

**PART 5B : GENERAL SPECIFICATION REQUIREMENTS
FIRE DETECTION AND EVACUATION INSTALLATIONS**

INDEX

<u>Item</u>	<u>Description</u>	<u>Page</u>
5.18.	General Information.....	E5/13
5.19.	Standardisation.....	5/13
5.20.	Compliance with Regulations	5/14
5.21.	Standards.....	5/15
5.22.	Standards and Samples	5/16
5.23.	Identification of Subsections and Components.....	5/16
5.24.	Availability of Components	5/16
5.25.	Radio and TV Interference.....	5/16
5.26.	Delivery	5/17
5.27.	Methods of Fixing.....	5/17
5.28.	Protective Painting.....	5/17
5.29.	Wiring.....	5/18
5.30.	Construction of Free Standing Equipment Racks/Control Board	5/19
5.31	Finish.....	5/24
5.32	Identification of Labels.....	5/26
5.33	Earthing.....	5/27
5.34	Cables	5/28
5.35.	Installation of Conduit System.....	5/31

INDEX

<u>Item</u>	<u>Description</u>	<u>Page</u>
5.36.	Electrical Equipment and Components, Electrical ComponentsE5/33 and Circuits	E5/33
5.37.	Testing of System and TrainingE5/35	E5/35
5.38	DrawingsE5/36	E5/36
5.39.	Variations to the ContractE5/37	E5/37
5.40	Manuals and LiteratureE5/37	E5/37
5.41.	Tests and ReportsE5/38	E5/38
5.42.	WarrantyE5/39	E5/39
5.43.	Guarantee of InstallationE5/39	E5/39
5.44.	Contractors Liability in respect of DefectsE5/39	E5/39
5.45.	MaintenanceE5/39	E5/39
5.46.	Materials and PackingE5/40	E5/40
5.47.	Compliance with RegulationsE5/41	E5/41
5.48.	Certificate of Compliance for Electrical InstallationsE5/41	E5/41
5.49.	Electronic EquipmentE5/41	E5/41
5.50.	Special EquipmentE5/42	E5/42
5.51	Electromagnetic CompatibilityE5/42	E5/42
5.52.	Making GoodE5/42	E5/42
5.53.	ManualsE5/42	E5/42
5.54.	WorkmanshipE5/43	E5/43
5.55	Completion of ContractE5/43	E5/43

PART 5B

**GENERAL TECHNICAL SPECIFICATION
FIRE DETECTION and EVACUATION INSTALLATIONS**

5.18 GENERAL INFORMATION

This specification covers the general requirements regarding the material, equipment, installation, testing and commissioning of the installation.

The general specification shall be read in conjunction with the requirements for tendering, conditions of contract and the technical requirements in the project specification.

Should any differences or contradictions exist between the general specification and the project specification, then the latter shall take preference.

The technical, construction and performance requirements contained in this general specification must be regarded as being of minimum required standards and therefore full compliance is a necessity.

These specifications are not exhaustive and full compliance with these requirements does not release the Contractor from his contractual undertaking to provide an installation that complies in all aspects with the operational requirements specified.

The installation shall include all necessary items, whether specified in detail or not, and shall be carried out in the best possible way to ensure a complete high quality installation to the approval of the Engineer.

On being requested to do so by the Engineer, the Contractor shall supply a certificate of compliance issued by a recognised Research Laboratory, or the South African Bureau of Standards, for material and or equipment used.

Should any material and apparatus used comply with or be in accordance with the standard of any other recognised standards institution, this must be clearly stated at the time of the tender.

5.19 STANDARDISATION

Individual components or apparatus shall be of the same make, type or series for each item used throughout the installation.

Standardisation and mutual interchangeability of parts and components is essential and must be considered in the contractor=s approach to the interpretation of the specification.

The aim must be to standardise component types, series and makes, thus reducing the number of items to be held as spare parts.

Equipment shall be readily available and imported equipment shall be available in South Africa on a well established agency basis, proof of which shall be submitted with the tender.

Preference to locally manufactured equipment shall be given.

Manufacture of sub-units or sub-assemblies shall be standardised to ensure uniformity.

5.20 COMPLIANCE WITH REGULATIONS

The installation shall be erected and commissioned in compliance with the regulations and the conditions as set out in the conditions (terms) of contract which include the following in particular:

- (a) The SANS Regulations applicable to Fire Detection and Evacuation installation systems.
- (b) The Occupational Health and Safety Act, as amended, which includes the code of practice for the wiring of premises: SANS 0142, as amended, in terms of regulation C175 of the aforementioned act.
- (c) The regulations of the local Municipality.
- (d) The regulations of the local Supply Authority.
- (e) The regulations of the local Fire Brigade.
- (f) The regulations of Telkom SA Ltd.
- (g) The regulations of the Post Office.
- (h) The regulations of any Government Department or public service company, where applicable.
- (i) Government Notices.
- (j) Radio Act No.3 of 1952.

It must clearly be understood that where there are differences in standards in the requirements as set out above, the higher standard and stricter requirements shall apply.

In the instance of direct discrepancies, the requirements as stipulated in the specification must be given first priority, and thereafter the requirements as decided by the Engineer.

Should any requirements, by-law or regulations, which contradicts the requirements of this specification, apply or become applicable during erection of the installation, the contractor shall immediately inform the Engineer of such a contradiction.

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

5.21 STANDARDS

All materials and apparatus used shall comply in respect of quality, manufacture, test and performance with the relevant current specification of the following standards institutes:

(a) The South African Bureau of Standards (SABS)

SANS 10139	:	Fire safety in buildings Automatic fire detection, fire extinguishers (built-in)
SANS 50054-1	:	Automatic fire detection systems - Introduction
SANS 50054-2	:	Fire Detection & Fire Alarm Systems – Control & Indicating Equipment
SANS 50054-3	:	Fire Detection & Fire Alarm Systems Devices & Sounders
SANS 50054-4	:	Fire Detection & Alarm Systems – Power Supply Equipment
SANS 50054-5	:	Fire Detection detectors, heat and point Detectors
SANS 50054-7	:	Fire Detection & Alarm systems – Smoke Detectors
SANS 50054-11	:	Fire Detection & Fire Alarm – Manual Call Points
SANS 1253	:	Fire doors and Fire Shutters
SANS 8201	:	Acoustics – Audible Emergency Evacuation Signal.
SANS 60331-11	:	Tests For Electric Cable under Fire Conditions
BS 5942 &)	:	Intercom systems
BS 6840)	:	Intercom systems, installations

(b) The Fire Offices Committee of the United Kingdom (FOC)

(c) The Underwriter=s Laboratories (UL)

The relevant code shall be quoted in the detail specification.

Should material and apparatus used comply with or be in accordance with the standard of any other recognised standards institution, this must be clearly stated in the schedules at the end of this specification.

Imported materials must comply with the requirements of the appropriate SABS or BS specification although these materials need not necessarily bear the SABS mark.

All material shall be suitable for the conditions on site. These conditions shall include weather conditions, altitude, as well as conditions under which the materials are installed and used.

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

5.22 STANDARDS AND SAMPLES

Equipment, materials and apparatus used in the installation shall be of best commercial quality with a high reliability and shall be selected for ease of maintenance.

Samples of all items of equipment used and the relevant SABS or BS test reports or certificates shall be submitted to the Engineer on his request before installation is commenced.

All such samples may be retained until completion of the contract. All such samples shall have securely attached thereto labels designating the contract by name and number (if any), the name of the contractor, and any further relevant information.

5.23 IDENTIFICATION OF SUBSECTIONS AND COMPONENTS

Equipment should be delivered to site in the largest sub-assemblies which are practical.

Components, equipment and sub-assemblies shall be assembled in the workshop, after manufacture.

Individual units shall be clearly marked by employing an identification code in such a manner that re-assembly, erection and installation on site could be done in the shortest time and with the minimum adjustment on site.

Where practical completed electronic and other control units shall be assembled in the workshop for preliminary tests, this shall be done to check whether the equipment complies with predetermined set values and shall produce certain predetermined set results.

The Engineer may upon request of the contractor visit existing installations or prototype assemblies in the factory to determine whether such units and workmanship are of the required standard for this installation.

5.24 AVAILABILITY OF COMPONENTS

All components used in the system shall be readily available in the Republic of South Africa. A list of suppliers shall be compiled and submitted with the tender.

5.25 RADIO AND TV FREQUENCY INTERFERENCE

The Contractor must allow for the interference suppression components where required to ensure that the installation shall not cause interference to radio, television, paging systems and any audio/visual appliances used in the hospital.

All necessary steps are to be taken to ensure compliance with ICASA regulations

5.26 DELIVERY

The Contractor must satisfy himself that the delivery date for all items of equipment put forward by him will allow the complete installation to be installed energized and capable of operation in time to allow full commissioning and testing prior to contract completion.

It will be the Contractor's responsibility to place orders timeously so as to meet the programme. No substitution to the tendered items will be allowed due to the Contractor not having placed orders timeously.

5.27 METHODS OF FIXING

The size of bolts and screws shall be the largest permitted by diameter of the hole in the apparatus concerned and are to be of adequate length. When fixing any item of equipment, all bolt or screw holes provided therein shall be used and fixing in each hole is to be secure.

5.27.1 Light Weight Equipment

All light weight fixing to brick or concrete shall be made with steel screws and Fischer or other approved plugs. Plugs made of wood shall not be allowed. Holes of the requisite size for the plug which shall suit the screw used, are to be neatly drilled in the concrete or brickwork (not in the joints between bricks) to a depth excluding plaster or soft wall finish, equal to at least the length of the plug to be used. The plug length shall be such that when the screw is in place all the threaded length is in the plug. Fixing to timber shall be made with greased brass wood screws. For fixing to hollow tiles, etc., screw anchor type fixing shall be used, fitted as above as far as possible.

Fixing to soft or hard fibre boards, etc., which are inaccessible to the back shall be made with sheradised self-tapping screws of appropriate size or with springs or gravity toggles.

5.27.2 Heavy Equipment

All heavy weight fixing to brick or concrete shall be by means of mild steel bolts of appropriate size of the grouted bolt type or by one of the various types of suitable expanding bolt fixings. After erection of equipment all exposed metal work or fixing shall be treated with two coats of paint to match the finish of the equipment.

5.28 PROTECTIVE PAINTING

The paintwork of all equipment and plant which is damaged during the course of erection and prior to acceptance by the Engineer, must be satisfactorily made good by the Contractor at his own expense.

5.29 WIRING

All conduit, trunking, ducting, sleeves for cables, wire ways, etc., shall be supplied and installed by the Contractor. The onus is on the Contractor to ensure that these installations conform in all respects to this specification.

5.29.1 General Wiring

All cabling shall be looped from point to point. There shall be no joints in cabling or wiring. Not more than three conductors shall be looped together in any one terminal. Where multiway terminations are necessary, these may only be made off in suitable junction boxes, appropriately labelled.

There shall be no cutting away or nicking of wire stands.

The junction of main cables and branch cables shall be made with suitable junction blocks to facilitate the isolation of various sections in the event of fault location.

Ends should all be plier twisted and firmly terminated in approved junction blocks, which shall be fitted with built in cable protectors.

Standard 600V grade PVC insulated stranded annealed copper conductors manufactured to SANS 1507-1-6 and SANS 1574 - 1992 for 230/400V applications shall be used.

5.29.2 Equipment Wiring

Equipment shall be wired in PVC insulated copper wire.

The internal wiring of equipment shall be neatly done. All soldered connections shall be neatly and carefully made. All cable runs shall be neatly laced and tied to suitable supports. The capacity, type and insulation of each conductor shall be adequate for its function and excessive compressive stress shall be avoided in looms.

Cable entries shall be provided and so designed that no damage to the cable can result during normal use.

High quality heat resistant plastic cables must be used to minimize damage to adjacent wiring in the event of electrical faults causing high currents and heating of the faulty circuits.

All terminations are to be via numbered terminals, and all wires are to be numbered at both ends to correspond with the wiring diagrams. Should any particular wiring Colour Code be adopted, this is to be kept standard throughout the installation.

All soldered joints are to be fixed so that there is no strain on the joints.

5.29.3 Signal Wiring

Wiring of the various parts of the systems carrying a.c. or d.c. signals shall be by means of multicore, stranded cabling comprising PVC insulated annealed copper wires combined as coded twisted pairs and sheathed with extruded PVC.

The signal cable shall be such that cross-talk isolation between wires at audio frequency shall be less than 50dB and the insulation shall be rated at 300V.

In general, all low voltage signal cables shall be spaced at least 150mm from supply mains cables.

5.29.4 Identification of Wiring

All wiring is to be uniquely identified by means of numbered ferrules in the case of single core wiring or by means of numbered cores or a strictly adhered to colour coding system in the case of colour coded multicore wiring. Where colour coding is used the International accepted code of Blue, Orange, Green, Brown, Slate shall be strictly adhered to and the same colour shall be used throughout for a specific circuit.

5.29.5 Wiring Terminals

All wires shall be clearly identified by using plastic label tags.

Cable ends shall be terminated in approved terminal blocks as supplied by MS, Klippon, Wago or other approved type - cheese blocks are not acceptable. Terminals shall be easily accessible, clearly labelled, well supported and easy to wire using a spring mechanism to grip the wire. Tenderers must take note that it is a special request that all PLC and I/Os, loudspeaker lines to outside building installations, shall be wired to *fused* terminals or where this requirement is not feasible surge arrestors shall be fitted so as to provide adequate and efficient lightning protection.

Identification shall be such that any circuit can be clearly identified and traced from the wiring diagrams. These wiring diagrams shall clearly show all terminals, draw boxes, joints, points of termination, etc., and shall be such that a circuit can easily be traced from point to point throughout the system.

5.30 CONSTRUCTION OF FREE STANDING EQUIPMENT RACKS/CONTROL BOARDS

5.30.1 Framework

Free standing equipment racks/control boards shall be manufactured from angled, channel or folded steel metal sections and metal framework with a solid U-channel base frame, sufficiently braced to support all equipment and span floor and access holes.

Separate sections of the framework shall be bolted together with rubber packing installed between joints to provide a finished appearance.

Depending upon the number and size of components, a common front panel may be installed over one or more groups of equipment.

5.30.2 Grouping of Switchgear and Control Equipment

Switchgear and control equipment shall be logically arranged and grouped.

5.30.3 Internal Wiring

5.30.3.1 Type of Conductors

Noted that where Fire Rated Cables is required, conductors consisting of FIRE RATED PH120 cable is to be installed.

Generally as required Standard 600V grade PVC insulated stranded annealed copper conductors (230V/400V) manufactured to SANS 1507 and SANS 1574 shall be employed for the internal wiring of control boards.

Except in cases where cables are specified, all wiring shall be done with PVC-insulated, single core stranded copper conductors and bare stranded or green PVC-insulated copper conductors for earth continuity in compliance with SANS 1507 and SANS 1574.

The PVC-insulated copper conductors shall be compounded and stabilized to comply with SANS 1411 Part 2

If the internal ambient temperature is likely to exceed 60°C, SANS approved stranded 600V grade silicone rubber insulated stranded copper conductors shall be used.

The wiring of low voltage systems and circuits (less than 50 V) may be done by means of multi-core single conductor PVC-insulated and PVC shrouded cables.

5.30.3.2 Wiring

Wiring shall be arranged in horizontal and vertical rows and may be -

- (a) bunched and strapped using Hellermann or similar strapping and studs which are fixed to tubular harness supports.
- (b) bunched and flat mounted using PVC covered steel tape fixed directly to the chassis.
- (c) open cleat wired in a Wirac or similar cleat bunch.
- (d) installed according to the Siemens X or similar wiring system, or
- (e) may be installed in Egaduct or similar PVC wiring channels

Bunched conductors shall be neatly formed to present a uniform appearance without twisting or crossing the conductors.

Conductors leaving harnesses shall be so arranged that they are adjacent to the chassis.

These conductors shall first be led in the same direction as the conductors in the harness and shall then be bent over the top of the harness and progress to its final destination. Bunched conductors may not be grouped into smaller bunches within the large harness.

5.30.3.3 Wiring across hinged panels

Conductors to hinged panels and doors shall be secured on both the door and the frame and shall be looped between the two points.

The loop shall be arranged to produce a twisting motion when the door is opened or closed.

A flexible protection sleeve shall be installed over the conductors.

5.30.3.4 Flat multiple cables

The wiring in the desk section of desk type consoles shall, where possible, be by means of flat multiple PVC-insulated cables.

These cables shall serve as connections between equipment mounted on hinged panels, the electronic racks and the terminals.

Flat multicore flexible PVC-insulated conductors shall be installed between equipment mounted on hinged panels and equipment mounted within these consoles and the terminals in the consoles.

5.30.3.5 Current Rating Conductors

The current rating of conductors for the internal wiring shall be sufficient to carry the maximum continuous current that can occur in the circuit.

This value shall be determined from the circuit breaker or fuse protection of the circuit.

Conductors ratings for PVC-insulated, single core copper conductors are specified in the table below for maximum internal ambient temperatures of 35°C.

Nominal cross-section (mm ²)	CONDUCTOR CURRENT RATING (A)				
	Number of conductors bunched together				
	1	2-3	4-5	6-9	10 & more
1,5	13	12	10	9	8
2,5	17	16	14	12	10
4	22	20	18	16	13

5.30.3.6 Wiring Channels

Where wiring channels are used, they shall be installed horizontally and vertically.

Under no circumstances may power and control circuit wiring be installed in the same wiring channel.

Channels containing control circuit wiring shall not be more than 60% full.

Channels in which power circuits are installed shall not be more than 40% full.

5.30.4 Terminal Strips

All external wiring such as power, control interlocking, alarm, measuring and DC circuits shall terminate on numbered terminal strips of the Klippon or other approved manufacture.

The correct terminal size as recommended by the manufacture for each conductor to be connected, shall be used throughout.

Terminals for power wiring shall be separated from other terminals.

Terminals for internal wiring shall not be interposed with terminals for external circuits.

Spring-loaded snap or pin type terminals attached to glass fibre or artificial resin reinforced isolator boards may only be used for electronic control circuits where the current rating does not exceed 0,1A.

5.30.5 Termination of Conductors

All conductors terminating on meters, fuse holders and other equipment with screwed-on terminals, shall be fitted with lugs.

The lugs shall be soldered or crimped to the end of the conductor.

The insulation of conductors shall only be removed over the portion of the conductors that enter the terminals of equipment and strands may not be cut from the end of the conductor.

Conductor terminals connected to Klippon, or other approved type terminals need not be soldered or ferruled. When more than one conductor enters a terminal, the strands shall be securely twisted together.

Connections to circuit breakers, isolators or contactors shall be installed by one of the following methods:

- (a) a ferrule of the correct size
- (b) soldering the end of the conductor, or
- (c) winding one conductor strand around the end to totally cover the end.

External cable connections shall be secured by cable glands fixed to gland plates installed within the rack/consols.

5.30.6 Identification of Conductors

Under no circumstances may PVC adhesive tape be used for the bunching of conductors or for the colour identification of conductors.

The colour of the insulation material of conductors for all 230V circuits shall correspond to the colour of the supply phase for the circuit and the colour of the insulation material of all neutral conductors for 230V circuits shall be black.

All other conductors, supplying control circuits, etc., shall be coded in colours other than those specified above and a colour code shall be devised for the installation of the other conductors that will enable positive identification on the wiring diagrams.

5.30.7 Busbars

Unless specified to the contrary, busbars shall be manufactured of solid drawn high conductivity copper with a rectangular cross-section in accordance with SANS 784 as amended and BS 159 where applicable.

Busbars shall be supplied for the following applications:

- (a) Distribution of supply voltage
- (b) Connection bars for parallel cubes
- (c) Connection bars for neutral conductors
- (d) Earth busbars

The maximum allowable temperature of busbars (including joints) carrying full load current in an ambient temperature as specified shall not exceed 80°C.

5.30.8 Mounting of Equipment

5.30.8.1 Access

All equipment, busbars and wiring shall be completely accessible when the front and/or back panels are removed.

E5/23

5.30.8.2 Space Requirements

In designing control boards or racks, the following requirements shall strictly be adhered to:

- (a) A minimum of 75mm between any piece of equipment and the frame or internal partitioning. This minimum space is required above, below and on the sides of the equipment.
- (b) A minimum of 75mm between horizontal rows of equipment. The maximum outside dimensions of equipment shall be considered.

5.30.8.3 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 the meters shall be covered by removable covers of isolating material fixed to the door to protect the terminals of instruments and to prevent accidental contact.

5.30.8.4 Fuses

Fuses for instrumentation shall be mounted in an easily accessible position with a label clearly indicating the fuse rating.

Fuse holders shall be mounted semi-recessed in the front panel so that fuses can readily be changed without removing the front panel.

5.31 Finish

5.31.1 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 shall be used.

Care shall be taken to ensure that all edges and corners are properly covered.

5.31.2 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 picking 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 phosphating, a passivating layer consisting of a high quality zinc chromate primer shall be applied, followed by two coats of high quality baked enamel to BS 3830.

The minimum paint thickness after baking shall be 0,06mm in diameter.

The paint shall have a minimum shock resistance of 25kg/cm on 1mm mild steel and a scratch resistance of 2000 grams.

5.31.3 Powder Coated 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 picking and washing may be employed.

The metal parts shall be pre-heated and then covered by a microstructure paint powder applied electrostatically.

The paint shall be baked on and shall harden with 10 minutes at a temperature of 190°C.

The minimum paint thickness after baking shall be 0,05mm.

The paint shall have a minimum shock resistance of 25kg/cm on 1mm mild steel plate and a scratch resistance of 2000 grams.

5.31.4 Colour

The colour used shall correspond to the colour specified in the project specification.

If no colour is specified the colour shall be dark grey, code G12 of SANS 1091 on the outside and white on the inside or a light grey code G80 or G54 of SANS 1091 inside and outside.

Should metal hinged panels be used, these shall be finished in a lighter grey colour paint than the surrounding framework unless otherwise specified in the project specification.

Should stainless steel type panels be specified, these shall be brushed in 150 grit, the grain orientated parallel to the side of the console.

Should aluminium type panels be specified, these shall be of the anodized satin finished type.

5.32 Identification Labels

5.32.1 Material

Identification labels shall be installed for all control equipment.

The labels shall be in both official languages.

Engraved plastic or Ivorine type labels shall be installed.

The labels shall bear white lettering on a black background or vice versa.

5.32.2 Method of Labelling

Boards shall be supplied with the following labels:

Number and allocation of board -

Example: DB.AB

These labels shall be fixed to the outside of the board in a prominent position.

The lettering shall be a minimum of 10mm high.

In each control board an identification label shall be installed on the front panel stating which equipment or group of control equipment is housed in that particular section of subsection of the board -

Example: POWER SUPPLY 24V DC

Individual control components such as push buttons, switches, relays, contactors, etc., shall each have an identification label corresponding to the identification letter and/or code number shown on the schematic diagrams.

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 doors or front panels respectively.

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

5.32.3 Fixing of Labels

Engraved labels shall be secured by means of brass nuts and bolts or slotted label holders.

A sufficient number of bolts shall be installed to prevent labels from warping.

Self-tapping screws will not be allowed.

5.33 EARTHING

The installation shall be earthed properly in accordance with the latest edition of SANS 0142, and the bye-laws of the local authority.

All earth conductors shall be bare stranded copper conductors or stranded conductors with green and yellow PVC-insulation, unless specified otherwise in the project specification.

5.33.1 Earth Connection

A separate earth connection shall be supplied between the earth busbar in each rack/control board and the earth busbar in the main electrical board. These connections shall consist of bare, stranded copper conductors supplied along the same routes as the interconnecting supply cables or wiring.

The size of the incoming earth wire shall be in relation to the main incoming power supply conductors complying with the requirements of SANS 0142.

Under no circumstances shall general connection points, bolts, screws, etc., be utilized for earthing purposes but it will be the responsibility of the contractor to provide separate earth terminals or clamps.

All earth connections shall be tin-plated and fixed with approved ferrules. The entire connection shall then be soldered.

The earth conductors of all sub-circuits shall be connected to the earth busbar of the supply board.

The ends of all metal channels and cable trays containing cables and conductors under load shall be earthed to the nearest control board 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 method of joining the racks is sufficient for earth continuity.

All metal conduits shall, where installed by the contractor, terminate on the rack/boards or junction boxes.

Where this cannot be done the conduit end shall be earthed separately with a stranded conductor.

An earth conductor shall be installed in all types of flexible conduit.

The earth conductor shall be connected securely to the metal parts at both ends.

In order to avoid formation of earth loop currents in electronic circuits, printed circuit layouts must be designed such that a common earthing track or point is established.

Where digital integrated circuits are used, decoupling of the supply line (VCC) to earth must be done with suitable decoupling capacitors at regular intervals to avoid fluctuation of potentials during switching.

Feedback loops in earth potential tracks and stray capacitance between pointed tracks must be avoided in radio frequency (RF) in the VHF or UHF spectrum.

Common earthing bars or points should be utilized where banks of electronic equipment are connected to function on common banks.

These points could either be at Absolute \cong earth potential, i.e. returning to the earth of the input power circuits, or may be at Floating \cong earth potential, i.e. an earth potential insulated (by making use of an insulating transformer from the supply earth potential).

The resistance between the earth electrode and earth on electronic equipment shall be less than 2ohms.

Any conducting material that has been anodized, eg. aluminium, may not be used as an earth busbar unless special precautions have been taken to ensure that the anodizing material has been removed where the earthing connections are made.

Connections to electronic equipment must be made using cadmium plated lugs, bolts and nuts fixed to properly cleaned and prepared surfaces on the electronic sub-racks or trays.

From the sub-rack earthing point to all the individual earthing points of the electronic equipment, separate copper conductors must be installed for each electronic rack.

The conductor size shall be determined according to SANS 0142, must be sufficient for that particular rack and must be soldered to the terminal(s) of the edge connector(s) on that rack.

All connections between racks or sub-racks for the conveying of signals in the VHF, UHF or microwave frequency range shall be made using co-axial cable with matching impedance.

Termination of co-axial cable shall be in proper connectors (plugs and sockets) of the BNC or RG8U or equivalent type depending on the particular application.

5.34 CABLES

Cables shall generally be of the Fire Rated PH120 and /or PVC-insulated type, individual cores of multicore cables being identified by means of distinctive colouring of the PVC-insulated material of the individual cores.

All cables shall be supplied and installed ***without joints*** unless written approval has been obtained from the Administration.

5.34.1 Voltage Ratings

All cables shall be suitable for the voltage to be applied between the conductors and between the conductor and earth.

All cables to be used in systems with a system voltage between 50 Volt and 500 Volt, shall have a volt rating of 600/1000 Volt.

5.34.2 Termination of PVC-Insulated, Armoured Cables

All ends of PVC SWA PVC cables shall be terminated with approved glands ensuring a watertight connection between the sheath, gland and equipment.

In cases where copper earth conductors (SANS 1507) are joined to the armouring, special glands (SANS 1213) shall be used.

The glands to be used shall be constructed so that the armouring of the cable is clamped between two bevelled cores with a screw-clamp.

The cable gland shall be screwed to the gland plate or equipment and fixed with a locknut.

A neoprene or PVC shroud shall be used to seal the gland and sheath watertight.

Cable cores shall be connected to equipment with suitable lugs.
Exposed armouring shall be covered with bitumen-base paint.

5.34.3 Cables in False Floor Areas

Cables shall preferably be installed in the false floor space below equipment racks, control boards or control consoles if so provided.

Cables shall be installed in groups parallel and adjacent to each other in straight line and/or in groups at 90° to each other.

Generally the cables shall be installed directly on the concrete floor and groups shall be bound together by means of steel straps approximately 12mm wide.

Groups of cables crossing each other at 90° shall be approximately 50mm apart vertically.

For this purpose, the contractor shall supply and install O-Line or similar type cable trays manufactured and bent in the shape of a bridge spanning the lower group of cables.

The two cable tray approach section of the bridge shall be inclined at an angle of 30° to the horizontal.

Cable tray bridge sections shall be bolted to the concrete floor at both ends by means of 12mm diameter Rawl or similar bolts and nuts.

5.34.4 Cables Fixed to Walls and Vertical Ducts

Cables to be installed and fixed to walls and in vertical ducts, shall be clamped to galvanised O-Line or similar type channels fixed to the wall face.

The O-Line channels shall be installed at vertical distances not exceeding 600mm and shall be secured to the walls by means of Rawl bolts or by means of a self-drilling anchoring system.

Cables shall be arranged parallel and adjacent to each other and each cable shall be supported and fixed to the O-Line or similar type clamps.

The size of the clamp (and the corresponding catalogue number) shall be determined from the diameter of the cables.

All cables larger than 35mm² 4-core shall be clamped to the O-Line or similar channel by means of J type cleats.

Cables installed on horizontal distribution sections other than in false floor areas shall be installed on cable trays.

Cables for the installation of other services including communication systems and other 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 low voltage systems.

Where armoured cables are used for low voltage services, they shall be installed in separate cable trays or shall otherwise be at least 1 metre away from power cables.

Where unarmoured cables are used for these other services, they shall be installed in separate conduits or metal channels.

5.34.5 Identification of Cables

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 drawings to be submitted when the installation has been completed.

Cables shall be marked with non-deteriorating bands with raised or punched numbers.

The marking may be done by means of lettering punched into aluminium foil.

The foil shall be wrapped around each respective cable and bound with aluminium tape.

The cables shall be marked as follows:

- (a) At both terminations.
- (b) At T-sections of four-way joints of cable trays and/or metal channels.
- (c) At entries to vertical ducts should cables extend up and down at the particular point of entry, the cables shall be marked directly above and below such a point of entry.

5.35 INSTALLATION OF CONDUIT SYSTEM

5.35.1 General

In general the conduit for interconnecting wiring to various types of outlets for electronic installations shall be in accordance with the General Electrical Specification.

5.35.2 Outlets

All accessories such as detector outlets, break glass units, microphone input points, etc., shall be accurately positioned.

It is the responsibility of the 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 contractor to determine the correct final floor, ceiling and roof levels.

5.35.3 Draw Boxes

Draw boxes shall not be installed in positions where they will be inaccessible after completion of the installation.

All installed draw boxes shall be pointed out to the Administration and the positions of all draw boxes shall be indicated on the As installed drawings.

5.35.4 Wall Outlets

Where more than one 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 making any joints in the wires.

5.35.5 Ceiling Outlets

Where the conduit end is used to support detectors, sirens loudspeakers, etc., a ball-and-socket type lid shall be fitted to the ceiling outlet box in all cases where the conduit from the concrete or ceiling is longer than 500mm

In all other cases, a dome lid may be used.

Where equipment is specified as ceiling mounted it shall be fixed directly to the draw box, this shall be done by a minimum of two screws screwed to the box or alternatively by screws fixed directly to the concrete ceiling.

5.35.6 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 cladded surfaces.

5.35.7 Excess Holes

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

Brass stopping plugs shall be used in conduit accessories.

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

5.35.8 Sequence of the Work

Wiring shall only be carried out after the conduit installation and plaster have been completed, but before painting has commenced.

No conductors shall be installed before the conduits have been cleaned of all debris and moisture.

5.35.9 Circuits

Conductors that are connected to different control boards shall not be installed in the same conduit.

In the case of power distribution, the wiring of one circuit only will be allowed in 20mm diameter conduit with the exception of the wiring between control boards and fabricated sheet metal boxes close to control boards. In this case more than one circuit will be allowed.

5.35.10 Looping

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 or draw boxes and not in conduits.

Conductor jointing : executed by approved ferruling properly covered with heat shrink.

5.35.11 Number of Conductors

The number of conductors that may be drawn through a conduit shall comply with the requirements of SANS 0142.

5.35.12 Drawing in of Conductors

When conductors are drawn through conduit, care shall be taken that they are not kinked or twisted.

Care shall also be taken that the conductors do not come into contact with materials or surfaces that may damage or otherwise adversely affect the durability of the conductor.

5.36 ELECTRICAL EQUIPMENT AND COMPONENTS, ELECTRONIC COMPONENTS AND CIRCUITS

5.36.1 General

Electronic components such as I.Cs shall be of a type and model obtainable in the RSA and not specifically designed for the equipment in which it is used.

The contractor shall clearly indicate to the Engineer which of the equipment offered does not comply with this requirement before approval shall be granted.

5.36.2 Relays

The coil, contacts and operating mechanism of all relays shall be contained in a transparent, dust proof enclosure of plastic or other suitable synthetic material.

Relays shall be supplied with plug-in bases of Bakelite or other insulating material.

Bases shall be fixed to the equipment rack, control board or console frame in a fashion to facilitate removal or insertion of the relay and enclosure.

Relay bases shall be fitted with wire-spring type retaining clips to ensure positive relay contact even when the relay is subjected to severe vibrations.

Relay contact ratings shall be sufficient for the current drawn over the contacts taking the impedance of the load into account.

5.36.3 Push Buttons

Impulse type push buttons shall be of robust construction and shall be suitably rated for the switching duty and for the control functions specified.

The push buttons shall be suitable for flush mounting in control boards, consoles or in outlet boxes in walls.

Push buttons shall be fitted with screw-on-retaining rings.

Red push buttons generally be used for tripping, stopping or switching of functions and **Green** push buttons for starting or switching on functions.

Push buttons installed in walls or on other non-metallic surfaces, shall be mounted in purpose-made flush or surface mounted boxes equipped with a mounting plate with slotted holes and a suitable cover plate.

Self-locking type push buttons shall be similar in construction to impulse type push buttons. When such a push button is depressed a second time, it shall cancel the original switching state.

Illuminated push buttons, key-operated push buttons, buttons plates, legend plates, etc., shall be supplied as specified. Economy resistors shall be provided with illuminated push buttons.

Push buttons shall comply with the requirements of the relevant clauses of BS EN 60730 and BS EN 61058 or VDE 0660.

Generally switching functions of push buttons shall be indicated by means of symbols or figures engraved on the moulded shroud. This shall be the preferred method of identifying the function of push buttons.

5.36.4 Indicating Lights

Indicating lights to be installed on equipment racks, control boards and consoles shall be similar in construction to the shroud of push buttons, and shall illuminate internally when indicating a switching state.

The colour of the shroud shall be green and red respectively for indicating an **On** and **Off** switching state or any other colour specified for a particular control function indication.

5.36.5 Potentiometer Type Controller

Controllers shall be of the quadrant type with linear movement.

Each controller shall be fitted with a scale marked as specified with unit divisions indicated numerically.

The quadrant controller shall rotate about a swivel operating through an arc of approximately 90° with the *Off* position at the bottom end nearest to the operator and the maximum at the top.

5.37 TESTING OF SYSTEM AND TRAINING

5.37.1 Factory Acceptance

A Factory Acceptance Test of the various components of the systems shall be provided on request.

5.37.2 Commissioning

After installation and run-up, a commissioning and hand-over procedure shall be followed by the contractor to demonstrate proper operation of the system, in accordance with this specification.

5.37.3 Training

5.37.3.1

The Contractor shall be required to train technical personnel in the proper operation and maintenance of the system. A total of 2 people will be nominated for this purpose. Training shall be done on site. Tenderers shall indicate the time allowed for this purpose, but the minimum period acceptable will be one day.

5.37.3.2

It is the intention to obtain a very thorough understanding of the system. To this end, training shall be done in three ways:

5.37.3.2

Formal hands-on- training sessions of the operating personnel in system operation, covering all software and hardware operational aspects.

5.37.3.3

During the installation phase a person will be designated to be closely involved with the installation and commissioning process. The intention is not to interfere with the Contractors= installation team, but to observe in order to obtain the maximum possible information regarding the installation.

5.37.3.2.3

Software instruction - During these sessions the operators will be familiarized with the software regarding the generation of reports by the system, set-up of analogue limits, modification of displays, configuration, as well as other operational requirements of the software.

5.38 DRAWINGS

The specification drawings are in diagrammatic form and are not manufacturing drawings and the dimensions given are only sufficient for tendering purposes or to enable the Contractor to complete his working drawings. Due allowance must be made in the tender for such items not shown or detailed on the drawings, but which are nevertheless necessary for the proper execution of the works and operation of the system.

The Contractor shall submit for approval:

(a) Builder=s Work Drawings

Builder=s work drawings shall include positions, sizes and masses of major pieces of equipment, as well as all other building requirements such as shelves, cupboards, etc., necessary for the successful installation of equipment and operation of the system.

(b) Electrical Drawings, such as:

General arrangement drawings of the equipment in the relevant area.

Line Diagrams of each part of the system.

Interconnection Diagrams.

Cable and Equipment Schedules.

All cable routes shall be shown on the site plan drawings.

Two prints of manufacture/erection drawings for approval.

The Engineer requires two (2) weeks from the date of receipt to check drawings submitted. Drawings shall be submitted in sufficient time to permit the Contractor to meet his fabrication programme, since no claim for extension of the contract will be considered should drawings not be submitted timeously.

It is the Contractor=s responsibility to ensure that all drawings conform to the specification and to correct any errors, omissions or deviations. If manufacture drawings differ from the specification, the Contractor shall make specific mention of each deviation in a letter accompanying the submission, giving the reasons for the deviations and any cost implications, if any.

Should the drawing indicate work which **does** deviate from the specification and is not pointed out, the Consulting Engineer reserves the right to amend such workshop drawings at any stage when the deviation is discovered, **ie.** even after installation, at the Contractors expense.

Where it is necessary to consider the building and electrical details of the project when compiling workshop drawings, the Contractor must refer to the detailed Architectural drawings produced by the Architect and the drawings of the Electrical details produced by the Consulting Electrical Engineer. Both these sets of drawings are in the possession of the Client.

The accuracy and practicability of all shop dimensions necessary for the manufacture and installation of the equipment remains the responsibility of the Contractor. Approval of submitted information shall not be construed as a complete check and shall not relieve the Contractor of his responsibilities as defined elsewhere.

5.39 VARIATIONS TO THE CONTRACT

The Contractor shall, upon a written request from the Engineer, price any variation intended to his works within seven (7) days of such request.

Failing to submit prices to such variations within the stipulated period, may result in them being priced by the Engineer and issued officially as variation orders.

The Contractor shall rate on his priced variations the extra time required to carry out the work intended. Should the Contractor fail to inform the Engineer of extra time required it shall be assumed that such work will be carried out within the contract period and no later claim for extension of time will be considered.

The Contractor shall perform no work that involves a cost implication or a variation in price to the original contract amount unless the Contractor is in possession of:

- (a) an approved variation order.
- (b) a letter of definite instruction from the Consulting Engineer advising him to proceed without the approved variation order.

5.40 MANUALS AND LITERATURE

At the stage of performance testing, the Contractor shall submit to the Consulting Engineer, three (3) copies of maintenance and operating instructions each containing the following:

- (a) A full set of electrical drawings of the final installation.
- (b) A full set of control drawings of the final installation.
- (c) Literature on all equipment installed, including wiring diagrams, recommended spare part lists together with the model number, etc., and the name and address of the supplier.
- (d) Test certificates for fire detection installations.
- (e) All workshop drawings of the system as installed.

(f) Trouble-shooting check list.

(g) All wiring diagrams.

Wiring diagrams are to be correct in every respect and checked before being submitted.

All the above relevant information shall be properly filed and indexed in appropriate files.

5.41 TESTS AND REPORTS

5.41.1 General

Where practical according to the discretion of the Engineer, complete electronic and other control units shall be assembled in the workshop for preliminary tests. This shall be done to check whether the equipment complies with predetermined set values and shall produce certain predetermined set results. It is in the interest of the contractor to notify the Engineer when the installation reaches various stages of completion, in order that he may inspect the installation and point out any discrepancies. These inspections shall be considered informal and under no circumstances will they in any part or in whole invalidate the requirements of the specification. Any costs incurred in correcting discrepancies shall be to the Contractors account.

5.41.2 Pre-Final Inspection

A pre-final inspection of the installation shall be made at the contractors request at least seven days prior to the official testing and acceptance of the installation once the installation is, in the Contractor=s opinion, complete and ready to operate. After this pre-final inspection the installation must be set into trial operation. The installation shall only be deemed ready for official acceptance subject to its having maintained the specified performance without any failure for a period of seven consecutive days. Upon completion of the installation and the trial run, the Contractor must conduct tests and submit the results to the Engineer for evaluation before requesting the Engineer to take first delivery of the entire, or any part, of the installation.

The Department shall be informed 7 (seven) days in advance prior to the actual tests being done.

5.42.3 Final Acceptance

On the day of the first delivery inspection, the Contractor shall be ready and fully equipped to repeat the tests in the presence of the Engineer. The system will be considered for acceptance only after satisfactory tests of the entire system has been accomplished by a representative of the Contractor in the presence of the Engineer. The Contractor shall provide on-site services of an authorized technical representative of the manufacturer/s, to supervise all connections and fully test all devices and components of the complete installation as installed. The Engineer shall witness all tests conducted by the contractor or the manufacturer/s in accordance with the final acceptance test plan. Properly calibrated standard test equipment shall be utilized to complete tests that shall confirm the compliance of the complete system with the requirements of the specification.

5.42 WARRANTY

All equipment and wiring supplied and installed under this specification shall be warranted from inherent mechanical or electrical defects for a period of 12 (twelve) months.

5.43 GUARANTEE OF INSTALLATION

The Contractor shall guarantee all system components in hardware and software and the whole of the installation against any defect of materials or workmanship for a period of 12 twelve months (one year) after acceptance of the installation.

During the stated period of guarantee the Contractor shall replace free of charge all components failing or malfunctioning. However, system components damaged or stolen on site prior or after installation by negligence of the Department shall be exempted from this guarantee.

5.44 CONTRACTORS LIABILITY IN RESPECT OF DEFECTS

Any defects or faults which may appear within 12 months from the date of completion of the installation due to materials or workmanship not being in accordance with the specification shall be made good by the Contractor within such period as may be determined by the Engineer.

Should the Contractor fail to rectify the defects or faults within the predetermined period, the Department shall be entitled to rectify such defects or faults or to arrange for the rectification thereof and to recover from the Contractor any damages and costs as a result of the Contractor=s failure to comply with these terms.

5.45 MAINTENANCE

The Contractor will be required to maintain the complete system in good working order for a period of twelve months after the installation has been taken over. ***The Contractor shall supply free maintenance during the one year guarantee period inclusive of spares and labour.*** The maintenance shall include standard maintenance during normal working hours (08:00-17:00) at three monthly intervals and a 24-hour service on request.

After the lapse of this twelve months period, the contractor may be required to enter into a prolonged maintenance agreement in the form of a maintenance contract on a continued basis for one calendar year. The agreement will initially be for one calendar year, and may subsequently be renewed for yearly periods.

The Contractor shall prepare and submit a pro-forma maintenance and service contract. The contract shall be a formal service agreement signed by an authorised employee and shall include the monthly cost of the services to be provided and to what extent the price quoted will be subject to variation.

The service contract shall include the following minimum provisions:

- (a) To provide regular scheduled preventative maintenance and service of at least one man-day per three months period, i.e. at least four man-days per year, by trained service representatives of the Contractor or suppliers.
- (b) At each visit which shall be arranged in advance with the Department, a record of all maintenance carried out shall be kept. The time and date of visits shall be entered in a log book, kept by the Department.
- (c) To check the mechanical soundness of all parts.
- (d) To replace all defective parts.
- (e) To clean all equipment.
- (f) To carry out thorough system check with the use of all the testing equipment and instruments required. A detailed report comparing the system performance at the time of testing and at the time of handing over shall be prepared and handed to the Department along with comments.
- (g) To comment on improved system reliability and system design changes as it becomes available from the manufactures, enabling the Department to keep up with the latest trends.

Entering into a prolonged maintenance and service contract shall in no way invalidate the one year guarantee and maintenance as stated above.

The Contractor must state the details in the schedules of this specification for the cost of the year maintenance, the prolonged maintenance over the year period and over five years after the prolonged maintenance period has expired.

The Contractor shall keep adequate stocks of spares for the equipment offered, for a minimum period of 10 (ten) years and the submission of a tender will imply that the Contractor guarantees adequate stock for the minimum period.

5.46 MATERIALS AND PACKING

The successful Contractor is urged to order materials as early as possible as he will be held responsible for any delay in the delivery thereof. The Contractor shall be responsible for packing all materials and goods in a manner that will ensure that no damage thereto occurs in transit.

5.47 COMPLIANCE WITH REGULATIONS

The entire installation shall comply fully with the applicable regulations valid in the RSA and described in this specification. In addition the Contractor shall issue all notices and pay all the required fees in respect of the installation to the local authorities and shall exempt the Department from all losses, cost or expenditure which may arise as a result of the Contractor=s negligence to comply with the requirements of the regulations of this specification.

5.48 CERTIFICATE OF COMPLIANCE FOR ELECTRICAL INSTALLATIONS

On completion of the electrical parts of the installation, the Contractor must issue a certificate of compliance to the Department as described in the Occupational Health and Safety Act (Act 85 of 1993). First delivery will not be taken without this certificate.

Certificate of Compliance shall be of the approved type as issued by the ***Electrical Contracting Board of South Africa***. No other compliance will be acceptable. This certificate is to be handed to the Engineer.

5.49 ELECTRONIC EQUIPMENT

All equipment must be protected from damage or faulty operation resulting from external factors such as static electricity, induced voltages, magnetic forces, radio waves, lightning, etc., in accordance with SANS requirements. (Note must be taken in particular of SANS 03 and 03 A with regard to Lightning Protection.) All electronic equipment inputs from power points, telephone wires, antenna feeder cables and data or signal lines, must be issued with in-line protection. The products of manufacturers that carry the SANS mark of that have CSIR approval, must be used. (Examples hereof are ***Zaptrap, Clearline, Copa and Irengo***.)

Equipment, sensitive to interferences and spikes in electrical power, variance in the voltage and frequency as normally occurs and is inevitable in the electricity distribution network and the municipal supply to the building, must be equipped with the necessary stabilisers, over and under voltage protection equipment, suppressors, etc. Equipment must be manufactured and installed (inter alia be provided with suppressors), so that it shall not cause any interference in respect of other equipment, or have an effect on the working thereof. Fully installed equipment/systems must meet SABS requirements in so far as interference is concerned that may arise as a result of this equipment. (Static electricity, induced voltages, magnetic forces, radio waves and sound levels are included herein.) The Contractor must submit full explanations of his methods in order to comply with all the aforementioned. The onus is on the Contractor to provide proof after installation that the applicable standard or specified values have been complied with and any adjustments/additional equipment shall be for his own account.

5.50 SPECIAL EQUIPMENT

Any special instruments, equipment, software, components or terminations that may be required during calibration, initiation or programming/re-programming, must be provided to as part of the contract.

5.51 ELECTROMAGNETIC COMPATIBILITY

As the buildings will house a conglomeration of equipment together with radio frequency equipment, the Contractor must design electromagnetic compatibility into the system and ensure that the one system shall not affect the other adversely when operating, eg. cellular telephones shall not interfere in any way with the rest of the equipment.

5.52 MAKING GOOD

The Contractor shall be responsible for making good of all damages, disturbances to the building installations, finished surfaces and other services or trades, which he or his employees may have caused. The Contractor will be responsible for keeping the areas where installation work is performed tidy. The Contractor shall remove from the site all rubble and litter resulting from the installation of the system.

5.53 MANUALS

Deviations or alternatives under this heading may be offered after consent has been given by the Engineer. Each type of equipment/system must be issued with three full sets of manuals in English.

Each set must contain the following sections and information:

- (a) The equipment and function must be identified.
- (b) The working thereof must be described in full.
- (c) The prescribed and acceptable conditions of usage.
- (d) All applications and procedures must be set out in full.
- (e) The function and operation of all controls, indicators and adjustable components must be described.
- (f) Components with factory codes, or marked in any other way unclearly or in a manner not well known, must be given with generally available equivalents.
- (g) Complete electric circuit diagrams, functional diagrams and explanations of components as well as programming of components must be provided.
- (h) Any special installation/mounting or initiation procedures must be explained.

An abridged version of the above mentioned, or stated otherwise, a Quick Reference Guide hereof, aimed at the end-user, must be provided in a durable plastic cover along with every system/item of equipment.

Comprehensive fault detection procedures and diagrams must be provided on both use and maintenance levels.

The information must enable any suitably qualified technician to undertake urgent repairs to and maintenance of the equipment.

5.54 WORKMANSHIP

The contract shall be executed with the best workmanship in a workmanlike manner to the satisfaction of the Engineer. Should any material or workmanship not be to the satisfaction of the Engineer, it shall be rectified at the cost of the Contractor and all rejected material shall be removed from site.

The Contractor shall be responsible for the correct and complete erection of the installation. Inspection by the Engineer shall not release the Contractor from this responsibility.

Before the installation is handed over, the Contractor shall ensure that all paint surfaces are clean and undamaged. Final coats of paint may be applied on site immediately prior to completion.

5.55 COMPLETION OF CONTRACT

The contract will only be considered complete when all the conditions and requirements stipulated in this document and the following have been carried out:

- (a) The work completed to the satisfaction of the Engineer, the Architect and the Employer.
- (b) The system commissioned and functioning as intended by this document.
- (c) All operating and maintenance manuals, as specified, have been submitted and approved.
- (d) All commissioning results have been submitted, checked and approved by the Engineer.

Only when the above requirements have been fulfilled will the issuing of a completion and acceptance certificate be considered.