installed in a suitable position to accommodate expansion as well as contraction. The conduit at the higher temperature shall be insulated from the rest of the installation with a suitable material. The above conditions, for example, apply where conduits leave cold rooms.

1.5.3.13 Flush Mounted Outlet Boxes

The edges of flush mounted outlet boxes shall not be deeper than 10mm from the final surface. Where this is not the case, an extension box which ends flush with the surface, shall be screwed to the outlet box. This method shall be used in partitions and clad surfaces.

1.5.3.14 Excess Holes

All excess holes in draw boxes, distribution boxes, switchboards, cable ducts or trunking, power skirting, etc., shall be securely blanked off to render the installation vermin proof.
1.5.3.15 Terminations

Switchboards, Power Skirting, etc.:
A female bush and two lock nuts shall be installed where conduits terminate in pressed steel switchboards and distribution boxes, cable ducts, power skirting, etc. The conduit end shall only project far enough through the hole to accommodate the bush and lock nut.

Draw Boxes:
A female bush and lock nut shall be used to terminate conduits at draw boxes and outlet boxes without spouts.

1.5.4 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, 1,5m for metallic conduit and 450mm for PVC conduit, by means of saddles screwed to the roof timbers. The Contractor shall supply and install all additional supporting timbers in the roof space as required.

Nail or crampets will not be allowed.

Under flat roofs, in false ceilings or where there is less than 0,9m 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 in close proximity to the boards.

Conduits and wiring in open roof spaces above ceilings, other than ceilings of concrete, shall be installed before the ceilings and walls are painted, and before removable ceiling tiles are installed.

Cross-Overs in conduit routes shall be minimised. Where cross-overs are unavoidable one conduit only shall be offset to cross the other conduit. Where several conduits enter the same draw box, they shall be as far as possible installed parallel to each other.

Draw boxes with cover plates shall be installed where required. Draw boxes shall as far as possible be installed near gangplanks. Socket and switch boxes will not be accepted as draw boxes in open roof spaces.

Conduits shall be looped between outlet boxes.

Where luminaires are secured directly to draw boxes in false ceilings or where ceiling roses or special connections are used, flush mounted, rear entry round draw boxes which are independently fixed to roof beams, shall be provided.

All conduit ends for lighting outlets in ceilings shall be securely supported.

Draw boxes for fluorescent luminaires shall be installed as specified in the previous paragraph but luminaires shall be installed as specified.

1.5.5 **Conduit in Concrete and Screeds**

In order not to delay building operations, the Electrical sub-contractor shall ensure that all conduits and accessories which are to be cast in concrete are placed in position in good time. The Electrical sub-contractor or his representative shall be in attendance when the concrete is cast.

All boxes, etc., 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.

Draw boxes, expansion joints and round ceiling boxes shall be installed where required and shall be neatly finished to match the finished slab and wall surfaces. Ceiling draw boxes shall be of the deep type. In hollow tile slabs, rear-entry draw boxes shall be used. In columns where flush mounted draw boxes are installed, the conduits shall be offset from the surface of the column immediately after leaving the draw box.

Draw boxes and/or inspection boxes shall, where possible, be grouped together under a common approved cover plate. The cover plate shall be secured by means of screws.

All conduits, draw boxes etc., shall be securely fixed to the shuttering to prevent displacement when concrete is cast. Wire will not be accepted for securing boxes to the shuttering where off-shutter finishes are required. All draw boxes and outlet boxes shall be plugged with wet paper before they are secured to the shuttering.

Conduits will not be allowed in concrete floor slabs of boiler rooms (or boiler houses), laundries or other damp areas. Equipment in damp areas shall only be supplied from above by means of multi-core PVC-insulated cables which shall either be installed in galvanised steel ducting or on galvanised cable trays. All socket outlets and three phase outlets in damp areas shall be supplied from above.

The installation of conduits in floor screeds shall be kept to a minimum. Where conduits are installed in screeds, the top of the conduit shall be at least 20mm below the surface of the screed. Where the screed is laid directly on the ground, galvanised conduits shall be used. This ruling will always be applicable to the lowest floor of a building. A minimum distance of twice the outside diameter of the conduit shall be left free between adjoining conduits. Conduits shall be secured to the concrete slab at intervals not exceeding 2.0m.

All draw boxes, conduits, etc., which are installed in concrete shall be cleaned with compressed air and provided with draw wires two days after removal of the shuttering. Errors that occur during the installation of the conduits, or any lost draw boxes, or blocked conduits, shall be immediately reported to the Engineer.
in order that an alternative route can be planned and approved by the Engineer before the additional concrete is cast. Any additional cost shall be to the Sub-Contractor’s account.

1.5.6 **Surface Installation (metal)**

Except where installed in ceiling spaces, the installation of conduit on the surface of walls and concrete slabs will only be allowed when authorised, in writing, by the Engineer. Where surface conduits are specified, saddles shall be of the hospital (spacer) type.

All conduits shall be installed horizontally or vertically as determined by the route and the Sub-Contractor shall take all measures to ensure a neat installation. Where conduits are to be installed directly alongside door frames, beams, etc., that are not true, conduits shall be installed parallel to the frames, beams, etc.

Conduits shall be firmly secured by means of saddles spaced at maximum intervals of 1500mm. Saddles shall be submitted to the Engineer for approval prior to commencement of installation. Where saddles are used to secure vertical lengths of conduit connected to surface mounted switch boxes or socket outlet boxes, the saddles shall be spaced so that the intervals between the box and the first saddle, between any two successive saddles and between the last saddle and the ceiling or roof are equidistant. Conduits shall be secured within 250mm before and after each 90° bend.

Joints will not be allowed in conduit runs of lengths less than 3500mm when these conduits are installed on the surface of a wall. Threads shall not be visible at joints of completed installations, except where running joints are used. Running joints will be allowed only when absolutely necessary. All running joints shall be provided with lock nuts and shall be painted with red lead immediately after installation.

Inspection bends or tee pieces shall not be used. Non-inspection type bends may be used in the case of 40mm or 50mm diameter conduits. All draw boxes supporting luminaires or other equipment shall be fixed independently of the conduit installation.

1.5.7 **Flexible Conduits**

In installations where the equipment has to be moved frequently to enable adjustment during normal operation, for the connection of motors or any other vibrating equipment, for the connection to thermostats and sensors on equipment, for stove connections and where otherwise required by the Engineer, flexible conduit shall be used for the final connection to the equipment.
The lengths of flexible conduit shall be as short as possible to comply with the requirements of the particular connection but shall not exceed 600mm, except when specified or approved by the Engineer.

Flexible conduit shall preferably be connected to the remainder of the installation by means of a draw box. The flexible conduit may be connected directly to the end of a conduit if an existing draw box is available within 2000mm of the junction and if the flexible conduit can easily be rewired.

Flexible conduit shall consist of metal-reinforced plastic conduit or PVC covered metal conduit with an internal diameter of at least 15mm, unless approved to the contrary. In false ceiling voids, flexible conduit of galvanised steel construction may be used. Connectors for coupling to the flexible conduit shall be of the gland or screw-in type, manufactured of either brass or cadmium or zinc plated mild steel.

Flexible conduit connections shall be provided with an internal or external earth wire connection as required by the local Supply Authority, with preference given to internal earth wires where no specific local regulations apply.

### 1.5.8 Expansion Joints

Where conduits cross expansion joints in the structure, approved type draw boxes which provide a flexible connection in the conduit installation shall be installed.

The draw box shall be installed adjacent to the expansion joint of the structure and a conduit sleeve, one size larger than that specified for the circuit, shall be provided on the side of the draw box nearest the joint. The one end of the sleeve shall terminate at the edge of the joint and the other shall be secured to the draw box by means of locknuts.

The circuit conduit passing through the sleeve shall be terminated 40mm inside the draw box. The gap between the sleeve and the conduit at the joint shall be sealed to prevent the ingress of wet cement.

The conduit boxes shall be drilled and tapped and the earth wire shall be bonded to the boxes by means of a 2,5mm² copper wire (minimum) with lugs and brass screws.

Draw boxes at the expansion joint shall be provided with a suitable steel cover plate fixed to the boxes by means of screws. The cover plates shall be installed before the ceilings are painted by others.
1.5.9 Chases and Builder’s Work

Except where otherwise specified, the Electrical sub-contractor shall be responsible for the builder's work connected with conduits, outlet boxes, switchboard trays, bonding trays and other wall outlet boxes as well as the necessary chasing and cutting of walls and the provision of openings in ceilings and floors for luminaires and other electrical outlets. The Electrical sub-contractor shall notify the Main Contractor of his requirements and the responsibility lies with the Electrical sub-contractor to ensure that these requirements are met.

Electrical materials to be built in must be supplied, placed and fixed in position by the Electrical sub-contractor when required by the Main Contractor. The Electrical sub-contractor shall also ensure that these materials are installed in the correct positions.

Where no Main Contractor is on site the Electrical Contractor is required to cover conduits installed in chases by a layer of 4:1 mixture of coarse sand and cement, finished 6mm below the face of the plaster and roughened. In all cases chases shall be deep enough to ensure that the top of conduits are at least 12mm below the finished plaster surface.

The Electrical sub-contractor is responsible for the cutting of chases and the building-in of conduits or other equipment. He will be held responsible for all damage as a result of this work and will be required to make good to the satisfaction of the Engineer. Chases shall be made by means of a cutting machine.

Under no circumstances shall face brick walls or finished surfaces be chased or cut without the written permission of the Engineer. Where it is necessary to cut or drill holes in the concrete structure, then prior permission of the Structural Engineer shall be obtained to ensure that the structure is not weakened.
1.5.10 Connections to Switchboards

Wherever possible conduits connected to switchboards shall terminate in a common fabricated sheet steel draw box installed in the vicinity of the switchboard. In open roof spaces this draw box shall be placed in a roof space of not less than 900mm clearance. Lighting and plug circuits may be separately grouped in common conduits or metal ducts (trunking) from the distribution board to the draw box.

The draw box shall be of sheet steel with a minimum thickness of 1.6mm and shall be provided with a removable cover plate.

Where flush mounted switchboards are required, the recessed switchboard tray shall be built into the brick or concrete wall. All conduits from the floor or roof shall be fully recessed and shall be bonded directly to the tray.

Where surface mounted switchboards are specified but where the conduits can be fully recessed, the conduit shall be connected to a recessed connection box installed behind the switchboard. An opening with the same dimensions as the connection box shall be cut in the back of the switchboard and be provided with a suitable grommet.

1.6 Cable Trays and Ladders

The Sub-Contractor shall supply and install all cable trays or ladders as specified or as required by the cable routes including the necessary supports, clamps, hangers, fixing materials, bends, angles, junctions, reducers, T-pieces, etc.

1.6.1 Cable Trays

Metal cable trays shall be manufactured from perforated rolled steel or an approved steel wire mesh type. Only the following metal cable tray types may be used:

a) **Less than 200mm wide:**
   1.6mm minimum thickness with 12mm minimum return

b) **200mm x 350mm:**
   Equivalent to trays supplied by "O-line" manufactured from 2mm thick steel with folded over returns and a minimum up-stand of 50mm.
c) **350mm and wider:**

2.4mm minimum thickness with 76mm return as alternative to (b) above.

The return of trays shall not be perforated and the top of the return shall be smooth. The same cable tray type shall be used in long parallel tray runs.
1.6.2 Cable Ladders

Metal cable ladders shall consist of 76mm high side rail of 2mm minimum thickness. Cross pieces consisting of OL3300 "O-line" (similar or equal) channel sections shall be spaced at maximum intervals of 250mm. Where cables of 10mm dia. or smaller are installed on cable ladders, the spacing of the cross pieces shall be 125mm. Cables shall be clamped in position by means of purpose made cable clamps that fit into the cross pieces. Cross pieces consisting of slotted metal rails which accommodate plastic or metal cable binding bands, may be used in vertical cable runs against walls, etc, where the prior approval of the Engineer has been obtained. These cross pieces are not acceptable in horizontal cable runs.

1.6.3 Plastic Cable Trays

Rigid PVC cable trays are acceptable. Only the following tray types may be used:

- a) Less than 250mm wide - 3.0mm minimum thickness and 40mm minimum return.
- b) 250mm and wider - 4.0mm minimum thickness and 60mm minimum return.

1.6.4 Finishes

Metal cable trays and ladders shall be finished as follows:

- a) In coastal areas - Hot-dip galvanised to SABS 763 or epoxy power coated
- b) False ceiling voids - Electro-galvanised or epoxy power coated
- c) Vertical building ducts - Hot-dip galvanised to SABS 763 or epoxy power coated
- d) Plant rooms, substations-coated - Service tunnels, basements electro galvanising or epoxy powder coated
- e) Damp areas, exposed - hot-dip galvanised to SABS 763 or epoxy powder coated to weather
- f) Undercover industrial - hot-dip galvanised to SABS 763 or epoxy powder coated

The abovementioned finishes shall apply unless specified to the contrary in the Detailed Technical Specification. Hot-dipped galvanised or electro-galvanised trays and ladders shall be cold galvanised at all joints, sections that have been cut and at places where the galvanising has been damaged. Powder coated trays and ladders shall likewise be touched up at joints, cuts and damaged portions.
### 1.6.5 Supports, Fixings and Joints

Trays shall be supported at the following maximum intervals:

- **a)** 1.6mm thick metal trays - 1.5m maximum spacing
- **b)** 2.4mm thick metal trays - 1.5m spacing and 75mm return
- **c)** Metal cable ladders - 1.5m spacing
- **d)** 3.0mm thick PVC trays, - 1.5m maximum spacing with 40mm return
- **e)** 4.0mm thick PVC trays, - 1.5m maximum spacing with 60mm return

In addition, trays and ladders shall be supported at each bend, offset and T-junction.

Joints shall be smooth without projections or rough edges that may damage the cables. The Sub-Contractor will be required to cover joints with rubber cement or other hardening rubberised or plastic compounds if in the opinion of the Engineer joints may damage cables. Joints shall as far as possible be arranged to fall on supports. Where joints do not coincide with supports, joints shall in the case of trays with single returns (items (a) and (c) of paragraph 1.6.2) be made by means of wrap-around splices of the same thickness as the tray and at least 450mm long.

The two cable tray ends shall butt tightly at the centre of the splice and the splice shall be bolted to each cable tray by means of at least 8 round head bolts, nuts and washers. Splices shall have the same finish as the rest of the tray. Where joints which do not coincide with supports occurring in trays with folded over returns, tight fitting metal guide pieces, at least 450mm long, shall be inserted in the folded returns to provide the necessary support to the two cable tray ends. Splices as described above shall be provided if trays sag.

Trays shall be bolted to supports by at least two hexagon headed bolts and nuts per support. Bolts shall be securely tightened to avoid cables being damaged during installation. The use of square nuts is not permitted.

The supports for cable trays and ladders shall in all cases be securely fixed to the structure by means of heavy duty, expansion type anchor bolts. It is the responsibility of the Sub-Contractor to ensure that adequate fixing is provided since cable trays and ladders that work loose shall be rectified at his expense.

Horizontal and vertical bends, T-junctions and cross connections shall be supplied by the Sub-Contractor. The dimensions of these connections shall correspond to the dimensions of the linear sections to which they are connected. The radius of all bends shall be 450mm minimum. The inside dimensions of
horizontal angles or connections shall be large enough to ensure that the allowable bending radius of the cables is not exceeded. Sharp angles shall have a 45° gusset.

All accessories shall be manufactured by the supplier of the ladder / tray, site fabricated accessories shall not be permitted unless prior written approval has been given by the Engineer.

### 1.6.6 Cables and Earthing Installation

Cables shall be installed adjacent and parallel to each other on the trays with spacings as determined by the current ratings. Horizontal trays and ladders shall in general be installed 450mm below slabs, ceilings, etc., to facilitate access during installation.

Metal trays and ladders shall be bonded to the earth bar of the switchboard to which the cables are connected. Additional bare copper stranded conductors or copper tape shall be bolted to the tray or ladder where the electrical continuity cannot be guaranteed.

### 1.7 Cable Channels

The Electrical sub-contractor shall supply and install all cable channels as specified or as required by the cable and wiring installation including the necessary supports, hangers, fixing materials, bends, angles, junction T-pieces end caps, etc.

Cable ducts shall be of the "Cabstrut" type or similar. The ducts shall be rolled from 1,2mm minimum sheet steel and shall be finished as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Area</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>In coastal areas (under all circumstances)</td>
<td>Hot-dipped galvanised to SANS 121 or epoxy powder coated</td>
</tr>
<tr>
<td>2</td>
<td>Cast in concrete</td>
<td>Pre-galvanised</td>
</tr>
<tr>
<td>3</td>
<td>False ceiling voids</td>
<td>Pre-galvanised</td>
</tr>
<tr>
<td>4</td>
<td>Vertical building ducts</td>
<td>Hot-dipped galvanised to SANS 121 or epoxy powder coated</td>
</tr>
<tr>
<td>5</td>
<td>Surface mounted in plant - rooms, sub-stations, service tunnels and basements</td>
<td>Epoxy powder coated or electro-galvanised</td>
</tr>
<tr>
<td>6</td>
<td>Damp areas, exposed to weather, underground</td>
<td>Hot-dipped galvanised to SANS 121 or epoxy powder coated</td>
</tr>
</tbody>
</table>
Undercover industrial applications

The abovementioned finishes shall apply unless specifically to the contrary in the Detailed Technical Specification. Epoxy powder coats shall comply with paragraph 1.16.9. Hot-dipped galvanised or electro-galvanised ducts shall be cold galvanised at all joints, sections that have been cut and at places where galvanising has been damaged. Powder coated ducts shall likewise be touched up at joints, cuts and damaged portions using spray canisters recommended by the manufacturers of the channels.

All channels shall have metal snap-in cover plates. Cover plates for wider channels shall be fixed by means of screws which shall permanently be tapped into the cover plates spaced at suitable intervals to prevent warping. The finish of the covers shall comply with paragraph 1.7.2

Adjoining lengths shall be correctly aligned and securely joined by means of fishplates and mushroom bolts, washers and nuts or connection pieces that are pop-riveted to both adjoining sections. All adjoining sections shall be rectangular and shall butt tightly. Covers shall fit tightly across the joint.

All conductors in inverted cable channels shall be retained by means of metal clips or metal spacer bars at not less than 1m centres.

All cable channels shall be vermin proof after installation. Holes shall be covered by means of screwed metal plugs or by means of metal strips that are bolted or pop-riveted to the channel. Wooden or other plugs which are driven into holes or other temporary plugs or covers are not acceptable.

Electrical and mechanical continuity shall be maintained throughout the channel installation. A tinned copper bonding strip shall be installed across each joint and secured to both adjoining channels by means of brass bolts, nuts and washers. The channel shall be bonded to the earth bar of the associated switchboard.

All bends shall be of easy sweep design with 45° gussets. Burrs and sharp edges shall be removed and the inside edges of all joints shall be lined with rubber cement or other suitable rubberised or plastic compound to prevent conductor insulation laceration.
Multiple duct runs or internal metal partitions shall be used where conductors for power, control and other services are present.

Where vertical duct lengths exceed 5m, conductors shall have intermediate fixings.

Channels shall be large enough to ensure that the combined total cross-sectional area (including insulation) of all conductors does not exceed 40% of the cross-sectional area of the channel.

The Sub-Contractor shall supply and install all hangers, supports or fixings for the channels. Channels up to 75 x 75mm shall be supported at maximum intervals of 1m and larger channels at maximum intervals of 2m. Channel runs shall be carefully planned to avoid clashes with other services and to ensure that all covers can be removed after completion of the entire installation. The method of fixing the channels or supports to the structure shall comply with paragraph 1.4 with particular reference to paragraphs 1.4.6 and 1.4.8. Purpose made cable clamps, hangers, etc. shall be used as required.

Where channels are cast into concrete, the reinforced type shall be used. Additional spacer blocks shall be used where necessary to prevent ducts from being bent while the concrete is cast. Channels shall be filled with polystyrene or other suitable fillers to prevent the ingress of cement and shall be securely fixed in position to the shuttering.

Where channels pass through walls, asbestos filling shall be installed around the conductors to serve as a fire barrier.

All conduit connections shall be terminated by means of two lock nuts and a brass female bush.

All holes with passing conductors shall be equipped with grommets.

1.8 Installation of Luminaires

The mounting positions of luminaires shall be verified on site. All luminaires shall be placed symmetrically with respect to ceiling panels, battens, beams, columns or other architectural features of the space. The layout as shown in the documents shall generally be adhered to but any discrepancies or clashes with structural or other features must be referred to the Engineer before commencing erection of the installation. Should the Sub-Contractor neglect to refer such discrepancies to the Engineer, costs incurred
as a result of subsequent alterations to suit the architectural features shall be to the Sub-Contractor's account.

Cover plates shall be fitted over all draw boxes and outlets for luminaires that are not covered by the luminaire canopy, lamp-holder, ceiling rose or similar accessories.

Luminaires (especially fluorescent luminaires) may also be suspended from ceilings by means of suspended metal channels. The channel may be supported by conduits or threaded rods.

Should metal rods be utilised, these shall be screwed to anchor bolts fixed in the roof slab.

Wiring shall either be installed in conduits fixed to the metal channel or in the metal channels. Purpose-made clamps shall be used to fix the fittings to the cable channel.

In all cases where luminaires are fixed to false ceilings, the Sub-Contractor shall ensure that the ceiling is capable of carrying the weight of the luminaires before commencing installation.

Should any doubt exist in this regard, the matter shall be referred to the Engineer.
In cases where the mass of the luminaire is not carried by the ceiling but by a support or other suspension method, provision shall be made to prevent relative movement between the ceiling and luminaire, ceiling rose or connection point.

Fluorescent luminaires to be installed directly against concrete slabs or walls shall be fixed to the outlet box and at two additional points. The additional fixing can be effected by:

a) bolts built into the ceiling or wall,

b) screws an approved plugs, or

c) anchor bolts.

Shot-fired fixings are not acceptable. If specified or where approved by the Engineer, fluorescent fittings may be fixed to metal channels installed against concrete slabs or walls. The metal channel fixing may in this case be short-fired or fixed by any of the abovementioned methods. Purpose-made clamps shall be used to fix fittings to cable channels.

When fixing fluorescent luminaires to false ceilings, a gap shall not be visible, except where the ceiling tile is of non-fire resistant material, between the fitting and the ceiling. The luminaire shall be fixed directly to the ceiling beams by means of 40mm round-head wood screws and washer or alternatively be fixed to 50 x 76mm wooden supports that are fixed to the ceiling beams. In the case of tiled ceilings with exposed or concealed T-section supports, the luminaires shall be fixed to the metal supports by means of butterfly screws, pop-rivets or bolts with nuts and washers. Self-tapping screws may not be used.

In cases where fluorescent luminaires are installed in tandem, only one connection outlet need be supplied per circuit. All luminaires shall be coupled to one another by means of nipples or brass bushes and lock nuts to ensure that wiring is not exposed and that earth continuity is maintained. Luminaires on the same circuit may be wired through the channel formed by the fitting canopies. In this case silicon-rubber insulated conductors shall be used and internal connections shall be made at terminal blocks.

Screw connectors are not acceptable. The wiring for any other circuits or outlets, even though these may be in the same row may not be installed through the fitting canopies. The Sub-Contractor shall ensure that continuous rows are straight and parallel to the relevant building lines.

Where recessed luminaires are required, the Sub-Contractor shall maintain close liaison with the Ceiling Contractor. In the case of tiled ceilings, the luminaires shall be installed while the metal supports are being
installed and before the tiles are placed in position. The Sub-Contractor shall be responsible for the co-
ordination of the cutting of ceiling tiles with the Main Contractor and the Ceiling Contractor concerned. All
mounting rings and other accessories shall fit closely into cut-outs to ensure a proper finish.

In cases where special ceilings e.g. aluminium strips, decorative glass, metal leaves, etc., are to be
installed, the Sub-Contractor and the manufacturer of the ceiling shall agree upon the method of fixing of
luminaires to the ceiling.

Waterproof and flameproof luminaires shall be screwed directly to the conduit end. Draw boxes that may
be required must be approved by the Engineer beforehand.

Surface mounted bulkhead luminaires shall not be screwed directly to conduit ends. The conduit shall
terminate in a round draw box at the top or back of the fitting. The PVC-insulated conductors shall
terminate in a porcelain terminal strip in the draw box. Asbestos or silicon-rubber insulated conductors
shall be used from the terminal strip to the luminaire lamp-holder. Porcelain-screw connectors will also be
allowed.

1.9 Installation of Light Switches

All light switches shall be installed 1400mm above the finished floor level unless specified to the contrary.
Mounting heights given shall be measured from the finished floor level to the centre of the switch.

Unless specified to the contrary, switches adjacent to doors shall be installed on the side containing the
lock. If the position of the lock is not shown on the drawings, the position shall be verified before the switch
box is installed. Switch boxes in brick or concrete walls, shall be installed 150mm from the door frame.
Light switches installed in partitions or door frames shall be of the type designed for that purpose.

Where the lower portion of a wall is face brick and the upper portion plastered, light switches shall be
installed wholly in the plaster, provided that the lower edge of the plaster is not higher than 1600mm above
the finished floor level. In general where different wall finishes are used in the same area, switches shall
be installed within the same finish and not on the dividing lines between finishes.

Switches shall be installed in standard rustproof (galvanised) pressed steel switch boxes with the
necessary knock-outs for the proper termination of conduits. The installation of switch boxes shall comply
with the requirements of paragraph 1.5 of this specification. Boxes shall be flush mounted or recessed as specified for the whole installation.

Cover plates which overlap the switchbox and which fit tightly against the wall finishes shall be installed in the case of flush mounted switch-boxes. All fixing screws in cover plates and switch grids shall be supplied and securely fitted.

Where flush mounted switches are installed in special wall finishes, e.g. wood or board panels, acoustic tiles or other cladding, etc., and where the wall finishes have to be cut to accommodate the switch, it may be necessary to fix an escutcheon plate to the wall to cover the cut-outs. The escutcheon plate shall fit closely around the switch box and shall be fixed independently of the switch box and cover plate. Bevelled cover plates that overlap the switch boxes shall be used. Cover plates shall be fixed to the switch boxes and shall fit firmly against the escutcheon plate.

Surface mounted switches shall consist of a metal switch-box, cover plate and switch specially manufactured for the purpose. Switch boxes shall be fixed to the surface as described in paragraph 1.4 of this specification.

Cover plates shall under no circumstances be cut unless specifically authorised in exceptional cases by the Engineer.

Light switches installed in partitions shall preferably be of the type designed for this purpose to be accommodated in the partition design. Switches installed in the metal support do not require switch boxes. Switches may not be flush mounted in partition walls without switch boxes.

Switches that are exposed to the atmosphere or are installed in damp areas shall be of the waterproof type.

The sides of adjacent switches, plugs, push-buttons, etc., shall be parallel or perpendicular to each other and uniformly spaced. A common escutcheon plate shall be used for flush mounted outlets and accessories where the cover plates do not cover the cut-outs in the finishes.
1.10 Installation of Socket Outlets

Unless otherwise specified outlets shall be installed at the following heights above finished floor level:

- Flush mounted socket outlets in general: 300mm
- Surface mounted socket outlets in general: 1200mm
- Kitchens and prep area, surface or flush mounted: 1400mm
- Offices - surface or flush mounted: 300mm

All mounting heights shall be measured from finished floor level to the centre of the outlet box. Socket outlet boxes shall comply with paragraph 1.9.4.

1.11 Provision for Telephone Installation

This specification covers only the supply and installation of outlet points and wiring channels and/or conduits for telephones in buildings. The telephone installation will be carried out by Telkom personnel or Specialist Contractor.

All provisions for telephones in buildings shall comply with the latest issue of "FACILITIES FOR TELECOMMUNICATION SERVICES IN BUILDINGS" as issued by Telkom. In cases where the provision of this publication and the requirements of the Detail Technical Specification are in conflict, the latter shall take precedence.

The size and position of the Main Telephone Distribution Board where required, shall be installed according to the requirements of the Detailed Technical Specification.

The board shall consist of a metal tray, architrave frame and hinged doors and shall be flush mounted in the position shown on the drawings.

A 20mm thick wooden panel shall be installed in the main telephone distribution board and shall cover the entire back of the board.

The finish of the board shall comply with the requirements of paragraph 1.16.9.
All conduits to telephone outlets or sub-distribution boards in the building as well as the main incoming sleeves shall terminate at the main distribution board as indicated on the drawing.

Where 100 x 100 x 50mm draw boxes are specified, the boxes shall be provided with a cover plate. A wooden panel need not be provided in these cases.

The Sub-Contractor shall make provision for outlets with blank cover plates only.

Telephone outlets in walls shall consist of flush mounted 100 x 50 x 50mm draw boxes with blank cover plates.

Telephone outlets in floors shall be of the same type as floor outlets for power sockets which may be specified in the Detailed Technical Specification.

These provisions also apply to underfloor ducting. If no floor outlets are specified, 100 x 100 x 50mm flush mounted draw boxes with blank cover plates shall be provided in the floor at the positions indicated on the drawings.

Where power skirting is specified for telephone installations, the Sub-Contractor need only install the skirting with covers since the telephone socket outlet will be fixed directly to the cover.

Where multiple power skirting is provided containing other services, no other cables may be installed in the section intended for telephone cables and the separation between the sections shall be maintained throughout the installation.

Telephone outlets shall be inter-connected and connected to the telephone distribution boards as shown on the drawings.

If the inter-connecting conduits are not specified, conduit sizes shall be 25mm diameter for a maximum of 10 outlets and 32mm diameter for 11 to a maximum of 20 outlets.

Metal channels or power skirting installed on the same floor level on opposite walls of the same area as well as parallel runs of underfloor ducting intended for the installation of telephone cables, shall be inter-connected at intervals of 8 metres. Conduits may be used for these inter-connections.
All conduit and all ducts or channels which do not have removable covers, shall be provided with galvanised steel draw wires.

Conduit connections to power skirting, or surface mounted metal channels, shall be made by means of a 100 x 100 x 50mm draw box which is flush mounted immediately behind the duct or channel in which the telephone cables are to be installed. A hole shall be cut in the back of the duct or channel, immediately opposite the draw box. The edges of the hole shall be grommeted. The draw box shall be accessible from the front when the cover is removed.

Purpose-made accessories for the connection of conduits to underfloor ducts shall be used. Where these are not available a 100 x 100 x 50mm draw box shall be installed below the underfloor duct opposite a floor telephone outlet. A hole shall be cut in the back of the duct opposite the draw box. The draw box shall be accessible from the top via the floor outlet.

1.12 Cabling

Unless otherwise specified, the following cable tyres shall be used:

a) **High voltage supplies (6.6/11k/V):**
   PILCDSTA or XLPE.

b) **Low voltage supplies in ground:**
   PVC-insulated, armoured.

c) **Low voltage supplies in substations and to main switchboards:**
   PVC-insulated, armoured.

d) **Supplies to sub-distribution boards:**
   PVC-insulated, armoured or unarmoured when installed in conduit, sleeves or metal channels.

e) **Connections to equipment:**
   PVC-insulated, armoured, or without armouring when installed in conduit or metal channels.

It is a definite requirement that the Sub-Contractor shall only instruct competent personnel to install and connect the various cable types.

All cables used shall conform to the relevant SABS or BS specifications and shall be installed, protected and terminated according to approved methods in compliance with the manufacturer's requirements.
Cables with conductors smaller than 1.5mm² may not be used except for communication systems or control systems with a system voltage of less than 50V. Where cables are grouped together (in cable channels, pipe, etc) the minimum conductor size shall be 2.5mm² or greater as determined from the appropriate sections of the SABS Code of Practice.

All unarmoured cables shall be installed in metal wiring channels or conduit unless another method has been approved by the Engineer.

All cables shall be suitable for the voltage to be applied between phases and between each phase and earth.

All cables to be used in systems with a system voltage between 50V and 600V shall have a voltage rating or 600/1000V.

All 6.6/11kV cables shall be factory-tested according to SANS 6284 parts 1 to 5 and all 600/1000V cables to SANS 60227. Test certificates shall be handed to the Engineer.

The same group derating and ambient temperature correction factors stated in the SABS Code of Practice for PVC cables shall be applicable.

Cable ends shall be terminated strictly in accordance with manufacturer's specification to prevent tracking and contamination. The termination shall withstand the same test voltage as the rest of the cable.

Cable cores shall be marked with colour tape to identify the phase colour.

1.12.1 Low Voltage PVC Insulated Cables

All low voltage cables shall be manufactured according to SANS 60227 and shall bear the SABS mark.

The voltage gradient of the PVC dielectric shall be for 600/1000 Volts and for general purpose use unless otherwise stated.

All low voltage PVC insulated cables shall have stranded copper annealed conductors unless otherwise called for.
### 1.12.2 Underground Cables

The storage, transport, handling and installation of underground cables shall be executed according to approved methods and the Sub-Contractor shall ensure that suitable labour and equipment is available. Only armoured cables may be installed along underground cable routes.

Unless specified to the contrary, low voltage cables shall be installed at a depth of 600mm and high voltage cables installed at a depth of 1000mm below ground level. Where cables are installed in layers the uppermost layer shall comply with the above and each additional layer shall be at least 300mm lower.

The Sub-Contractor shall be responsible for all trenching unless specified to the contrary and shall take all necessary precautions and provide the necessary warning signs and/or lights to ensure that the public and/or employees on site are not endangered.

The Sub-Contractor shall ensure that the trenches will not endanger existing structures, road, railways or other property.

The Sub-Contractor shall verify the existence of all other services and ensure that they are not damaged during trenching operations.

Trenches between the points indicated shall be straight. Any deviations due to obstructions or existing services shall be approved by the Engineer.

Cable trenches shall not be less than 200mm wide at the lowest point where one or two cables are to be installed and the width shall be increased where more cables are to be installed so that cables can be installed at least one cable diameter apart throughout the run.

Unless specified to the contrary, dimensions of trenches will be as follows:

a) **High Voltage Cable trenches**

   - Width: 450mm
   - Depth: 1000mm
b) **Low Voltage Cable trenches (Main / Feeder cables)**
   - Width: 450mm
   - Depth: 600mm

c) **Low Voltage Cable trenches (Service & Streetlight cable)**
   - Width: 300mm
   - Depth: 600mm

d) **Telkom Cable/sleeve trenches**
   - Width: 300mm
   - Depth: 600mm

Cables shall be bedded in river sand or sifted soil (not clay). The bed shall extend 75mm below and 100mm above the cable. Under no circumstances may stone bigger than 50mm mesh be allowed to come into contact with the cables.

Cables installed in the same trench shall be laid parallel to each other at least one cable diameter apart. The cable shall be removed from the drum in such a manner that no twisting, tension or mechanical damage is caused and must be adequately supported at short intervals during the whole installation operation. Cable rollers shall be used as far as possible. Where cables have to be drawn through pipes or ducts, a suitable cable sock shall be used and particular care shall be exercised to avoid abrasion, elongation or distortion of any kind. Ends of all pipes and ducts shall be sealed with a non-hardening watertight compound.

Trenches may not be refilled before the Engineer has inspected the cable and trenches. Should the Sub-Contractor ignore this requirement, trenches may be re-opened at the cost of the Sub-Contractor should the Engineer wish to carry out an inspection.

Backfilling shall be of earth of a proper grading to ensure settling without voids. The earth shall be tamped down after the addition of every 150mm layer. The surface shall be made good to match the surrounding surface area.

Where cables cross roads, railways or other service areas and where cables enter buildings, the cables shall be installed in asbestos cement, pitch fibre, hard walled PVC or earthenware pipes.

Where pipes have to be built into the structure, the Sub-Contractor shall issue the pipes to the Main Contractor and ensure that they are installed correctly.
The ends of all pipes shall be sealed with a non-hardening watertight compound after the installation of cables. All pipes intended for future use shall be sealed.

1.12.3 Cables in Building Trenches

Cables installed in floor trenches in buildings or substations shall comply with the requirements of paragraph 1.13.8.

Cables shall be installed in one of the following ways:

a) Laid on the floor of the trench providing that cables are separated by a distance at least equal to the diameter of the largest cable installed.

b) On vertical cable trays or metal supports fixed to the side of the trench. Cables shall be suitable clamped in position.

All floor trenches shall be covered with suitable reinforced chequer plates and shall be supplied and installed by the Main Contractor unless specified to the contrary.

Floor trenches may have to be filled with sand in certain instances. The trench shall then be filled with sand and covered in one of the following ways:

a) Reinforced concrete planks or tiles
b) A screed of sand and cement
c) Cast iron frames filled with concrete in cases where motor car traffic is present, e.g. parking garages.
d) Removable chequered cover plates.

Cables shall leave filled cable trenches via a pipe which protrudes at least 300mm beyond the cover. These pipes shall be firmly fixed in position and sealed with a non-corroding non-hardening watertight compound.
1.12.4 Fixing of Cables

All cables shall be spaced to comply with the correction factors which are applicable to the current rating in accordance with the SABS Code of Practice for the Wiring of Premises. All cables shall be spaced apart unless specifically approved by the Engineer.

Cables for telephones, communication systems and other extra low voltage systems (less than 50V) shall be separated from power cables. In vertical building ducts a physical barrier shall be provided between power cables and cables for other services.

Where armoured cables are used for such other services, they shall be installed in separate cable trays or shall otherwise be at least 1m away from power cables. Where unarmoured cables are used for these other services, they shall be installed in separate conduits or metal channels.

Cables may be installed in one of the following ways:

a) On horizontal cable trays,
b) against vertical cable trays with suitable clamps,
c) against horizontal or vertical metal supports or brackets with suitable clamps, or,
d) on clamps which are fixed to the structure.

The maximum spacing between cleats (clamps) to which cables are fixed in horizontal and vertical cable routes shall be determined from the table below. Additional cleats shall be installed at each bend or offset in the cable run.

The maximum distance between supports or cleats for multi-core cables shall be 20 times the outside diameter of the cable with a maximum spacing of 550mm for unarmoured cables and 30 times the outside diameter of the cable with a maximum spacing of 900mm for armoured cables.

Where cables penetrate floors, walls or other structural elements, suitable sleeves of asbestos cement, earthenware, steel or pitch fibre shall be provided. Both ends of the sleeves shall be sealed with a non-corrosive, watertight, non-hardening compound.

Unless clearly specified to the contrary, earth continuity conductors shall be installed with all cables that form part of the low voltage distribution system.
The earth continuity conductor shall consist of one of the following:

a) A bare stranded copper conductor
b) One of the cable cores. In this case a green heat-shrunk sleeve shall be placed over the conductor end to clearly identify the core that is being used as earth conductor
c) Copper wire strands that form part of the armouring. In this case a special gland designed for this purpose shall be used.

The cross-sectional area of the earth conductor shall be as determined from the SABS Code of Practice but shall not be less than 2.5mm². A single conductor may be used where parallel cables supply the same load.

A single conductor may be installed serving several underground cable routes. Where branch circuits occur, an earth conductor shall be bolted and brazed to the main earth conductor.

The earth conductor shall be connected to the earth busbar of the switchboards to which the associated cables are connected. The earth conductor shall also be bonded to the cable armouring and lead sheath (if appropriate) at both ends and at all joints.

All cables shall be identified at both ends and at all joints and as otherwise specified according to a code or number system. These numbers shall appear on the as-built drawings.

Cables shall be marked with non-deteriorating bands with raised or punched numbers. PVC tape with punched numbers is not acceptable for this purpose.

All conductors shall be installed in conduits, cable channels (trunking) or power skirting and shall under no circumstances be exposed. Cable channels and power skirting shall be of metal construction unless specifically approved otherwise.

Wiring shall only be carried out after the conduit installation and plaster work is completed, but before painting has commenced. No conductors shall be installed before the conduits have been cleaned of all debris and moisture.
1.12.5 Conductors

Conductors that are connected to different switchboards shall not be installed in the same conduit. The wiring of one circuit only will be allowed in 20mm diameter conduit with the exception of the wiring between switchboards and fabricated sheet metal boxes close to switchboards, in which case more than one circuit will be allowed.

**Note:** No conductor jointing will be accepted.

All wiring shall be carried out according to the loop-in system. If a conductor joint is found necessary in an isolated case, jointing will only be accepted in cable channels and not in conduits. Conductor jointing shall be executed by approved ferruling properly covered with PVC-insulated tape.

In cases where the conductors of more than one circuit are installed in conduit, cable channels or power skirting, the conductors of each separate circuit (earth conductor inclusive) shall be taped at intervals of one metre with PVC-insulation tape. The conductors of different circuits shall however remain separate in order that any given circuit can be withdrawn.

Conductors entering switchboards or control boards shall be grouped and bound by means of plastic or metal bands (not tape).

With the exception of three phase outlets, circuits of different phases shall not be present at lighting, switch or socket outlet boxes.

The insulation of conductors shall only be removed over a portion of the conductors that enter the terminals of switches, plugs or other equipment. When more than one conductor enters a terminal, the strands shall be securely twisted together.

When earth continuity conductors are looped between terminals of equipment, the looped conductor ends shall be twisted together and then be soldered or ferruled to ensure that earth continuity is maintained when the conductors are removed from a terminal.

The colours of conductor insulation for wiring purposes shall comply with the SANS 10142-1- Code of Practice. The colours for sub-circuits shall as far as possible correspond with the colour of the supply
phase. The colours of conductors for wiring to two-way and intermediate switches shall differ from phase conductors.

Single pole switches shall be connected to the phase conductor and not to the neutral conductor.

Where conductor sizes are not specified, the following minimum conductor sizes shall be used:

- **Lighting circuits**: 1,5mm² + 1,5mm² earth conductor
- **Plugs circuits**: 2,5mm² + 2,5mm² earth conductor
- **Stove circuits**: 10mm² + 6mm² earth conductor
- **Geyser circuits (up to 3kW)**: 2,5mm² + 2,5mm² earth conductor
- **Geyser circuits (+3 to 6kW)**: 4,0mm² + 2,5mm² earth conductor
- **Motor circuits**: 2,5mm² (minimum)
- **Bell circuits**: 1,5mm²

When wiring is installed in removable partitions, the vertical and/or horizontal metal supports of the walls may be utilised for wiring on condition that:

i) the conductors are not exposed,
ii) the metal supports are properly earthed,
iii) a separate earth continuity conductor is drawn in together with the current carrying conductors and is earthed to the metal parts of the switches and/or the plugs, and
iv) conductors are installed in the metal and non-inflammable sections of the partitions.

Conductors enclosed in a copper braid are especially suited to the wiring of partitions where the copper braid is used as an earth continuity conductor. Copper braided cables shall be connected to the rest of the installation at a draw box.

### 1.13 Earthing

#### 1.13.1 Substations

The main earthing system shall be installed by specialist under a separate contract.
The Sub-Contractor shall be responsible for all earthing from the point of entry of the main earthing tails where they enter the building.

**1.13.2 Earthing of the Installation**

The installation shall be earthed properly in accordance with the SABS Code of Practice for the Wiring of Premises and with the by-laws of the Local Authority. All earth conductors shall be bare stranded copper conductors or stranded conductors with green PVC-insulation.

**1.13.3 Earth Busbar**

The main substation earth bar or, where no separate substations earth is provided, the earth busbar of the main switchboard, shall be connected to the earthing electrode by means of two lengths of solid copper strapping or two stranded conductors, each with the following cross-sectional area:

<table>
<thead>
<tr>
<th>Total installed capacity in kVA</th>
<th>Cross-sectional area in mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 50</td>
<td>50</td>
</tr>
<tr>
<td>50 – 100</td>
<td>100</td>
</tr>
<tr>
<td>100 – 150</td>
<td>150</td>
</tr>
<tr>
<td>More than 150</td>
<td>240</td>
</tr>
</tbody>
</table>

The two copper straps or conductors shall be connected at opposite ends of the main distribution board earth bar or, in the case of a separate sub-station earth, shall be connected midway between the centre and either end of the earth bar.

The connections to the earth electrodes shall be soldered and bolted.

The earth of the Local Authority's supply shall also be connected to the earth busbar. Where the abovementioned connections are mounted on the outside of buildings, the connections shall be installed in galvanised conduit run 300mm under ground level.
1.13.4 **Sub-Distribution Boards**

A separate earth connection, consisting of bare stranded copper conductors and supplied along the same routes as the supply cables, shall be supplied between the earth busbar in each sub-distribution board and the earth busbar in the main switchboard.

If the supply connections consist of conductors in conduit, the earth conductors shall be drawn in the same conduit. The sizes of earth conductors shall be in accordance with the SABS Code of Practice for the Wiring of Premises.

1.13.5 **Sub-Circuits**

The earth conductors of all sub-circuits shall be connected to the earth busbar of the supply board. All single phase socket outlet circuits shall be supplied with 2,5mm² earth conductors. All lighting circuits shall be supplied with 2,5mm² earth conductors.

All single phase and three phase outlets, electrical appliances, equipment, electrical motors, etc, shall be earthed as stipulated in the SABS Code of Practice for the Wiring of Premises. The requirement specified in paragraph 1.13.20 shall be strictly adhered to.

1.13.6 **Ring Mains**

Common earth conductors may be used where various circuits are installed in the same wiring channel. In such instances, the sizes of earth conductors shall be determined in collaboration with 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.

1.13.7 **Connections**

Under no circumstances shall any connection points, bolts, screws, etc used for earthing be utilised for any other purpose. It will be the responsibility of the Sub-Contractor to supply earth terminals or clamps where these are not provided by others. The ends of all bare earth conductors shall be tinned. All earth connections shall be tinned and fixed with approved ferrules. The entire connection shall then be soldered.
1.13.8 Power Skirting

All power skirting to accommodate socket outlets shall be earthed with a 2,5mm² earth conductor. This conductor shall be installed over the entire length of the power skirting and connected to the earth busbar in the nearest switchboard. The conductor shall be bolted to the skirting on both sides. The conductor may not be used as an earth conductor for the plug circuits and shall be independent of any other earth conductor.

1.13.9 Wiring Channels and Cable Racks

The ends of all metal channels and racks containing cables or conductors under load shall be earthed to the nearest switchboard with copper strapping or 2,5mm² stranded conductors. Adjoining rack sections shall be connected at joints with copper strapping or 2,5mm² conductors, unless the Engineer specifies that the method of joining the racks is sufficient for earth continuity. In cases where metal channels or racks are installed less than 2,0m above floor level, those shall be earthed by the same method as for power skirting.

1.13.10 Conduit

All metal conduits shall terminate in switchboards or junction boxes as specified in section 1.5. Where this cannot be done the conduit end shall be earthed separately with a 2,5mm² bare copper stranded conductor.

1.13.11 Plastic Conduit

Where plastic conduit is installed, stranded copper earth conductors shall be installed in the conduits and fixed securely to all metal appliances and equipment, including switchboxes, plug boxes, draw boxes, switchboards, luminaires, etc.

1.13.12 Flexible Conduit

An external earth conductor shall be installed together with all non-metal flexible conduit. The earth conductor shall be connected securely to the metal parts on both ends.
1.13.13 Water Pipes at hot water Cylinders

Cold and hot water pipes within 1 metre from the geyser shall be bonded with solid or perforated 12 x 1.8mm copper strapping and earthed via a 10mm² BCEW.
1.14 Connections

1.14.1 Connections to Luminaires

Connections to the wiring of luminaires and other appliances, where connectors are used, shall be effected by means of brass screw couplers shrouded in porcelain, neoprene or PVC, or by means of porcelain or PVC screw connectors.

Where knock-outs are used for the wiring of luminaires and other appliances, brass bushes or gripper glands shall be used.

In luminaires capable of housing incandescent lamps above 60 watts, the wiring from the lamp-holder to the general wiring shall be varnished cambric insulated, roved and braided asbestos or heat resisting silicon compound insulated conductors.

Connections to luminaires with incandescent lamps shall be installed in a box situated behind the luminaire or ceiling rose.

Connections to luminaires with fluorescent lamps may be installed inside the metal canopy on condition that the frame and/or diffuser holder where applicable can be removed without disconnecting the conductors.

The central terminal of Edison Screw (E.S.) lamp-holders shall be connected to the phase conductor (i.e. conductor with red insulation) and the screwed housing to the neutral conductor (i.e. conductor with black insulation).

1.14.2 Stove Connections

The connections to each stove, unless specified to the contrary, shall consist of 2 x 10mm² insulated conductors and a 6mm² copper earth conductor in 1 x 25mm conduit.

A 60A D.P. micro gap isolator shall be flush mounted in a wall outlet box adjacent to the stove at 1400mm above the finished floor level to the centre of the box. The cover plate shall either fall entirely within the tiled surface or entirely within the plastered surface. A white baked enamel cover plate shall be installed unless specified to the contrary.
The conduit from the isolator shall terminate behind the stove with the end set out of the wall pointing downwards (height will be indicated).

The connection from the conduit end to the stove shall be by means of flexible conduit of sufficient length to enable the stove to be moved 600mm from its normal position for cleaning or maintenance purposes.

Crimped lugs shall be provided on all conductors or cable cores for connections to stoves. Soldered lugs may not be used.

### 1.14.3 Connections to Hot Water Cylinders

Hot water cylinders (geysers) will be supplied and installed by others unless specified to the contrary. The Sub-Contractor shall however provide the electrical supply and make the connection to the cylinders.

The connection to each hot water cylinder shall consist of:

- **a)** Capacity 3kW and less: 2 x 2.5mm² conductors and 1 x 2.5mm² earth conductor
- **b)** Capacity 4kW - 6kW: 2 x 4mm² conductors and 1 x 2.5mm² earth conductor

Conductor sizes for larger hot water cylinders shall be determined in accordance with the SABS Code of Practice for the Wiring of Premises with a safety factor of 15%.

The conduit from the switchboard shall terminate in a flush round draw box near the terminals of the hot water cylinder. The connection between the draw box and terminal box of the hot water cylinder shall consist of screwed conduit which is connected to the cylinder by means of a coupling and brass male bush or a locknut and brass bushnut.

Only in instances where hot water cylinders are mounted out of normal reach, e.g. in high roof areas high above the walkways or in inaccessible built-in cupboards, may the connection be made by means of flexible conduits. In these instances, a round draw box with dome lid shall be provided for the connection.

Each hot water cylinder shall be served by a separate circuit and shall have a separate earth conductor. Circuit protection shall consist of a double pole circuit breaker.

All water heaters shall be provided with local means of insolation.
1.14.4 Connections to Motors

Connections to motors or other vibrating equipment may be made as follows:

a) Metal reinforced plastic or PVC covered metal flexible conduits shall be used with individual conductors or a multi-core PVC-insulated cable and separate bare earth conductor installed inside the conduit. The flexible conduit shall not be longer than 600mm. Screwed conduit shall be used from the end of the flexible conduit to the isolator and/or starter.

b) In the case of high voltage motors armoured XLPE or PILCA cables of the correct voltage rating shall be used and shall be terminated as described in this specification.

An isolator and/or starter shall be mounted within 2m of the motor. Unless specified to the contrary, the starter will be supplied by others but the Sub-Contractor shall install and provide the connection to the motor and starter.

Supply cables may not be installed across floors which are for general use. All cables and/or flexible conduits shall terminate in suitable glands and shall have sufficient slack to allow positioning of the motor, especially where slide rails have been provided.

1.15 Switchboards and Distribution Boards

1.15.1 Design and Construction of Free Standing Switchboards

Switchboards shall be factory built assemblies of switchgear and control gear (FBAs) of the multi-cubicle type and shall comply with IEC 439.

Switchboards shall be floor mounted with exterior panelling including doors and covers presenting a flush and uniform appearance. A channel section base-frame shall be provided.

a) Switchboard operation on cable access shall be as follows:

1. front operation with rear cable access
2. front operation with front cable access
3. back to back switchboards with front and rear operation and cable access
4. cable entry from above and below
b) Compartments shall be provided for:
   1. main busbars
   2. auxiliary busbars, if applicable
   3. cabling
   4. incoming and outgoing functional units
c) Segregation in the base-frame shall be provided to correspond with divisions in the switchboard sections when cable entry is from below. Access for sealing the cable slot with vermiculite cement shall be provided from the front or rear of the section to:
   1. reduce the danger of fire spreading
   2. prevent vermin entering. The base-frame shall be sealed with a cover plate when cable entry is from above.
d) Increase in depth of certain sections of switchboards for high current ratings shall be subject to the Engineer's approval.
e) Switchboards shall be designed to confine internal arcing faults and to direct arcs and gases arising from these away from the operator.

The arrangement of functional units and spacing between them shall be such that forced cooling is not necessary.
f) Conductors passing through holes in compartments shall be protected by means of neoprene grommets. Bevelling of sheet steel will not be accepted as a substitute.
g) Measures shall be taken to prevent electrolytic corrosion where dissimilar metals are in contact with each other.
h) Bolts shall be of the correct size for the holes provided and shall be fitted with matching sizes of washers and lock washers. Where removable covers are provided with bolt fastening, the nuts shall be either welded in position or securely fixed by means of a mechanical fixing device. Self-tapping screws, captive head nuts or cage nuts are not acceptable.
i) Switchboards shall be designed to permit the addition of identical sections.

Functional units other than fuse switches within their own enclosures shall be located in their own compartments, separated from each other and the busbars. Barriers shall be provided to prevent accidental contact with live conducting parts of the circuit and to protect the unit from falling objects.

Fused switches, moulded case circuit breakers, etc., within their own enclosures, shall be barrier protected from falling objects and accidental contact with live conducting parts of the circuit and adjacent switches.
Barriers shall be robust with high impact strength and made of material which is self-extinguishing or resistant to flame propagation.

Each functional unit compartment and cable compartment shall be provided with individual hinged doors for easy access except where flush mounted equipment prevents this. Power and control busbar compartments shall be provided with removable covers requiring the use of a tool for their removal.

Doors shall have adequate points of hinging and latching and shall be reinforced to prevent distortion when open. Non-ferrous fasteners shall be of the type detailed in Part 2 with four keys being supplied per switchboard. A release mechanism shall be provided on the cable compartment door hinges to allow the doors to be removed.

All removable doors and covers shall be identified to enable replacement in the correct position.

Doors shall have stops to prevent over swing of the door when opening and to avoid interference with adjacent compartments. Dust-proof seals shall be provided on all doors.

When cables enter a switchboard from below, a cable gland plate shall be provided at a minimum height of 300mm above the point of entry. In case of cables entering from above, the cable gland plate shall be mounted at the point of entry.

The gland plate shall be removable and shall be supported to prevent movement of the cables.

When cables enter a switchboard from below, adequate access shall be provided beneath the gland plate to ensure that once the cables have been installed, the floor slot can be sealed from above using vermiculite cement. The arrangement shall be such that once this slot is sealed level with the floor, each base frame sub-section shall be sealed from the adjacent base frame sub-section.

When cables enter from above, the gland plates shall effectively seal the switchboard opening.

The switchboards shall be designed and manufactured to the degree of protection specified in Part 2 in accordance with IEC 144.
The minimum degree of protection shall apply when all functional units are connected. In the test, disconnected and removed positions, adequate protection shall be provided against contact with live parts.

Busbars shall be made of hard drawn copper of suitable dimensions and in accordance with IEC 439 with regard to temperature rise at the specified altitude and mechanical strength for the rated fault conditions. The neutral busbar shall have a current carrying capacity of half that of the phase busbar unless otherwise specified.

Busbars shall be contained within their own compartment. Duplicate busbars shall have individual compartments to provide access for maintenance to either set of busbars with the other set energised.

Small leads connected directly to the busbars, shall be provided with a 20 amp HBC fuse mounted at the busbar.

Conductors between the busbars and the supply side of a single functional unit shall be rated for the same fault level as the busbars. Where the conductors to the components included in the unit are phase segregated, braced and substantially fault free, they shall be capable of withstanding the let-through current of the protection device in the unit.

Busbars and connections shall be air insulated and shall be taped and/or shrouded on all sections where accidental contact is possible. Insulating materials shall be resistant to flame propagation, non-hygroscopic and resistant to tracking.

Joints and tees in busbar connections shall be made with sherardised bolts, nuts and washers of not less than 12mm diameter. High tensile (black) bolts of not less than 10mm diameter and having a reference symbol ‘R’ for the tensile range in accordance with BS 970 will be accepted as an alternative.

Joints shall be made with at least two bolts and the overlap shall be sufficient to ensure ample mechanical strength and joint conductivity. Unless otherwise approved, the overlap shall not be less than six times the thickness or shall equal the width of the busbar material, whichever is the greater.

AC or DC busbars and functional unit conductors and connections shall be clearly marked to indicate the supply phase or pole they are connected to. The phases shall be coloured red, white and blue, with the neutral colour black and the protective conductor (earth bar) green and yellow. DC busbars shall be coloured red for positive and black for negative.
A separate copper protective conductor to which all metal parts are connected shall be installed in the inside rear of each switchboard along the entire length. The bar shall be in an accessible position to allow for the earthing of cables.

The protective conductor shall have a current carrying capacity sufficient to withstand the earth fault current that may occur in the switchboard. The cross-section shall be calculated with the aid of the formula in Appendix B of IEC 439 but shall not be less than 200mm².

The neutral busbar shall be connected to the protective conductor by means of a removable bolted link on the cable side of each incoming functional unit. The link shall be easily accessible from the front of the switchboard for removal and testing.

Non-current carrying parts, including relays, metres, etc, shall be effectively connected to the protective conductor by means of their mounting arrangement on the panel or by a separate earthing conductor connected to the protective conductor. This shall include the earth terminals provided on equipment.

All parts of the protective circuit within the switchboard shall be designed to withstand the highest thermal and dynamic stresses that may occur.

1.15.2 Construction of Flush Mounted Switchboard

Bonding trays for flush mounted switchboards shall be of rigidly constructed 1.6mm thick galvanised steel, braced and reinforced. Formed gussets shall be provided at the corners. All the tray joints shall be properly welded or securely bolted with a brass or cadmium plated steel earth connecting stud and nut.

Where switchboards are to be built into 116mm thick walls, expanded metal shall be spot welded to the rear of the bonding trays. The expanded metal shall protrude at least 150mm on each side to prevent plaster from cracking.

Ample 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 allowed for any size of specified conduit. Provision shall however be made for termination of at least 2 x 25mm diameter conduits at top and 2 x 25mm diameter conduits at the bottom of each tray.
The architrave frame shall be of 2.0mm thick sheet steel with bevelled edges. The architrave frame shall accommodate the chassis, panels and doors. The architrave shall overlap the bonding tray by at least 25mm on each side. The architrave frame shall be fixed to the tray in such a fashion to allow for depth adjustment and irregularities of the wall.

Semi-flush mounted switchboards shall be equipped with extension frames. Generally the frame depths shall be 50mm but may be altered to suit each application.

The chassis for mounting of switchgear and equipment shall be of rigid construction and shall be fixed securely to the architrave frame or bonding tray by means of bolts screwed into tapped holes or bolts and nuts. Self-tapping screws are not acceptable. The chassis position shall be adjustable in the horizontal plane.

A suitably stiffened panel manufactured of 2.0mm thick sheet steel shall be installed in the architrave frame for flush mounting of switchgear. The panels shall have machined punched slots for housing the specified and future switchgear, instruments, fuse holders, isolating switches, indicator lamps, etc. In exceptional cases contractors will be allowed to protrude through the panel. Blanking plates shall be provided in positions where future switchgear will be installed. The distance between the inside of the closed doors and the panels shall be not less than 40mm. No equipment may be mounted on the panel (faceplate) unless it is permanently hinged to the switchboard frame.

The panel for each switchboard shall be secured to the architrave frame by means of captive fasteners such as "DZUS" or "CAMLOC". 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 or dome nuts will not be allowed. Where it is required that equipment be mounted on the panel, the panel shall be securely hinged to the switchboard frame.

Two chromium plated handles shall be provided on each front cover. The handles shall be mounted at the top and bottom of each panel. Handles can be omitted if "DZUS" or "CAMLOC" fasteners are used.

Where hinged panels are specified, the hinges shall be fixed to the architrave frame and the panel shall be secured by means of studs and hexagonal chromium plated nuts or by means of a suitable lock or latch which can be operated with a screwdriver. The panel shall be removable when it is in the open position.
1.15.3 Construction of Surface Mounted Switchboards

Surface mounted switchboards shall be equipped with a 1.6mm sheet steel reinforced tray. Securing lugs shall be provided to fix the tray to walls or any other structure. A solid brass or cadmium plated steel earth connection stud and nut shall be provided.

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 20mm to accommodate flush doors.

The requirements for chassis, panels and doors shall be as specified for flush mounted switchboards. The doors shall be hinged and shall fit flush in the frame in the closed position. Knock-outs shall not be provided unless specifically called for.

1.15.4 Power and Control Wiring

a) Power circuit wiring and connections in a switchboard shall be rated to the full rating of the associated equipment, i.e. fused switch, contactor, circuit-breaker, etc., and not to the circuit or fuse rating. Wiring to be in accordance with SANS 10142-1.

b) Neutral connections shall have the same rating as the phase connections unless otherwise approved.

c) Control circuits shall be wired using a minimum of 2,5mm² conductors. Current and voltage transformer circuits shall be wired using a minimum of 4mm².

d) Conductors shall be general purpose 600/1000V grade PVC-insulated wire to SABS 1507-3

e) Wiring for circuits up to 50V shall be in 0,5mm² flexible 300/500V grade PVC-insulated wire in accordance with SABS 1507

f) Single or solid conductor wire shall not be used.

g) Joints or splices in any wiring are not acceptable.

h) Panel and equipment terminals, labels, etc, shall be accessible after the wiring has been completed.
i) Terminals which are on the live side of fuses and isolating switches shall be completely shrouded to prevent accidental contact.

j) Aluminium conductors are not acceptable.

Wiring shall present a neat appearance and shall be braced, clipped and/or laced to prevent vibration and to ensure that it shall not deform under fault conditions. Connections to equipment on swing doors shall be arranged so as to give a twisting motion and not a bending motion to the conductor.

Power wires shall bear the colour along their entire length of the phase to which they are connected.

Control wire sheaths shall be coloured grey for AC circuits.

Control wiring leads shall be marked at both ends with an interlocking type of ferrule with permanent black letters impressed on a white background.

For all control wires without lug terminations the numbered ferrule must not fall off when disconnecting the wire and in this regard, the use of one strand of wire to retain the ferrule is acceptable.

Single pole and double pole moulded-case circuit breakers shall be wired in a way that the supply to the switchboard is equally balanced.

Stripping of insulation shall not result in damage to the conductors. The stripping tools used shall be of the type which permits the length of strip to be pre-set. Control wiring shall be terminated with pre-insulated, crimped or compression type lugs. Crimping tools shall be of the type which will not release the termination during normal operation until the conductor crimp has been correctly formed. Any damaged wiring will be rejected.

Lugs shall be of the hooked blade type when used in conjunction with screw clamp spring loaded insertion type terminals, ring tongue type when used with stud or direct screw mounted connections and wire pin when used with pinch screw type connections such as indicating lamp fittings.

Not more than two conductors shall be connected to any side of a terminal.
Each terminal strip shall be provided with not less than 10% spare terminals, with a minimum of two, unless otherwise approved.

Terminations for power wiring and cabling shall be provided with pressure type clamping connections or bolted connections capable of accepting crimped or compression type lugs on conductors.

An undrilled solid copper bar shall be provided for terminating all external power cables above 70mm, or where three or more cables in parallel are specified. The arrangement shall be suitable for accepting cable lugs of conductors up to 630mm².

Cables shall be made off directly onto circuit-breakers, switches, contractors, thermal-overloads, etc. Terminals or solid copper terminating conductors shall be provided where necessary. Provision shall be made for bracing and for fixing the cable leads to prevent vibration.

Where a large number of control terminals are mounted in close proximity, the terminals shall be in vertical rows with a minimum of 125mm below rows. Spare terminals shall be mounted at the bottom of the row unless the cabling drawing shows otherwise.

Terminals shall be provided for all cores of external control cable as indicated on the drawings whether internally connected or not.
1.15.5 Testing

Electrical switch panels shall be inspected by the Engineer at their place of manufacture, prior to delivery to site. At such inspection and testing, the Sub-Contractor shall demonstrate the functioning of the switch panel to the Engineer. Any defects in materials, finishes and operation of the switch panels shall be corrected at their place of manufacture prior to delivery to site.

Type and routine tests shall be carried out on either a complete switchboard or a representative portion thereof to verify its characteristics.

Type tests shall be performed in accordance with IEC 439:

- verification of temperature rise limits
- verification of dielectric properties
- verification of the short circuit strength
- verification of the effectiveness of the protective circuit
- verification of clearances and creepage distances
- verification of mechanical operation
- verification of degree of protection

If evidence is available of type tests already made on similar equipment, this may, subject to the Engineer’s approval, be acceptable in lieu of these tests.

Copies of test certificates shall be submitted to the Engineer.

Routine test shall be performed in accordance with IEC 439:

- inspection of the switchboard including inspection of wiring and electrical operation tests
- dielectric test. This test shall have a duration of 60 seconds
- checking of protective measures and of the electrical continuity of the protective circuits.

1.15.6 Construction of LV Switch Cubicles (Kiosks)

Switch cubicles shall be of sufficient size to accommodate all the specified equipment. All equipment shall be installed as described in paragraph 1.16.7.
Switch cubicles shall be manufactured of mild steel sheet metal with a minimum thickness of 2mm or cold rolled 3CR 12 sheet metal with a minimum thickness of 1.6mm. Fibre reinforced or other corrosion proof material (e.g. glass fibre) may also be used if adequately reinforced.

Two ventilation slots or grilles, approximately 150 x 125mm and covered on the inside with copper mesh, shall be provided on opposite sides of the cubicle.

Doors shall be provided in the front and back panels and shall swivel through 180°. Rigid padlocks and base plates for security latches shall be provided on the doors. Openings for security latches shall be blanked with chromed brass discs.

Warning & danger signs shall be mounted on each door in compliance with the requirements.

The kiosk shall be mounted on a well finished concrete base, with minimum height of 150mm above ground level in the case of mild steel and any of the other specified acceptable materials. The kiosk can be made for direct mounting into the ground in which case it shall be equipped with a base, forming part of the structure, for this purpose. The switch cubicle shall protrude at least 10mm past the edges of the base to prevent water collecting on the base.

All equipment shall be mounted flush behind a single front panel with the exception of metres and time switches. The panel shall be fixed by means of captive fasteners such as "DZUS" or "CAMLOC". Chromed handles shall be provided on the panel. Metres and time switches may be installed on the surface of the flush panels.

1.15.7 Mounting of Equipment

A minimum clearance of 50mm shall be maintained between items of equipment and the side of the compartment. Where extra equipment is specified after the design has been finalised, this clearance requirement may be altered subject to the Engineer's approval.

No piece of equipment shall be mounted in any position where it is not visible and accessible to a viewer looking into the compartment through the door opening.

Mounting of Circuit Breakers
All moulded case circuit breakers shall be flush mounted with only toggles protruding. Miniature circuit breakers may be installed in clip-in trays mounted on the frame. Special provision shall be made for large main switches. Circuit breakers shall be installed so that the toggles are in the up position when “ON” and down when “OFF”.

**Mounting of Contactors**

Contactors shall only protrude through the panel in special cases. Plastic covers or other coverings will not be required.
Instrumentation

All metering instruments shall be mounted flush in the front panel unless otherwise specified. In certain instances it may be required that instruments be mounted flush in the door. In these instances the back of metres shall be covered by removable covers of isolating material fixed to the door to protect the terminals of instruments and to prevent accidental contact. Equipment mounted normally on the surface, e.g. time switches and relays, shall be mounted behind the front panel. In these cases hinged access panels shall be provided in the front panel.

Fuse-Links and Carriers

Fuses shall be of the high rupturing capacity type and shall be mounted on insulated draw-out carriers which shall hold the fuses positively after withdrawal. In all cases the top terminal shall be the live terminal. This applies also for MCB's.

DC circuits shall have fuses in the positive and negative leads.

Fuses shall be so positioned that they are readily accessible to a person standing on the floor.

Fuses for instrumentation shall be mounted on the outside of the compartment door adjacent to or below the instrument.

Fuses shall be provided with labels giving their rating and duty.

Solid link holders shall be coloured white.

Spare Fuses

One spare fuse of each type and size used in each board shall be fitted on 'Terry' clip holders on the inside of the front panel.

Control Equipment

All equipment performing control functions, e.g. control relays, transducers, and time relays not requiring adjustment, shall be mounted behind the front panel.
Current Transformers

Current transformers shall comply with SANS 60044

Current transformers shall be accessible and easily removable.

Secondary windings of current transformers shall be earthed at one point only. Each group of current transformers, i.e. protection, metering, etc, shall be earthed directly to the protective conductor (earth bar).

Current transformers shall be naturally air-cooled, and shall be able to withstand the maximum fault current for the duration of time taken by the functional unit to clear, with protective devices set at the maximum time delay settings.

Main Circuit Breakers

a) Rack-out type air circuit breakers shall be mounted in a separate compartment with only the handle or operating mechanism protruding. A positive device shall be provided to ensure that the circuit breaker is secured in the:

- connected position
- test position
- disconnected position

It shall be possible to remove the circuit breaker from its compartment. It shall not be possible to insert a circuit breaker into a circuit of higher rating.

Automatically-operated shutters shall be provided so that on racking out the circuit breaker, these shutters cover the isolating sockets to prevent inadvertent contact with live busbars and circuits. Busbar shutters shall be labelled with the word BUSBARS in letters of at least 50mm high.

Mechanical interlocks shall be provided to ensure that:

- the circuit breaker main contacts cannot be engaged and disengaged unless the circuit breaker contacts are fully open
- the circuit breaker cannot be closed unless it is in the connected, disconnected or test position
- the action of disengaging the circuit breaker from the connected, disconnected or test position shall automatically trip the circuit breaker.

Circuit breakers shall be capable of carrying continuously the load current stated in the drawings at site altitude when mounted within the compartment specified without forced ventilation.

If the main switch is a moulded case circuit breaker or isolator, it shall be installed flush in a separate compartment.

Contractors controlling the supply shall be installed behind separate front panels.

All metering, protection and indicating equipment shall be clearly visible from the front of the board. Where doors are specified the equipment shall be installed flush in the doors and covered as described in 'Instrumentation' above.

Fuses or control gear providing back-up protection for circuit breakers shall be installed behind separate front panels.

**Standby Supplies**

Where standby power from a diesel-generator set or other source is available and has to be connected to some of the equipment on a switchboard, the switchboard shall be divided into electrically separate sections with sheet metal division plates to isolate power and mains power sections.

A means shall be provided to isolate both the standby and mains power supplies simultaneously. For this purpose, either a 6-pole rotary switch or mechanically and electrically interlocked circuit breakers may be used. Electrical interlocking alone is not sufficient. Rotary switches may only be used on boards where the fault level does not exceed 10kA.

A separate 3-pole isolator, fuse switch or circuit breaker shall be provided as main switch for both the standby power section and the mains power section in addition to the isolator of (b) above. Where a 6-pole rotary switch is used as isolator for the incoming supplies, this switch may be located in the standby section of the switchboard in which case the rotary switch can also serve as the isolator for the standby section. This arrangement is acceptable where the equipment on the mains power section of the switchboard can be turned off whenever it is necessary to work on the standby section of the switchboards.
The main switches to the standby and mains power sections shall be interlocked with the doors providing access to those sections to ensure that the door can only be opened when the switches are in the OFF position.

1.15.8 General

All switchboards shall be of ample size to accommodate all the specified switchgear and provide space for future switchgear. For every 4 (or part of 4) circuit breakers of a kind on a switchboard, space for an additional circuit breaker of similar size shall be allowed unless future space requirements are clearly specified. The clearance between adjoining switchgear or switchgear openings shall be as specified in paragraph 1.16.7 of this specification.

All specified external dimensions for switchboards shall be strictly adhered to. If the clearances specified in paragraph 1.16.7 cannot be adhered to as a result of restricting external dimensions, the Sub-Contractor or Manufacturer shall obtain the opinion of the Engineer before manufacturing the switchboards.

The Sub-Contractor shall ascertain the exact position of switchboards and shall arrange timeously for the installation of cable sleeves, openings in the structure, flush draw trays behind switchboards and supports over cable trenches.

In general, flush and surface mounted switchboards shall be mounted 2000mm above finished floor level - measured to the top of the switchboard. The upper ends of switchboards may not be higher than 2,1m above finished floor level.

In addition to paragraph 1.19 of this specification, the following labels shall be provided for switchboards:

a) Main labels: A white traffolite label shall be provided to clearly identify each switchboard and subsections of switchboards.

b) The fixing of main labels shall be done as per paragraph 1.19.2. Lettering shall be black with a maximum height of 20mm letters.

c) Compartment labels: Front panels shall be identified with white traffolite labels fixed to the doors or front panel respectively. The function of the equipment and circuits shall be clearly identified.

d) The fixing of compartment labels shall be done as per paragraph 1.19.2. Lettering shall be black with a maximum height of 8mm letters.
e) Equipment labels: All equipment shall be identified with the necessary labels. The labels for equipment mounted on doors shall be identified with white traffolite labels having black lettering engraved on them, with a maximum height of 3mm letters.

The equipment labels shall be secured by means of high quality double sided tape.

The labels for all equipment, installed behind panels, shall be fixed to the chassis close to the equipment.

If this equipment is positioned too close to each other to accommodate descriptive engraved labels, the equipment may be identified by a code or number label which shall be fixed close to the equipment. The code or number shall be identified on a legend board which shall be installed on the switchboard behind a protective cover.

The types of labels for equipment behind the doors or covers shall be subject to the Engineer's approval.

Drawings

The following drawing requirements must be adhered to:

a) A set of three prints of the shop drawings for the switchboards shall be submitted to the Engineer for approval before the boards are manufactured. The following information shall be presented:
   i) A complete wiring diagram of the equipment on the boards, and the internal wiring of such equipment.
   ii) 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 of busbars shall be shown.
   iii) All labelling information on a separate sheet.
   iv) The make, catalogue number and capacity of all equipment such as isolators, circuit breakers, fuses, contractors, etc.

The approval of drawings shall not relieve the Sub-Contractor of his responsibility to the Employer to supply the switchboards according to the requirements of this specification or to the requirements of the Detailed Technical Specification.
b) A complete set of "Record" transparent drawings of all switchboards shall be submitted to the Engineer immediately after completion of the installation. The following information shall be presented:

i) Items (a) and (d) of the previous paragraph.

ii) 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.

iii) A separate schedule of all equipment.

Where such transparent drawings as called for above are modified during the execution of the contract, the Electrical Sub-Contractor shall at his own expense modify or replace such drawings. Accurate drawings of the equipment shall be forwarded to the Employer.

1.15.9 Paint Finish

Metal components of the framework, panels and chassis shall be finished with a high quality paint applied according to the best available method. Baked enamel, electrostatically applied powder coating or similar proven methods may be used. Care shall be taken to ensure that all edges and corners are properly covered. Whichever finishing method is employed, it shall be backed up by written certification that the quality of finish complies with the relevant SANS standard.

Baked Enamel Finish

Prior to painting, all metal parts shall be thoroughly cleaned of rust, mill scale, grease and foreign matter to a continuous metallic finish. Sand or shot blasting, or acid pickling and washing may be employed for this purpose. Immediately after cleaning all surfaces shall be covered by an electrolytically applied rust inhibiting, tough, unbroken metal phosphate film and then thoroughly dried.

Within forty-eight (48) hours after phosphatising, a passivating layer consisting of a high quality zinc chromate primer shall be applied, followed by two (2) coats of high quality baked enamel. The minimum paint thickness after baking shall be 0.06mm. The paint shall have a shock resistance of 25kg / cm on 0.9mm soft steel plate and a scratch resistance of 2000 grams.
Powder Coated Finish

Prior to painting, all metal parts shall be thoroughly cleaned of rust, mill scale, grease and foreign matter to a continuous metal finish. Sand or shot blasting, or acid pickling and washing may be employed for this purpose. The metal parts shall be pre-heated and then covered by a microstructured paint powder applied electrostatically. The paint shall be baked on and shall harden within 10 minutes at a temperature of 190°C. The minimum paint thickness after baking shall be 0.5mm and shall have a shock resistance of 25kg / cm on 0.9mm soft steel plate and a scratch resistance of 2000 grams.

Colour

Refer to the detail technical specification for switchboard colours.

Before the installation is handed over, the Sub-Contractor shall ensure that all paint surfaces are clean and undamaged.

1.16 Commissioning and Testing

The Electrical sub-contractor shall commission and test the entire installation at his own expense, including provision of all test equipment, such testing to be done in the presence of the Engineer, who shall have been notified of the dates and approximate duration of the tests sufficiently early to allow him to witness tests if necessary.

The Sub-Contractor shall properly test and call for inspection by the Engineer any work which is to be covered, concealed, built-in, otherwise closed up or rendered inaccessible, before such closing up takes place. The Engineer may require any work of this nature which he has not been called on to inspect before closing up, to be uncovered or made accessible to him entirely at the Sub-Contractor’s expense, making good included.

It is in the interest of the Sub-Contractor to notify the Engineer when the installation reaches various stages of completion (e.g. before plastering, final finishes, before casting concrete, etc) in order that the Engineer may inspect the installation and point out discrepancies. These inspections shall be considered informal and under no circumstances will they, in part or in whole, invalidate the requirements of the document. Any costs incurred in correcting discrepancies shall be to the Sub-Contractor’s account.
The Sub-Contractor shall keep full and proper written records of all tests conducted and commissioning information, such data to be properly indexed and submitted to the Engineer for his records.

The Sub-Contractor shall test electrical wiring for compliance with regulations and have the complete installation tested by the relevant authorities.
The Engineer reserves the right to inspect any item of equipment during manufacture or before delivery to site. The Sub-Contractor shall make available any item for such inspection. The Engineer shall also be furnished with manufacturer’s test certificates whenever these are required by law or called for by the Engineer.

The Sub-Contractor shall commission the complete installation prior to inviting the Engineer to accept it, commissioning including inter alia the following services, as relevant:

a) The Sub-Contractor shall record all motor running currents and set overload protection devices to correct values.

b) The Sub-Contractor shall adjust and set all time clocks, time delay relays, automatic control devices and check their function for correctness and response.

c) The Sub-Contractor shall remedy any defects apparent on the installation prior to calling upon the Engineer to accept the plants.

1.17 Labelling and Identification

All equipment shall be labelled and identified using white traffolite labels having black lettering engraved on them; where two similar items exist, they shall additionally be numbered for clarity in identification.

Labels shall be secured by means of white rivets, slotted label holders or screwed on. Self-tapping screws will not be allowed.

All other equipment including metres, instruments, indicator lights, switches, push-buttons, circuit breakers, fuses, etc., shall be identified. The function of the equipment and circuits shall be clearly identified. Flush mounted equipment within doors or front panels shall be identified with labels fixed to the doors or front panels respectively.

All labels shall be in English unless otherwise indicated in the detail technical specification.
1.18 **Operating and Maintenance Manuals; “As Built” or “As Installed” Record Drawings**

Provide three hard copies and one disk of all operating and maintenance manuals and record drawings.

Provide a PDF of the operating and maintenance manuals. Employ a specialist to prepare manuals for the form and content of the operating and maintenance manuals.

The format and contents must be agreed with the Engineer and the Client representative. The Operating and maintenance manuals must include, and would not be limited to the following:

a. Index of Contents
b. A full description of each of the systems installed, written to ensure that the Employer’s staff fully understand the scope and facilities provided. Description to include data on general design parameters, normal associated operating conditions and manufacturers’ information concerning correct operation, etc., based on commissioning results.

c. A description of the mode of operation of all systems.
d. Diagrammatic drawings to each system (including distribution boards) indicating principal items of plant, equipment, valves, etc.
e. A photo-reduction of all record drawings, together with an index.
   i. Size A4
   ii. Size A3
f. Legend for all colour-coded services.
g. Schedules (system by system) of plant, equipment, valves, etc, stating their locations within the building, duties and performance figures. Ensure each item has a unique code number cross-referenced to the record and diagrammatic drawings and schedules.
h. The name, address and telephone number of the manufacturer of every item of plant and equipment together with catalogue list and order acknowledgement numbers.
i. Manufacturer’s technical literature for all items of plant and equipment, assembled specifically for the project, excluding irrelevant matter and including detailed drawings, electrical circuit details and operating and maintenance instructions.
j. A copy for all Test Certificates, Certificates of Compliance, Inspection and Test Records, Commissioning and Performance Test Records (including, but not limited to, electrical circuit tests, corrosion tests, type tests, start and commissioning tests) for the installations and plant, equipment, valves, etc., used in the installations.
k. A copy of all manufacturers’ guarantees or warranties.
l. Copies of Insurance and Inspecting Authority Certificates and Reports.
m. Starting up, operating and shutting down instructions for all equipment and systems installed.
n. Details of procedures to maintain plant in safe working conditions.
o. Control sequences for all systems installed.
p. Schedule of all fixed and variable equipment settings established during commissioning.
q. Back-up copies of any system software.
r. Documentation of the procedures for updating and/or modifying software operating systems and control programs.
s. Instructions for the creation of:
   i. Control procedure routines
   ii. Graphic diagrams
t. Details of the software revision for all programs provided.
u. Two back-up copies of all software items, as commissioned.
v. Details of lubrication systems and lubrication schedules for all lubricated items.
w. A list of normal consumable items.
x. A list of recommended spares to be kept in stock by the Employer, being those items subject to wear or deterioration and which may involve the Employer in extended deliveries when replacements are required at some future date.
y. A list of any special tools needed for maintenance cross referenced to the particular item for which required.
z. Procedures for fault finding.
   aa. Emergency procedures, including telephone numbers for emergency services.
   bb. Copies of all items incorporated in the plant room and switch room schedules and schematics.
   cc. Encase the Manuals in A4 size, plastic-covered, loose leaf, four ring binders with hard covers, each indexed, divided and appropriately cover-titled. Fold drawings larger than A4 and include in the binder so that they may be unfolded without being detached from the rings.
   dd. Provide record drawings. Include the provision of relevant framed plasticised drawings in all electrical rooms.
   ee. Three copies of all “AS BUILT” or “AS INSTALLED” record drawings, in print form, are required to be handed to the Engineer before completion of the project. There shall have
been previously submitted to the Electrical Engineer for comment and approval. The Electrical Engineer also requires 2 copies of all record drawings to be made available on disk on CAD format. All “AS BUILT” or “AS INSTALLED” record drawings are to be prepared by the Electrical contractor in CAD format.

### 1.19 Maintenance Instructions and Guarantees

Retain copies of all maintenance instructions and guarantees delivered with components and equipment (failing which, obtain), register with manufacturer as necessary and hand this over to the Employer on, or before Practical Completion. Notify the Employer of telephone numbers for emergency services by Specialist Contractors and Suppliers after Practical Completion.
Detailed Technical Specification

December 2015

National Department of Health
Detailed Technical Specification

December 2015

National Department of Health
## Issue and revision record

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<td>0</td>
<td>2015/12/10</td>
<td>Faatimah Vally</td>
<td>Ronald Mabote</td>
<td>Abdul Chand</td>
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**Information class:** Standard

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1.1 General

This specification covers the supply, delivery, installation, testing, commissioning and maintenance during the guarantee period of the General Electrical Installation covered under the scope of works for the construction of the four clinics in the Vhembe district, Polokwane, Limpopo.

1.2 Scope of Works

The scope of works covers the following areas of work as extracted from the “IUSS- Building Engineering Services proposal V1.1 NHC approved” manual. The following works would be undertaken as part of this commission by our practice:

a) Electrical installation in buildings (small power and lighting),
b) Telephone systems,
c) Intercom systems,
d) Public address systems,
e) Nurse call system,
f) Bedhead ducting system,
g) TV Antenna systems,
h) Security system,
i) UPS system,
j) Lightning Protection and earthing system,
k) Electrical reticulation and distribution,
l) High and low voltage power supplies,
m) Emergency Generator system,
n) Power feeds to HVAC points and sewerage pumps.
1.3 Related Work by Others

The following work will be provided by others:

a) Plaster and patching of conduit chases
b) Closing up of ducts and openings in slabs or through walls after the installation of cables,
c) Fireproofing of all inter-floor openings to be carried out by the Principal Contractor,
d) Installation of air-conditioning units,
e) Installation of extract fans,
f) Installation of geysers,
g) Inter-connection between air-conditioning panels and equipment fed from it,
h) Internal air-conditioning equipment in air-conditioning distribution boards,
i) Supply to fan coil units installed in ceiling void.

1.4 Documentation

This document forms part of the principal builder's document. All terms and conditions of contract would be as per the main document.

1.5 Local Supply Authority

The Local Supply Authority is Eskom. The successful tenderer shall ensure that he is fully conversant with all the by-laws of the local supply authority. The electrical contractor shall liaise with the local supply authority to ensure the timeous approval of the installation. The existing supply is a 140kVA, 400V, 50Hz supply.

1.6 Site Conditions

All equipment shall be suitably rated and shall be able to perform as specified under the following site conditions:

- Main HV Supply Voltage: 11kV 3-Wire Unearthed System
- Nominal LV Supply: 400/230V (No Load) 4-Wire, 3 Phase System with earth neutral
1.6.1 **Maintenance and Guarantee**

Refer to Main contract document.

1.6.2 **Regulations**

The total installation shall conform to the Occupational Health and Safety Act 85 of 1993 and to SANS 10142-1 of 2003, the Wiring of Premises-Low Voltage Installations, as well as all the regulations and by laws of the Local Supply Authority.

1.6.3 **Notice and 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. The connection cost will be paid directly by the client to the supply authority. However, the electrical contractor shall allow for the liaison with the electrical supply authority in this respect.

1.7 **Conduit and Accessories**

The type of conduit and accessories required for the service shall be the PVC type bearing the SANS mark of approval and shall be as detailed in the general technical specification. It shall conform to SANS 950 of 2008.

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.

Draw-boxes are to be provided in accordance with the “Wiring Code” and wherever necessary to facilitate easy wiring. Draw boxes to be priced as indicated in the Bill of Quantities.

For light and socket outlet circuits, the conduit used shall have an external diameter of 20mm. In all other instances the sizes of conduit shall be in accordance with the “Wiring Code” for the specified number and size of conductors, unless otherwise directed in part 2 of this specification or indicated on the drawings.

Under no circumstances will conduit having a wall thickness of less than 1,6mm be allowed in screeding laid on top of concrete slabs.
Aluminium and zinc alloy connectors will not be acceptable.

1.8  Wiring

Except where otherwise specified, wiring shall be carried out in conduit or trunking 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 conduits to be clear of moisture and debris before wiring have commenced.

Unless otherwise specified or indicated on the service drawings, the wiring of the installation shall be carried out in accordance with SANS 10142-1. Further to the requirements concerning the installation of earth conductors to certain light points as set out in SANS 10142, 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 2.5mm² conductors and a 1.5mm²-earth conductor, unless otherwise indicated. For socket outlet circuits the wiring shall comprise 4mm² conductors and a 2.5mm²-earth conductor. In certain instances, as will be directed in other parts of this specification, the sizes of the aforementioned conductors may be increased for specified circuits. Sizes of conductors to be drawn into conduit in all other instances, such as feeders to distribution boards, power points etc., shall be as specified elsewhere in this specification or indicated on the drawings. Sizes of conductors not specified must be determined in accordance with SANS 10142-1.

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 600/1000 V grade cable to SANS 1507-3.

Where cable ends connect onto switches, luminaires etc., 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.
1.9 Main L.V. Reticulation

The main L.V. cabling indicated on the drawings shall be supplied and installed in cable trenches, on cable trays, racks or baskets as indicated on the drawings.

The excavation and backfilling of cable trenches measured in the Schedule of Quantities shall form part of this contract.

The L.V. cable installation shall be carried out in accordance with the requirements of the SANS 10142.

All cables shall be made off at both ends and connected to the terminals of the equipment as indicated on the drawings.

Quantities in the Schedule of Quantities will not be used for ordering purposes. Cables shall be ordered from drawings issued for construction read in conjunction with the relevant specifications as well as on site conditions and measurements.

All cables shall have stranded copper conductors and shall be of the PVC/SWA/PVC type, 600/1000V grade. Cables with aluminium conductors shall be allowed only after consultation with the engineer and on proving the equivalent carrying capacity of shall a cable.

The cables shall be armoured with a single layer of galvanised steel wire.

All cables shall bear the SANS 1507-3 mark of approval and shall have colour coded PVC insulated conductors.

1.10 Installation

All LV cables shall be installed as indicated on the drawings. The installation shall be carefully planned to reduce the number of cable crossings to a minimum.

The following different types of installations shall be employed:

i. Cables on trays and ladders.
ii. Cables in excavated trenches.
1.10.1 Cables on Cable Trays or Ladders

Cables on cable trays and ladders shall be neatly laid on the ladders and strapped to the ladders/trays at 1200mm intervals. A minimum of a half cable diameter space shall be allowed between cables.

1.10.2 Cables in Trenches

Cables installed in trenches shall be installed in accordance with the General Technical Specifications. Cable markers complying with the requirements of the General Technical Specifications shall be provided at 30m intervals and at all direction changes.

The excavation and backfilling of cable trenches shall be carried out by the electrical contractor. Cable trenches shall have a minimum depth of 600m for 600/1000V cables and shall be 1000mm for higher voltage cables.

1.10.3 Identification of Cables

Cables shall be identified as described in the General Technical Specifications. All cables entering or exiting the Main L.V. Board, sub-distribution boards, and/or any other equipment, shall be clearly marked at both ends with a suitable cable marker fixed to the cables.

1.11 Earthing of Installation

The entire installation shall be earthed in accordance with the code of practice for the wiring of premises – SANS 10142-1 of 2003.

1.11.1 Lightning Protection of Installation

The lightning protection installation shall be done in accordance with SANS 10313.

The tender makes allowance for the testing and reporting back by a specialist supplier on the condition of the existing earthing system. Should the existing system not be adequate, a provisional sum has been allowed for the repairs to this system.
1.12 Testing of the Installation

The Electrical Subcontractor shall have the complete electrical installation tested as per the relevant SANS specification and have the formalities pertaining to the local authorities completed.

Subsequent to the inspection/testing of the installation by the Local Authorities, the Electrical Subcontractor shall in the presence of the Engineer, test all lighting and power circuits with respect to:

a) Phase Balance.
b) Insulation Level.
c) Earth Continuity.
d) Voltage Levels.
e) Polarity.

The Electrical Subcontractor shall have the following instruments available on site for the full duration of the last eight months of the contract:

a) Phase rotation meter.
b) Digital current and voltmeters [0 600A, 0 400V].
c) Null balance megger testers.
d) Earth leakage testers.
e) 0 2500A tong tester.

All instruments required for special tests such as pressure testing, etc., shall be provided when required.

A Certificate of Compliance duly signed by an authorised person representing the electrical contractor shall be provided for each tested area. This document shall be signed by the responsible Engineer representing Mott MacDonald, when he deems the installation to be fully in accordance with his design.
1.13 **Lighting Installation**

The circuit wiring of general lighting circuits shall be 2.5mm² PVC insulated copper conductors and a 2.5mm² bare copper earth conductor in trunking or 20mm dia. Conduit, unless otherwise specified.

Light switches, where indicated, shall be similar or approved equal to CLIPSAL Series 2000 or CRABTEE DIAMOND range and shall be of flush type complete with covers, suitable for switching of the actual complements and types of lamps utilised.

The wiring trunking in ceiling voids shall be suitably sized to accommodate the number of lighting circuits as indicated on the drawings and shall be pre-fitted with knock-outs for unswitched 5A socket outlets to accommodate the number of lighting circuits as indicated on the drawings.

1.13.1 **Light Fittings**

Light fittings shall be similar or equal to the fittings indicated in the schedule. Where alternate fittings have been quoted, then the Engineer reserves the right to reject the alternate fitting, should the fitting not be of the same standard and quality as the fitting specified.

Tenderers shall base their rates on the delivery, handling, storage, installation, commissioning, guarantee and 12 month maintenance of the light fittings.

All globes, lamps and control gear shall be as new and in working order when the building is handed over. Tubes and lamps exceeding 100 hours of operation shall be replaced at no cost to the client.

The permanent fittings shall not be used for temporary lighting during construction unless prior arrangements have been made with the Engineer. Should the fittings be utilised before practical completion and the hand over date, the Electrical Subcontractor shall obtain an extended guarantee from the supplier. All light fittings shall be guaranteed for a period of twelve [12] months after the practical completion and hand over date.
1.13.2 Self-Contained Emergency Lighting

Emergency Lighting with NIMH batteries shall be provided as required by the OHS act 85 of 1993. In general, all EXIT signs and escape passages shall be provided with battery back-up lighting.

The EXIT lights shall be wired with separate circuits from a dedicated section in the corresponding distribution board or from the UPS.

The EXIT lights shall be equipped with NIMH batteries that will provide backup at 50% output for 30 minutes. All emergency fluorescent fittings shall be marked with a clear distinctive mark (red dot) for future visual identification.
1.13.3 Schedule of light fittings

The contractor shall supply and install the following luminaires as part of this installation. The fittings shall be subject to the approval of the engineer and the principal agent. A sample of each fitting shall be provided for approval. The approved fitting shall be kept in a sample store until the end of the project. The sample fitting has been priced in the bill of quantities. The following fittings shall be supplied and installed by the electrical sub-contractor as part of his installation.

<table>
<thead>
<tr>
<th>Luminaire Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 General description</td>
<td>Aluminium framed LED panel</td>
</tr>
<tr>
<td>Lamps</td>
<td>44W LED lamps</td>
</tr>
<tr>
<td>Dimensions</td>
<td>600 x 600 mm</td>
</tr>
<tr>
<td>IP rating</td>
<td>Protection level - IP20</td>
</tr>
<tr>
<td>Efficiency</td>
<td>77.3 lm/W</td>
</tr>
<tr>
<td>Body</td>
<td>Aluminium framed LED panel</td>
</tr>
<tr>
<td>Sample fitting</td>
<td>Lighting Innovations NLB - PL6060-L</td>
</tr>
<tr>
<td>D1 General description</td>
<td>Recessed LED round downlighter</td>
</tr>
<tr>
<td>Lamps</td>
<td>13.2 W Diffused flat LED ceiling light, 4000K</td>
</tr>
<tr>
<td>Dimensions</td>
<td>90 mm diameter, 92 mm height</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Min Efficiency of 55 lm/W (WW), 60lm/W (NW)</td>
</tr>
<tr>
<td>Body</td>
<td>Fitting Available in White and Aluminium</td>
</tr>
<tr>
<td>Reflector</td>
<td>High performance White Optic Reflector</td>
</tr>
<tr>
<td>Control gear</td>
<td>Dali dimmable</td>
</tr>
<tr>
<td>Sample fitting</td>
<td>Lighting Innovations - CL5H - Diff- F</td>
</tr>
<tr>
<td>P1 General description</td>
<td>Suspended LED pendant</td>
</tr>
<tr>
<td>Lamps</td>
<td>75W LED neutral white (4000K)</td>
</tr>
<tr>
<td>Dimensions</td>
<td>550mm diameter, 3000mm height</td>
</tr>
<tr>
<td>IP rating</td>
<td>Protection level - IP54</td>
</tr>
<tr>
<td>Efficiency</td>
<td>&gt;89%</td>
</tr>
<tr>
<td>Body</td>
<td>Aluminium Housing</td>
</tr>
<tr>
<td>Diffuser</td>
<td>Acrylic diffuser</td>
</tr>
<tr>
<td>Control gear</td>
<td>Dali dimmable</td>
</tr>
<tr>
<td>Standard</td>
<td>SANS approved- 60598</td>
</tr>
<tr>
<td>Other</td>
<td>Halo effect</td>
</tr>
<tr>
<td>Sample fitting</td>
<td>Beka Schreder - LEDdisk - maxi</td>
</tr>
</tbody>
</table>
### P2
**General description**

Neutral White LED disk fitting

**Lamps**
16W LED neutral white (4000K)

**Dimensions**
340mm diameter, 3000mm height

**IP rating**
Protection level – IP54

**Efficiency**

**Body**
Aluminium Housing

**Diffuser**
Acrylic diffuser

**Control gear**
Dali dimmable

**Standard**
SANS approved - 60598

**Sample fitting**
Beka Schreder - LEDdisk - Midi

### P3
**General description**

Pole-mounted LED fitting exterior luminaire

**Lamps**
66W LED neutral white (5000K)

**Dimensions**
313 x 678 mm, 77mm depth

**IP rating**
Protection level - IP66

**Body**
Marine grade aluminium

**Protector**
High-impact clear glass or high-impact acrylic

**Control gear**
Pre-programmable stand-alone dimming

OWLET remote management

**Standard**
SANS approved - 60598

**Sample fitting**
Beka Schreder – LEDlume - Midi

### B1
**General description**

Surface mounted LED bulkhead

**Lamps**
15W/840 LED

**Dimensions**
280mm diameter, 108mm depth

**IP rating**
Protection level - IP65

**Body**
High pressure die-cast aluminium

**Diffuser**
Opal acrylic

**Control gear**
Control gear is mounted onto a base plate for cool operation

**Standard**
SANS approved - 60598 - 1

**Sample fitting**
Lighting Innovations - Saturn Dome Bulkhead

### S1
**General description**

Channel LED Luminaire

**Lamps**
35W single LED strip

**Dimensions**
110 x 1510 mm

**IP rating**
Protection Level - IP20

**Body**
Extruded Aluminium

**Diffuser**
PMMA Matt Opal Profile + Hi Mt.LT 87 high transmission diffuser

**Standard**
SABS approved

**Sample fitting**
Regent Lighting Solutions - Linear Maxi
1.14 “Record” Drawings

The Electrical contractor shall provide "Record" drawings comprising of one [1] complete set of the electrical drawings, showing the final positions of all outlet points and electrical equipment. This set shall be a mark-up of the last issued drawings to site by the Engineer. The record drawings shall be completed after practical completion has been accepted by the client shall be given to the Engineer at least 30 days prior to final completion has been accepted by the client.

1.15 Maintenance and Operating Manuals

The Electrical contractor shall provide 3 sets of maintenance manuals and operating manuals which shall contain the information described in the general technical specification.

1.16 Fire Detection Installation

The entire installation shall be monitored by means of a Fire Detection system in accordance with SANS 10139 of 2007. A complete analogue addressable Fire Detection system would be installed. The electrical subcontractor shall ensure that the Fire Detection systems contractor shall meet the requirements of the specification and all interfaces between the Fire Detection system, HVAC system, generators and the general electrical installation have been attended to as defined in this document. The Fire Detection contractor may, on request of the client, be required to provide for the further maintenance of the Fire detection installation on completion of the 12 months maintenance guarantee period. The Fire Detection installation supplied under this contract shall have a 12 months maintenance contract included in the prices quoted in the Bill of Quantities.
1.17 Distribution Boards

The distribution boards indicated in the schedules shall be installed on site by the electrical contractor. The electrical contractor will ensure that the distribution board manufacturer meets the requirements of the specification and the programme of works.

A shop drawing of each of the distribution boards shall be submitted to the engineer for comment before construction begins. A reasonable amount of time shall be afforded to the engineer to check these drawings.

Schedule of DBs

Distribution board - DB MLV

Location: Plant Room

Fault Level: 10kA

Main Cable Feed: 185mm² 4 core PVC/SWA/PVC and 95mm² BCEW (Normal)

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Description</th>
<th>Switchgear</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Main Breaker</td>
<td>300A, TP, 10kA</td>
<td>1</td>
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<tr>
<td>Normal</td>
<td>Feeder</td>
<td>40A, TP, 5kA</td>
<td>3</td>
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<tr>
<td>Normal</td>
<td>Feeder</td>
<td>30A, SP, 5kA, MCCB</td>
<td>1</td>
</tr>
<tr>
<td>Normal</td>
<td>Feeder</td>
<td>60A, TP, 5kA, MCCB</td>
<td>3</td>
</tr>
<tr>
<td>L1 to L2</td>
<td>Lighting</td>
<td>16A, SP, 5kA, MCCB</td>
<td>2</td>
</tr>
<tr>
<td>P1</td>
<td>Power</td>
<td>20A, DP E/L breaker (1)</td>
<td>1</td>
</tr>
<tr>
<td>P1</td>
<td>Power</td>
<td>20A, SP, 5kA, MCCB</td>
<td>1</td>
</tr>
</tbody>
</table>
**Distribution board - DB A**

Location:

Fault Level: 10kA

Main Cable Feed: 25mm² 4 core PVC/SWA/PVC and 16mm² BCEW (Normal)

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Description</th>
<th>Switchgear</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Main Breaker</td>
<td>40A, TP, 10kA</td>
<td>1</td>
</tr>
<tr>
<td>L1 to L4</td>
<td>Lighting</td>
<td>16A, SP, 5kA, MCCB</td>
<td>4</td>
</tr>
<tr>
<td>P1 to P2</td>
<td>Power</td>
<td>20A, DP E/L breaker (5+4)</td>
<td>2</td>
</tr>
<tr>
<td>P1 to P9</td>
<td>Power</td>
<td>20A, SP, 5kA, MCCB</td>
<td>9</td>
</tr>
<tr>
<td>HV1 to HV3</td>
<td>HVAC</td>
<td>20A, SP isolator</td>
<td>3</td>
</tr>
<tr>
<td>UPS</td>
<td>Local Main</td>
<td>20A, SP, 5kA, MCCB</td>
<td>1</td>
</tr>
<tr>
<td>L1-U</td>
<td>Lighting</td>
<td>16A, SP, 5kA, MCCB</td>
<td>1</td>
</tr>
<tr>
<td>P1-U</td>
<td>Power</td>
<td>20A, SP, 5kA, MCCB</td>
<td>1</td>
</tr>
</tbody>
</table>

**Distribution board - DB B**

Location:

Fault Level: 10kA

Main Cable Feed: 16mm² 4 core PVC/SWA/PVC and 10mm² BCEW (Normal)
### Circuit Description

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Description</th>
<th>Switchgear</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Main Breaker</td>
<td>40A, TP, 10kA</td>
<td>1</td>
</tr>
<tr>
<td>L1 to L14</td>
<td>Lighting</td>
<td>16A, SP, 5kA, MCCB</td>
<td>14</td>
</tr>
<tr>
<td>P1 to P2</td>
<td>Power</td>
<td>20A, DP E/L breaker (4+4)</td>
<td>2</td>
</tr>
<tr>
<td>P1 to P8</td>
<td>Power</td>
<td>20A, SP, 5kA, MCCB</td>
<td>9</td>
</tr>
<tr>
<td>HV1 to HV3</td>
<td>HVAC</td>
<td>20A, SP isolator</td>
<td>3</td>
</tr>
<tr>
<td>PP1</td>
<td>Access Control Panel</td>
<td>60A, SP isolator</td>
<td>1</td>
</tr>
<tr>
<td>UPS</td>
<td>Local Main</td>
<td>20A, SP, 5kA, MCCB</td>
<td>1</td>
</tr>
<tr>
<td>L1-U to L2-U</td>
<td>Lighting</td>
<td>16A, SP, 5kA, MCCB</td>
<td>2</td>
</tr>
<tr>
<td>P1-U</td>
<td>Power</td>
<td>20A, SP, 5kA, MCCB</td>
<td>1</td>
</tr>
</tbody>
</table>

### Distribution board - DB C

**Location:**

**Fault Level:** 10kA

**Main Cable Feed:** 16mm² 4 core PVC/SWA/PVC and 10mm² BCEW (Normal)
## Distribution board - DB D

**Location:**

Fault Level: 10kA

Main Cable Feed: 25mm² 4 core PVC/SWA/PVC and 16mm² BCEW (Normal)

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Description</th>
<th>Switchgear</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Main Breaker</td>
<td>30A, TP, 10kA</td>
<td>1</td>
</tr>
<tr>
<td>L1</td>
<td>Lighting</td>
<td>16A, SP, 5kA, MCCB</td>
<td>1</td>
</tr>
<tr>
<td>P1</td>
<td>Power</td>
<td>20A, DP E/L breaker</td>
<td>1</td>
</tr>
<tr>
<td>P1</td>
<td>Power</td>
<td>20A, SP, 5kA, MCCB</td>
<td>1</td>
</tr>
</tbody>
</table>
PP1 TO PP4 | Access Control | 20A, SP isolator | 1
---|---|---|---
UPS | Local Main | 20A, SP, 5kA, MCCB | 1
L1-U | Lighting | 16A, SP, 5kA, MCCB | 1
P1-U | Power | 20A, SP, 5kA, MCCB | 1

Distribution board - DB E (Magwedza and Makonde DB E1 and E2 – are identical to each other and DB-E spec will apply)

Location:

Fault Level: 10kA

Main Cable Feed: 35mm² 4 core PVC/SWA/PVC and 25mm² BCEW (Normal)

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Description</th>
<th>Switchgear</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Main Breaker</td>
<td>60A, TP, 10kA</td>
<td>1</td>
</tr>
<tr>
<td>L1 to L6</td>
<td>Lighting</td>
<td>16A, SP, 5kA, MCCB</td>
<td>6</td>
</tr>
<tr>
<td>P1</td>
<td>Power</td>
<td>20A, DP E/L breaker (3)</td>
<td>1</td>
</tr>
<tr>
<td>P1 to P3</td>
<td>Power</td>
<td>20A, SP, 5kA, MCCB</td>
<td>3</td>
</tr>
<tr>
<td>PP1-PP3</td>
<td>Geyser</td>
<td>20A, SP isolator</td>
<td>3</td>
</tr>
<tr>
<td>UPS</td>
<td>Local Main</td>
<td>20A, SP, 5kA, MCCB</td>
<td>1</td>
</tr>
<tr>
<td>L1-U to L2-U</td>
<td>Lighting</td>
<td>16A, SP, 5kA, MCCB</td>
<td>2</td>
</tr>
<tr>
<td>P1-U</td>
<td>Power</td>
<td>20A, SP, 5kA, MCCB</td>
<td>1</td>
</tr>
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</table>
Distribution board - DB Sewer Plant

Location:

Fault Level: 10kA

Main Cable Feed: 50mm² 4 core PVC/SWA/PVC and 25mm² BCEW (Normal)

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Description</th>
<th>Switchgear</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Main Breaker</td>
<td>60A, TP, 10kA</td>
<td>1</td>
</tr>
<tr>
<td>L1</td>
<td>Lighting</td>
<td>16A, SP, 5kA, MCCB</td>
<td>1</td>
</tr>
<tr>
<td>PP1-PP4</td>
<td>Pumps</td>
<td>20A, SP isolator</td>
<td>4</td>
</tr>
</tbody>
</table>

1.18 Cables

The following cables shall be installed as part of this contract. The electrical contractor shall ensure that the laying, handling, delivery, installation and testing of the cables complies with the specifications defined in section 2.13 and 2.14 of this specification. Terminations to be priced by the supplier of the equipment for terminating on equipment. Terminations in electrical DB allowed elsewhere.

The length of the cables indicated below is not to be used to order cables. It is merely indicative. The contractor is to measure the cable length on site. The cable installation in the bill of quantities is provisional and is subject to re-measure.

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Distance</th>
<th>Cable-PVC/PVC/SWA/PVC</th>
<th>Cable - BCEW</th>
<th>Breaker</th>
<th>Fault level</th>
</tr>
</thead>
</table>

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Document1
<table>
<thead>
<tr>
<th>Minisub</th>
<th>DK</th>
<th>Depth</th>
<th>Diameter</th>
<th>Core</th>
<th>Thickness</th>
<th>Current</th>
<th>Power</th>
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<tbody>
<tr>
<td>DK</td>
<td>DB A</td>
<td>85m</td>
<td>25mm</td>
<td>4</td>
<td>16mm</td>
<td>40A</td>
<td>1.76 MVA</td>
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<tr>
<td>DK</td>
<td>DB B</td>
<td>40m</td>
<td>16mm</td>
<td>4</td>
<td>10mm</td>
<td>40A</td>
<td>2.23 MVA</td>
</tr>
<tr>
<td>DK</td>
<td>DB C</td>
<td>50m</td>
<td>16mm</td>
<td>4</td>
<td>10mm</td>
<td>40A</td>
<td>1.87 MVA</td>
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<tr>
<td>DK</td>
<td>DB D</td>
<td>150m</td>
<td>25mm</td>
<td>4</td>
<td>16mm</td>
<td>30A</td>
<td>0.45 MVA</td>
</tr>
<tr>
<td>DK</td>
<td>DB E-1</td>
<td>50m</td>
<td>35mm</td>
<td>4</td>
<td>25mm</td>
<td>60A</td>
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</tr>
<tr>
<td>DK</td>
<td>DB E-2</td>
<td>80m</td>
<td>35mm</td>
<td>4</td>
<td>16mm</td>
<td>60A</td>
<td>0.65 MVA</td>
</tr>
<tr>
<td>DK</td>
<td>DB - Sewer Pump</td>
<td>130m</td>
<td>50mm</td>
<td>4</td>
<td>25mm</td>
<td>60A</td>
<td>0.25 MVA</td>
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## ISSUE AND REVISION RECORD

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Originator</th>
<th>Checker</th>
<th>Approver</th>
<th>Description</th>
<th>Standard</th>
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<tr>
<td>A</td>
<td>10th December 2015</td>
<td>F.Munshi</td>
<td>V.Vythilingam</td>
<td>V.Ramsundara</td>
<td>Fire Tender Spec</td>
<td></td>
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</tbody>
</table>

**Information class:**

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We accept no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties.

This document contains confidential information and proprietary intellectual property. It should not be shown to other parties without consent from us and from the party which commissioned it.
DEFINITIONS

National Building Regulation Definitions

Any term defined in the National Building Regulations has the same meaning when used in this code. Particular attention is drawn to the definition of “council”. In both the regulations and the code any term that is not defined shall be assumed to have its ordinarily accepted meaning or that which the context may imply. In addition, in accordance with the normal tenets of law, words used in the present tense include the future; words used in the masculine gender include the feminine; and the singular number includes the plural and the plural the singular.

“acceptable”, ‘adequate”, satisfactory” or “suitable” means acceptable, adequate, satisfactory or suitable -

(a) in the opinion of any local authority; or
(b) in relation to any document issued by the council, in the opinion of the council;

access door
entrance door to an emergency route

“approval” means –
(a) approval by any local authority, including approval contemplated in section 7(7)(b) of the Act; or
(b) approval by the review board on appeal to the review board in terms of the Act;

“approved” means –
(a) approved by any local authority; or
(b) approved by the review board on appeal to the review board in terms of the Act;

“competent person” means a person who is qualified by virtue of his experience and training;

“Elbow” a bend to change the direction of the air flow.

common path of travel
part of an escape route that leads to only one exit door, access door or escape door

dead end
area from which escape is possible in one direction only

dead-end corridor
corridor that leads to safe escape in one direction only
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1. Fire Protection System Specification

1.1 Purpose

The fire protection system consists of two components: The detection (by other disciplines) and the protection systems. The former is intended to provide early warning in the event of a fire in the building, while the latter provide the means to fight fires that has occurred.

The fire protection system is required to ensure that there is a high degree of fire protection throughout the building, where there is a possibility of fires and where an outbreak of fire could cause major equipment damage leading to serious business interruption.

1.2 Scope of Works

1.2.1 General

For all the intents and purposes the scope of this document covers the provision of fire protection to all buildings, whether specified in detail or not.

In all instances the systems shall be supplied complete. The following components are required:

- Dry Chemical Powder Portable Fire Extinguishers
- Pipe work and connections feeding Hydrants (where extension applies) and Hose Reels
- Hose reels and Hydrants
- Signage indicating positioning of equipment and emergency escape routes

1.2.2 Design Work

For all intent and purpose this section shall be regarded as a detailed specification and design work as required, the contractor shall be limited to the following:

The design work for fire protection systems includes:

- The design and installation of any hose reel shall comply with the requirements in SANS 543, shall be installed in accordance with SANS 10105-1 and SANS 10400-W, and shall be maintained in accordance with the requirements in SANS 1475-2.

- Any Hydrant (where required in terms of 4.35.1 shall be provided at a rate of not less than one per 1000m² or part thereof).
• All pipe systems shall be pressure tested to 1.5 times of the working pressure and pipes shall be fixed to structures using approved galvanised hanging materials and bolts. There may be instances where rock anchors may have to be employed for the satisfactory suspension of pipe systems. These anchors shall be drilled and fixed by others but the fire protection contractor shall be responsible to mark out the exact location for all of the rock anchors prior to the commencement of drilling.

• Water installations, which convey water solely for fire-fighting purposes, shall be in accordance with SANS 10400-W.

• Pipes on the outlet side of the pressure reducing valves shall be joined using the following method:
  - 150mm diameter and above flanges,
  - 25mm diameter to 80mm diameter – Victaulic type joints, or
  - Malleable iron screwed fittings to SABS 509.

All pipes, fittings, hangers, shall be of galvanised finish and where welded flanged and welded fittings are used, the pipe assemblies shall be hot dipped galvanised prior to erection.

1.3 Documentation

The technical documentation associated with Fire protection is split into two parts, namely Specifications and Drawings.

1.3.1 Works information Technical Specification

This document is the Technical Specification for the Fire Protection Systems. It needs to be read in conjunction with the fire protection drawings, returnable Technical Data Schedule and Bills of Quantities.

1.3.2 Drawing Schedule

The Engineer’s tender drawings for this project are listed below:

353538-M-401-T-A0-A – Magwedza Fire Protection Layout
353538-M-402-T-A0-A – Thengwe Fire Protection Layout
353538-M-403-T-A0-A – Makonde Fire Protection Layout
353538-M-404-T-A0-A – Mulenzhe Fire Protection Layout
353538-M-405-T-A0-A – Borwa Fire Protection Layout
2. Fire Protection Equipment Specification

2.1 Fire Mains

The fire main systems shall be installed in accordance with the drawings and shall be fed from the pumps located close to the reservoir:

- Pipes of 100mm diameter shall be installed using SABS 719 black pipe having a wall thickness of 6mm.
- Weld flanges shall be of the SABS 1123 type suitable for the nominal pressure required of the system.
- All weld fittings shall be of the JIS types which are compatible with the SABS 62/1971 heavy quality pipe specified.
- After fabrication all flanges and butt welded pipes and fittings shall be hot dip galvanized prior to dispatch to the building.
- All hanging materials, including nuts, bolts, washers, and adaptors etc. shall be manufactured from mild steel and shall be of galvanized finish.
- All pipe system welding shall be undertaken by coded welders in keeping with ASME 9 and 10% of the welds shall be X-ray inspected to ensure weld quality in respect of weld preparation and weld procedures etc.
- Any defects in the welds shall be rectified free of additional expenses by the fire protection contractor.
- If more than 20% of the welds X-ray inspected fail then all welds shall be re-done at no additional expense to the client.
- All clamps and supports used for the additional support of the fire mains shall be manufactured of mild steel and shall have a galvanized finish. All exposed threads on hanger/support assemblies shall be painted with two coats of an approved zinc rich paint to minimize the onset of corrosion.
- All fire main pipes shall be tested at the manufacturers works prior to dispatch and shall be hard stamped with the SABS mark.
- The fire main pipe systems shall be pressure tested using a calibrated test pump/pressure gauge to 1.5 times the highest working pressure.
- All pipes and fittings installed on the downstream side of the pressure reducing valves plus pipes and fittings installed on the sprinkler systems, shall be of a similar pipe schedule as indicated earlier in this section, and shall be galvanized medium quality and not heavy quality.
- The fittings used on the main fire water distribution can be welded or joined utilizing “Victaulic” type joints.
- All pipe fittings, flanges, joints and hanger assemblies shall be galvanized finish.
- All exposed pipe threads on hanging material and bolts etc., shall be painted with two coats of zinc rich paint after installation.
- All valves shall be of the flanged cast iron heavy waterworks pattern, suitable for a maximum working pressure of 15 Bar.
- All valve flanges/drillings to be compatible with the flanges required on the pipes.
- All valves shall be fitted with OPEN and SHUT indicators and shall be clockwise closing with a rotational indicator stamped on the hand wheel.
- All isolation valves, pressure reducing valves and accessories fitted on the fire mains shall be painted with three coats of red epoxy paint, one primer, one undercoat, and one top coat. All coats of paint are to be compatible and shall be applied in keeping with the paint manufacturer’s application instructions.

2.2 Pressure Reducing Valve Stations

Pressure Reducing Valves (PRVs), where required, are to be mounted in the location as indicated on the drawings.

The PRVs can be subjected to a maximum inlet pressure of up to 14Bar.

- Each valve shall give, at the closed head condition, positive total shut off such that the pressure in the downstream pipe system can never exceed 7 bar pressure requirement.
- Each PRV shall be installed on galvanized supports secured and bolted to the wall of the station in the location indicated.
- Each PRV shall be provided with the following control equipment:
  - 1 – Isolating valve on the inlet connection, the specification being detailed earlier in this report.
  - 1 – 100mm diameter Bourden type glycerin filled pressure gauge with gunmetal gauge cock.
  - (0-20bar) on the inlet connection to the PVR,
  - 1 – 100mm diameter Bourden type glycerin filled pressure gauge with gunmetal gauge cock (0-15bar) on the outlet connection from the PRV,
  - 1 – Isolating valve on the outlet connection similar to that installed on the inlet connection.
2.3 Dry Chemical powder Portable Fire Extinguisher

All portable fire extinguishers shall be supplied complete with quick release brackets and fixings for wall mounting. The brackets are to be fixed to the structure with bolts.

Portable fire extinguishers installed in a building shall comply with the requirements in SANS 10400 Part T, and shall be installed, maintained and serviced by competent persons in accordance with SANS 1475-1 and SANS 10105-1.

- The dry chemical hand-held fire extinguisher shall be of the nominal sizes specified.
- These units shall be suitable for Class A, B, & C fires.
- The fire extinguishers shall be operated by gas cartridge.
- The fire extinguishers shall have a minimum discharge of 10 seconds with a minimum effective range of 6m in still air.
- All fire extinguishers shall be fitted with means to provide visual indication that the unit has been partially or fully discharged.
- Each extinguisher shall be marked with operating instructions, and markings shall conform to SABS requirements.
- Each extinguisher shall be stamped with the design pressure, test pressure and test date.
- All fire extinguishers shall have a suitable short flexible oil resistance hose complete with nozzle.
- All fire extinguishers shall be Chubb, Angus or equally approved alternative.

2.4 Hydrant Valves and Hose Reel Stations

Hydrant valves shall be of the 65mm diameter instantaneous coupling type and shall be manufactured from gunmetal, and shall comply with SANS 1128-2. These valves shall have flanged connections and shall be fitted to mating flanges on the fire water main system. A clockwise closing cast hand wheel shall be fitted to the hydrant to enable the valve to be opened and shut.

At each installed hydrant valve there shall be a non-corrosive free standing hydrant hose box, the doors of which can be secured by way of lock and key. The key shall be mounted in a break glass type key holder and shall be mounted on the side of the hose box.

Each hydrant hose box shall be fully equipped with:

- 1 × 30 meter lengths of high quality non-percolating hose, each length to be fitted with alloy couplings;
- 1 × adjustable spray type branch pipe which is electrically safe;
- 1 × spare hydrant valve rubber.
All hydrant hose boxes (where applicable) shall be painted red and shall be marked externally “FIRE HOSE”.

Hydrant valves and hose boxes shall be provided as indicated on the drawings and the minimum size of feed pipe to any hydrant valve shall not be less than 100mm in diameter.

2.5 Hose Reels

- Hose reel for the purpose of firefighting shall be installed in this building at a rate of 1 x hose reel for every 500 m² as indicated on the drawing.
- Any hose reel installed shall comply with the requirements in SANS 543 and shall be installed in accordance with SANS 10105-1 and SANS 10400-W.
- Any hose reel so installed shall be positioned to ensure that the end of the hose will reach any point in the area to be protected.
- Any hose reel installed in this building shall bear, in a prominent position on the reel disc facing the user, a certification mark from an accredited certification body.

3. Testing

All pipe work shall be pressure tested with a test pump and accurate oil filled pressure gauge for a period of 24 hours to 50% over the maximum normal working pressure. The test shall be witnessed by the client or his authorized representative(s). Triplicate copies of signed pressure test certificates will be obtained by the Fire Protection Contractors for distribution.

Water for testing and commissioning shall be provided free to the Fire Protection contractor, but the Fire Protection Contractor shall be responsible for all temporary connections into the existing water distribution pipework for the purposes of obtaining such test water.

3.1 Commissioning

The complete system shall be commissioned by a competent person employed by the fire protection contractor and shall include for final setting of all pressure reducing valves and all isolating valves.

3.2 Operating and Maintenance Manuals

Four Installation, operating and maintenance manuals, in hard covers, shall be handed to the client on the completion of the contract.
The manuals shall include:

I. Instruction in case of fire
II. Full design criteria
III. Emergency telephone numbers of installer
IV. Component data sheets
V. Sources of supply – items in telephone numbers
VI. Full set of “Record” drawings in print form
VII. Full set of “Record” drawings provided separately in electronic form.

An electronic copy on a hard disc of all of the above documentation and “as installed” drawings shall be handed over to the client on completion of the work.

3.3 Inspection

Inspection of the work on site shall be undertaken by a competent experienced genuine third party inspectorate such as the SABS or fire consultant.

3.4 Test and certificates

Where applicable the required testes and certificates shall be provided, these includes, but are not limited to:

- Pump type test and routine test certificates.
- Valve materials and test certificates
- Materials certificates for all pipes shall be provided. All fabrication and painting of pipework, whether site or not, shall be done under suitable conditions of cleanliness, dryness, humidity, temperature and ventilation.
4. **ERECUTION**

The contractor shall refer to the general clauses within this document as applicable to shipping and erecting.

No cranes or lifting equipment is called for and the contractor is to familiarize him/her with his/her own specific need in this regard and price the latter accordingly.

At Site before erection, the Contractor shall thoroughly check packages for any deterioration and damage that may have occurred during the transportation process. The Contractor shall perform corrective actions, as required.

A laydown area for the material will be made available to the Contractor in the vicinity of the works.

Pipes and fittings shall not be allowed to drop on or strike objects that will damage them, but shall be lifted, loaded, unloaded and erected using suitable hoisting equipment. Care shall be exercised in handling and storing to avoid distortion, flattening, denting, scoring or other damage.
5. BILL OF QUANTITIES
Mechanical
Heating, Ventilation and Air-conditioning
Tender Specification

DEPARTMENT OF HEALTH – SMALL AND SMALL+ CLINIC
December 2015
Mechanical
HVAC
Tender Document

NDOH SMALL AND SMALL+ CLINIC

DECEMBER 2015
ISSUE AND REVISION RECORD

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Information class: Standard

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We accept no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties.

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5. Bill of Quantities
DEFINITIONS

Any term defined in the National Building Regulations, has the same meaning when used in this code. Particular attention is drawn to the definition of “council”. In both the regulations and the code, any term that is not defined, shall be assumed to have its ordinarily accepted meaning or that which the context may imply. In addition, in accordance with the normal tenets of law, words used in the present tense include the future; words used in the masculine gender include the feminine; and the singular number includes the plural and the plural the singular.

“acceptable”, “adequate”, “satisfactory” or “suitable” means acceptable, adequate, satisfactory or suitable -
(a) in the opinion of any local authority; or
(b) in relation to any document issued by the council, in the opinion of the council;

“air conditioning system” means a system of mechanical ventilation where air that has been cleansed is supplied to a building under conditions of controlled temperature, humidity, distribution and movement;

“air duct” means any pipe, tube, conduit or enclosed space used or to be used in any building for the transmission of air in an artificial ventilation system;

“approval” means –
(a) approval by any local authority, including approval contemplated in section 7(7) (b) of the Act; or
(b) approval by the review board on appeal to the review board in terms of the Act;

“approved” means –
(a) approved by any local authority; or
(b) approved by the review board on appeal to the review board in terms of the Act;

“artificial ventilation system” means a system in which air is caused to circulate through a room by means of a mechanical apparatus which forces air into or extracts air from such room;

“Bracket” means a brace extended from a wall or hung from a slab to support a weight or equipment.

“competent person” means a person who is qualified by virtue of his experience and training;

“Elbow” a bend to change the direction of the air flow.

“fire-damper” means an automatic damper and its assembly that complies with the requirements contained in SABS 193;

“pressurization” means the creation of a positive air pressure differential between one area of and the remainder of a building and “pressurized” shall have a corresponding meaning;

“PVC Pipe” - a type of plastic pipe used in plumbing. Usually used for drains and vents and occasionally used for cold water.

“R-value” - The ability of a material to resist the flow of heat

“wind load” means the force exerted by the action of wind;
## ABBREVIATIONS

<table>
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<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>DP</td>
<td>Drain Point</td>
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<tr>
<td>HVAC</td>
<td>Heating, Ventilation and Air-conditioning</td>
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<tr>
<td>PVC</td>
<td>Poly Vinyl Chloride</td>
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<tr>
<td>RA</td>
<td>Return Air</td>
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<tr>
<td>SA</td>
<td>Supply Air</td>
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<td>Variable Refrigerant Volume</td>
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<tr>
<td>VRF</td>
<td>Variable Refrigerant Flow</td>
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The following National Acts/Regulations and Codes of Practice will also be applicable.


- SANS 0142 for the Wiring of Premises.
- SANS 10400 (previously SABS 0400) - The application of the National Building Regulations.
- The Construction Regulations.
- Specifications and Codes of Practice issued by Standards South Africa and the British Standards Institute. The former shall take precedence over the latter where both organizations have issue similar, but conflicting standards or codes of practice.
- Compensation for Occupational Injuries and Diseases Act (Act 130 of 1994)
- SABS 0400 – National Building Regulations
- SABS 1091 – National colour standards for paint
- SABS 1186 – Symbolic Safety Signs
- SABS Code of Practice 0142 for the Wiring or Premises
- BS 5925 – Ventilation of Buildings
- BS 5720 – Ventilation Equipment
- Government and Local Authorities ordinances.
- Regulations, By-Laws, Rules and other statutory requirements

The complete document is structured so that the client and the installer can understand the SANS requirements.
1. GENERAL SPECIFICATION

1.1 Introduction

This specification covers the detail requirements for the Heating, Ventilation and Air-conditioning, for the NDOH Small Clinics. This document must be read in conjunction with the drawing layouts, which covers the HVAC systems, NDOH Small Clinics Drawing Register.

The design is based on the following SANS documents:

- SANS 10400 (Part O)
- SANS 10400 (XA)

The installation of the various groupings as mentioned above must be strictly installed to these documents. The complete document is structured so that the HVAC Contractor can understand the SANS requirements.

1.2 Scope of Work

This general specification describes the usual material required for air conditioning and ventilation installations and the general methods of constructing and installing the various components and equipment associated herewith. The review and compliance must be adhered to the relevant standards stipulated in 1.1.

All mechanical HVAC works are to be included in this contract and are to be executed by the HVAC contractor/HVAC contractor. All work is to be carried out strictly according to the relevant SANS Specifications, Codes of Practice and Institutional requirements. Such installations must be completed from shop drawings stage, procurement, installation, commissioning, handover of an operational system and relevant documentation pertaining to the operational and maintenance of the plant and equipment.

The works comprise the following HVAC systems and facilities:

- Internal or indoor units i.e. Console wall mounted units
- External components i.e. Whirly Birds
- All support types for the equipment and piping i.e. threaded rods, nuts, bolts, cable trays etc.
- Electrical cabling from isolators or DB boards for condenser units
- Electrical cabling from the isolators
- Commissioning of the systems and quality check sheet compilation as and when requested by the mechanical engineer.

The HVAC works is engineered, specified and shown on drawings and set out in this tender document.
The engineering, quality control and inspections, selection of Plant and Materials, preparation of workshop drawings, drawings, testing, adjusting, commissioning and preparation of operation and maintenance manuals, are to be executed in a systematic manner and programmed, under the Contractor’s supervision and direction.

The HVAC Contractor MUST ensure that the team responsible for the installation and commissioning of the system MUST be trained by the relevant supplier of procurement, prior to commencement of the installation.

Inclusive of the installation of the systems outlined above, will be the documentation required prior and upon handover of the product procurement and project execution. This is indicated in Section 1.5 and 1.6 of this document.

1.2.1 Drawing Schedule

The Engineer’s tender drawings for this project are listed below:

353538-M-101-T-A0-A – Magwedza HVAC Layout
353538-M-102-T-A0-A – Thengwe HVAC Layout
353538-M-103-T-A0-A – Makonde HVAC Layout
353538-M-104-T-A0-A – Mulenzhe HVAC Layout
353538-M-105-T-A0-A – Borwa HVAC Layout

1.3 Work not included

The following principal items of work will be done under specifications of other trades:

- All electrical power points i.e. isolators to be provided and co-ordinated with the electrical HVAC contractor.
- Drain point for the condensate header to flow into, at the ablution blocks or point of discharge and co-ordinated with the plumbing contractor.
- Making good of penetrations for ducting and weather louvers and must be co-ordinated with the main contractor.
1.4 Codes and Permits

Execute the work in full accordance with the requirements of all the Government agencies having jurisdiction. i.e. the requirements of Institutional Bodies such as the Local Authorities are to be adhered to.

1.5 Drawings

1.5.1 Interpretation of Drawings

1.5.1.1. No exclusions from, or limitation in the language used in the drawings or specifications shall be interpreted as meaning that appurtenances, or accessories necessary to complete any required system or item or equipment are to be omitted.

1.5.1.2 The drawings of necessity utilize symbols and schematic diagrams to indicate various items of work. Neither of these have any dimensional significance, nor do they delineate every item required for the intended installations. The work shall be installed in accordance with the diagrammatic intent expressed by the HVAC shop drawings and in conformity with the dimensions indicated on final architectural and structural working drawings and on equipment shop drawings.

1.5.2 Tender Drawings

1.5.2.1 The drawings accompanying this specification shall be deemed to indicate the general layout and requirements only and are not Shop Drawings.

1.5.2.2 The Engineer shall provide the Contractor, free of charge, with a set of Specification Documents, to include all Tender Drawings.

1.5.3 Architectural and Structural Drawings

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

1.5.4 Builders Work Drawings

1.5.4.1 All Builders work and work to be carried out by others in accordance with the specification, has been indicated in the document further, as a reference to the selected equipment, **Annexure A, Drawing Register.**
1.5.4.2 Such Builder’s Work Drawings to verify all HVAC contractor selections of equipment must accompany the Shop Drawings from the HVAC contractor, and indicate the location and extent of all foundations, bases, openings, timber frames and all other builder’s work and the capacities and/or dimensions of all electrical and water supply points, the method of terminating such supplies and the position of the connection points, the position and dimensions for all condensate drainage connections and any other work to be provided by others for the Works, as detailed in these specifications.

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

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

1.5.4.5 When approved the following number of copies of each such drawing shall be delivered to each of the following:

- Architect 1 Copy
- Quantity Surveyor 1 Copy
- Structural Engineer 1 Copy
- Electrical Engineer 1 Copy
- Main Contractor 2 Copies

1.5.5 Shop Drawings

1.5.5.1 The Contractor shall submit to the Engineer, for approval within the time frame of 2 weeks of appointment duplicate copies of all Shop Drawings as required for the manufacture and installation of the Works or as the Engineer may reasonably require.

1.5.5.2 All shop drawings for work outside of plant-rooms shall be drawn to a scale of not smaller than one in hundred. All details shall be drawn to a scale to show the detail required.

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

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

1.5.5.5 The Contractor shall also supply copies of all approved drawings in accordance with the requirements for the Operating and Maintenance Instructions.

1.5.5.6 Drawings approved as above described shall not be departed from except as authorized by the Engineer.
1.5.5.7 The Engineer shall have the right at all reasonable times, to inspect at the factory of the HVAC Contractor, all Drawings of any portion of the Works.

1.5.6 **Mistakes on Drawings**

1.5.6.1 Any expense resulting from an error or omission in or from delay, in delivery of the Drawings shall be borne by the HVAC contractor.

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

1.6 **Operating and Maintenance Manuals**

1.6.1 Any expense resulting from an error or omission in or from delay in delivery of the Drawings shall be borne by the HVAC contractor.

1.6.2 A condition of the final acceptance of the works will be the provision of three copies of an approved comprehensive Maintenance and Operating Instruction Manual.

Each copy of the manual is to include the following, but not limited to:

- A general description of the system and its operation.
- Details of the method of operation of the plant and controls.
- An equipment and controls list giving the following:
  - Description
  - Quantity
  - Make
  - Model Number
  - Location
  - A schedule of the servicing to be done on each item of equipment and controls and the frequency.
  - A log sheet giving the design parameters and provisions for the logging of these parameters by the plant operator.
  - Description of automatic control system, accompanied by control schematics (where necessary).
  - Step-by-step instructions for starting/stopping each item of equipment.
  - A record of relevant readings taken during final commissioning and hand-over tests.
1.6.3 Upon completion of the installation, there shall be furnished a set of drawings reflecting all work as actually installed, marked as RECORD DRAWINGS.

1.6.4 In the case of underground piping and work concealed above hung ceilings, dimensions off of column lines are to be included. Roughing in partitions need not be shown, except for stacks and risers.

1.6.5 The HVAC contractor, in addition to the operating and maintenance manuals, shall give detailed explanation of and instructions to the Owner on the operation of the complete installation, as finally commissioned and handed over.

1.6.6 The HVAC contractor shall operate the whole plant for a period of five consecutive full working days, after the plant is handed over.

1.6.7 During this period, the HVAC contractor shall instruct the Owner in the operation of the plant.

1.7 **Practical Completion**

1.7.1 The certification will be awarded to the contractor upon completion of all equipment installation, to include the operation of the system via permanent power supply. This must be viewed or witnessed by the Main Contractor and Engineer.

1.8 **Equipment Submittals**

1.8.1 Equipment specifications selected for procurement by the HVAC contractor must be compiled as an equipment submittal, for review and approval by the Engineer, prior to procurement.

1.8.2 The items must include for:
   - Air-conditioning units,
   - Condensate Piping Types,
   - Refrigerant piping and insulation,
   - Extract and Fresh Air Fans,
   - Ducting type and grade,
   - Filters media,
   - Damper Types

1.9 **Tests**

1.9.1 Subject the piping inside the building to a pressure test when soldering and connections are completed.
1.9.2 Test all refrigerant distribution systems and to a pressure of at least 50% of working pressure. Run test for a 24 hour period with no loss in pressure.

1.9.3 Furnish and pay for all devices, materials, supplies, labour and power required in connection with tests. Make all tests in the presence of and to the satisfaction of the Engineer, Consultant and Architect, and other Inspectors, as required.

1.9.4 Repair or if required by the Architect and Consultant, replace defective work with new work without extra charge to the Owner. Repeat tests as directed, until all work is proven satisfactorily.

1.9.5 Restore to its original conditions, any work damaged or disturbed by tests, engaging the original trades to do the work of restoration.

1.9.6 Notify the Engineer, Consultant, Architect and Inspectors having jurisdiction, at least 48 hours in advance of making the required tests, so that arrangements may be made for their presence, to witness the tests.

1.10 General Installation of Piping

1.10.1 Install pipes approximately as shown on the drawings and as directed during installation, as straight and direct as possible forming right angles or parallel lines with building walls and other pipes and neatly spaced. Erect pipe risers plumb and true and parallel with walls and other pipes and neatly spaced.

1.10.2 Keep all horizontal runs of piping, except where concealed in partitions, as high as possible and close to walls. Maintain minimum pitch on all soil, waste and rain water lines.

1.10.3 Do not install pipes or other apparatus in a manner which interferes with the full swing of doors.

1.10.4 The arrangement, positions and connections, of pipes, fixtures, drains, valves and the like, indicated on the drawings, shall be followed as closely as possible, but the right is reserved by the Architect to change locations and elevations to accommodate conditions which may arise during the progress of the work, prior to installation, without additional compensation for such changes.

1.10.5 Ream all screwed pipe smooth before installation. Do not bend, flatten, split or otherwise injure pipe.

1.10.6 Use reducing fittings, unless otherwise approved in special cases, in making reduction in size of pipe especially for the refrigerant piping.

1.10.7 Do not install exterior piping in water or when trench or weather conditions are unsuitable for work, as decided by the Engineer or Architect.

1.10.8 Galvanised cover sheets to be used for external or exposed piping on the plantroom levels.

1.10.9 Use friction type wrenches and vices on all copper tubing and brass piping.

1.10.10 Carry fixture connections, concealed in building construction, to points above floor, break out close to the underside of fixture and rise exposed to fixture.

1.10.11 Do not use/install any 95º drainage junctions or non-standard angles, in any horizontal run, prior to approval from the Engineer and Architect.
1.10.12 The ends of pipes and the jointing material shall be properly inspected to ensure that no defective parts are used. The pipes shall be jointed according to the instructions of the manufacturer.

1.11 **Coordination with Other Trades**

1.11.1 Render full co-operation to other trades. Provide any information necessary to permit work of all trades, to be installed satisfactorily and without interference or delay.

1.11.2 Where work is to be installed in close proximity to work of other trades, or where there is evidence that work may interfere with work of other trades, assist in working out space conditions to make satisfactory adjustments.

1.12 **Valve Charts and Tags**

1.12.1 Provide an approved valve tag for each valve, except valves within two metres of equipment it controls, need not be tagged. Attach the tag to valve handle or spindle with chrome chain.

1.12.2 Provide diagrammatic charts of all piping systems. Provide schedules of all valves. Provide three copies of charts and schedule bound booklets. Valve numbering system shall differentiate between classes of service and shall indicate floor level where valve is installed. Submit method for approval before final preparation.

1.12.3 These drawings must be included in the O&M Manuals upon handover.

1.13 **Hangers and Supports**

1.13.1 Properly supported piping by approved type hangers and supports of ample size to carry pipe and its contents. Support horizontal threaded pipe at least every 3 metres, copper tubing every 2 metres and C.I. soil pipe every 2 metres and behind every hub.

1.13.2 All hangers and brackets to be galvanised type or similar approved, with sound insulating inserts or approved equal.

1.13.3 Furnish and pay for all devices, materials, supplies, labour and power required in connection with tests. Make all tests in the presence of and to the satisfaction of, the Architects, Consultant, and other Inspectors as required.

1.13.4 Repair, or if required by the Architect and/or Consultant, replace defective work with new work without extra charge to the Owner. Repeat tests as directed, until all work is proved to be satisfactory.

1.13.5 Restore to its original conditions, any work damaged or disturbed by tests, engaging the original Trades to do the work of restoration.

1.13.6 Certification documents of the supports to be included in the operation and maintenance manual for all supports used for each system.
1.13.7 All support brackets must be of the correct size, strength and must allow for expansion, contraction and anchoring of the pipes.

1.13.8 A full detail of the hangers and supports proposed must be submitted for fixing, with indication on Shop drawings.

1.13.9 The brackets and supports must be positioned and set out to allow for sufficient access for maintenance or removal of equipment, valves, etc.

1.13.10 Hangers and supports that are to be used for material with thermal insulation properties, must be provided with load bearing insulation to prevent any compression or crushing of the insulation.

1.13.11 Generally, supports shall preferably be proprietary products, such as UNISTRUT or failing this, shall be galvanised mild steel sections, purpose fabricated to suit the application.

1.13.12 Under no circumstances, whatsoever, will mild steel straps be accepted as a supporting method.

1.13.13 All supports shall cradle the equipment to be supported, and not riveted or welled to the equipment.

1.13.14 Rod hangers must be at a minimum of 10mm support for the indoor unit installation.

1.13.15 Fastening methods shall employ REDHEAD or RAMSET or HILTI anchor bolts or their equivalent for fixing supports to the building structure.

1.14 **Soldering**

1.14.1 Solder shall be in accordance with SABS 24-1971 (as amended) or DIN 1707 and to be grade 97/3 i.e. 07% tin and 3% copper. The flux used shall be water based and contain no ammonia and to be Everflux or similar approved.

1.14.2 Sizes 76 and 108 done with a hard silver solder as Silbraloy or a 30 - 40% cadmium based silver solder using the oxygen acetylene torch method.

1.15 **Expansion**

1.15.1 Expansion offsets/expansion loops shall be installed, as indicated on the drawings and in accordance with the manufacturer’s specifications.

1.16 **Penetration of pipes in Walls**

1.16.1 Any copper piping chased into walls require to be protected with a buff tape or an approved equivalent, no brown paper or cement bags may be used.
1.17 Guarantee of Workmanship and Material

1.17.1 Submit, upon completion of the work, a single guarantee stating that all portions of the work are in accordance with the Contract requirements, perfect as to materials and workmanship and will so remain for a period of twelve months from the date of final acceptance and/or beneficial occupation to the Owner.

1.17.2 Guarantee that during the one year period that the appointed HVAC contractor, will repair all defective work and will replace all defective work and all defective materials furnished, or installed under this section, without charge to the Owner.

1.18 Quality Assurance

1.18.1 The HVAC contractor shall institute an approved Quality Assurance System (QA) which shall be submitted for approval. The records of this QA system shall be kept throughout the duration of the contract and must be submitted at regular intervals. The QA system shall comply with SABS 0157.

1.19 Insulation

1.19.1 Pipe work – to be insulated with Armacell Closed Cell, CFC-free or approved equal.

1.19.2 Valves and Fittings - metre plain preformed pipe section.

1.19.3 Exposed Piping - to be insulated with Armacell (Closed Cell, CFC-free with 0.5mm thick corrugated aluminium muffs secured with 15mm aluminium strapping banks and seals.

1.19.4 All thermal and acoustic insulation materials, adhesives, straps and finishes used shall, when tested in accordance with SABS Standard 1238-1979 and BS standard 476, comply with the stated indexes for surface spread of flame, heat contribution, smoke contribution and fire index.

1.19.5 Material shall be free from substances, which in the event of a fire would generate appreciable quantities of smoke, noxious or toxic fumes.

1.19.6 Flexible ducting complete with insulation shall be constructed of non-combustible material as required in terms of the building regulations provided that:

- Approved combustible flexible connections may be used where the length of such connection does not exceed 1,5m and such connection does not pass through any wall or floor which is required to have a specified fire resistance.
- Approved combustible flexible joints not more than 250mm in length may be used in any plant room where such plant room is protected by a smoke detection system.
1.20 **Noise Attenuation**

1.20.1 Units shall be installed in accordance with manufacturer’s recommendations and shall be capable of being fitted into the spaces indicated on the drawings.

1.20.2 The unit shall not drum, vibrate or leak under any operating conditions.

1.20.3 Noise level in the conditioned space through the operation of the unit at any operation point shall not exceed the specified noise level with an 8db room attenuation factor in each octave band.

1.20.4 All penetrations through building structures shall be sealed against ingress of water and air.

1.20.5 All piping/conduits/wiring/supports shall be neatly and securely fixed to the building structure.

1.20.6 Method of fixing shall be submitted for acceptance to Engineer prior to installation.

1.20.7 The units shall be suitable for mounting as indicated on drawings.

1.20.8 Condenser air intake and discharge arrangements shall be such that no short-circuited discharge air can be drawn back into the air intake.

1.20.9 Support plinths for the plantroom area, must be indicated to have an absorption layer between the floor slab and plinth. Such must be co-ordinated with the main Contractor for compliance.
2. TECHNICAL SPECIFICATION

2.1 Description of the Works

2.1.1 General

All Heating, Ventilation and Air-conditioning works are to be included in this contract and are to be executed by the HVAC contractor. All work is to be carried out strictly according to the relevant SANS Specifications, Codes of Practice and Institutional requirements. The works comprise a standalone console unit system and facilities being catered for, which form part of the contract.

2.1 Description of System

The designed system for the building is the standalone system, which is regarded viable for the application. Console units (floor-ceiling) are self-contained units, which are mostly utilised in large commercial offices and can be used for low-wall or ceiling suspended mounting. The units are installed by drilling two ventilation holes in any wall thickness even glass and then hung. The idea of “No Outdoor” unit provides a solution for complex installations such as with building aesthetics in mind to ensure continuity of all architectural features and designs on exterior walls. They incorporate the latest technology and are ideal for residential applications, offices and shops.

The system is designed to incorporate the clients required energy efficiency using approved refrigerant gas, to further satisfy green building requirements. The units allow for space storage and for independent user operation for personal comfort needs. Each air-conditioned space in the building will include air conditioning units and accompanying hard wired controllers. The average heat load demand taken into account caters for 120-160 W/m² in the cellular office spaces. Controllers will be operated by the users, to cater for the working space temperature requirements. The space temperature shall be maintained between 21.5°C and 24.5°C in summer and 20°C and 23°C in winter. The moisture loads, outdoor climatic conditions and ventilation rates do not require active management of the Relative Humidity to meet a 40% to 60% RH criteria.

Anti-vibration mounts and/or spring mounts must be installed for all equipment, to absorb the vibration and eliminate sound during operation.

Extraction in ablutions and plant rooms is to take place via whirly birds with transfer grilles for make-up air.
2.2 **General Scope of Works**

The purpose of the document is to define the scope of work related to the installation of the HVAC system for the Building. The development comprises of a ground level only, for the building to include standalone single units, creating the comfort required.

2.3 **Design Parameters**

<table>
<thead>
<tr>
<th>Site</th>
<th>Limpopo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient Temperature</td>
<td>Summer</td>
</tr>
<tr>
<td>Site Ambient Temperature</td>
<td>33.3°C dB, 21.1°Cwb</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Indoor Design Conditions</th>
<th>Summer and Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor Design Conditions</td>
<td>22°C dB ± 1.5°C, 50% relative humidity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operating Voltage General Frequency</th>
<th>400V, 3-phase, 230V, 1-phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>50 Hz</td>
</tr>
</tbody>
</table>

| Toilet Extraction Frequency of Use | 8 hours/day or connected to the light switch for operation |

<table>
<thead>
<tr>
<th>Fresh Air Fans</th>
<th>Operated with AC unit start-up, to include an override switch for independent operation, when required.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Noise Levels</th>
<th>Occupied Office Space</th>
<th>Unoccupied Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise Levels</td>
<td>NC 35</td>
<td>NC 45</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fresh Air Rate</th>
<th>L/s/person</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh Air Rate</td>
<td>7.5 L/s</td>
</tr>
</tbody>
</table>
2.4 Evaporative/Indoor Units

2.4.1 The evaporator unit shall be made of sheet metal and shall be thermally and acoustically insulated throughout, on all panel inner surfaces. Exposed edges of insulation material are to be neatly finished with riveted galvanized sheet metal nosing strips. Readily removable panels shall provide easy access to all the internal components.

2.4.2 Where the unit is exposed in the occupied space, the external casing shall be aesthetically pleasing. Approval of the Architect must be confirmed prior to ordering of any equipment.

2.4.3 The evaporator coils shall be manufactured from copper tube with aluminium bonded fins, unless otherwise specified. In areas of high humidity (e.g. coastal regions), tubes and fins are to be copper.

2.4.4 The evaporator fan or fans shall be aluminium, forward curved tangential type and shall be dynamically balanced. The fan motor must be mounted on rubber bushes and quiet operation must be ensured.

2.4.5 Electric heaters, when required, shall be of the incaloy sheathed type, suitable for operation in still air. The element shall be properly supported in the air stream. An auto-reset “klixon” shall be provided, as well as a manually resettable overheat thermostat to switch off the heater in the event of a “no-flow” failure.

2.4.6 The type of indoor unit is specified in the schedule.

2.4.7 Each indoor unit/group of units shall have a unique address in case of individual/group control and in case of a central controller the address shall be set from the central controller.

2.4.8 Installation to comply to manufactures detailed specification and guideline.

2.5 Controls

2.5.1 Temperature control of indoor units shall be PID control. Set points shall be adjustable within a range between 19°C and 24°C. Controller shall select cooling/heating/ventilation mode on the unit and control the refrigerant supply to the unit within an electronic control device. Controllers shall have self-diagnostic capabilities and shall memorise the last malfunction.

2.5.2 Where a wireless remote controller is provided a manual override function shall be provided on the indoor unit.

2.5.3 A LCD controller shall be capable of controlling units individually or in groups. Fan speed and air distribution shall be controlled individually on indoor units in individual or group control arrangement. Controllers shall be clearly marked and easy to operate.

2.5.4 Control panels shall be installed in a position approved by the engineer and the Architect. Wiring to be installed in approved trunking or ducting.

Control and safeties shall include but not be limited to the following:
- internal overload protection on all motors
- high and low pressure cut-out (automatic reset)
2.6 Equipment Bases

2.6.1 Static plinths, 100mm minimum high, shall be provided by the Principal Contractor for mounting equipment upon them. The plinths are to be rectangular in shape unless otherwise stated or shown on the drawing and 150mm larger all around the equipment to be mounted on them. This must be indicated on the Shop drawings and co-ordinated with the Principal contractor.

2.6.2 All anti-vibration mountings shall be installed in full accordance with their manufacturer’s application instruction, similar to that of Alstom, ex E.M Arnot.

2.6.3 All equipment bases and anti-vibration mountings shall be corrosion free.

2.6.4 Full details of all floating steel bases and all anti-vibration mounting selections shall be approved by the engineer prior to the mounting being ordered and the bases fabricated.

2.6.5 Where applicable, the HVAC contractor shall exercise particular care to prevent damage to the roof slab when hoisting, positioning and connecting the air-conditioning units and shall note that he/she will be responsible for repairs caused as a result of this installation.

2.6.6 All cut joints and holes within ducting, equipment casing, supports, stands, platforms, suspension brackets and supporting cable trays shall be fully protected against corrosion.

2.7 Air Filters

2.7.1 Air filters shall be installed before the fan for the fresh air supply to the internal units.

2.7.2 The filters are to be at a minimum of 50mm thick, high performance washable pleated panel filters.

2.7.3 These filters must be installed to allow for easy access during the requirement of maintenance i.e. to be fitted into holding frames, which shall be designed to allow a negligible quantity of air to bypass the filters.

2.7.4 The return air grilles to have 4mm washable filters installed for each unit return flow.

2.8 Door Grilles (Where applicable or indicated)
2.8.1 Door grilles shall be of extruded aluminium construction suitable for fitting into doors of varying thickness and shall be finished in a colour to suit the architect's requirements.

2.8.2 Door grilles shall be fixed to doors by means of countersunk screws with a colour to match the grilles.

2.9 **Intake and Exhaust Weather Louvers**

2.9.1 The weather louver shall be complete with a mounting frame suitable for building in by the builder, on a 25mm timber frame by the builder.

2.9.2 The weather louver shall be vermin-proof and of an aluminium vane type, natural anodised.

2.10 **Vibration Isolators: Flexible Connectors**

2.10.1 Suction and discharge lines from the compressor shall be fitted with flexible connectors of the bronze braided hose type, having sweat-ends, to fit over copper tubing having the same size as the line in which they are installed.

2.11 **Noise and Vibration**

2.11.1 Sound attenuators and vibration isolating must be installed to all equipment generating the noise levels during operation.

2.11.2 Due to the close proximity of the units to sensitive occupied areas, it is essential that the in selecting vibration isolators, which match the characteristics of the machinery used. The HVAC contractor is responsible for the prevention of direct transmission of vibration from moving plant to the structure.

2.11.3 The HVAC contractor is to make the necessary corrections in an accepted manner without additional charge for noise in excess of the specified limits and vibration considered excessive by the Engineer and for the transmission of noise and vibration due to faulty plant or workmanship.

2.11.4 Anti-vibration cuff connections of flexible joints shall be used on ductwork where it joins vibrating equipment such as fans and air-conditioning units.

2.11.5 If in the opinion of the engineer, any equipment operates with, or transmits from it, objectionable vibrations or noise above the levels specified for the individual areas, it will be necessary to rectify or replace such equipment to the full approval of the engineer at no additional cost to the owner.

2.11.6 Sound attenuators shall be the product of a manufacturer regularly engaged in the production thereof such as Luft, Donkin, Trox, or other equal and approved.
2.11.7 Published catalogue data or a certified laboratory test report showing sound attenuation characteristics of each sound absorber shall be submitted for approval.

2.11.8 Sound attenuators shall be flanged and provided complete with matching flanges.

2.11.9 Casings shall be constructed of galvanised mild steel sheet, flanged for connection to ductwork, complete with matching flanges. The thickness of sheet steel shall be not less than the thickness specified for ductwork of the same dimensions.

2.11.10 The sound absorbing material shall not impart any odour to the discharge air, delaminate or be loosened by the air stream under regular operating conditions. The material shall be vermin-proof, fire retardant and rot resistant.

2.11.11 The provisions for sound attenuation and nominal sizes thereof as shown on the drawings are based on average published data for noise attenuation, and are for tendering purpose only.

2.11.12 The HVAC contractor shall produce his own calculations and select attenuators to maintain specified noise levels, based on the actual selected equipment.

2.11.13 Anti-vibration mountings shall be installed in conjunction with all the relevant bases, and in accordance with their manufacturers application instructions.

2.11.14 All equipment bases and anti-vibration mountings shall be corrosion free.

2.11.15 All equipment and particularly that, which is mounted on the roof, shall operate without objectionable noise or vibration being transmitted, to the full satisfaction of the Engineer.

2.11.16 Rectangular ductwork in the vicinity of critical areas, shall be provided with internal acoustic insulation.

2.11.17 Anti-vibration cuff connections of flexible joints, shall be used on ductwork, where it joins vibrating equipment such as fans and air-conditioning equipment.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Minimum Deflection</th>
<th>Static Deflection</th>
<th>Type of Mountings</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air-conditioning units and condensing units on concrete bases</td>
<td></td>
<td></td>
<td>Neoprene Vibration Pads</td>
<td>NK or WMW</td>
</tr>
<tr>
<td>Over occupied spaces</td>
<td>To suit fan speed</td>
<td></td>
<td>Helical spring with level adjustment</td>
<td>SLR</td>
</tr>
<tr>
<td>Axial flow fan</td>
<td>6mm</td>
<td></td>
<td>Neoprene in sheer and compression</td>
<td>30N</td>
</tr>
</tbody>
</table>

2.12 Toilet Ventilation

2.12.1 The toilet extraction system WHIRLY BIRD(s) are positioned at high level within the toilets and ducted to the relevant sanitary ware of the ablution services for each toilet section i.e. male and female.
2.12.2 The whirly bird (s) extract via extract grilles creating a negative pressure to allow the odours to be displaced by fresh air.

2.12.3 The whirly birds(s) operate 24hrs a day

2.12.4 Make up air for the toilets will be via door grilles at 300 x 300mm neck sizes, as indicated on the drawings.

2.12.5 The transfer grilles to extract from the toilet areas not accessible to openable windows.

2.13 **Corrosion Protection**

2.13.1 All nuts and bolts shall be either hot dip galvanised or stainless steel unless otherwise specified.

2.13.2 All galvanised nuts and bolts shall be de greased, patch primed and finish coated in accordance with the specification for the respective area of the plant.

2.13.3 Care must be taken to prevent or mitigate the corrosion caused by dissimilar metal contact on cooling coils, tubes and tube plates, pipes, flanges, frames etc. Typical metals encountered would be copper, aluminium, zinc, mild steel and stainless steel.

2.13.4 The junctions between dissimilar metals must be electrically insulated where possible.

2.13.5 Pipe flanges between dissimilar metals must be insulated using insulating gaskets for the flange faces and insulating sleeves and washers for all nuts and bolts.

2.13.6 Where the insulation of the junction between dissimilar metals is not practical, the cathode surface on the electrolyte or ‘wet’ side must be coated for a minimum distance of 100 mm from the junction. The applied coating must effectively isolate the coated surface from the electrolyte.

2.14 **Labelling**

2.14.1 Labels shall be firmly fixed to all major items of plant. These labels shall describe the item of equipment and indicate a reference or identification number, as defined on the engineers drawings.

2.14.2 Labels shall be provided on all gauges, meters, instruments, pilot lamps, remote control switches, motor controllers and panel mounted items. These labels shall clearly identify the equipment controlled by the item.

2.14.3 Labels shall be manufactured of non-corroding, non-glossy material. Lettering to be black engraved on a white background. All labels shall be permanently fixed, either by screwed fixing or an approved adhesive or glue. “Double-sided” tape fixing will not be accepted.
2.15 **Painting and Cleaning**

2.15.1 Labels Painting shall comprise of the following consecutive processes. Firstly to thoroughly clean, descale and degrease all surfaces, in accordance with acknowledged good practice, to which a good coating of approved zinc-rich primer and finish with two coats of quality high gloss enamel of an acceptable make. An approval by the engineer is to verify the final finish.

2.15.2 Whereas, it would not be necessary to paint ductwork, conduits or pipework installed in roof voids, shafts etc., it is still a requirement to this equipment is properly cleaned and treated. However, non-visible items that are not galvanised must be treated to prevent rust collection and possible failure.

2.15.3 Due to the sensitivity of the equipment during the construction phase, the HVAC contractor must ensure that prior to practical completion, all equipment have been cleaned, filters cleaned and overspray of paint, plaster and cement, removed.

2.16 **Automatic Controls (where applicable)**

2.16.1 Provide, install and set into operation all the automatic control devices shown on the relevant drawings and interlock same as required to perform their function correctly.

2.16.2 The temperature controllers shall be as per the specified type in the bill of quantities, and as indicated on the suppliers wiring diagrams.

2.16.3 Room thermostats shall be securely mounted to suitable bases, mounted on the walls or other building surfaces. Each thermostat shall be located as shown on the drawings, of if not will respond to average temperature in the room.

2.16.4 The thermostats, in which the adjusting mechanism is integral with the sensing element, shall be locked or concealed adjusting devices by means of which the operating points, can be adjusted through a range of a maximum of 5 degrees and 10%, respectively, above and below of the operating set points.

2.16.5 An override must be catered for, from BMS systems, for allowing an hour of operation by a single user, post working hours i.e. 17:00.

2.16.6 The plant and fans to be started in sequence by means of time delay relays, or as indicated on the electrical layouts.

2.16.7 Each refrigerant circuit within the packaged air-conditioning units shall include a dual pressure switch, with manual reset on the high pressure side and an oil pressure switch.

2.16.8 Ventilation fans shall be interlocked with the air-conditioning systems. However an override to allow for operation during air-conditioning failure to be allowed for.

2.16.9 The air-conditioning plant and fans must be linked to the fire detection system, to switch of in the case of an emergency alarm or activation of the detection system.
2.17 **Electrical**

2.17.1 A switched power supply, terminating in an isolator adjacent to the condensing unit, shall be provided by others.

2.17.2 Main power incomers to plantrooms will be provided by others.

2.17.3 The HVAC contractor shall supply all power and control wiring from the isolator to the condensing unit and from the evaporator unit to the condenser unit.

2.17.4 This MUST be co-ordinated on site to ensure that correct circuit breakers are provided by the electrical contractor.

2.17.5 Electrical wiring shall comply with the SANS code of practice for the Wiring of Premises and the additional requirements of the local authorities who have jurisdiction over the site works, as well as being in accordance with best modern practice.

2.17.6 Galvanised conduits and conduit fittings must be installed in positions that are exposed to weather or moisture surroundings. Where, galvanising has been removed by threading, cutting etc., the exposed parts shall be suitably treated, with cold galvanising to render them weatherproof and rust resistant.

2.17.7 No conduit is to cross an expansion joint in the structure, without an approved arrangement for crossover.

2.17.8 Exposed conduits must be fitted with steel saddles of same finish as the conduits, pitched at centres not exceeding 2 meters.

2.17.9 Conduits shall be galvanised to SANS specifications. All joints shall be screwed. No conduit less than 20mm shall be used.

2.17.10 Exposed conduits shall be fitted with steel saddles of same finish as conduits pitched at centres not exceeding 2 metres.

2.17.11 All wiring shall, unless otherwise specified, be carried out with PVC insulated cable to SANS 150-1970.

2.17.12 The wiring in all plant rooms shall be supported on cable trays or cable ducts. Cable trays must be run strictly vertical or horizontal planes, with 45° bends allowed only.

2.17.13 All earthing shall be carried out in accordance with wiring regulations, earthing connections being executed with appropriate copper earthing strip using brass bolts, nuts and washers, to ensure continuity to main building earth provided by others.

2.17.14 On cable systems, leave sufficient cable slack, to allow free cable movement, to take up vibration.

2.17.15 All connections to vibration equipment, must be made so as to not impose strain on conduits, cables, conductors or equipment and shall be sufficient length to allow full adjustment of motors on slide rails.
2.18 **Commissioning**

2.18.1 Following completion of the works or any portion of the works as specified or directed by the engineer, the HVAC contractor shall balance, set and test the works or portion of the works, in accordance with the following requirements, to establish the capacity and satisfactory performance of the Plant.

2.18.2 All balancing, setting and testing shall be done by the HVAC contractor entirely at his/her own expense. The HVAC contractor shall provide all facilities and apparatus for the testing of the plant and shall carry out tests as may be necessary to satisfy the engineer that the plant meets with the requirements of the specification.

2.18.3 The HVAC contractor shall also carry out or attend upon all tests required by Government and Local Authorities who have jurisdiction over the works and shall obtain all necessary certificates of approval and acceptance and provide the engineer with triplicate copies off all such certificates prior to or at such time as, providing the engineer with copies of the “preliminary tests” report.

2.18.4 The HVAC contractor shall when required, provide the engineer with equipment selection and performance data for all major items of plant such as the Air-conditioning units, Fans, etc.

2.18.5 The Engineer reserves the right to insect any item of equipment during the manufacture or before delivery to site. The HVAC contractor shall make available any item for such inspection.

2.18.6 The condensate drains shall be tested for proper functioning by pouring water down them at a rate of at least 4 times normal drainage.

2.18.7 Air systems shall be checked for obstructions and balancing to provide the required air-flow or quantity at each outlet without objectionable noise and draughts and so that the velocity of the air is relatively uniform over the area of the outlet.

2.18.8 All automatic controls and safety devices shall be checked for correct performance and satisfactory operation and set to the respective settings required.

2.18.9 The HVAC contractor shall ensure that the plant operates satisfactorily and uninterrupted for a period of 7 days prior to final acceptance by the engineer. Evidence of this, for the air-conditioning systems, shall be given in the form of a 24 hour long continues recording temperature and humidity, which recording shall cover at least 50% of the areas handled by one plant and shall be handed over to the engineer prior to inviting him to the final tests and acceptance of the completed installation.

2.18.10 The original recorded graphs shall be supplied to the engineer and the HVAC contractor shall also obtain and provide the engineer with the daily maximum dry and wet bulb temperature readings recorded in the area on the same days as the inside conditions are recorded. Such information may be obtained from local weather conditions.
2.19 Close Out

2.19.1 Defects Period

2.19.1.1 The installation shall have a 12 month guarantee, inclusive of manufacturers’ recommended scheduled maintenance and servicing, from the date of practical completion. The compressors on the condensing units shall include a guarantee from the Manufacturer for a period of 5 years from the date of handover to the Client. The guarantee shall cover the performance of the works and any defects due to inferior materials or workmanship. The Subcontractor shall repair or replace any such defects without delay.

2.19.2 Training

2.19.2.1 The design team and contractor are contractually obligated to provide fully encompassing project knowledge to the building owner / facilities management team through the development, generation and execution of the following key activities and materials.

2.19.2.2 The Subcontractor shall provide a training course for the Client’s operation and maintenance staff members after the system is functionally complete. Training to include a discussion of the system design and layout and demonstrate routine operation, maintenance and troubleshooting procedures.

2.19.2.3 At building handover the contractor is contractually required to provide the following documentation to the building owner and undertake all required training to ensure that all building systems are included:

<table>
<thead>
<tr>
<th>Fully documented Design Intent including summary schematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>As-Built / Installed Drawings (including both digital and hardcopy to reflect the as-built systems &amp; equipment)</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Operations and Maintenance Manuals; fully collated, indexed and referenced (electronic compilation to be submitted in addition to hard copy)</th>
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<tbody>
<tr>
<td>• Describing how facility will be operated;</td>
</tr>
<tr>
<td>• By whom – operational responsibility matrix;</td>
</tr>
<tr>
<td>• Building occupant training requirements for occupant interactive systems</td>
</tr>
</tbody>
</table>
Commissioning Report; Including documentation requirements and:

- To include all major plant and equipment as discipline applicable (including chillers, boilers, heat pumps, air handling units, water treatment/recycling systems, onsite generation systems, water distribution (chilled, heating hot water and domestic hot and cold water), lighting system, air distribution, lifts and vertical transportation systems and automated controls (within the BMS and/or Energy metering, HVAC, and wet services)

Training of Building Management Staff: Training to be conducted; training register to be maintained and submitted by all contractors. The following minimum training must be provided:

- Covering Information provided in the design intent report (including energy and environmental features & strategy)
- Review of controls set up, programming, monitoring, alarms and troubleshooting
- Review of O&M manuals
- Building operation for the following conditions:
  - Start up
  - Normal Operation
  - Unoccupied Operation
  - Seasonal Changeover
  - Shutdown
  - Emergency
- Measures that can be taken to optimize energy efficiency
- Occupational health and safety (OH&S) issues and risks
- Maintenance requirements and sourcing replacements / attic stock
- Obtaining and addressing occupant satisfaction feedback
3. COMMISSIONING

3.1 Introduction

3.1.1 This specification is to be read in conjunction with the contents of the extracts from base building specification appended to include the Architects specification and layouts.

3.2 Nominated Commissioning Methodologies

3.2.1 Standards

- SANS 5151 – Non-ducted air conditioners and heat pumps-Testing and rating for performance.
- SANS 10147 – Refrigeration systems including plants associated with air conditioning systems.
- SANS 10173 – The installation, testing and balancing of air conditioning ductwork.
- SANS 10400-(Part O) – Application of the National Building Regulations.
- SANS 13253 – Ducted air conditioners and air-to-air heat pumps-Testing and rating for performance.
- SANS 54511-1 – Air conditioners, liquid chilling Automatic electrical controls for household and similar use Part 1-General Particular requirements for temperature sensing controls.
- SANS 60730-2-9 – Automatic electrical controls for household and similar use Part 2-9-General Requirements.
- SANS 60730-2-11 – Automatic electrical controls for household and similar use Part 2-11-Particular requirements for energy regulators.
- SANS 60730-2-15 – Automatic electrical controls for household and similar use Part 2-15-Particular requirements for automatic electrical air flow, water flow and water level sensing controls.
- SANS 60730-2-18 – Automatic electrical controls for household and similar use Part 2-18-Particular requirements for automatic electrical water and air flow sensing controls, including mechanical requirements
- Packages and heat pumps with electrically driven compressors for space heating and cooling Part 1-Terms and definitions.
- SANS 54511-2 - Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling Part 2-Test conditions. SANS 60730-1

3.2.2 Knowledge Transfer

3.2.2.1 The design team and contractor are contractually obligated to provide fully encompassing project knowledge to the building owner / facilities management team through the development, generation and execution of the following key activities and materials.
3.2.2.2 At building handover the contractor is contractually required to provide the following documentation to the building owner and undertake all required training to ensure that all building systems are included:

- **Fully documented Design Intent** including summary schematics
- **As-Built / Installed Drawings** (including both digital and hardcopy to reflect the as-built systems & equipment)
- **Operations and Maintenance Manuals**: fully collated, indexed and referenced (electronic compilation to be submitted in addition to hard copy)
  - Describing how facility will be operated;
  - By whom – operational responsibility matrix;
  - Building occupant training requirements for occupant interactive systems
- **Commissioning Report**: Including ALL documentation requirements and:
  - Demonstrate that the services were commissioned in compliance with Commissioning Codes for all services;
  - Include commissioning dates, records of all functional/commissioning testing undertaken, a list of any future seasonal testing, and a written list of outstanding commissioning issues
  - Include the outcomes and changes made to the building as a result of the commissioning process, accounting for all of the recommendations
  - To include all major plant and equipment as discipline applicable (including chillers, boilers, heat pumps, air handling units, water treatment/recycling systems, onsite generation systems, water distribution (chilled, heating hot water and domestic hot and cold water), lighting system, air distribution, lifts and vertical transportation systems and automated controls (within the BMS and/or Energy metering, HVAC, and wet services)

### 3.3 Test Certificates

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

A600 Quality Control

610 GOVERNING STANDARDS

- The following are the Governing standards for the works:
  - South African National Standards (SANS).
  - British standards (BS).
  - European Norms (EN).
  - International standards (ISO)
  - Agreement certificates

612 BUILDING CODES & REGULATIONS

- Comply with the following:
  - Construction Regulations.
  - Building Regulations.

620 QUALITY ASSURANCE & QUALITY CONTROL

- Create and maintain a quality assurance and quality control system.
- Set out the quality programme in a quality control manual:
  - Make sure that essential inspection requirements are known and carried out during all phases of the works.
- Describe:
  - The organisation systems.
  - Inspection and test plan procedures.
  - Personnel to be employed, together with their qualifications.
  - Methods of checking each type of test and tolerance.
  - Recording of checks.
622 MATERIALS

- Materials to be new unless specified otherwise.
- Health hazards: No proposed materials shall present a hazard to health.
  
  - Conduct a hazardous materials survey prior to any demolition
  - Any hazardous material found in buildings or structures to be demolished to be removed by a registered hazardous waste disposal company
  - Obtain certificates proving that the hazardous waste was disposed of correctly.

- Harmful materials: Do not use.
  
  - Asbestos or products containing asbestos.
  - Lead where the metal or its products may be directly ingested, inhaled or absorbed.
  - Urea formaldehyde.
  - Materials comprising mineral fibres with a diameter of 3 microns or less and a length of 200 microns or less not stabilised to prevent fibre migration.

- Alternative materials: To be certified in writing by the Architect before substitution of a different product or material to that specified.

626 ALTERNATIVE MATERIALS

- Obtain the written approval of the Architect before substitution of a different product or material to that specified.
  
  - Submit: Evidence that the alternative product is equivalent in respect of material, safety, reliability, function and appearance.
  - A request for a substitution shall be deemed to be a warranty by the Contractor to the client that such substitutions meet the requirements of the Specification.

- Where any substitution alters the specified requirements, submit sufficient information on substituted materials to allow evaluation by the Architect on any deviations from the Specification.
• The Contractor shall obtain written approval from the Architect or the Employer before substituting adhesives or sealants listed in the adhesives and sealants schedule.

630 CERTIFICATION

• Requirement: The Contractor to certify that all products and materials used on the project comply with this specification.

WORKMANSHIP

640 SKILLED PERSONNEL AND METHOD STATEMENTS

• Personnel:
  
  o Use persons skilled in the processes required
  o When requested, provide evidence to show an individual's ability to carry out the work/process.

• Contractor's method statements:
  
  o Describe: The order of work and methods to be employed.
  o Identify solutions regarding workmanship which affect: Fabrication, holding, storing and handling, setting-out, site assembly, bolting, joining and welding of components.
  o Propose methods, principles, details, etc. for Site cutting of components as part of the method statement.
5. Bill of Quantities
Mechanical Internal Wet Services
Tender Specification

NATIONAL DEPARTMENT OF HEALTH – SMALL AND SMALL+ CLINICS
December 2015
Mechanical
Internal Wet Services (IWS)
Tender Specification

NDOH SMALL AND SMALL+ CLINICS

DECEMBER 2015
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<td>Z. Thys</td>
<td>V. Vythilingam</td>
<td>V. Ramsundara</td>
<td>IWS Tender Spec</td>
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2 WATER TREATMENT
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3 DISTRIBUTION SYSTEMS
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7 BILL OF QUANTITIES
DEFINITIONS

For the purposes of this part of SANS 10252, the definitions given in the National Building Regulations and Building Standards Act, 1977 (Act 103 of 1977), and the following definitions apply:

“acceptable”, “adequate”, satisfactory” or “suitable” means acceptable, adequate, satisfactory or suitable -

aerator
device fitted to the outlet of a tap or mixing valve, to entrain air in the discharge

air vessel
air chamber, hydrosphere expansion tank, closed chamber (with or without diaphragm) that utilizes the compressibility of contained air or gas, to

a) promote a more uniform flow of water when the chamber is connected to the delivery pipe or suction pipe of a reciprocating pump, or
b) minimize shock due to water hammer when the chamber is connected to a high-pressure water system, or
c) augment the transient supply pressure in an installation.

appliance
any receptacle, apparatus or device that is permanently connected to the water supply, such as storage tanks, cisterns and sanitary fixtures.

approved
approved by the local authority in whose area of jurisdiction the installation is carried out, including approval contemplated in section 7 of the National Building Regulations and Building Standards Act, 1977 (Act 103 of 1977), or approval by the review board in terms of the above Act

solar water heater
water heater that is designed to be integrally connected to solar water heating panels and receives its heating energy from such a panel

auxiliary outlet
anti-vacuum device that incorporates an open outlet to the atmosphere and that cannot be closed or become submerged and is sited on the downstream side of a terminal water fitting

backflow
flow of water in a pipe in a direction opposite to the normal direction of flow

backflow prevention device
double check valve backflow preventer
water fitting that incorporates at least two independently acting non-return valves, complete with facilities for testing the water tightness of each non-return valve independently

reduced-pressure backflow preventer
water fitting incorporating two or more return valves and an automatically operating pressure differential relief valve located between two non-return valves, and including facilities for testing the water tightness of the control stages within the valve
ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
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<tr>
<td>SHR</td>
<td>Shower</td>
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<tr>
<td>UR</td>
<td>Urinal</td>
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<td>WHB</td>
<td>Wash hand basin</td>
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<tr>
<td>WC</td>
<td>Water closet</td>
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<tr>
<td>WH</td>
<td>Water heater</td>
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The following National Acts/Regulations and Codes of Practice will also be applicable.


- SANS 14, malleable cast iron fittings threaded to ISO 7-1.
- SANS 32 (SABS EN 10240), Internal and/or external protective coatings for steel tubes – Specification for hot dip galvanized coatings applied in automatic plants.
- SANS 62-1, Steel pipes – Part 1: Pipes suitable for threading and of nominal size not exceeding 150 mm.
- SANS 62-2 (SABS 62-2), Steel pipes – Part 2: Screwed pieces and pipe fittings of nominal size not exceeding 150 mm.
- SANS 121 (SABS ISO 1461), Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods.
- SANS 151 (SABS 151), Fixed electric storage water heaters.
- SANS 181 (SABS 181), Thermostats for electric storage water heaters.
- SANS 198 (SABS 198), Functional-control valves and safety valves for domestic hot and cold water supply systems.
- SANS 226 (SABS 226), Water taps (metallic bodies).
- SANS 241 (SABS 241), Drinking water.
- SANS 460, Plain-ended solid drawn copper tubes for potable water.
- SANS 514 (SABS 514), Immersion heaters for electric storage water heaters.
- SANS 533-1 (SABS 533-1), Black polyethylene pipes for the conveyance of liquids – Part 1: Low density black polyethylene pressure pipes.

The complete document is structured so that the client and the installer can understand the SANS requirements.
1.1 Introduction

The design is based on the following SANS documents:

- SANS 10252-1 (water installation)
- SANS 10254 (geyser installation)
- SANS 10400 XA (general installation)
- SANS 10252-2 (Drainage installation)

The installation of the various groupings as mentioned above must be strictly installed to these documents. The complete document is structured so that the client and the installer can understand the SANS requirements.

Water saving devises can be used to limit the usage of domestic water, as our country’s water recourses are limited. The use of shower heads with flow rated not greater than 10 litres /min. and wash hand basin taps with flow restrictor can also be considered. Heating of hot water by means of solar to reduce the electrical demand will also be implemented.

1.2 General

1.2.1 Scope of Work

a) Provide all material and equipment and perform all the work necessary for the complete execution of all the Plumbing Work as shown on the Plumbing Drawings and on the General Construction Drawings, as herein specified and without excluding the generality of the foregoing, including the following systems:

i. Cold water reticulation system.
ii. Hot water reticulation system.
iii. Drainage and vent systems.
1.2.2 Work not included

a) The following principal items of work will be done under Specifications of other trades:

i. Water storage tanks incl. intakes and outlets are included in the civil engineer's scope of works
ii. Utility services from municipal mains to the site boundary (where required).
iii. Piping to terminate within 2 metres of A/C equipment. Final connections to heating, ventilating and air conditioning equipment will be made by the Heating, Ventilating and Air Conditioning Contractor.
iv. All concrete, paving and tar or masonry work required for plumbing installation of brick manholes, valve chambers and thrust blocks.
v. The Electrical Contractor will mount all starters furnished by this Contractor, except starters specified to be factory mounted and wired as part of the equipment and will do all wiring necessary to supply power to electrical motors and remote operating valves, furnished by this Contractor, including connections from the disconnect switches and starters to the motors.
vi. All finished painting of exposed pipes and apparatus.
 vii. All patching and/or remedial work to floors and wall penetrations by others.

1.2.3 Codes and Permits

a) Execute the work in full accordance with the requirements of all Governmental agencies having jurisdiction.

1.2.4 Interpretation of Drawings

a) No exclusions from, or limitation in the language used in the drawings or specifications shall be interpreted as meaning that appurtenances or accessories necessary to complete any required system or item or equipment are to be omitted.

b) The drawings of necessity utilize symbols and schematic diagrams to indicate various items of work. Neither of these have any dimensional significance nor do they delineate every item required for the intended installations. The work shall be installed in accordance with the diagrammatic intent expressed by the Plumbing drawings and in conformity with the dimensions indicated on final architectural and structural working drawings and on equipment shop drawings.
1.2.5 General Installation of Pipe

a) Install pipes approximately as shown on the drawings and as directed during installation, as straight and direct as possible forming right angles or parallel lines with building walls and other pipes and neatly spaced. Erect pipe risers plumb and true and parallel with walls and other pipes and neatly spaced.
b) Keep all horizontal runs of piping, except where concealed in partitions, as high as possible and close to walls. Maintain minimum pitch on all soil, waste and rain water lines.
c) Do not install pipes or other apparatus in a manner which interferes with the full swing of doors.
d) The arrangement, positions and connections, of pipes, fixtures, drains, valves and the like, indicated on the drawings shall be followed as closely as possible, but the right is reserved by the Architect to change locations and elevations to accommodate conditions which may arise during the progress of the work, prior to installation, without additional compensation for such changes.
e) Ream all screwed pipe smooth before installation. Do not bend, flatten, split or otherwise injure pipe.
f) Use reducing fittings, unless otherwise approved in special cases, in making reduction in size of pipe.
g) Where chrome plated piping is installed, cut and thread pipe so that no un-plated pipe threads are visible when the work is completed.
h) Do not install exterior piping in water or when trench or weather conditions are unsuitable for work, as decided by the Architect.
i) Use friction type wrenches and vices on all copper tubing and brass piping.
j) Carry fixture connections, concealed in building construction, to points above floor, break out close to the underside of fixture and rise exposed to fixture.
k) Do not use/install any 95º Drainage junctions in any horizontal run.

1.2.6 Co-Operation with Other Trades

a) Render full co-operation to other trades. Provide any information necessary to permit work of all trades to be installed satisfactorily and without interference or delay.
b) Where work is to be installed in close proximity to work of other trades, or where there is evidence that work may interfere with work of other trades, assist in working out space conditions to make satisfactory adjustments.

1.2.7 Record Drawings

a) Upon completion of the installation, there shall be furnished a set of drawings reflecting all work as actually installed. In the case of underground piping and work concealed above hung ceilings,
dimensions off of column lines are to be included. Roughing in partitions need not be shown, except for stacks and risers.

1.2.8 Approvals

a) Submit for approval by the Architect in conjunction with the Engineer, manufacturer's shop drawings and or descriptive literature for the following:

   i. Sanitary ware
   ii. Brassware
   iii. Vent Valves
   iv. Pipe Hangers
   v. Circulating pumps and controls
   vi. Valves

1.2.9 Tests

a) Subject the drains, waste and vent piping inside the building to a water test. The water test shall include the entire system from the lowest point to the highest pipe above the roof. Water test shall be made in accordance with all local requirements. The system shall be tested to a hydrostatic pressure equivalent to at least a three metre head of water. After filling, shut off water supply and allow it to stand two hours, under test, during which time there shall be no loss or leakage or an air test as described in SANS 10252-2.

b) Test all interior water distribution systems and to a pressure of 1000 kPa. Run test for two hours with no loss in pressure.

c) Furnish and pay for all devices, materials, supplies, labour and power required in connection with tests. Make all tests in the presence of and to the satisfaction of the Consultant and Architect, plumbing and other Inspectors as required.

d) Repair or if required by the Architect and Consultant, replace defective work with new work without extra charge to the Owner. Repeat tests as directed, until all work is proven satisfactorily.

e) Restore to its original conditions, any work damaged or disturbed by tests, engaging the original trades to do the work of restoration.

f) Notify the Consultant, Architect and Inspectors having jurisdiction, at least 48 hours in advance of making the required tests, so that arrangements may be made for their presence to witness the tests.
1.2.10 Valve Chart & Tags

a) Provide an approved valve tag for each valve, except valves within two metres of equipment it controls, need not be tagged. Attach the tag to valve handle or spindle with chrome chain.
b) Provide diagrammatic charts of all piping systems. Provide schedules of all valves. Provide three copies of charts and schedule bound booklets. Valve numbering system shall differentiate between classes of service and shall indicate floor level where valve is installed. Submit method for approval before final preparation.

1.2.11 Hangers & Supports

a) Properly supported piping by approved type hangers and supports of ample size to carry pipe and its contents. Support horizontal threaded pipe at least every 3 metres, copper tubing every 2 metres and C.I. soil pipe every 2 metres and behind every hub – refer to Table 1-1 for support details.
### STEEL TUBES

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### COPPER TUBES

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### CAST IRON DRAIN PIPES

Manufacturer’s Specifications state That each pipe section must be supported at least twice.

### DRAIN PIPES HDPE – PVC – UPVC – PE etc.

<p>| | |</p>
<table>
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</table>

b) All hangers and brackets to be Murpo type with sound insulating inserts or approved equal.

c) Furnish and pay for all devices, materials, supplies, labour and power required in connection with tests. Make all tests in the presence of and to the satisfaction of, the Architects, Consultant, Plumbing and other Inspectors as required.

d) Repair, or if required by the Architect and/or Consultant, replace defective work with new work without extra charge to the Owner. Repeat tests as directed, until all work is proved to be satisfactory.

e) Restore to its original conditions, any work damaged or disturbed by tests, engaging the original Trades to do the work of restoration.

### 1.2.12 Guarantee of Workmanship & Materials

a) Submit, upon completion of the work, a single guarantee stating that all portions of the work are in accordance with the Contract requirements, perfect as to materials and workmanship and will so remain for a period of twelve months from the date of final acceptance and/or beneficial occupation to the Owner.

b) Guarantee that during the one year period that the appointed Contractor will repair all defective work and will replace all defective work and all defective materials furnished or installed under this section, without charge to the Owner.

### 1.2.13 Excavation & Backfill

a) All trenching, bedding and backfill shall be in accordance with SABS 1200- DB/LB/LD (as amended) and to the manufactures recommendations.

b) All excavation and backfill shall be of the Plumber. The Plumber shall be responsible for the cooperation of the trench routing, slope and elevation and shall supervise the grading, backfilling etc., of trenches in which plumbing work is laid.
c) Normal fillings of the trench should then proceed in layers not exceeding 300mm in thickness, each layer well rammed. Heavy mechanical rammers should not be used until the fill has reached a depth of 300mm above the top of the pipe. Special consideration and selection of backfilling material will be necessary. That is, no stones or rocks in the backfilling mentioned below.

d) Minimum ground cover to be 900mm piping below surface beds as per levels indicated on drawings.

1.2.14 Material for Bedding Side – Filling

a) Soils, excavated from the trench (such as free draining coarse sand, gravel, loam and soil of a friable nature) will be suitable for use as side fill material, but they must be capable of being compacted sufficiently to provide adequate support for the pipe. Soils such as hard chalk which breaks up when wet and clay should not be used immediately around the pipe for bedding, side fill or backfill. The material excavated from the trench is unsuitable, and a medium granular backfill material shall be used.

1.2.15 Bedding & Side – Filling

a) The filling must be carried out with necessary care before backfilling, any levelling pegs or temporary packing shall be removed. The thickness of the bedding under the barrel of the pipe should not be less than one third of the diameter and a minimum of 100mm thick. In very soft or wet conditions, or where the bottom of the trench is very irregular, this thickness should be increased as necessary to give a suitable bed. The bedding shall be thoroughly compacted in layers not more than 150mm thick to give a uniform bed, true to gradient, on which the pipe may be laid. Pipes shall be laid directly on this bedding. Bricks or other hard material must be placed under the pipes for temporary support. Further bedding material should be placed around the pipe and be thoroughly compacted in 75mm layers by careful hand tamping up to the crown of the pipe, eliminating all cavities under the two lower quadrants of the pipe. The same material should be placed over the crown of the pipe for not less than two thirds of the diameter, with a minimum height of 100mm and a maximum of 300mm, and be thoroughly compacted. The process of filling and tamping shall proceed equally on either side of the pipe, so as to maintain equal pressure on both sides.
1.2.16 Compaction

a) Compaction under paved areas and under roads shall be kept to within 2% of the optimum moisture content while compacting, it to the specified density. Compaction will be carried out in layers as described in the previous paragraph. A 95% modified AASHTO density shall be applicable where no density is specified. Except for the above cases, the major part of the backfilling of pipes shall be done to 80% modified AASHTO or unless specified by the Structural Engineer.

1.2.17 Quality Assurance

The drainage system would consist of a soil stack (black water) and waste stack (grey water). The soil fittings like WC’s, and urinals would discharge into the soil stack and connect directly to the municipal sewer. Other fittings like the sinks, WHB’s and showers would join the waste stack which ties into the soil drainage line eventually joining the sewer line provided by the civil engineer. This sewer line enters a treatment facility specified by the civil engineer.

1.3 Drainage System

1.3.1 Overview

The drainage system would consist of a soil stack and waste stack. The soil fittings like WC’s, and urinals would discharge into the soil stack and connect directly to the sewer line entering a treatment plant by the civil engineer. Other fittings like the sinks, WHB’s and showers would join the waste stack, which joins the soil line and then the sewer line which discharges into the said treatment plant.

1.3.2 Scope

a) Complete sanitary drainage system as indicated on drawings.

1.3.3 General

a) Horizontal drainage shall be installed at a grade of 1:60 or unless otherwise noted and as required by the local authority and SABS 0400 and Code of Practice SANS 10252-2.
b) Cleanout tees or inspection eyes are to be installed at the base of each soil or waste stack.
c) Vents extending above roof level shall be located at least three (3) metres away from any window, door or air intake opening.

1.3.4 Materials

a) All internal piping in the building shall be HDPE piping with butt welded or electro-fusion joints.

1.3.5 Manholes

a) The Contractor shall construct manholes of precast concrete sections (except for the inside base slab) in the positions shown on the drawings, or in accordance with the instructions issued by the Consultant and Architect.

b) The Consultant and Architect shall inspect the manhole excavation and no concrete shall be placed before this instruction to continue. Foundations shall be of a Class B20/38 concrete.

c) The ends of the pipes in the sewer projecting into the manhole shall be flush with the inside of the manhole unless otherwise directed by the Consultant and Architect. The inverts of the manholes shall be formed by using channel sections laid to the specified levels and slopes. A steel trowel shall be used to finish off the surface of the benching constructed with Class B30/19 concrete. Step irons inside manholes shall be 300mm centre line to centre line on the vertical plane and 300mm apart on a horizontal plane; they shall be cast iron into the walls of the precast manhole sections during the process of manufacture. The ends of each section of precast manhole shall have a joint that will prevent horizontal displacement and they shall be made watertight with a suitable sealer. Covers on the precast manholes shall be bedded in a 1:2 cement sand mortar.

1.3.6 Joining of Pipes

a) The ends of pipes and the jointing material shall be properly inspected to ensure that no defective parts are used. The pipes shall be jointed according to the instructions of the manufacturer.
1.3.7 Fixing of Pipes

Pipes shall be “fixed” with double fixing points and not allowed to “swing” on a single hanger and only approved prefabricated pipe supports/brackets shall be used. The complete pipe installation shall be cleaned and sterilised according to SANS 10252-1. Appropriate provision shall be made for thermal expansion of the piping installation and air releasing and backflow prevention where necessary.

Water hammer shall be eliminated by means of suitable water hammer arrestors and suitable pipe anchors and supports. Approved flexible couplings shall be provided between the pumps and the pipe installation. All fittings and equipment shall be provided with a shut-off facility such as a valve or angle valve. Pipes shall be installed in such a manner as to allow easy access for maintenance and operation.

1.3.8 Cleaning of Pipes

a) The Contractor shall maintain the sewer clean of all water, mortar, soil or any other foreign matter and shall temporarily plug the ends of each section between manholes immediately after the section has been satisfactorily tested and approved by the Consultant and Architect. After removal of the plugs, the Contractor shall again remove any foreign matter that may have entered the sewer.

1.4 Domestic Water System

1.4.1 Scope

a) Complete domestic water system including service to the building from property line.

1.4.2 General

a) All valves shall be easily accessible for maintenance and/or removal and on all branches servicing equipment.
b) All ferrous to non-ferrous connections are to be made with an approved dielectric to prevent electrolytic action.

**1.4.3 Prevention of Water Contamination**

a) Wherever possible, provide over-rim water supplies to plumbing fixtures and equipment. Provide necessary below-rim connections, water closet and urinal flush valves, hose bibs, and hose connections with approved vacuum breakers and/or check valves as noted or required.

b) Kitchen or other equipment supplied under other divisions of work and/or by Owner and having below-rim water supply connections, may not arrive on the job in code approved condition, in which case the Sub-Contractor shall provide missing vacuum breakers and/or check valves, or relocate same to code approved positions.

**1.4.4 Materials**

a) All water supply pipes shall be as indicated on the general-arrangement drawings.

**1.4.5 Fittings**

a) Only high quality brass fittings shall be used for the water piping. These fittings will also be vandal proof. Fittings must also be locally available as to ensure spare parts are easily available for the maintenance team.

**1.4.6 Valves**

All valves shall be approved and shall be marked with a metal tag, numbered by means of an engraved number and locked with a galvanised chain and a master key padlock in terms of the owner’s master key schedule. All special valve numbers shall be indicated on the as-built drawings and three master keys shall be handed over upon completion to the contractor.
Specifications:

a) Gate valves size 100mm and smaller shall be Consolidated Brass Foundry Ball o’ Flo 90° lever Ballcocks or approved equal.
b) Valves in the hot and cold water systems to be as per the bill of quantities.
c) Gate valves larger than 100mm shall be VOSA Waterworks to SABS 664 class 10 as manufactured by Vosa Valves (Pty) Limited or approved equal.
d) Check valves (Non return) 50mm and smaller to be Walcro 2150. 65mm to 100mm to be Walcro or approved equal.
e) Check valves larger than 100mm and on Pump discharges to be cast steel with brass trim, silent double centre spring type.
f) Globe valves are to be installed on all Hot Water Return lines as indicated. Valve to be metal disc, screwed bonnet with screwed ends.
g) Globe valve for by-pass to pressure reducing stations.

1.4.7 Pressure Gauges

a) Provide gauges on the inlet and outlet of each master pressure reducing valve assembly and where noted.
b) Gauge : 100mm diameter black enamel casing, phosphor bronze single spring Bourdon tube, phosphor bronze bushed rotary precision movement dial range with at least 1% accuracy with brass tee handle cock and siphon tube. Gauge to be calibrated in kPa.

1.4.8 Soldering

a) Solder shall be in accordance with SABS 24-1971 (as amended) or DIN 1707 and to be grade 97/3 i.e. 7% tin and 3% copper. The flux used shall be water based and contain no ammonia and to be Everflux or approved equal.

Sizes 76 and 108 done with a hard silver solder as Silbraloy or a 30 - 40% cadmium based silver solder using the oxygen acetylene torch method.

---

6Where required.
1.4.9 Expansion

a) Expansion offsets/expansion loops shall be installed as indicated on the drawings and in accordance with the manufacturer’s specifications.

1.4.10 Pipes in Walls

a) Any copper piping chased into walls are required to be protected with a buff tape or an approved equivalent, no brown paper or cement bags may be used.
b) However, note clearly that all water piping is to remain surface-mounted when reticulated within the buildings.

1.4.11 Hot Water Circulators

a) Provide and install a hot-water circulating pump, inline type with bronze body and bronze balanced impellers. Pump shall be of the capacity and head as indicated and shall have spring loaded mechanical seal, with rubber ring rotating against stationary carbon seat. Pumps shall be Walcro SE50B or approved equal with a capacity of 0.011 litres per second against a 3 metre head.

1.5 Fixtures

1.5.1 Scope

a) All plumbing fixtures as specified and/or indicated unless otherwise noted.
b) Install kitchen sinks and hook-up kitchen equipment both provided under work of other divisions and/or Owner, and provide required trim and "P" traps for same as specified herein, provide water supply fixtures with angle stops figure numbers 2301k and CP Sanbrassa copper connectors as manufactured by Consolidated Brass Foundry or equal approved.

1.5.2 General

a) Fixtures shall be best quality regular selection genuine white vitreous or stainless steel or acid resisting enameled cast iron as specified free from cracks, dents, grazes, chips, twists, discoloration and other defects. Surfaces of enameled iron fixtures not required to be enameled: Factory coat of white paint. Fixtures shall have manufacturer's guarantee label or trade paint. Fixtures shall have manufacturer's symbol signifying acid resisting material.
b) Exposed pipe, fittings, traps, escutcheons, valves, valve handles and accessories, both above and below fixtures shall be chrome plated brass.
c) During the course of construction, cover exposed fittings with Vaseline and burlap and cover fixtures with wooden protection housing. Uncover and thoroughly clean fixtures and fittings when directed. Fixtures shall be in perfect condition at completion of job and any fixtures not in perfect condition at that time, due to damage during construction or any other cause, shall be replaced by the Sub-Contractor at no additional cost.
d) Should there be conflicting instructions between the above and the architect’s specification, the latter would take preference.

1.5.3 Fixture Connections

a) As per Architect’s sanitary schedules and the IWS drawings.

1.5.4 Fixtures

b) As per Architect's sanitary schedules.
1.5.5 Scope

a) Provide insulation as herein specified on all hot water and hot water return piping, including said piping immediately behind fixtures.

1.5.6 General

a) Pipe work – to be insulated with Armaflex (K-Flex) EC/R or approved equal.
b) Valves and Fittings - metre plain preformed pipe section.

Exposed Piping - to be insulated with Armaflex (K-Flex) EC/R with 0.5 mm thick corrugated aluminium muffs secured with 15mm aluminium strapping banks and seals.
2 WATER TREATMENT

2.1 Process Description and Equipment Requirements

2.1.1 Potable water

In order to supply potable water to the clinics, the following procedures are to be followed specific to the clinic in question. This system proposed is to be specific to the water yield and quality of borehole water available at each specific clinic site based on detailed water quality studies provided.

- Water is first pumped from the borehole through a pre-treatment dispenser
- During pre-treatment, Chlorine and Flocculent are dispensed to eliminate all germs and bacteria
- A water filtering system is installed on the outlet of the water reservoir tank, consisting of a sand and activated carbon (AC) filter
- The sand filter sifts all roughage while the AC filter removes colour, odour, taste and excess Chlorine from the water
- Manual filters are fitted with a multi-port valve that can be set to perform various functions (filter, rinse, backwash, etc)
- Fully automated water filtering systems are specified
- The water then passes through UV 55 treatment before entering the building to ensure no Ecoli or Coliforms to push through in the water.

2.2 Exclusions

The following list of items is excluded for this specification:

- Electrical connections to any of the control panels.
- Chemicals.
- Civil or any construction other than connection of piping and the treatment plant scope of supply.
- Alterations to sectional tanks, including flanges and adaptors required for connection to the treatment plant scope of supply. The said tanks, which fall under the scope of the civil engineer, are to be supplied with all the necessary flanges.
- Backwash piping is limited to 5m.
- Bleed piping is limited to 2m.
- Cranage and off-loading.
- Site storage.
• Anything not listed in this water treatment plant specification.
3 DISTRIBUTION SYSTEMS

3.1 Potable Water

The domestic (potable) water system is designed on the basis that there will be a supply of domestic water from a borehole for daily usage but does not guarantee:

- Water pressure, and
- Water quality

Further notes regarding this are as follows:

- The system shall be designed and constructed in accordance to SANS 10252-1
- The system shall comprise a borehole water connection feeding an elevated domestic (potable) water storage tank, via a borehole water treatment system. The reticulation to the building will be gravity fed, comprising of the necessary instrumentation for optimum operation of the system.
4 PUMPING SYSTEM

4.1 Operating Principles

- Hot water circulation pump supplied as compact assembly according to DIN standard 1988/T5. A typical depiction is shown in Figure 4-1.

![Figure 4-1 Typical Hot water circulation pump](image)

MAGNA3 25-40:

- The MAGNA3 incorporates a 4-pole synchronous, permanent-magnet motor (PM motor). The pump speed is controlled by an integrated frequency converter.
- A differential-pressure and temperature sensor is incorporated in the pump.
- Automatic Night Setback
- No external motor protection required
- Analog input (more than a pump function as heat energy meter)

Liquid:
Pumped Liquid: Domestic hot water

Liquid temperature range: -10 to 110 °C

Median Liquid Temperature: 60 °C

**Technical:**

Actual calculated flow: 0.0113 l/s

Resulting head of the pump: 3 m

TF class: 110

**Material:**

- Pump housing: Stainless steel
  
  EN 1.4308
  
  ASTM 351 CF8

- Impeller: PES 30%GF

**Installation:**

Range of ambient temperature: 0 to 40° C

Maximum operating pressure: 10bar

Pipe connection: G1 ½"

Pressure stage: PN10

Port-to – port length: 180mm

**Electrical data:**
Power input – P1: 9 to 56W
Maximum current consumption: 0.09 to 0.46A
Mains frequency: 50Hz
Rated voltage: 1 x 230V
Enclosure class (IEC 34-5): X4D
Insulation class 9IEC 85): F

Others:
Label: Grundfos Blueflux
Energy (EEI): 0.19
Net weight: 4.81kg
Gross weight: 5.27 kg
Shipping volume: 0.015 m³
5 HOT-WATER SYSTEM

5.1 Supply

To supply all wash hand basins, showers, cleaning facilities and kitchens. Hot water shall be generated by means of solar as the main source of heat generation. The water shall be stored in 1 x 1000 L and 1 x 300 L hot water storage tanks for the clinic and accommodation facilities respectively.

- The system to comprise of:
  - The solar collectors
  - Duty hot water recirculation pumps
  - Hot water storage vessels.
  - Piping, valves, insulation and associated equipment required to enable the system operate to its maximum potential.

5.2 Solar-Thermal Collectors

The solar collector shall be the flat-plate type, glazed collectors with copper tube on plate absorber in an insulated enclosure. The collectors shall comply with all requirements of SABS 1307:1992 and shall be hail resistant.

The solar collectors shall be supplied in 2m² sized as per the requirements for the applications. The piping connectors shall be made at each of the four corners (with two brass plugs) to facilitate installation and drainage and shall be connected in a diagonal inlet and outlet configuration.

The collector enclosure shall be vented and drained with weep holes to prevent condensation build up. The solar collectors shall be suitable for mounting at an angle of tilt of 45° (to the horizontal) on the roof of the building and be suitable for floor mounted with a base. Only the collectors with hail resistant glazing shall be accepted for the installation. The installation shall comply with SANS 10252-1: 2004.
6 COMMISSIONING

6.1 Requirements

6.1.1 Overview

Comprehensive pre-commissioning, commissioning, and quality monitoring are contractually required to be performed for all wet services installations and the requirement for full commissioning of the building systems is such that all services are to be FULLY commissioned.

6.1.2 Nominated Commissioning Methodologies

- Hot and cold water installation: SANS 10252-1
- Drainage: SANS 10252-2
- Geyser installation: SANS 10254
- General installation: SANS 10400
- Solar heating: SANS 10106 and 10254

6.1.3 Knowledge Transfer

The design team and contractor are contractually obligated to provide fully encompassing project knowledge to the building owner / facilities management team through the development, generation and execution of the works.

At building handover, the contractor is contractually required to provide the following documentation to the building owner and undertake all required training to ensure that all building systems are included:
### Table 6.1 Project knowledge transfer

<table>
<thead>
<tr>
<th>Fully documented Design Intent</th>
<th>including summary schematics</th>
</tr>
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<tbody>
<tr>
<td><strong>As-Built / Installed Drawings</strong></td>
<td>(including both digital and hardcopy to reflect the as-built systems &amp; equipment)</td>
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<tr>
<td><strong>Operations and Maintenance Manuals</strong>: fully collated, indexed and referenced (electronic compilation to be submitted in addition to hard copy)</td>
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<tr>
<td>- Describing how facility will be operated;</td>
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<td>- By whom – operational responsibility matrix;</td>
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<td>- Building occupant training requirements for occupant interactive systems</td>
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<tr>
<td><strong>Commissioning Report</strong>: Including ALL SANS documentation requirements to:</td>
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<tr>
<td>- Demonstrate that the services were commissioned in compliance with SANS Commissioning Codes for all services;</td>
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<td>- Include commissioning dates, records of all functional/commissioning testing undertaken, a list of any future seasonal testing, and a written list of outstanding commissioning issues</td>
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<tr>
<td>- Include the outcomes and changes made to the building as a result of the commissioning process, accounting for all of the recommendations.</td>
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<tr>
<td>- To include all major plant and equipment as discipline applicable (including any chillers, boilers, heat pumps, air handling units, water treatment/recycling systems, onsite generation systems, water distribution (chilled, heating hot water and domestic hot and cold water), lighting system, air distribution, lifts and vertical transportation systems and automated controls (within the BMS and/or Energy metering, HVAC, and wet services)</td>
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<tr>
<td><strong>Training of Building Management Staff</strong>: Training to be conducted; training register to be maintained and submitted by all contractors. The following minimum training must be provided:</td>
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<tr>
<td>- Covering Information provided in the design intent report/specification (including energy and environmental features &amp; strategy)</td>
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<tr>
<td>- Review of controls set up, programming, monitoring, alarms, and troubleshooting</td>
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<tr>
<td>- Review of O &amp; M manuals</td>
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<tr>
<td>- Building operation for the following conditions:</td>
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<tr>
<td>- Start up</td>
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<td>- Normal Operation</td>
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<td>- Unoccupied Operation</td>
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<td>- Seasonal Changeover</td>
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<td>- Shutdown</td>
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<td>- Emergency</td>
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<tr>
<td>- Measures that can be taken to optimize energy efficiency</td>
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</table>
• Occupational health and safety (OH&S) issues and risks
• Maintenance requirements and sourcing replacements / attic stock
• Obtaining and addressing occupant satisfaction feedback

### 6.2 STANDARDS

#### 6.2.1 Overview

The standards currently used at similar facilities will be applied unless otherwise specified. The standards shall be in accordance with:

- Government and Local Authorities Ordinances, Regulations, By-laws and Rules;
- Occupational Health and Safety Act 85 of 1993 (Act 85 of 1993);
- Compensation for Occupational Injuries and Diseases Act (Act 130 of 1994);
- The applicable South African National Standards (SANS).

#### 6.2.2 Design (Internal Wet-Services)

The Wet Services design and contractor installation shall conform to the following requirements:

- Design as per SANS 10400 – The application of the National Building Regulations.
- The Factories, Machinery and Building Work Act.

The latest amendments to these standards and codes of practice shall apply.
7 BILL OF QUANTITIES
Mechanical
LIQUEFIED PETROLEUM
GAS
Tender Document

NDOH SMALL AND SMALL+ CLINIC

DECEMBER 2015
## ISSUE AND REVISION RECORD

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<th>Originator</th>
<th>Checker</th>
<th>Approver</th>
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<td>10(^{th}) December 2015</td>
<td>Z. Thys</td>
<td>V. Vythilingam</td>
<td>V. Ramsundara</td>
<td>LPG installation Specification</td>
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DEFINITIONS

acceptable
acceptable to the approving authority

approved
approved by the approving authority

approving authority
appropriate of the following:

a) within the scope of the Trade Metrology Act, 1973 (Act No. 77 of 1973), and in respect of the control of the mass of gas sold: the Director of Trade Metrology;

b) within the scope of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993), and in respect of the control of general safety: the Chief Inspector;

c) within the scope of SANS 10400 and in respect of the evaluation and control of installations in accordance with this part of SANS 10087: the local authority in whose area of jurisdiction the installation is installed;

d) within the scope of the Mine Health and Safety Act, 1996 (Act No. 29 of 1996), and in respect of the control of general safety: the Chief Inspector

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assembly
system that includes connection by pipe or similar ducts, fittings and valves that operate under gauge pressure and are used for the conveyance of liquid or vapour

caravan
motor home: small dwelling that is used for domestic or recreational purposes and that can be towed by a vehicle or is self-propelled

competent person
any person that has the knowledge, training and experience specific to the work or task being performed
container
cylinder that complies with SANS 10019 and that is approved for the storage and conveyance of liquefied petroleum gas of individual water capacity not exceeding 500 L

critical location
area that is not ventilated for the dispersal of LPG

equipment
combination of pipes, pipe fittings, appliances and any appurtenances connected to the system

fixed appliance
any appliance that is permanently mounted into a fixture, for example, a stove or a fireplace

installation
combination of one or more containers connected to a manifold system, including pipework and appliances

liquefied petroleum gas: LPG
commercial butane, commercial propane, or a mixture of light hydrocarbons (predominantly propane, propene, butane and butene) that is gaseous under conditions of ambient temperatures and pressure, and that is liquefied by an increase of pressure or a lowering of temperature

manifold
where two or more containers are connected to each side of the changeover device

mechanical joint
any joint that is made by the application of a mechanically or manually applied force that uses threads to tighten couplings, or crimping, or sealing rings, or washers, or any other sealing medium

NOTE Welded, soldered or, in the case of HDPE piping, electrofused jointing are excluded and not deemed to be mechanical joints.

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mobile home

dwelling that is larger than a caravan mobile unit and that can be towed by a motor vehicle

mobile unit

purpose-built unit, vehicle, or caravan which may accommodate appliances for gas use

operating pressure

pressure at which an appliance will operate (gauge pressure)

high pressure

pressure that exceeds 150 kPa (gauge pressure)

intermediate pressure

pressure that exceeds 5 kPa but that does not exceed 150 kPa

low pressure

pressure that does not exceed 5 kPa

pressure regulator

device that reduces the pressure of the gas from a higher pressure to a constant lower pressure

registered installer

person that has the ability, appropriate training, knowledge and experience to carry out the work that is undertaken in a safe and proper manner, and who is registered in accordance with the requirements of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993)

user

person who uses the equipment for his own benefit, or has the right of control over the use of the equipment, but does not include a lessor or any person employed in connection with that equipment

ventilation
supply and removal of air (by natural or mechanical means (or both)) to and from a space or spaces

in a building

NOTE It normally comprises a combination of purpose-provided ventilation and infiltration.

permanent ventilation

ventilation opening which is permanently fixed in the open position

ventilation opening

any means of purpose-provided ventilation (whether it is permanent or closable), which opens directly to external air, such as the open able parts of a window, a louvre or a background ventilator

NOTE It also includes any door that opens directly to external air.
1. **LPG TECHNICAL SPECIFICATION**

1.1 **Codes and Permits**

1. Over and above full compliance with the regulations as set out in the National Building Regulations and SANS, execute the work in full accordance with the requirements of all the Government agencies having jurisdiction, i.e. the requirements of Institutional Bodies such as the Local Authorities are to be adhered to.

1.2 **Documentation**

1.2.1 **Interpretation of Drawings**

1. No exclusions from, or limitation in the language used in the drawings or specifications shall be interpreted as meaning that appurtenances, or accessories necessary to complete any required system or item or equipment are to be omitted.

2. The drawings of necessity utilize symbols and schematic diagrams to indicate various items of work. Neither of these have any dimensional significance, nor do they delineate every item required for the intended installations. The work shall be installed in accordance with the diagrammatic intent expressed by the plumbing shop drawings and in conformity with the dimensions indicated on final architectural and structural working drawings and on equipment shop drawings.

1.2.2 **Tender Drawings**

1. The drawings accompanying this specification shall be deemed to indicate the general arrangement and requirements only and are not Shop Drawings.

2. The Engineer shall provide the Contractor, free of charge, with a set of Specification Documents, which shall include all Tender Drawings and a provisional bill of quantities.
1.2.3 **Architectural and Structural Drawings**

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

1.2.4 **Builders Work Drawings**

1. All builders work and work to be carried out by others in accordance with the specification has been indicated in the Internal Wet-Services Tender Information Package and can be consulted for the specific drawings in this regard.

2. Such Builder’s Work Drawings to verify all subcontractor selections of equipment must accompany the Shop Drawings from the subcontractor, and indicate the location and extent of all foundations, bases, openings, timber frames and all other builder’s work and the capacities and/or dimensions of all electrical and water supply points, the method of terminating such supplies and the position of the connection points, the position and dimensions for all condensate drainage connections and any other work to be provided by others for the Works, as detailed in these specifications.

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

4. Within a reasonable period after receiving such drawings, the Engineer shall signify his approval (prior to any construction works commencing), or otherwise, and one signed copy of each approved Drawing shall be returned to the Contractor.

5. When approved, the following number of copies of each respective drawing shall be delivered to each of the following parties:
   - a. Architect 1 Copy
   - b. Quantity Surveyor 1 Copy
   - c. Structural Engineer 1 Copy
   - d. Electrical Engineer 1 Copy
   - e. Main Contractor 2 Copies
1.2.5 Shop Drawings

1. The Contractor shall submit to the Engineer, for approval within the time frame of 2 weeks of appointment, duplicate copies of all Shop Drawings as required for the manufacture and installation of the Works or as the Engineer may reasonably require.

2. All shop drawings for work outside of plant-rooms shall be drawn to a scale of not smaller than one in hundred. All details shall be drawn to a scale to show the detail required.

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

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

5. The Contractor shall also supply copies of all approved drawings in accordance with the requirements for the Operating and Maintenance Instructions.

6. Drawings approved as above-described shall not be deviated-from except as authorized by the Engineer.

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

1.2.6 Mistakes on Drawings

1. Any expense resulting from an error or omission in or from delay, in delivery of the Drawings shall be borne by the Contractor.

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

1. Any expense resulting from an error or omission in or from delay in delivery of the Drawings shall be borne by the Contractor.

2. A condition of the final acceptance of the works will be the provision of three copies of an approved comprehensive Maintenance and Operating Instruction Manual.

3. Each copy of the manual is to include the following, but not limited to:
   a. A general description of the system and its operation.
   b. Details of the method of operation of the plant and controls.
   c. An equipment and controls list giving the following:
      d. Description
      e. Quantity
      f. Make
      g. Model Number
      h. Location
      i. A schedule of the servicing to be done on each item of equipment and controls and the frequency.
      j. A log sheet giving the design parameters and provisions for the logging of these parameters by the plant operator.
      k. Description of automatic control system, accompanied by control schematics (where necessary).
      l. Step-by-step instructions for starting/stoping each item of equipment.
      m. A record of relevant readings taken during final commissioning and hand-over tests.
      n. Certificate of Compliance
      o. “RECORD" drawings, wiring diagrams, piping schematics.

4. Upon completion of the installation, there shall be furnished a set of drawings reflecting all work as actually installed, marked as RECORD DRAWINGS.

5. In the case of underground piping and work concealed above hung ceilings, dimensions of column lines are to be included. Roughing in partitions need not be shown, except for stacks and risers.

6. The Contractor, in addition to the operating and maintenance manuals, shall give detailed explanations of and instructions to the Owner on the operation of the complete installation, as finally commissioned and handed over.

7. The Contractor shall operate the whole plant for a period of five consecutive full working days, after the plant is handed over.

8. During this period, the Contractor shall instruct the Owner in the operation of the plant.
1.3 Piped Distribution Systems

1.3.1 General Requirements

1.3.1.1 Excluded Materials

1. Materials excluded from all parts of the Works and in particular from use in this Section are: Free lead, asbestos and asbestos-contained products.

1.3.1.2 Scope

1. The Work described in this section comprises the provision of all labour, materials, plant, tools and equipment required to properly execute all pipe and pipe fitting work indicated on the Drawings and/or in this Specification.
2. All pipework shall be entirely suitable for operation with the particular fluids conveyed and pressures and temperatures of the systems in every respect.
3. Pipework required for the following gases:
   a. LPG – Liquid Petroleum Gas

1.3.1.3 Schedules

1. Materials, equipment and appliances selected are specified on the equipment data sheets.
1.3.1.4 Drawings

1. Piping systems shown on the drawings (except where otherwise specifically stated) are diagrammatic, indicate the general routing and sizes required, and may not necessarily show all components in their true positions.
2. Piping systems shall be properly arranged for drainage and venting, application of thermal insulation and to meet the design and application intent.
3. The general-arrangement drawing schedule is indicated below:

<table>
<thead>
<tr>
<th>Drawing Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>353538-M-501-T-A0-A</td>
<td>Magwedza Gas Reticulation Layout</td>
</tr>
<tr>
<td>353538-M-502-T-A0-A</td>
<td>Thengwe Gas Reticulation Layout</td>
</tr>
<tr>
<td>353538-M-503-T-A0-A</td>
<td>Makonde Gas Reticulation Layout</td>
</tr>
<tr>
<td>353538-M-504-T-A0-A</td>
<td>Mulenzhe Gas Reticulation Layout</td>
</tr>
<tr>
<td>353538-M-505-T-A0-A</td>
<td>Borwa Gas Reticulation Layout</td>
</tr>
</tbody>
</table>

1.3.1.5 Inspection and Testing

1. No insulation or other covering shall be applied until inspection and testing is satisfactorily concluded.
1.3.2 Pipework Installations

1.3.2.1 Protection and Storage

1. All pipes shall be properly supported clear of the ground on stable and secure pipe racks and stored to manufacturer’s written instructions.
2. No pipe nor material of any kind shall be placed inside another pipe or fitting if any lining or coating has been applied to either.
3. Rubber or compound gaskets or sleeves not for immediate installation shall be stored in a cool area protected from direct sunlight.

1.3.2.2 Transport, Cutting, and Handling of Pipe

1. Spigot and socket ends shall not be damaged during transport to point of installation.
2. Pipes damaged in cutting or handling shall be rejected. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the barrel of the pipe.
3. Pipe lining and coatings shall not be damaged.
4. The interior of pipes, valves and fittings shall be thoroughly cleaned of foreign matter before being placed in position and shall be kept clean during installation works.
5. Cuts in non-metallic pipes shall be made in accordance with the manufacturer’s instructions.
6. Cuts in all pipes shall be made square to the axis of pipes and all burrs and other irregularities removed by reaming and filing before fixing.
7. Pipe cuts at valves and special castings shall be accurately made to bring all valves, castings and other fittings to their correct positions.

1.3.2.3 Installation

1. Each part of the piping system shall be complete, provided with all isolating, regulating and control valves and accessories necessary for satisfactory commissioning, operation and maintenance.
2. Corroded pipes shall not be used. Dirt and foreign matter shall be excluded from pipes by the use of screwed iron end caps, plugs or rigid plastic covers. Improvised plugs will not be permitted. A valve fitted to the open end of a disconnected pipe is not acceptable for pipe sealing.
3. All bends shall be long radius, and all tees swept pattern unless this precludes natural venting of pipework. Sets, double sets and springs shall be formed from long lengths of tube using as large a radius as practicable, and shall be free from evidence of buckling.

4. All piping shall be grouped wherever practicable and erected to present a neat appearance. Pipes shall be installed parallel to each other and parallel or at right angles to building surfaces.

5. All rising and dropping pipes shall be truly vertical. No joints shall be formed within wall, floor or ceiling thickness, nor in positions inaccessible after completion.

6. Two or more pipes changing direction together shall remain parallel and co-planar.

7. Multiple pipe runs shall be fixed in such a manner that subsequent access to any pipe is possible without disturbing other pipes, and without interference with the installation of equipment, ducts or other piping systems. Maintenance access shall be provided.

8. Piping to be insulated or otherwise covered shall be fixed to permit the application of the covering around the full circumference and also to leave 25mm minimum space between covered pipes.

9. Pipes to be concealed shall be installed neatly and as close as possible to the building structure, allowance being made for supports, brackets, adjacent services and thermal insulation.

10. Reductions in bore of vertical pipework shall be made with concentric reducing fittings.

11. Reduction in bore of horizontal pipework shall be made with eccentric reducing fittings normally arranged with a line able crown to prevent air trapping.

12. In pipework laid to falls for drainage a line able invert shall be maintained.

13. The use of bushes is not permitted.

14. Before connecting up to return mains, the piping shall be thoroughly blown or flushed out at a velocity not less than twice the design velocity of the system. After flushing, all strainer baskets shall be cleaned and refitted.

15. The bottom of all risers shall have capped or flanged scale and dirt pockets equal to the size of the riser and at least 300mm in length with 29mm drain cock and line-size isolating lubricated plug cocks.

1.3.2.4 Pipe Sleeves

1. Where pipes pass through floor slabs, walls, the roof, or penetrate any other form of construction, pipe sleeves shall be supplied and accurately placed in the structure.

2. Pipe sleeves shall provide 15mm clearance around the pipe or, where the pipe is to be thermally insulated or otherwise covered, 15mm clearance around the covering surface so that the sleeve may be packed and sealed with mineral or glass wool sealed at both ends with waterproof and fire retardant mastic.

3. Roof sleeves shall be provided with water-shedding external cowls and flashing.
1.3.2.5 Protecting Pipe Sleeves

1. Gas protecting pipe sleeves through floors shall be supplied and fixed in the following locations:
   a. In mechanical plant rooms
   b. In kitchen areas,
   c. In slabs over mechanical and electrical plant rooms
   d. In all floors having a waterproof membrane
2. The pipe sleeves shall be set to extend for the full thickness of the structural element and 50mm minimum above finished level.

1.3.2.6 Wall and Floor Plates

1. Where pipes penetrate walls, floors or ceilings, (except in plant, equipment and cleaner’s rooms or other storage areas), split type chromium plated steel wall plates shall be fixed, closely fit to the building surface and provide a neat appearance. Samples shall be submitted for approval before fixing is commenced.

1.3.2.7 All Venting and Draining

1. All piping systems shall be arranged for proper circulation and venting, so that the complete installation may be drained through full-bore drain valves at the main headers. Drain piping shall fall in direction of flow.
2. All high points shall have air bottles for the collection and release of trapped air. Branch pipes shall be sloped to avoid air traps. Drain valves shall be accessible and outlets extended to low level.
3. Automatic air vents, with isolating valves, shall be provided at high points on branch pipes where specified with discharge pipes extended to suitable drains.
4. Low points and equipment items shall have 20mm size gland pattern drain cocks with hose union and cap.
1.3.2.8 Equipment Connections

1. All branch connections to items of plant shall have provision for isolation and flanged or union type connectors on the “equipment” side of isolating valves to permit drainage, disconnection and removal.

1.3.3 Provision for Thermal Movement

1.3.3.1 General

1. Wherever practicable, accommodation of thermal expansion or contraction shall be by the use of pipe loops, sets or changes of direction.
2. Short branches shall be dog-legged to reduce the strain on joints.
3. Where such methods are not practicable, sheathed corrugated bellows expansion joints of axial, single hinge or double hinge type to suit the application shall be used.
4. The sub-contractor shall submit with the relevant installation drawings, all thermal movement calculations, loop, bellow and anchor selections or designs to sufficient detail to satisfy the Engineer that adequate provision for thermal movement has been made.

1.3.3.2 Anchor Points

1. Pipe anchors capable of resisting the maximum calculated applied stresses shall be of fabricated mild steel sections or be proprietary accepted units.
2. Pipe anchor points shall be established only as specified.
3. All guide and anchor bracket details shall be submitted for inspection prior to manufacture. Anchor loads shall be shown.
1.3.3.3 Pipe Supports and Hangers

1. Support systems shall be of correct size, strength and allow for expansion, contraction and anchoring of the piping systems.
2. Full details of hangers and supports proposed for use shall be submitted before fixing commences.
3. Vertical drops shall be properly restrained and supported to prevent offset and sway.
4. Piping at all equipment and valve positions, and at main junctions, shall be adequately supported to prevent any distortion or transmission of strain to connected equipment or valves.
5. Brackets and supports shall be arranged to allow sufficient access for adjustment, maintenance and removal of equipment, valves and accessories with the minimum of dismantling and without the need for additional temporary supports after items are removed.
6. A proprietary support system for all pipework may be used to achieve technical and visual compatibility of supports subject to prior arrangement.

1.3.3.4 Support Materials

1. Supports and hangers for mild steel piping shall be ferrous. Supports and hangers for copper piping shall either be non-ferrous, or have a liner to prevent electrolytic action. Supports and hangers for chromium plated or stainless steel piping shall be chromium plated.
1.3.3.5  Supports, Spacing, and Sizes

1. Spacing for piping supports shall be as follows:

<table>
<thead>
<tr>
<th>Pipe Material</th>
<th>Pipe size (DN)</th>
<th>Support Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Horizontal (m)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vertical (m)</td>
</tr>
<tr>
<td>Copper and stainless Steel</td>
<td>15-22</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.8</td>
</tr>
<tr>
<td>Steel</td>
<td>28</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.4</td>
</tr>
<tr>
<td>35-54</td>
<td></td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.0</td>
</tr>
</tbody>
</table>

1.3.3.6  Safety and Pressure Relief Valves

1. Safety and pressure relief valves shall be located as specified, or in positions required by the Standard for pressure vessels fitted.
2. Safety valves shall be of the totally enclosed spring loaded type with padlock.
3. Relief valves shall be mounted with the centre line of the valve spindle in a vertical position to ensure that the valve reseats properly after operation.
4. Relief pipes from valves shall be run in full bore tubing of the same quality as the service vessel or pipeline. The piping shall be carried clear of any insulation and arranged to discharge in a visible and safe position.
1.3.3.7 Valve Labels

1. Valve labels shall be firmly attached to each valve, except those immediately adjacent to the apparatus controlled, and shall be rectangular engraved laminate white/black/white with consecutive number engraved through top layer.
2. Valve numbers and application shall be shown on the labels by description or symbol agreed.

1.3.4 Instruments and Gauges

1.3.4.1 Pressure and Altitude Gauges

1. Generally, valves pressure gauges shall be installed at the following locations:
   a. On system pressurization equipment
   b. On each side of pressure reducing valve sets

1.3.5 Pipework Identification

1.3.5.1 General

1. Pipework identification banding shall be applied after covering and/or protective and decorative painting is complete. Identification colours and bands shall be to SANS Standards.
2. The colour coding shall be provided as follows:
   a. At 8m intervals on straight runs
   b. At all changes of direction
   c. Within 300mm of valves
   d. Within 300mm of all equipment items
   e. At all junction points and branch (unless end of branch is visible from junction)
   f. All lines passing through walls and floors where lines are accessible and not visible from an identified main.
3. Direction of flow arrows and graphical symbols shall be stencilled in black on a regular white background.
4. Letters and symbols shall be pipe nominal bore or 50mm in height whichever is the lesser.
5. Symbols shall conform to the legend on the Record Drawings and plant room charts.
6. Identification colour scheme shall be listed in the Operating and Maintenance Instructions.

1.3.5.2 Schedule of Pipeline Material, Valves, and Appliances

<table>
<thead>
<tr>
<th>Service</th>
<th>Size (DN)</th>
<th>Pipe Material</th>
<th>Working Pressure</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Petroleum Gas</td>
<td>Up to 54</td>
<td>Copper tube, Phosphorous deoxidized, non-arsenical copper, with dimensions in accordance with SANS 1453-2008</td>
<td></td>
<td>SANS 1453 -2008</td>
</tr>
</tbody>
</table>

1.4 Liquefied Petroleum Gas

1.4.1 Liquefied Petroleum

1.4.1.1 General

1. The piped LPG gas shall be installed by the sub-contractor, in accordance with the requirements and recommendations of all the relevant SANS Standards current edition including all amendments issued up to twenty–eight days prior to the date for return of the Tender.
2. The works shall include the supply, delivery, installation, testing, commissioning and setting into operation, the piped medical gases systems.
3. The installations must fully comply with the requirements of BS 5682, including any revisions/amendments issued up to 28 days prior to the date set for the return of the Tender.
4. “An understanding must be given in writing that only fully experienced and competent personnel will be employed on the listed gas sub-contract and for the full duration of the sub-contract.”

1.4.1.2 Pipework Materials

1. Pipes and fittings used for the conveyance of medical gases shall be constructed from phosphorous deoxidized, non – arsenical copper to SANS 1453- 2008.
2. Pipes shall be delivered bundled and each end shall individually be sealed with an adhesive tape marked “de-greased pipes”.
3. Pipe and fittings shall be accompanied by manufacturers’ certification that de-greasing and subsequent complete removal of degreasing agent has been carried out satisfactorily.
4. Terminations for the attachment of flexible hoses and connections between fixed pipework and permanent flexible hoses shall be made by means of approved terminal units or non-interchangeable couplings designed to prevent cross-connection.
5. The terminal units and non-interchangeable screw thread connectors shall comply with BS 5682.
6. Hoses shall have satisfactory anti-static properties as defined in “Hospital Technical Memorandum” or they shall be provided with suitable continuous electrical bonds.
7. Pipe fittings shall be end-fed capillary fittings to BS 864, Part 2. Each fitting of 15mm size and larger shall be legibly marked with the marker’s name or trademark and with the SANS identification symbol. All end-feed fittings installed shall be of the same make.
8. Pipe jointing fittings shall be capable of withstanding the hydraulic test of 700kPa working pressure and 1400kPa test pressure.
9. All other fittings for connection to copper pipes (e.g. valves and control panel fittings) shall be copper, brass, gunmetal or bronze to the appropriate standard.
10. All pipes, pipe fittings and sub-assemblies of fittings for connection to pipes shall be thoroughly cleaned and degreased for oxygen service and be completely free from particulate matter and toxic residues.
11. Pipe fittings and assemblies shall be individually sealed in bags or boxes and delivered to site identified as “degreased fittings”.

1.4.1.3 Brazing (Copper to Copper)

1. Brazing copper to copper joints shall be made using a copper –phosphorous silver brazing alloy. No flux shall be used. The following method shall be used.
   a. All pipe joints made on site shall be made by using the CO2 purge method.
b. Commercial grade CO2 or Nitrogen shall be used as in internal gas shield so as completely to prevent the formation of oxides on the inside of the pipes and fittings.

c. The CO2/N2 gas shall be supplied to the inside of the pre-assembled, unbraced pipework through a pressure regulator and flow controlling device.

2. All pipework shall be installed using the minimum practicable number of joints, brazed or otherwise. The installation of an excessive number of couplings in straight pipelines is not permitted.

### 1.4.1.4 Mechanical Joints

1. Mechanical (threaded or flanged) joints may be used where pipelines are connected to items designed for such connections (e.g. valves and control equipment). Mechanical joints shall not be used elsewhere in the pipework installation.

2. Connections to all instruments shall be by means of purpose made unions using annealed copper jointing washers, the purpose being to aid the removal/ replacement of such instruments.

3. Jointing between dissimilar metals, other than between copper and copper alloys, will not be permitted.

### 1.4.1.5 Brazing (Copper to Copper Alloys)

1. Copper to brass /gunmetal/bronze brazed joints shall be made only at the specialist sub-contractor’s works using silver brazing filler or other suitable proprietary brand.

### 1.4.1.6 Welding (Mild Steel to Mild Steel)

1. All joints shall be fusion welded. Pipe welding operations and testing shall be described in the section “Distribution Systems”.

1. Commercial grade CO2 or Nitrogen shall be used as in internal gas shield so as completely to prevent the formation of oxides on the inside of the pipes and fittings.
2. The CO2/N2 gas shall be supplied to the inside of the pre-assembled, unbraced pipework through a pressure regulator and flow controlling device.
3. All pipework shall be installed using the minimum practicable number of joints, brazed or otherwise. The installation of an excessive number of couplings in straight pipelines is not permitted.

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2. Connections to all instruments shall be by means of purpose made unions using annealed copper jointing washers, the purpose being to aid the removal/ replacement of such instruments.
3. Jointing between dissimilar metals, other than between copper and copper alloys, will not be permitted.

### 1.4.1.5 Brazing (Copper to Copper Alloys)

1. Copper to brass /gunmetal/bronze brazed joints shall be made only at the specialist sub-contractor’s works using silver brazing filler or other suitable proprietary brand.

### 1.4.1.6 Welding (Mild Steel to Mild Steel)

1. All joints shall be fusion welded. Pipe welding operations and testing shall be described in the section “Distribution Systems”.

1.4.1.7 Control of Cylinders

1. The sub-contractor shall remove all CO2 cylinders from site at the end of the contract and must not become mixed up with manifold gas cylinders.

1.4.1.8 Testing and Inspection of Joints

1. Due to the manufacturing tolerances on the copper tube and fittings, complete penetration of the capillary space by brazing alloy may not occur and.

2. The minimum penetration at any point on the joint must be three times the nominal wall thickness of the tube. Minimum penetration should be as follows:

Table 1-4 Minimum piping joint penetrations

<table>
<thead>
<tr>
<th>Nominal OD mm</th>
<th>Nominal wall thickness mm</th>
<th>Minimum penetration mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>0.6</td>
<td>1.8</td>
</tr>
<tr>
<td>15</td>
<td>0.7</td>
<td>2.1</td>
</tr>
<tr>
<td>22</td>
<td>0.9</td>
<td>2.7</td>
</tr>
<tr>
<td>28</td>
<td>0.9</td>
<td>2.7</td>
</tr>
</tbody>
</table>

1.4.1.9 Degreasing and Cleanliness

1. All pipes shall be cleaned and degreased to the standard required for oxygen service and shall be free of particulate matter and harmful/toxic residues.

2. Pipes up to and including 54mm shall be steam cleaned internally, dried, shot blasted and blown through with medical quality compressed air, then individually capped at both ends after a visual inspection. The steam used for the purposes of cleaning shall be dry and oil-free and shall be drawn through a 0.1 micro meter sintered stainless steel filter.
1.4.1.10 Installation

1. The pipework installation shall generally be in accordance with section “Distribution Systems- (Piped)” within this specification.
2. All pipelines shall be accessible, particularly mechanical joints, for inspection and maintenance.
3. Pipelines shall preferably be fabricated by brazing or welding to prevent the possibility of leaks. Pipelines routed in duct, shall comply with relevant regulations and codes of practice.
4. Pipeline shall be installed to avoid:
   a. Mechanical and chemical damage
   b. Excessive heat
   c. Electrical sparks
   d. Splashing, dripping or permanent contact with oil, grease or bituminous compound
   e. Traps or pockets
5. There should be a minimum of 50mm between the pipeline and electrical conduits and hot water or steam pipelines.
6. Unless shown otherwise on the drawings, pipes shall follow the contour of walls or other building structure lines. Vertical pipework shall be plumb.
7. Pipework within ceiling or wall voids or partitions shall not be covered until the pipework installation has passed the specified pressure tests.
8. Copper pipelines passing through walls and partitions shall be inserted through copper sleeves which shall project 200mm beyond finished floor levels and 6mm beyond wall and ceiling finishes surface.
9. Pipework in contact with wood shall be wrapped with two layers of PVC adhesive tape half lapped.

1.4.1.11 Supports

1. Pipelines shall be adequately supported to prevent sagging or undue stress being placed on the pipeline; allowance should also be made for expansion and contraction if necessary.
2. Recommended pipe support intervals shall be described in the section “Distribution Systems’ within this specification.

1.4.1.12 Valves
1. All valves necessary for the safe operation of the complete installation shall be supplied and located as shown on the drawings. No deviation from those positions shall be made without the Engineer’s written permission. Each valve shall be fitted with an identity number label.

2. All valves on distribution pipework shall be of non-ferrous material and of the non-lubricated type.

3. Valves concealed in cupboards or similar situations must be provided with permanent and prominent labels fixed to the walls adjacent to the cupboards. Labels shall be of Traffolyte and must conform to the general décor and appearance of the area within which they are located.

4. Valves shall be of the lever operation ball type or bellows type. Wheel screw down valves shall close in a clockwise direction, lever ball valves shall close with a 90 deg. clockwise turn. Wheel valves shall have the direction of opening or closing indelibly cast or engraved on the wheel by means of arrows and the words “OPEN” and “CLOSED”. Lever ball valves shall have “ON/OFF” cast or engraved on them. On/off indicators shall be clearly visible from the valve operating position. Each valve shall carry the manufacturer’s serial or identification number, the valve size and the direction of flow.

1.4.1.13 Identification and Colour Coding

1. Identification colours for Piped Gas pipelines shall be in accordance with “ISO 9002 PIPE IDENTIFICATION” or local SANS Standards equivalent.

2. All pipework shall be identified as the installation proceeds with the appropriate colours, separately and clearly at valves, junctions and change of direction, on each side of walls, floors and partitions and in addition, at 2m intervals by means of self-adhesive 2-ply vinyl tape. The tape shall be wrapped to overlap, so that the tape adheres to itself as well as to the pipe.

3. The self-adhesive banding shall be not less than 50mm wide and shall include the name and graphic symbol of the service. The lettering shall not be less than 6mm in height. Each point of identification shall also have an arrow clearly indicating the direction of gas flow and the nominal size of the pipe in mm.

4. Terminal units shall be identified by the appropriate colour identification ring around the outlet, and the name of the service. The name and colour shall be permanent in that the name must be indented, etched or otherwise made indestructible and that the coloured part must be of hard plastic, vitreous enamel or similar indelible materials.
1.4.1.14 Regulators

1. Regulators shall:
   a. Be of diaphragm type
   b. Have concealed adjustment on regulators located at the manifold/plant and branch pipelines.
   c. Regulators at outlets may have accessible adjustment control.
   d. Have inlet and outlet pressure gauges. Gauges should be marked with the gas name.
2. Regulators shall be cleaned and degreased.

1.4.1.15 Purging

1. Consideration shall be given to the requirement of cleaning and purging the gas pipelines.
2. The incorporation of traps and pockets within the pipework shall, where possible, be avoided. If impracticable, then provision shall be allowed for draining and purging this section.
3. Depending on the size of the system, or that section of the system to be purged, the gases shall be discharged into a well-ventilated room or to atmosphere.

1.4.1.16 Manifolds

1. The manifold shall comprise of two or more cylinders arranged as duty and standby banks, connecting to a common outlet.
2. Change-over between duty and standby cylinder banks shall be automatic.
3. All gas systems shall be installed with a low pressure alarm light located within the cylinder store.
4. The manifold shall be clearly identified as to the contained gas and shall be provided with warning and instruction notices. The alarm light shall be supplied and wired by the Sub-contractor.

1.4.1.17 Electrical Equipment

1. All electrical equipment shall be manufactured and installed in accordance with national or international regulations and standards.
2. Where flammable gases are used, all electrical equipment shall be flameproof or safe to classification appropriate to each gas.

1.4.1.18 General Conditions, Testing, and Commissioning

1. The testing and commissioning procedures shall generally comply with the SANS Standards and any relevant local Codes of Practice.
2. Adequate precautions must be taken during the testing procedures.
3. Tests and checks during the contract period shall be witnessed and certified by the Engineer.
4. The Sub-contractor shall provide the Engineer with signed test certificates, in triplicate, for each of the tests specified.
5. The manifold, pressure gauges and safety devices shall be removed or disconnected from the pipeline before testing.
6. Nitrogen (N2) or medical air shall be used for all testing procedures, with the service gas used for final leakage tests.
7. The following tests and checks shall be carried out during the contract period before the installations are formally handed over:-
8. Tests and checks:
9. Pressure test for leakage in pipelines only.
10. Valve Tightness and Correct Valve Zoning Test:
11. Relief Valve Test:
12. Initial Tests for Leakage on Completed Installations:
13. Continuity/Anti-confusion Test:
14. Purging/ Particulate Testing:
15. Functional Tests:
16. Purging into Service:
17. Final Tests for Leakage on Completed Installations:

1.5 Automatic Controls and Control Panels

1.5.1 Work Included

1. Supply and installation of gas manifold with automatic duty to standby changeover switches and automatic pressure regulators.
1.5.2 Related Work

1. Supply and installation of Gas cylinders, support brackets.

1.5.3 Electric/Electronic Controls

1. Alarm systems, MCP and control panels.

1.5.4 General Controls

1. Supply and installation of automatic pressure relief valves.

1.5.5 Control and Starter Panels

1. Supply and installation of MCP’s and controls for the installation.

1.5.6 Workmanship

1. The sub-contractor shall complete the installation to the highest quality and standard and in accordance with the latest edition of SANS regulations and codes of practice. Only qualified gas installers shall be allowed to do the installation.
1.5.7 Performance and Tests

1. Should the Sub-contractor’s performance on the contract not be acceptable, the main contractor reserves the right to effect immediately whatever action is required in order to ensure timeous completion of the works and minimise losses without the requirement of any formal notice period to the sub-contractor and all costs incurred due to such action shall be for the sub-contractor’s account.

2. The Sub-contractor shall guarantee that the installation will be installed and adjusted in such a manner that it will, within the capacity limits specified, meet the design intent and be installed in a manner acceptable as being of good workmanship and using good quality new materials.

1.5.8 Maintenance Period

1. The sub-contractor shall furnish all maintenance on the entire sub-contract works for a period of twelve months after handover. Maintenance shall include systematic examination and adjustment of equipment at least once a month.

2. The sub-contract shall in the course of such maintenance or on-call during the maintenance period, repair or replace defective parts if required, and shall use only genuine standard parts produced by the manufacturer of the original part.

3. The sub-contractor shall supply all spare parts, lubricants, refrigerant chemicals, filters, fuses etc. during the maintenance period. Renewals or repairs resulting from misuse, however, shall not be made at the expenses of the sub-contractor.

1.6 Practical Completion

1. The certification will be awarded to the contractor upon completion of all equipment and instrumentation installations, to include the operation of the system via permanent power supply. This must be viewed or witnessed by the engineering supervisor and where required, the respective engineer.
1.7 Equipment Submittals

1. Equipment specifications selected for procurement by the Contractor must be compiled as an equipment submittal, for review and approval by the Consultant, prior to procurement.

2. The items must include for:
   a. Manifolds;
   b. Piping Types;
   c. Valves;
   d. Cylinders;
   e. Controls and instrumentation.

1.8 Coordination with Other Trades

1. Render full co-operation to other trades. Provide any information necessary to permit work of all trades, to be installed satisfactorily and without interference or delay.

2. Where work is to be installed in close proximity to work of other trades, or where there is evidence that work may interfere with work of other trades, assist in working out space conditions to make satisfactory adjustments.

1.9 Valve Charts and Tags

1. Provide an approved valve tag for each valve. Valves within two metres of equipment which it controls need not be tagged. Attach the tag to valve handle or spindle with chrome chain.

2. Provide diagrammatic charts of all piping systems. Provide schedules of all valves. Provide three copies of charts and schedule bound booklets. Valve numbering system shall differentiate between classes of service and shall indicate floor level where valve is installed. Submit method for approval before final preparation.

3. These drawings must be included in the O&M Manuals upon handover.
1.10 Penetration of Pipes in Walls

1. Any copper piping chased into walls require to be protected with a buff tape or an approved equivalent, no brown paper or cement bags may be used.

1.11 Guarantee of Workmanship and Material

1. Submit, upon completion of the work, a single guarantee stating that all portions of the work are in accordance with the Contract requirements, perfect as to materials and workmanship and will so remain for a period of twelve months from the date of final acceptance and/or beneficial occupation to the Owner.
2. Guarantee that during the one year period that the appointed Contractor, will repair all defective work and will replace all defective work and all defective materials furnished, or installed under this section, without charge to the Owner.

1.12 Quality Assurance

1. The contractor shall institute an approved Quality Assurance (QA) System which shall be submitted for approval. The records of this QA system shall be kept throughout the duration of the contract and must be submitted at regular intervals. The QA system shall comply with SABS 0157.

1.13 Knowledge Transfer

1. The design team and contractor are contractually obligated to provide fully encompassing project knowledge to the building owner / facilities management team through the development, generation and execution of the following key activities and materials.
2. At building handover, the contractor is contractually required to provide the following documentation to the building owner and undertake all required training to ensure that all building systems are included:
a. Fully documented Design Intent including summary schematics
b. As-Built / Installed Drawings (including both digital and hardcopy to reflect the as-built systems & equipment)
c. Operations and Maintenance Manuals; fully collated, indexed and referenced (electronic compilation to be submitted in addition to hard copy)
d. Describing how facility will be operated;
e. By whom – operational responsibility matrix;
f. Building occupant training requirements for occupant interactive systems
g. Complete specifications and instruction manuals of all installed equipment and instrumentation.
h. Include commissioning dates, records of all functional/commissioning testing undertaken, a list of any future seasonal testing, and a written list of outstanding commissioning issues;
i. Include the outcomes and changes made to the building as a result of the commissioning process, accounting for all of the recommendations;
j. To include all major plant and equipment as discipline applicable (including chillers, boilers, heat pumps, air handling units, water treatment/recycling systems, onsite generation systems, water distribution (chilled, heating hot water and domestic hot and cold water), lighting system, air distribution, lifts and vertical transportation systems and automated controls (within the BMS and/or Energy metering, HVAC, and wet services)
620 QUALITY ASSURANCE & QUALITY CONTROL

- Create and maintain a quality assurance and quality control system.
- Set out the quality programme in a quality control manual:
  - Make sure that essential inspection requirements are known and carried out during all phases of the works.

- Describe:
  - The organisation systems.
  - Inspection and test plan procedures.
  - Personnel to be employed, together with their qualifications.
  - Methods of checking each type of test and tolerance.
  - Recording of checks.

622 MATERIALS

- Materials to be new unless specified otherwise.
- Health hazards: No proposed materials shall present a hazard to health.
  - Conduct a hazardous materials survey prior to any demolition
  - Any hazardous material found in buildings or structures to be demolished to be removed by a registered hazardous waste disposal company
  - Obtain certificates proving that the hazardous waste was disposed of correctly.

- Harmful materials: Do not use.
  - Asbestos or products containing asbestos.
  - Lead where the metal or its products may be directly ingested, inhaled or absorbed.
  - Urea formaldehyde.
  - Materials comprising mineral fibres with a diameter of 3 microns or less and a length of 200 microns or less not stabilised to prevent fibre migration.
  - Mineral wool insulation unless it complies to European Directive 97/69/EC and is not classified as a possible human carcinogen.
Polychlorinated biphenyls (PCBs).

- Alternative materials: To be certified in writing by the Architect before substitution of a different product or material to that specified.

### 624 SOURCING TIMBER AND TIMBER BASED PRODUCTS

- Procure all softwood and temperate hardwood timbers from sustainable sources.
- All plywood/manufactured boards to use softwood and temperate hardwoods from sustainable sources.
- Do not use tropical hardwoods in timber or timber based products from unsustainable sources or of unknown origin.
- All timber and timber based products to carry the Forest Stewardship Council (FSC) trademark.
- Documentation: Provide an FSC certificate and chain of custody certificate regarding the provenance of all timber.

### 626 ALTERNATIVE MATERIALS

- Obtain the written approval of the Architect before substitution of a different product or material to that specified.

  - Submit: Evidence that the alternative product is equivalent in respect of material, safety, reliability, function and appearance.
  - A request for a substitution shall be deemed to be a warranty by the Contractor to the client that such substitutions meet the requirements of the Specification.

- Where any substitution alters the specified requirements, submit sufficient information on substituted materials to allow evaluation by the Architect on any deviations from the Specification.
- The Contractor shall obtain written approval from the Architect or the Employer before substituting adhesives or sealants listed in the adhesives and sealants schedule.
630 CERTIFICATION

- Requirement: The Contractor to certify that all products and materials used on the project comply with this specification.

1.1.1 Workmanship

640 SKILLED PERSONNEL AND METHOD STATEMENTS

- Personnel:
  - Use persons skilled in the processes required
  - When requested, provide evidence to show an individual's ability to carry out the work/process.

- Contractor's method statements:
  - Describe: The order of work and methods to be employed.
  - Identify solutions regarding workmanship which affect: Fabrication, holding, storing and handling, setting-out, site assembly, bolting, joining and welding of components.
  - Propose methods, principles, details, etc. for Site cutting of components as part of the method statement.
1.2 Sustainability and Environmental Requirements

1.2.1 Environmental

810 ENVIRONMENTAL OBJECTIVES

- Comply with the Employer's Environmental Policies and Objectives.
  - Minimise adverse effects on the natural environment.

812 ENVIRONMENTAL MANAGEMENT PLAN [MAN-6]

  - Take account of recommendations from Ecologist, and/or any EIA requirements.
- Obtain: ISO 14001 Environmental Management System accreditation before and throughout the project
- EMP objectives to reduce impact of:
  - Pollution.
  - Construction waste by recycling.
  - Water and energy usage.
  - Minimise the environmental impact of construction on the project site and surrounding environment
  - Develop an emergency procedure to manage environmental incidents
  - Identify roles and responsibilities of individuals and parties responsible for implementing the EMP.
  - Establish objectives and targets for environmental performance.
• Environmental Management Plan: Submit for assessment.
• Maintain: Internal audit trail demonstrating compliance with the EMP.

1.2.2 Waste Management

820 WASTE MANAGEMENT OBJECTIVES [MAN-7]

• Conduct a hazardous waste survey prior to any demolition.
  
  o Where hazardous waste is identified, the materials are removed by a registered hazardous waste disposal company and certificates for safe disposal are issued.

• Reuse or re-cycle at least 70% of all demolition and construction waste (as measured by mass).

822 WASTE MANAGEMENT PLAN [MAN-7]

• Implement a project specific Waste Management Plan in line with the project specific EMP which covers:
  
  o Demolition and Construction waste.
  o Types of waste to be collected for recycling or for reuse
  o Stipulating that waste and recycling waste be measured by mass
  o How recycling and reuse occurs
  o How hazardous waste is managed
  o How all generated waste is monitored
  o Who is responsible for the various aspects of the plan, including instructions to employees and sub-contractors on recycling and reuse procedures.

• Make sure relevant subcontractors reuse and/or recycle to reach the minimum percentage target.
• Comply with either informal or bulk recycling criteria.
• Measure waste by mass, if waste is measured by volume convert the results to mass using the densities given in the following table:
### Table 1-5 Solid-waste characteristics

<table>
<thead>
<tr>
<th>Solid Waste Type</th>
<th>Density (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardboard</td>
<td>60</td>
</tr>
<tr>
<td>Gypsum wall board</td>
<td>300</td>
</tr>
<tr>
<td>Rubble</td>
<td>830</td>
</tr>
<tr>
<td>Steel</td>
<td>600</td>
</tr>
<tr>
<td>Wood</td>
<td>180</td>
</tr>
<tr>
<td>Mixed waste</td>
<td>210</td>
</tr>
</tbody>
</table>

- Exclude waste that is not normally sent to landfill such as:
  - Soil (from land clearing and excavation activities)
  - Land clearing debris
  - Waste that legally must be withheld from general construction waste (i.e. asbestos)

- Retain waste records.
- Submit quarterly report.
- Submit a final report summarising waste recycling achievements.
1.2.3 Procurement

830 SOURCING MATERIALS

• Definitions:

  • Sourced: Is defined as - the point of extraction, harvesting, recovery, processing, and/or manufacturing.
  • Distance: Is defined as - as the bird flies.
  • Reused/recycled: The location from where the material was salvaged is equivalent to 'point of manufacture' and the location of original manufacture is equivalent to 'point of extraction'.

• Included:

  o Materials or products used in the construction of the project and permanently installed on the project site.

• Excluded:

  o Mechanical, electrical and plumbing components.
  o Specialty items such as elevators, escalators and equipment.

• Maximise the proportion of materials sourced using the following target criteria:

  o Source minimum 20% of contract value within 400km of the site.
  o Source minimum 10% of contract value within 50km of the site.

• Low embodied energy content of materials.
• Low GWP for refrigerant gases (global warming potential to be 10 or less). [EMI-4]
• Zero ODP refrigerants or fire protection gases (no ozone depletion potential). [EMI-1, EMI-4]
• Prefabricated assemblies and components.
• Give preference to materials or products that contain a reused component and/ or postconsumer recyclable content, targeting 1% of the contract value of materials or products that comply with these criteria. [MAT-3]
• Low VOC content for primers, paints, coatings, adhesives, sealants, carpets and flooring. [IEQ-13]
• Low phenol formaldehyde content of composite timber products (E1, E0 or super E0 limit value). [IEQ-14]
• All foamed insulation used in the works shall be manufactured to exclude HFC, CFC, and HCFC-free blowing agents, i.e. zero ODP and a global warming potential of less than 5 with a target of zero GWP. [EMI-4]
• Use of alternative cement replacement materials, acceptable to the Structural Engineer, such as such as pulverised fuel ash (PFA), and or ground granulated blast-furnace slag (GGBS). [MAT-5]
• Avoid the use of PVC by selecting alternative materials to fulfil the same function. [MAT-7]

832 CERTIFICATION OF PRODUCTS AND MATERIALS BY MAIN CONTRACTOR

• Obtain for each product that the contractor takes custody of: Copy of all manufacturer's Material Data Sheet (MDS) expressing formaldehyde emissions/ volatile organic compound limits for all products used in the contract.
• Record and retain all documentation related to products/ materials for future audit.
• Record quantities and types of waste material recycled or re-used.
• Certify that all products and materials used in the works comply with the requirements of this specification.
• At the end of construction works: Prepare a Confirmation Letter in the form of a final audit, to ensure that the correct materials and products were used by the Contractor, Subcontractors, and relevant trades, wherever specified by describing the application, amount, type and supplier of each relevant product used.
1.2.4 Paints and Coatings

850 SCOPE

- 95% of all painted surfaces must meet the following requirements.
- Included paints and coatings are defined as site applied:
  - Paints, varnishes, protective coatings.
  - Solvent-based paints used in an interior application.
  - Exterior-grade paints used in an interior application.
  - Any liquid applied finishes used in an internal application.

- Excluded paints and coatings are defined as:
  - Paints and coatings applied off site.
  - Internal car parks painting.
  - Exterior applications.

852 PRIMERS/ PAINTS/ UNDERCOAT/ SEALERS AND VARNISH[IEQ-13]

Table 1-6 Total-volatile-organic-compound restrictions
860 PERFORMANCE COATINGS FOR FLOORS [IEQ-13]

- One + two pack floor coating - Maximum TVOC: 140g/litre

862 SOLVENT BASED COATINGS [IEQ-13]

- Coatings not covered elsewhere - Maximum TVOC: 200g/litre

864 OPENED AND UNOPENED TINS

- Opened and unopened tins from the contract, store securely on site for use:
  - In snagging.
  - In defect repairs.
  - By the Facilities Manager in maintenance of the building in use.

1.2.5 Adhesives and Sealants

866 SCOPE

- These specifications apply to adhesives and sealants for:
  - All on site applications
  - All internal applications including non-occupied areas, but excluding internal car parks.
  - All exposed and concealed applications
  - 95% of all sealants and adhesives used in the internal applications for this project.
  - Exterior applications are excluded
868 ADHESIVES [IEQ-13]

- Indoor carpet tile/Sheet Adhesive - Maximum TVOC: 50g/litre.
- Carpet pad adhesive - Maximum TVOC: 50g/litre.
- Wood flooring and laminate adhesive - Maximum TVOC: 100g/litre.
- Rubber flooring adhesives - Maximum TVOC: 60g/litre.
- Sub-floor adhesive - Maximum TVOC: 50g/litre.
- Ceramic Tile adhesive - Maximum TVOC: 65g/litre.
- Cove base adhesive - Maximum TVOC: 50g/litre.
- Dry wall and panel adhesive - Maximum TVOC: 50g/litre.
- Multipurpose construction adhesive - Maximum TVOC: 70g/litre.
- Structural glazing adhesive - Maximum TVOC: 100g/litre.
- Architectural sealants including fireproofing and waterproofing sealants - Maximum TVOC: 250g/litre.

1.2.6 Carpentry and Joinery

870 SOURCING OF TIMBER AND TIMBER BASED PRODUCTS - SUSTAINABLE SOURCES

OF TIMBER [MAT-8]

- Included:
  - Solid timber
  - Composite wood products
  - Formwork
  - Temporary works
  - Structural timber
  - External/internal cladding
  - Flooring/wall/ceiling finishes
  - External/internal joinery (windows, doors, balustrades).
• Timber to be:
  
  o Reused timber, or
  o Post-consumer recycled timber, or
  o Forest Stewardship Council (FSC) certified timber [www.fsc.org]

• Procure all softwood timbers and all temperate hardwoods from sustainable sources.
• Do not use tropical hardwoods or timber-based products from unsustainable or unknown origin in the works.
• Endangered species of timber (Check the CITIES website).
• All new timber and timber based products to carry the Forest Stewardship Council's (FSC) Trademark certification system for good forest management.
• Provide: Documentary evidence in the form of an FSC certificate and chain of custody certificate regarding the provenance of all timber supplied from:

Table 1-7 Timber chain-of-custody breakdown

- The last person in the chain of ownership for materials being supplied to the construction project does NOT need to be CoC certified, but the company from whom the materials are being received does.
872 WOOD BASED BOARDS [IEQ-14]

- Definition: Composite wood products used in the building including exposed and concealed applications.
  - All particle boards and MDF to be from softwood or temperate hardwoods from sustainable sources.
  - All plywood to be from softwood or temperate hardwoods from sustainable sources.

- Exclusions:
  - Exterior applications
  - Composite wood formwork
  - Internal car park applications
  - Reused composite wood products
  - Raw timber

Table 1-8 Maximum formaldehyde emissions levels
1.2.7 Carpets

878 CARPET TILES[IEQ-13]

- Definition: 100% of all project carpets, including backing and underlay.
- Volatile organic compound maximum emission:
  - TVOC emissions: 0.5 mg/m²/hr
  - 4-Phenylcyclohexene emission rate: 0.05 mg/m²/hr

1.2.8 Ground-Works

880 HARDCORE, SUB-BASES AND BACKFILLING [MAT-3]

- Recycle demolished building masonry as hard-core.
- Recycle paving and hard-core on site in sub-bases to new pedestrian pavements.
- Use non-naturally occurring (Industrial waste product) aggregate for non-structural purposes.

1.2.9 Concrete Work

882 CONCRETE [MAT-5]

- Cement:
  - Reduction of cement content by using cement replacement materials like pulverized fuel ash, ground granulated blast furnace slag or silica fume cements (CEM II to SANS 50197).

- Coarse Aggregate:
1.2.10 Steel

- **Definition:**
  - Steel includes structural steel, concrete reinforcement steel (i.e. stressed, in situ, precast), steel products (i.e. hot rolled beams, columns, angles, Mullions, cold-formed products (i.e. purlins, girts, cladding, profiled steel decking and roof sheeting).

- **Requirement:** More than 60% of all reinforcing steel to have a post-consumer recycled content greater than 90% of all steel used on the project to have an average postconsumer recycled content greater than 60%.
  - Provide: Full supporting documentation.

- **Exclusions:**
  - Pre-existing steel retained in a refurbishment project.
  - Door frames.
  - Balustrades
  - Railings
  - Fences
  - UFAD pedestals
  - Architectural features
884 STRUCTURAL STEEL [MAT-6]

- Subject to agreement with the Structural Engineer, select structural steel with at least a 60% post-consumer recycled content. [MAT-6]
- Hot rolled beams, columns, angles, hollow sections, parallel flange channels, mullions, purlins, girts and light-steel framing systems.
  - Material: Steel to SANS 1431 with 40% post-consumer recycled content.

- Mild Steel Floor Grating Panels
  - Material: Hot dip galvanised mild steel with 40% post-consumer recycled content. Type: Load bearing bar with dimpled top.

- Mild Steel Floor-plate
  - Material: Hot dip galvanised mild steel with 40% post-consumer recycled content.

886 REINFORCING STEEL [MAT-6]

- Plain bar reinforcement
  - Grade: Grade 250 Steel bars for concrete reinforcement with a post-consumer recycled content of 90%, or is re-used reinforcement.

- Deformed bar reinforcement
  - Grade: Grade 450 Steel bars for concrete reinforcement with a post-consumer recycled content of 90%, or is re-used reinforcement.

- Designated fabric reinforcement
- Welded steel fabric for concrete reinforcement with a post-consumer recycled content of 90%, or is re-used reinforcement.

- Permanent steel formwork
  - Steel to SANS 1431 with 40% post-consumer recycled content.

### 1.2.11 Above Ground Drainage

#### 888 DRAINAGE PIPE MATERIAL [MAT-7]

- Drainage pipework to be from one of the following materials:
  - Glass
  - Vitrified clay
  - Cast iron
  - Copper
  - Stainless steel
  - ABS
  - Polypropylene
  - High density polyethylene (HDPE)
1.2.12 PVC Minimisation

890 PVC MINIMISATION [MAT-7]

- Requirement: Replace 30% of the total cost of PVC content with alternative materials.

**Table 1-9 PVC-usage cost analysis**

<table>
<thead>
<tr>
<th>PVC usage</th>
<th>Expected cost within the project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulation</td>
<td>Actual cost</td>
</tr>
<tr>
<td>Pipes</td>
<td>85-100%</td>
</tr>
<tr>
<td>Conduits</td>
<td>95-100%</td>
</tr>
<tr>
<td>Sheathing of copper wires and cables</td>
<td>10%</td>
</tr>
<tr>
<td>Backing of commercial grade carpet tile</td>
<td>10%</td>
</tr>
</tbody>
</table>

1.2.13 Insulation

892 THERMAL INSULATION [EMI-4]

- Foam based thermal insulation:
  - Zero Ozone Depletion Potential
  - Manufactured without the use of, CFC's, HCFC's, HFC's and HFA's as blowing agents
894 SOLAR REFLECTANCE INDICES

- Surface coatings of roof waterproofing membranes: SRI minimum 79.
- Roof sheets less than 10° pitch: SRI minimum 79.
- Roof sheets more than 10° pitch: SRI minimum 29.
- Roof structures providing shade to roads, sidewalks, courtyards: SRI minimum 29.
- Roof hard landscape paving materials: SRI minimum 29.
2. PROVISIONAL BILL OF QUANTITIES