a world class African city

City of Johannesburg

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ADDENDUM	**NO. 01**
CONTRACT NUMBER:	**JW14337**
CONTRACT TITLE:	**DRIEFONTEIN WASTEWATER TREATMENT WORKS: INFRASTRUCTURE RENEWAL PLAN – REPLACEMENT OF MCC AT UNIT 2 BIO-REACTOR**
SUBJECT	**ADDENDUM 1**
DATE	**28 NOVEMBER 2024**
SENDER	**PETER LOUW, 011 688 1676** peter.louw@jwater.co.za **GCINA NDELA,011 688 1796** gcina.ndela@jwater.co.za

Tenderers are required to incorporate the following documents into the tender document and return the Addendum:

- **Johannesburg Water Particular Specifications.**
- **Extension of closing date from 04 December 2024 at 10:30 am to 23 January 2025 at 10:30 am.**

Yours faithfully

02.12.2024

Ithuteng Tabe
Acting General Manager: Supply Chain Management

Addendum Received
Name of Tenderer:……………………………………………………………………
Signatory:……………………………………………………………………
Signature:……………………………………………………………………
Date:……………………………………………………………………

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

AUTOMATION AND CONTROL DESIGN STANDARDS

GENERAL

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 18 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Automation And Control Design Standards**

JW Reference: **BWW523C**

Document Ref. No: **General**

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Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	
Approved	Manager	T. Thabeng	09/09/2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
2019-08-26	18	C. Du Toit	Cover page updated
2019-06-15	17	C. Du Toit	Updated all specifications & held workshops to get JW approval.
2014-04-17	16	C. Du Toit	Updated all specifications with reference to FJB specification, added blown fibre systems, added
2013-10-07	15	C. Du Toit	Updated footers and specifications for Cabling, PLC Panels, Field Junction Boxes And Panels, Clean Power And Surge Protection, Flow Meters
2012-07-27	14	C. Du Toit	Updated headers & footers.
2012-03-08	13	C. Du Toit	Updated Specifications for Cabling, Networking, Chlorine Analysing, Nitrate Measurement, Turbidity
2011-07-11	12	C. Du Toit	Removed 2010 logos, updated surge protection requirements, updated analyser requirements, updated
2010-07-27	11	C. Du Toit	Updated PLC panel and FJB paint requirements, network switch data, gas flow meter requirements, cable route markers & cable ladder materials and pH
2010-03-12	10	C. Du Toit	UPS requirements altered, PLC and IJB GA submission requirements altered, and core switch specifications

2009-08-18	9	C. Du Toit	Added new logos.
2009-05-08	8	C. Du Toit	Added requirements from client meeting on 04 May 2009.
2009-03-25	7	C. Du Toit	Logos altered
2009-03-12	6	C. Du Toit	Load Cells added
2009-02-27	5	C. Du Toit	Density Measurement altered
2009-02-24	4	C. Du Toit	Networking altered
2007-10-16	3	C. Du Toit	Density Measurement added
2007-06-05	2	C. Du Toit	Revision block updated and ”Joburg” logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

Introduction

The Automation And Control Design Standards consist of several volumes, as indicated in the “Volume Index” below. These standards serve as a basis for the design, procurement, installation and maintenance of all items related to automation and control. It further serves to ensure that all automation and control projects are designed and executed to the same high standards and to ensure that Johannesburg Water can maintain a level of standardization across all plants, while at the same time adhering to all the rules governing design and procurement for all projects.

These design standard documents must be read in conjunction with the detailed descriptions, scope of work, schedule of quantities, etc. contained in the tender documents. Where discrepancies exist between these design standards and the detailed specifications in the tender documents, the detailed specifications in the tender documents will take precedence.

All volumes will be updated as requirements, technology, etc. changes to ensure that these standards are always fit-for-purpose and in accordance with the latest specifications.

AUTOMATION AND CONTROL DESIGN STANDARDS INDEX

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PLC Hardware	2	N/A
PLC Panels	3	15
PLC Software (Future)	4	N/A
Clean Power And Surge Protection	5	14
Cabling	6	17
Networking	7	15
Flow Measurement	8	18
Level Measurement	9	14
pH Measurement	10	15
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Dissolved Oxygen Measurement	12	14
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Turbidity & Suspended Solids Measurement	14	14
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JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

VOLUME 3 : PROGRAMMABLE LOGIC CONTROLLER (PLC) PANELS

Johannesburg Water (SOC) Ltd.
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Revision 15 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 3 : Programmable Logic Controller (PLC) Panels**

JW Reference: **BWW523C**

Document Ref. No: **VOLUME 3**

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Approved	Manager	T. Thabeng	09/09/2019	

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2018-11-30	13	C. Du Toit	Added spare space requirements, PLC fan position, terminal requirements, use of bolts, fused terminal
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2013-10-07	11	C. Du Toit	Updated footer, screws in backing plates and PLC fan requirements.
2012-07-27	10	C. Du Toit	Updated headers & footers.
2012-03-08	9	C. Du Toit	Changed (Pty) to (SOC).
2011-07-11	8	C. Du Toit	Removed 2010 logo.
2010-07-27	7	C. Du Toit	Altered I/O card terminal requirements and minimum panel powder coating thickness.
2010-03-12	6	C. Du Toit	Altered submission time of PLC panel drawings.

2009-08-18	5	C. Du Toit	New logos added.
2009-03-25	4	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client's requirements.
2008-10-08	3	C. Du Toit	"Joburg" & "JW" Logos added to top & partnership logos removed.
2007-06-05	2	C. Du Toit	Revision block updated and "Joburg" logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

INDEX

3 PROGRAMMABLE LOGIC CONTROLLER (PLC) PANELS

3.1 Scope

3.1.1 This specification covers the manufacturing, supply and installation of Programmable Logic Controller panels used for process monitoring and control applications at Johannesburg Water wastewater sites.

3.2 Abbreviations

3.2.1 In this specification the following abbreviations will apply :-

BS	:	British Standards
PLC	:	Programmable Logic Controller
I/O	:	Input/Output
CPU	:	Central Processing Unit
UPS	:	Uninterruptible Power Supply
MCC	:	Motor Control Centre
MCB	:	Miniature Circuit Breaker

3.3 Standards

3.3.1 All design standards for cabling shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	:	National Standards for the wiring of premises.
SANS 1091:2004	:	National Colour Standard.
SANS 1274-2005	:	Coatings applied by the powder-coating process.
BS 381C:1980	:	Paint colour chart.

3.4 General Requirements

3.4.1 The PLC control panel shall house the following items:-

3.4.1.1 The PLC and all I/O modules and racks.

3.4.1.2 Fibre-optic network interface modules.

3.4.1.3 All network switches and hubs.

3.4.1.4 All field instrumentation and MCC interface cables shall be marshalled in this panel.

3.4.1.5 All power supply and distribution circuitry and equipment.

3.4.1.6 All lightning and surge protection devices as required.

3.4.1.7 Marshalling terminals as required

3.4.1.8 Interposing relays as required.

3.4.2 The supply and installation shall in general comply with the relevant clauses in all specifications attached to the tender documentation.

3.4.3 The panels shall be free standing units with bottom cable entry (via a glanding plate) and have front door access (hinged and lockable).

3.4.4 The panel should be manufactured from sheet steel not less than 2,0 mm thick. The panel will have a door on the front which opens to practically the full width and height of the panel. The panel shall be free standing and shall not be more than 2 200 mm high, 2 400mm wide and 600mm deep and it should be sized to accommodate all the PLC and associated equipment required for the actual PLC I/O and future spare capacity as indicated in the PLC schematic diagram.

3.4.5 Once the door is open there should be no obstruction to prevent full access to every point inside the panel.

3.4.6 The panel shall be epoxy powder coated electric orange (Shade B26) finish. Interior chassis mounting plates will be finished in appliance white. All removable parts and hardware will be cadmium yellow passivized.

3.4.7 Each panel and control function should be clearly labelled with labels engraved on laminated engraving board with black letters on a white background. All labels must be attached with chrome plated, screws and nuts or screws and tapped holes. On the backing plate only tapped holes may be used. Screws with nuts on the backing plate will not be acceptable.

3.4.8 The panel must be vermin-proof and must have a protection rating of no less than IP 55.

3.4.9 This specification must be read in conjunction with the PLC Hardware Specification (Volume 2 of the Automation And Control Standards).

3.4.10 All labelling must comply with the requirements as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

3.5 Standard Features

3.5.1 Each panel shall have the following features as standard:-

3.5.1.1 Ventilation fans with air filters shall be mounted on the PLC panel at high level with no air outlets. The fans must pressurise the panel to prevent the ingress of dust.

3.5.1.2 Ventilation fans must have proper screw terminals in an enclosed terminal box. No exposed terminations, soldered connections or push-on lugs will be accepted.

3.5.1.3 A 230V AC switch socket outlet shall be mounted inside the panel (supplied from the UPS section). This socket must have a shaved earth which shall be used for the PLC programmer only.

3.5.1.4 Interior lighting at the top of the panel must be arranged to switch on, via a micro switch, when the panel door is opened. This light must be an LED light with a CCT (Correlated Colour Temperature) of 4000K to 6000K. The light must be fitted with a diffuser and it must supply no less than 680 lm (Net luminous flux). The lamp must have proper screw terminals in an enclosed terminal box. No exposed terminations, soldered connections or push-on lugs will be accepted.

3.5.1.5 A substantial area of removable gland plates on the floor of the panel, split into two or more sections.

3.5.1.6 A sheet steel pocket welded onto inside of the door to hold A4 sized drawings, books etc.

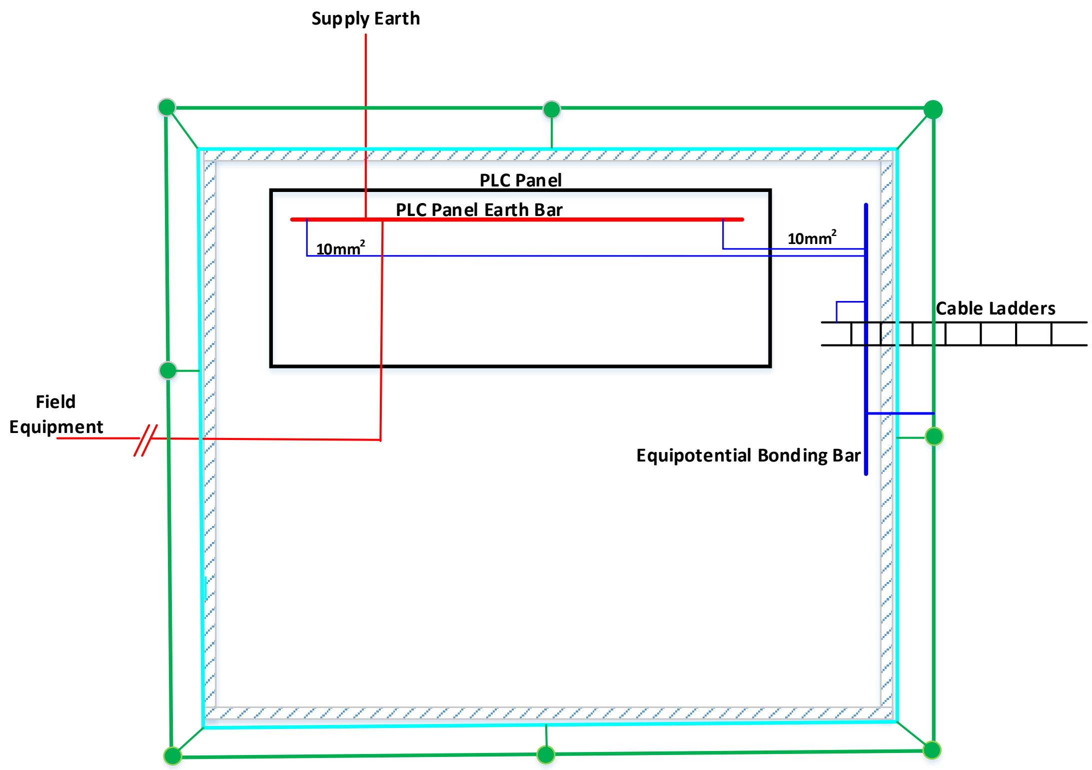
3.5.1.7 No holes may be drilled for tapping, riveting, bolts & nuts, etc. in any section of the panel where it will compromise the protection rating of the panel. I.e. only in the backing plate or in the glanding plate may holes be drilled. Where drilling is unavoidable, e.g. to affix labels, the holes must be sealed so that the protection rating of the panel is not compromised.

3.5.1.8 Bolts with nuts shall not be used to attach equipment to any mounting plate at any point. On mounting plates only bolts in tapped holes will be acceptable. Bolts with nuts will be allowed on enclosure doors however, where the bolts and nuts are easily accessible.

3.5.1.9 Where bolts are used on the door or any outside panels of the enclosure, a sealing method (e.g. rubber washers) must be used to ensure that the IP protection rating of the enclosure is not compromised.

3.5.1.10 Wherever bolts are used, the bolts must be as short as practically possible so that there are no long protrusions that can injure people or snag clothing, wiring, other equipment, etc. If bolts are cut to the correct length, the ends of the bolts must be neatly de-burred and smoothed so that there are no sharp edges that can cause injuries and so that the nuts can be easily screwed on and off. No more than four threads of the bolt end must be visible beyond the nut. It is however preferred that the correct length of bolts are used so that shortening is not required.

3.5.1.11 A copper earth bar running the full width (i.e. left-end to right-end) of the panel at the bottom with solid electrical connection to the panel doors and to the steel of the panel at two or more places and provided with terminals for connection of equipment and screen earth wires. This earth bar must be connected to the equipotential bonding bar of the building via at least 2 x $10mm^2$ earth conductors (one from each end of the panel earth bar), as shown in the sketch below.



3.5.1.12 Separate AC and DC distribution sections if both AC and DC are used.

3.5.1.13 A free-standing (i.e. not the PLC rack mounted) 24V DC Power supply for all analogue I/O cards or I/O sub-bases (where required), 24V DC I/O distribution (if required), field instrumentation supplies (if required), etc.

3.5.1.14 Where stopper plugs are used to seal holes that are not used, no plastic stopper plugs will be acceptable. All stopper plugs must be threaded, non-corrodible, metal plugs with rubber washers on both sides of the panel to ensure at least an IP65 seal (see examples below).

3.6 Wiring, Relays and Terminals

3.6.1 All terminals shall be screw-type terminals and shall be mounted on raised DIN terminal rail, secured to the chassis plate at the back of the panel.

3.6.2 Proprietary type wire strippers shall be used and no stranded conductor shall be terminated if one or more strands have been damaged.

3.6.3 Not more than one wire shall be connected to any terminal unless the terminal can accept pin lugs on either side of a screw or unless proper connecting material is used (see examples below).




3.6.4 Every wire shall be marked at both ends with a numbering system approved by the Engineer, and all terminating wires shall also be suitably crimped to a terminal lug. Not more than one wire shall be crimped into a single lug.

3.6.5 All wiring shall be flexible, tinned, annealed, multi-strand copper wire not less than:-

3.6.5.1 1,5mm² for 230V AC or 110V AC power

3.6.5.2 1,0mm² for 24V DC or AC power

3.6.5.3 0,5mm² for all PLC I/O wiring between modules and marshalling terminals

3.6.5.4 4,0mm² for earth drain

3.6.6 Irrespective of the minimum wire sizes allowed in this specification, contractors must ensure that all cables and wiring are capable of carrying the full system currents, inclusive of de-rating factors as specified in the latest version of SANS 10142.

3.6.7 All wire terminations must be done by using suitable lugs. No more than one wire may be crimped into a single lug. Where pin lugs are crimped onto the ends of wires, correctly sized pin lugs must be used, which fit into the terminals properly and such that the tightening of the terminal does not result in the loosening of the pin lug.

3.6.8 All panel wiring shall run in suitably sized slotted trunking for as much of their course as possible, thereafter in spiral band or similar conduit to its destination if the exposed run would exceed 100mm.

3.6.9 The distance between the terminals and the trunking or between equipment (such as relays, surge protection, circuit breakers, etc.) and trunking shall not be less than 50mm.

3.6.10 Control wiring should not run with power wiring and all cross-overs shall be at ninety degrees.

3.6.11 A block of terminals shall be allocated to each I/O module. The terminal block shall be labelled with the PLC rack number and module slot allocation.

3.6.12 The terminals allocated for the various I/O modules must be as per the design drawings submitted by the Engineer. If it forms part of the contractor's scope of work to submit design drawings, the terminals allocated for the various I/O modules must be approved by the Engineer. All terminals shall be sequentially numbered from top to bottom for each I/O channel for every type of I/O card.

3.6.13 Each analogue and digital input and output channel shall have surge protection units as specified in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

3.6.14 Internal wiring shall be colour coded as follows:-

3.6.14.1 230V AC Power

Live	Brown
Neutral	Blue
Earth	Green and Yellow

3.6.14.2 24V DC Power

Positive	Red
Negative	Black

3.6.14.3 Digital Inputs

230V AC	Yellow
24V DC	Red

3.6.14.4 Digital Outputs

230V AC	Grey
24V DC	Red

3.6.14.5 Relay Outputs

230V AC	Grey
24V DC	Red

3.6.14.6 Analogue Signals

Positive	Orange
Negative	Purple

3.6.15 A terminal section for AC and DC power distribution shall be included in the PLC panel where both voltages are used for PLC I/O. The terminal groups shall be clearly identified to indicate the various voltages.

3.6.16 A separate power distribution section shall be used for the AC and DC supplies where both voltages are used. Miniature circuit breakers (MCB's) shall be used to feed the various items of equipment such as PLC I/O cards, fans, lights, field instruments, etc. Fused terminals may be used if it is indicated as such on the design drawings submitted by the Engineer.

3.6.17 Two types of mains supplies shall be made available to the PLC panels: Raw Mains and UPS Mains. The raw mains incomer shall feed the non-critical items such as fans, 24V DC power supplies, 230V AC terminal section, 230V AC I/O modules, relay output modules, etc. The UPS supply shall feed the critical items required for PLC communications in the event of a raw mains power supply interruption. Such items are plugs (for PC), lights (inside the PLC panel), fibre-optic interface modules, PLC Processor, etc. Unless otherwise specified, PLC I/O and field instruments need not be supplied by UPS power.

3.6.18 All wiring must be continuous from one termination (in a terminal strip or device such as a relay, contactor, surge arrester, etc.) to the next. No spliced wiring will be accepted.

3.6.19 Where relays (not relays that are part of the PLC hardware, such as in I/O sub-bases) are used, such relays must be pluggable, so that relays can be replaced without the need to disconnect wiring and the relays must have visible indication when it is energised.

3.7 Existing PLC Panels

3.7.1 All modifications and wiring changes to existing panels must comply with the specifications as laid down for new panels.

3.8 Factory Acceptance

3.8.1 Before delivery of the PLC systems and/or the PLC panels, a comprehensive system factory acceptance test must take place. The Engineer must be notified one week in advance of the proposed test.

3.8.2 The test shall comprise of at least, but not be limited to:

3.8.2.1 Checking the panel manufacturing and assembly for compliance with this specification.

3.8.2.2 Layout, numbering and labelling of equipment.

3.8.2.3 Wiring – sizes, numbering, colours, termination, etc.

3.8.2.4 Wiring as per drawings, I/O schedules, etc. (i.e. loop checks).

3.9 Loop Isolators

3.9.1 Loop isolators are required where the instruments and the relevant PLC are fed from different power sources. Loop isolators must provide isolation between the instrument signals and the power supply. Separately powered isolators are preferred.

3.10 Uninterruptible Power Supply (UPS)

3.10.1 An Uninterruptible power supply must be installed to isolate the PLC from the "raw" mains supply.

3.10.2 The UPS must comply with the UPS requirements as specified in the Clean Power And Surge Protection specification (Volume 5 of the Automation And Control Design Standards).

3.10.3 The raw mains incomer to the PLC panel shall feed the non-critical items such as fans, 24V DC power supplies, 230V AC terminal section, 230V AC I/O modules, relay output modules (if required), etc. The UPS supply shall feed the critical items that keep PLC communications established should the raw mains power supply be interrupted, such as plugs, lights, fibre-optic interface modules, PLC (CPU), etc.

3.10.4 Tenderers must satisfy themselves that the UPS rating is adequate to supply all the equipment which they are offering.

3.11 Over-Voltage/Lightning Protection

3.11.1 The function of the over-voltage/lightning protection units is to prevent damage from occurring to the electrical and electronic devices due to destructive voltages, by resistive coupling, capacitive coupling or inductive coupling, arising from extraneous events such as lightning discharges, switching surges etc. All lightning and surge protection must be in accordance with the requirements in the Clean Power And Surge Protection specification (Volume 5 of the Automation And Control Design Standards).

3.11.2 The protection units on the 230V AC mains incomers of the PLC panel (if not provided on the mains elsewhere) shall consist of at least IEC Class II protection. Preferably Class I and Class II, or a combined Class I + Class II protection must be used.

3.11.3 Each individual supply from the 24V DC distribution and from the 230V AC distribution to field instruments or other field supplies must be equipped with at least Class II medium surge protection.

3.12 Spares

3.12.1 The tenderer will be required to provide at least 10% spare fuses and other consumable items which may be required during commissioning. In addition to commissioning spares, a recommended spare list for three years maintenance, should be submitted. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

3.13 Painting (Powder Coating Method)

3.13.1 General

Switchboards and panels shall be epoxy powder coated in accordance with Type 1 coatings to SANS 1274-2005.
Unless specified otherwise, a high gloss finish in the following colour shall be provided:
Colour - Light Orange, Colour No. B26, Munsell Ref. 2,5 YR C/14 to SANS 1091 : 2004 and Colour No. 381C-557 to BS 381C : 1980.
Paintwork must be guaranteed against blistering, peeling, cracking and general deterioration which can lead to rusting, corrosion, etc. for a period of no less than three years. If the tenderer cannot comply with this requirement, it must be clearly stated as such in the tender.

3.13.2 Specifications

The following specifications in accordance with SANS 1274-2005 shall be provided:-

Property	Requirement	Test Method
Thickness, minimum	50 micron	6,7
Marking Resistance (400g)	No marking	6.20
Impact Resistance, J, minimum	6,78	6.10
Water Resistance, h, minimum	720	6.13
Humidity resistance, h, minimum	1000	6.14
Resistance to salt fog, h, minimum	1000	6.16

3.13.3 Surface Preparation

Surface preparation of sheet steel components shall be carried out by means of the multi-bath zinc phosphate/chromate passivation treatment.

All fabricated sheet steel components are to be degreased and de-rusted ready for treatment.
A steel surface is considered ready for treatment when all dirt, grease, rust, mill scale, moisture or other contaminants have been removed in an alkaline degreaser to give a dry, clean, bright, metallic surface.
Steel plate less than 4mm thick - black steel sheet shall be pickled to white metal condition while pre-pickled, bright, cold rolled sheet steel shall be solvent cleaned. These surfaces shall be treated within eight hours in all cases while still uncontaminated and rust-free.
The prepared steel surface shall be treated by means of immersion in a heated zinc phosphate solution bath, rinsing and thereafter chromate passivated by means of immersion in the final treatment bath.

3.13.4 **Powder Coating**

A thermosetting powder consisting of epoxy/polyester resin shall be applied by means of an electrostatic spray gun to give a uniform coating thickness of 50 to 60 micron. Less than 50 micron will not be acceptable.

The powder coating shall be baked at a metal temperature of 185ºC so as to melt the powders to form a continuous film over the metal substrate.

3.14 Drawings And Diagrams

3.14.1 The tenderer must submit layout drawings, showing the PLC panel size, cable entry, location of equipment, details of equipment (such as fans, lights, plugs, trunking size, circuit breakers, fuses, terminals, etc.), panel colour, material of construction (e.g. 2mm mild steel), etc. for approval by the Engineer before any manufacturing commences.

3.14.2 The drawings must be accompanied with data lists of the proposed equipment. These data sheets must show the type, supplier, make, model, size, etc. of equipment where applicable. For example:

Terminals - Phoenix SK12, 4mm, white.
MCB's - Merlin Gerin, 5A, 10kA, single-pole.
Etc.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 5 : CLEAN POWER AND SURGE PROTECTION

Johannesburg Water (SOC) Ltd.
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Revision 14 August 2019

DOCUMENT CONTROL SHEET

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JW Reference: BWW523C

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Approved	Manager	T. Thabeng	09/09/2019	

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2019-08-26	14	C. Du Toit	Cover page updated
2019-06-15	13	C. Du Toit	Revision approved by JW
2018-11-30	12	C. Du Toit	Requirements for static and manual bypass switches on UPS corrected & added reference to Labelling
2014-04-17	11	C. Du Toit	Added more detail to "transformer-based" UPS description
2013-10-07	10	C. Du Toit	Updated numbering in item 5.7 and clarified "transformer-based" UPS
2013-02-04	9	C. Du Toit	Updated Footer
2012-07-27	8	C. Du Toit	Updated headers & footers.
2012-03-08	7	C. Du Toit	Changed (Pty) to (SOC).
2011-07-11	6	C. Du Toit	Altered rated operating current for SPDs, added data sheets & removed 2010 logo.
2009-08-18	5	C. Du Toit	Logos altered and UPS size altered.

2009-03-25	4	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client's requirements.
2007-11-22	3	C. Du Toit	Item number referred to in item 5.11.3 corrected.
2007-06-05	2	C. Du Toit	Revision block updated and "Joburg" logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

INDEX

5 CLEAN POWER AND SURGE PROTECTION

5.1 Scope

5.1.1 This specification covers the selection, installation, testing, marking and termination of Uninterruptible Power Supplies and Surge Protection used for low voltage power and control installations at Johannesburg Water wastewater sites.

5.2 Abbreviations

5.2.1 In this specification the following abbreviations will apply :-

SANS	:	South African National Standards
IEC	:	International Electrotechnical Commission
PLC	:	Programmable Logic Controller
UPS	:	Uninterruptible Power Supply
CE	:	Official marking to indicate compliance with essential requirements of European Union directives
LGA	:	Local Government Association
GS	:	Geprüfte Sicherheit ("Tested Safety") is a voluntary certification mark
EMC	:	Electromagnetic Compatibility
EN	:	British Standard (BS EN)
PWM	:	Pulse Width Modulation
THD	:	Total Harmonic Distortion
Vpc	:	Volts per cell
Ah	:	Ampere hour
SPD	:	Surge Protection Device
LPZ	:	Lightning Protection Zone
ICASA	:	Independent Communication Authority of South Africa

5.3 Standards

5.3.1 All design standards for cabling shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	:	National Standards for the wiring of premises.
SANS 61643-1	:	Surge protection devices – performance requirements and testing methods
IEC 61643-1	:	Surge protection devices – performance requirements and testing methods
EN 50091-1, -2	:	General and safety requirements for UPS
EN 61000-3-2	:	Limits for harmonics

5.4 Uninterruptible Power Supply (UPS) General Requirements

5.4.1 The UPS must be a **TRUE** on-line, double conversion transformer-based unit (i.e. using a transformer which is an integral part of the UPS, on the **input** to the UPS). Hybrids, transformerless units or units with external, separate transformers will not be acceptable.

5.4.2 The UPS must employ PWM technology.

5.4.3 The UPS must have battery backup for at least 30 minutes at the **FULL RATED LOAD** of the UPS.

5.4.4 The output wave form shall be sinusoidal in form with the THD at full line load not exceeding 3%.

5.4.5 The output voltage variation must not exceed 2%.

5.4.6 Interference shall not exceed the limits laid down by ICASA.

5.4.7 The UPS must have a battery low voltage/DC cut-off which is not lower than 1,67 Vpc.

5.4.8 The UPS must be accompanied by the tenderer's proof of their ability to install, test, service, repair, etc. these devices in the field and that they have a suitable after-sales infrastructure.

5.4.9 The UPS must be equipped with an integral static bypass switch as well as an integral manual/maintenance bypass switch.

5.4.10 The UPS static bypass switch must be upgradable in order to be matched to the load inrush current.

5.4.11 The tenderer must be willing and able to provide a complete factory load test, which can be witnessed by the engineer and/or client.

5.4.12 If it is an imported UPS, the vendor must be the **ACTUAL** importer of the UPS. In other words, a middleman who cannot provide factory load tests or suitable after-sales service and backup will not be acceptable.

5.4.13 A voltage free contact rated for 230V AC at 2 amps shall be provided in all the UPS units. This general alarm relay shall be internally wired to energise when a collective signal from all alarms is healthy. Alternatively, this relay shall de-energise when a fault occurs, raw mains is interrupted or the battery power is low.

5.4.14 The UPS must be supplied complete with maintenance free batteries and with a capacity to run the system for 30 minutes at full load. If external battery packs are provided, the battery charger must be adequately rated to re-charge the additional batteries at the C/10 rate.

5.4.15 The UPS system shall be suitable for operation from a 230V AC single phase supply and must supply a nominal single phase 230 Volt, 50 Hz output.

5.4.16 Tenderers must satisfy themselves that the UPS rating is adequate to supply all the equipment which they are offering.

5.4.17 The units shall be able to sustain an overload of 125% for one minute or 150% for ten seconds whereupon it shall switch itself off. A full short circuit shall cause the unit to switch off without sustaining damage.

5.4.18 The UPS must be able to operate normally in an ambient service temperature of 0ºC to +35ºC and a relative humidity of 5 to 95% non-condensing at 1500 to 3000m above sea level.

5.4.19 The rated output voltage must be user selectable from 220/230/240V.

5.4.20 The output frequency must not vary by more than 3Hz.

5.4.21 All labelling must comply with the requirements as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

5.5 UPS Rating

5.5.1 The UPS should be able to supply a load with a power factor of 0.7 to unity. Tenderers must submit both the VA and Wattage rating of each UPS offered.

5.5.2 The UPS efficiency must be no less than 89% from zero to full load.

5.5.3 The UPS must be suitably rated to supply all the required equipment specified in this tender and any attached specifications and provide backup to this equipment for no less than 30 minutes at full load. Even if the equipment does not require it however, the UPS must not have a rating of less than 3kVA.

5.6 UPS Backup Batteries

5.6.1 Tenderers must state the exact number of batteries that will be used.

5.6.2 Tenderers must state the type of batteries that will be used.

5.6.3 Tenderers must state the Ah rating of the batteries that will be used.

5.6.4 Tenderers must state the design life of batteries that will be used (3-5years, 10 years, etc.).

5.7 UPS Standards

5.7.1 All imported UPSs must have a CE rating.

5.7.2 The UPS must have CE, LGA/GS markings.

5.7.3 The UPS must comply with safety conformance to EN-50091-1.

5.7.4 The UPS must have EMC conformance to EN-50091-2 and EN-61000-3-2.

5.8 UPS Data Sheets

5.8.1 The tenderer must complete the data sheet below with his tender:

Technical Data Sheet: UPS

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model (E.g. true on-line, double conversion)	
Transformer-based unit (Y/N?)	
Technology employed (E.g. pulse width modulation)	
Output voltage variation	
Output frequency variation	
UPS rating (VA and Watts)	
UPS efficiency from zero to full load	
Maximum harmonic distortion at full load	
Overload handling capabilities (E.g. “x”% load for “y” minutes)	
Power backup period from batteries at full rated load	
Compliance with standards rating and markings (E.g. “Yes, full compliance” or “No”.	
Tenderer to provide complete factory load test that can be witnessed by the Engineer?	
Staff available for installation, testing and backup service?	
Number of batteries to be used	
Type of batteries to be used	
Ah rating of batteries	
Design life of batteries	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

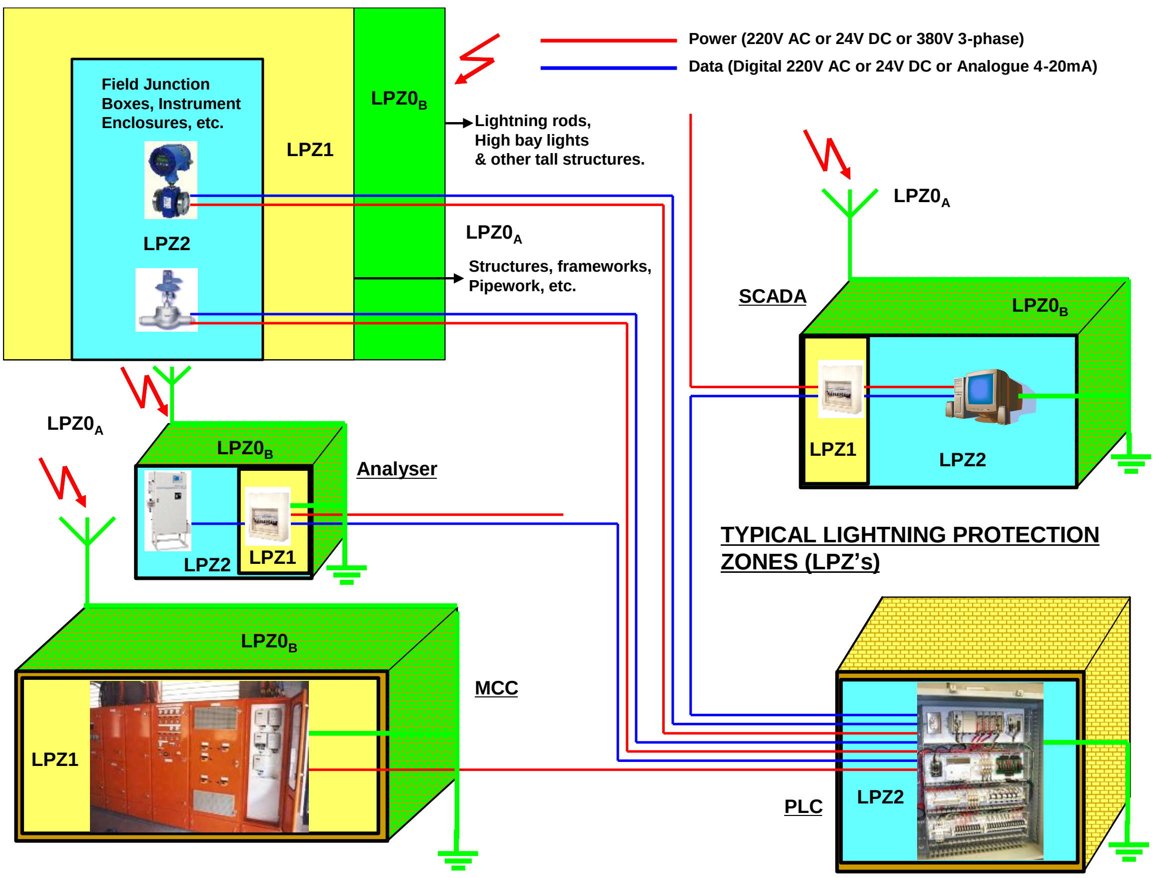
5.9 Surge Protection General

5.9.1 All labelling must comply with the requirements as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

5.9.2 The **Protection Level** required (i.e. Level I, Level II or Level III-IV in accordance with Table L.2 in SANS 10142-1:2003 Annex L) needs to be established for every installation where there is doubt about these requirements. This requirement looks at the consequential loss resulting from potential lightning hazards. Generally for all JHB Water wastewater sites in the Gauteng area, Level III-IV will suffice. In other words, a lighting impulse level of 100kA (10/350µs) needs to be considered when designing protection systems.

5.9.3 The function of the Surge Protection Device (SPD) is to prevent damage from occurring to the electrical and electronic devices due to destructive currents and voltages arising from extraneous events such as lightning discharges, switching surges etc. All lightning and surge protection must comply with SANS 10142-1:2003 Annex L, SANS 61643-1/IEC 61643-1 and any other specifications referred to in SANS 10142-1:300 Annex L.

5.9.4 The definition of lightning protection zones (LPZs), as specified in SANS 61643-1/IEC 61643-1, must be used to determine the **Class** of SPD to be used (i.e. Class I, Class II or Class III in accordance with SANS 61643-1/IEC 61643-1). These classes (also referred to as IEC Classes or IEC Category Classes or Types) define the surge handling ability which SPDs must have for use in each Class.



5.9.5 Notwithstanding the requirements of SANS 10142-1:2003 Annex L, the surge handling ability of the SPDs installed in the various LPZs for JHB Water applications must be as follows:

At the Interface Between:	**IEC Class SPD Required**	**Min. Required SPD Rating**
LPZ 0_A and LPZ 1	Class I	For Single Units: I_{imp} = 50kA (10/350 µs) for SPDs between PHASE and NEUTRAL I_{imp} = 100kA (10/350 µs) for SPDs between NEUTRAL and PE and For Combination Units: I_{imp} = 25kA (10/350 µs) per channel
LPZ 0_B and LPZ 1	Class II	I_{sn} = 20kA (8/20 µs) for SPDs between PHASE and NEUTRAL I_{sn} = 12kA (10/350 µs) for SPDs between NEUTRAL and PE
LPZ 1 and LPZ 2	Class III	I_{sn} = 5kA (8/20 µs)

Where: I_{imp} = The standard impulse current curve with a 10/350 µs waveform
I_{sn} = The nominal discharge current or peak value of the current flowing through the SPD. It has an 8/20 µs impulse current waveform.

5.9.6 All SPDs used must limit the voltage to less than two times the nominal operating voltage for systems below 60V (AC or DC) and for systems above 60V it must limit the voltage to the values given in Table L.1 in SANS 10142-1:2003 Annex L.

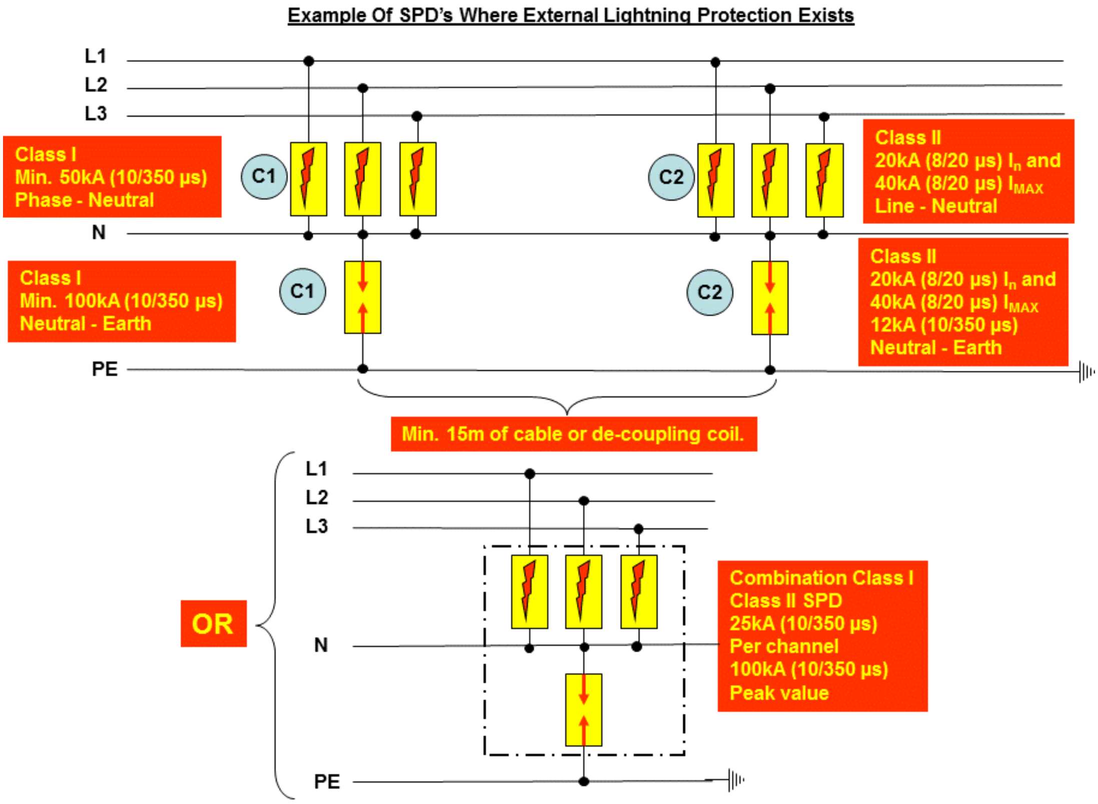
5.9.7 In order to ensure that individual protective devices are selectively effective, i.e. each protection stage only takes on the amount of interference energy which it is designed for, if one protection stage is faced with the threat of an energy overload, the upstream, more powerful arrester must "respond" and thus take over the discharge of the interference energy.

5.9.8 Even though surge arresters (i.e. Class II and Class III devices), by definition, are only tested to pulse waveforms of 8/20 µs, it is imperative to determine the ability of the device to carry an impulse current of the partial lightning currents with the waveform 10/350 µs for the co-ordination between surge arrester (i.e. Class II and Class III devices) and lightning current arrester (i.e. Class I devices), and also for the SPD.

5.9.9 All SPDs must be DIN rail mounted.

5.9.10 Should the building (where the PLC, distribution board, etc. and surge protection is installed) have external lightning protection, then a combination of Class I lightning current arresters (min. rating of 50kA (10/350 µs) each phase to neutral) plus one Spark Gap (min. rating of 100kA (10/350 µs) neutral to earth) and Class II nominal discharge current I_n = 20kA (8/20 µs) and maximum discharge current I_{MAX} = 40kA (8/20 µs), non-linear surge arresters from each phase to neutral and one Spark Gap, nominal discharge current I_n = 20kA (8/20 µs) and maximum discharge current I_{MAX} = 40kA (8/20 µs) surge arresters must be installed as per SANS 10142-1:2003 Annex L (see the diagram below). In all other cases a minimum of Class II SPDs are required.

5.9.11 These surge arresters (Class I and II or combination Class I/Class II above) must be installed from each Phase to Neutral and from Neutral to Earth. It must be borne in mind that if Class I **<u>and</u>** Class II SPDs are used, a minimum of 15m of cabling is required between these two systems for de-coupling. Another alternative is to use the correct coils available on the market to simulate the 15m difference. Preference will however be given to **combination** Class I and Class II units with pluggable modules because this eliminates coils and long cables and it allows replacement/inspection without the need to disconnect cables.



5.9.12 For Class I lightning arresters the minimum conductor size is 16mm² and pre-fusing of 315 Amps is required if the upstream protection is greater than 250 Amps. Fuses must be connected in series with the SPDs and must have the same fault current level or higher than that of the panel or board where they are installed.

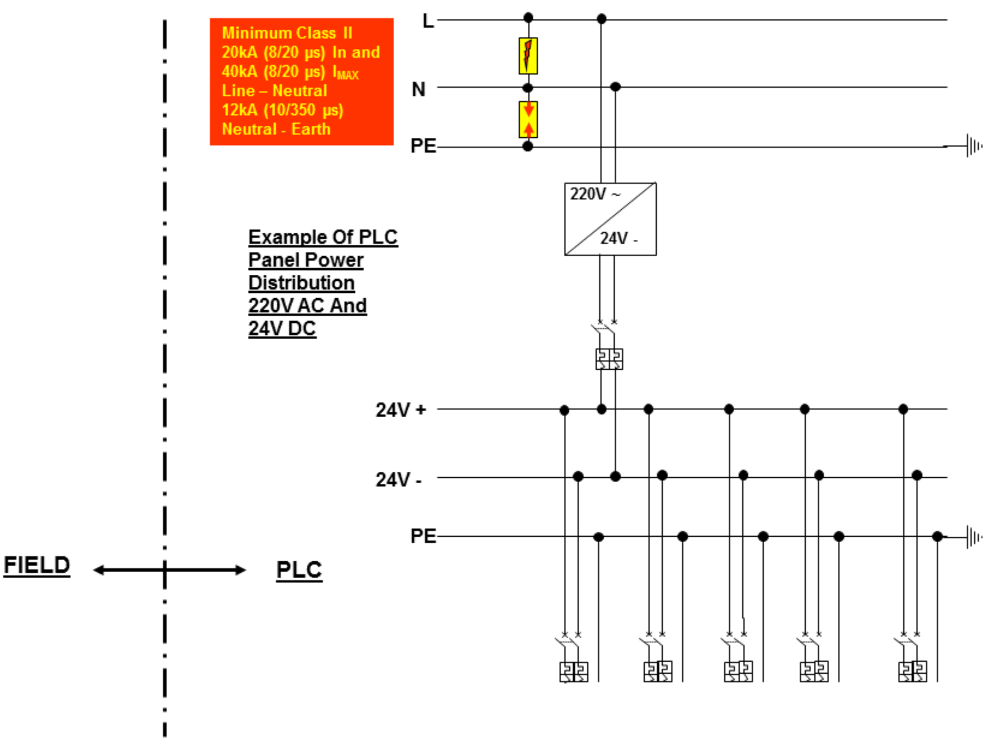
5.9.13 For Class II the minimum conductor size is 6mm² and pre-fusing of 125 Amps is required if the upstream protection is greater than 250 Amps. Fuses must be connected in series with the SPDs and must have the same fault current level or higher than that of the panel or board where they are installed.

5.10 Surge Protection On Mains Power

5.10.1 If there is no external lightning protection on the building, the protection units on the mains supply of the PLC panel must consist of at least IEC Category Class II, nominal discharge current I_n = 20kA (8/20 µs) and maximum discharge current I_{MAX} = 40kA (8/20 µs), non-linear surge arresters from each phase to neutral and one Spark Gap, nominal discharge current I_n = 20kA (8/20 µs) and maximum discharge current I_{MAX} = 40kA (8/20 µs), surge arrester from neutral to earth (same arrangement as the example shown above).

5.10.2 All the surge arresters must be DIN rail mounted and must comply with IEC 61643-1 (other designations, SANS 61643-1 and SANS IEC 61643-1) and there must be visual indication if the unit is over stressed (i.e. it has failed).

5.10.3 The spark gap must be able to withstand surges of 12kA (10/350 µs) and must specifically bond between neutral and earth.



5.11 Surge Protection On Field I/O

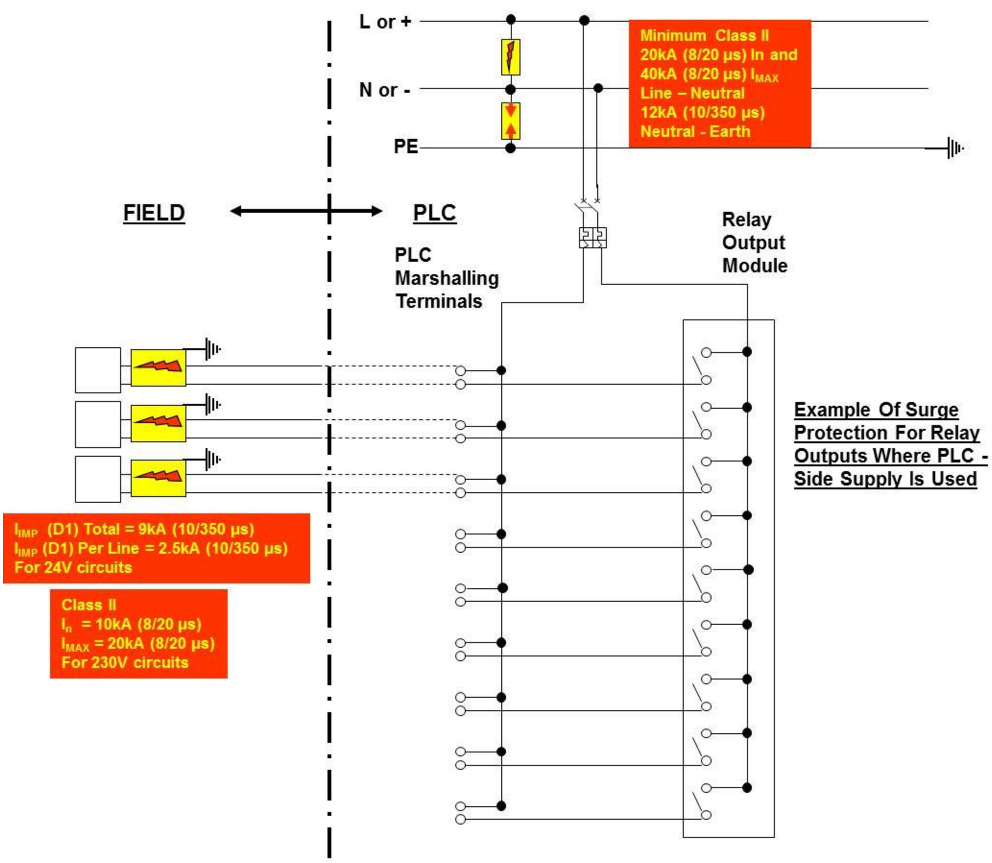
5.11.1 SPDs used for data protection (i.e. of digital and analogue I/O connected to devices outside the PLC building where induced voltages and currents are possible) must be designed to repeatedly withstand direct lightning currents I_{imp} of 2.5kA (10/350 µs) per line and nominal (i.e. peak) surges I_{sn} of 20kA (8/20 µs) for 4-20mA control loops, 24V DC digital and analogue systems and 24V AC systems. SPDs used for 230V AC digital I/O connected to devices outside the PLC building where induced voltages and currents are possible, must be designed to repeatedly withstand nominal discharge currents I_n of 10kA (8/20 µs) and maximum discharge currents I_{max} of 20kA (8/20 µs). These 230V AC SPDs must be rated at least Class II according to IEC 61643-1 or Type 2 according to IEC 61643-11.

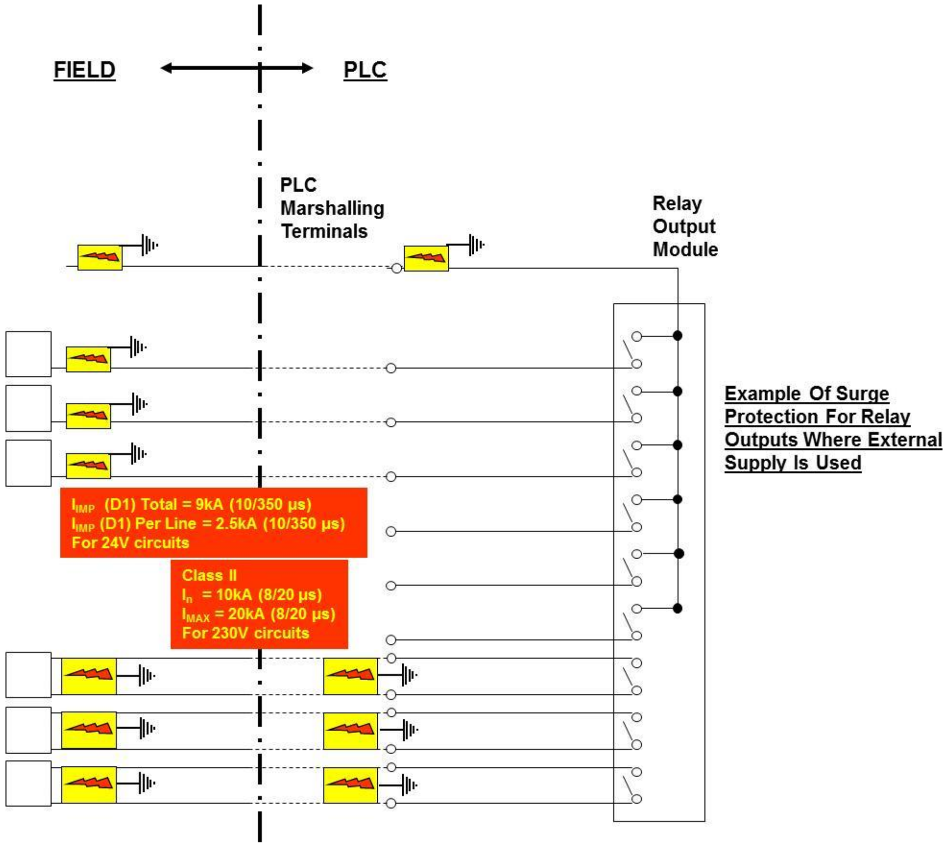
5.11.2 SPDs must be installed at both ends of each cable (i.e. at the PLC and at the field instrument, MCC, control panel, junction box, etc).

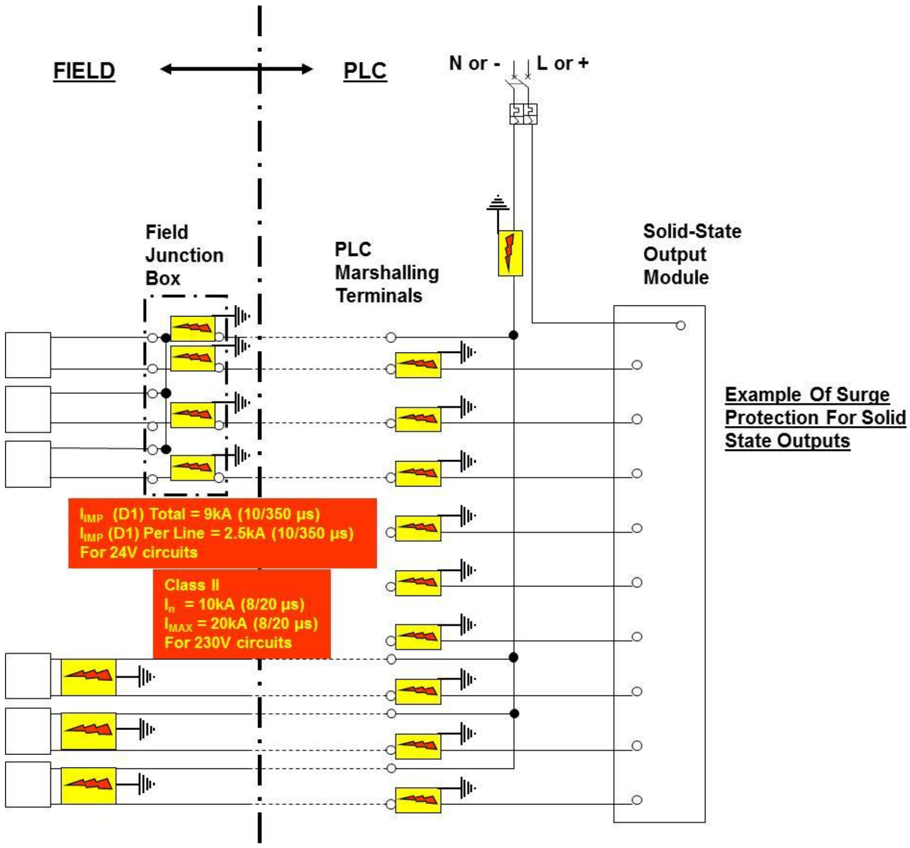
5.11.3 The LPZ in which the instrument, instrument distribution board or instrument junction box is, must be used to determine the ratings of the SPD. The ratings on digital and analogue I/O protection must just never be lower than the ratings mentioned in item 5.11.1 above.

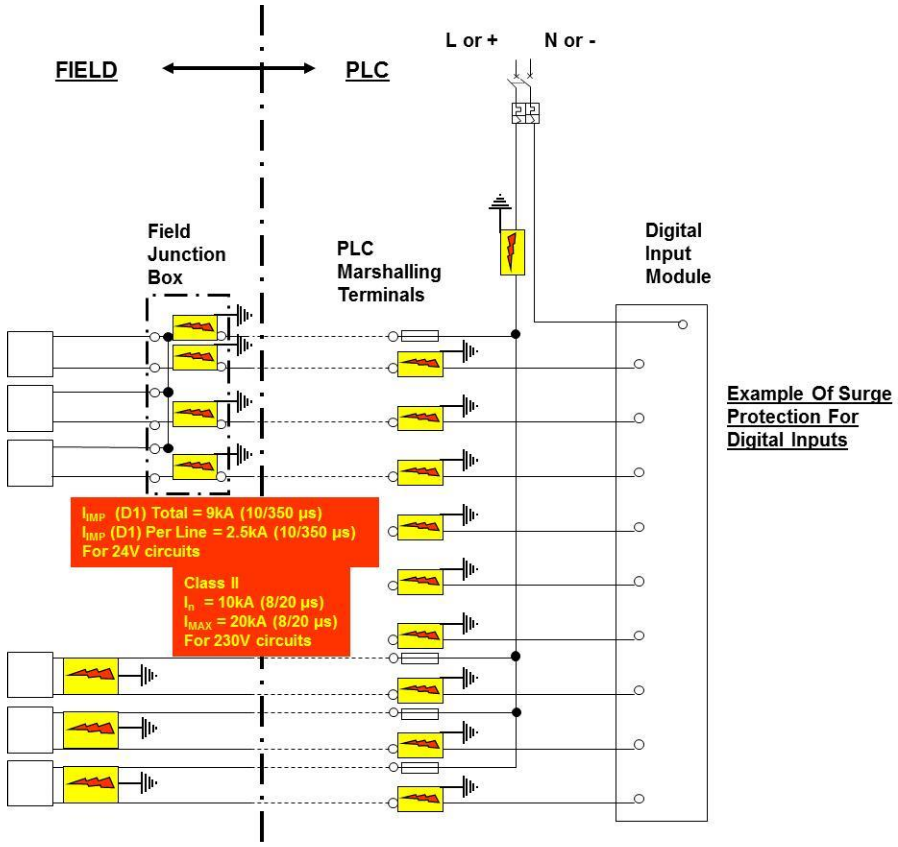
5.11.4 The rated operating current for SPDs used for protection of I/O systems must not be less than 0.75Amp.

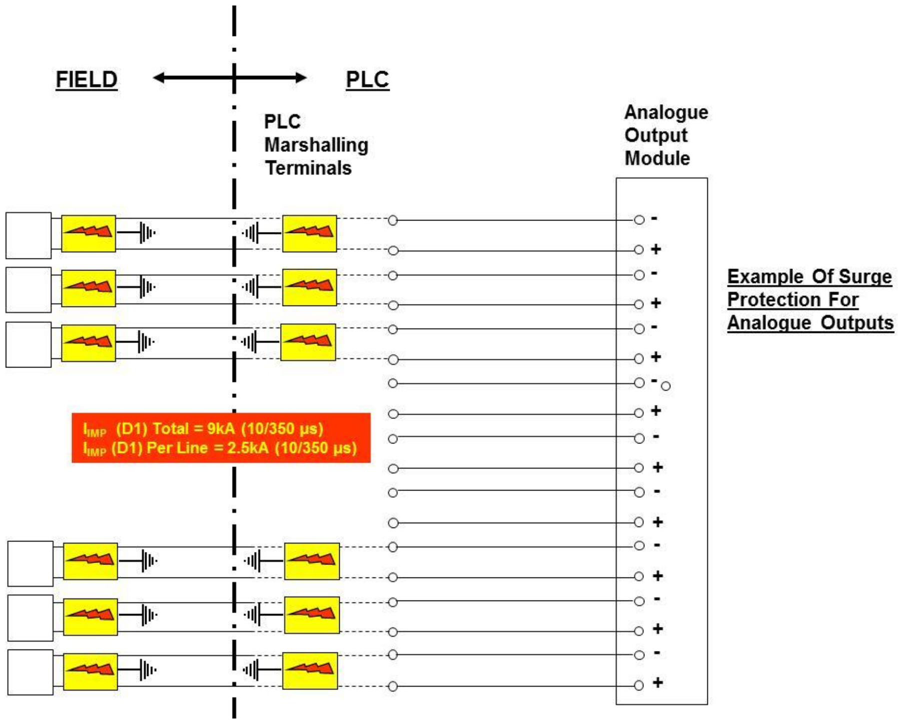
5.11.5 All SPDs must consist of a base and a pluggable top which can be disconnected without interrupting the signals.

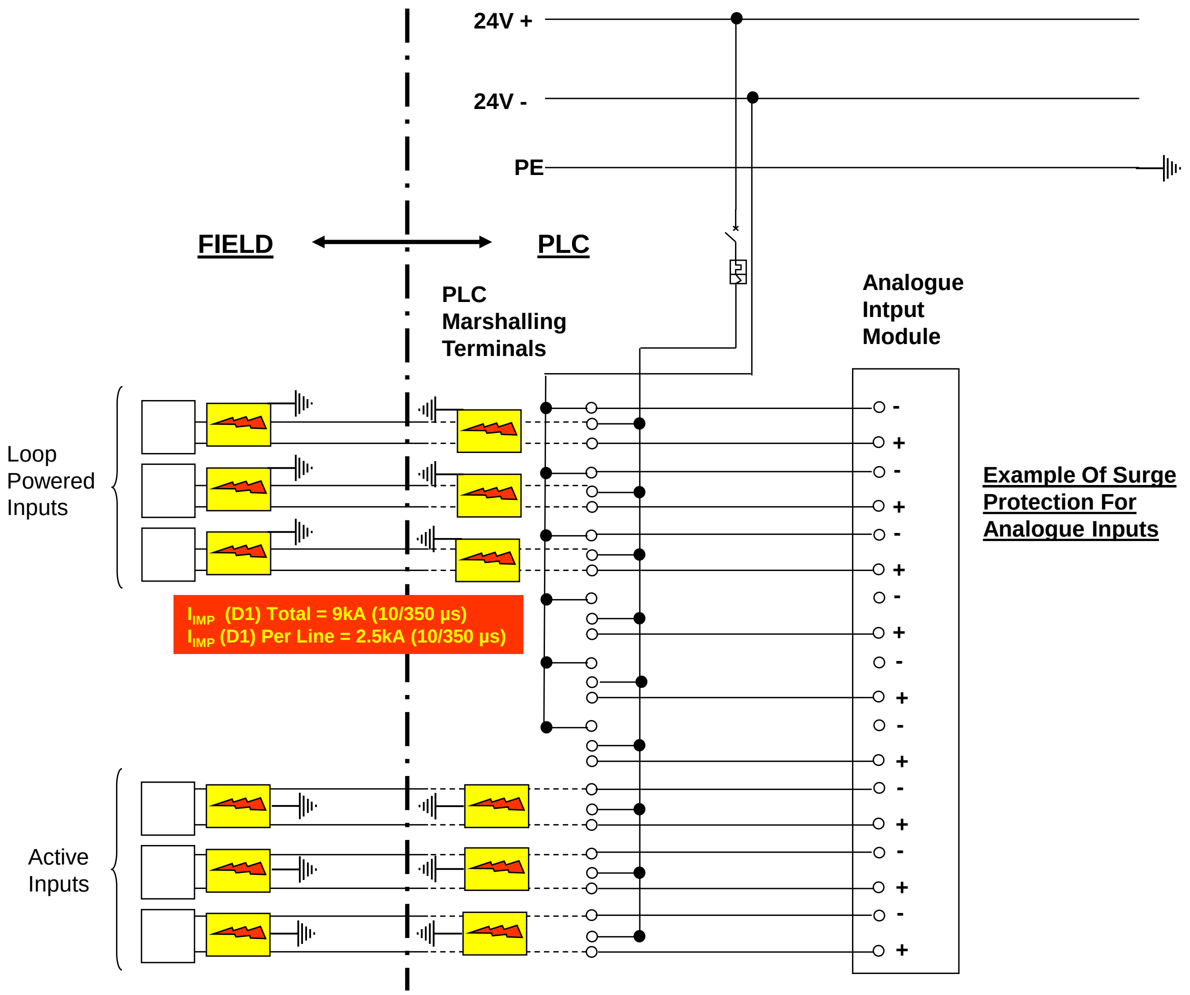

L or +
N or -
PE
Minimum Class II
20kA (8/20 µs) In and
40kA (8/20 µs) I_MAX
Line – Neutral
12kA (10/350 µs)
Neutral - Earth
FIELD
PLC
PLC
Marshalling
Terminals
Relay
Output
Module
Example Of Surge
Protection For Relay
Outputs Where PLC -
Side Supply Is Used
I_IMP (D1) Total = 9kA (10/350 µs)
I_IMP (D1) Per Line = 2.5kA (10/350 µs)
For 24V circuits
Class II
I_n = 10kA (8/20 µs)
I_MAX = 20kA (8/20 µs)
For 230V circuits


FIELD
PLC
PLC Marshalling Terminals
Relay Output Module
Example Of Surge Protection For Relay Outputs Where External Supply Is Used
I IMP (D1) Total = 9kA (10/350 µs)
I IMP (D1) Per Line = 2.5kA (10/350 µs)
For 24V circuits
Class II
I n = 10kA (8/20 µs)
I MAX = 20kA (8/20 µs)
For 230V circuits


FIELD
PLC
N or -
L or +
Field Junction Box
PLC Marshalling Terminals
Solid-State Output Module
Example Of Surge Protection For Solid State Outputs
I IMP (D1) Total = 9kA (10/350 µs)
I IMP (D1) Per Line = 2.5kA (10/350 µs)
For 24V circuits
Class II
I n = 10kA (8/20 µs)
I MAX = 20kA (8/20 µs)
For 230V circuits


FIELD
PLC
L or +
N or -
Field
Junction
Box
PLC
Marshalling
Terminals
Digital
Input
Module
Example Of Surge
Protection For
Digital Inputs
IMP (D1) Total = 9kA (10/350 µs)
IMP (D1) Per Line = 2.5kA (10/350 µs)
For 24V circuits
Class II
In = 10kA (8/20 µs)
IMAX = 20kA (8/20 µs)
For 230V circuits


FIELD
PLC
PLC
Marshalling
Terminals
Analogue
Output
Module
Example Of Surge
Protection For
Analogue Outputs
IMP (D1) Total = 9kA (10/350 µs)
IMP (D1) Per Line = 2.5kA (10/350 µs)


24V +
24V -
PE
FIELD
PLC
PLC
Marshalling
Terminals
Analogue
Intput
Module
Loop
Powered
Inputs
I_IMP (D1) Total = 9kA (10/350 µs)
I_IMP (D1) Per Line = 2.5kA (10/350 µs)
Active
Inputs
Example Of Surge
Protection For
Analogue Inputs

5.12 Surge Protection Data Sheets

5.12.1 The tenderer must complete the relevant data sheets below with his tender:

Technical Data Sheet: Mains Surge Protection

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Order No./Part No./Reference No.	
Class (E.g. Class I, Class II, combined Class I/Class II, etc.)	
Surge current rating at the relevant waveform (E.g. 20kA, 10/350µs, phase-to-neutral)	
Rated operating voltage	
Rated operating current	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

Technical Data Sheet: Surge Protection 230V Digital I/O

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Order No./Part No./Reference No.	
Class (E.g. Class I, Class II, combined Class I/Class II, etc.)	
Discharge current rating at the relevant waveform (E.g. 20kA, 10/350µs, phase-to-neutral)	
Rated operating voltage	
Rated operating current	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

Technical Data Sheet: Surge Protection 24V DC Digital I/O

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Order No./Part No./Reference No.	
Lightning Impulse Current and pulse form (E.g. 9kA - 10/350µs – total, 2.5kA - 10/350µs – per line, etc.)	
Rated operating voltage	
Rated operating current	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

Technical Data Sheet: Surge Protection Analogue I/O

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Order No./Part No./Reference No.	
Lightning Impulse Current and pulse form (E.g. 9kA - 10/350µs – total, 2.5kA - 10/350µs – per line, etc.)	
Rated operating voltage	
Rated operating current	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 6 : CABLING

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 17 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 6 : Cabling**

JW Reference: **BWW523C**

Document Ref. No: **VOLUME 6**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	
Approved	Manager	T. Thabeng	09/09/2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
2019-08-26	17	C. Du Toit	Cover page updated
2019-08-14	16	C. Du Toit	Updated materials for use in corrosive areas (GRP).
2019-06-15	15	C. Du Toit	JW comments included (Trenching under roads, sleeve draw wires, route marker painting, manhole covers and
2018-11-30	14	C. Du Toit	Added maximum losses for OTDR & OLTS testing, standards for data cable testing, protective tiles and
2014-04-17	13	C. Du Toit	Added blown fibre, splicing requirements & laser safety.
2013-10-07	12	C. Du Toit	Updated footer, bends for cable racks, cores in fibre-optic cables, fibre-optic cable type, earthing for theft
2012-07-27	11	C. Du Toit	Updated headers & footers.
2012-03-08	10	C. Du Toit	Updated support material for Ferric Chloride areas.
2012-03-08	9	C. Du Toit	Altered height of cable route markers, added new wiring size requirements and precedence of wiring sizes,
2011-07-11	8	C. Du Toit	Added cable theft prevention measures and removed 2010 logo.

2010-07-27	7	C. Du Toit	Added details of cable route markers and updated materials for cable ladders.
2009-08-18	6	C. Du Toit	Added new logos, cable rack material & colour and warning tape in trenches.
2009-05-08	5	C. Du Toit	Added requirements from client meeting on 04 May 2009.
2009-03-25	4	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client's requirements.
2008-10-08	3	C. Du Toit	"Joburg" & "JW" Logos added to top & partnership logos removed.
2007-06-05	2	C. Du Toit	Revision block updated and "Joburg" logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

INDEX

6 CABLING

6.1 Scope

6.1.1 This specification covers the selection, installation, testing, marking and termination of electrical cables used for low voltage power and control installations as well as fibre-optic and copper cables for data transmission, used in process monitoring and control applications at Johannesburg Water wastewater sites.

6.2 Abbreviations

6.2.1 In this specification the following abbreviations will apply :-

SANS	:	South African National Standards
IEC	:	International Electrotechnical Commission
EN	:	Standards from the European Committee for Standardization
PLC	:	Programmable Logic Controller
UV	:	Ultra Violet
PVC	:	Poly Vinyl Chloride
OTDR	:	Optical Time Domain Reflectometer
OLTS	:	Optical Loss Test Set
SFP	:	Small Form Pluggable

MRM Ref. No. : The nominal mass in kg/m^2 multiplied by 100, used for steel wire mesh reinforcing.

6.3 Standards

6.3.1 All design standards for cabling shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	:	National Standards for the wiring of premises
SANS 1507	:	Electric Cables (300/500V to 900/3300V)
SANS 1574	:	Electric Cables Flexible cords and flexible cables
SANS 1411-1 to 7	:	Material of insulated electric cables and flexible cords
SANS 1507-1 to 3	:	Electric cables with extruded solid dielectric insulation for fixed installations (300/500V to 1900/3300V)
SANS 1803-1	:	Lugs and ferrules for insulated cables
SANS 60793	:	Optical fibres
SANS 1024:2006	:	Steel wire mesh
IEC 60793	:	Optical fibres
SANS 60794	:	Optical fibre cables
IEC 60794	:	Optical fibre cables

ISO/IEC 14763-3	:	Fibre optic testing
TIA/EIA 568-B.2-10	:	Copper data cable testing
EN 50288	:	Multi-element metallic cables used in analogue and digital communications and control
ISO/IEC SANS 11801:2002	:	Information Technology – Generic cabling for customer premises
IEC 60332-1	:	Flammability of a single vertical cable

6.4 General

6.4.1 All cables and wiring supplied must be supplied complete with fittings, accessories, etc.

6.4.2 The installation of all wires and cables must comply with SANS 10142-1:2003 and SANS 1507-1 to 3, all as amended.

6.4.3 The installation of flexible cords must comply with SANS 1574:2004 as amended.

6.4.4 All power, control and instrumentation cables (i.e. excluding fibre-optic cabling for data transmission) and wires must have untinned, annealed, multi-strand copper conductors and must comply with, SANS 1507-2 and SANS 1507-3: 2002 as amended.

6.4.5 All power, control and instrumentation cables (i.e. excluding fibre-optic cabling for data transmission) and wires must comply with the latest edition of SANS 1411-1 to 7 in terms of material of construction. The sheath of these cables must be an impermeable, halogen-free, reduced smoke emission, flame retardant, UV stabilised compound in accordance with the latest edition of SANS 1411.

6.4.6 All fibre-optic cables must comply with SANS 60793-1 for measurement and test methods, SANS 60793-2 for product specifications and SANS 60794 for generic, sectional and family specifications.

6.4.7 All blown fibre-optic installations must comply with the requirements of SANS 60794-5 which specifies the requirements of microduct optical fibre cables, microduct fibre units, microducts and protected microducts for installation by blowing for outdoor and/or indoor use.

6.4.8 All fibre-optic micro cables must comply with the requirements of SANS 60794-5-10 and all blown fibre-optic bundles must comply with the requirements of SANS 60794-5-20.

6.4.9 All blown fibre installations must be done by people who can provide proof of certified training by a recognized supplier/installer such as Lonspeare SA (Pty) Ltd. or equivalent.

6.4.10 Where fibre-optic data communication is employed, blown fibre installations will be the preferred method. Only where the use of fibre-optic cabling is unavoidable, will such cabling, instead of blown fibre assemblies be accepted.

6.4.11 All wires and cables must be from fresh stock, with the manufacturer’s original wrappings, labels and seals intact when delivered to site.

6.4.12 All cables must be inspected for visible defects or signs of damage before installation. A checklist of cables checked for visible defects/damage must be available on request.

6.4.13 All cable ends must be sealed or capped immediately after cutting to prevent ingress of moisture, dirt, impurities, etc. This applies to cables to be installed as well as cable remaining on the drum.

6.4.14 Where cables or wires of different voltages run in the same trunking, cable trays, cable racks or cable supports, all insulation must be rated for the highest voltage being conducted.

6.4.15 For PLC panel wiring, this specification must be read in conjunction with the PLC Panels Specification (Volume 3 of the Automation And Control Standards).

6.4.16 All electrical and instrumentation cables must be tested, and the results recorded, for insulation resistance and conductivity in accordance with SANS 1507-3:2002 as amended, before installation and again before final termination. Rectification of faults in cables before final termination will be for the contractor’s account.

6.4.17 For PLC I/O wiring, the minimum conductor size shall be 0.5mm^2 but contractors must ensure that all cables and wiring are capable of carrying the full system currents, inclusive of de-rating factors as specified in SANS 10142-1:2003 as amended.

6.4.18 All wiring for PLC panels, junction boxes, control panels, etc. shall be flexible, untinned, annealed, multi-strand copper wire of not less than:-

6.4.18.1 6mm^2 for 230V AC power between the main incoming circuit breaker of the PLC panel and the distribution AC circuit breakers.

6.4.18.2 4mm^2 for 24V DC power between the main DC circuit breaker of the PLC panel and the distribution DC circuit breakers.

6.4.18.3 1,5mm^2 for 230V AC or 110V AC power from below the distribution circuit breakers.

6.4.18.4 1,0mm^2 for 24V DC or AC power from below the distribution circuit breakers.

6.4.18.5 0,5mm^2 for all PLC I/O wiring between modules and marshalling terminals.

6.4.18.6 4,0mm^2 for earth drain.

6.4.19 Irrespective of the minimum wire sizes allowed in this specification, contractors must ensure that all cables and wiring are capable of carrying the full system currents, inclusive of de-rating factors as specified in SANS 10142-1:2003 as amended. If wiring of greater cross-sectional area than the sizes indicated in item 6.4.17 and 6.4.18 above are indicated on project design drawings, the larger wiring sizes will take precedence.

6.4.20 All wires and cable cores must be fitted with suitable lugs at the end of each wire or core. The fitting of lugs and ferrules must comply with SANS 1803-1:2002 as amended. No more than one wire may be crimped into a single lug. Where pin lugs are crimped onto the ends of wires, correctly sized pin lugs must be used, which fit into the terminals properly and such that the tightening of the terminal does not result in the loosening of the pin lug.

6.4.21 The use of lugs and ferrules must comply with SANS 1803-1:2002 as amended.

6.4.22 The outer sheath of all power cabling must be black and the outer sheath of all instrumentation and control cabling must be orange. The power supply to instruments and transmitters are regarded as part of the instrumentation cabling and must therefore have an orange outer sheath. The outer sheaths of all blown fibre microduct assemblies must also be orange. Where blown fibre microduct assemblies have an outer sheath of a specific material (such as UV protection) which is not available in orange, the contractor can apply to the Engineer for a concession to use the assembly as is and only attach an orange heat-shrink (for identification purposes) at the ends where terminations are made.

6.4.23 The jacket or buffer tubes of fibre cores in fibre-optic cables must be colour coded and terminated in the following sequence:

Fibre/Tube	**Colour**
1	Blue
2	Orange
3	Green
4	Brown
5	Grey (Slate)
6	White
7	Red
8	Black
9	Yellow
10	Violet
11	Pink (Rose)
12	Aqua (Turquoise)

6.4.24 All fibre-optic cable will be CST (corrugated steel tape) or steel wire armoured, rodent-proof, UV protected, loose-tube, water blocking, suitable for use in direct burial and manufactured with an orange PVC sheath. The conductive steel armour of installed fibre cables shall be properly grounded to the protective earth at all termination points.

6.4.25 All blown fibre microduct assemblies installed in trenches must be suitable for direct burial in terms of strength and mechanical protection.

6.4.26 All blown fibre microduct assemblies installed on cable racks or supports above ground must have suitable mechanical protection. Suitable mechanical protection includes, blown fibre microduct assemblies on racks that are covered with metal covers, blown fibre microduct assemblies installed in metal tubing and blown fibre microduct assemblies with steel wire armouring or steel tape armouring.

6.4.27 Where blown fibre microduct assemblies are installed in buildings or in cable tunnels, such microduct assemblies must have an inner and outer sheath of fire retardant material. The outer sheath must also be low-smoke and halogen-free.

6.4.28 Where blown fibre microduct assemblies are exposed to direct sunlight, such microduct assemblies must have an outer sheath that is UV protected.

6.4.29 The contractor must take very careful note of the requirements for blown fibre microduct assemblies as outlined in items 6.4.25 to 6.4.28 above. These requirements imply that where the installation conditions change, suitable blown fibre microduct assemblies must be installed to suit the requirements of each section of the installation. The table below gives an example of the blown fibre microduct assembly requirements for various sections of an installation:

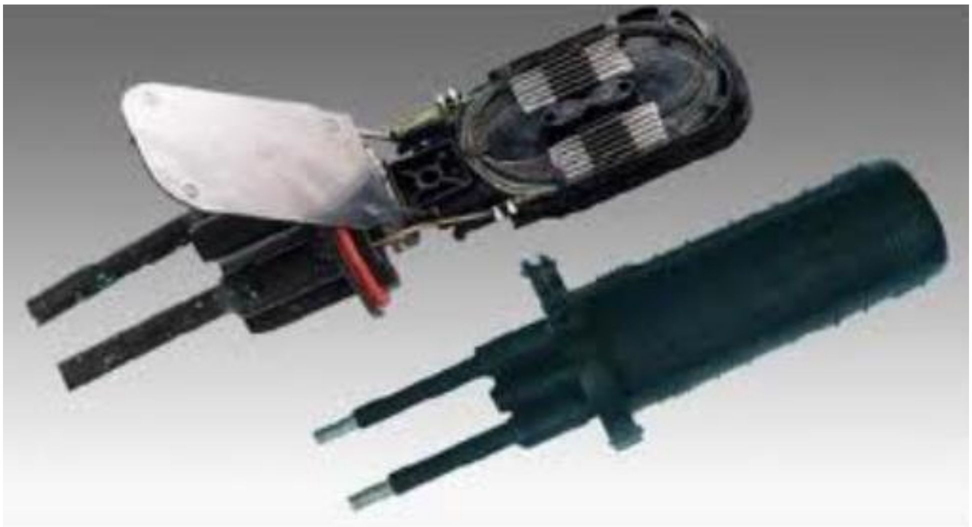
Installation Condition	Blown Fibre Microduct Assembly Requirem
In ceiling of a building	Rodent-proof, low-smoke, fire retardant, halogen
On a cable support against the side of the building	Steel wire or steel tape armoured, UV protected.
Buried in a trench	Suitable for direct burial.
On a rack in the open above ground	Mechanical protection, UV protection (if mechani protection is not steel covers or metal tubing).
On a rack inside a building	Mechanical protection, low-smoke, halogen-free, retardant.

6.4.30 All cables on racks, in trenches, in tunnels, in wire ways, on cable supports, etc. must be vermin-proof. I.e. such cables must be equipped with suitable armouring to prevent rodents or other vermin from chewing through core conductors or their insulation.

6.4.31 Bending of all cables and microduct assemblies for blown fibres must be limited to the safe criteria specified by the manufacturers.

6.4.32 Holes for cables or blown fibre microduct assemblies passing through walls, floors, partitions, ceilings, etc. must be done neatly and must be sealed off with plaster or filler as appropriate.

6.4.33 Splices in cables are prohibited, unless the route lengths exceed the maximum length of a drum or if the Engineer agrees to a splice. In such cases splices are to be made by using approved proprietary types of junction boxes, installed in an appropriate manner. For fibre-optic cables, dome splicing kits with a protection rating of at least IP68, installed in a manhole must be used. The dome splicing kit must be mounted vertically inside the manhole. The manhole must be big enough to create a 3m service loop in the each cable without exceeding the minimum bending radius of the cable and big enough to mount the enclosure appropriately in the manhole. Only fusion splices will be acceptable and ease of access to the splice must be ensured. Examples of such dome splicing kits are shown below. Alternatively the splice can be made in a junction box that complies with all the requirements of the specification “Field Junction Boxes And Panels” (Volume 19 of the Automation And Control Standards), mounted on a proper support, above ground level. Once a splice is completed, all the testing requirements of items 6.8.8 and 6.8 9 below must be complied with.



6.4.34 For blown fibre microduct assemblies, in-line splicing kits, installed in a manhole, can be used if a splice is approved by the Engineer. These kits must also have a protection rating of at least IP68. Only fusion splices will be acceptable and ease of access to the splice must be ensured. An example of such an in-line splicing kit is shown below. Alternatively the splice can be made in a junction box that complies with all the requirements of the specification “Field Junction Boxes And Panels” (Volume 19 of the Automation And Control Standards), mounted on a proper support, above ground level. Once a splice is completed, all the testing requirements of items 6.8.8 and 6.8 9 below must be complied with.

6.4.35 Splices in copper cables can be done with the aid of proprietary, resin-encapsulated splices that are completely water-proof (such as Scotch Cast or similar). Alternatively the splice can be made in a junction box that complies with all the requirements of the specification “Field Junction Boxes And Panels” (Volume 19 of the Automation And Control Standards), mounted on a proper support, above ground level.

6.4.36 Manholes used for splicing can be constructed using bricks or concrete. The manhole must allow for adequate drainage of water. All sleeves entering the manhole must be sealed with an appropriate sealer that will prevent moisture, dirt, rodents, etc. from getting into the sleeves, but the sealant must be of such material that it can easily be removed if required in future. The area around the sleeve where it enters the manhole must also be sealed to prevent moisture, mud, rodents, etc. from getting into the manhole. The manhole must not have any sharp edges that can damage cables or microduct assemblies.

6.4.37 Cables or conductors passing through holes must be fully protected against damage by correctly fitted grommets, bushes, etc.

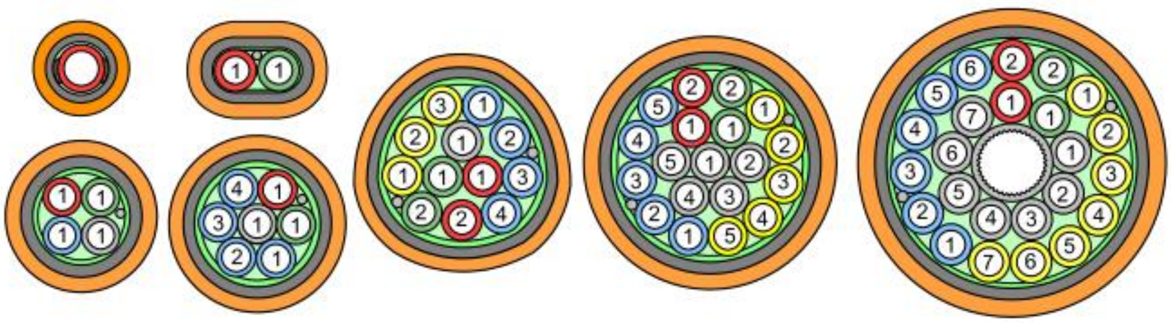
6.4.38 All cable routes, including trenches, cable racks, tunnels, cable supports, etc. must be clearly marked on drawings and submitted for approval by the Engineer. The project will not be regarded as complete until such cable route drawings have been submitted and approved.

6.4.39 The jacket or buffer tubes of fibre bundles used in blown fibre installations must be colour coded and terminated in the following sequence:

Fibre/Tube	**Colour**
1	Blue
2	Orange
3	Green
4	Brown
5	Grey (Slate)
6	White
7	Red
8	Black
9	Yellow
10	Violet
11	Pink (Rose)
12	Aqua (Turquoise)

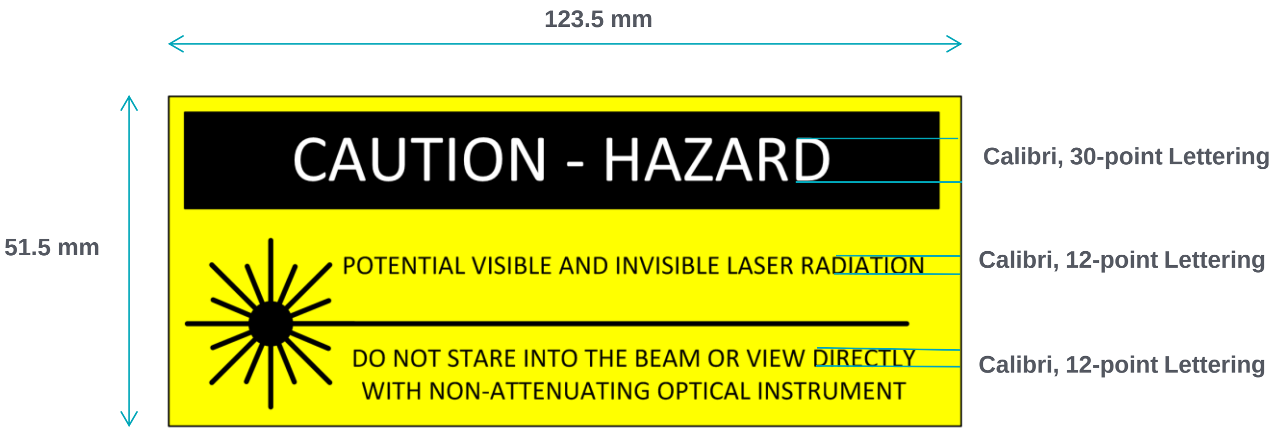
6.4.40 The microducts (or inner tubes) of microduct assemblies used for blown fibre installations must be constructed from low-friction Poly Ethylene (PE). These microducts must be 5/3.5 in size (i.e. 5mm OD and 3.5mm ID). Surrounding the group of microducts, must be a layer of waterswell tape. Where steel wire armour or steel tape armour is not used, the microduct assembly must be metal-free.

6.4.41 Microducts in microduct assemblies must be available in 1, 2, 4, 7, 12, 19 and 24 microduct assemblies and must be numbered and colour-coded as indicated in the sketch below.



6.4.42 The routes (i.e. source and destination) of microducts installed at each splice and/or termination must be noted down in detail during installation. This record must indicate for each fibre bundle that is blown into a microduct: Source – microduct colour – microduct number and Destination – microduct colour – microduct number. This detailed record must be submitted to the Engineer for approval before the blowing in of fibre bundles commences. Once it is approved, installation must be done according to this record. If a change is made, such a change must be recorded and a final “as-built” record of the installation must be produced for record purposes. The project will not be regarded as complete until such microduct route records have been submitted and approved.

6.4.43 Wherever fibre-optic ends exist, such as at patch panels, splices, switches, transmitters, receivers, etc. and where it would be possible for a person to look into such fibre-optic ends, a danger warning as shown by the image below (or equivalent approved by the engineer), must be affixed to the panel, enclosure, etc. This label must comply with all the requirements stipulated in the JW Labelling Specification (Volume 25 of the Automation And Control Standards).



6.5 Cabling On Racks And Supports

6.5.1 Cable ladders shall, unless otherwise specified, be heavy-duty cable ladder standard pattern.

6.5.2 Cable ladders used inside Elutriation Terrace pump stations or in areas within 10m or less of Ferric Chloride, Sodium Hypochlorite or Chlorine shall be manufactured from corrosion resistant GRP (Glass Reinforced Polyester). All GRP cable ladders shall consist of a 75 mm high side rail. The minimum thickness of the material that the cable rack is to be manufactured from, shall at least be 4mm. Cross rungs shall be spaced at maximum intervals of 300 mm (centre-to-centre). All screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel for all these corrosive applications, and all exposed metal shall be painted with a 2-component auto-motive or industrial paint (2K poly urethane paint). Racks for instrumentation and control cabling shall contain pigmentation to produce an electric orange rack. A sample of the rack material must be approved by the engineer before manufacturing commences. Sections of rack, bends, t-pieces etc. shall be joined together with the correct dowels and resins as specified by the supplier. Wherever racking is drilled or cut, the exposed areas of GRP must be sealed with the same resin and painted with 2K paint to ensure that the material does not fray. Channels or other sections used for securing of cable ladders should also be made from GRP. All cable glands must be totally encapsulated glands (envirogland type) as shown in the example below.

6.5.3 The GRP profile (cable rack or equipment support) shall consist of pultruded (i.e. a continuous process of pulling material, such as **glass fiber** and resin, through a shaped die for manufacturing of composite materials with constant cross-section), e-glass roving and e-glass multi-axial fabric strength mat, sandwiched between polyester synthetic veil or tissue of minimum 35 gram/ m^2, all of which is encased in an isophthalic vinyl-ester resin. The resin must contain UV stabiliser. It must also contain pigment to provide colour and additional environmental protection. The rack or support must be cleaned and de-greased before it is painted with a 2K automotive or industrial poly urethane paint.

6.5.4 Cable ladders used inside de-watering buildings shall be metal cable ladders, manufactured from corrosion resistant, powder coated, 3CR12 grade stainless steel. All cable ladders shall consist of at least 75 mm high side rail. The minimum sheet thickness of the material that the cable rack is to be manufactured from shall at least be 2mm. Cross rungs shall be spaced at maximum intervals of 300 mm (centre-to-centre). All screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel. Metal racks for instrumentation and control cabling shall be powder coated electric orange.

6.5.5 Cable ladders used for all applications other than those mentioned in items 6.5.2 to 6.5.4 above shall be heavy-duty metal cable ladders, manufactured from corrosion resistant hot-dipped galvanised, powder coated, mild steel. All metal cable ladders shall consist of at least 75 mm high side rail. The minimum sheet thickness of the material that the cable rack is to be manufactured from shall at least be 3mm. Cross rungs shall be spaced at maximum intervals of 300 mm (centre-to-centre). All screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel. Racks for instrumentation and control cabling shall be powder coated electric orange.

6.5.6 Power and control cabling must always be separated by no less than 500mm. Where it is unavoidable to cross power and control cabling, such cross-overs must be done at right angles.

6.5.7 Only single layers of cable will be allowed on a rack, to reduce de-rating and for ease of replacement and/or repairs.

6.5.8 Bends in cable racks and supports shall have radii which will ensure that cables are not bent more than the safe criteria specified by the cable manufacturers. For this reason all racking, whether horizontal or vertical must include 90 degree bends where there are 90 degree direction changes in cable runs. I.e. cabling cannot be run from one straight cable rack onto another straight cable rack at 90 degrees, without a 90 degree cable rack bend.

6.5.9 Angle iron cable supports may be used. All such angle iron supports must be hot-dipped galvanised, 3CR12 grade stainless steel, 304 grade stainless steel or 316 grade stainless steel and electric orange powder coated as for the cable racks. The material will depend on the application area as specified in items 6.5.2 to 6.5.5 above.

6.5.10 No more than two cables may be run on a single angle iron support.

6.5.11 The size of angle iron supports must be such that no part of a cable projects beyond the support.

6.5.12 The minimum size of angle iron cable supports is 25mm x 25mm x 5mm.

6.5.13 Wherever possible cable racks must be mounted in the vertical plane to avoid accumulation of dirt and debris.

6.5.14 UV stabilised PVC straps may be used for cables up to 4core x 25mm^2. For cables of larger diameter than this (i.e. 30mm diameter and larger), stainless steel strapping must be used.

6.5.15 Cables must be marked at both ends with stainless steel cable markers strapped to the cable with stainless steel or UV resistant straps in a position where this number is visible without the need to move cables or equipment to view the number. Cable numbering must comply with all the requirements of the Labelling Specification (Volume 25 of the Automation And Control Standards).

6.6 Electric Cable Terminations

6.6.1 All cable terminations must be made in a professional manner and cables shall be made off by using appropriate cable glands and UV treated shrouds. Glands similar or equal to the “Enviro” glands supplied by some manufacturers must be used. All cable glands must be:

- environmentally sealed to IP68 against the ingress of water from <u>either end</u> of the cable gland
- constructed from brass and black nylon plastic encapsulation
- supplied complete with brass locknut
- have a loose cone bush and cone ring
- suitable for use in an Ex e application and must therefore have an Ex identification band

6.6.2 Proprietary type wire strippers shall be used and no stranded conductor shall be terminated if one or more strands have been damaged.

6.6.3 Not more than one wire shall be connected to any terminal unless the terminal can accept pin lugs on either side of a screw or unless proper connecting material is used (see examples below).




Every wire shall be marked at both ends with a numbering system as specified in the Labelling Specification (Volume 25 of the Automation And Control Design Standards), or if approved by the Engineer, and all terminating wires shall also be suitably crimped to a terminal lug. Not more than one wire shall be crimped into a single lug. Bare wire terminations will not be accepted.

6.6.4 Where lugs are bolted onto studs, suitably sized lugs must be used. Enlarged holes in lugs will not be accepted.

6.6.5 Where pin lugs are crimped onto the ends of wires, correctly sized pin lugs must be used, which fit into the terminals properly and such that the tightening of the terminal does not result in the loosening of the pin lug.

6.6.6 Where cable cores are terminated, sufficient slack must be allowed for wiring changes, re-terminations, etc.

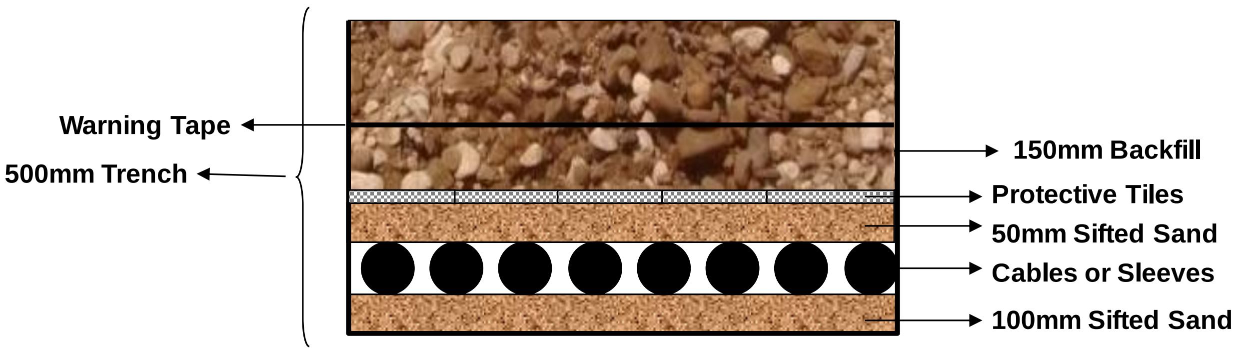
6.6.7 Where cable junction boxes, terminal boxes or terminations in instruments or any other panels in the field take place it must be ensured that such a junction box, termination box, instrument, etc. is not exposed to fire hazards from burning grass or other vegetation. If such a termination point is out in the open field (e.g. where grass grows below and/or around it), a clear area of at least 2.5m radius around this termination point must be provided. This must be a permanent clearing, such as a cement or concrete surface. A mere clearing of vegetation which can grow back again will not be accepted.

6.7 Cables, Sleeves Or Microduct Assemblies In Trenches

6.7.1 All cabling in trenches must be armoured cables to ensure sufficient mechanical protection.

6.7.2 Where cabling (electrical or fibre-optic) has to be done between points where cabling will not run along cable racks, in cable ducts or in cable tunnels, these cables or microduct assemblies for blown fibre must be run in trenches. Overhead cabling will not be acceptable. Blown fibre microduct assemblies buried in trenches must be suitable for direct burial.

6.7.3 Cable trenches must be at least 500 mm deep. There must be a 100mm layer of selective backfill (soft sifted sand), free of sharp and hard objects, at the bottom of the trench and another 50mm layer of selective backfill (soft sifted sand) directly above the cable, sleeves or microduct assemblies. Thereafter a single layer of protective pre-cast concrete tiles must be placed, without spaces between tiles, so that it forms one continuous protective layer. On top of the concrete tiles a layer of approximately150mm backfill must be placed before placing plastic cable warning tape. The warning tape must consist of a strip of polyethylene of thickness 0,04 mm and of nominal width 230 mm, completely impregnated with a pigment such that the colour of the tape is yellow, colour No B49 of SANS 1091, and having printed at intervals not exceeding 1 metre along its length, a black-triangle and an electric flash symbol and the words "Danger, Gevaar, Ingozi". Thereafter the trench must be filled with sand (see the sketch below).



6.7.4 Protective concrete tiles in trenches are there to provide protection against hand digging and warning of cables below. These tiles therefore can be paving blocks, precast wall slabs, etc. Requirements are that the tiles are not less than 38mm thick and will not break under their own weight (i.e. when the longest span of the tile or slab is supported on its ends) or when laid in the trenches by commonly accepted means.

The tiles must also not break when the soil is compacted. The tiles must cover the entire width and length of the trench. Before purchasing any protective tiles, the contractor must submit details of the proposed tiles to the engineer for approval.

6.7.5 Where trenches pass under roads, railway lines, buildings, structures, etc., the cable trench must be at least 800 mm deep and at least 110mm HDPE (High-density polyethylene) double wall, corrugated pipes must be used as sleeving.

6.7.6 Protective concrete tiles in trenches under roads must comply with all the requirements listed in item 6.7.4 above plus the concrete tiles must not break if subjected to the heavy vehicle traffic on that road. The requirements mentioned in items 6.7.5 and 6.7.6 must be extended for 2 meters beyond the edge of roads to ensure that cables and cable sleeves will suffer no damage from heavy vehicles driving beyond the edge of the road.

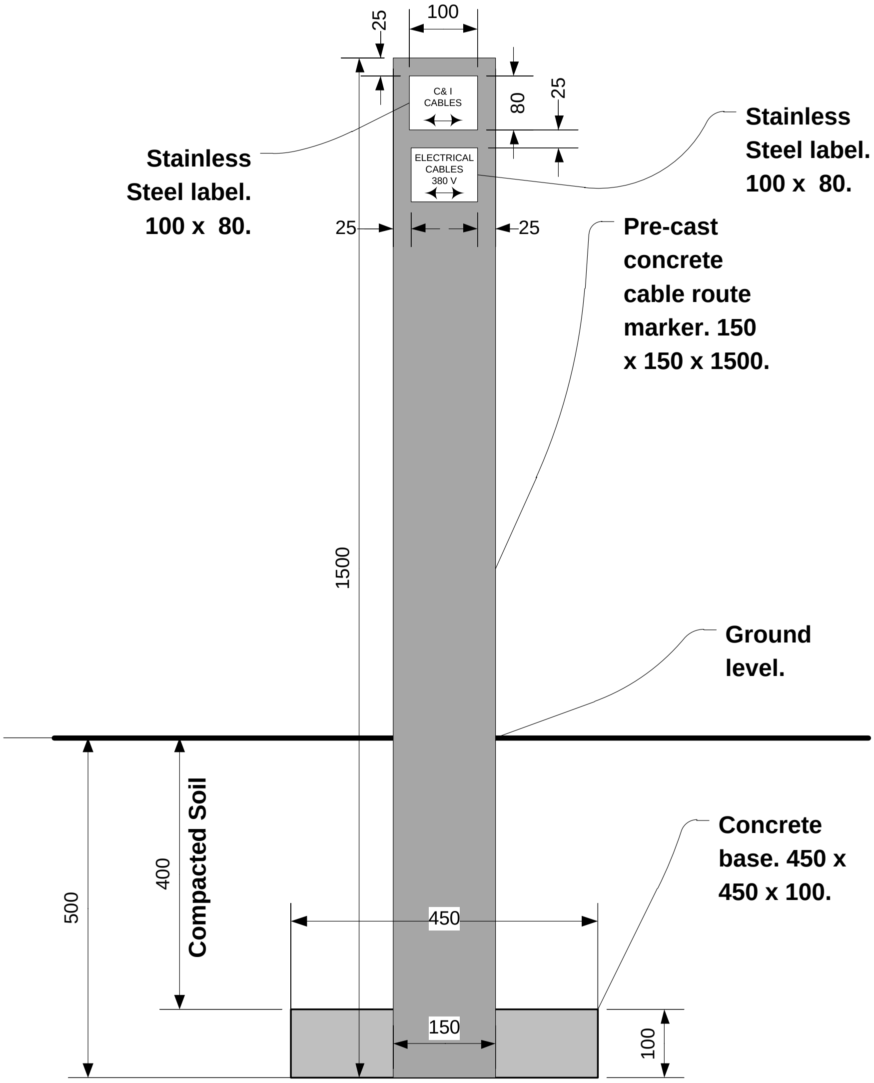
6.7.7 Cable route markers, in the form of concrete pre-cast posts, which stand 1.0m above ground level, secured in the ground, must be installed every 50m on straight runs and at every change in direction of the trench. Movable route markers will not be acceptable. The post must be equipped with a stainless steel plate engraved with “C&I CABLES” and/or “DATA CABLES” as applicable and the direction indicated in which the cables run. If there are electrical cables in the same trench, there must be a separate label engraved with “ELECTRICAL CABLES”, the voltage and the direction indicated in which the cables run. If there are data communication cables in the same trench, there must be a separate label engraved with “DATA CABLES” and the direction indicated in which the cables run. These labels must be cast into the concrete post so that they cannot be pried off.

6.7.8 At the bottom of the post a 450 x 450 x 100mm concrete base must be cast to ensure that the route marker can only be removed if it is deliberately dug out of the ground. Steel reinforcing mesh of MRM reference 156, in accordance with SANS 1024:2006 is required in the concrete and the concrete compressive strength of the base must not be less than 15 MPa. (Note: Reinforcing mesh to MRM 156 consists of 3.55mm diameter wire used to create 100 x 100 mm squares).

6.7.9 These route markers must be installed right next to the trench and not over the cables, so that the trench can be re-opened without affecting the route marker. The labels on the route marker must be on the trench side of the route marker.

6.7.10 All route markers for C&I and data cables must be painted with two coats synthetic polymer base emulsion paint for exterior use, complying with SANS 1586 Grade 1. The first coat may be thinned with no more than 10% water to aid penetration. Thereafter reflective yellow paint, suitable for use on concrete, must be applied.

6.7.11 The diagram below provides the required detail of these cable route markers.



6.7.12 Power and control cables must remain separated by at least 500mm as stated earlier. This means that power and control cables are not to be installed in the same cable sleeve.

6.7.13 Where sleeves are used for cables, an accessible manhole must be installed on every 50m straight run of sleeve and at every change of direction. This manhole can be built from bricks or concrete or it can be polyethylene Stakboxes as shown in the example below. Lids used on Stakboxes must not be made of material that is prone to theft for scrap metal (such as mild, steel, cast iron, etc.

6.7.14 The manhole must be large enough to allow proper access for cable installation. For example a manhole on a straight length of sleeving must in any event also not be smaller than 300mm x 300mm. Manholes installed at a change of direction must be large enough so that the bending radius of any cable running through it is not smaller that the manufacturer’s recommended bending radius. The manhole must also not be smaller than 300mm x 300mm. If the manhole is required to make cable splices (fibre or copper) it must comply with all the requirements of item 6.4.36 above and there must be enough space so that cable loops can be comfortably left in the manhole without exceeding manufacturer’s recommended minimum bending radii. Such a manhole must in any event also not be smaller than 600mm x 600mm.

6.7.15 The larger the number of cables running through the manhole, the larger the manhole must be to ensure ease of cable installation.

6.7.16 The depth below ground level at which the cables run through the manhole must not be less that the required cable burial depth as specified in item 6.7.3 above.

6.7.17 All sleeves entering the manhole must be sealed with an appropriate sealer that will prevent moisture, dirt, rodents, etc. from getting into the sleeves, but the sealant must be of such material that it can easily be removed if required in future. The area around the sleeve where it enters the manhole must also be sealed to prevent moisture, mud, rodents, etc. from getting into the manhole. The manhole must not have any sharp edges that can damage cables or microduct assemblies.

6.7.18 Where manholes are installed in roads, paving or paths where vehicles can travel, the lids and lid support structure must be strong enough so that heavy vehicle traffic from that area will have no detrimental effect on the lid or manhole. Such manhole covers must not be manufactured from material such as cast iron which is prone to theft. Metal covers filled with concrete will be acceptable.

6.7.19 The manhole covers shall either have a latch that requires a special tool to unlock and remove, or be heavy enough that lifting equipment is required to remove them (see the picture below).

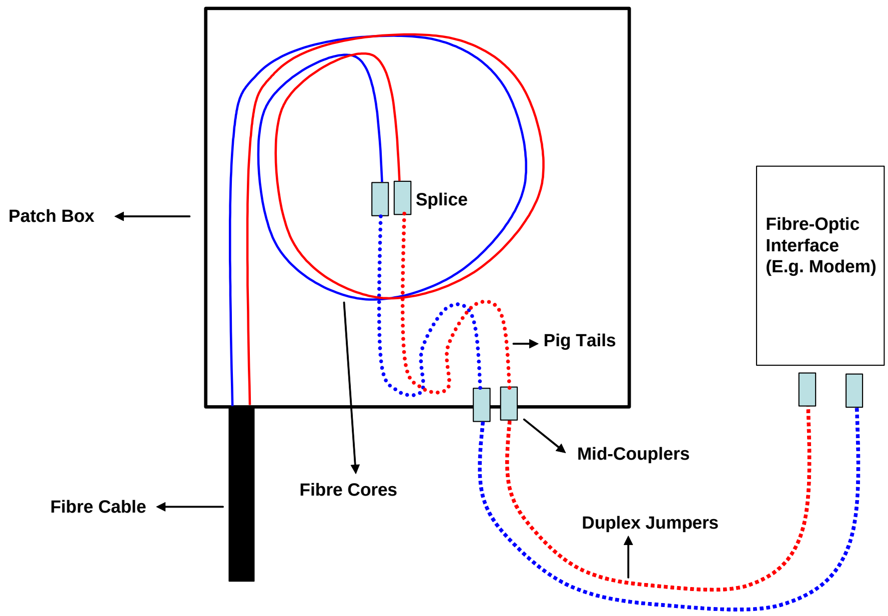
6.7.20 The base of the chamber must be made up of a dry mix of stone and cement so that it forms a hard but porous surface which is free draining for any water which enters the chamber.

6.7.21 All installed sleeves must be equipped with draw wires (or equivalent, such as nylon rope) to allow pulling in of cables. These draw wires must be non-corrosive and must be strong enough to pull the cables intended for that sleeve.

6.8 Fibre-Optic Data Cable Terminations

6.8.1 All terminations must be done by fusion splicing cores of the fibre-optic cable onto pre-fabricated “pig tails”, inside a “patch box”. The optical fibres will be terminated in the sequence specified in item 6.4.23 and 6.4.39 above.

6.8.2 The “patch box” must be equipped with mid-couplers, to accept the “pig tails” from inside the “patch box”. The other end of these mid-couplers must accept the ends of the duplex jumpers fitted with LC connectors at both ends, which in turn are connected to the fibre-optic interface (modem, switch, hub, etc.). This arrangement is to ensure that disconnecting for testing or maintenance purposes does not involve working where the splices were made (see the sketch below).



6.8.3 The "patch box" must be hardened and robust, with a minimum environmental rating of IP65 and suitable for use in industrial applications.

6.8.4 All splices must be fusion splices, and not mechanical splices.

6.8.5 All fibre-optic cables must be at least 12-core cables to ensure sufficient spare cores in the event of faults and for future modifications, additions, etc.

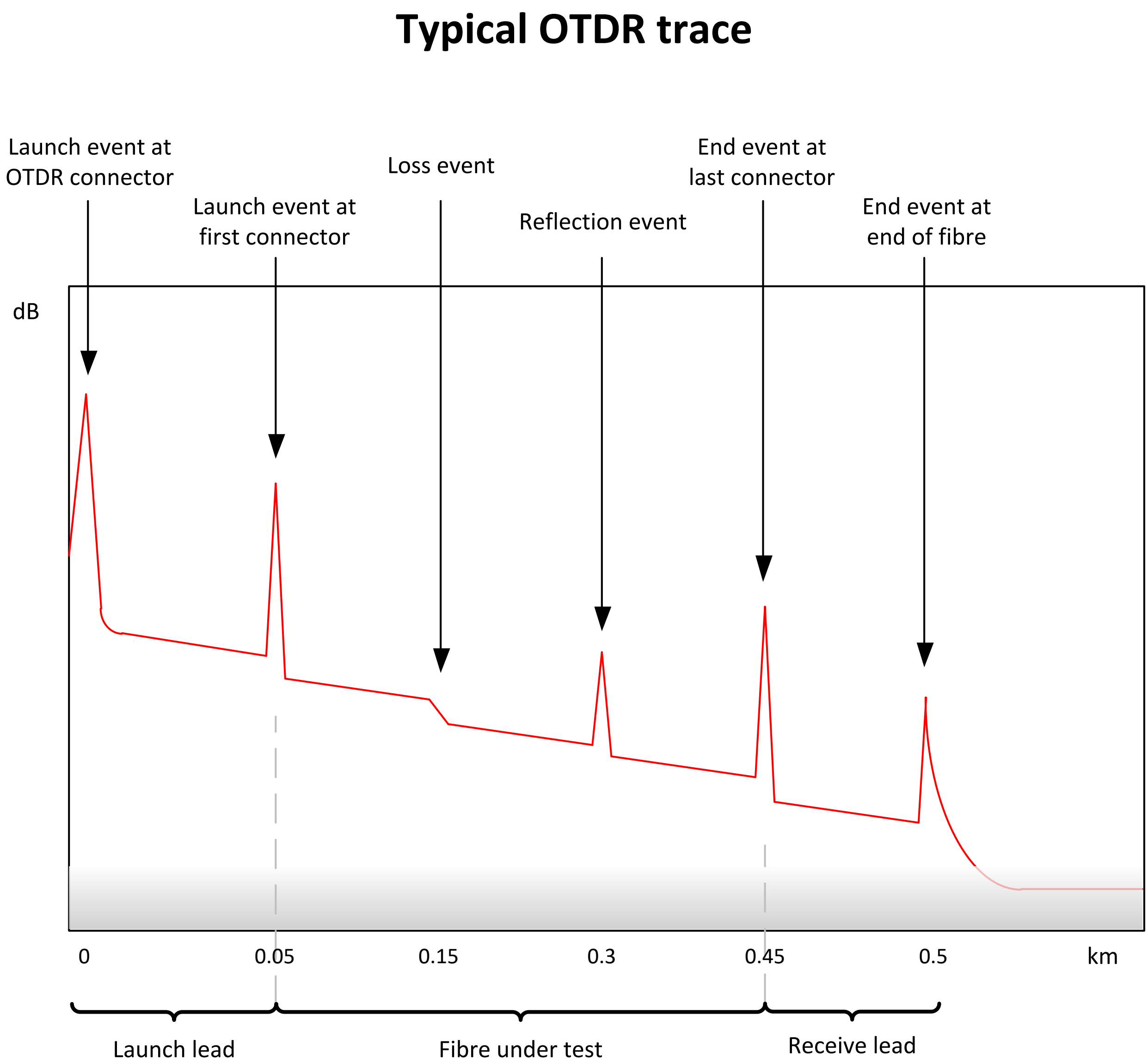
6.8.6 All fibre-optic data communication cables must be single mode.

6.8.7 All fibre-optic cables supplied must comply with the relevant parts of SANS 60793/ IEC 60793 and SANS 60794/ IEC 60794 in terms of construction, installation and testing.

6.8.8 All the fibres and splices must be tested by an experienced fibre-optic network specialist and the results saved for analysis. The following tests have to be completed and test certificates have to be produced:

6.8.8.1 OTDR (optical time domain reflectometer) tests for all fibres at both 1310nm and 1550nm wavelengths, in both directions, must be completed when the cable is delivered to the site and again after the installation has been completed.

6.8.8.2 When performing OTDR tests, adequate launch and receiving leads must be used so that the splicing on both ends of the cable is clearly visible on the OTDR trace. The pulse width must be set to the minimum possible width for the distance under test and the time duration of the test must not be less than sixty (60) seconds. The scale of the trace should be set to 1.5x to 2x the length of the cable under test. The measured loss of each event must be captured in MS Excel and the original OTDR results must be saved in its native format. The results must be supplied to the engineer for approval. A typical OTDR trace is shown below.

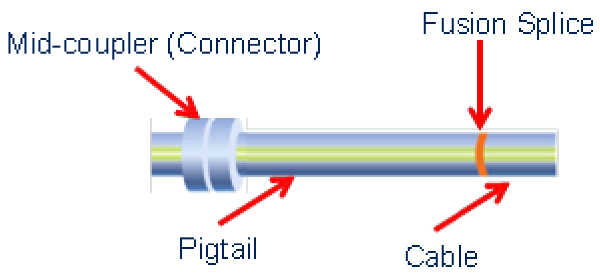


6.8.8.3 OLTS (optical loss test set) analysis with a power source and power meter must be done for all fibres after the installation has been completed. These tests must be done in both directions and the results have to be captured in MS Excel. A typical test report for one fibre is shown below. (P/Loss = Power Loss; ORL = Optical Reflection Loss).

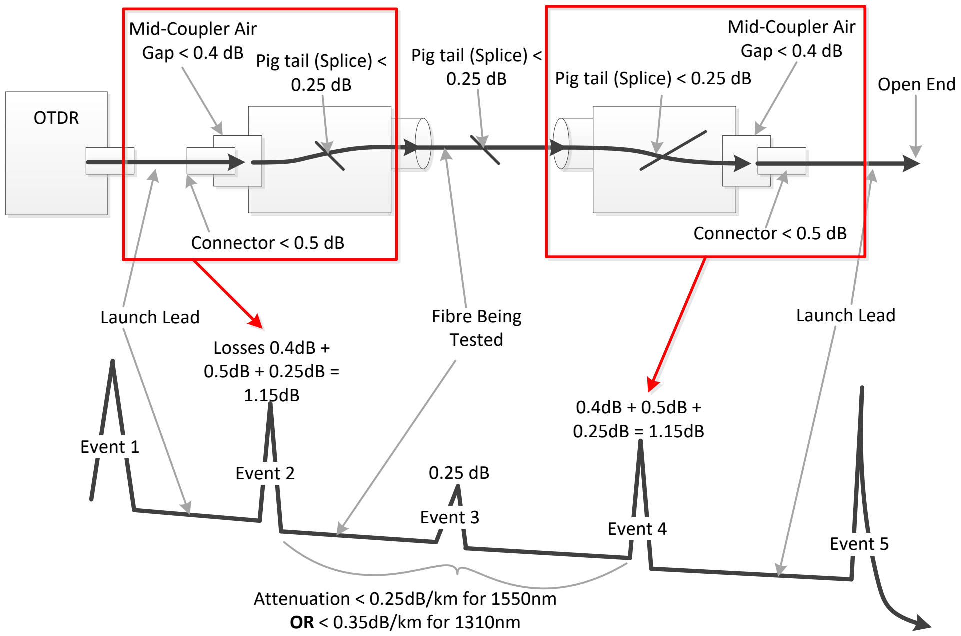
Fibre ID	**Wavelength**	**P/Loss**	**P/Loss**	**Average**	**ORL A**	**ORL B**	**Length**
		A->B	**B->A**				
	(nm)	(dB)	(dB)	(dB)	(dB)	(dB)	(km)

6.8.9 Losses in any fibre-optic core measured end-to-end at wavelengths of 1310nm and 1550nm, must not exceed **0.25dB per fusion splice**. The attenuation over the length of the fibre must not exceed 0.35dB/km at 1310nm and 0.25dB/km at 1550nm.

6.8.10 Losses over any connection (i.e. including mid-couplers) must not exceed 0.5dB.



6.8.11 The figure above shows a typical patch box situation (see item 6.8.2) where a pigtail is spliced onto the cable at one end and onto a connector (the mid-coupler) at the other end. These two events are too close together to be identified as separate events by an OTDR test. The overall maximum acceptable loss (at 1310 nm or 1550nm) for this combination will thus be **0.5 (connection) + 0.25 (fusion splice) = 0.75 dB**. This requirement is illustrated in the sketch below.



6.8.12 SFP's should be used so that the length of a fibre measured from one end to the other is greater than 5% of the rated maximum distance specified by the manufacturer of the SFP.

6.9 Copper Data Cables

6.9.1 All copper data cable shall be a high performance, 4-pair, Category 6, 23 AWG, unshielded, twisted pair (U/UTP) with solid copper conductors, polyolefin insulated PVC or low-flammability sheath and colour-coded pairs.

6.9.2 All copper data cable shall be tested after installation using an instrument with the capability of certifying the cable as Category 6 as specified in the TIA/EIA 568-B.2-10 industry standard.

6.10 Data Cabling General

6.10.1 All data cabling systems must be designed and installed in accordance with ISO/IEC SANS 11801:2002.

6.10.2 The cables must comply with EN 50288-5/6.

6.10.3 In terms of flammability, the cables or blown fibre microduct assemblies inside buildings (whether on racks, in ceilings, under floor panels, etc.) must comply with IEC 60332-1.

6.11 Cable Theft Prevention Measures

6.11.1 Cable theft prevention methods must be discussed with each site manager and implemented to suit the unique requirements in each area on each site.

6.11.2 Trenches in high risk areas (as defined by the relevant site manager) will have a 100mm thick layer of 20/20 concrete (i.e. 20MPA strength and 20mm aggregate size) supplied in the place of the concrete tiles.

6.11.3 Where inverted culverts with cable racking inside the culverts and concrete covers over the culverts are used the concrete covers must be constructed of reinforced concrete. The slabs must be sized to suit the width of the culvert. Each slab must weigh at least 100kg and must be provided with only two lifting holes.

6.11.4 Where cables are laid in trenches, the contractor must ensure that cable de-rating factors are strictly applied in accordance with SANS 10142-1:2003 to prevent cables from overheating. This clause is especially important to adhere to when existing inverted culverts with existing installed cables are to be filled with soil.

6.11.5 No bare copper conductors are to be used for earth conductors, earth strapping, earth bonding, etc. If possible a 5-core cable should be used to allow the 5th core to be used as an earth conductor. If this is not a viable option, a 2-core PVC, SWA cable must be installed as an earth cable.

6.11.6 For short runs of earth cable (such as bonding of earth bars or earthing conductors of buildings), other cable (i.e. not copper), approved by the Engineer, must be used.

6.11.7 For high risk areas where cable racking is used, such cable racks must be covered with solid covers of the same material and complying with the same paint specification as the racking itself. Such covers must be bolted onto the rack in such a way that either special tools or a disk grinder would be required to remove these covers.

6.11.8 If any additional cable theft prevention methods are required, such requirements will be made clear to the contractor at the time of tender.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 7 : NETWORKING

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Revision 15 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 7 : Networking**

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Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	L. G
Approved	Manager	T. Thabeng	09/09/2019	

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2019-08-26	15	C. Du Toit	Cover page updated
2019-06-25	14	C. Du Toit	Revision approved by JW.
2018-11-30	13	C. Du Toit	Added reference to Labelling specification.
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2013-10-07	11	C. Du Toit	Updated footer.
2012-07-27	10	C. Du Toit	Updated headers & footers.
2012-03-08	9	C. Du Toit	Changed (Pty) to (SOC), updated core switch port requirements, core switch power supply requirements,
2011-07-11	8	C. Du Toit	Removed 2010 logo.
2010-07-27	7	C. Du Toit	Area and core switch requirements clarified, data irrelevant to tenderers deleted and data sheets
2010-03-12	6	C. Du Toit	Fibre core switch requirements updated to specify Gigabit uplinks and to include a data sheet.

2009-08-18	5	C. Du Toit	New logos added.
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2009-02-24	3	C. Du Toit	Switch requirements from specialist added plus "Joburg" & "JW" Logos added to top & partnership
2007-06-05	2	C. Du Toit	Revision block updated and "Joburg" logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

INDEX

7 NETWORKING

7.1 Scope

7.1.1 This specification covers the supply and installation of equipment, the network topologies, the communication methods and the security for data communication systems, typically between Programmable Logic Controllers and Supervisory systems, used in process monitoring and control applications at Johannesburg Water wastewater sites.

7.2 Abbreviations

7.2.1 In this specification the following abbreviations will apply :-

CD	:	Compact Disk
CLI	:	Command Line Interface
DiffServ	:	Differentiated Services
EMC	:	Electro-Magnetic Compatibility
GARP	:	Generic Attribute Registration Protocol
GMRP	:	GARP Multicast Registration Protocol
GUI	:	Graphical User Interface
GVRP	:	GARP VLAN Registration Protocol
HTTPS	:	Hyper Text Transfer Protocol Secure switches
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical and Electronic Engineers
IGMP	:	Internet Group Management Protocol
LACP	:	Link Aggregation Control Protocol
LAN	:	Local Area Network
LED	:	Light Emitting Diode
MAC	:	Media Access Control
Mbit	:	Mega bits
Mbps	:	Mega bits per second
MDI/MDI-X	:	Medium Dependent Interface/ Medium Dependent Interface (crossed)
OS	:	Operating system
PC	:	Personal Computer
PLC	:	Programmable Logic Controller
QoS	:	Quality Of Service
RD	:	Read
RSTP	:	Rapid Spanning Tree Protocol
SANS	:	South African National Standards
SCADA	:	Supervisory Control And Data Acquisition

SNMP	:	Simple Network Management Protocol
SSH	:	Secure Shell
SSL	:	Secure Sockets Layer
TCP/IP	:	Transmission Collision Protocol/Internet Protocol
TOS	:	Type Of Service
TX	:	Transmit
USB	:	Universal Serial Bus
VLAN	:	Virtual Local Area Network

7.3 Standards

7.3.1 All design standards shall be subject to the latest amendments and editions of the following standard specifications:-

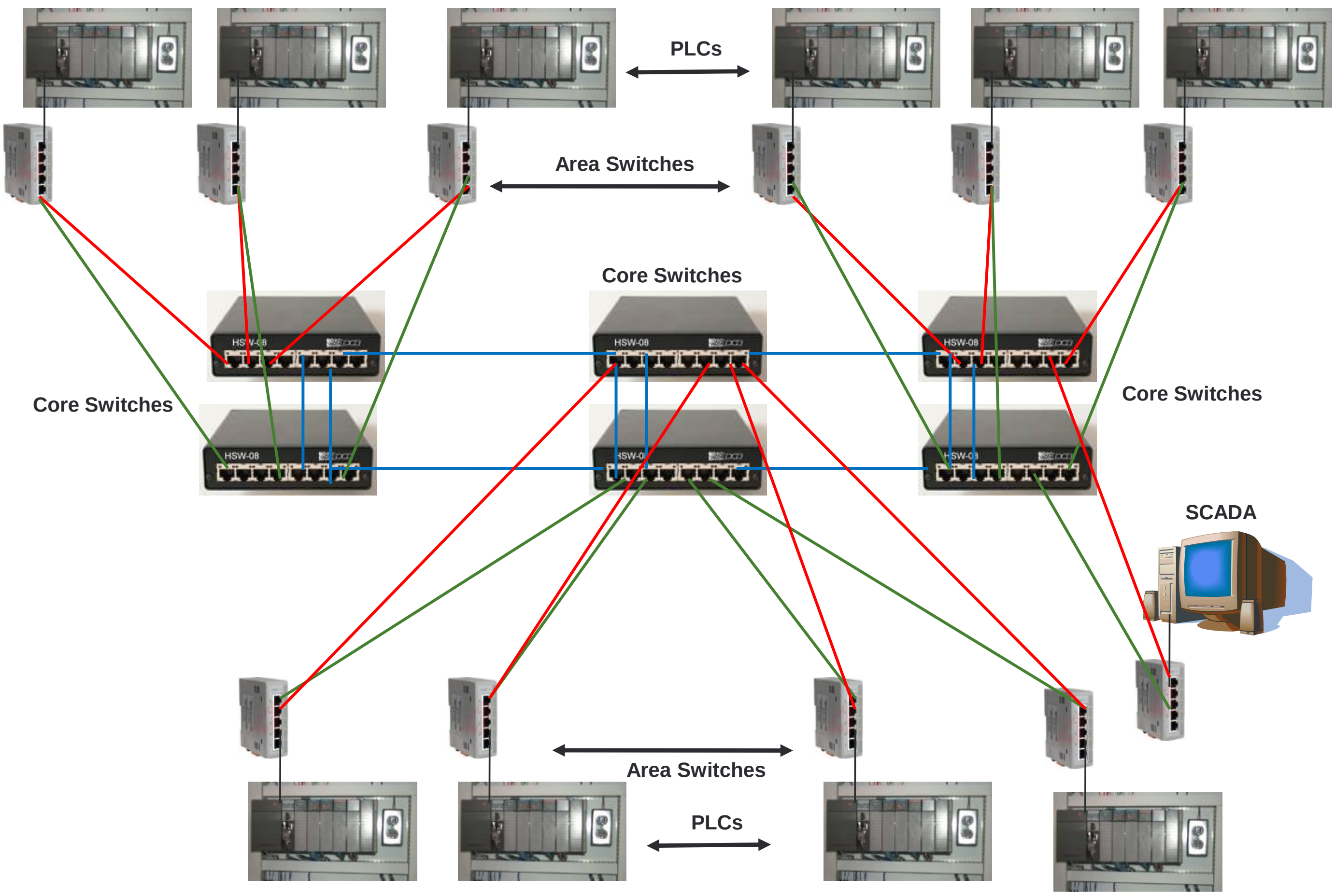
SANS 10142-1	:	National Standards for the wiring of premises
IEEE 802.3-2005	:	Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method and physical layer specifications
IEEE 802.3ad (Now IEEE 802.1AX)	:	Link Aggregation
IEEE 802.1d	:	MAC Bridges
IEEE 802.1p	:	Quality of service
IEEE 802.1Q	:	VLAN Tagging
IEEE 802.1w	:	Rapid Spanning Tree Protocol
IEEE 802.1X	:	Port Based Network Access Control
IEC 60068-2-6	:	Environmental Testing - Vibration
IEC 60068-2-27	:	Environmental Testing – Test Ea and guidance: Shock
SANS 61000-4/IEC 61000-4	:	Electromagnetic compatibility – testing and measurement techniques

7.4 Communication Protocol

7.4.1 The preferred method of communication between PLC's or between PLC's and SCADA systems is Ethernet TCP/IP.

7.4.2 Systems must be designed and equipment selected with the view of communicating via TCP/IP over Ethernet.

7.5 Network Topology



7.5.1 The preferred topology is an Ethernet star/mesh topology as indicated in the diagram above.

7.5.2 Where existing installations make the use of a star/mesh topology impractical, contractors must link into the existing system in such a way that future conversion to a star/mesh topology will not be hampered by the current installation.

7.5.3 All systems must be designed and equipment selected with the view of converting to a star/mesh topology when possible.

7.5.4 Network redundancy must be such that if one core switch fails, there must be a second one that can maintain communication (as shown in the diagram above).

7.5.5 Data communication between core switches and from core switches to the area switch patch panels must be done via 9/125µm, single mode, PVC, CST (Corrugated Steel Tape) cable or single mode blown fibre microduct assemblies (see the Cabling Specification (Volume 6 of the Automation And Control Standards)). The number of cores must be as specified in the project scope of work and the tender bill of quantities.

7.5.6 Each core switch pair (i.e. the two core switches which form a dual redundant system at a particular location) must be equipped with two UPSs (Uninterruptable Power Supplies) as specified in the “Automation And Control Design Standards, Volume 5, Clean Power And Surge Protection”. The two power supplies must be connected to both switches (i.e. each UPS supplies both core switches) to provide redundancy. These supplies must also be equipped with proper surge protection as detailed in the same specification - “Automation And Control Design Standards, Volume 5, Clean Power And Surge Protection”.

7.6 Switches

7.6.1 Minimum Requirements For Area Switches

7.6.1.1 Only industrial type switches will be accepted. No standard “commercial” or “Office” switches will be accepted. These switches must have at least an IP 20 rating, must have a rugged high-strength metal case and must have DIN-rail or panel mounting ability. They must have an operating temperature of at least 0 to 55ºC, without the use of cooling fans and must be able to work in relative humidity up to 95% without condensation.

7.6.1.2 Redundancy and fault recovery:

- Must comply with IEEE 802.1w for Rapid Spanning Tree Protocol

7.6.1.3 Remote management and monitoring:

- Must support SNMP V1/V2/V3 for different levels of network management security

7.6.1.4 Area switches must have at least two SFP uplink ports which are 1000Base-LX Gigabit Ethernet standard compatible. These ports must be compatible with Duplex LC-type connectors for single-mode fibre.

7.6.1.5 Area switches must have the number of copper ports as specified in the project scope of work and the tender bill of quantities. The copper ports must be 10BASE-T/100BASE-TX compatible in order to communicate with the PLCs. These ports must be capable of accepting RJ45 connectors on CAT-6 cable.

7.6.1.6 In terms of configuration, maintenance, management and monitoring features required, all area switches must:

- Have support for loading or saving configurations to a remote host
- Have port monitoring for debugging
- Have line-swap fast recovery to normal operation (within milliseconds) after devices are unplugged and then re-plugged into different ports
- Be configurable by Operating System (OS) independent web browser, using secure HTTPS

7.6.2 Minimum Requirements For Core Switches

7.6.2.1 Only industrial type switches will be accepted. No standard “commercial” or “Office” switches will be accepted. These switches must have redundant, dual DC power units, must have at least an IP 30 rating, must have a rugged high-strength metal case and must be 19” rack-mounted switches. They must have an operating temperature of at least 0 to 55ºC, without the use of cooling fans and must be able to work in relative humidity up to 95% without condensation.

7.6.2.2 Redundancy and fault recovery:

- Must comply with IEEE 802.1w for Rapid Spanning Tree Protocol
- Must comply with IEEE 802.3ad (now 802.1AX) for link aggregation or port trunking and must have at least 4 trunks.

7.6.2.3 Broadcast isolation and network segmentation:

- Must comply with IEEE 802.1Q in terms of support for VLAN Registration Protocol (GVRP) to ease network planning

7.6.2.4 Quality of service:

- Must comply with IEEE 802.1p/1Q in terms of support for TOS/DiffServ in order to increase determinism

7.6.2.5 Multicasting:

- Must have IGMP Snooping and GMRP for filtering multicast traffic from industrial Ethernet protocols

7.6.2.6 Security and authentication:

- Must comply with IEEE 802.1X in terms of support for SSL to enhance network security

7.6.2.7 Remote management and monitoring:

- Must support SNMP V1/V2/V3 for different levels of network management security

7.6.2.8 Core switches must be managed, Layer 3 switches with the number of ports as specified in the project scope of work and the tender bill of quantities.

7.6.2.9 Core switches must provide support for a minimum of four trunked Gigabit SFP ports with 1000Base-LC, LC connectors.

7.6.2.10 Core switches must provide support for a minimum of eight SFP ports that will support a combination of Fast Ethernet ports (10/100Base-TX,) and Gigabit Ethernet ports (1000Base-T, 1000Base-LX).

7.6.2.11 In terms of configuration, maintenance, management and monitoring features required, all core switches must:

- Have support for loading or saving configurations to a remote host
- Have port monitoring for debugging
- Have line-swap fast recovery to normal operation (within milliseconds) after devices are unplugged and then re-plugged into different ports
- Be configurable by Operating System (OS) independent web browser, using secure HTTPS
- Be configurable by CLI by Local Serial console and remote SSH network connection
- Support ping commands to identify network segment integrity

7.7 Compliance With Standards

7.7.1 It is important that all equipment is selected and installations are done to industrial standards. These are usually harsh environments in terms of dirt, industrial activities such as welding, grinding, etc. and electrical interference such as lightning, capacitor switching, large drives starting and stopping, etc.

7.7.2 The complete installation and networking system must comply with IEEE 802.3-2005.

7.7.3 The equipment installed must comply with SANS 61000-4/IEC 61000-4 for EMC.

7.7.4 The equipment installed must comply with IEC 60068-2-6 for vibration (10 to 57 Hz – amplitude 0.15mm, 57 to 150 Hz – acceleration 2g).

7.7.5 The equipment installed must comply with IEC 60068-2-27 for shock (12 shocks semi-sinusoidal, 15g, 11ms).

7.7.6 All installations must comply with the requirements of SANS 10142-1.

7.8 Network Switch Data Sheets

7.8.1 For network switches supplied, the tenderer must supply the data sheets shown in Appendix A with his tender.

7.8.2 All installations must comply with the requirements of SANS 10142-1.

7.9 Redundancy Testing

7.9.1 All the core network switches and area switches that have been installed in a redundant configuration must to be tested by a network specialist and the results documented. The contractor must make the following equipment available to complete these tests:

- Two portable area switches as specified in 7.6.1
- Two portable computers, running from a CD ROM-booted operating system (e.g. Linux LiveCD)

7.9.2 The following ping test procedures must be followed using ICMP (Internet Control Message Protocol).

- Continuous ping messages will be sent form a portable test computer located at the core switch to a remote portable test computer that will be moved around all the network points (i.e. the area switches) to confirm the data throughput, latency (ping time) and network failover time.
- Confirm that the round-trip ping times with a packet size of 10kb does not exceed 2 milliseconds.
- Confirm that the continuous ping messages recovers within 3 seconds after either one of the redundant core switches has been powered down or powered up and after either one of the fly leads to the area switch has been disconnected form a core switch.
- Capture the result as indicated in the following example:

Port No	PING Time	SW0-A Switch Down	SW0-B Switch Down	SW0-A Link Down	SW0-B Link Down	Comments
1	<1ms	✓	✓	✓	✓	Location L2

7.10 Labelling

7.10.1 All labelling must comply with the requirements as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

APPENDIX 1

DATA SHEET - FIBRE "CORE" GIGABIT ETHERNET SWITCHES

DESCRIPTION	DATA
Manufacturer	
Model or Type	
Part or Order Number	
19" Rack-mount switch?	☐ Yes ☐ No
Comply with IEEE 802.1w for Rapid Spanning Tree Protocol?	☐ Yes ☐ No
Comply with IEEE 802.3ad (now 802.1AX) for link aggregation or port trunking?	☐ Yes ☐ No
Switch has at least 4 trunks?	☐ Yes ☐ No
Comply with IEEE 802.1Q i.t.o. support for VLAN Registration Protocol (GVRP)?	☐ Yes ☐ No
Comply with IEEE 802.1p/1Q i.t.o. support for TOS/DiffServ?	☐ Yes ☐ No
Comply with IEEE 802.1X i.t.o. support for SSL?	☐ Yes ☐ No
Support SNMP V1/V2/V3 for different levels of network management security?	☐ Yes ☐ No
Is it a managed, Layer 3 switch?	☐ Yes ☐ No
At least 8 SFP ports that will support a combination of Fast Ethernet ports (10/100Base-TX) and Gigabit Ethernet ports (1000Base-T, 1000Base-LX)?	☐ Yes ☐ No
Support for loading or saving configuration to a remote host?	☐ Yes ☐ No
Port monitoring for debugging?	☐ Yes ☐ No
Has line-swap fast recovery to normal operation (within milliseconds) after swapping devices?	☐ Yes ☐ No
Configurable by Operating System (OS) independent web browser, using secure HTTPS?	☐ Yes ☐ No
Configurable by CLI by Local Serial console and remote SSH?	☐ Yes ☐ No
Support ping commands to identify network segment integrity?	☐ Yes ☐ No

Local Agent?	☐ Yes ☐ No
Local agent contact details	
Guarantee period	

DATA SHEET – "AREA" ETHERNET SWITCHES

DESCRIPTION	DATA
Manufacturer	
Model or Type	
Part or Order Number	
Comply with IEEE 802.1w for Rapid Spanning Tree Protocol?	☐ Yes ☐ No
SFP Uplink ports which are 1000BASE-LX Gigabit Ethernet standard compatible?	☐ Yes ☐ No
Uplink ports compatible with Duplex LC-type connectors for single-mode fibre?	☐ Yes ☐ No
Support for loading or saving configuration to a remote host?	☐ Yes ☐ No
Port monitoring for debugging?	☐ Yes ☐ No
Has line-swap fast recovery to normal operation (within milliseconds) after swapping devices?	☐ Yes ☐ No
Configurable by Operating System (OS) independent web browser, using secure HTTPS?	☐ Yes ☐ No
Local Agent?	☐ Yes ☐ No
Local agent contact details	
Guarantee period	

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 8 : FLOW MEASUREMENT

Johannesburg Water

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Revision 18 August 2019

DOCUMENT CONTROL SHEET

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Prepared	HOD	C. Du Toit	2019-08-26	
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Approved	Manager	T. Thabeng	09/09/2019	

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2019-08-26	18	C. Du Toit	Cover page updated
2019-06-15	17	C. Du Toit	Added electronic calibration data storage requirement.
2018-11-30	16	C. Du Toit	Changed from annubar to thermal dispersion gas flow measurement.
2018-11-30	15	C. Du Toit	Added reference to Labelling specification and made allowance for new area/velocity flow measurement.
2014-04-17	14	C. Du Toit	Added reference to FJB specification.
2013-10-07	13	C. Du Toit	Updated footer, updated mag flow meter requirements & added area-velocity flow meters
2012-07-27	12	C. Du Toit	Updated headers & footers.
2012-03-08	11	C. Du Toit	Corrected accuracy requirements for electromagnetic flow meters.
2012-03-08	10	C. Du Toit	Altered gas flow to use orifice plate or pitot tube and changed (Pty) to (SOC).
2011-07-11	9	C. Du Toit	Removed 2010 logo.
2010-07-27	8	C. Du Toit	Gas flow meter ambient temperature range altered and data about classification of IS designs and installations

2009-08-18	7	C. Du Toit	New logos and transmitter position requirements added and mag flow pulse output requirements altered.
2009-05-08	6	C. Du Toit	Added requirements from client meeting on 04 May 2009.
2009-03-25	5	C. Du Toit	JW Wastewater Partnership deleted, logos altered as per client's requirements and data sheets for magnetic
2007-11-07	4	C. Du Toit	Flow meters for distributing/flow diversion added.
2007-09-10	3	C. Du Toit	Gas flow measurement added and "Minimum" 500 ohm load changed to "Maximum".
2007-06-05	2	C. Du Toit	Revision block updated and "Joburg" logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

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8 FLOW MEASUREMENT

8.1 Scope

8.1.1 This specification covers the supply and installation of Flow meters, complete with sensors, transmitters, indicators, panels, etc. used for process monitoring and control applications at Johannesburg Water wastewater sites.

8.2 Abbreviations

8.2.1 In this specification the following abbreviations will apply :-

BS	:	British Standards
PLC	:	Programmable Logic Controller
I/O	:	Input/Output
CPU	:	Central Processing Unit
UPS	:	Uninterruptible Power Supply
MCC	:	Motor Control Centre
MCB	:	Miniature Circuit Breaker
SPD	:	Surge Protection Device
FJB	:	Field Junction Box
SSO	:	Switched Socket Outlet
SPDT	:	Single Pole Double Throw (refers to relay or switch contact arrangements).
LCD	:	Liquid Crystal Display
LED	:	Light Emitting Diode
PTFE	:	Polytetrafluoroethylene
O&M	:	Operating And Maintenance

NPT	:	National Pipe Thread
DP	:	Differential Pressure
LP	:	Low Pressure
HP	:	High Pressure
RH	:	Relative Humidity
IS	:	Intrinsically Safe

8.3 Standards

8.3.1 The supply and installation of all Flow meters and associated cabling, panels and any other equipment shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	:	National Standards for the wiring of premises.
SANS 1091:2004	:	National Colour Standard.
SANS 1274-2005	:	Coatings applied by the powder-coating process.
BS 381C:1980	:	Paint colour chart.
BS 3680	:	Measurement of liquid flow in open channels.
SANS10108:2005	:	The classification of hazardous locations and the selection of apparatus for use in such locations.
SANS60079-10:2005	:	Electrical apparatus for explosive gas atmospheres. Part 10: Classification of hazardous areas.
SANS60079-11:2005	:	Electrical apparatus for explosive gas atmospheres. Part 10: Intrinsic safety “i”.
SANS10086-1	:	The installation, inspection and maintenance of equipment used in explosive atmospheres Part 1: Installations including surface installations on mines

8.4 General Requirements

8.4.1 This specification must be read in conjunction with the following specifications:-

8.4.1.1 PLC Panels Specification (Volume 3 of the Automation And Control Standards).

8.4.1.2 Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

8.4.1.3 Cabling Specification (Volume 6 of the Automation And Control Standards).

8.4.1.4 Field Junction Boxes And Panels (Volume 19 of the Automation And Control Standards).

8.4.1.5 Labelling (Volume 25 of the Automation And Control Standards).

8.4.2 Where cables are exposed to physical damage (including damage from rodents) armoured cables must be used or un-armoured cables must be run in steel conduit.

8.4.3 All power supply cables to instruments must have a black outer sheath, while all control cables (such as digital and analogue signals to PLC's) must have an orange outer sheath as specified in the Cabling Specification (Volume 6 of the Automation And Control Standards).

8.4.4 FJB's and as far as practically possible all instrument sensors and transmitters, must be mounted such that all equipment, wiring, numbers, terminations, etc. are readily accessible and can be viewed clearly. No equipment may be mounted such that it becomes a hazard or dangerous to view or gain access to such equipment.

8.4.5 Where sensors and/or transmitters cannot be mounted where they are readily accessible, the installation must be done in such a way that the sensor or transmitter can easily be moved to a safe and convenient position for testing, maintenance, replacement, etc. (e.g. by using hinged brackets, telescopic brackets, etc.).

8.4.6 Where transmitters can be exposed to the elements (wind, rain, ultra violet, etc.) such transmitters must be installed inside the FJB. LCD displays must always be protected from direct sunlight, either by facing them away from the sun or by installing it inside the FJB, in the shade of the FJB canopy. Where transmitters are protected from the elements (i.e. inside buildings) but they are exposed to potentially harmful conditions like moisture from splashing or equipment being hosed down, or the sensor is in such a position that the transmitter display is not clearly visible from floor level, without the need to climb onto ladders or structures to access it, the transmitter must also be installed inside the FJB. Only where transmitters are not exposed to the elements or any other harsh or potentially harmful conditions and where the displays on such transmitters are clearly legible by an average person standing on the ground or the normal walking surface (e.g. grating above ground level), can the transmitter be mounted outside the FJB.

8.4.7 FJB's must be mounted against a wall or structure or on a sturdy pedestal such that the top of the FJB enclosure is no higher than 1.8 m from the floor and easily accessible from the front.

8.4.8 All instrument installations must be done in accordance with the manufacturer's requirements and recommendations for proper operation. It is the tenderer's responsibility to ensure that he/she is familiar with both the requirements of the manufacturer as well as the installation requirements, in terms of location, site conditions, materials, equipment or substances to be measured (e.g. hot liquids, acids, abrasive material, etc.) and to ensure that if there are potential problems, they can be pointed out and rectified before orders for equipment are placed.

8.4.9 Costs incurred for alterations required to ensure proper operation of instruments, after orders have been placed, will be for the tenderer's account. For example, if instruments have been ordered and it is found there is insufficient space to install the instrument, or the instrument is not flooded with liquid all the time as it is required for proper operation, or the instrument transmitter is sometimes flooded in its installed position, or the sensing head is sometimes outside the medium it is supposed to measure, or the instrument linings are damaged by abrasive liquids, or the sensor is does not have a suitable range of measurement, etc. alterations or replacements required to rectify such problems will be for the tenderer's account if the Engineer finds that the tenderer was negligent in his/her assessment of the installation.

8.4.10 Each instrument must be equipped with a circuit breaker connected to the power supply of the instrument, to enable local isolation in case of repairs or replacement.

8.4.11 The supplier of the instrument must be present for the installation, testing and commissioning of the instrument on site. Due allowance must be made for this in the tender sum.

8.4.12 The tenderer must supply a complete and detailed set of documentation for the installation, connections, terminations, power supply, technical details, setting up, calibration (if applicable), testing, etc. of the instrument for inclusion in a final O&M manual.

8.4.13 If a flow meter (for any application) is offered, which has the facility to store calibration and set-up data electronically, so that it can be downloaded when an instrument is replaced, the contractor must include the supply of all the necessary equipment (special cables, memory cards, etc.) to enable the use of this facility.

8.4.14 Completed data sheets are required as part of the returnable documents of each tender. Failure to complete these data sheets, supplied at the end of this specification, will lead to disqualification of the tender.

8.5 Surge Protection

8.5.1 Each instrument and its associated equipment must be suitably protected against surges from induced voltages, switching of equipment, lightning strikes, etc. as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

8.5.2 The power supply to the instrument must be equipped with suitable surge protection, both at the instrument and at the source of the power supply (i.e. at the distribution board, MCC, PLC panel, etc.), as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

8.5.3 Both the digital and analogue signals between the instrument and other remote devices (such as the PLC), must be equipped with suitable surge protection, both at the instrument and at the remote device as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

8.6 Open Channel Flow Measurement – Controller/Transmitter

8.6.1 Flow calculations for all open channel flow measurement must be done in accordance with BS 3680.

8.6.2 All flow measurements in open channels must be done by using ultra-sonic distance measurement, which is converted into a flow value at weirs or venturi flumes. Where there are no weirs or venturi flumes, area/velocity flow meters must be used (see requirements later in this specification).

8.6.3 All instrument transmitter enclosures must have at least an IP 65 or higher rating.

8.6.4 The instrument must be equipped with an isolated, active, 4 – 20mA output which will be connected to a maximum 500 ohm load. This output must be user-programmable.

8.6.5 The instrument must be equipped with at least one SPDT relay, rated for at least 230V AC, 500mA, for totalised flow pulses. This output must be user-programmable for the units-per-pulse.

8.6.6 The transmitter must be suitable for use with a 230V AC, 50/60 Hz power supply.

8.6.7 The transmitter must have an accuracy of at least 0.25% or 6mm, whichever is greater.

8.6.8 The transmitter must have a resolution of at least 0.1% or 2mm, whichever is greater.

8.6.9 The transmitter must have an LCD or LED display showing instantaneous flow and totalised flow.

8.7 Open Channel Flow Measurement – Sensor/Transducer

8.7.1 The range of the sensor must be suitable for the application (see items 8.4.8 and 8.4.9 of this specification).

8.7.2 The sensor must be suitable for an operating temperature range of -10ºC to +50ºC.

8.7.3 The sensor must be equipped with automatic temperature compensation.

8.7.4 The sensor must have a protection rating of at least IP 67 or higher.

8.7.5 Brackets used for the mounting of ultra-sonic sensor heads and velocity sensor heads (if external velocity sensors are used) must be made of at least 3CR12 grade stainless steel.

8.8 Full Pipeline Flow Measurement – Controller/Transmitter

8.8.1 All flow measurements in full pipelines must be done by using electro-magnetic flow (mag-flow) measurement, which is converted into a flow value where accuracy of measurement is required for dosing and/or custody transfer of flow. Where measurement for flow distribution or flow diversion is required or for pump protection (i.e. where high accuracy is not essential), non-intrusive flow measurement using external sensors can be applied. These systems must incorporate either ultrasonic time of flight or Doppler principles. Ultrasonic time of flight systems can be used on clean water with low contents of air bubbles or other entrained gasses and suspended solids of less than 10,000 milligrams/litre. Doppler systems can be used on liquids with entrained particles or gasses of 100 microns or larger and suspended solids in excess of 75 milligrams/litre.

8.8.2 All instrument transmitter enclosures must have at least an IP 65 or higher rating.

8.8.3 The instrument must be equipped with an isolated, active, 4 – 20mA output which will be connected to a maximum 500 ohm load. This output must be user-programmable.

8.8.4 The instrument must be equipped with at least one SPDT relay, or an output that can be used to drive a relay, for totalised flow pulses. This output must be user-programmable for the units-per-pulse.

8.8.5 The transmitter must be suitable for use with a 230V AC, 50/60 Hz power supply.

8.8.6 The transmitter for electro-magnetic flow meters must have an accuracy of at least 0.5%, or better, of the measured value for flow velocities which are greater than 0.5 meters/second. Transmitters of flow meters for flow distribution/diversion can have an accuracy of less than 0.5% but they must not be less accurate than ±2% of the full scale for Doppler meters and not less than ±2% of the measured value for time of flight meters. For both Doppler and time of flight meters these accuracy requirements apply to flow velocities of 0.5 meters/second or greater. Repeatability must not be less than 1% of the measured value.

8.8.7 The transmitter must have an LCD or LED display showing instantaneous flow and totalised flow.

8.9 Full Pipeline Flow Measurement – Sensor/Transducer

8.9.1 The range of the sensor must be suitable for the application (see items 8.4.8 and 8.4.9 of this specification).

8.9.2 The sensor lining for electro-magnetic flow meters used in sludge or non-corrosive liquids must be Neoprene or Rubber, suitable for operating in temperatures ranging from -10ºC to +80ºC.

8.9.3 The sensor lining for electro-magnetic flow meters used in corrosive or heated liquids must be PTFE, suitable for operating in temperatures ranging from -20ºC to +150ºC.

8.9.4 The sensor must have a protection rating of at least IP 68 or higher.

8.9.5 The sensor tube material for electro-magnetic flow meters must be at least 304, 316 or 3CR12 grade stainless steel.

8.9.6 The sensor electrode material for electromagnetic flow meters must be at least 304, 316 or Hastelloy C grade stainless steel.

8.9.7 The sensor for electromagnetic flow meters must have either a grounding electrode or earth rings fitted.

8.9.8 Where process flow in the pipeline cannot be stopped or isolated by any other means, isolation hand valves must be fitted on either side of electro-magnetic flow meters for removal/replacement of the flow meter.

8.9.9 The sensor material for flow meters used for flow distribution/diversion must be stainless steel.

8.9.10 Magnetic flow meters must be equipped with an “Empty Pipe” detection which is configurable to stop the 4-20mA flow indication and/or operate a potential free contact, or an output that can be used to drive a relay, for PLC interfacing.

8.9.11 Electro-magnetic flow meters must not be a wafer-type. I.e. the sensor tube or wafer must be housed in a flanged stainless steel spool piece which can readily be bolted onto flanges in the pipe where it must be installed.

8.10 Partially Filled Pipeline Or Channel Flow Measurement – Controller/Transmitter

8.10.1 Where electro-magnetic flow meters (e.g. for full pipes) or conventional ultrasonic flow meters (e.g. at weirs or venturi flumes) cannot be used, such as in partially filled pipes or open channels without a weir or venturi, area-velocity flow meters must be used. A liquid velocity measurement as well as a liquid depth measurement, together with the dimension of the pipe or channel which is programmed into the controller/transmitter, must then be used to produce a proportional flow measurement.

8.10.2 The flow measurement must be done by using ultrasonic, microwave or radar signals to measure both velocity and depth of liquid.

8.10.3 The controller/transmitter must have at least an IP66 rating or higher.

8.10.4 The controller/transmitter must have a backlit LCD display to display flow rate and total flow.

8.10.5 The error of the level measurement must not be more than 0.25% of the range and the error of the velocity must not exceed 2% of the velocity reading.

8.10.6 The repeatability and linearity must be 0.1% or better.

8.10.7 The unit must be suitable for use with a 230V AC supply.

8.10.8 The unit must have 3 x 4-20mA outputs, one for flow, one for level and one for velocity.

8.10.9 The unit must have at least 2 x SPDT relays, rated at no less than 2A at 230V AC. One of the relays must be programmable for flow pulses and the other must be programmable for flow and/or level alarm.

8.10.10 The unit must have at least 3 x 4-20mA outputs, one for velocity, one for level/depth and one for flow. These outputs will be connected to a maximum 500 ohm load.

8.10.11 The unit must suitable for operating in temperatures ranging from minus 15ºC to +60ºC.

8.11 Partially Filled Pipeline Flow Measurement – Sensors/Transducers For Velocity Measurement

8.11.1 If the velocity sensor is installed below the water, the velocity sensor must be shaped and installed in such a manner that the cabling to it is protected from any debris that might flow in that pipe or channel.

8.11.2 The velocity sensor must be able to measure in a range of 0.03 to 6.2 m/sec and reverse flow of -1.5m/sec if a submerged sensor is used. If an non-submerged sensor is used, it must be able to measure in a range of 0.2 to 6 m/sec.

8.11.3 The velocity sensor must be suitable for operating in temperatures ranging from minus 15ºC to +65ºC.

8.11.4 The velocity sensor must be equipped with continuous, automatic temperature compensation.

8.12 Partially Filled Pipeline Flow Measurement – Sensors/Transducers For Level Measurement

8.12.1 The level sensor must have a low profile, in order to provide the maximum measuring distance in enclosed pipes.

8.12.2 The level sensor must have a measuring range of at least 3.66m and a minimum range (deadband) of not more than 203.2mm.

8.12.3 The level sensor must be suitable for operating in temperatures ranging from minus 15ºC to +65ºC.

8.12.4 The level sensor must be equipped with continuous, automatic temperature compensation.

8.13 Partially Filled Pipeline Flow Measurement – General

8.13.1 The submerged velocity sensor must not be installed in locations where sediment builds up.

8.13.2 The sensors must not be installed in locations where there is high water turbulence (the lower the turbulence, the higher the accuracy).

8.13.3 The sensors must be installed in locations where the velocity and level are equally distributed across the channel or pipe.

8.13.4 The channel or pipe where the sensors are installed must not have drops or direction changes immediately upstream of the sensors.

8.13.5 The slope of the pipe or channel where the sensors are installed must not exceed 3%.

8.13.6 Under no circumstances must sensors be installed in a manner or in a location which makes it impossible for site maintenance staff to access it for repairs or replacement later.

8.14 Gas Flow

8.14.1 The flow measurement must be done by using thermal dispersion technology, with a guaranteed drift-free operation and a turn down ratio up to 100:1 to measure volumetric gas flow. With thermal dispersion, two temperature probes are used. The first probe generates a temperature and the second one measures the dispersed temperature. Thermal dispersion measurement must be unaffected by changes in gas pressure or gas temperature. The sensor must also maintain a minimum accuracy of 2% of the reading ± 0.2% of full scale for changes in gas composition as high as ±2.5% of CH_4.

8.14.2 The instrument must be equipped with a remote transmitter which can be mounted in an IJB located in an easily accessible location in a non-hazardous area for viewing, maintenance and repairs. The transmitter shall have a 10-digit LED display for indication of flow rate and totalised flow. Where compensating leads for Pt100s are used, the contractor must ensure that the cable between the sensor and transmitter is installed as supplied by the supplier. I.e. cables must not be cut. Excess cable must be coiled up neatly at the IJB.

8.14.3 The instrument must be equipped with integrated compensation for humidity. The average biogas composition which will be used must be 60% Methane and 40% Carbon Dioxide.

8.14.4 All instrument transmitter enclosures must have at least an IP 67 or higher rating.

8.14.5 The instrument must be equipped with a 4 – 20mA output which will be connected to a maximum 500 ohm load, for instantaneous volumetric flow in m^3/hr. It must also be equipped with a pulsed output for flow totalization.

8.14.6 The instrument must be suitable for use with a 24V DC power supply and it must have an EEx [i, e or d] rating, suitable for use in a Zone 1 area with Methane gas.

8.14.7 The sensor shall be of the insertion type with full stainless steel design. The housing shall be a compression-proof, dual compartment, stainless steel housing of material type DIN 1.4571 (316Ti). All sealing on the housing shall be done with Viton "O" rings.

8.14.8 The sensor must be equipped with a hot tapping unit for ease of insertion removal during normal digester operation. The compression fitting on the hot tapping unit must be with a metal-Viton elastomer design, resistant to pipe vibration and with a robust, threaded process connection for frequent mounting/dismounting of the sensor for inspection.

8.14.9 The sensor must be installed strictly in accordance with the supplier's recommendations and requirements. The sensor must be equipped with locating pins to ensure that the sensor cannot be replaced incorrectly after removal.

8.14.10 The range of the instrument must be suitable for the application (see items 8.4.8 and 8.4.9 of this specification)

8.14.11 The instrument must be suitable for an ambient operating temperature range of minus 20ºC to +70ºC and a process temperature operating range of minus20ºC to +120ºC.

8.14.12 The instrument must be suitable for operating in a humidity range of 0 to 100% RH.

8.15 Spares

8.15.1 The tenderer will be required to provide a recommended spares list for three years maintenance. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

8.16 Hazardous Areas

8.16.1 If the flow meter is going to be used for any combustible gas flow measurement, the tenderer must ensure that there is a hazardous area classification for the area in which the instrument will be installed.

8.16.2 If no hazardous area classification exists, the tenderer must allow a suitable cost for the classification of all relevant areas and must clearly indicate this cost in either the Bill Of Quantities or in a covering letter.

8.16.3 The flow meter and associated equipment supplied must all be suitable for use in the hazardous area concerned.

8.17 Intrinsically Safe Installations

8.17.1 Where intrinsically safe (IS) installations are required the tenderer must allow a cost to have the IS design from the Engineer certified as safe and compliant with the relevant legal requirements. This certification can only be done by a suitably accredited organization or company.

8.17.2 Once the certified IS design has been installed, the installation must be certified as correct and in accordance with the certified design. The tenderer must allow a cost for the certification. This certification can only be done by a suitably accredited organization or company.

8.17.3 All instruments supplied for use in a hazardous area must have the hazardous area rating and classification (E.g. Ex ia IIC T5) and suitable marking as specified in SANS 10108, ARP 0108:2007, Annex B, indicated on the instrument and the instrument must be certified by an approved testing/certification body as listed in SANS 0108, ARP 0108:2007.

8.18 Data Sheets

8.18.1 All data sheets in the attached Appendix 1 must be completed.

APPENDIX 1

DATA SHEET – OPEN CHANNEL FLOW METER

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output Type & Programmable (Y/N)?	
Digital Output Type & Rating (E.g. SPDT, 230V AC, 5A) & Programmable (Y/N)?	
Controller/Transmitter Enclosure Rating	
Accuracy	
Resolution	
Programmable Totaliser (Y/N)?	
Display Data & Type (E.g. instantaneous & total LCD)	
Transducer/Sensor range	
Transducer/Sensor temperature operating range	
Transducer/Sensor temperature compensation (Y/N)?	
Transducer/Sensor enclosure rating	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

DATA SHEET – FULL PIPELINE FLOW METER (MAGNETIC)

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output Type & Programmable (Y/N)?	
Digital Output Type & Rating (E.g. SPDT, 230V AC, 5A or 24V DC output) & Programmable (Y/N)?	
Controller/Transmitter Enclosure Rating	
Accuracy	
Repeatability	
Programmable Totaliser (Y/N)?	
Display Data & Type (E.g. instantaneous & total LCD)	
Transducer/Sensor range	
Transducer/Sensor wafer-type or flange-type?	
Transducer/Sensor temperature operating range	
Transducer/Sensor temperature compensation (Y/N)?	
Transducer/Sensor enclosure rating	
Transducer/Sensor lining material	
Transducer/Sensor tube material	
Transducer/Sensor grounding details	
Transducer/Sensor equipped with “Empty Pipe” detection as specified (Y/N)?	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

DATA SHEET – FULL PIPELINE FLOW METER FOR DISTRIBUTION/DIVERSION

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output Type & Programmable (Y/N)?	
Digital Output Type & Rating (E.g. SPDT, 230V AC, 5A) & Programmable (Y/N)?	
Controller/Transmitter Enclosure Rating	
Accuracy	
Repeatability	
Programmable Totaliser (Y/N)?	
Display Data & Type (E.g. instantaneous & total LCD)	
Transducer/Sensor range	
Transducer/Sensor temperature operating range	
Transducer/Sensor material	
Transducer/Sensor rating	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

DATA SHEET – GAS FLOW METER

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output	
Hazardous area rating (E.G. Ex ia IIC T5)	
Hazardous classification certification body (E.G. CSA, CESI, DEMKO, DMT, LCIE, etc.) as approved by SANS 10108, ARP 0108:2007.	
Controller/Transmitter Enclosure Rating	
Accuracy	
Range	
Display Data & Type (E.g. instantaneous m^3/hr LCD)	
Ambient temperature operating range	
Process temperature operating range	
Humidity range	
Sensor material	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

DATA SHEET – AREA-VELOCITY FLOW METER

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output Type & Programmable (Y/N)?	
No. Of Analogue Outputs	
Digital Output Type & Rating (E.g. SPDT, 230V AC, 2A) & Programmable (Y/N)?	
No. Of Relay Outputs	
Controller/Transmitter Enclosure Rating	
Velocity Accuracy	
Level Accuracy	
Repeatability & Linearity	
Programmable Totaliser (Y/N)?	
Display Data & Type (E.g. instantaneous & total LCD)	
Velocity Transducer/Sensor range	
Level Transducer/Sensor range	
Velocity Transducer/Sensor temperature operating range	
Level Transducer/Sensor temperature operating range	
Velocity Transducer/Sensor temperature compensation (Y/N)?	
Velocity Transducer/Sensor temperature compensation (Y/N)?	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 9 : LEVEL MEASUREMENT

Johannesburg Water (SOC) Ltd.
PO Box 61542
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Revision 14 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 9 : Level Measurement**

JW Reference: **BWW523C**

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ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	L. G
Approved	Manager	T. Thabeng	09/09/2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
2019-08-26	14	C. Du Toit	Cover page updated
2019-06-25	13	C. Du Toit	Revision approved by JW.
2018-11-30	12	C. Du Toit	Added reference to Labelling specification.
2014-04-17	11	C. Du Toit	Added reference to FJB specification.
2013-10-07	10	C. Du Toit	Updated footer
2012-07-27	9	C. Du Toit	Updated headers & footers.
2012-03-08	8	C. Du Toit	Changed (Pty) to (SOC).
2011-07-11	7	C. Du Toit	Removed 2010 logo.
2010-07-27	6	C. Du Toit	Transmitter relay rating altered.
2009-08-18	5	C. Du Toit	New logos and transmitter position requirements added.
2009-03-25	4	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client's requirements.

2007-10-09	3	C. Du Toit	“Minimum” 500 ohm load changed to “Maximum”
2007-06-05	2	C. Du Toit	Revision block updated and ”Joburg” logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

INDEX

9 LEVEL MEASUREMENT

9.1 Scope

9.1.1 This specification covers the supply and installation of Level meters, complete with sensors, transmitters, indicators, panels, etc. used for process monitoring and control applications at Johannesburg Water wastewater sites.

9.2 Abbreviations

9.2.1 In this specification the following abbreviations will apply :-

BS	:	British Standards
PLC	:	Programmable Logic Controller
I/O	:	Input/Output
CPU	:	Central Processing Unit
UPS	:	Uninterruptible Power Supply
MCC	:	Motor Control Centre
MCB	:	Miniature Circuit Breaker
SPD	:	Surge Protection Device
FJB	:	Field Junction Box
SSO	:	Switched Socket Outlet
SPDT	:	Single Pole Double Throw (refers to relay or switch contact arrangements).
LCD	:	Liquid Crystal Display
LED	:	Light Emitting Diode
O&M	:	Operating And Maintenance

9.3 Standards

9.3.1 The supply and installation of all Level meters and associated cabling, panels and any other equipment shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	:	National Standards for the wiring of premises.
SANS 1091:2004	:	National Colour Standard.
SANS 1274-2005	:	Coatings applied by the powder-coating process.
BS 381C:1980	:	Paint colour chart.

9.4 General Requirements

9.4.1 This specification must be read in conjunction with the following specifications:-

9.4.1.1 PLC Panels Specification (Volume 3 of the Automation And Control Standards).

9.4.1.2 Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

9.4.1.3 Cabling Specification (Volume 6 of the Automation And Control Standards).

9.4.1.4 Load Cells And Their Installation

9.4.1.5 Labelling (Volume 25 of the Automation And Control Standards).

9.4.2 Where cables are exposed to physical damage (including damage from rodents) armoured cables must be used or un-armoured cables must be run in steel conduit.

9.4.3 All power supply cables to instruments must have a black outer sheath, while all control cables (such as digital and analogue signals to PLC's) must have an orange outer sheath as specified in the Cabling Specification (Volume 6 of the Automation And Control Standards).

9.4.4 FJB's and as far as practically possible all instrument sensors and transmitters, must be mounted such that all equipment, wiring, numbers, terminations, etc. are readily accessible and can be viewed clearly. No equipment may be mounted such that it becomes a hazard or dangerous to view or gain access to such equipment.

9.4.5 Where sensors and/or transmitters cannot be mounted where they are readily accessible, the installation must be done in such a way that the sensor or transmitter can easily be moved to a safe and convenient position for testing, maintenance, replacement, etc. (e.g. by using hinged brackets, telescopic brackets, etc.).

9.4.6 Where transmitters can be exposed to the elements (wind, rain, ultra violet, etc.) such transmitters must be installed inside the FJB. Where transmitters are protected from the elements (i.e. inside buildings) but they are exposed to potentially harmful conditions like moisture from splashing or equipment being hosed down, or the sensor is in such a position that the transmitter display is not clearly visible from floor level, without the need to climb onto ladders or structures to access it, the transmitter must also be installed inside the FJB. Only where transmitters are not exposed to the elements or any other harsh or potentially harmful conditions and where the displays on such transmitters are clearly legible by an average person standing on the ground or the normal walking surface (e.g. grating above ground level), can the transmitter be mounted outside the FJB.

9.4.7 FJB's must be mounted against a wall or structure or on a sturdy pedestal such that the top of the FJB enclosure is no higher than 1.8 m from the floor and easily accessible from the front.

9.4.8 All instrument installations must be done in accordance with the manufacturer's requirements and recommendations for proper operation. It is the tenderer's responsibility to ensure that he/she is familiar with both the requirements of the manufacturer as well as the installation requirements, in terms of location, site conditions, materials, equipment or substances to be measured (e.g. hot liquids, acids, abrasive material, etc.) and to ensure that if there are potential problems, they can be pointed out and rectified before orders for equipment are placed.

9.4.9 Costs incurred for alterations required to ensure proper operation of instruments, after orders have been placed, will be for the tenderer's account. For example, if instruments have been ordered and it is found there is insufficient space to install the instrument, or the instrument is not flooded with liquid all the time as it is required for proper operation, or the instrument transmitter is sometimes flooded in its installed position, or the sensing head is sometimes outside the medium it is supposed to measure, or the instrument linings are damaged by abrasive liquids, or the sensor is does not have a suitable range of measurement, etc. alterations or replacements required to rectify such problems will be for the tenderer's account if the Engineer finds that the tenderer was negligent in his/her assessment of the installation.

9.4.10 Each instrument must be equipped with a circuit breaker connected to the power supply of the instrument, to enable local isolation in case of repairs or replacement.

9.4.11 The supplier of the instrument must be present for the installation, testing and commissioning of the instrument on site. Due allowance must be made for this in the tender sum.

9.4.12 The tenderer must supply a complete and detailed set of documentation for the installation, connections, terminations, power supply, technical details, setting up, calibration (if applicable), testing, etc. of the instrument for inclusion in a final O&M manual.

9.4.13 Completed data sheets are required as part of the returnable documents of each tender. Failure to complete these data sheets, supplied at the end of this specification, will lead to disqualification of the tender.

9.5 Surge Protection

9.5.1 Each instrument and its associated equipment must be suitably protected against surges from induced voltages, switching of equipment, lightning strikes, etc. as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

9.5.2 The power supply to the instrument must be equipped with suitable surge protection, both at the instrument and at the source of the power supply (i.e. at the distribution board, MCC, PLC panel, etc.), as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

9.5.3 Both the digital and analogue signals between the instrument and other remote devices (such as the PLC), must be equipped with suitable surge protection, both at the instrument and at the remote device as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

9.6 Level Measurement – Controller/Transmitter

9.6.1 All level measurements must be done by using ultra-sonic distance measurement, which is converted into a level value.

9.6.2 All instrument transmitter enclosures must have at least an IP 65 or higher rating.

9.6.3 The instrument must be equipped with an isolated, active, 4 – 20mA output which will be connected to a maximum 500 ohm load. This output must be user-programmable.

9.6.4 The instrument must be equipped with at least three to five SPDT relays, rated for at least 230V AC, 2A, for preset level outputs. These outputs must be user-programmable for various levels.

9.6.5 The transmitter must be suitable for use with a 230V AC, 50/60 Hz power supply.

9.6.6 The transmitter must have an accuracy of at least 0.25% or 6mm, whichever is greater.

9.6.7 The transmitter must have a resolution of at least 0.1% or 2mm, whichever is greater.

9.6.8 The transmitter must have an LCD or LED display showing instantaneous level and relay status.

9.7 Level Measurement – Sensor/Transducer

9.7.1 The range of the sensor must be suitable for the application (see items 9.4.8 and 9.4.9 of this specification).

9.7.2 The sensor must be suitable for an operating temperature range of -10ºC to +50ºC.

9.7.3 The sensor must be equipped with automatic temperature compensation.

9.7.4 The sensor must have a protection rating of at least IP 67 or higher.

9.7.5 Brackets used for the mounting of ultra-sonic sensor heads must be made of at least 3CR12 grade stainless steel.

9.8 Spares

9.8.1 The tenderer will be required to provide a recommended spares list for three years maintenance. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

9.9 Labelling

9.9.1 All labelling must comply with the requirements as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

9.10 Data Sheets

9.10.1 All data sheets in the attached Appendix 1 must be completed.

APPENDIX 1

DATA SHEET – LEVEL METER

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output Type & Programmable (Y/N)?	
Digital Output Quantity, Type & Rating (E.g. 5 x SPDT, 230V AC, 5A) & Programmable (Y/N)?	
Controller/Transmitter Enclosure Rating	
Accuracy	
Resolution	
Display Data & Type (E.g. instantaneous level & relay status LCD)	
Transducer/Sensor range	
Transducer/Sensor temperature operating range	
Transducer/Sensor temperature compensation (Y/N)?	
Transducer/Sensor enclosure rating	
Local agent (Y/N)?	
Local agent contact details.	
Guarantee period	

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 12 : DISSOLVED OXYGEN MEASUREMENT

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DOCUMENT CONTROL SHEET

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Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	L. G
Approved	Manager	H. Makola	2019-10-07	

RECORD OF REVISIONS

Date	Revision	Author	Comments
2019-08-26	14	C. Du Toit	Cover page updated
2019-06-15	13	C. Du Toit	Revision approves by JW.
2018-11-30	12	C. Du Toit	Added reference to Labelling specification.
2014-04-17	11	C. Du Toit	Added reference to FJB specification.
2013-10-07	10	C. Du Toit	Updated footer
2012-07-27	9	C. Du Toit	Updated headers & footers.
2012-03-08	8	C. Du Toit	Changed (Pty) to (SOC).
2011-07-11	7	C. Du Toit	Removed 2010 logo.
2010-07-27	6	C. Du Toit	Transmitter relay rating altered.
2009-08-18	5	C. Du Toit	New logos and transmitter requirements added.
2009-03-25	4	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client's requirements.
2007-10-09	3	C. Du Toit	"Minimum" 500 ohm load changed to "Maximum"

2007-06-05	2	C. Du Toit	Revision block updated and "Joburg" logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

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12 DISSOLVED OXYGEN MEASUREMENT

12.1 Scope

12.1.1 This specification covers the supply and installation of Dissolved Oxygen meters, complete with sensors, transmitters, indicators, panels, etc. used for process monitoring and control applications at Johannesburg Water wastewater sites.

12.2 Abbreviations

12.2.1 In this specification the following abbreviations will apply :-

BS	:	British Standards
PLC	:	Programmable Logic Controller
I/O	:	Input/Output
CPU	:	Central Processing Unit
UPS	:	Uninterruptible Power Supply
MCC	:	Motor Control Centre
MCB	:	Miniature Circuit Breaker
SPD	:	Surge Protection Device
FJB	:	Field Junction Box
SSO	:	Switched Socket Outlet
SPDT	:	Single Pole Double Throw (refers to relay or switch contact arrangements).
LCD	:	Liquid Crystal Display
LED	:	Light Emitting Diode
D.O.	:	Dissolved Oxygen
mg/l	:	Milligram per litre
O&M	:	Operating And Maintenance

12.3 Standards

12.3.1 The supply and installation of all Dissolved Oxygen meters and associated cabling, panels and any other equipment shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	:	National Standards for the wiring of premises.
SANS 1091:2004	:	National Colour Standard.
SANS 1274-2005	:	Coatings applied by the powder-coating process.
BS 381C:1980	:	Paint colour chart.

12.4 General Requirements

12.4.1 This specification must be read in conjunction with the following specifications:-

12.4.1.1 PLC Panels Specification (Volume 3 of the Automation And Control Standards).

12.4.1.2 Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

12.4.1.3 Cabling Specification (Volume 6 of the Automation And Control Standards).

12.4.1.4 Field Junction Boxes And Panels (Volume 19 of the Automation And Control Standards).

12.4.1.5 Labelling (Volume 25 of the Automation And Control Standards).

12.4.2 Where cables are exposed to physical damage (including damage from rodents) armoured cables must be used or un-armoured cables must be run in steel conduit.

12.4.3 All power supply cables to instruments must have a black outer sheath, while all control cables (such as digital and analogue signals to PLC's) must have an orange outer sheath as specified in the Cabling Specification (Volume 6 of the Automation And Control Standards).

12.4.4 FJB's and as far as practically possible all instrument sensors and transmitters, must be mounted such that all equipment, wiring, numbers, terminations, etc. are readily accessible and can be viewed clearly. No equipment may be mounted such that it becomes a hazard or dangerous to view or gain access to such equipment.

12.4.5 Where sensors and/or transmitters cannot be mounted where they are readily accessible, the installation must be done in such a way that the sensor or transmitter can easily be moved to a safe and convenient position for testing, maintenance, replacement, etc. (e.g. by using hinged brackets, telescopic brackets, etc.).

12.4.6 FJB's must be mounted against a wall or structure or on a sturdy pedestal such that the top of the FJB enclosure is no higher than 1.8 m from the floor and easily accessible from the front.

12.4.7 Where transmitters can be exposed to the elements (wind, rain, ultra violet, etc.) such transmitters must be installed inside the FJB. Where transmitters are protected from the elements (i.e. inside buildings) but they are exposed to potentially harmful conditions like moisture from splashing or equipment being hosed down, or the sensor is in such a position that the transmitter display is not clearly visible from floor level, without the need to climb onto ladders or structures to access it, the transmitter must also be installed inside the FJB. Only where transmitters are not exposed to the elements or any other harsh or potentially harmful conditions and where the displays on such transmitters are clearly legible by an average person standing on the ground or the normal walking surface (e.g. grating above ground level), can the transmitter be mounted outside the FJB.

12.4.8 All instrument installations must be done in accordance with the manufacturer's requirements and recommendations for proper operation. It is the tenderer's responsibility to ensure that he/she is familiar with both the requirements of the

manufacturer as well as the installation requirements, in terms of location, site conditions, materials, equipment or substances to be measured (e.g. hot liquids, acids, abrasive material, etc.) and to ensure that if there are potential problems, they can be pointed out and rectified before orders for equipment are placed.

12.4.9 Costs incurred for alterations required to ensure proper operation of instruments, after orders have been placed, will be for the tenderer's account. For example, if instruments have been ordered and it is found there is insufficient space to install the instrument, or the instrument is not flooded with liquid all the time as it is required for proper operation, or the instrument transmitter is sometimes flooded in its installed position, or the sensing head is sometimes outside the medium it is supposed to measure, or the instrument linings are damaged by abrasive liquids, or the sensor is does not have a suitable range of measurement, etc. alterations or replacements required to rectify such problems will be for the tenderer's account if the Engineer finds that the tenderer was negligent in his/her assessment of the installation.

12.4.10 Each instrument must be equipped with a circuit breaker connected to the power supply of the instrument, to enable local isolation in case of repairs or replacement.

12.4.11 The supplier of the instrument must be present for the installation, testing and commissioning of the instrument on site. Due allowance must be made for this in the tender sum.

12.4.12 The tenderer must supply a complete and detailed set of documentation for the installation, connections, terminations, power supply, technical details, setting up, calibration (if applicable), testing, etc. of the instrument for inclusion in a final O&M manual.

12.4.13 Completed data sheets are required as part of the returnable documents of each tender. Failure to complete these data sheets, supplied at the end of this specification, will lead to disqualification of the tender.

12.5 Surge Protection

12.5.1 Each instrument and its associated equipment must be suitably protected against surges from induced voltages, switching of equipment, lightning strikes, etc. as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

12.5.2 The power supply to the instrument must be equipped with suitable surge protection, both at the instrument and at the source of the power supply (i.e. at the distribution board, MCC, PLC panel, etc.), as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

12.5.3 Both the digital and analogue signals between the instrument and other remote devices (such as the PLC), must be equipped with suitable surge protection, both at the instrument and at the remote device as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

12.6 Dissolved Oxygen Measurement – Controller/Transmitter

12.6.1 All D.O. measurements must be done by using a membrane operating principle.

12.6.2 All instrument transmitter enclosures must have at least an IP 65 or higher rating.

12.6.3 The instrument must be equipped with an isolated, active, 4 – 20mA output which will be connected to a maximum 500 ohm load. This output must be user-programmable for D.O. As an option the instrument must be equipped with a second isolated, active, 4 – 20mA output which will be connected to a maximum 500 ohm load. This output must be for temperature.

12.6.4 The instrument must be equipped with at least one to three SPDT relays, rated for at least 230V AC, 2A. Two relays for preset D.O. outputs and one relay for alarm status (i.e. transmitter failure, out of range measurement, etc.). The preset outputs must be user-programmable for various D.O. values.

12.6.5 The transmitter must be suitable for use with a 230V AC, 50/60 Hz power supply.

12.6.6 The transmitter must have an accuracy of at least 0.01mg/l or 1% saturation.

12.6.7 The transmitter must have a resolution of at least 0.1mg/l.

12.6.8 The transmitter must have an LCD or LED display, which is selectable to show instantaneous D.O. or temperature. It must also show relay status.

12.6.9 The transmitter must have automatic compensation for temperature, altitude and salinity.

12.7 Dissolved Oxygen Measurement – Transducer/Sensor

12.7.1 The range of the sensor must be from 0.00 to 9.99 mg/l and must be suitable for the application (see items 12.4.8 and 12.4.9 of this specification).

12.7.2 The sensor must be suitable for an operating and measurement temperature range of 0ºC to +50ºC.

12.7.3 The sensor must be equipped with automatic temperature compensation.

12.7.4 The sensor must have a protection rating of at least IP 67 or higher.

12.7.5 Brackets used for the mounting of the sensor must be made of at least 3CR12 grade stainless steel.

12.7.6 The sensor must be supplied, complete with a cleaning unit (air or water), equipped with a user-programmable cleaning cycle.

12.8 Spares

12.8.1 The tenderer will be required to provide a recommended spares list for three years maintenance. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

12.9 Data Sheets

12.9.1 All data sheets in the attached Appendix 1 must be completed.

APPENDIX 1

DATA SHEET – DISSOLVED OXYGEN METER

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Operating principle	
Power Supply (Voltage)	
Analogue Output Type & Programmable (Y/N)?	
Digital Output Quantity, Type & Rating (E.g. 3 x SPDT, 230V AC, 5A) & Programmable (Y/N)?	
Controller/Transmitter Enclosure Rating	
Accuracy	
Resolution	
Controller/Transmitter temperature, altitude & salinity compensation (Y/N)?	
Display Data & Type (E.g. instantaneous D.O. Temperature & relay status LCD). Selectable (Y/N)?	
Transducer/Sensor D.O. range	
Transducer/Sensor temperature measuring range	
Transducer/Sensor temperature operating range	
Transducer/Sensor temperature compensation (Y/N)?	
Transducer/Sensor enclosure rating	
Transducer/Sensor cleaning system type & programmable (Y/N)?	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

VOLUME 13 : MIXED LIQUOR SUSPENDED SOLIDS MEASUREMENT

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 14 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 13 : Mixed Liquor Suspended Solids Measurement**

JW Reference: **BWW523C**

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DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	L. G
Approved	Manager	H. Makola	2019-10-07	

RECORD OF REVISIONS

Date	Revision	Author	Comments
2019-08-26	14	C. Du Toit	Cover page updated
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2007-10-09	3	C. Du Toit	"Minimum" 500 ohm load changed to "Maximum"

2007-06-05	2	C. Du Toit	Revision block updated and "Joburg" logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

INDEX

13 MIXED LIQUOR SUSPENDED SOLIDS MEASUREMENT

13.1 Scope

13.1.1 This specification covers the supply and installation of Mixed Liquor Suspended Solids meters, complete with sensors, transmitters, indicators, panels, etc. used for process monitoring and control applications at Johannesburg Water wastewater sites.

13.2 Abbreviations

13.2.1 In this specification the following abbreviations will apply :-

BS	:	British Standards
PLC	:	Programmable Logic Controller
I/O	:	Input/Output
CPU	:	Central Processing Unit
UPS	:	Uninterruptible Power Supply
MCC	:	Motor Control Centre
MCB	:	Miniature Circuit Breaker
SPD	:	Surge Protection Device
FJB	:	Field Junction Box
SSO	:	Switched Socket Outlet
SPDT	:	Single Pole Double Throw (refers to relay or switch contact arrangements).
LCD	:	Liquid Crystal Display
LED	:	Light Emitting Diode
MLSS	:	Mixed Liquor Suspended Solids
mg/l	:	Milligram per litre
O&M	:	Operating And Maintenance

13.3 Standards

13.3.1 The supply and installation of all Mixed Liquor Suspended Solids meters and associated cabling, panels and any other equipment shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	:	National Standards for the wiring of premises.
SANS 1091:2004	:	National Colour Standard.
SANS 1274-2005	:	Coatings applied by the powder-coating process.
BS 381C:1980	:	Paint colour chart.

13.4 General Requirements

13.4.1 This specification must be read in conjunction with the following specifications:-

13.4.1.1 PLC Panels Specification (Volume 3 of the Automation And Control Standards).

13.4.1.2 Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

13.4.1.3 Cabling Specification (Volume 6 of the Automation And Control Standards).

13.4.1.4 Field Junction Boxes And Panels (Volume 19 of the Automation And Control Standards).

13.4.1.5 Labelling (Volume 25 of the Automation And Control Standards).

13.4.2 Where cables are exposed to physical damage (including damage from rodents) armoured cables must be used or un-armoured cables must be run in steel conduit.

13.4.3 All power supply cables to instruments must have a black outer sheath, while all control cables (such as digital and analogue signals to PLC's) must have an orange outer sheath as specified in the Cabling Specification (Volume 6 of the Automation And Control Standards).

13.4.4 FJB's and as far as practically possible all instrument sensors and transmitters, must be mounted such that all equipment, wiring, numbers, terminations, etc. are readily accessible and can be viewed clearly. No equipment may be mounted such that it becomes a hazard or dangerous to view or gain access to such equipment.

13.4.5 Where sensors and/or transmitters cannot be mounted where they are readily accessible, the installation must be done in such a way that the sensor or transmitter can easily be moved to a safe and convenient position for testing, maintenance, replacement, etc. (e.g. by using hinged brackets, telescopic brackets, etc.).

13.4.6 Where transmitters can be exposed to the elements (wind, rain, ultra violet, etc.) such transmitters must be installed inside the FJB. Where transmitters are protected from the elements (i.e. inside buildings) but they are exposed to potentially harmful conditions like moisture from splashing or equipment being hosed down, or the sensor is in such a position that the transmitter display is not clearly visible from floor level, without the need to climb onto ladders or structures to access it, the transmitter must also be installed inside the FJB. Only where transmitters are not exposed to the elements or any other harsh or potentially harmful conditions and where the displays on such transmitters are clearly legible by an average person standing on the ground or the normal walking surface (e.g. grating above ground level), can the transmitter be mounted outside the FJB.

13.4.7 FJB's must be mounted against a wall or structure or on a sturdy pedestal such that the top of the FJB enclosure is no higher than 1.8 m from the floor and easily accessible from the front.

13.4.8 All instrument installations must be done in accordance with the manufacturer's requirements and recommendations for proper operation. It is the tenderer's responsibility to ensure that he/she is familiar with both the requirements of the

manufacturer as well as the installation requirements, in terms of location, site conditions, materials, equipment or substances to be measured (e.g. hot liquids, acids, abrasive material, etc.) and to ensure that if there are potential problems, they can be pointed out and rectified before orders for equipment are placed.

13.4.9 Costs incurred for alterations required to ensure proper operation of instruments, after orders have been placed, will be for the tenderer's account. For example, if instruments have been ordered and it is found there is insufficient space to install the instrument, or the instrument is not flooded with liquid all the time as it is required for proper operation, or the instrument transmitter is sometimes flooded in its installed position, or the sensing head is sometimes outside the medium it is supposed to measure, or the instrument linings are damaged by abrasive liquids, or the sensor is does not have a suitable range of measurement, etc. alterations or replacements required to rectify such problems will be for the tenderer's account if the Engineer finds that the tenderer was negligent in his/her assessment of the installation.

13.4.10 Each instrument must be equipped with a circuit breaker connected to the power supply of the instrument, to enable local isolation in case of repairs or replacement.

13.4.11 The supplier of the instrument must be present for the installation, testing and commissioning of the instrument on site. Due allowance must be made for this in the tender sum.

13.4.12 The tenderer must supply a complete and detailed set of documentation for the installation, connections, terminations, power supply, technical details, setting up, calibration (if applicable), testing, etc. of the instrument for inclusion in a final O&M manual.

13.4.13 Completed data sheets are required as part of the returnable documents of each tender. Failure to complete these data sheets, supplied at the end of this specification, will lead to disqualification of the tender.

13.5 Surge Protection

13.5.1 Each instrument and its associated equipment must be suitably protected against surges from induced voltages, switching of equipment, lightning strikes, etc. as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

13.5.2 The power supply to the instrument must be equipped with suitable surge protection, both at the instrument and at the source of the power supply (i.e. at the distribution board, MCC, PLC panel, etc.), as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

13.5.3 Both the digital and analogue signals between the instrument and other remote devices (such as the PLC), must be equipped with suitable surge protection, both at the instrument and at the remote device as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

13.6 MLSS Measurement – Controller/Transmitter

13.6.1 All MLSS measurements must be done by using a light scatter operating principle.

13.6.2 All instrument transmitter enclosures must have at least an IP 65 or higher rating.

13.6.3 The instrument must be equipped with an isolated, active, 4 – 20mA output which will be connected to a maximum 500 ohm load. This output must be user-programmable for MLSS.

13.6.4 The instrument must be equipped with at least one to three SPDT relays, rated for at least 230V AC, 2A. Two relays for preset MLSS outputs and one relay for alarm status (i.e. transmitter failure, out of range measurement, etc.). The preset outputs must be user-programmable for various MLSS values.

13.6.5 The transmitter must be suitable for use with a 230V AC, 50/60 Hz power supply.

13.6.6 The transmitter must have an accuracy of at least 5% or 100mg/l, whichever is greater.

13.6.7 The transmitter must have a resolution of at least 1% or 50mg/l, whichever is greater.

13.6.8 The transmitter must have an LCD or LED display, which will show instantaneous MLSS and relay status.

13.7 MLSS Measurement – Transducer/Sensor

13.7.1 The range of the sensor must be from 0.00 to 10,000 mg/l and must be suitable for the application (see items 13.4.8 and 13.4.9 of this specification).

13.7.2 The sensor must be suitable for an operating temperature range of 0ºC to +50ºC.

13.7.3 The sensor must have a protection rating of at least IP 67 or higher.

13.7.4 Brackets used for the mounting of the sensor must be made of at least 3CR12 grade stainless steel.

13.7.5 The sensor must be supplied, complete with a cleaning unit (air or water), equipped with a user-programmable cleaning cycle.

13.8 Spares

13.8.1 The tenderer will be required to provide a recommended spares list for three years maintenance. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

13.9 Data Sheets

13.9.1 All data sheets in the attached Appendix 1 must be completed.

APPENDIX 1

DATA SHEET – MIXED LIQUOR SUSPENDED SOLIDS METER

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Operating principle	
Power Supply (Voltage)	
Analogue Output Type & Programmable (Y/N)?	
Digital Output Quantity, Type & Rating (E.g. 3 x SPDT, 230V AC, 5A) & Programmable (Y/N)?	
Controller/Transmitter Enclosure Rating	
Accuracy	
Resolution	
Display Data & Type (E.g. instantaneous MLSS & relay status LCD).	
Transducer/Sensor MLSS range	
Transducer/Sensor temperature operating range	
Transducer/Sensor enclosure rating	
Transducer/Sensor cleaning system type & programmable (Y/N)?	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

VOLUME 19 : FIELD JUNCTION BOXES AND PANELS

Johannesburg Water (SOC) Ltd.
PO Box 61542
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Revision 19 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 19 : Field Junction Boxes And Panels**

JW Reference: **BWW523C**

Document Ref. No: **VOLUME 19**

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ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	L. G
Approved	Manager	T. Thabeng	09/09/2019	TE

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2019-08-26	19	C. Du Toit	Cover page updated
2019-08-14	18	C. Du Toit	Use of materials in corrosive areas updated (GRP)
2019-06-25	17	C. Du Toit	Stopper plugs used updated.
2019-06-15	16	C. Du Toit	Cable terminations plus wiring and terminations updated to correspond with that in PLC Panels and
2019-01-28	15	C. Du Toit	Included Cydna requirement for no direct sunlight on display units.
2018-11-30	14	C. Du Toit	Updated reference to Labelling specification, IJBs should not cause obstruction, clearing to be created
2014-04-17	13	C. Du Toit	Updated FJB stands and labelling
2013-10-07	12	C. Du Toit	Updated footer and racking on IJB stands
2012-07-27	11	C. Du Toit	Updated headers & footers.
2012-03-08	10	C. Du Toit	Added Polycarbonate boxes and updated labelling requirements.

2012-03-08	9	C. Du Toit	Changed required paint thickness for IJBs, added requirements for supports/brackets and changed (Pty)
2011-07-11	8	C. Du Toit	Removed 2010 logo.
2010-07-27	7	C. Du Toit	Altered minimum panel powder coating thickness & hinges material.
2010-03-12	6	C. Du Toit	Altered submission time of FJB panel drawings.
2009-08-18	5	C. Du Toit	New logos and data display viewing requirements
2009-03-25	4	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client’s requirements.
2008-10-08	3	C. Du Toit	“Joburg” & “JW” Logos added to top & partnership logos removed.
2007-06-05	2	C. Du Toit	Revision block updated and ”Joburg” logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

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19 FIELD JUNCTION BOXES AND PANELS

19.1 Scope

19.1.1 This specification covers the manufacturing, supply and installation of Field Junction Boxes, Field Equipment Panels and any other panels used for housing terminals, surge protection devices, instruments, control switchgear (such as pushbuttons, selector switches, indicating lamps, potentiometers, etc.) for process monitoring and control applications at Johannesburg Water wastewater sites.

19.2 Abbreviations

19.2.1 In this specification the following abbreviations will apply :-

BS	:	British Standards
PLC	:	Programmable Logic Controller
I/O	:	Input/Output
MCB	:	Miniature Circuit Breaker
LPZ	:	Lightning Protection Zone
SPD	:	Surge Protection Device

19.3 Standards

19.3.1 All design standards for cabling shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	:	National Standards for the wiring of premises.
SANS 1091:2004	:	National Colour Standard.
SANS 1274-2005	:	Coatings applied by the powder-coating process.
BS 381C:1980	:	Paint colour chart.

19.4 General Requirements

19.4.1 The Field Panel will typically house the following items:-

19.4.1.1 Terminals, fuses, MCB's, trunking, surge protection, relays, etc.

19.4.1.2 Pushbuttons, selector switches, potentiometers, indicating lamps, etc.

19.4.1.3 Power supplies, indicating instruments, etc.

19.4.1.4 Instruments such as transmitters.

19.4.2 The supply and installation shall in general comply with the relevant clauses in all specifications attached to the tender documentation.

19.4.3 The panels shall be free standing units with bottom cable entry (via a glanding plate) and have front door access (hinged and lockable).

19.4.4 For areas other than those mentioned in item 19.4.12 below, the panel should be manufactured from at least 3CR12 grade stainless steel typically not less than 1,5 mm thick. All hinges, locking devices, bolts, nuts and washers must also be at least 3CR12 stainless steel. The panel will have a door on the front which opens to the full width and height of the panel. The panel shall be free standing and the top edge of the panel shall not be more than 1,8m above floor level and it should be sized to accommodate all the associated equipment comfortably.

19.4.5 Once the door is open there should be no obstruction to prevent full access to every point inside the panel.

19.4.6 The panel shall be epoxy powder coated electric orange (Shade B26) finish. Interior chassis mounting plates will be finished in appliance white.

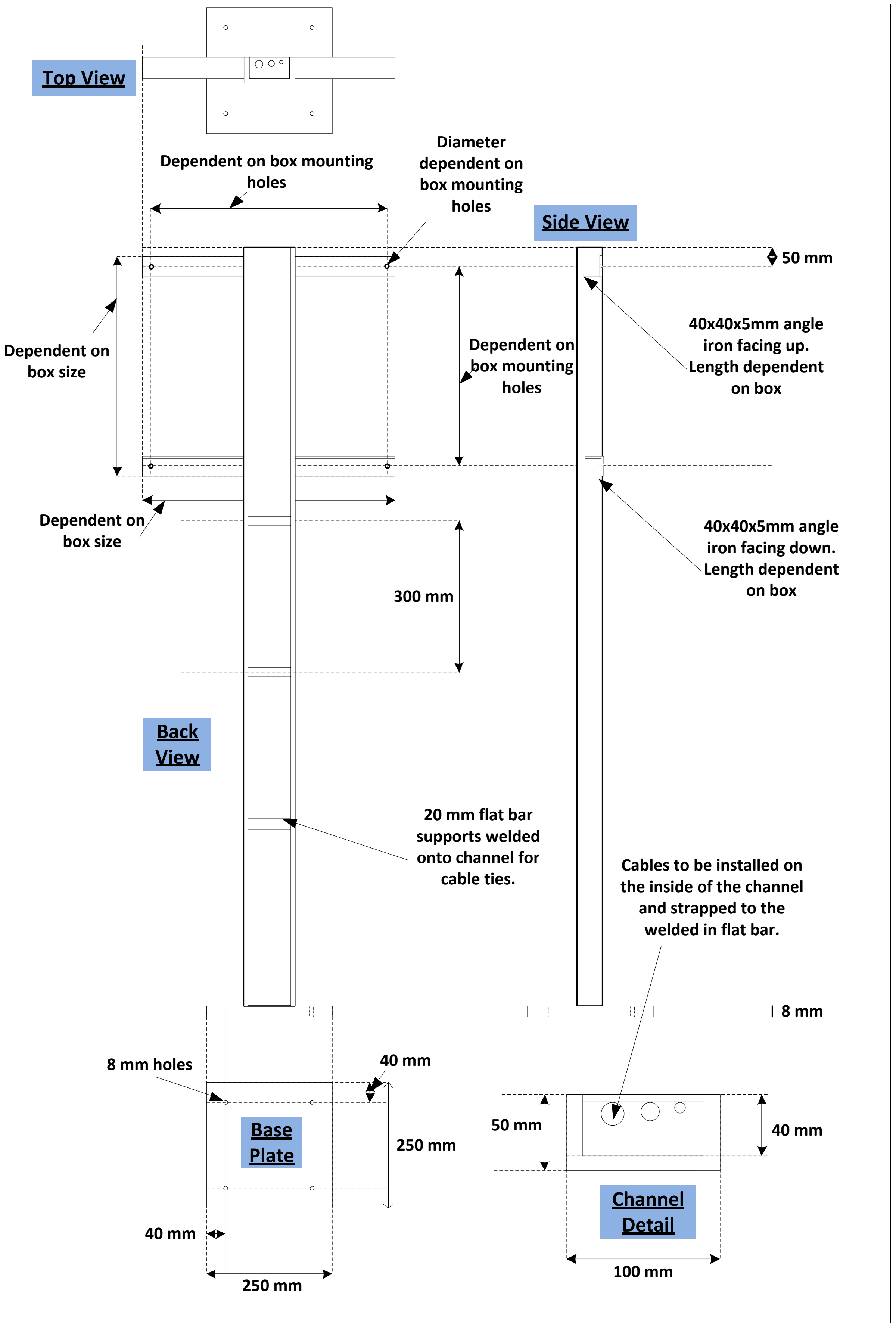
19.4.7 All IJBs should be clearly labelled with labels as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

19.4.8 The panel must be vermin-proof and must have a protection rating of no less than IP 65.

19.4.9 Where equipment such as pushbuttons, selector switches, potentiometers, etc. are required on the panel exterior, a double door system must be used. The equipment must be mounted on a hinged door, which in turn is located inside a second hinged door fitted with a transparent panel so that all relevant equipment can be viewed without the need to open this external door. This external door with the glass panel must ensure that the IP 65 protection rating is not compromised by the fitting of equipment such as pushbuttons, switches, etc.

19.4.10 Where outer doors are equipped with transparent panels, such a panel must consist of a material that will not deteriorate significantly due to its exposure to the elements such as ultra-violet radiation, heat, wind, rain, etc. Glass panels will be preferred.

19.4.11 Where there are no existing structures against which the panel can be mounted, a sturdy stand (see the picture below), or mounting bracket must be manufactured of the same material as the panel (i.e. at least 3CR12 grade stainless steel), painted to the same specification and in the same colour as the panel. A ladder type cable rack of suitable width to accommodate all the cabling, plus at least 10% spare space must be fitted to the stand or structure to enable proper securing of the cables, if the cables cannot comfortably be run inside the channel used for the stand or if there is no stand (i.e. where brackets or wall-mounting is used). The cable racking must comply with all the requirements in the Cabling Specification (Volume 6 of the Automation And Control Standards).


Top View
Dependent on box mounting holes
Diameter dependent on box mounting holes
Side View
50 mm
Dependent on box size
Dependent on box mounting holes
40x40x5mm angle iron facing up. Length dependent on box
Dependent on box size
40x40x5mm angle iron facing down. Length dependent on box
300 mm
Back View
20 mm flat bar supports welded onto channel for cable ties.
Cables to be installed on the inside of the channel and strapped to the welded in flat bar.
8 mm
8 mm holes
40 mm
250 mm
Base Plate
40 mm
250 mm
50 mm
40 mm
Channel Detail
100 mm

19.4.12 Field junction boxes used inside Elutriation Terrace pump stations or in areas within 10m or less of Ferric Chloride, Sodium Hypochlorite or Chlorine shall be manufactured from Polycarbonate. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel, painted with 2K poly urethane paint, for all these applications. A sample of the panel must be approved by the engineer before manufacturing or purchasing commences. Channels or other sections used for securing of these junction boxes should be made from GRP (Glass Reinforced Polyester). Where transparent covers are used, they must be high visibility Polycarbonate with UV filtration. Since these Polycarbonate panels are used in highly corrosive atmospheres, they must contain as little metal as possible. Hinges, locking devices, etc. wherever possible, should also be Polycarbonate. All cable glands must be totally encapsulated glands (envirogland type) as shown in the example below.

19.4.13 The GRP profile (cable rack or equipment support) shall consist of pultruded (i.e. a continuous process of pulling material, such as **glass fiber** and resin, through a shaped die for manufacturing of composite materials with constant cross-section), e-glass roving and e-glass multi-axial fabric strength mat, sandwiched between polyester synthetic veil or tissue of minimum 35 gram/ m^2, all of which is encased in an isophthalic vinyl-ester resin. The resin must contain UV stabiliser. It must also contain pigment to provide colour and additional environmental protection. The rack or support must be cleaned and de-greased before it is painted with a 2K automotive or industrial poly urethane paint.

19.4.14 IJB’s shall not be installed such that they obstruct passageways or are close to the road where moving objects such as vehicles, forklifts etc. can damage the IJB.

19.4.15 Where cable junction boxes, terminal boxes or terminations in instruments or any other panels in the field take place it must be ensured that such a junction box, termination box, instrument, etc. is not exposed to fire hazards from burning grass or other vegetation. If such a termination point is out in the open field (e.g. where grass grows below and/or around it), a clear area of at least 2.5m radius around this termination point must be provided. This must be a permanent clearing, such as a cement or concrete surface. A mere clearing of vegetation which can grow back again will not be accepted.

19.5 Standard Features

19.5.1 Each panel shall have the following features as standard:-

19.5.1.1 No ventilation fans shall be mounted in the panel and thereby compromise the protection rating.

19.5.1.2 No holes may be drilled for tapping, riveting, bolts & nuts, etc. in any section of the panel where it will compromise the protection rating of the panel. I.e. only in the first (i.e. inner) door of a 2-door panel, in the backing plate or in the glanding plate may holes be drilled. Where drilling is unavoidable, e.g. to affix labels, the holes must be sealed so that the protection rating of the panel is not compromised.

19.5.1.3 Bolts with nuts shall not be used to attach equipment to any mounting plate at any point. On mounting plates only bolts in tapped holes will be acceptable. Bolts with nuts will be allowed on enclosure doors however, where the bolts and nuts are easily accessible.

19.5.1.4 Where bolts are used on the door or any outside panels of the enclosure, a sealing method (e.g. rubber washers) must be used to ensure that the IP protection rating of the enclosure is not compromised.

19.5.1.5 Wherever bolts are used, the bolts must be as short as practically possible so that there are no long protrusions that can injure people or snag clothing, wiring, other equipment, etc. If bolts are cut to the correct length, the ends of the bolts must be neatly de-burred and smoothed so that there are no sharp edges that can cause injuries and so that the nuts can be easily screwed on and off. No more than four threads of the bolt end must be visible beyond the nut. It is however preferred that the correct length of bolts are used so that shortening is not required.

19.5.1.6 A copper earth bar running the width of the panel at the bottom with solid electrical connection to the panel doors and to the steel of the panel at two or more places and provided with terminals for connection of equipment and screen earth wires.

19.5.1.7 Terminals and equipment of the same voltage must be grouped together, while terminals and equipment of different voltages must be clearly marked and separated by at least 50mm or by suitable insulated barriers to ensure that inadvertent contact or accidental terminations in the wrong place are avoided. Where such barriers are used between terminals of different voltages, these barriers must be larger than the terminals (i.e. standard terminal end barriers will not be acceptable) to ensure that there is a clear separation and to avoid accidental incorrect terminations.

19.5.1.8 Where the panel will be installed out in the open (i.e. not in an area where it is in the shade), the panel must be equipped with a cover which will provide shade for the panel while allowing air flow between the panel and the cover. Such panels should as far as practically possible be installed to face South and the cover should ensure that all transmitters, analysers, pushbuttons, lamps, etc. are protected from direct sunlight. It must be ensured that transmitter LED/LCD displays are **never** exposed to direct sunlight.

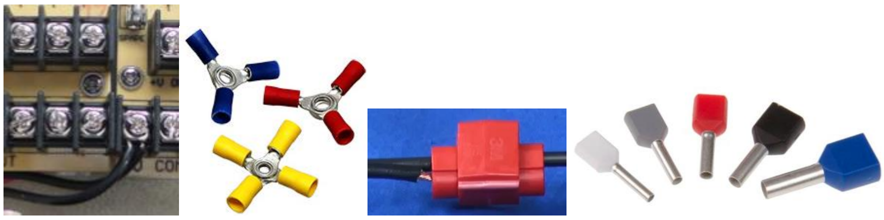
19.5.1.9 Where stopper plugs are used to seal holes that are not used, no plastic stopper plugs will be acceptable. All stopper plugs must be threaded, non-corrodible, metal plugs with rubber washers on both sides of the panel to ensure at least an IP65 seal (see examples below).

19.6 Wiring and Terminals

19.6.1 All terminals shall be screw type terminals and shall be mounted on raised DIN terminal rail, secured to the chassis plate at the back of the panel.

19.6.2 Proprietary type wire strippers shall be used and no stranded conductor shall be terminated if one or more strands have been damaged.

19.6.3 Not more than one wire shall be connected to any terminal unless the terminal can accept pin lugs on either side of a screw or unless proper connecting material is used (see examples below).



Every wire shall be marked at both ends with a numbering system as specified in the Labelling Specification (Volume 25 of the Automation And Control Design Standards), or if approved by the Engineer, and all terminating wires shall also be suitably crimped to a terminal lug. Not more than one wire shall be crimped into a single lug. Bare wire terminations will not be accepted.

19.6.4 All wiring shall be flexible, tinned, annealed, multi-strand copper wire not less than:-

19.6.4.1 1,5mm² for 230V AC or 110V AC power

19.6.4.2 1,0mm² for 24V DC or AC power

19.6.4.3 0,5mm² for all PLC I/O wiring between modules and marshalling terminals

19.6.4.4 4,0mm² for earth drain

19.6.5 Irrespective of the minimum wire sizes allowed in this specification, contractors must ensure that all cables and wiring are capable of carrying the full system currents, inclusive of de-rating factors as specified in SANS 10142-1:2003 as amended.

19.6.6 All wire terminations must be done by using suitable lugs. Where pin lugs are crimped onto the ends of wires, correctly sized pin lugs must be used, which fit into the terminals properly and such that the tightening of the terminal does not result in the loosening of the pin lug.

19.6.7 All panel wiring shall run in suitable sized slotted trunking for as much of their course as possible, thereafter in spiral band or similar conduit to its destination if the exposed run would exceed 100mm.

19.6.8 The distance between the terminals and the trunking or between equipment (such as relays, surge protection, circuit breakers, etc.) and trunking shall not be less than 50mm.

19.6.9 Control wiring should not run with power wiring and all cross-overs shall be at ninety degrees.

19.6.10 Each analogue and digital input and output to and from the PLC shall have surge protection units as specified in the Clean Power And Surge Protection Specification

(Volume 5 of the Automation And Control Standards).

19.6.11 Internal wiring shall be colour coded as follows:-

19.6.11.1 230V AC Power

Live	Brown
Neutral	Blue
Earth	Green and Yellow

19.6.11.2 24V DC Power

Positive	Red
Negative	Black

19.6.11.3 Digital Inputs

230V AC	Yellow
24V DC	Red

19.6.11.4 Digital Outputs

230V AC	Grey
24V DC	Red

19.6.11.5 Relay Outputs

230V AC	Grey
24V DC	Red

19.6.11.6 Analogue Signals

Positive	Orange
Negative	Purple

19.6.12 A terminal section for AC and DC power distribution shall be included in the panel where both voltages are used for equipment power supplies. The terminal groups shall be clearly identified to indicate the various voltages.

19.6.13 All wiring must be continuous from one termination (in a terminal strip or device such as a relay, contactor, surge arrester, etc.) to the next. No spliced wiring will be accepted.

19.7 Existing Panels

19.7.1 All modifications and wiring changes to existing panels must comply with the specifications as laid down for new panels.

19.8 Factory Acceptance

19.8.1 Before delivery of the panels, a comprehensive system factory acceptance test must take place. The Engineer must be notified one week in advance of the proposed test.

19.8.2 The test shall comprise of at least, but not be limited to:

19.8.2.1 Checking the panel manufacturing and assembly for compliance with this specification.

19.8.2.2 Layout, numbering and labelling of equipment.

19.8.2.3 Wiring – sizes, numbering, colours, termination, etc.

19.8.2.4 Wiring as per drawings, I/O schedules, etc. (i.e. loop checks).

19.9 Over-Voltage/Lightning Protection

19.9.1 The function of the over-voltage/lightning protection units is to prevent damage from occurring to the electrical and electronic devices due to destructive voltages, by resistive coupling, capacitive coupling or inductive coupling, arising from extraneous events such as lightning discharges, switching surges etc. All lightning and surge protection must be in accordance with the requirements in the Clean Power And Surge Protection specification (Volume 5 of the Automation And Control Design Standards).

19.9.2 The SPD's on all incoming power supplies to the panel shall be in accordance with the LPZ in which the panel is and must comply with the requirements of SANS 10142-1:2003 Annex L. Even if the LPZ dictates that class III surge protection is required, at least class II surge protection must be installed.

19.9.3 All analogue and digital input and output circuits shall be in accordance with the LPZ in which the panel is and must comply with the requirements of SANS 10142-1:2003 Annex L. and even if the LPZ dictates that class III surge protection is required, at least class II surge protection must be installed. for protection of these circuits.

19.10 Spares

19.10.1 The tenderer will be required to provide at least 10% spare fuses and other consumable items which may be required during commissioning. In addition to commissioning spares, a recommended spare list for three years maintenance, should be submitted. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

19.11 Painting (Powder Coating Method)

19.11.1 **General**

Switchboards and panels shall be epoxy powder coated in accordance with Type 1 coatings to SANS 1274-2005.
Unless specified otherwise, a high gloss finish in the following colour shall be provided:
Colour - Light Orange, Colour No. B26, Munsell Ref. 2,5 YR C/14 to SANS 1091 : 2004 and Colour No. 381C-557 to BS 381C : 1980.
Paintwork must be guaranteed against blistering, peeling, cracking and general deterioration which can lead to rusting, corrosion, etc. for a period of no less than three years. If the tenderer cannot comply with this requirement, it must be clearly stated as such in the tender.

19.11.2 **Specifications**

The following specifications in accordance with SANS 1274-2005 shall be provided:-

Property	Requirement	Test Method
Thickness, minimum	50 micron	6,7
Marking Resistance (400g)	No marking	6.20
Impact Resistance, J, minimum	6,78	6.10
Water Resistance, h, minimum	720	6.13

Humidity resistance, h, minimum	1000	6.14
Resistance to salt fog, h, minimum	1000	6.16

19.11.3 **Surface Preparation**

Surface preparation of sheet steel components shall be carried out by means of the multi-bath zinc phosphate/chromate passivation treatment.
All fabricated sheet steel components are to be degreased and de-rusted ready for treatment.
A steel surface is considered ready for treatment when all dirt, grease, rust, mill scale, moisture or other contaminants have been removed in an alkaline degreaser to give a dry, clean, bright, metallic surface.
Steel plate less than 4mm thick - black steel sheet shall be pickled to white metal condition while pre-pickled, bright, cold rolled sheet steel shall be solvent cleaned.
These surfaces shall be treated within eight hours in all cases while still uncontaminated and rust-free.
The prepared steel surface shall be treated by means of immersion in a heated zinc phosphate solution bath, rinsing and thereafter chromate passivated by means of immersion in the final treatment bath.

19.11.4 **Powder Coating**

A thermosetting powder consisting of epoxy/polyester resin shall be applied by means of an electrostatic spray gun to give a uniform coating thickness of 50 to 60 micron. Less than 50 micron will not be acceptable.

The powder coating shall be baked at a metal temperature of 185ºC so as to melt the powders to form a continuous film over the metal substrate.

19.12 Drawings And Diagrams

19.12.1 The tenderer must submit layout drawings, showing the panel size, cable entry, location of equipment, details of equipment (such as trunking size, circuit breakers, fuses, terminals, etc.), panel colour, material of construction (e.g. 2mm 3CR12 SS), etc. for approval by the Engineer before any manufacturing commences.

19.12.2 The drawings must be accompanied with data lists of the proposed equipment. These data sheets must show the type, supplier, make, model, size, etc. of equipment where applicable. For example:

Treminals	- Phoenix SK12, 4mm, white.
MCB's	- Merlin Gerin, 5A, 10kA, single-pole.
Etc.	

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 21 : LOAD CELLS

Johannesburg Water (SOC) Ltd.
PO Box 61542
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Revision 11 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 21 : Load Cells**

JW Reference: **BWW523C**

Document Ref. No: **VOLUME 21**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	HOD	C. Du Toit	2019-08-26	[signature]
Reviewed	Engineer	L. Gobinca	2019-08-26	L. G [signature]
Approved	Manager	T. Thabeng	09/09/2019	[signature]

RECORD OF REVISIONS

Date	Revision	Author	Comments
2019-08-26	11	C. Du Toit	Cover page updated
2019-06-15	10	C. Du Toit	Added feedback from the specification workshop.
2018-11-30	9	C. Du Toit	Added reference to Labelling specification.
2014-04-17	8	C. Du Toit	Added reference to FJB specification.
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2009-03-25	2	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client's requirements.
2009-03-12	1	C. Du Toit	Included comments from JW. Approved revision.

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2009-02-04	B	C. Du Toit	Included comments subsequent to additional research.
2009-02-02	A	C. Du Toit	First Draft

INDEX

21 LOAD CELLS

21.1 Scope

21.1.1 This specification covers the supply and installation of Load Cells, complete with sensors, transmitters, indicators, panels, etc. used for process monitoring and control applications at Johannesburg Water wastewater sites.

21.2 Abbreviations

21.2.1 In this specification the following abbreviations will apply :-

BS	:	British Standards
PLC	:	Programmable Logic Controller
I/O	:	Input/Output
CPU	:	Central Processing Unit
UPS	:	Uninterruptible Power Supply
MCC	:	Motor Control Centre
MCB	:	Miniature Circuit Breaker
SPD	:	Surge Protection Device
FJB	:	Field Junction Box
SSO	:	Switched Socket Outlet
SPDT	:	Single Pole Double Throw (refers to relay or switch contact arrangements).
LCD	:	Liquid Crystal Display
LED	:	Light Emitting Diode
O&M	:	Operating And Maintenance

21.3 Standards

21.3.1 The supply and installation of all Load cells and associated cabling, panels and any other equipment shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	:	National Standards for the wiring of premises.
SANS 1091:2004	:	National Colour Standard.
SANS 1274-2005	:	Coatings applied by the powder-coating process.
BS 381C:1980	:	Paint colour chart.

21.4 General Requirements

21.4.1 This specification must be read in conjunction with the following specifications:-

21.4.1.1 PLC Panels Specification (Volume 3 of the Automation And Control Standards).

21.4.1.2 Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

21.4.1.3 Cabling Specification (Volume 6 of the Automation And Control Standards).

21.4.1.4 Field Junction Boxes And Panels (Volume 19 of the Automation And Control Standards).

21.4.1.5 Labelling (Volume 25 of the Automation And Control Standards).

21.4.2 Where cables are exposed to physical damage (including damage from rodents) armoured cables must be used or un-armoured cables must be run in steel conduit.

21.4.3 All power supply cables to instruments must have a black outer sheath, while all control cables (such as digital and analogue signals to PLCs) must have an orange outer sheath as specified in the Cabling Specification (Volume 6 of the Automation And Control Standards).

21.4.4 FJBs and as far as practically possible all instrument sensors and transmitters, must be mounted such that all equipment, wiring, numbers, terminations, etc. are readily accessible and can be viewed clearly. No equipment may be mounted such that it becomes a hazard or dangerous to view or gain access to such equipment.

21.4.5 Where sensors and/or transmitters cannot be mounted where they are readily accessible, the installation must be done in such a way that the sensor or transmitter can easily be moved to a safe and convenient position for testing, maintenance, replacement, etc. (e.g. by using hinged brackets, telescopic brackets, etc.).

21.4.6 Where transmitters can be exposed to the elements (wind, rain, ultra violet, etc.) such transmitters must be installed inside the FJB. Where transmitters are protected from the elements (i.e. inside buildings) but they are exposed to potentially harmful conditions like moisture from splashing or equipment being hosed down, or the sensor is in such a position that the transmitter display is not clearly visible from floor level, without the need to climb onto ladders or structures to access it, the transmitter must also be installed inside the FJB. Only where transmitters are not exposed to the elements or any other harsh or potentially harmful conditions and where the displays on such transmitters are clearly legible by an average person standing on the ground or the normal walking surface (e.g. grating above ground level), can the transmitter be mounted outside the FJB.

21.4.7 FJBs must be mounted against a wall or structure or on a sturdy pedestal such that the top of the FJB enclosure is no higher than 1.8 m from the floor and easily accessible from the front.

21.4.8 All instrument installations must be done in accordance with the manufacturer’s requirements and recommendations for proper operation. It is the tenderer’s responsibility to ensure that he/she is familiar with both the requirements of the

manufacturer as well as the installation requirements, in terms of location, site conditions, materials, equipment or substances to be measured (e.g. hot liquids, acids, abrasive material, etc.) and to ensure that if there are potential problems, they can be pointed out and rectified before orders for equipment are placed.

21.4.9 Costs incurred for alterations required to ensure proper operation of instruments, after orders have been placed, will be for the tenderer's account. For example, if instruments have been ordered and it is found there is insufficient space to install the instrument, or lifting equipment cannot be inserted to fit the instrument, or the instrument is interfered with by mechanical structures, or the safe loading capacity of the instrument is exceeded, or there is incorrect eccentric or concentric loading on a load cell, or the sensor does not have a suitable range of measurement, etc. alterations or replacements required to rectify such problems will be for the tenderer's account if the Engineer finds that the tenderer was negligent in his/her assessment of the installation.

21.4.10 It is the express responsibility of the tenderer to guarantee that this instrument will work correctly for this application and that it will not require regular maintenance (i.e. more frequently than once in 6 months) under normal operation conditions. If the instrument does not work correctly or if regular maintenance is required for it to work properly, the tenderer will be required to replace the instrument with one that does work correctly, and the cost of such replacement (including the cost for another instrument, labour and material) will be for the tenderer's account.

21.4.11 Each instrument which is a 2-wired, 24V DC, loop powered device must be equipped with a suitably sized fuse in a latched fuse holder, connected to the power supply of the instrument, to enable local isolation in case of repairs or replacement.

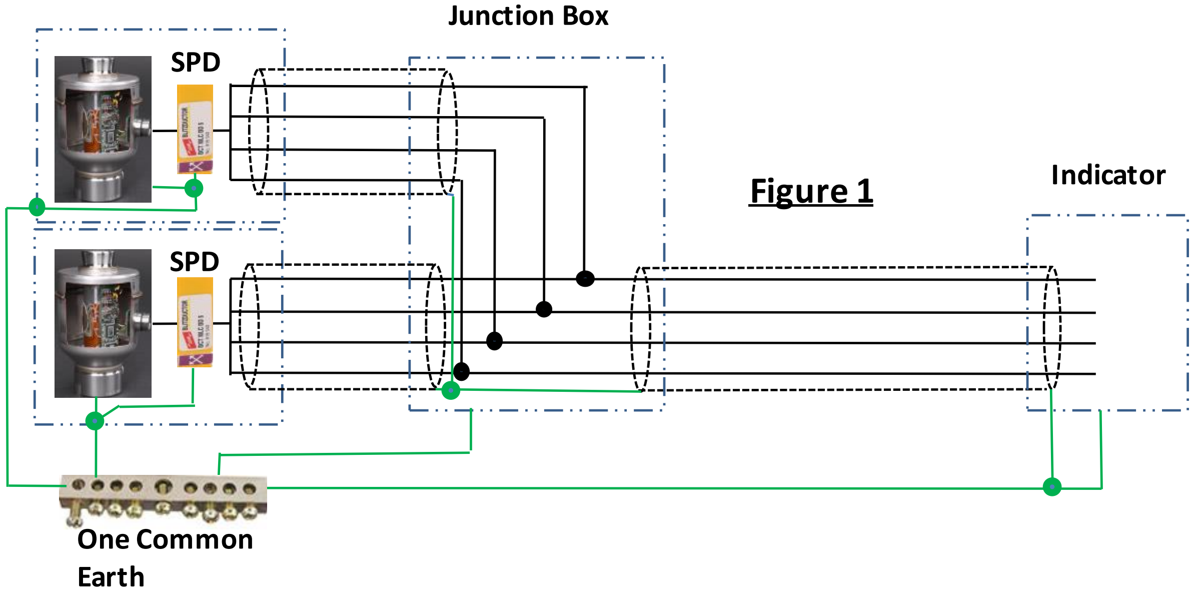
21.4.12 Each instrument which is a 230V AC powered device must be equipped with a 2-pole circuit breaker, connected to the power supply of the instrument, to enable local isolation in case of repairs or replacement.

21.4.13 The supplier of the instrument must be present for the installation, testing and commissioning of the instrument on site. Due allowance must be made for this in the tender sum.

21.4.14 The tenderer must supply a complete and detailed set of documentation for the installation, connections, terminations, power supply, technical details, setting up, calibration, testing, etc. of the instrument for inclusion in a final O&M manual.

21.4.15 Completed data sheets are required as part of the returnable documents of each tender. Failure to complete these data sheets, supplied at the end of this specification, will lead to disqualification of the tender.

21.5 Screening, Earthing And Surge Protection

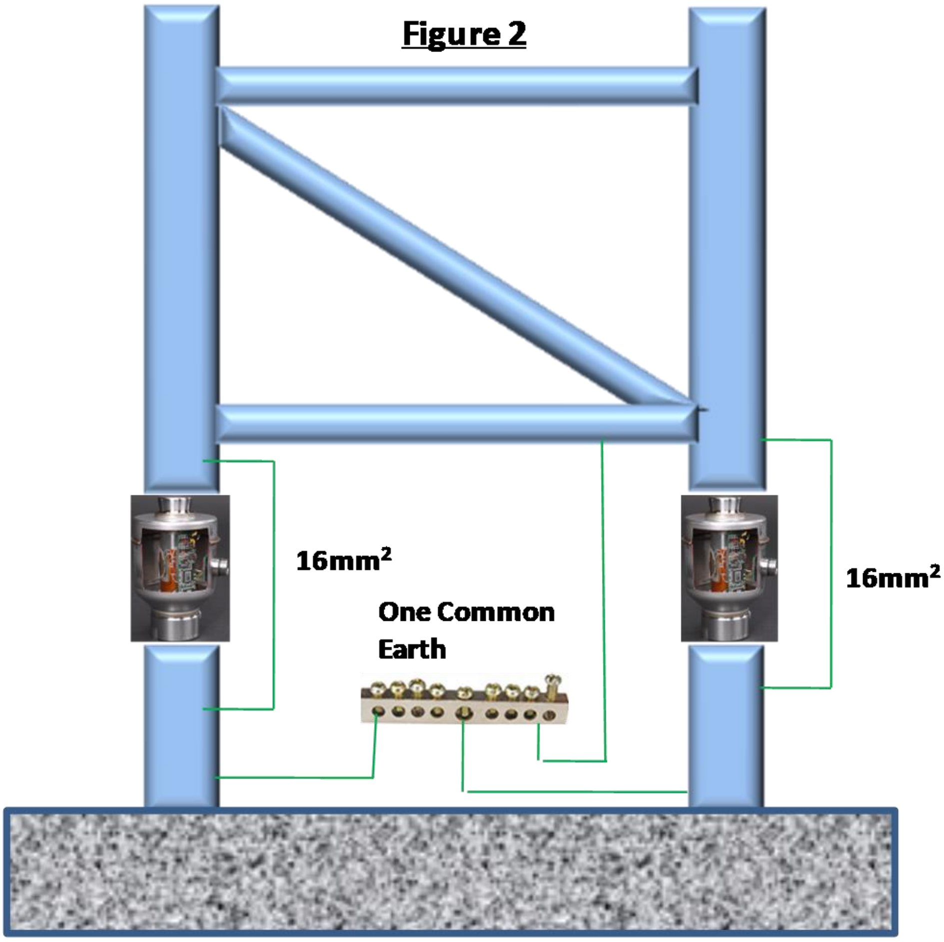


21.5.1 Each instrument and its associated equipment must be suitably protected against surges from induced voltages, switching of equipment, lightning strikes, etc. as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

21.5.2 The power supply to the instrument must be equipped with suitable surge protection, both at the instrument and at the source of the power supply (i.e. at the distribution board, MCC, PLC panel, etc.), as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

21.5.3 Both the digital and analogue signals between the instrument and other remote devices (such as the PLC), must be equipped with suitable surge protection, both at the instrument and at the remote device as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

21.5.4 All load cells, junction boxes, SPDs, indicators, etc. must be equipped with good earthing connections.



21.5.5 Avoid earth current loops by:

- Earthing cable screens at one end only (see Figure 1)
- Using one common earth point, instead of multiple earths (see Figure 1 and Figure 2)
- Grounding the load cell and the SPD at the same point (see Figure 1)

21.5.6 When welding is done, put the earth clamp as close as possible to the point of welding and avoid high currents running through the load cell.

21.5.7 When welding is done, and the load cell cannot be removed, at least disconnect the load cell cables.

21.6 Load Cells And Their Installation

21.6.1 The design and manufacturing of the vessel to be weighed by load cells must be done in conjunction with the supplier of the load cells to ensure that all factors such as wind forces, asymmetrical loading, maintenance, number of load cells, brackets for load cells, etc. have been taken into consideration. Where wind forces, asymmetrical loading, etc. can cause the vessel to be lifted from one or more of the load cells, it has to be ensured that the brackets used provide protection against the vessel being lifted off a load cell.

21.6.2 It must be ensured that the load cell can move freely, without obstruction from external systems or devices such as chutes, brackets, supports, pipes, cables, etc.

21.6.3 The vessel must be designed to avoid impact forces which can lead to overloading and subsequent damage to the load cells.

21.6.4 Pipe connections, cable connections, etc. must be done via extremely flexible connections to avoid interference with mass measurement.

21.6.5 A flexible, multi-strand, copper conductor of not less than $16mm^2$ must be connected to the structure on either side of the load cell to ensure that harmful currents from surges, welding, etc. are diverted across the load cell.

21.6.6 The structure design and load cell selection must be such that load cells can be removed for maintenance or replacement, without overloading other load cells on the same vessel. Dummy load cells must be provided for fitting during construction (before the actual load cells are installed) or for fitting during replacement.

21.6.7 The number and location of load cells must be such that each load cell will bear the same amount of weight. I.e. situations where one load cell can bear virtually no weight must be avoided by proper installation measures (such as shimming) during commissioning and setting up.

21.6.8 Pivot weighing (i.e. where half the vessel is weighed by load cells while the other half is supported on dummy load cells or flexure beams acting as pivots) can only be done where symmetrical vessels containing liquids are weighed and where it can be ensured that the pivot system will not introduce friction which can lead to false weight readings.

21.7 Load Cells Measuring Criteria

21.7.1 The measuring range of the load cell must be suitable for the application (see items 21.4.8 and 21.4.9 of this specification).

21.7.2 Each load cell must be manufactured from stainless steel or from tool steel which is Electroless Nickel (“EN”) plated and painted to SANS 1274-2005, and must be hermetically sealed to IP68.

21.7.3 Since these load cells are not used in “Scales For Trade”, only medium accuracy load cells are required. Each load cell must have a combined error of no greater than 0.2% of the measured range. The overall system error (including the mechanical installation) must not be greater than 0.5% of the measured range.

21.7.4 Each load cell must have a temperature operating range of at least -10ºC to +45 ºC.

21.8 Load Cell Junction Box And Indicator

21.8.1 Each system must be supplied, complete with a local junction box where all the load cell cables are connected in parallel to provide a single output related to the weight being measured.

21.8.2 Each system must also be supplied, complete with a local indicator. There must be a single multi-core cable wired from the local junction box to the local indicator.

21.8.3 Each local indicating unit must be equipped with a means of calibrating and performing tare functions. These functions however must only be available to suitably qualified personnel. I.e. there must be a means of preventing unauthorised people from performing these functions (such as password protection, a lock-out key, etc.).

21.8.4 The local indicating unit must be equipped with an isolated, active, 4 – 20mA output for mass, which will be connected to a maximum 500 ohm load.

21.8.5 The local indicating unit must have a potential-free relay contact for a collective failure on the system as well as change-over relay contacts for at least three programmable threshold limits. Each contact must be suitable for switching 500mA at 230V AC,

21.8.6 The local indicating unit must be suitable for a 230V AC, ±10%, power supply.

21.8.7 The local indicating unit must have at least a 5-digit display.

21.8.8 The local indicating unit and the local junction box must have a protection rating of not less than IP 65 and it must comply with the requirements of the Field Junction Boxes Specification (Volume 19 of the Automation And Control Standards) if it is a free-standing enclosure. If it (the local junction box and/or the local indicator) is mounted inside another field junction box (i.e. the field junction box containing the cabling to the PLC and/or the MCC), it can be manufactured of poly-carbonate or similar material and need only have a protection rating of not less than IP 54.

21.8.9 The local indicating unit and the local junction box, with all electronic and indicating instrumentation, must have a temperature operating range of at least -10ºC to +45 ºC.

21.9 Spares And Manufacturer/Authorised Distributor Requirements

21.9.1 The tenderer will be required to provide a recommended spares list for three years maintenance. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

21.10 Data Sheets

21.10.1 All data sheets in the attached Appendix 1 must be completed.

21.10.2 Where terms and conditions apply to warranties or guarantees, these should be clearly stated in the data sheets in the section where “Guarantee period” is requested.

APPENDIX 1

DATA SHEET – LOAD CELLS

DESCRIPTION	DATA
Load Cell	
Load Cell Make/Manufacturer	
Type/Model	
Material Of Construction	
IP Rating	
Measuring range	
Manufacturer/authorised distributor (Y/N)?	
Manufacturer/authorised distributor contact details.	
Guarantee period	
Combined Accuracy (% of measured range)	
Local Indicator	
Power Supply (Voltage)	
Analogue Output Type	
Change-over relay contacts for programmable limits (Y/N)?	
Self-diagnostics with failure alarming (Y/N)?	
Local Indicator Enclosure Rating	
Guarantee period	
Local Junction Box	
Local Junction Box Enclosure Rating	

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 23 : PRESSURE MEASUREMENT

Johannesburg Water

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Revision 8

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DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 23 : Pressure Measurement**

JW Reference: **BWW523C**

Document Ref. No: **VOLUME 23**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	
Approved	Manager	T. Thabeng	09/09/2019	

RECORD OF REVISIONS

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2019-08-26	8	C. Du Toit	Cover page updated
2019-06-15	7	C. Du Toit	Added remote transmitters as requested by JW.
2018-11-30	6	C. Du Toit	Added reference to Labelling specification and made
2014-04-17	5	C. Du Toit	Added reference to FJB specification.
2013-10-07	4	C. Du Toit	Updated footer
2012-07-27	3	C. Du Toit	Updated headers & footers.
2012-03-08	2	C. Du Toit	Changed (Pty) to (SOC).
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

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23 PRESSURE MEASUREMENT

23.1 Scope

23.1.1 This specification covers the supply and installation of Pressure meters, complete with sensors, transmitters, indicators, panels, etc. used for process monitoring and control applications at Johannesburg Water wastewater sites.

23.2 Abbreviations

23.2.1 In this specification the following abbreviations will apply :-

BS	:	British Standards
PLC	:	Programmable Logic Controller
I/O	:	Input/Output
CPU	:	Central Processing Unit
UPS	:	Uninterruptible Power Supply
MCC	:	Motor Control Centre
MCB	:	Miniature Circuit Breaker
SPD	:	Surge Protection Device
FJB	:	Field Junction Box
SSO	:	Switched Socket Outlet
SPDT	:	Single Pole Double Throw (refers to relay or switch contact arrangements).
LCD	:	Liquid Crystal Display
LED	:	Light Emitting Diode
O&M	:	Operating And Maintenance

23.3 Standards

23.3.1 The supply and installation of all Pressure meters and associated cabling, panels and any other equipment shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	:	National Standards for the wiring of premises.
SANS 1091:2004	:	National Colour Standard.
SANS 1274-2005	:	Coatings applied by the powder-coating process.
BS 381C:1980	:	Paint colour chart.

23.4 General Requirements

23.4.1 This specification must be read in conjunction with the following specifications:-

23.4.1.1 PLC Panels Specification (Volume 3 of the Automation And Control Standards).

23.4.1.2 Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

23.4.1.3 Cabling Specification (Volume 6 of the Automation And Control Standards).

23.4.1.4 Field Junction Boxes And Panels (Volume 19 of the Automation And Control Standards).

23.4.1.5 Labelling (Volume 25 of the Automation And Control Standards).

23.4.2 Where cables are exposed to physical damage (including damage from rodents) armoured cables must be used or un-armoured cables must be run in steel conduit.

23.4.3 All power supply cables to instruments must have a black outer sheath, while all control cables (such as digital and analogue signals to PLC's) must have an orange outer sheath as specified in the Cabling Specification (Volume 6 of the Automation And Control Standards).

23.4.4 FJBs and as far as practically possible all instrument sensors and transmitters, must be mounted such that all equipment, wiring, numbers, terminations, etc. are readily accessible and can be viewed clearly. No equipment may be mounted such that it becomes a hazard or dangerous to view or gain access to such equipment.

23.4.5 Where sensors and/or transmitters cannot be mounted where they are readily accessible, the installation must be done in such a way that the sensor or transmitter can easily be moved to a safe and convenient position for testing, maintenance, replacement, etc. (e.g. by using hinged brackets, telescopic brackets, etc.).

23.4.6 Where transmitters can be exposed to the elements (wind, rain, ultra violet, etc.) such transmitters must be installed inside the FJB. Where transmitters are protected from the elements (i.e. inside buildings) but they are exposed to potentially harmful conditions like moisture from splashing or equipment being hosed down, or the sensor is in such a position that the transmitter display is not clearly visible from floor level, without the need to climb onto ladders or structures to access it, the transmitter must also be installed inside the FJB. Only where transmitters are not exposed to the elements or any other harsh or potentially harmful conditions and where the displays on such transmitters are clearly legible by an average person standing on the ground or the normal walking surface (e.g. grating above ground level), or where it is not practically possible (for example where a transmitter is screwed directly into a socket in a pipe or vessel), can the transmitter be mounted outside the FJB.

23.4.7 FJBs must be mounted against a wall or structure or on a sturdy pedestal such that the top of the FJB enclosure is no higher than 1.8 m from the floor and easily accessible from the front.

23.4.8 All instrument installations must be done in accordance with the manufacturer's requirements and recommendations for proper operation. It is the tenderer's responsibility to ensure that he/she is familiar with both the requirements of the manufacturer as well as the installation requirements, in terms of location, site conditions, materials, equipment or substances to be measured (e.g. hot liquids, acids, abrasive material, etc.) and to ensure that if there are potential problems, they can be pointed out and rectified before orders for equipment are placed.

23.4.9 Costs incurred for alterations required to ensure proper operation of instruments, after orders have been placed, will be for the tenderer's account. For example, if instruments have been ordered and it is found there is insufficient space to install the instrument, or the instrument is not flooded with liquid all the time as it is required for proper operation, or the instrument transmitter is sometimes flooded in its installed position, or the sensing head is sometimes outside the medium it is supposed to measure, or the instrument linings are damaged by abrasive liquids, or the sensor is does not have a suitable range of measurement, etc. alterations or replacements required to rectify such problems will be for the tenderer's account if the Engineer finds that the tenderer was negligent in his/her assessment of the installation.

23.4.10 Each instrument must be equipped with a circuit breaker connected to the power supply of the instrument, to enable local isolation in case of repairs or replacement.

23.4.11 The supplier of the instrument must be present for the installation, testing and commissioning of the instrument on site. Due allowance must be made for this in the tender sum.

23.4.12 The tenderer must supply a complete and detailed set of documentation for the installation, connections, terminations, power supply, technical details, setting up, calibration (if applicable), testing, etc. of the instrument for inclusion in a final O&M manual.

23.4.13 Completed data sheets are required as part of the returnable documents of each tender. Failure to complete these data sheets, supplied at the end of this specification, will lead to disqualification of the tender.

23.5 Surge Protection

23.5.1 Each instrument and its associated equipment must be suitably protected against surges from induced voltages, switching of equipment, lightning strikes, etc. as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

23.5.2 The power supply to the instrument must be equipped with suitable surge protection, both at the instrument and at the source of the power supply (i.e. at the distribution board, MCC, PLC panel, etc.), as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

23.5.3 Both the digital and analogue signals between the instrument and other remote devices (such as the PLC), must be equipped with suitable surge protection, both at the instrument and at the remote device as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

23.6 Pressure Measurement – Controller/Transmitter

23.6.1 All instrument transmitter enclosures must have at least an IP 65 or higher rating.

23.6.2 The instrument must be equipped with a 4 – 20mA output which will be connected to a maximum 500 ohm load. If a pressure switch is required, the instrument must be equipped with two digital outputs of which the pressure operating value can be adjusted.

23.6.3 The transmitter must be equipped with an LCD or LED display to show the instantaneous pressure (for analogue or digital (pressure switch) instruments).

23.6.4 The transmitter must be mounted inside and IJB (Instrument Junction Box) which will be located in a suitable area for viewing, maintenance, etc. I.e. instruments with a transmitter local to the sensor will not be accepted.

23.6.5 The transmitter must have an error of not more than 0.2% of the full scale value for analogue instruments. This error must include non-linearity, hysteresis, repeatability plus zero-point and full scale deviations. If the error is defined by the maximum deviation of the transmitter output from a best fit straight line (B.F.S.L) in any one calibration cycle, this error must not be greater than 0.1% of the span (or full scale value). For digital instruments (pressure switch) the combined error (including non-linearity, hysteresis, zero point and full scale error) must not be greater than 1%.

23.6.6 The transmitter must be suitable for an ambient operating temperature range of -10ºC to +50ºC.

23.7 Pressure Measurement – Sensor/Transducer

23.7.1 All pressure measurements must be done by using a threaded instrument with a flush diaphragm sensor to ensure that there are no parts protruding into a pipe or vessel and which can lead to snagging of material in the medium being measured.

23.7.2 The range of the sensor must be suitable for the application (see items 23.4.8 and 23.4.9 of this specification).

23.7.3 The sensor must be suitable for an operating temperature range of -10ºC to +100ºC.

23.7.4 The sensor must be equipped with automatic temperature compensation.

23.7.5 The sensor must have an overpressure safety of not less than 1.33 times the measuring range.

23.7.6 The sensor diaphragm material must be ceramic.

23.8 Spares

23.8.1 The tenderer will be required to provide a recommended spares list for three years maintenance. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

23.9 Data Sheets

23.9.1 All data sheets in the attached Appendix 1 must be completed.

APPENDIX 1

DATA SHEET – PRESSURE METER

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output Type	
Digital Output Quantity, Type & Rating (E.g. 2 x PNP, 250mA) & Programmable (Y/N)?)	
Controller/Transmitter Enclosure Rating	
Controller/Transmitter Accuracy	
Resolution	
Display Data & Type (E.g. instantaneous pressure & LCD)	
Transmitter ambient temperature range	
Sensor temperature operating range	
Sensor process connection - Flush diaphragm (Y/N)?	
Transducer/Sensor temperature compensation (Y/N)?	
Sensor overpressure safety rating (??? times range)	
Local agent (Y/N)?	
Local agent contact details.	
Guarantee period	

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

VOLUME 25 : LABELLING

Johannesburg Water (SOC) Ltd.
PO Box 61542
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Revision 3 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 25 : Labelling**

JW Reference: **BWW523C**

Document Ref. No: **VOLUME 25**

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RECORD OF REVISIONS

Date	Revision	Author	Comments
2019-08-26	3	C. Du Toit	Cover page updated
2019-07-04	2	C. Du Toit	JW requirements from electrical workshop for wire numbering included.
2019-06-15	1	C. Du Toit	JW requirements included (Arial font on labels and no more than 4 threads showing on bolt ends).
2018-11-30	A	C. Du Toit	Initial revision issued for comment/approval

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25 LABELLING

25.1 Scope

25.1.1 The purpose of this document is to cover the requirements for the supply and installation of labels on all C&I equipment, cables, wires, and panels.

25.1.2 If there is a discrepancy between the requirements of this specification and the requirements in the tender Scope of Work, the Scope of Work will take precedence.

25.2 Abbreviations

25.2.1 In this specification the following abbreviations will apply :-

Contractor	:	The persons/s named as a contractor in the letter of tender accepted by the employer.
Employer	:	The person/entity named as Employer in the tender, and the legal successors in title to this person.
Engineer	:	The person appointed by the Employer to act as Engineer for the purposes of this contract.
BS	:	British Standards
ICP	:	Instrument Control Panel
IJB	:	Instrument Junction Box
PLC	:	Programmable Logic Controller
SPDT	:	Single Pole Double Throw (refers to relay or switch contact arrangements).
LCD	:	Liquid Crystal Display
LED	:	Light Emitting Diode
PTFE	:	Mixed Liquor Suspended Solids
O&M	:	Operating And Maintenance
UV	:	Ultraviolet

25.3 Standards

25.3.1 All design standards shall be subject to the latest amendments and editions of the following standard specifications:

SANS 10142-1	:	National Standards for the wiring of premises.
SANS 1186	:	Information and Safety Signs.
SANS 1040	:	National Building Regulations

25.4 Performance And Installation Requirements

25.4.1 The attachment of labels must not at any time compromise the IP protection rating of any panel or enclosure.

25.4.2 Glue-on labels will only be permitted if industrial type glue or industrial type double-sided adhesive tape is used. Normal commercial or household glue or double-sided adhesive tape will not be accepted. This glue or tape must also not be used where environmental conditions such as wind, rain, UV, etc. can lead to the deterioration of the adhesive tape.

25.4.3 Any deviations from this specification need to be approved in writing by the engineer.

25.4.4 Where glue or adhesive tape is not used, signs and labels shall be affixed using corrosion resistant, mechanical fixings.

25.4.5 Not more than one item will be labelled with one label**, i.e. there will not be a continuous strip of labels for multiple items.** Each item shall have a separate, unique label assigned to it**.**

25.4.6 Allowed label materials are as follows:

25.4.6.1 Traffolyte or equal, or hard plastic sandwich board. (black lettering on white background) (not applicable to cables).

25.4.6.2 Reverse engraved acrylic material, with filled letters and reverse sprayed. (not applicable to cables).

25.4.6.3 Engraved or embossed stainless steel (for cable labels).

25.4.7 Labels that will be outside and frequently exposed to wind, rain and UV radiation must be either Traffolyte or equal, stainless steel, brass or aluminium, with engraved letters filled with black, or embossed lettering.

25.4.8 At the engineer's request the contractor shall provide proof that materials used for labels are corrosion proof or UV resistant. The cost of this needs to be allowed for in the tender.

25.4.9 The font used for all printed and engraved labels shall be Arial.

25.4.10 Specific requirements for labels listed in the tender specification supersede any general requirements listed in this specification.

25.4.11 Bolts with nuts shall not be used to attach labels to any mounting plate at any point. On mounting plates only bolts in tapped holes will be acceptable (if glue or double sided tape as mentioned in item 25.4.2 above is not used). Bolts with nuts will be allowed on enclosure doors however, where the bolts and nuts are easily accessible.

25.4.12 The use of pop rivets to attach labels will not be allowed.

25.4.13 The preferred method of attaching labels is to use corrosion resistant screws in tapped holes.

25.4.14 Where bolts are used on the door or any outside panels of the enclosure, a sealing method (e.g. rubber washers) must be used to ensure that the IP protection rating of the enclosure is not compromised.

25.4.15 Wherever bolts are used, the bolts must be as short as practically possible so that there are no long protrusions that can injure people or snag clothing, wiring, other equipment, etc. If bolts are cut to the correct length, the ends of the bolts must be neatly de-burred and smoothed so that there are no sharp edges that can cause injuries and so that the nuts can be easily screwed on and off. No more than four threads of the bolt end must be visible beyond the nut. It is however preferred that the correct length of bolts are used so that shortening is not required.

25.5 Safety

25.5.1 Where hazardous or dangerous equipment, conditions or materials are present, safety signs and labels shall be attached in such a way that it is clear what the hazard or danger is.

25.5.2 Any hazard, for which there is not a standard symbol defined in the standards mentioned in item 25.3.1 of this document, will be identified by simple wording and symbols approved or specified by the engineer.

25.5.3 Self-adhesive safety signs on vinyl will be permitted on enclosures if the safety signs are standard or approved by the engineer.

25.5.4 Where approved by the engineer, internally mounted, project specific safety labels and charts may be printed on plastic or laminated thin card, protected behind Perspex.

25.5.5 The contractor will supply safety signs for all hazardous components, including, but not limited to:

25.5.5.1 Busbar covers.

25.5.5.2 Fibre Optic patch panels and switches where laser light could be harmful to one’s sight.

25.5.5.3 Power inside a panel that does not originate inside the panel itself i.e. it may not be powered down when the panel is isolated.

25.5.6 The text size for Information/warning labels inside enclosures shall be 6mm high (16pt).

25.5.7 The text size for Information/warning labels outside enclosures shall be 10mm high (26pt).

25.6 Enclosures

25.6.1 Labels with the name of the enclosure shall be attached to the outside of the enclosure, on the front at eye height, or as close to eye height as is practical.

25.6.2 The label will be attached with corrosive resistant bolts or screws either into a tapped hole, or via a corrosion resistant washer and nut at the back. Nuts and bolts can only be used on enclosures where such nuts and bolts are readily accessible (e.g. on the enclosure door).

25.6.3 Every PLC panel, ICP, or IJB, shall have an engraved stainless steel label attached with the following information clearly visible inside the panel, ICP, or IJB:

25.6.3.1 Contractor name.

25.6.3.2 Contractor contact information.

25.6.3.3 Enclosure serial/identification number and manufacture date.

25.6.4 The text size for Enclosure name labels shall be 10mm high (26pt).

25.7 Cables

25.7.1 Identical labels shall be attached at both ends of each cable.

25.7.2 Labels for cables in a PLC panel/MCC panel/IJB/ICP shall be located at the entry to the panel, on the inside and outside of the panel, where the cable numbers inside and outside the panel are not visible from one location (e.g. cables at the PLC panel entry, where cable numbers are either visible inside the PLC panel or inside the cable trench).

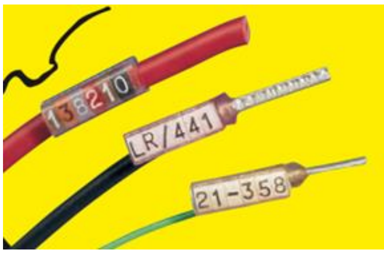
25.7.3 Labels for cables of instrument sensors and other field mounted components shall be located within 100mm of the termination point.

25.7.4 Labels for cables must be attached via either stainless steel straps or cable ties that are certified as UV stabilized.

25.7.5 The text size for cable identification labels shall be at least 6mm (16pt).

25.8 Wires

25.8.1 No separate wire numbers slid onto wires will be accepted. A wire number holder must be attached to the wire and the wire numbers must then be inserted into the wire holder (see the examples below).



These wire number holders must surround the wire completely. I.e. they must slide onto the wire. Clip-on holders will not be accepted.

25.8.2 Wires shall be labelled at both ends with the numbers indicated on construction drawings.

25.9 Components

25.9.1 Each component inside IJBs, ICPs, and PLC panels shall be clearly identified with a unique label as indicated on the construction drawings.

25.9.2 Labels will not be attached to trunking or any other item that can be removed for maintenance, including the component itself. Removal of trunking or replacement of components must not affect the component labelling.

25.9.3 Pushbuttons and other controls must be labelled with their function on a separate label (E.g. Stop, Start, Open, Close, etc.).

25.9.4 Labels for components are allowed to be inserted in a rail on the mounting plate, if this rail is specifically made for the relevant labels. The rail shall not obscure any part of any lettering.

25.9.5 Labels shall be located directly below, above or adjacent to the relevant equipment, as long as the label is clearly visible and it is clear and unambiguous as to which item of equipment the label refers to.

25.9.6 All terminal strips, and terminals must be labelled with labels that attach to the relevant terminal strip marker or terminal respectively.

25.9.7 The text size for component identification labels shall be 4mm high (10pt).

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

ELECTRICAL PARTICULAR SPECIFICATION INDEX

GENERAL

Johannesburg Water (SOC) Ltd.
PO Box 61542
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August 2019

DOCUMENT CONTROL SHEET

Document Title: **Electrical Particular Specifications**

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Approved	Regional Maintenance Manager	T. Thabeng	August 2019	

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6	2019-08-20	B. Pieterse(WSP)	Review of existing Electrical Standards, plus New Design Guidance & workshops with Best Practice & Operations
5	2014-06-03	PDNA	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design guidance
4	2012-05-30	PDNA	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design guidance
3	2011-08-30	PDNA	Omit FIFA Logo
2	2010-05-30	PDNA	Review of Electrical Standards
1	2009-05-12	PDNA	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design guidance

Introduction

The Electrical Particular specifications consist of several volumes, as indicated in the “Volume Index” below. These particular specifications serve as a basis for the design, procurement, installation and maintenance of all Electrical items in accordance with the J Water preferred standards. It further serves to ensure that all electrical projects are designed and executed to the same high standards and also to ensure that Johannesburg Water can maintain a level of standardization across all plants in terms of operations, efficiency & maintenance, technical skills knowledge across all the respective plants, whilst at the same time adhering to all the rules governing design and procurement for all projects as well as adherence to regulatory requirements.

These particular specification documents must be read in conjunction with the detailed descriptions, scope of work, schedule of quantities, etc. contained in the tender documents. Where discrepancies exist between these particular specifications and the detailed specifications in the tender documents, the detailed specifications (Scope of Works) in the tender documents will take precedence.

All volumes will be updated as requirements, technology, etc. change to ensure that particular specifications are always fit-for-purpose and in accordance with the latest specifications.

ELECTRICAL DESIGN STANDARDS INDEX

Description	Volume No.	Revision	Date
Electrical Motors	E01	4	2019-08-20
Electrical Cable Racks	E02	5	2019-08-20
Electrical Isolator Pushbutton Station (Local start/stop) Equipment	E03	5	2019-08-20
Electrical Low Voltage Distribution Boards and Motor Control Centres	E04	6	2019-08-20
Electrical Low Voltage Power and Control Cables	E05	5	2019-08-20
Electrical Medium and Low Voltage Cable Installation	E06	5	2019-08-20
Electrical Industrial Welding Plugs, Couplers and Socket Outlets	E07	4	2019-08-20
Electrical Wiring	E08	4	2019-08-20
Electrical Building Installation	E09	4	2019-08-20
Electrical Busbar Trunking	E10	4	2019-08-20
Electrical Earthing and Lighting Protection	E11	5	2019-08-20
Electrical Medium Voltage Cables	E12	4	2019-08-20
Electrical Medium Voltage Switchgear	E13	4	2019-08-20
Electrical Supply and Installation of a Standby Generator	E14	4	2019-08-20
Electrical Transformers	E15	4	2019-08-20
Electrical Uninterruptable Power Supply Unit	E16	4	2019-08-20
Electrical Variable Speed Drive (VSD) Units	E17	5	2019-08-20

Electrical Miniature Substations	E18	4	2019-08-20
Electrical 11kV Ring Main Unit	E19	2	2019-08-20
Electrical Overhead Lines up to 22kV	E20	1	2019-08-20
Electrical Lighting and Illumination	E21	1	2019-08-20
Electrical Testing and Commissioning	E22	Incl. in each specification	
Electrical Power Factor Correction	E23	1	2019-08-20
Electrical Battery Tripping Unit	E24	1	2019-08-20
Electrical Earthing and Earth Mat	E25	Specialist/ Design specific to project conditions (E11)	
Electrical Colour Coding of Equipment	E26	1	2019-08-20

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
E01 : ELECTRICAL MOTORS

Johannesburg Water

Johannesburg Water (SOC) Ltd.
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Revision 4

August 2019

City of Johannesburg
Johannesburg Water (SOC) Ltd

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4	2019-08-20	B Pieterse	Review of Electrical Standards, plus New Design Guidance
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2	2012-05-30		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
1	2009-05-12		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance

PARTICULAR SPECIFICATION: VOLUME E01: ELECTRICAL MOTORS

CONTENTS

E01.1 SCOPE

This specification shall cover all electric motors to be designed, supplied installed and tested that shall drive any of the items of equipment to be supplied under the contract. This specification shall be read together with those specifying the mechanical driven equipment.

E01.2 INTERPRETATIONS

E01.2.1 Abbreviations

In this Specification, the following abbreviations will apply:

ANSI : American National Standards Institute
ASTM : American Society for Testing and Materials
BS : British Standards Institution
SANS : South African National Standards

E01.2.2 Standards

The latest edition, including all amendments to until the date of tender, of the following particular national and international specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

(a) SANS 1804-2 : Low-voltage three-phase standard motors

(b) SANS 60529 : Degrees of protection provided by enclosures (IP code)

(c) SANS 60034 : Rotating electrical machines

(d) BS 1486-2 : Heavy duty lubricating nipples

(e) SANS 60034-1 : Rotating electrical machines Part 1: Rating and performance

(f) ISO 281 : Rolling bearings - dynamic load ratings and rating life

E01.3 GENERAL REQUIREMENTS

(a) Electric motors shall be manufactured in South Africa and shall comply with the requirements of SANS 1804-2.

(b) Imported motors shall be accepted only if they form an integral part of the equipment offered. Where imported motors are offered they shall be submitted to the South African Bureau of Standards to be tested in accordance with the requirements of SANS 1804-2.

(c) The Engineer shall be provided with the appropriate certificates obtained from the South African National Standards stating that such motors do comply, prior with the installation of the motors. However, where tests reveal that motors do not comply, it shall be the responsibility of the Contractor to supply alternative motors that comply with the requirements of SANS 1804-2.

(d) Where imported motors are not normally kept in stock in South Africa, written proof shall be provided of the availability of replacement parts as well as the delivery period of the parts after placing the orders.

(e) All motors shall be standard catalogue models and shall be readily available.

(f) All motors shall where possible, be from the same manufacturer and shall have the same interchangeable frames. Variations in type and size shall, where possible, be limited to prevent stocking a variety of special spares.

(g) All motors shall be wound for direct-on-line (DOL) type of starting.

E01.4 WORKING VOLTAGE AND SUPPLY SYSTEMS

(a) The motors shall be capable of operating within ± 10% of the nominal supply voltage without risk of damage. All motors shall be suitable for operating continuously at the specified 3-phase voltage system under actual service conditions, including the ± 10% voltage tolerance, without exceeding the specified temperature rise determined by the resistance on a basic full load heat run.

(b) All motors shall be capable of operating continuously under actual service conditions at any supply frequency between 48 and 51 Hz together with any voltage between ± 5% of the nominal supply voltage.

(c) The slip-in speed of any motor at 80 percent of the nominal voltage at 50Hz shall not exceed a percentage agreed on by the engineer, and the motors shall be capable of operating at this voltage for a period of five minutes without deleterious heating.

E01.5 TEMPERATURE RISE

The temperature rise, as determined by resistance, of all motors, shall not exceed the following derated values:

Insulation class	E	B	F	H
Temperature rise (K)	50	60	80	100

E01.6 EFFICIENCY AND POWER FACTOR

(a) All motors supplied will be energy-efficient as described in SANS 60034-31: Selection of energy-efficient motors

(b) The efficiency of all motors shall be guaranteed by the contractor. Deviations from the guaranteed efficiency shall be within the limits specified in SANS 1804-2.

(c) The guaranteed efficiency of each motor size and rating shall be as determined in accordance with SANS 60034. A basic test certificate of efficiency will be accepted for a motor of identical size and rating or a basic test of efficiency shall be conducted if no certificate is available.

(d) The power factor of motors with a capacity of 20 kW or more shall not be less than 0,85 under all operating conditions.

E01.7 VIBRATION

(a) Motors shall be statically and dynamically balanced.

(b) All motors shall be checked for inadvertent vibration without load, and at full rated voltage at the manufacturer's works, and the vibration amplitude as measured shall be in accordance with SANS 60034-1.

(c) The ratio of axial to radial vibration shall not exceed 0,5.

E01.8 NOISE LEVEL

Unless specified differently all motors shall be of 'normal sound power', in compliance with SANS 60034.

E01.9 ENCLOSURE AND FRAME

(a) Each motor shall be ingress protected to the degree required by its application, and its enclosure shall be designed for the system of cooling associated therewith.

(b) Notwithstanding the requirements above, the minimum degree of protection shall be IP 55 to SANS 60529, or alternatively specified. Motors shall preferably be of the totally enclosed fan-cooled (TEFC) type.

(c) The motor cooling system must be of an aerodynamic design with minimal noise levels and superb airflow distribution over the frame with superior mechanical strength. All motor cooling fan covers will be constructed in metal.

(d) All motors of the vertical-spindle type and exposed to the weather, shall be provided with a robust canopy of approved design by the Engineer.

E01.10 MOTOR TYPE

Motors shall be of the squirrel-cage induction type. Slip-ring induction motors or other approved types will be considered if the contractor is of the opinion that better results could be obtained by using such motors. Full electrical and mechanical details of each alternative shall be submitted with the tender documents. Alternative motors must be accepted by the Engineer in writing.

When motors are connected to VFD's with variable torque loads operated under usual service conditions, inverter-ready general-purpose motors must be supplied (IEC 60034-1)

When motors are connected to VFD's operating at extremely low speeds and/or with a constant torque load, or when operating over base speed, definite-purpose, inverter-duty motors must be supplied (IEC 60034-1).

Larger inverter-duty motors must be equipped with a constant speed auxiliary blower to provide adequate cooling at low motor operating speeds. The contractor must submit a statement from the motor supplier on the need for an auxiliary blower when omitted.

Inverter-duty motors above the 500 frame size should have both bearings insulated, and be equipped with a shaft grounding brush with a ground strap from the motor to the drive case. For frame sizes below 500, the contractor must check with the motor manufacturer regarding requirements for motor bearing insulation.

E01.11 RATING AND STARTING REQUIREMENTS

(a) Motors shall be adequately rated for the service for which they are intended, and due allowance shall be made for the temperature, altitude, climatic conditions and variations in the supply voltage. Motors shall not exceed 120% of the required capacity without prior approval from the Engineer.

(b) Not only shall motors be based on the full load requirements, but also the motor capacity and starting characteristics shall be compatible with the requirements of the driven equipment.

(c) Where motors are required to drive high inertia loads, the starting torque of the motor and the torque curve of the driven load shall be submitted to the Engineer for approval prior to manufacture. Such motors shall be capable of at least three starts per hour, with two consecutive starts from normal operating temperature, or more frequently if required by the Engineer.

(d) Motors shall be of the continuously running duty class S1 unless otherwise specified in the detailed specification or if a more onerous duty is dictated by the drive requirement.

(e) All squirrel-cage induction motors shall be suitable for direct on line starting at full voltage. Single-speed motors shall conform to SANS 60034-12, Design B characteristics unless approved by or dictated by the drive requirements.

(f) Unless otherwise approved, the 15% tolerance on locked-rotor torque permitted by SANS 60034-1 will not be accepted and shall be limited to 10%.

(g) Documentation shall include performance curves to suit the designed working conditions.

(h) When making a selection of the motor size for driven equipment, motor power shall be over-rated by a factor of thirty percent (30%) more than the demand of the driven equipment.

E01.12 BEARINGS

(a) All motors shall, wherever possible, be provided with pre-lubricated sealed bearings.

(b) Re-greasable bearings shall require only one lubrication per year. Grease lubrication of ball or roller bearings, where approved, shall be by means of hexagonal button-type grease nipples to BS 1486- 2, Nos. 21A or 21B (industrial type).

(c) Grease-lubricated bearings shall have relief holes to ensure that the bearings have been correctly packed, which holes shall be positioned so that the excess grease can be easily removed. Cups shall be fitted to contain excess grease.

(d) Bearings shall be protected against eddy currents and shall be capable of withstanding vibrations caused by unbalanced loads.

(e) All bearings shall be designed for a minimum L_{10h}, basic life rating of 50 000 hours at the rated load and speed for the application in accordance with ISO 281.

E01.13 EARTHING

All motors shall be provided with a machined or spot-faced boss earth point, tapped to receive a bolt of not less than 10 mm in diameter for earthing purposes. This earth point must be located on one side of the motor, between the mounting feet.

A protective earth cable must be installed between the MCC earth bar and the motor earth point, sized in accordance with SANS1042-1.

Earth bonding must be installed between the motor frame and the motor support structure as well as the cable support structure.

E01.14 HEATERS AND DRAINAGE

Non-submersible motors that will be located outdoors or in a damp location such as in a drainage sump shall be provided with suitable means of drainage to prevent the accumulation of water due to condensation. They shall also be fitted with anti-condensation heaters suitable for a 220V AC supply if considered advisable by the manufacturer.

All motors shall be supplied with anti-condensation heaters (220V AC supply) to keep the motor temperature at 23°C when the motor is not operational to prevent moisture from condensing in the motor unless specified otherwise.

Heater terminal boxes shall be fitted on the motor frame and shall be of robust design, liberally sized and complete with suitable terminal block and mechanical cable gland or conduit entry.

E01.15 TERMINAL ARRANGEMENTS

(a) All motor terminal boxes must be oversized to fit a cable one size bigger than the standard cable as a minimum

(b) The terminal box must be installed with an OME supplied seal between the terminal box and the motor chassis

(c) Motor cable termination blocks must confirm to the IEC 60034-1 standard

(d) The line connections of each motor shall be brought out to a terminal box located in an approved position. In the case of two-speed motors, separate terminal boxes shall be provided for each speed.

(e) Terminal boxes shall be of the totally enclosed type designed to exclude the ingress of dust and moisture and sealed from the internal circuit of the motor, and shall be manufactured from sand-cast metal. The wall thickness of the terminal boxes and the dimension of the cable inlet shall be as specified in SANS 1804-2. The terminal box shall be so designed that the cable entry may be made in any one of four positions placed at right angles to one another.

(f) Winding termination in the motor terminal boxes shall be properly secured or fastened to avoid hot connections during operation.

(g) Terminal boxes shall be of ample size to allow the cable to be terminated in the box. Under no circumstances shall the cable be allowed to be in contact with the inside of the box or lid.

(h) Terminals shall be of a substantial design and shall be suited to receive cable lugs. Pinch-screw connections will not be accepted.

(i) The terminal arrangement shall permit the motor to be disconnected from its supply cable without damaging the cable tails and shall allow the supply cable and motor windings to be tested separately.

(j) The electrical clearance and creepage distances, with the correct cable terminations in position, shall comply with the requirements of SANS 60034.

(k) Terminal markings shall be clear and permanent. Irrespective of the direction of rotation required on the site, the connections shall be such that, when the supply leads L1 - L2 - L3 are connected to the motor terminals U - V - W respectively, the motor shall rotate in a clockwise direction when viewed from the driving end.

(l) Motors suited for only one-directional rotation, shall be clearly marked as such by an arrow fixed to the motor frame at the driving end.

(m) Before the contractor orders terminal boxes for electrical equipment, he shall supply details of the proposed boxes to the engineer for approval. These precautions are necessary to ensure that the size of the connecting blocks installed is sufficient to accommodate the cables supplied and connected by another contractor, and that sufficient space exists within the box to route cables conveniently.

E01.16 MOTOR/LOAD COUPLING

(a) Motors shall be coupled direct to the equipment to be driven by means of approved couplings and/or gearboxes unless specified differently. Refer to the relevant sections for specific specifications on transmission couplings and gearboxes. Vee-belt and chain drives will be considered only if direct coupling of the motor to the equipment is impossible or impractical.

Motors driving vee-belt or chain drives shall be fitted with heavy-duty bearings suited to the full side thrust at 120% of full load torque and short-term overloads of up to 250% of the full load torques during starting. The stiffness of the rotor shaft shall be checked to ensure that resonance and fatigue do not occur.

(b) Where applicable, the flanges of the motors and equipment shall be identical.

(c) The precision tolerance class shall apply to all flange-mounted motors with regard to concentricity, perpendicularity and shaft run-out.

E01.17 INFORMATION PLATES FOR MOTORS

In addition to the information required by SABS 948-1the following shall also be marked on the nameplates:

(a) Year of manufacture,

(b) The order number,

(c) Total mass of motor in kilogram,

(d) Diagram indicating the number, type and positions of heaters and temperature detectors if applicable,

(e) Bearing types and sizes, and

(f) Bearing grease interval or bearing replacement interval where pre-packed bearings are used.

E01.18 ADDITIONAL SPECIFICATIONS FOR TWO-SPEED MOTORS

The following additional specifications apply to all two-speed motors:

(a) Terminal markings shall be as per SANS 1804-2.

(b) The starting current shall not exceed six times the full load current of the high-speed rating.

E01.19 SUBMERSIBLE MOTORS

The following additional requirements apply specifically to all submersible motors:

All submersible motors shall be suited for submersion up to a depth of 1,5 times the depth of submersion shown on the drawings for each application, or as specified in the detail specifications.

All submersible motors shall have dynamically balanced rotors supported by maintenance-free, sealed-for-life ball bearings.

All motors shall be suitably coated to ensure the satisfactory operation of the motor under the specified class of service.

All terminal boxes shall be waterproof and suited for submersion up to the depth as specified for the motors.

An adequate length of waterproof cable, purpose-made for submersion, shall be supplied with each submersible motor. The coupling of this cable to the normal power-distribution cable, which usually is of the PVC type with steel-wire armour, shall be placed at least 1 m above the maximum water level by means of a purpose-made, weatherproof, outdoor junction box. The submerged cable shall be supported to minimize any movement of the cable, which results from turbulence caused by the operation of the equipment or the flow of the water.

Thermistor protection temperature switches shall be provided for submersible motors.

Seal monitors shall be provided for submersible motors, together with the required seal monitor relays. The cost for the seal monitor relays shall be deemed included in the rates tendered for the equipment.

E01.20 ADDITIONAL REQUIREMENTS

(a) The rotation speed of motors shall not exceed 1 500 rpm unless approved by the Engineer.

(b) Thermistor protection shall be provided for each winding of each motor. Motors rated below 22kW shall have no thermistor and heater protection devices installed on them. Motor rated 22kW and above shall have both thermistor and heater protection devices installed on them.

(c) Motors below 55kW shall be started by the DOL type method of starting. Motors including 55kW and above shall be started by the softer-starter type method of starting.

(d) A separate thermistor and heater terminal box shall be fitted on the motor frame next to the power terminal box and shall be of robust design, liberally sized and complete with suitable terminal block and mechanical cable gland or conduit entry.

(e) The minimum preferred class of insulation is Class F, derated in accordance with the relevant clause above.

E01.21 TECHNICAL DATA SHEETS

Details of all individual electric machines and equipment requiring electrical energy shall be indicated on the technical data sheet provided for in the tender Schedules (included in the technical data sheets.

E01.22 TESTING

Tests on completion (commissioning tests) shall be performed as described below in this specification.

E01.22.1 Performance Tests

(a) One motor of every type shall be tested for temperature rise and excess torque. Type test certificates on identical motors will be acceptable in lieu of these tests. Should type test certificates not be available, the first motor of each size manufactured shall be tested. All tests shall be in accordance with SANS 60034.

(b) The measurement of the temperature rise of the stator windings of motors for use on voltages up to 1 000 volts shall be by the increase in resistance method as is now permitted by SANS 60034.

E01.22.2 Routine Tests

(a) Each motor shall be tested at the manufacturer's works for light-run, locked rotor, insulation resistance, high voltage, air-gap clearances and Tan Delta on each complete stator.

(b) All tests shall be in accordance with SANS 60034.

E01.22.3 Test Certificates

(a) Four copies of all test certificates, showing the results of all tests performed, shall be supplied at a date not later than the delivery date of the motors.

(b) The test certificates shall contain power factor and efficiency figures for 125%, 100%, 75%, 50% and 25% of full load conditions as calculated from the test results.

E01.22.4 Witnessing of Tests

All type and routine tests on motors larger than 45 kW shall be witnessed by the Engineer.

E01.22.5 Testing of Terminal Box Assembly

(a) Proof shall be given to show that a prototype terminal and cable box assembly of the type being supplied on medium voltage motors has been tested under internal short-circuit conditions and that the pressure relief diaphragm ruptured protecting the case of the terminal box from serious damage. In addition, that a through fault current test was made to demonstrate that the complete assembly is capable of handling the short-circuit current without damage. The fault current for these tests shall have been 45 000 ampere for a duration of 0.25 seconds.

(b) These type tests shall have been witnessed by an independent authority.

E01.23 DRAWINGS FOR APPROVAL

The following drawings shall be submitted for approval:

(a) Dimensioned outline and foundation drawings of the motors. (Shaft diameter, shaft height and motor weight to be clearly shown).

(b) Detailed drawings of the bearing arrangement, showing all lubrication pipes, coolers and pumps.

(c) Cross-sectional dimensioned drawings of the cable boxes.

(d) Detailed drawings of the motor base plate showing full constructional details with dimensions.

(e) For motors of 250 kW and larger fully dimensioned drawings of the shaft showing all tolerances.

(f) For motors designed for voltages of 3.3 kV and above, drawings showing the end winding bracing arrangements.

E01.24 STORAGE

The contractor must ensure that the storage requirements as specified by the manufacturer are adhered to strictly so as avoid voiding of the warranty. Every effort must be taken to ensure the motor is protected against ingress of water, vermin or anything that may affect its future operation. The following are only given as guidelines, the contractor is expected to exercise due care in the storage and handling of electric motors.

(a) The motor should be store upright in its normal position, free of dust, dirt, gasses and corrosive atmospheres.

(b) Motors should be stored under roof on a concrete base, normally in a store environment. Do not remove the motor from the wooden pallet.

(c) For bigger units, which cannot be housed in a store or relevant building, shed must be built with a proper concrete floor. Do not remove the motor from the wooden pallet.

(d) Store the bigger units close to the final position within access with overhead crane or mobile crane.

(e) Do not stack any objects on top of or against the motor.

(f) Motors must be stored in places free from vibrations in order to avoid damage to the bearings.

(g) The motors space heaters/ anti condensation heaters and similar accessories must be switched on at all times to avoid condensation and corrosion within the enclosure.

(h) If painting has been damaged during transportation, it must be repainted to avoid rusting.

(i) Ensure all machined surfaces and shaft extensions are covered with grease or a rust inhibiting substance.

(j) For slip-ring motors, the brushes must be lifted to avoid condensation between contact surfaces and slip rings.

(k) Before operation all brushes and contact surfaces have to be inspected and brush seating confirmed.

(l) When any motor is kept for extended period, the shaft must be manually turned on monthly intervals.

(m) For big machines with frames greater than or equal to 400mm, the shaft should be rotated monthly at any number of turns and then put at rest at 180 degrees difference from previous stationary position.

(n) When a motor is not immediately required in operation, it should be protected against moisture, high temperature and impurities in order to avoid damage to the insulation system.

(o) If the ambient contains high humidity, periodical insulation resistance inspection is recommended during storage.

(p) The following guidelines show the approximate insulation resistance values that can be expected from a clean and dry motor at 40° Celsius ambient.

(q) Minimum insulation resistance = rated voltage (kV) + 1 (Mega ohm) using 2 times the rated voltage.

(r) These periodical measurements should be recorded and be available prior to installation.

E01.25 ERECTION AND INSTALLATION

E01.25.1 <u>Erection</u>

(a) When motors are erected, care shall be taken to ensure that adequate tolerance margins are made available to ensure interchangeability with replacement motors.

(b) A minimum of 10 mm of packers shall be provided under the motor frame or motor bedplate to allow for adjustments in height.

(c) Before holding-down bolts are grouted in, the motor shall be lined up and the bolts shall be properly centred in the hole of the bedplate.

(d) The bending radius of the motor supply cable should not be exceeded when installing the cable (SANS10142-1).

(e) Motor supply cables must be supported and should not hang from the terminal box/gland.

E01.25.2 <u>Bearing Inspection</u>

(a) The Engineer shall inspect motors having ball/roller bearings.

(b) The grease shall be examined to ensure that it is not hard.

(c) Providing that no roughness is felt when the shaft is rotated by hand and that the motor runs without undue noise or vibration, the bearings will be considered acceptable.

(d) Should the bearings fail or exhibit the symptoms of brinelling during the guarantee period, the Contractor, free of charge, without delay, shall change them.

E01.25.3 Alignment

(a) After erection, the alignment of the half-couplings between the motor and the driven machine shall be measured. In the case of a pedestal, bearing motor the air gap clearance between the rotor and the stator shall also be measured. A record shall be kept of these figures and they shall be submitted to the Engineer for approval.

(b) A horizontal sleeve bearing or limited end-float roller bearing motor shall be run uncoupled from its load to ensure that it rotates at the axial position indicated on the shaft and that the rotor is free to move to either side of this position. Particular attention shall be paid to ensure that the free running position and the rotor end-float are in agreement with the axial movement of the flexible coupling.

E01.25.4 Drying Out

(a) The Contractor shall dry out all motors larger than 100 kW and all smaller motors which have stood in the open during rain or have been flooded or whose cold insulation resistance is below 1.5 MΩ, before they are connected to the supply. If a motor is flooded, the motor bearings shall be replaced as a matter of urgency.

(b) The method of drying the motor shall be by placing the motor in a heating oven.

Sufficient heat shall be applied to produce a temperature of 60ºC but not greater than 80ºC for a Class A or 90º C for Class B insulation systems. Insulation resistance measurements and temperature readings shall be taken regularly every half hour at the start of dry-out until the motor attains an even temperature and thereafter every hour.

The characteristic dry-out curve of insulation resistance versus temperature shall be plotted and dry-out may be considered complete four hours after the resistance readings have started to rise from the steady minimum value, providing that the winding temperatures have remained steady during this period.

(c) The Contractor shall provide all equipment and the personnel required for the drying-out operation.

(d) In the case of motor smaller than 100kW, the onus remains on the Contractor to satisfy himself that a motor is dry before it is connected to the supply.

(e) Any motor, which fails as a result of being commissioned in a damp condition, shall be repaired at the cost of the Contractor.

E01.25.5 Double Shaft Extensions

The unused shaft extensions of a double-ended shaft motor shall be covered with an approved rust preventative after the motor is commissioned.

E01.26 TESTING AND COMMISSIONING

The contractor must supply a Manufacturers Test Certificate with each motor supplied.

The contractor must do a visual inspection as well as an insulation test on each motor before installation.

The contractor must do a direction test on each motor before handing the installation over. Where equipment can be damaged when rotated in an incorrect direction, the equipment must be disconnected from the motor before the direction check is done.

All test results must recorded and submitted to the Engineer for approval. The Engineer must be informed timeously off all tests to allow witnessing.

E01.27 MEASUREMENT AND PAYMENT

No separate payment will be made for electric motors for equipment unless otherwise specified in the detail specifications. All direct and indirect costs associated with such motors shall be deemed included in the rates tendered for the equipment.

Where separate payment is required for electric motors and specified as such in the detail specifications, the following payment items shall be applicable:

Item	**Unit**
Supply and delivery electric motors	No

The unit of measurement shall be the number of motors supplied.

The tendered rate shall include full compensation for the design, manufacture, corrosion protection, supply, handling, transport, testing and delivery of each complete motor as specified in the detail specification to ensure satisfactory operation after installation.

Separate items will be scheduled for different sizes/types of motors required.

Item	**Unit**
Installation, test and commission of electric motors	No

The unit of measurement shall be the number of motors installed.

The tendered rate shall include full compensation for the installation and coupling of the motor to the required load. The tendered rate shall include full compensation for all required installation material.

Separate items will be scheduled for different sizes/types of motors required.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
E02 : ELECTRICAL CABLE RACKS

Johannesburg Water

Johannesburg Water (SOC) Ltd.
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Revision 5

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ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	Senior Electrical Engineer	B Pieterse	August 2019	
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Approved	Regional Maintenance Manager	T Thabeng	August 2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
5	2019-08-20	B Pieterse	Review of Electrical Standards, plus New Design Guidance
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3	2012-05-30		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
2	2010-05-03		Review Electrical Standards
1	2009-05-12		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance

PARTICULAR SPECIFICATION: VOLUME E02: ELECTRICAL CABLE RACKS

CONTENTS

E02.1 SCOPE

This specification covers the supply, delivery and installation of cable ladders for industrial installations. Only cable ladders are to be supplied. Cable trays shall not be acceptable. Cable ladders are not recommended for large cables and open ground as they expose the cable to theft.

E02.1.1 Statutory Documents and Standards

Cable ladders shall be manufactured in accordance with the requirements of the latest editions of the following standards:

(a) SANS 10044	:	Welding
(b) SANS 10064	:	Preparation of steel surfaces for coating
(c) SANS 1274	:	Coatings applied by the powder process
(d) SANS 10162-1	:	The structural use of steel Part 1: Limit-states design of hot-rolled steelwork
(e) SANS 10162-2	:	The structural use of steel Part 2: Limit-states design of cold-formed steelwork
(f) SANS 10162-4	:	The structural use of steel Part 4: The design of cold-formed stainless steel structural members
(g) SANS 10142-1	:	The wiring of premises Part 1 – Low voltage Installations

E02.1.2 Particular Specifications to be read in conjunction with this specifications

This specification shall be read in conjunction with the following specifications:-

(a) E06	:	ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION

E02.2 CABLE LADDER MATERIAL

All cable ladders shall, unless otherwise specified, be heavy-duty cable ladder standard pattern.

Cable ladders used inside Elutriation Terrace pump stations or in areas within 50m or less of Ferric Chloride, Hypochlorite or Chlorine shall be manufactured from corrosion resistant GRP (Glass Reinforced Polyester) in which vinylester resin is used. All GRP cable ladders shall consist of a 75 mm high side rail. The minimum thickness of the material that the cable rack is to be manufactured from, shall at least be 4mm. Cross rungs shall be spaced at maximum intervals of 300 mm (centre-to-centre). All screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel for all applications, except for Ferric Chloride areas, where 304 grade stainless steel must be used. Racks for instrumentation and control cabling shall contain pigmentation to produce an electric orange rack. A sample of the rack material must be approved by the engineer before manufacturing commences. Sections of rack, bends, t-pieces etc. shall be joined together with the correct dowels and resins as specified by the supplier. Wherever racking is drilled or cut, the exposed areas of GRP must be sealed with the same resin to ensure that the material does not fray. Channels or other sections used for securing of cable ladders should as far as possible be made from the same GRP material. Where this is not possible, 316 grade stainless steel support systems shall be used for all applications, except for Ferric Chloride areas, where 304 grade stainless steel must be used.

Cable ladders used inside de-watering buildings shall be metal cable ladders, manufactured from corrosion resistant, powder coated, 3CR12 grade stainless steel. All cable ladders shall consist of at least 75 mm high side rail. The minimum sheet thickness of the material that the cable rack is to be manufactured from shall at least be 2mm. Cross rungs shall be spaced at maximum intervals of 300 mm (centre-to-centre). All screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel. Metal racks for instrumentation and control cabling shall be powder coated electric orange. If GRP ladder racking (as described in item 6.5.2 above) is cheaper than 3CR12 grade ladder racking, the GRP racking should be used inside de-watering buildings as well.

Cable ladders used for all applications other than those mentioned above shall be heavy-duty metal cable ladders, manufactured from 3CR12 grade, powder coated, stainless steel. All metal cable ladders shall consist of at least 75 mm high side rail. The minimum sheet thickness of the material that the cable rack is to be manufactured from shall at least be 3mm. Cross rungs shall be spaced at maximum intervals of 300 mm (centre-to-centre). All screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel. Racks for instrumentation and control cabling shall be powder coated electric orange.

E02.3 CABLE LADDER ACCESSORIES

E02.3.1 General

Cable ladder accessories shall be considered to be horizontal bends, vertical bends, internal bends, external bends, Tee-pieces, cross-pieces, reducers (transition pieces), support struts and fasteners. The accessories shall have dimensions that correspond to the dimensions of the linear sections to which they are connected. The radii of all bends shall be 1 m minimum.

The inside dimensions of horizontal angles or connections shall be large enough to ensure that the allowable bending radius of the cables are not exceeded. Sharp angles shall be 45º metered.

E02.4 INSTALLATION

Cable ladders shall be installed within accessible civil constructed cable ducts. These ducts may form part of the scope of works or may be existing.

Cable ladders are required to be installed within the cable ducts in the motor control centre rooms, on site electrical reticulation, and on access platforms to the mechanical equipment.

Cable ladders shall be installed within accessible cable ducts and shall be supported by a strut channel section securely fixed to the wall. The corrosion protection shall be of the same system as that of the cable ladder. Only vertical installation of cable ladder will be allowed in cable ducts. All cable must be installed on cable ladders and no loose cables will be accepted.

Cable ladders shall be supported with the struts, channels, brackets, clamps, cantilever arms and nuts/bolts/washers. Unless otherwise agreed, drilling into or welding onto metal columns, trusses and other metal building structures are not allowed and suitable clamps must be used to fix the cable ladders to the building structure.

The platform mounted cable ladder reticulation shall be installed at minimum of 150 mm from the supporting concrete structure.

Crevice corrosion of the metal elements in contact with concrete surface shall be eliminated by means of a suitable layer of non-shrink grouting.

Unless otherwise agreed, all screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be stainless steel 316.

All cable ladders shall be spliced with splice sets. The corrosion protection of splices shall be of the same system as that of the cable ladder.

All cable racks not installed in closed ducts or inside buildings will be installed with flat (vertical installation) or peaked covers (horizontal installation). The corrosion protection of covers shall be of the same system as that of the cable ladder.

All cable ducting must be covered with anti-theft covers. All exposed cable on cable ladders must be covered with anti-theft covers.

All overhead cable ladders crossing a walkway must be at least 2000mm above floor level.

Structural designs must be done for any cable bridges. Support material must be corrosion protected to the same standard as the cable ladder. The design must be approved by the Engineer.

E02.5 EARTH BONDING OF CABLE RACKING

All cable rack joints must be equipotential bonded. Both the ends of cable racking must be bonded to an equipotential bonding bar. Where cable racks enter a lighting protected structure, the bonding conductor must be connected to the rack as close as possible to the point of entrance. All bonding conductors must be equal to 6 sq. mm copper PVC insulated wire.

The bonding conductor cable will be a composite stranded cable made up of tinned copper wires and galvanised steel wires that are braided-interwoven to form the cable. The complex braided and interwoven wires of steel and copper make it very difficult to separate and is unattractive and uneconomical to copper thieves and scrap dealers. The conductor must be insulated in clear PVC.

E02.6 CORROSION PROTECTION

All cable ladders and the cable ladder accessories shall be coated as specified below.

The preparation of the metal surfaces of the cable ladders and cable ladder accessories shall be in accordance with the latest edition of SANS 10064, prior to the application of protective coating.

Corrosion protection shall conform to the coating system stated below:

E02.6.1 <u>Powder Coating Systems</u>

All cable ladder shall be coated in the colour B26 – orange

E02.6.1.1 Paint System 1: Powder Coating, seven (7) stage zinc phosphate treatment, pure epoxy primer, polyester finishing coat, thickness 140 µm.

Paint System	Host Material	Preparation	Primer Coat	Finishing Coat	Dry film Thickness
			(70 µm)	(70 µm)	(µm)
No 1	304 L SS	7 stage zinc phosphate pre-treatment	Epoxy	Epoxy	140

E02.6.1.2 Upon the completion of the corrosion protection specified, the Contractor shall be required to perform the following quality control testing procedures:-

- Impact testing in accordance with SABS 6: Part J,
- Cross hatch adhesion test
- Bend test

E02.6.1.3 The corrosion protection shall form part of the quality control system as approved by the Engineer and the Tenderer shall submit a certificate of compliance upon the delivery of all cable rack supplied. The tenderer will supply a sample of all cable rack to Johannesburg Water for testing purposes.

E02.6.1.4 Epoxy Powder Coat Products

Item	Product type	Powder – Lak
1	Epoxy primer	23-007
2	Pure Epoxy / Polyester finishing coat	Series 3000

E02.7 INSPECTION

After installation, a visual inspection should be conducted with the Engineer. The contractor must compile a butt list with all items not to the satisfaction of the Engineer.

E02.8 MEASUREMENT AND PAYMENT

Item	**Unit**
Supply and deliver cable ladder	m

The unit of measurement shall be per linear length in meter of cable ladder supplied and delivered. Separate items shall be scheduled to include for each size of cable ladder required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete cable ladder.

Item	**Unit**
Install cable ladder	m

The unit of measurement shall be per linear meter of cable ladder installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of cable ladder installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the cable ladders installed under the Contract.

Item **Unit**

Supply and deliver horizontal bends .... No

The unit of measurement shall be the number of horizontal bends supplied and delivered. Separate items shall be scheduled to include for each size of horizontal bend required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete horizontal bends.

Item **Unit**

Install horizontal bends .... No

The unit of measurement shall be the number of horizontal bends installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size horizontal bend installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the horizontal bends installed under the Contract.

Item **Unit**

Supply and deliver vertical bends .... No

The unit of measurement shall be the number of vertical bends supplied and delivered. Separate items shall be scheduled to include for each size of vertical bend required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete vertical bends.

Item **Unit**

Install vertical bends .... No

The unit of measurement shall be the number of vertical bends installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of vertical bend installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the vertical bends installed under the Contract.

Item **Unit**

Supply and deliver internal bends .... No

The unit of measurement shall be the number of internal bends supplied and delivered. Separate items shall be scheduled to include for each size of internal bend required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete internal bends.

Item **Unit**

Install internal bends .... No

The unit of measurement shall be the number of internal bends installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of internal bend installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the internal bends installed under the Contract.

Item **Unit**

Supply and deliver external bends .... No

The unit of measurement shall be the number of external bends supplied and delivered. Separate items shall be scheduled to include for each size of external bend required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete external bends.

Item	**Unit**
Install external bends	No

The unit of measurement shall be the number of external bends installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of external bend installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the external bends installed under the Contract.

Item	**Unit**
Supply and deliver Tee-pieces	No

The unit of measurement shall be the number of Tee-pieces supplied and delivered. Separate items shall be scheduled to include for each size of Tee-piece required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete Tee-pieces.

Item	**Unit**
Install Tee-pieces	No

The unit of measurement shall be the number of Tee-pieces installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of Tee-pieces installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the Tee-pieces installed under the Contract.

Item **Unit**

Supply and deliver cross-pieces .... No

The unit of measurement shall be the number of cross-pieces supplied and delivered. Separate items shall be scheduled to include for each size of cross-piece required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete cross-pieces.

Item **Unit**

Install deliver cross-pieces.. No

The unit of measurement shall be the number of cross-pieces installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of cross-pieces installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the cross-pieces installed under the Contract.

Item **Unit**

Supply and deliver reducers (transition-pieces) .... No

The unit of measurement shall be the number of transition pieces supplied and delivered. Separate items shall be scheduled to include for each size of transition-piece required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete transition-pieces.

Item Unit

Install reducers (transition-pieces).. No

The unit of measurement shall be the number of transition-pieces installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of transition-pieces installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the transition-pieces installed under the Contract.

Item **Unit**

Supply and deliver cable ladder support struts material **m**

The unit of measurement shall be per linear meter of material supplied and delivered. Separate items will be scheduled in the Schedule of Quantities differentiating each size of cable ladder support struts supplied and delivered under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the cable ladder support struts material.

Item **Unit**

Install cable ladder support struts **m**

The unit of measurement shall be per linear meter of material supplied and installed. Separate items will be scheduled in the Schedule of Quantities differentiating each cable ladder support struts installed under the Contract.

The tendered rates shall include for all labour, handling, cutting, welding, painting, drilling and mounting, etc., for the complete installation and inspection of the cable ladders support struts installed under the Contract.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
E03 : ELECTRICAL ISOLATOR
PUSHBUTTON STATION
(LOCAL START/STOP) EQUIPMENT

Johannesburg Water

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 5

August 2019

City of Johannesburg
Johannesburg Water (Pty) Ltd

DOCUMENT CONTROL SHEET

Document Title:	**Particular Specification – E03 : Electrical Isolator Pushbutton Station (Local Start/Stop) Equipment**
JW Reference:	**BWW523C**
Document Ref. No:	**E03**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	Senior Electrical Engineer	B Pieterse	August 2019	
Reviewed	Director	R Baard	August 2019	
Approved	Regional Maintenance Manager	T Thabeng	August 2019	

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Date	Revision	Author	Comments
5	2019-08-20	B Pieterse	Review of Electrical Standards, plus New Design Guidance
4	2014-06-03		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
3	2012-05-30		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
2	2010-05-03		Review Electrical Standards
1	2009-05-12		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance

PARTICULAR SPECIFICATION: VOLUME E03: ELECTRICAL ISOLATOR PUSHBUTTON STATION (LOCAL START/STOP) EQUIPMENT

CONTENTS

E03.1 SCOPE

This section covers the requirements for local isolator/start/stop pushbutton stations. Local isolator/start/stop pushbutton stations shall be supplied, delivered, installed and commissioned for each mechanical equipment driven by a motor.

E03.2 STANDARDS

The latest edition, including all amendments up to date of tender of the following particular national specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

(a) SANS 62262 : Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)

(b) SANS 60529 : Degrees of protection provided by enclosures (IP code)

(c) SANS 10142-1 : The wiring of premises Part 1 Low-voltage installations

(d) SANS 60439-1 : Low-voltage Switchgear and Control gear Assemblies Part 1 Type-tested and partially type-tested assemblies

(e) SANS 60439-2 : Low-voltage Switchgear and Control gear Assemblies Part 2 Particular requirements for busbar trunking systems (busways)

(f) SANS 60439-3 : Low-voltage Switchgear and Control gear Assemblies Part 3 Particular requirements for low-voltage switchgear and control gear assemblies intended to be installed in places where unskilled persons have access for their use - Distribution boards

(g) SANS 60947-1 : Low-voltage Switchgear and Control gear Part 1 General rules

(h) SANS 60947-2 : Low-voltage Switchgear and Control gear Part 2 Circuit breakers

(i) SANS 60947-3 : Low-voltage Switchgear and Control gear Part 3 Switches, disconnectors, switch-disconnectors and fuse-combination units

(j) BSI-BS 3858 : Specification for Binding and identification sleeves for use on electric cables and wires

(k) SANS 1091 : National colour standard

E03.3 GENERAL REQUIREMENTS

E03.3.1 <u>Particular specifications to be read in conjunction with this specification</u>

This specification shall be read in conjunction with the following specifications:-

E26: ELECTRICAL SPECIFICATION FOR COLOUR CODES
G02: PARTICULAR SPECIFICATION FOR CORROSION PROTECTION
E08: WIRING

E03.3.2 <u>General Requirements</u>

(a) The enclosure will be manufactured from 3CR12 stainless steel.
(b) The enclosure will be rated IP65 to SANS 60529 and shall be fitted with a canopy.
(c) The enclosure shall be painted electric orange (B26).
(d) The Isolator Pushbutton Station will be equipped with

- A green flush START pushbutton with spring return. In case of a bidirectional drive a START FORWARD and START REVERSE pushbutton will be installed;
- A red flush STOP pushbutton with spring return;
- A red mushroom head EMERGENCY STOP button with mechanical latching, turn to release. The emergency stop pushbutton will be lockable (key reset) and not a padlockable unit. This will not be a lockout point, but will be used for Process use only.
- A three-pole non-fusible disconnect switch complete with a shaft extension and a door interlocked red and yellow padlockable rotary handle mounted on the door. The current rating of the disconnect switch must match the motor rating as specified in the motor equipment schedule (rated for on-load conditions).
- All equipment must be installed in one box (power and control).

(e) The Isolator Pushbutton Station will be clearly labelled with an identity label, engraved with 30mm high black on white characters, and shall be mounted on top of the enclosure. The name of the associated drive will be shown.

(e) All pushbuttons shall be labelled with an identity label, engraved with 10mm high black on white characters and shall be mounted above the pushbutton.

(f) The Isolator Pushbutton Station shall be mounted within a radius of 1000mm maximum from o the associated drive. If this is not possible, the Engineer will indicate the position of the Pushbutton Station.

(g) The station shall be pedestal mounted at least 1100mm above floor level. The pedestal design shall be approved by the Engineer.

(h) The pedestal base plate shall be installed on 10mm of epoxy grout to prevent crack corrosion.

(i) The pedestal material shall be Stainless steel (3CR12) and have minimum thickness of 6mm. The pedestal shall be painted electric orange (B26).

(j) The station enclosure shall be designed to provide adequate space for the following:

- The required pushbuttons, the disconnect switch and the respective labels.
- A single multi-core control cable (including glanding) shall be installed from the MCC to the station, from where the required signals shall be individually wired, as per the cable schedule.
- Power cable/s (including glanding) shall be installed from the MCC to the station, providing power to the associated motor, as per the cable schedule.

E03.4 DIMENSION FOR ISOLATOR STATION

The dimensions of the start/stop isolator pushbutton stations shall allow ample space to accommodate all the equipment, taking into account the bending radius of all cables and minimum clearances. The contractor must supply design drawings of the Isolator Pushbutton Station to Johannesburg Water or their representative for approval prior to manufacturing.

E03.5 FASTENERS

All fasteners in concrete shall be 316 stainless steel. Pedestal bases shall be sealed against the ingress of any crevice corrosion by means of a suitable non-shrink cementitious grout and approved by the Engineer.

E03.6 MEASUREMENT AND PAYMENT

Item	Unit
Supply and delivery of local start/stop isolator pushbutton stations	No

The unit of measure shall be the number of stations supplied and delivered.

The tendered rate shall include all costs related to the manufacture, supply and delivery of the local start/stop isolator pushbutton or control stations (as detailed in the schedule of quantities), including support pedestal in accordance with this specification and the additional requirements detailed in the detail specification complete with all mounting brackets.

Separate items will be scheduled in the schedule of quantities for different types and sizes, defined by the kW rating of the driven equipment, of pushbutton / control stations.

Item	**Unit**
Install local start/stop isolator pushbutton stations	No

The unit of measure shall be the number of stations installed.

The tendered rate shall include full compensation for installing, testing and commissioning of the local start/stop isolator or control stations as specified. The rate shall further include for pedestal support securing and sealing preventing crevice corrosion.

Separate items will be scheduled in the schedule of quantities for different types of pushbutton / control stations.

Separate items will be scheduled in the schedule of quantities for different types and sizes, defined by the kW rating of the driven equipment, of pushbutton / control stations.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

E04 : ELECTRICAL LOW VOLTAGE DISTRIBUTION BOARDS AND MOTOR CONTROL CENTRES

Johannesburg Water (SOC) Ltd.
PO Box 61542
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Revision 6 August 2019

City of Johannesburg
Johannesburg Water (SOC) Ltd

DOCUMENT CONTROL SHEET

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Prepared	Senior Electrical Engineer	B Pieterse	August 2019	
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Approved	Regional Maintenance Manager	T Thabeng	August 2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
6	2019-08-20	B Pieterse	Review of Electrical Standards, plus New Design Guidance
5	2014-06-03		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
4	2012-05-30		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
3	2011-08-30		Omit Fifa Logo
2	2010-05-30		Review Electrical Standards
1	2009-05-12		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance

PARTICULAR SPECIFICATION: VOLUME E04: ELECTRICAL LOW VOLTAGE DISTRIBUTION BOARDS AND MOTOR CONTROL CENTRES

CONTENTS

E04.1 INTRODUCTION

This specification is for the supply of low voltage (400V) distribution switchboards.

E04.2 SCOPE

E04.2.1 General

The scope of work includes the furnishing of all labour, material and services for the design, supply, manufacture, testing and inspection at works, delivery to site, off-loading and rectification of defects developing during the warranty period for equipment as specified below.

E04.2.2 Work to be Included

The work includes, but shall not be limited to the items listed below.-

(a) All work in E04.2.1 above.

(b) Documentation, as called for in the vendor QA and document requirement list and drawings and data.

(c) The supply of one complete set of any special tools required per switchboard that will be required for operation or maintenance purposes, including three spare sets of each type of fuse.

(d) Recommended spares for one year's operating period and the prices of it.

(e) Technical assistance if requested during checking for operational readiness.

E04.3 STANDARDS

In general, work and materials shall be in accordance with the latest practice and in particular in accordance with the latest revision of the following specifications, and any amendments thereto, the SANS specification taking precedence:

(a)	SANS 10142-1	:	The wiring of premises Part 1: Low-voltage installations
(b)	SANS 60439-1	:	Low-voltage switchgear and controlgear assemblies Part 1: Type-tested and partially type-tested assemblies
(c)	SANS 60439-2	:	Low-voltage switchgear and controlgear assemblies Part 2: Particular requirements for busbar trunking systems (busways)
(d)	SANS 60439-3	:	Low-voltage switchgear and controlgear assemblies Part 3: Particular requirements for low-voltage switchgear and controlgear assemblies intended to be installed in places where unskilled persons have access for their use - Distribution boards
(e)	SANS 1973-1	:	Low-voltage switchgear and controlgear Assemblies Part 1: Type-tested ASSEMBLIES with stated deviations and a rated short-circuit withstand strength above 10 kA
(f)	SANS 60947-1	:	Low-voltage Switchgear and Control gear Part 1: General rules
(g)	SANS 60947-2	:	Low-voltage Switchgear and Control gear Part 2: Circuit-breakers
(h)	SANS 60947-3	:	Low-voltage Switchgear and Control gear Part 3 Switches, disconnectors, switch-disconnectors and fuse-combination units
(i)	SANS 60947-4.1	:	Low-voltage Switchgear and Control gear Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters
(j)	SANS 60947-4.2	:	Low-voltage Switchgear and Control gear Part 4-2: Contactors and motor-starters - AC semiconductor motor controllers and starters
(k)	SANS 60947-4-3	:	Low-voltage Switchgear and Control gear Part 4-3: Contactors and motor-starters - AC semiconductor controllers and contactors

for non-motor loads

(l)	SANS 60947-5-1	:	Low-voltage Switchgear and Control gear Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices
(m)	SANS 62262	:	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
(n)	SANS 60529	:	Degrees of protection provided by enclosures (IP code)
(o)	IEC 60228	:	Conductors of insulated cables
(p)	BSS 3858	:	Binding and identification sleeves for use on electric cables and wires
(q)	SANS 1507-1	:	Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) Part 1: General
(r)	SANS 1507-2	:	Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) Part 2: Wiring cables
(s)	SANS 1574-1	:	Electric Cables – Flexible Cords and Flexible Cables Part 1: General
(t)	SANS 1574-3	:	Electric Cables – Flexible Cords and Flexible Cables Part 3: PVC-insulated cables for industrial use
(u)	SANS 1619	:	Small power distribution units (ready-boards) for single-phase 230 V service connections
(v)	SANS 61643-11	:	Low-voltage surge protective devices Part 11: Surge protective devices connected to low-voltage power systems - Requirements and test methods
(w)	SANS 61643-12	:	Low-voltage surge protective devices Part 12: Surge protective devices connected to low-voltage power distribution systems - Selection and application principles
(x)	SANS 61238-1	:	Compression and mechanical connectors for power cables for rated voltages up to 30 kV (Um = 36 kV) Part 1: Test methods and requirements
(y)	SANS 60730-2-7	:	Automatic electrical controls for household and similar use Part 2-7: Particular requirements for timers and time switches
(z)	SANS 62053-61	:	Electricity metering equipment (a.c.) - Particular requirements Part 61: Power consumption and voltage requirements)
(aa)	BSS 1322	:	Aminoplastic Moulding Materials
(bb)	SANS 60076-1	:	Power transformers, Part 1: General
(cc)	SANS 1091	:	National colour standard
(dd)	SANS 61869-1	:	Instrument transformers Part 1: General requirements
(ee)	SANS 61869-2	:	Instrument transformers Part 2: Additional requirements for current transformers
(ff)	SANS 61869-3	:	Instrument transformers Part 3: Additional requirements for inductive voltage transformers
(gg)	IEC 60051/BS 89	:	Direct acting indicating analogue electrical measuring instruments and their accessories. Specification for special requirements for ammeters and voltmeters
(hh)	BS EN 60255	:	Measuring relays and protection equipment. Common requirements
(ii)	SANS 156	:	Moulded-case circuit-breakers
(jj)	SANS 1195	:	Busbars
(kk)	BS159	:	High-voltage busbars and busbar connections

E04.3.1 Particular specifications to read in conjunction with this specification

This specification shall be read in conjunction with the following specifications:-

E26: ELECTRICAL COLOUR CODING OF EQUIPMENT

G02: PARTICULAR SPECIFICATION FOR CORROSION PROTECTION

E06: ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION

E08: WIRING

E04.3.2 Mandatory Requirements

All equipment and services shall comply with the mandatory requirements of:

(a) Occupational Health and Safety Act 85 of 1993 (as amended).

E04.4 SYSTEM DETAIL

Busbar voltage	400V ±10% as per system voltage on the site
Frequency	50 Hz
Phase rotation	R-Y-B-R
Phases	3Ph+N, with Protective Earth (PE)
Earthing system	TN-S

E04.5 GENERAL REQUIREMENTS

This section will be applicable to the following equipment:

(a) Motor Control Centres (MCC).

(b) Main Distribution Boards (MDB).

(c) Auxiliary Distribution Boards (ADB).

The following is described in separate sections:

(a) Flush Mounted Distribution Boards.

(b) Surface Mounted Distribution Boards

(c) LV Kiosks (Switch Cubicles)

E04.5.1 Manufacturing and Construction Details

E04.5.1.1 General

(a) Electrical panels will be floor standing unless specified differently.

(b) All floor-standing switchboards will be positioned above a cable trench with bottom entry cables.

(c) Electrical switchboards positioned inside Electrical Distribution/MCC rooms shall be manufactured with 2mm thick mild steel.

(d) Electrical switchboards positioned outside Electrical Distribution/MCC rooms shall be manufactured from 2mm thick stainless steel (3CR12) as a minimum. Heaters will be installed in the switchboards to prevent condensation.

(e) In special applications, the Electrical switchboards will be manufactured to the Engineers specification.

(f) 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.

(g) All specified external dimensions for switchboards shall be strictly adhered to.

(h) The Contractor or Manufacturer shall obtain the opinion of the Engineer before manufacturing any switchboard.

(i) The 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.

(j) 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 2100mm above finished floor level.

(k) Unless otherwise agreed or stated in this Specification, all screws, bolts and nuts shall be hexagonal to ISO metric commercial standards and shall be rustproof. Loose ‘bolts and nuts' shall not be used on steelwork. Blind threaded fastening system bushings or equivalent shall be used for thread sizes M5 and above. Studs projecting from the exterior surfaces of the board shall have chrome or cadmium plated dome nuts. Self-tapping screws shall not be utilised for any purpose on any equipment.

(l) The short-circuit current levels as indicated on drawings shall be deemed the maximum fault current occurring at the panel under symmetrical short circuit conditions on the line side of the final limiting device in a circuit. The duration of the maximum short circuit currents shall be deemed a minimum of one second. Evidence (in the form of certificates from testing authorities recognised by Johannesburg Water) of the ability of the 400V switchboards offered to withstand satisfactorily the prospective fault conditions shall be furnished with the tender.

(m) Switchboards shall be designed to confine internal arcing faults and to direct arcs and gases arising from these away from the operator.

(n) The general structure of the panel shall be designed and fabricated to ensure that no excessive vibration caused by the operation of any component is transmitted to any other components, thereby causing spurious tripping of any device.

(o) Measures shall be taken to prevent electrolytic corrosion where dissimilar metals are in contact with each other.

(p) 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.

E04.5.1.2 Panel Subdivision

(a) The Electrical panel will be constructed as one or more fully interchangeable modular, rigid, free standing columns, bolted together to form an extensible, composite, vermin proof unit of uniform appearance.

(b) Panels shall be designed to permit the addition of identical columns.

(c) Columns widths will be 600, 700, 800, 900 or 1000 mm for design flexibility. Columns will be 600 or 800mm deep. Increase in depth of certain sections of panels for high current ratings shall be subject to the Engineer's approval.

(d) The overall height of the column may not be more than 2300mm.

(e) Each column shall be divided horizontally into buckets.

(f) Panels will be split into transportable section with lengths not exceeding 3000mm for ease of transportation.

(g) A channel iron frame (minimum 100mm x 50mm) shall be provided under each panel section of transportable length, which shall be so constructed that it can be used for lifting the transportable section without distortion taking place.

(h) All panel section of transportable length shall be fitted with lifting lugs and shall have sufficient strength to withstand all stresses occurring during transportation, installation and operation without distortion or damage.

E04.5.1.3 Internal Form of Separation

(a) The minimum internal Forms of Separation for any Electrical switchboards shall be Form 3b, as described below:

i. Separation of busbars from all functional units;

ii. Separation of all functional units from one another;

iii. Separation of terminals for external conductors from the functional units, but not from those of other functional units;

iv. The power cable connections are disposed in the same compartment;

v. Maintenance services require extra care, as placed in the same compartment the connections of other units might be powered;

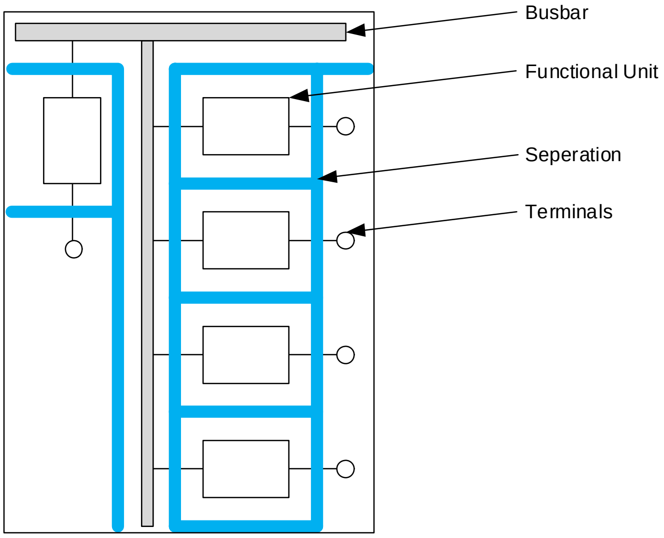

Figure 1: Form 3B

E04.5.1.4 Buckets

(a) Buckets will be equipped and wired as per the drawings issued by the Engineer.

(b) The buckets will be sized to accommodate all components with ease.

(c) Buckets will be fixed pattern with components permanently mounted to the chassis plate of the bucket.

(d) All bucket design and construction shall be based on natural cooling by convection or radiation. Attention shall be given to ventilation to prevent the accumulation of heat in buckets where power electronic drives (soft starters and VSD’s) or other heat generating equipment (i.e. control transformers) are contained. Extraction ventilation fans should be installed in these cases to remove heat from the cubicle. The filtered extraction fan should be placed as high as possible in the compartment door with a filtered air inlet opening as low as possible in the compartment door. The fan and opening must be sized to ensure all generated heat is extracted from the bucket. Natural convection cooling will not be accepted.

(e) Spare buckets shall be equipped generally as detailed on the drawings issued by the

Engineer, and shall include all circuit breakers, busbars, wiring, instruments, etc., with the exception that, in the case of withdrawable circuit breakers, only the breaker cradle shall be furnished.

E04.5.1.5 Doors

(a) Buckets shall have doors suitably constructed to ensure rigidity and shall be a neat fit in the framework and around the circuit breaker escutcheon plate.

(b) Doors shall be fitted with robust steel or brass hinges with at least two 6mm square recessed quick close/open latches. Hinges shall be provided at 500mm intervals per door with a minimum of two hinges per door. Each door shall be fitted with an equal number of hinges and latches. At least one of these latches shall be lockable with a padlock.

(c) Doors and covers shall be provided with a high-density neoprene gasket to form a firm seal. The neoprene seal shall be a nominal 5mm thick compressed to 3mm on closing of the door. The entire switchboard shall be effectively dust and splash proof to IP 54.

(d) All hinged doors shall be fitted with a robust mechanism to latch and hold the door in the wide-open position, to minimise inadvertent contact with live parts during maintenance operations.

(e) All hinged doors shall open to a minimum of 135° from the closed position, to facilitate easy access for maintenance.

(f) Doors should be the same width as the MCC column. A single door shall not exceed the width of 800mm. Where the column width exceeds 800mm, two doors must be installed.

(g) The Bucket door shall be interlocked with the circuit breakers to prevent opening of the door when the circuit breaker is in the "ON" position. A non-apparent door interlock defeat shall be provided for the opening of the door with the circuit breaker in the “ON” position for testing and maintenance. In addition, there shall be provision for attaching a padlock to the operating handle in the “OFF” position that prevent the circuit breaker from being operated. Should more than one padlock be fitted, a safety lockout hasp must be used.

(h) All access doors are to be effectively and permanently earthed to the main panel enclosure, by means of a suitable braided copper earth strap, not less than $6mm^2$, crimped with properly sized lugs and bolted at each end to the door and enclosure.

(i) All equipment mounted on bucket door will be flush mounted.

E04.5.1.6 Busbar Compartments

(a) The Busbar compartment shall contain the three phases and the neutral busbars, duly marked L1, L2, L3 and N or identifiable by colour coding Red, White, Blue and Black.

(b) The protective earth busbar shall be located in a separate compartment, and shall be duly marked PE.

(c) Provision shall be made for expansion or contraction of the busbars and the housing due to loadings, temperature changes and short circuit conditions. The busbars shall allow for expansion on both the left and right-hand side.

(d) The busbar compartment shall have bolted covers on the front of the panel for access to the busbars, insulators and joints. Removable covers shall be provided with captive screws.

(e) All busbars and droppers shall be securely supported by heavy, high di-electric, non-hygroscopic material with bracing to withstand stresses due to short circuits of one second duration and at least equal to the interrupting rating of the circuit breaker protecting the busbars.

(f) Busbar standoff insulators and support will be injection moulded (Polyamide 66 fibreglass reinforced (30%) (Halogen free)). Threaded inserts will be galvanized steel.

(g) The Busbar shall be supported by insulators made of flameproof and leakage-proof material. Busbars, insulators and supports shall be braced to withstand the mechanical and thermal effects of fault currents.

(h) Busbar insulators shall be mounted in such a way that they can be easily removed and replaced.

(i) In addition to any support/bracing required by the electrical conditions, the busbars shall also have sufficient support to prevent stresses being transmitted to the circuit breakers or any components by cable terminations. Particular attention must be paid to the termination arrangements of any multiple incoming three-core cables to ensure adequate glanding space.

(j) The following minimum air clearances shall be observed for busbars and other current carrying or live parts:

i. Phase – Earth : 30mm

ii. Phase – Phase : 45mm

Where these clearances cannot be attained, suitable insulating barriers shall be employed In addition, all busbar work (including connections to, from and between equipment) shall have applied solid insulation suitable for the rated voltages. GPO-3 (Glass Polymer laminate) insulation shall be used wherever possible. GPO-3 is constructed with fiberglass-reinforced thermoset polyesters. It must feature a combination of beneficial electrical and mechanical properties. These attributes include Dielectric strength, flame resistance, arc and track resistance, high-flex strength and high-impact strength. They maintain stability, will not melt under heat and have excellent overall electrical properties.

(k) The busbar compartment shall be constructed to ensure that fire or other faults cannot spread between the various sections. All insulation used on electrical conductors/connections and wiring shall be flame retardant types, constructed of low toxicity materials.

(l) The busbar compartment must have suitable sealing arrangement at each end as well as between the busbar compartment and buckets.

E04.5.1.7 Cable termination points

(a) Suitable termination points shall be provided to enable any multiple three-core cables to be terminated without cross-overs of different phases and with minimum lengths of cable "tails".

(b) All cable termination points and associated connections shall be suitably braced to withstand the available fault currents without damage. If necessary cable support clamps shall be provided for the individual cable tails after the cable gland.

E04.5.1.8 Cable Gland Plates

(a) Sectionalised removable gland plates shall be fitted and shall be fixed by means of captive nuts or screws and so located that ample space is available for the satisfactory entry and termination of cables

(b) Cable entry shall be at the bottom of the board.

(c) All gland plates are to be connected to the main panel earth bar via suitably sized copper conductors and unused sections shall be left blank.

(d) Gland plates for three-core cable of cross-sectional area 70mm^2 and above shall be minimum 5mm thickness.

(e) Mild steel gland plates shall be galvanised.

(f) Where single core cables are used, gland plates are to be of non-magnetic material or slit to mitigate effect of eddy currents.

(g) The cable gland compartments shall have removable covers attached with standard 6mm square recessed quick close/open latches.

E04.5.1.9 Labelling and markings

(a) The panel shall be provided with an identity label, engraved with 30mm high black on white characters and shall be mounted on top of the switchgear.

(b) Each buckets shall be labelled on the left top door corner with the reference letter(s) of that compartment, using durable designation label with 30mm high black letters on a white background. The labels shall have two designation letters, the first referring the column, numbered from A, left to right and the second referring to the bucket, numbered from 1 top to bottom.

(c) All buckets shall be clearly labelled with suitable inscriptions indicating their function. All labels shall have black characters at least 6mm high on white background.

(d) Incomers shall be labelled "Incomer from ……………....” as indicated on the drawings issued by the Engineer, using engraved black characters at least 6mm high on white background.

(e) Standby bus coupler (where applicable) shall be labelled "Standby Bus Coupler", using engraved black characters at least 6mm high on white background.

(f) All removable covers protecting live equipment shall be fitted with warning labels as well as ID tags to ensure the covers are replaced in the original position after removal. Warning labels shall be engraved white characters 6mm high on a red background.

(g) All electrical components/equipment shall be labelled (with designations corresponding to those of the Engineer’s schematic diagrams) to facilitate recognition.

(h) The labels for equipment mounted on doors shall be identified with white trifoliate labels having black lettering engraved on them, with a maximum height of 3mm letters.

(i) The equipment labels shall be secured by means of high quality double-sided tape.

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

(k) 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.

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

(m) Danger labels shall be white lettering 6mm high engraved on a red background.

(n) All labels and label brackets shall be affixed by machine screws. Adhesive labels are not acceptable.

(o) Over and above labelling requirements of this specification, the labelling requirements of SANS 10142-1 must be met.

E04.5.1.10 Insulation Materials

(a) Any insulation, filling putty, etc., used shall be selected such that it can withstand without harmful effect (mechanically or electrically), all temperatures encountered within the MCC.

E04.5.2 <u>Electrical Details</u>

E04.5.2.1 Busbars and Connections

(a) Busbars and connections shall generally comply with SANS 1195 for air clearances. Notwithstanding the contents of the above-mentioned specifications, all solid copper work shall be made of hard drawn high conductivity copper of constant cross-section throughout their lengths with a maximum design current density of 1,66A/mm².

(b) The Phase and Neutral busbars shall be manufactured with flat copper bars with a standard rectangular conductor profile, of the same cross-section over the whole width of the panel.

(c) Busbar droppers shall be manufactured with flat copper bars with a standard rectangular conductor profile, of the same cross-section over the whole length of the dropper. The use of flexible conductors as droppers from the main busbars to circuit breakers shall not be permitted.

(d) All busbar joints shall be silver plated or tinplated. High pressure bolted lap joints shall be used and all bolts shall be of the high tensile type.

(e) All fixed busbar joints (separation links) between adjacent sections shall be maintenance-free.

E04.5.2.2 Earth Bar

(a) A protective earth bar shall extend the whole length of each Electrical panel and shall be duly marked PE. The earth bar shall at least, be bolted to the switchgear housing at each column.

(b) Stranded clear insulated aluminium earth wire (equal to 70mm^2 copper wire) with crimp type terminals shall be provided at both ends of the protective earth bar for connection to the substation earth bar/earthing system.

E04.5.2.3 Control Wiring

(a) Each Electrical panel shall be equipped and completely wired at the factory and, only after satisfactory testing, be split, if necessary, for transportation.

(b) Control and instrumentation wiring shall be silicone insulated throughout and of flexible, stranded, annealed, untinned copper construction. All wiring shall comply with the table below. Conductors shall comply with SANS 1411, Part 1, Table 4, Class 5.

CT Wiring	-	2.5mm^2 phase coloured, common return black insulated, earth green/yellow
General Control Wiring	-	(AC) 1.0mm^2 grey
	-	(DC) 2.5mm^2 (positive – red, negative – black)
Control Neutral	-	(AC) 1.0mm^2 (same size as phase wiring) – black
LED's and PLC Inputs	-	(AC) 0.75mm^2 grey
	-	(DC) 0.75mm^2 (positive – red, negative – black)

(c) Notwithstanding the above-mentioned requirements, the vendor shall ensure wire size used is amply rated for the applicable current, under ambient conditions.

(d) All control/instrument panel wiring shall terminate by means of suitably sized compression crimp lugs on screw-type terminals. Terminals of the pressure pad type are not accepted. The minimum voltage rating of the control wiring shall be 600/1000V grade to SANS 1507 and SANS 1411 Parts 1 and 3.

(e) Wiring shall be run in plastic trunking. Only where a space problem exists will loomed wiring be acceptable.

Note: Stick-on harness holders are not acceptable.

(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) Conductors shall be general-purpose 600/1000V grade PVC-insulated copper wire to SANS 1507 and SANS 1574. Aluminium conductors are not acceptable.

(h) Single or solid conductor wire shall not be used.

(i) Joints or splices in any wiring are not acceptable.

(j) Panel and equipment terminals, labels, etc., shall be accessible after the wiring has been completed.

(k) Connections to equipment on swing doors shall be arranged to give a twisting motion and not a bending motion to the conductor.

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

(m) 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.

(n) 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.

(o) Not more than two conductors shall be connected to any side of a terminal.

(p) Each terminal strip shall be provided with not less than 10% spare terminals, with a minimum of two, unless otherwise approved.

E04.5.2.4 Power Wiring and Cable Terminations

(a) Power wiring on the "live" side of the circuit breakers (from the busbar dropper to the circuit breaker terminals) shall be as short as possible, sized to carry the maximum current continuously of the frame size of the respective circuit breaker and shall be a flexible copper conductor. The flexible connection shall be provided on all such connections and shall be designed to prevent the transmission of any forces that may arise between the busbar droppers and the circuit breaker. In terms of SANS 60439, this connection is deemed a fault free zone and the design and use of the flexibles shall in no manner compromise this zone.

(b) Power wiring on the "load" side of the circuit breaker terminals to cable termination terminal shall be as short as possible, sized to carry the maximum current continuously of the frame size of the respective breaker and shall be a flexible conductor. The flexible connection shall be provided on all such connections and shall be designed to prevent the transmission of any forces that may arise between the circuit breaker and the cable termination terminal. In terms of SANS 60439, this connection is deemed a fault free zone and the design and use of the flexibles shall in no manner compromise this zone.

(c) Terminals that are on the live side of fuses and isolating switches shall be completely shrouded to prevent accidental contact.

(d) Power circuit wiring and connections in a switchboard shall be rated to the full frame size rating of the associated equipment, i.e. fused switch, contactor, circuit breaker, etc., and not to the circuit or fuse rating.

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

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

(g) Power wiring terminations shall use an appropriate crimped accessory (the pressed tubular type of accessories). Stamped, folded, split-barrel type accessories are not acceptable.

(h) 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.

(i) In addition, hexagonal die type hydraulic crimping shall be used for all wiring greater than 16mm² in size.

(j) 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 fixing of the cable leads to prevent vibration.

(k) A predrilled 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.

E04.5.2.5 Wire Numbering

(a) Each end of every wire shall be marked with a wire number by means of plastic cable ferrules (black lettering on a white or yellow base).

(b) All wires shall be identified on both ends with a wire marker. The wire marker shall consist of a transparent flexible tube that slides over the wire with a wire identification label (black letters on a rigid white PVC tag) which slides into a label pocket on the tube. The tube must be correctly sized for the wire diameter.

(c) Split or open type marking ferrules shall not be used.

(d) Cable/wire marking ferrules shall correlate to the appropriate schematic or wiring diagrams.

(e) 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.

(f) All cables shall be identified on both ends with a cable marker. The cable marker shall consist of printed stainless steel band fixed to the cable with stainless steel strapping.

E04.5.2.6 Terminals and Connections

(a) All terminals will be of the screw-type. Terminals of the pressure pad type are not accepted Minimum rating for terminal blocks shall be 40A. Terminal strips/blocks shall be marked with designations corresponding with the suppliers/buyers drawings. Generally, terminal numbers shall be the same as the relevant wire number. No more than two wires may be connected to any one side of a terminal. Ten percent (10%) additional spare terminals shall be furnished.

(b) Terminals are to be provided for all door-mounted components, diodes, etc.

(c) Power connections on any equipment shall not use "Philips/Star” type screw/socket heads. Hexagon socket head cap screws (Allen type socket heads) are preferred.

(d) 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.

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

E04.5.2.7 Air Circuit Breakers (ACBs)

(a) ACBs shall be of the withdrawable type with self-aligning disconnecting devices with the disconnecting fingers preferably mounted on the breaker for ease of maintenance. The draw out mechanism shall hold the circuit breaker rigidly in the fully connected, test and fully disconnected positions.

(b) Safety shutters shall be provided to shield the fixed part automatically when the draw out parts removed preventing access to the conductors (main and auxiliary circuits). These shutters shall be clearly labelled indicating busbar and cable sections and in addition “live” section shall be labelled “400V – LIVE”. ACBs shall be equipped with inter-phase barriers.

(c) Each Incoming ACB from a transformer and each Bus Section ACB shall be equipped with a protection unit incorporating:

i. Overload protection (IDMT)

ii. Thermal overload protection

iii. Instantaneous short-circuit protection

All protection devices will be delivered with protection settings adjusted to the minimum level. The protection unit shall be fitted with a transparent cover that can be sealed in the closed position to prevent tampering with the settings.

(d) The Contractor shall take particular care to ensure that the ACB protection is correctly co-ordinated with the upstream and downstream protective devices.

(e) Current and time delay set points on ACBs shall be accessible from the front of the ACB without removing the ACB from its cradle and shall only be adjustable when the cubicle door is open.

(f) Interlocks shall be provided to ensure the following:

i. That the main circuit breaker cannot be removed from or to the fully connected position unless the ACB is open;

ii. That the compartment doors cannot be opened should any accessible portion of the ACB frame be energised;

iii. That the ACB cannot be closed unless in the fully connected, test or fully disconnected positions.

(g) Mechanical restrictions shall be provided to inhibit mismatch of ACBs of different ratings.

(h) Provision shall be made for the padlocking of any ACB in any one of the fully connected, test or fully open positions. In addition, all ACBs shall have padlocking facility to prevent the close push button being operated when padlocked.

(i) ACBs employed as incomers and bus-section switches shall incorporate captive key interlocks to prevent paralleling of incoming supplies. Locks with captive keys must be built into the ACB’s to prevent both Incomers and the Bus-coupler circuit breakers in the “ON” position at the same time. Padlocks will not be accepted for this application.

(j) The ACBs supplied shall be three pole, magnetic operated. The mechanism shall be of the stored energy type having hand charged spring with mechanical and electrical releases for closing.

E04.5.2.8 Moulded Case Circuit Breakers (MCCBs)

(a) MCCBs shall be of the manually operated type with thermal and instantaneous magnetic protection. Trip functions shall be resettable via the MCCB switching handle.

(b) Each MCCB shall be fitted with a vari-depth operating handle.

(c) Flash barriers shall be furnished to increase creepage distance between phases and shall be furnished on all circuit breaker cradles between the phases on both sides of the MCCB.

(d) The thermal trip elements of each MCCB shall be calibrated for the maximum ambient temperature at 40°C.

(e) Current ratings of MCCBs shall be detailed in the Single Line Diagram drawings.

(f) MCCBs shall be selected according to rating and the fault level as specified by the Engineer.

(g) The name of the MCCB manufacturer shall be furnished by the tenderer at tender stage.

(h) Each MCCB shall be provided with suitable insulation between the terminals of the MCCB and the back plate/chassis onto which the MCCB is mounted, such that any loose nut, screw, etc., which may fall between the MCCB terminals and back plate cannot cause a short circuit.

(i) Where interlocking is called for between the MCCBs this shall be effected using captive keys in the breaker or a mechanical interlock.

(j) All outgoing circuits shall be equipped with individual core balance earth leakage units arranged to shunt trip each respective outgoing circuit.

(k) Outgoing circuits rated 125A and above shall have IDMT 375 mA earth leakage units EPC type Elsec T. Outgoing circuits rated 100A and below shall have instantaneous 250 mA earth leakage units - EPC type Elsec – X. All earth leakages must be of the manual reset type.

(l) All circuit breakers, except bus couplers, shall be connected with the switched side to the load, i.e. with reference to power flow incoming to "LINE" and outgoing to "LOAD".

(m) The incoming terminals/shutters of all 400V circuit breakers shall be effectively shrouded and marked "400V LIVE" with white characters on a red ground.

E04.5.2.9 Miniature circuit breakers (MCBs)

(a) Miniature circuit breakers (MCBs) shall be confined to auxiliary circuits such as control and indication in which the prospective short-circuit current will not exceed 5kA (3ph at 440Vac), or 7.5kA (1p at 24Vdc). They shall be of the thermal and magnetic trip free type. Where the prospective short-circuit current exceeds the above values, cascaded circuit breakers should be used. All cascaded circuits must be marked with the wording "Warning: This is a cascaded system. Never replace any circuit breaker in the system with another circuit breaker that is not identical in manufacturer, type and rating."

(b) Auxiliary contacts on MCBs

i. Provide the position (open/closed/tripped) remote indication functions of the associated MCB.

ii. Clip on (no tool required) to the left-hand side of the MCB. The type that connects to the MCB operating lever is preferred.

iii. Shall be of good quality and will not interfere with the operation or tripping of the MCB.

E04.5.2.10 Surge Arrestors

(a) All Electrical switchboards shall have a surge arrestor fitted to each phase on the incoming circuit breaker. The surge arrestors shall be fitted to the LIVE side of the circuit breaker.

E04.5.2.11 Instruments and Meters

(a) Incoming CBs shall be equipped with the following as a minimum requirement:

i. A single 96mm x 96mm 5A secondary, combined maximum demand and instantaneous ammeter. The maximum demand portion shall have a thermal movement with 15-minute time lag and drag pointer having a reset facility. It shall have a built-in saturation transformer for increased overload capacity to 90 times rated current for one second;

ii. A 96mm x 96mm voltmeter connected to measure phase-to-phase voltage and phase to neutral voltage via a multi-position selector switch and a set of fuses suitably rated for voltage and short circuit current;

E04.5.2.12 Current Transformers

(a) All current transformers shall conform to SANS 61869-2. For protection purposes, class 10P CT's are to be used and for indicating purposes class 1 CT's are to be used and for metering purposes class 0.5 CT's are to be used. In general, current transformer mechanical and thermal ratings shall be co-ordinated with the short circuit ratings of the equipment.

E04.5.2.13 Fuses

(a) Fuse protection shall be used in cases were capacitive loads are switched i.e. Power factor correction or static capacitors panels.

(b) Fuses shall not be used for purposes other than voltmeter or kWh meter protection, unless specifically authorised. All short circuit protection shall be provided by means of circuit breakers and fast blow fuses for protecting the incoming side of the devices. In cases where the fault current level is excessively high, HRC fuses in conjunction with CB's should be considered to reduce the fault level and afford better protection for electrical personnel.

E04.5.2.14 Limit Switches

(a) Limit switches shall be metal encapsulated precision switches with robust and compact explosion-proof structures.

(b) Cables shall be equipped with a strain-relief device and safely cast into the enclosure. Switches shall have bottom, side or lateral cable outlets as per the requirement of the application. The integrated basic switch shall have a single-pole changeover contact with a high switching accuracy and a precise repeatability of the switching point.

(c) It shall have high vibration resistance and long mechanical life. It shall have a high protection class that would allow the switch to be used in all processes of Johannesburg Water wastewater treatment plants.

E04.5.3 Mounting of Equipment

E04.5.3.1 Clearance and Access

(a) A minimum clearance of 50mm shall be maintained between items of equipment and the side of the compartment.

(b) Where extra equipment is specified after the design has been finalised, this clearance requirement may be altered subject to the Engineer's approval.

(c) 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.

E04.5.3.2 Mounting of Circuit Breakers

(a) All moulded case circuit breakers shall be flush mounted with only toggles protruding.

(b) Miniature circuit breakers may be installed in clip-in trays mounted on the frame.

(c) Special provision shall be made for large main switches.

(d) Circuit breakers shall be installed so that the toggles are in the up position when "ON" and down when "OFF".

E04.5.3.3 Mounting of Contactors

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

E04.5.3.4 Instrumentation

(a) All metering instruments shall be mounted flush in the front panel unless otherwise specified.

(b) 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.

(c) 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.

E04.5.3.5 Fuse-Links and Carriers

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

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

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

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

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

(f) Solid link holders shall be coloured white.

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

E04.5.3.6 Control Equipment

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

E04.5.3.7 Current Transformers

(a) Current transformers shall be accessible and easily removable.

(b) 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).

(c) 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.

E04.6 MOTOR CONTROL CENTRE

A Motor Control Centre (MCC) is an assembly of one or more enclosed sections having a common power bus and principally containing motor control units that serves to govern in some predetermined manner the performance of an electric motor. Motor control centres are in modern practice a factory assembly of several motor starters. A motor control centre can include variable frequency drives, programmable controllers, metering apparatus etc. Motor Control Centre is used for controlling of various motors of a particular plant.

E04.6.1 MCC Buckets

(a) The following types of motor starters will be used:

i. Direct-on-line (DOL) type motor starting;

ii. Star/Delta (S/D) type motor starting;

iii. Forward/Reverse type motor starting;

iv. Soft starting (SS) type motor starting;

v. Variable Speed Drive (VSD) type motor starting.

(b) The main contactors on Star/Delta and Forward/Reverse type starters will be mechanically interlocked. The type of motor starting required shall be project specific and shall be indicated in the MCC schedule/s to be issued by the Engineer.

(c) All the protection devices, i.e. overloads, circuit breakers, motor thermistors, motor heaters, gearbox oil flow switches etc. on mechanical equipment shall be hard wired onto the individual motor starter circuits.

(d) Only one motor will be controlled from any MCC bucket.

E04.6.2 Busbars

(a) Main busbars in MCCs shall be rated for 2000 amps as a minimum.

(b) Busbar droppers in MCCs shall be rated for the maximum possible current (determined by the breaker frame size) in that section with a minimum rating of 1000 amps.

E04.6.3 Earth bar

(a) The earth bar shall be rectangular, with a minimum cross sectional area of 400mm² (10mm x 40mm).

E04.6.4 Power wiring

(a) The minimum MCC power wiring size shall be 25mm².

E04.6.5 Circuit Breakers

(a) Air circuit breaker (ACBs) will be used for Incomer circuit breakers on MCCs.

(b) Bus coupler circuit breakers on MCCs will use an air circuit breaker (ACBs).

(c) Moulded Case circuit breakers (MCCBs) will be used for outgoing feeders on MCCs up to a maximum rating of 800 amps.

E04.6.6 Instruments and Meters

(a) Incoming CBs shall be equipped with an power meter capable of providing multiple parameters of the connection including kWh, kVArh, kW, kVAr, PF, MD, etc. and provide a pulsed output and Ethernet connectivity.

(b) Each bucket shall be equipped with a suitably sized 5A current transformer (CT) operated

96mm x 96mm 90° movement suppressed maximum demand ammeter having an overload rating of 40 times the rated current for one second. The CT primary current rating will match (equal) the outgoing feeder circuit breaker current rating. The CT secondary current rating will be 5A.

E04.7 MAIN DISTRIBUTION BOARD

A Main Distribution Board is a panel from where electrical energy is taken out to distribute power to various consumer points. It has a single incoming power sources from a distribution transformer and includes feeder circuit breakers and protection devices to the consumers.

E04.7.1 Busbars

(a) Main busbars in MDBs shall be rated for 2000 amps as a minimum.

(b) Busbar droppers in MDBs shall be rated for the maximum possible current (determined by the breaker frame size) in that section with a minimum rating of 1000 amps.

E04.7.2 Earth bar

(a) The earth bar shall be rectangular, with a minimum cross sectional area of 400mm² (10mm x 40mm).

E04.7.3 Power wiring

(a) The minimum MDB power wiring size shall be 25mm².

E04.7.4 Circuit Breakers

(a) Air circuit breakers (ACBs) shall be used as Incomer circuit breakers on MDBs.

(b) Moulded Case circuit breakers (MCCBs) will be used for outgoing feeders on MDBs up to a maximum rating of 800 amps.

E04.7.5 Instruments and Meters

(a) Incoming CBs shall be equipped with an power meter capable of providing multiple parameters of the connection including kWh, kVArh, kW, kVAr, PF, MD, etc. and provide a pulsed output and Ethernet connectivity.

(b) Feeder CBs shall be equipped with an power meter capable of providing multiple parameters of the connection including kWh, kVArh, kW, kVAr, PF, MD, etc. and provide a pulsed output and Ethernet connectivity.

E04.8 AUXILIARY DISTRIBUTION BOARD

An Auxiliary Distribution Board is a panel from where electrical energy is taken out to distribute power to various consumer points. It has a single incoming power sources from a Main Distribution Board and includes feeder circuit breakers and protection devices to the consumers.

E04.8.1 Busbars

(a) Main busbars in ADBs shall be rated for 1000 amps as a minimum unless otherwise specified/approved by the engineer.

(b) Busbar droppers in ADBs shall be rated for the maximum possible current (determined by the breaker frame size) in that section with a minimum rating of 600 amps unless otherwise specified/approved by the engineer.

E04.8.2 Earth bar

(a) The earth bar shall be rectangular, with a minimum cross sectional area of 250mm² (10mm x 25mm) unless otherwise specified/approved by the engineer.

E04.8.3 Power wiring

(a) The minimum ADB power wiring size shall be 16mm² unless otherwise specified/approved by the engineer.

E04.8.4 Circuit Breakers

(a) Air circuit breakers (ACBs) shall be used as Incomer circuit breakers on ADBs unless otherwise specified/approved by the engineer.

(b) Moulded Case circuit breakers (MCCBs) will be used for outgoing feeders on ADBs up to a maximum rating of 800 amps.

E04.8.5 Instruments and Meters

(a) Incoming CBs shall be equipped with an power meter capable of providing multiple parameters of the connection including kWh, kVArh, kW, kVAr, PF, MD, etc. and provide a pulsed output and Ethernet connectivity.

(b) Feeder CBs shall be equipped with a suitably sized 5A current transformer operated 96mm x 96mm 90° movement suppressed maximum demand ammeter having an overload rating of 40 times the rated current for one second. The CT primary current rating will match (equal) the outgoing feeder circuit breaker current rating. The CT secondary current rating will be 5A.

E04.9 FLUSH MOUNTED DISTRIBUTION BOARD

E04.9.1 Internal for of Separation

(a) The internal for of separation will be specified by the Engineer.

E04.9.2 Bonding Tray

(a) Bonding trays for flush mounted switchboards shall be of rigidly constructed 1,6mm thick galvanised steel, braced and reinforced.

(b) 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.

E04.9.3 Expanded Metal

(a) Where switchboards are to be built into 116mm thick walls, expanded metal shall be spot welded to the rear of the bonding trays.

(b) The expanded metal shall protrude at least 150mm on each side to prevent plaster from cracking.

E04.9.4 Knock-Outs

(a) Ample knockouts 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.

(b) Knockouts shall be allowed for any size of specified conduit.

(c) 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.

E04.9.5 Architrave Frame

(a) The architrave frame shall be of 2,0mm thick sheet steel with bevelled edges.

(b) The architrave frame shall accommodate the chassis, panels and doors.

(c) The architrave shall overlap the bonding tray by at least 25mm on each side.

(d) The architrave frame shall be fixed to the tray in such a fashion to allow for depth adjustment and irregularities of the wall.

E04.9.6 Extension Frames

(a) Semi-flush mounted switchboards shall be equipped with extension frames.

(b) Generally, the frame depths shall be 50mm but may be altered to suit each application.

E04.9.7 Chassis

(a) 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.

(b) The chassis position shall be adjustable in the horizontal plane.

E04.9.8 Panel (Faceplate)

(a) A suitably stiffened panel manufactured of 2,0mm thick sheet steel shall be installed in the architrave frame for flush mounting of switchgear.

(b) 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.

(c) Blanking plates shall be provided in positions where future switchgear will be installed.

(d) The distance between the inside of the closed doors and the panels shall be not less than 40mm.

(e) No equipment may be mounted on the panel (faceplate) unless it is permanently hinged to the switchboard frame.

E04.9.9 Fixing of Panels

(a) The panel for each switchboard shall be secured to the architrave frame by means of captive fasteners. Alternatively, the panel may be secured to the architrave frame by means of two pins at the bottom and a latch or lock at the top of the panel. Self-tapping screws or dome nuts will not be allowed.

(b) Where it is required that equipment be mounted on the panel, the panel shall be securely hinged to the switchboard frame.

E04.9.10 Panel Handles

(a) Two chromium plated handles shall be provided on each front cover.

(b) The handles shall be mounted at the top and bottom of each panel.

E04.9.11 Hinged Panels

(a) 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.

(b) The panel shall be removable when it is in the open position.

E04.10 SURFACE MOUNTED DISTRIBUTION BOARD

This section refers to surface mounted sub-switchboards and not to floor standing main switchboards in substations or sub-main switchboards.

E04.10.1 Internal for of Separation

(a) The internal for of separation will be specified by the Engineer.

E04.10.2 Switchboard Tray

(a) Surface mounted switchboards shall be equipped with a 1,6mm sheet steel reinforced tray.

(b) Securing lugs shall be provided to fix the tray to walls or any other structure.

(c) A solid brass or cadmium plated steel earth connection stud and nut shall be provided.

E04.10.3 Construction

(a) All joints shall be welded or securely bolted.

(b) The tray shall be square and neatly finished without protrusions.

(c) The front tray sides shall be rounded with an edge of at least 20mm to accommodate flush doors.

(d) The requirements for chassis, panels and doors shall be as specified for flush mounted switchboards.

(e) The doors shall be hinged and shall fit flush in the frame in the closed position.

(f) Knockouts shall not be provided unless specifically called for.

E04.11 LV KIOSKS (SWITCH CUBICLES)

LV kiosks shall be of sufficient size to accommodate all the specified equipment.

E04.11.1 Framework

LV kiosks shall be manufactured of mild steel sheet metal with a minimum thickness of 2mm or cold rolled 3CR12 sheet metal with a minimum thickness of 1,6mm. Fibre re-inforced or other corrosion proof material (e.g. glass fibre) may also be used if adequately reinforced.

E04.11.2 Ventilation

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.

E04.11.3 Doors

Doors shall be provided in the front and back panels and shall swivel through 180º. 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.

E04.11.4 Warning Sign

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

E04.11.5 Base

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.

E04.12 STANDBY SUPPLIES

(a) 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 panel, the panel shall be divided into electrically separate sections with sheet metal division plates to isolate power and mains power sections. The section doors must be appropriately colour coded to provide visual distinguishing.

(b) 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 or contactors may be used. Electrical interlocking alone is not sufficient. Rotary switches may only be used on panels where the fault level does not exceed 10kA.

(c) A separate 3-pole 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.

(d) 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.

E04.13 ELECTRICAL SUBSTATION FIRE PROTECTION SYSTEM

It is the duty of the Contractor to appoint a trained and competent fire engineering company to design, supply, install, commission, and test and certify a fire protection system for each electrical substation building forming part of the contract.

Each fire protection system will consist out of a fire detection and an extinguishing system as described below. Both systems will be of the highest quality and latest technology, supplied by a reputable manufacturer. The contractor will submit written proof that local support is available to maintain the system and to supply spare parts as required.

E04.13.1 Fire Detection System

The fire detection system must:

(a) Utilise a sub-micron combustion particle detector that detects a fire at its initial stage, before the presence of smoke. This allows preventative action can be taken before any catastrophic event occurs.

(b) Utilise detectors suitable for dusty plant environments and must be impervious to false alarms caused by dust particles in substation buildings with sheet metal roofs where no ceilings are present.

(c) Cover the substation building, all electrical cabinets and all cable trenches.

(d) Only when there is a second alarm from a second detector the system will trigger the gas.

(e) Double Knock system (Trigger an alarm on the first detector activation and trigger the operation of a fire extinguishing system on a second detector activation).

(f) Alert a control and alarm signalling system in case of a fire or a system fault.

(g) Be designed and installed to conform to SANS/ISO 10139 and SANS 369 Parts 1 and 2.

E04.13.2 Fire Extinguishing System

The fire extinguishing system must:

(a) Utilise an automatic system to flood the substation building with a concentration of a gaseous extinguishing agent to extinguishing a fire burning in Class A, B, and C hazards by lowering the oxygen content below the level that supports combustion as quickly as possible.

(b) Utilise a non-toxic, human friendly extinguishing agent. The use of an extinguishing agent that does not support human life must be approved in writing by the Engineer. In this case, other safety measures such as a lockout system should be integrated to ensure safe entrance into the protected substation.

(c) Utilise an efficient extinguishing agent that is electrically non-conductive and that will not adversely affect the protected electrical equipment. No powder or other residue should remain after actuation of the system.

(d) Audible and visual warnings must alert personnel to vacate the protected substation area before discharging the agent.

(e) Utilise a colourless, odourless environment friendly extinguishing agent that is sustainable against impending global warming regulations.

(f) Utilise an extinguishing agent that has a low refill cost.

(g) Should be fully approved by the local authority to an internationally accepted engineering standard.

E04.13.3 Other measures

(a) All points where cable or other services enter the substation building must be properly sealed with a fire rated medium of at least one-hour or as per local standards and regulations.

(b) All ventilation and air conditioning devices must be tripped in the event of first detection of a fire.

(c) All ventilation openings and doors in the substation building should be sealed in the event of first detection of a fire.

(d) A room integrity test needs to be carried out to validate the hold-time for the extinguishing agent as per the room's natural leakage.

(e) All detection, alarm and extinguishing circuits are to be monitored for system faults.

(f) The substation fire protection system should operate a local audible and visual alarm system and report to a central 24-hour manned operations or security room.

(g) A local handheld fire extinguisher should also be installed within the substation as per local regulations. The type and number should conform to local standards and regulations.

E04.13.4 System Maintenance

(a) The contractor will include a fire protection system maintenance contract for a period of one year after commissioning. A trained and competent fire engineering company must do the maintenance.

(b) Thereafter a trained and competent fire engineering company should be contracted to inspect the system on a three-month basis. It should check that the system is operational in terms of its design and take corrective action in the event of a fault.

(c) The Client should visually check the system once a month for any faults reported on the control panel and anything that might appear out of the ordinary. The Client should immediately report to a competent fire engineering contracting company of any concerns or faults to ensure immediate rectification.

(d) A mandatory annual room integrity test should be carried out as per SANS 1520 Part 1.

(e) Should any physical alterations be made to a substation, a review on the fire protection system must be done to see if its performance has been compromised and appropriate actions should be made to ensure the integrity of the system.

E04.14 QA REQUIREMENTS

The vendor / contractor will be responsible for the following.

TABLE OF CONTENTS			
SECTION	**DESCRIPTION**	**REQUIRED (YES OR NO)**	**WHEN REQUIRED**
DRAWINGS & DESIGN (2 SETS OF EACH)	DESIGN CALCULATIONS		
	GA DRAWINGS	YES	ORDER + 3 WEEKS
	DETAIL DRAWINGS	YES	CONSTRUCTION
	AS BUILT DRAWINGS	YES	COMPLETION
	BROCHURES	YES	CONSTRUCTION
	SKETCHES		
	SCHEMATIC DIAGRAMS	YES	ORDER + 3 WEEKS
	RISK ASSESSMENT BY VENDOR	YES	CONSTRUCTION
	DATA SHEETS	YES	TENDER
	DESIGN CRITERIA	YES	CONSTRUCTION
QUALITY CONTROL DOCUMENTS (2 SETS OF	QUALITY CONTROL PLAN	YES	ORDER + 3 WEEKS
	MANUFACTURING PROGRAM	YES	ORDER + 3 WEEKS

EACH)			
MATERIAL CERTIFICATES		YES	MANUFACTURE
CERTIFICATES OF INSPECTION TESTING AND ACCEPTANCE	PRESSURE TEST CERTIFICATE	YES	DATA BOOK
	ELECTRICAL HAZARD CERTIFICATE		
	ELECTRICAL TEST CERTIFICATES	YES	DATA BOOK
	INSTRUMENT CALIBRATION CERTS.		
	VENDORS CERTIFICATE OF CONFORMANCE	YES	COMMISSIONING
	NON-CONFORMITY / CONCESSION REPORTS	YES	COMMISSIONING
MANUALS	OPERATING / MAINTENANCE MANUAL	YES	COMPLETION
	DATA BOOK	YES	DELIVERY – 1 WEEK
	DRAWINGS	YES	COMPLETION
	WARRANTY/GUARANTEES CERTIFICATES	YES	COMPLETION

E04.15 DRAWINGS AND DATA

(a) The vendor / contractor will supply shop drawings to the Engineer prior to manufacturing.

(b) No switchboard manufacturing may start if the drawings are not approved by the Engineer in writing. Should the vendor / contractor start manufacturing without approved shop drawings, any changes required by the Engineer will be for the vendor / contractor’s account.

(c) The following will be included in the shop drawings as a minimum:

i. General arrangement drawings

ii. Schematic diagrams

iii. Equipment lists, including the make, catalogue number and capacity of all equipment such as isolators, circuit breakers, fuses, contractors, etc.

iv. All labelling information on a separate sheet.

(d) The approval of the shop drawings shall not relieve the Contractor of his responsibility to the Client to supply the switchboards according to the requirements of this specification or to the requirements of the Detailed Technical Specification.

(e) The vendor / contractor will supply three hard copies and one soft copy of the equipment data book including all items as specified in the Vendor QA and document requirement list.

(f) Data books will be supplied to Johannesburg Water within 7 days from delivery of equipment. Johannesburg Water will review the data books within 14 days from issue and notify the Vendor of its acceptance or rejection of it.

(g) All drawings and documentation shall be in accordance with Johannesburg Water specifications bound in book format.

(h) A complete set of "As Built" drawings of all switchboards shall be submitted to the Engineer immediately after completion of the installation. The following information shall be presented:

i. Items (i) and (iv) 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.

(i) Where "As Built" drawings are modified during the execution of the contract, the Contractor shall at his own expense modify or replace such drawings. Accurate drawings of the equipment shall be forwarded to the Engineer.

E04.16 PAINTING AND PROTECTIVE COATING

E04.16.1 Powder Coating Systems

(a) Paint system 1: Powder Coating, seven Stage zinc, Phosphate pre-treatment, pure epoxy primer, Polyester finishing coat, and thickness 140 µm.

Paint System	Host Material	Preparation	Primer (70µm)	Finishing Coat (70µm)	Thickness µm
No 1	Mild Steel	7 stage phosphate pre–treatment	Epoxy	Epoxy	140

(b) On completion of the paint job, the powder manufacturer must carry out the following tests on the test panels:

i. SABS 6J impact test

ii. Cross hatch adhesion test

iii. Bend test

(c) The powder manufacturer must issue a Certificate of Compliance for each paint job, which should be included in the contract documentation.

(d) The preferred corrosion protection systems are applied onto cold rolled mild steel plate with a thickness of 2.0mm.

E04.16.2 Epoxy Powder Coat Products

Item	Product Type	Powder - Lak
1	Epoxy Primer	23-007
2	Pure Epoxy / Polyester Finishing Coat.	Series 3000

E04.16.3 General

(a) All chassis plates shall be painted white.

(b) All mild steel gland plates shall be galvanised for improved cable earthing.

(c) All panel doors on equipment supplied from a normal supply must be painted Electric Orange (B26).

(d) All panel doors on equipment supplied from an emergency supply must be painted Signal Red (A11).

(e) All panel doors on equipment supplied from an UPS supply must be painted Dark Violet (F06).

(f) Specific external colours will be provided by Johannesburg Water.

(g) Before the installation is handed over, the Contractor shall ensure that all paint surfaces are clean and undamaged.

E04.17 PERFORMANCE AND GUARANTEE

(a) The performance of the items supplied in terms of this specification, as defined by the order, shall be warranted by the Vendor and, if specified, be tested in accordance therewith.

(b) The vendor shall not be specifically required to conduct a performance test on site.

(c) A minimum warranty period of 12 months is required.

E04.18 INSPECTION AND TESTING

E04.18.1 Factory Acceptance Test

(a) The Johannesburg Water Representative shall have access, at all reasonable times, to those parts of the manufacturing facilities engaged in the manufacturing of items in terms of this specification. He is authorised to witness any stage of manufacture, tests and inspect documentation.

(b) The Johannesburg Water Representative is authorised to reject any items not manufactured to the requirements of the specification.

(c) All equipment shall be inspected at the vendor's works prior to delivery, to ensure compliance with the specification.

(d) No unit shall be considered complete until acceptance by Johannesburg Water.

(e) The minimum testing / pre delivery checklist shall be as follows:

i. The Johannesburg Water representative must carry out a clause-by-clause check of each switchboard, prior to delivery.

ii. This switchboard checklist is intended to assist this process but does not relieve him/her of the responsibility described above.

DETAILED INSPECTION ROUTINE

Order No. : ______________________________

Supplier/Vendor : ______________________________

Project : ______________________________

Motor Control Centre Designation : ______________________________

Inspected by : ______________________________

Date : ______________________________

		Comments
Overall Appearance		
☐		
☐	**Paint work : Compliance with Annexure A5**	
☐	**Paint thickness**	
☐	**Door fittings good**	
☐	**Dust sealing effective (neoprene seals)**	
☐	**Board fully assembled**	
☐	**Overall height less than specified height**	
☐	**Channel iron base frame (less than 3000m)**	
☐	**Lifting lugs provided**	
☐	**Equipment supplied in accordance with specification (contractors, overloads, circuit breakers, relays, etc.)**	

		Comments
Busbars		
☐	**Correct cross-section**	
☐	**Correct phasing with incomer/feeders**	
☐	**Rigidly supported/braced**	
☐	**Properly insulated**	
☐	**Joints tightened**	
☐	**Transport section joints supplied (Fishplates, nuts and bolts, control wiring and terminals, etc.)**	
☐	**Droppers from main bars to circuit breakers adequately rated, braced, insulated**	
☐	**Nothing unnecessary mounted on bus bars**	
☐	**Main earth bar, min 70mm²**	
☐	**Control busbars generally as above, separate from power busbars**	
☐	**Air clearances adequate throughout**	
Single Line Diagram Check		
☐	**As per approved single line diagram**	
Outgoing Circuit		
☐	**Correct size/rating for MCCB's**	
☐	**Correct size/rating for ACB's**	
☐	**Correct earth leakage relays**	
☐	**Correct current transformer and associated ammeters**	
☐	**Correct overload relays**	
☐	**Correct setting on overload relays**	
☐	**Reasonable provision for cable termination power and control mounting of equipment**	
☐	**Correct conductor sizing, power and control, and correct colouring**	
☐	**Correct indicator lights and colours**	
☐	**Air clearances correct throughout**	
Incoming Circuits		
☐	**Correct size/rating of ACB's**	
☐	**Correct metering and proper mounting**	
☐	**Connection of power factor meter**	
☐	**Fuses on volt meter, where applicable**	
☐	**Reasonable provision for termination of incoming cable/gland plate**	
☐	**Air clearances correct throughout**	
	Incomer status signal to PLC	
	Interlocks	
Pressure and Injection Tests		
☐	**Primary injection test for correct operation of all protection and overload relays**	
Operational Test		
☐	**Mechanical operation of all circuit breakers, preferably with doors closed**	
☐	**Shunt trip of all circuit breakers**	
☐	**Operation of overload relay**	
☐	**Correct operation of all interlocks**	
☐	**Correct operation of indicator lights**	

		Comments
□	**Correct operation of earth fault/overload alarm system, including general alarm panel**	
	Correct signals to PLC terminals	
	Correct interlocks	
	Door interlocks	
General Checks		
□	**Marking of control wires and power conductors**	
□	**Main Motor Control Centre label**	
□	**Cubicle labels fitted – designation and cubicle number**	
□	**Component labels fitted**	
□	**Warning labels on all removable covers giving access to live 400V conductors**	
□	**Labels for indicator lights, pushbuttons, etc.**	
□	**Terminal strip labels**	
□	**Incoming side of circuit breakers label**	
□	**Incoming circuit label – “FROM ________”**	
□	**No ‘Philips’ (star) screws**	
□	**No self-tapping screws**	
□	**Grommets fitted on all open holes**	
□	**Correct paint specification**	
□	**All documentation submitted**	
□	**Arc venting arrangements satisfactory**	
□	**Door latches fitted**	

(f) Specific testing and inspection requirements relating to switchgear boards are as follows:

i. Prior to shipment, the switchgear boards shall be completely assembled, wired, adjusted and tested by the supplier in the presence of the engineer and the client representative.

ii. Testing shall include primary injection tests of all current transformers, pressure tests to prove quality of insulation, functional tests of all mechanical and electrical components and electrical circuitry and any other tests required to ensure compliance with this specification.

iii. The supplier shall give one week’s notice of readiness for final tests to the Johannesburg Water representative. The vendor shall ensure that the equipment is ready for final testing before requesting the presence of the Johannesburg Water representative at such a test. Repeat inspections necessitated by the lack of readiness of the equipment may be charged to the vendor at the discretion of the Johannesburg Water representative.

E04.18.2 Site Acceptance Test and Commissioning

(a) A Site Acceptance Test (SAT) must be conducted at the place of installation prior to switching the DB on. The test shall include (as a minimum) the following:

i. A visual inspection to ensure all the design specifications are adhered to;

ii. Insulation resistance test;

iii. Function testing of all components.

iv. All switchboards must be thermal imaged a minimum of 1 week after being put on service. The image must be taken in normal operating conditions. The image must be analysed for hot spots and must be part of the Operations and Maintenance

Manuals presented at the end of the project.

E04.19 MEASUREMENT AND PAYMENT

Item Unit

Supply and deliver Switchboards or Motor Control Centres..No

The unit of measurement shall be the number of MCC's or boards supplied and delivered.

The tendered rate shall include full compensation for the manufacture, supply, testing and delivery of the boards as specified in the detailed specification.

Item Unit

Install Switchboards or Motor Control Centres ....No

The unit of measurement shall be the number of MCC's or boards installed.

The tendered rates shall include full compensation for the installation of the specified boards, including all required installation material to install the MCC or board in the required position including a heavy-duty strut, mounted 400mm below the gland plate. All incoming and outgoing cables shall be attached to this strut by means of K-clamps or approved equivalent clamps.

Item Unit

Commission Switchboards or Motor Control Centres ....No

The unit of measurement shall be the number of MCC's or boards.

The tendered rates shall include full compensation for the site testing and commissioning of the specified boards including the keeping of all commissioning records in triplicate, including all material, test equipment and labour required for the testing and commissioning.

Item Unit

Supply and install extra circuits on Switchboards and Motor Control Centres ....No

The unit of measurement shall be the number of circuits supplied and installed.

The tendered rate shall include full compensation for the manufacture, supply, testing and installing of extra circuits in switchboards or motor control centres (spare space being available on the board).

Item Unit

Supply and deliver level control equipment..No

The unit of measure shall be the number of level control systems supplied and delivered.

The tendered rate shall include full compensation for the supply, manufacturing, testing and delivery of all the material required for the level control system, including all float level switches, will the required length of cable attached to them, mounting brackets, terminal box and mounting equipment together will all material to facilitate a complete level control system.

Separate items will be measured for systems with different numbers of level switches.

Item Unit

Install level control equipment...No

The unit of measure shall be the number of level control systems installed.

The tendered rate shall include full compensation for installing, testing and commissioning of the level control system including the required brackets, junction boxes, cables etc. for a complete working system.

Item Unit

Modify existing motor starter panels ....No

The unit of measure shall be the number of motor starters to be modified.

The tendered rate shall include full compensation for the supply and delivery of all material and labour required to modify the motor starter panel as detailed in the detail specification.

Item Unit

Supply and install PLC/Scada alarm and status signals .... No

The unit of measure shall be the number of MCC's for which a siren and alarm light has been installed.

The tendered rate shall include for the full compensation for the supply, delivery, installation and commissioning of the specified siren and alarm light including all required installation material including cables required to render a fully operational system.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
E05 : ELECTRICAL LOW VOLTAGE POWER AND CONTROL CABLES

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 5 August 2019

City of Johannesburg
Johannesburg Water (SOC) Ltd

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – E05 : Electrical Low Voltage Power and Control Cables**

JW Reference: **BWW523C**

Document Ref. No: **E05**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	Senior Electrical Engineer	B Pieterse	August 2019	
Reviewed	Director	R Baard	August 2019	
Approved	Regional Maintenance Manager	T Thabeng	August 2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
5	2019-08-20	B Pieterse	Review of Electrical Standards, plus New Design Guidance
4	2014-06-03		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
3	2012-05-30		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
2	2010-05-03		Review Electrical Standards
1	2010-05-03		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance

PARTICULAR SPECIFICATION: VOLUME E05: ELECTRICAL LOW VOLTAGE POWER AND CONTROL CABLES

CONTENTS

E05.1 SCOPE

This specification covers the requirements with regards to the manufacture, supply, delivery, installation, testing and commissioning of power and control cables rated up to 600/1000V. The term cable shall indicate electrical conductors or carriers manufactured for supplying power for the control and supervision of multipurpose loads.

E05.1.1 Statutory Documents and Standards

Cables shall be strictly manufactured in accordance with the requirements of the latest editions of the following standards:

(a)	SANS 1507	:	Electrical cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V)
(b)	SANS 1411	:	Materials of insulated electric cables and flexible cords
(c)	SANS 1339		Electric cables - Cross-linked polyethylene (XLPE) insulated cables for rated voltages 3,8/6,6 kV to 19/33 kV
(d)	SANS 1520	:	Flexible electrical cables for use in mines
(e)	SANS 10198		The selection, handling and installation of electric power cables of rating not exceeding 33 kV
(f)	SANS 10142-1	:	The Wiring of Premises Part 1 – Low Voltage Installations
(g)	IEC 60245	:	Rubber insulated cables
(h)	IEC 60287	:	Electric cables - Calculation of the current rating
(i)	IEC 60811	:	Electric and optical fibre cables - Test methods for non-metallic materials
(j)	DIN VDE 0250-816	:	Cables – Wires and flexible cords for power installation – Heat-resistant silicone rubber insulated flexible cable

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

E05.1.2 Definitions and Terminology

In general, the following definitions and terminology shall apply:

Armouring	A layer or layers of galvanized steel wires applied to the cable to provide mechanical protection or earth continuity, or both.
Bedding	A layer of extruded compound applied to the cable beneath the armouring.
Cable	A length of core or more cores assembled, that may or may not be provided with an overall mechanical covering.
Core	A single insulated conductor without protective covering.
Direction of lay	The lateral direction of inclination to the axis (either left or right) of the receding helix formed by wire or core in a cable or flexible cord.
PVC	Polyvinyl chloride
Sheath	A solid extruded protective covering applied as the exterior of a cable or a flexible cord.

E05.1.3 Particular Specifications to read in Conjunction with this Specification

This specification shall be read in conjunction with the following specifications:-

E06: ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION

E05.2 GENERAL SCOPE

E05.2.1 Design and Supply

(a) Conductor sizes

The minimum conductor size for control cables shall be $2.5mm^2$.

The minimum conductor size for power cables on plant equipment (excluding small power and lighting) shall be $16mm^2$.

(b) Conductor material

In the case of plants with a high risk of cable theft, cables with aluminium conductors must be used where the nominal core diameter exceeding $25mm^2$. This must be agreed upon in writing by the Engineer.

E05.3 CONSTRUCTION

The cable shall be constructed as follows:

E05.3.1 Conductor Material

The copper conductors shall be of plain annealed or hard draw wire in accordance with the requirements of the latest edition of SANS 1411.

The aluminium conductors shall be of plain hard drawn aluminium wire in accordance with the requirements of the latest edition of SANS 1411.

E05.3.2 Insulation

The insulation material shall comprise of PVC in accordance with the requirements of the latest edition of SANS 1411.

E05.3.3 Core Colour Identification

The cable cores colour shall be in accordance with the requirements of the latest edition of SANS 1507-3.

E05.3.4 Bedding

The bedding shall consist of a continuous PVC extruded sheath.

E05.3.5 Armour

The armouring shall consist of one layer of round galvanised steel wire in accordance with the requirements of the latest edition of SANS 1411.

E05.3.6 Sheath

The outer sheathing shall be an impermeable, halogen free, reduced smoke emission, flame retardant PVC in accordance with the latest edition of SANS 1411.

E05.4 CABLE MARKINGS

The cables shall be legibly marked in accordance with the requirements of the latest edition of SANS 1507, and shall include the following:

(a) Conductor size in square millimetres
(b) Number of cores
(c) Conductor material (copper)
(d) The specification number (SANS 1507) to which the cable has been manufactured.
(e) The year of manufacture.
(f) Nominal voltage.

E05.5 STORAGE

Cables shall be packed on reeled drums. The moisture content of wooden cable drums shall not exceed 20%.

Each end of the cable shall before being secured to the reeled drum, be sealed by an acceptable method approved by the Engineer. The outer end shall be secured to the reel drum and the inner end shall be protected in a manner against mechanical damage.

The cable reeled drums shall be capable of taking a round spindle and be lagged with strong, closely fitted battens, at the inner and outer circumference to prevent damage to the cables. The spindle bearing plates shall be steel. The dimensions of the drum shall not exceed 1 100 mm width, 2 000 mm diameter and the spindle bearing plate shall not be less than 9 mm thick. Each drum shall be clearly marked on both sides in accordance with the latest edition of SANS 1507.

The ends of the PVC sheathed cable shall be sealed to avoid penetration of moisture. Each cable drum shall be numbered.

E05.6 CABLE SIZING AND DE-RATING

The cables shall be sized and de-rated in accordance with the requirements of the latest edition of SANS 10142-1.

E05.7 TESTING OF CABLES

E05.7.1 Testing and Commissioning

The contractor shall supply factory test certificates for each drum of cable supplied under the Contract.

After the installation is complete, the contractor and the Engineer shall inspect the installation. The Engineer must be notified in advance of the inspection dates. The contractor will keep a snag list, reflecting all items not acceptable to the Engineer. The contractor will correct the snag items as required to the Engineers approval, updating the snag list as the items are completed and signed off by the Engineer.

On completion of his work, the Contractor will issue an Electrical Certificate of Compliance (CoC). All tests deemed necessary to issue the CoC should be included. The Contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The Contractor shall notify the Engineer timeously so that he may witness the tests.

Each installed cable shall be tested in accordance with:

(a) The Occupational Health and Safety Act (OHSA) 1994;
(b) SANS 1507 (Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V));

SANS 1507 Test Wave	Duration (min)	Commissioning test voltage between conductors (V)			Commissioning test voltage between conductors / earth (V)		
		300/ 500	600/ 1000	1900/ 3300	300/ 500	600/ 1000	1900/ 3300
AC (rms)	15	1000	2000	6000	1000	2000	3500
DC	15	1500	3000	9000	1500	3000	5000

This test will be conducted to the Engineers judgement. The constructer must obtain written approval from the Engineer before conducting any tests.

(a) The requirements of the Local and Supply Authorities.

E05.8 QUALITY ASSURANCE

All the cables supplied under the Scope of Works of this project shall be designed and manufactured under a quality control system, typically to ISO 9000 series. The contractor must supply current compliance certificates on the manufacturers ISO classification.

E05.9 MEASUREMENT AND PAYMENT

Measurement and payment will distinguish between supply/delivery and installation/commissioning of the cabling lengths required.

Item **Unit**

Supply and delivery of low-voltage cable ....metre

The unit of measurement shall be the length of low-voltage cable supplied. It is the responsibility of the Contractor to verify the lengths of cables required on site. The Contractor shall only supply the required length of cables required. The final quantity of installed cable lengths shall determine the final quantity to be paid of the supplied cable lengths.

The tendered rate shall include for the design, manufacture, supply and delivery of the specified cable to the site.

Separate items shall be scheduled under this payment item for each size and type of cable.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

E06 : ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION

Johannesburg Water

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ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	Senior Electrical Engineer	B Pieterse	August 2019	
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Approved	Regional Maintenance Manager	T Thabeng	August 2019	

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Date	Revision	Author	Comments
5	2019-08-20	B Pieterse	Review of Electrical Standards, plus New Design Guidance
4	2014-06-03		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
3	2012-05-30		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
2	2010-05-03		Review Electrical Standards
1	2009-05-12		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance

PARTICULAR SPECIFICATION: VOLUME E06: ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION

CONTENTS

E06.1 SCOPE

This section covers the installation of cables for the distribution of electrical power to be installed in soil trenches, electrical cable ducts, buildings and structures for system voltages up to 11 kV at 50 Hz.

E06.1.1 Statutory Documents and Standards

The installation will be conducted in accordance with the requirements of the following standards. Where any document or standard is referenced, it shall be deemed the latest version of that document.

(a)	SANS 10198	:	The selection, handling and installation of electric power cables of rating not exceeding 33 kV
(b)	SANS 1507	:	Electrical cables with extruded solid dielectric insulation for fixed installations
(c)	SANS 10142-1	:	The wiring of premises Part 1 – Low Voltage installations
(d)	SANS 1213	:	Mechanical Cable Glands
(e)	DIN EN 50655-2 VDE 0278-655-2	:	Fingerprinting for heat shrinkable components for low and medium voltage applications up to 20,8/36 (42) kV

E06.1.2 Particular Specifications to be read in conjunction with this specifications

This specification shall be read in conjunction with the following specifications:-

(a)	E02	:	ELECTRICAL CABLE RACKS
(b)	E03	:	ISOLATOR PUSHBUTTON STATIONS
(c)	E04	:	MOTOR CONTROL CENTRES
(d)	E05	:	ELECTRICAL LOW VOLTAGE POWER AND CONTROL CABLES
(e)	E07	:	ELECTRICAL INDUSTRIAL WELDING PLUGS, COUPLERS AND SOCKET OUTLETS
(f)	E08	:	WIRING
(g)	E12	:	ELECTRICAL MEDIUM VOLTAGE CABLES

E06.2 GENERAL

E06.2.1 Cable theft prevention

Consideration must be given at design stage for the risk posed by cable theft. The routing of cables on site must be so that there is minimum risk of cable theft. This can be effected by avoiding use of bare earth copper cables, burying cables where possible, covering with secured covers, using a concrete paving over a cable route and any other approaches that will reduce probability of cable theft. As each site has different exposure to the risk of cable thefts, the user plant personnel must be involved in a risk assessment exercise to determine measures that may be applied on a site-by-site basis.

Cable runs outside of buildings must be buried. Where cables need to cross, rise onto structures, enter buildings or link structures, cable ladders may be used. In such cases, cable racks must be covered to prevent access. The cover may be bolted, welded in such a way that it is secure and may not be easily removed by simple tools.

E06.2.2 Competence of Personnel

Contractor supervisors overseeing work on or the installation of MV equipment and cables on site will be authorised under the Operating Regulations for High Voltage Systems (ORHVS). A valid authorisation certificate will be submitted with each tender. All contractor personnel working on medium voltage equipment shall work under the direct supervision of the authorised supervisor.

Cables, cable joints, cable terminations and cable accessories shall be installed in accordance with the manufacturer’s installation instructions by competent personnel. The Contractor shall only employ personnel fully conversant with the cable manufacturer's recommendations to lay, joint and terminate cables.

E06.3 CABLE INSTALLATION ON CABLE RACKS AND STRUCTURES

E06.3.1 Installation of Cables

Cables may be installed in one of the following ways:

(a) On horizontal or vertical cable ladders;
(b) Against horizontal or vertical metal supports or brackets;
(c) Fixed to structures.

E06.3.2 Installation of Cable Ladders

Cable ladders shall be installed:

(a) Within Motor Control Centre stations,
(b) On access platforms to the mechanical equipment;
(c) In accessible cable duct.

Cable ladders shall be supported with struts, channels, brackets, clamps, cantilever arms ext. The corrosion protection of the support elements shall be of the same system as that of the cable ladder. Nuts/bolts/washers shall be used as fasteners. Unless otherwise agreed, all screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be stainless steel 316.

On access platforms, the cable ladder will be installed at minimum of 150 mm from the supporting concrete structure. Crevice corrosion of the metal elements in contact with concrete surface shall be eliminated by means of a suitable layer of non-shrink grouting.

In accessible cable duct, cable ladder shall be supported by a 50mm high strut section securely fixed to the wall. The corrosion protection of the strut shall be of the same system as that of the cable ladder

To minimise cable theft, long cable runs on cable ladders should be avoided. For high risk areas where cable racking is used or, such cable racks must be covered with solid covers of the same material and complying with the same paint specification as the racking itself. Such covers must be bolted onto the rack in such a way that either special tools or a disk grinder would be required to remove these covers. If any additional methods to prevent cable theft are required, such requirements will be made clear to the contractor at the time of tender. This will also apply to all areas where cables are exposed or where cables are visible to by passers.

Before any cables are laid, the Engineer or his representative will inspect all cable racks.

E06.3.3 Installation of Cable Supports

Cable supports must be 3CR12-grade stainless steel, 304-grade stainless steel or 316-grade stainless steel and electric orange powder coated as for the cable racks. The size of angle iron supports must be such that no part of a cable projects beyond the support.

E06.3.4 Grouping and Spacing of Cables

Wherever possible cable racks must be mounted in the vertical plane to avoid accumulation of dirt and debris. Only single layers of cable will be allowed on a rack, to reduce de-rating and for ease of replacement and/or repairs. No more than two cables may be run on a single angle profile (3CR12) support.

Cables with a cross-sectional area of more than 16 mm² shall, be spaced two outside cable diameters apart, for which no grouping correction factor need be applied.

Where parallel cable runs are installed at different levels (e.g. on parallel cable trays), and where the spacing of the layers is not specified, a minimum spacing of 300 mm shall be maintained.

Medium voltage cables shall be separated from other cables and services throughout the installation, and shall be installed in separate floor trenches, pipes or metal channels as far as possible. Where this is not feasible, a minimum spacing of 500 mm shall be maintained.

Cables for telephone, communication and alarm systems and all other low voltage systems (less than 50 V), shall be separated from power cables. In 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 at least 500mm away from power cables or shall be installed on separate cable trays. In the case where unarmoured cables are used for these other services, they shall be installed in separate metal channels or conduits.

E06.3.5 Fixing of Cables on Cable Racks and Supports

UV stabilised PVC straps may be used for cables up to 4core x 25mm2. For cables of larger diameter than this (i.e. 30mm diameter and larger), stainless steel strapping must be used. All cables must be individually strapped.

E06.3.6 Spacing of Cable Supports

The most generally known method of supporting cables is the restrained installation where the distance between supports is small enough to prevent any noticeable sag in the cable.

The maximum spacing between cleats (clamps) to which cables are fixed in horizontal and vertical cable routes shall be determined from Table 1 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 control cables shall be 20 times the outside diameter of the cable with a maximum spacing of 500 mm for unarmoured cables and 30 times the outside diameter of the cable with a maximum spacing of 1 m for armoured cables. A minimum of 20 mm ventilation clearance shall be maintained between cables and the wall to which they are cleated. Spacing of supports for cables for high voltage lighting shall be in accordance with Table 8 of SANS 10142.

Table 1: Maximum Spacing of Supports (Cleats) (mm)

FOR RESTRAINED CABLE				
Cross-sectional area of Cable conductors (mm²)	Wire Armoured Cables		Other than Wire Armoured Cables and Unarmoured Cables	
	Horizontal Cable Routes	Vertical Cable Routes	Horizontal Cable Routes	Vertical Cable Routes
1,5	500	750	300	400
2,5	500	750	300	400
4,0	600	750	300	400
6,0	600	750	300	400
10,0	750	900	400	500
16,0	750	1 000	400	500
25,0	900	1 000	400	500
35,0	900	1 000	400	500
Above 35,0	900	1 000	400	500

E06.4 CABLE INSTALLATION IN CABLE TRENCHES

E06.4.1 General

The Contractor shall preserve the site as far as possible. Only the minimum of trees, shrubs, rocks, etc. shall be removed and cleared for the cable route.

The cable trench will be arranged as shown in figure 2 below:

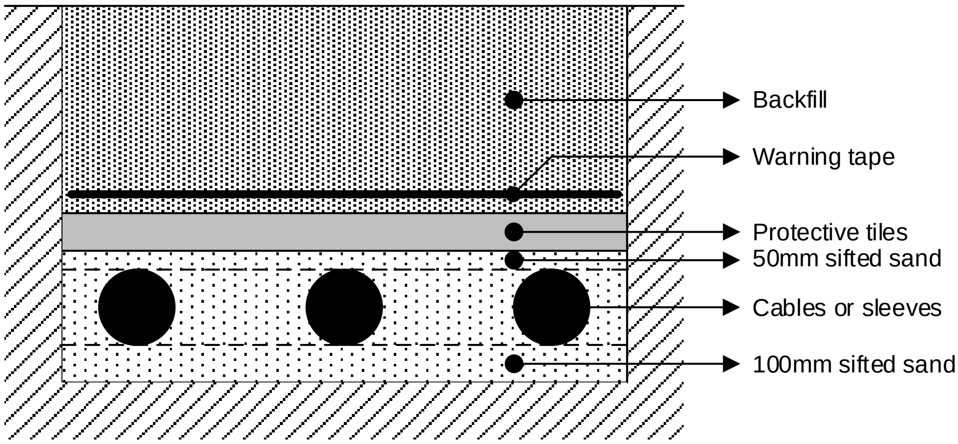

Figure 2: Cable trench arrangement

E06.4.2 Trench Routes

The cable trench shall be excavated along the route indicated on the relevant drawing. The routing should preferably traverse through the lowest theft risk areas as much as is possible.

The trench shall be as straight as possible and shall comply with all requirements. The Engineer shall determine the length of the trench to be excavated, which shall not exceed 300 m, before the cable is installed and the trench backfilled.

If any obstacle or interference should be encountered, which may require alterations to the trench or routes, such alterations shall receive prior written approval from the Engineer.

E06.4.3 Excavation of Cable Trenches

The exact positioning of trenches shall be approved on site by the Engineer and excavations shall not commence until approval has been received.

The trench shall be excavated to a depth indicated on the drawings for the different cables. Where depths are not indicated on the drawings, the following shall apply:

Cable trenches shall be excavated deep enough so that the top layer of the cables is buried a minimum of 600 mm below final ground levels for LV cables and 1000mm for MV cables.

The Contractor shall excavate by hand where he cannot excavate by means of machines due to limited access and the proximity of other services.

The bottom of the trench shall be level and shall follow the contours of the final ground level. Where the excavation is in excess of the required depth, the excavation shall be backfilled and compacted with suitable material to the required depth.

The Contractor shall remove all sharp projections, which could damage the cable where the trench is excavated through rocky formations, and shall remove all loose rocks, material, etc. from the bottom of the trench.

The Contractor shall trim the trenches and clean up the bottom of the trenches after he has completed the required excavation.

E06.4.4 Excavation of Jointing Chambers

Jointing pits shall be excavated to a depth of 1,2 m and shall be rectangular in shape and large enough for the cable jointers to work comfortably and in an efficient manner. Where more than one joint is to be made in the same position the joint pit shall be large and long enough to allow staggered joints to be made. The minimum size of a joint pit shall be as follows:

(a) One joint : 2,5 m long x 1,25 m wide

(b) Two joints : 3,0 m long x 1,5 m wide

E06.4.5 Excavated Material

No excavated material shall be left closer than 300 mm from the side of the excavation. The excavated material shall take up as small an area as possible with the safety of the workers and Works taken into consideration. The excavated material suitable for bedding material shall be placed separately on one side of the trench so that it is available when required.

Where surplus material or material unsuitable for backfilling has to be disposed of, the Contractor shall load and transport the material in the area provided to him, where it will be dumped.

E06.4.6 Inspection of Excavations

All cable excavations will be inspected by the Engineer prior to cable laying and backfilling commences.

The Contractor shall give the Engineer 24 hours' notice to do the inspections. No inspections shall be undertaken on Saturdays, Sundays and public holidays.

E06.4.7 Measurement of Excavations

Full detail of the cable trench dimensions and classification of the type of excavation shall be recorded by the contractor. The report will be presented to the Engineer as the final quantities for such excavations. The Contractor shall be responsible to keep all records as proof of progress and as basis for claims for payment. Inspections and measurements shall be completed before the installation of any bedding or backfilling.

The Contractor shall give the Engineer 24 hours' notice to be present when excavation are measured. No measurements shall be undertaken on Saturdays, Sundays and public holidays.

E06.4.8 Maintenance of Excavations

The Contractor shall maintain the excavation in a good condition, free of water, mud, loose ground, rocks, stones, gravel and other strange material until the cables are installed and the excavation is backfilled and compacted.

E06.4.9 Bedding Sand

A 100mm layer of sifted bedding sand free from sharp objects and rocks shall be laid and levelled at the bottom of each trench after the trench has been approved by the engineer, and prior to cable laying.

If the soil for the sand bed and sand cover has to be sifted, a sieve with holes 6 mm or smaller shall be used. Where this material is not available, the contractor shall import suitable material for such purposes. Where bedding has already been laid, the Engineer may instruct the Contractor to demonstrate that the minimum thickness of bedding has been provided for before authorising cable laying to proceed.

E06.4.10 Cable Laying

After approval of the trench, the cable shall be laid with the minimum of delay so that the trench can be backfilled. The Contractor shall, however, not backfill the trench until each length of cable has been inspected and approved by the engineer.

Only one cable shall be laid at a time and the Contractor shall take precautions that installed cables are not damaged. Cables should be laid with sufficient slack to relieve stresses.

The method to be used for laying cables shall be approved by the Engineer prior to the commencement of the laying of the cables.

Cable rollers shall be used when cables are drawn into trenches. The cable rollers shall be placed so that the cable does not touch the bottom or the sides of the trench. The rollers shall be of an approved construction without any sharp metal parts, which could damage the cables.

If the Contractor intends using a winch to draw the cable into the trench, a cable stocking shall be used or the draw wires shall be soldered to the cable so that the tension is exerted on all the cores, lead sheath and/or steel wire armouring at the same time.

The maximum tension on a cable during laying operations shall not exceed the value specified by the manufacturer.

Should the Engineer not be satisfied with the manner or method employed to lay the cable he shall have the authority to instruct the Contractor to lay the cable by hand or in accordance with approved standards.

Medium-voltage cables shall overlap by at least 1m, but not more than 1,5m at joints.

Sufficient lengths of cable shall be left at the beginning and end of the cable routes to allow for the termination of the cables. Where necessary the Engineer shall decide on what length of cable is to be left. The Contractor shall take the necessary precautions to protect the cable ends until they are terminated. The cable ends shall be sealed by means of lead or heat-shrink sealing caps to ensure that the cable is waterproof.

Where cables are drawn through sleeves, care shall be taken that they are not kinked or excessively bent. No bend in a cable shall have a radius less than the minimum-bending radius specified by the cable manufacturer.

The Contractor shall keep accurate records of each length of cable laid. The following information shall be recorded:-

(d) Cable drum number
(e) Size of cable
(f) Laid from where to where
(g) Length of cable
(h) Date laid

E06.4.11 Inspection of Cables

The Contractor shall be solely responsible for inspecting all cables before backfilling to ensure that the correct type and number of cables have been installed. All cable installation will be inspected by the Engineer prior to backfilling commences.

The Contractor shall give the Engineer 24 hours' notice to do the inspections. No inspections shall be undertaken on Saturdays, Sundays and public holidays.

E06.4.12 Measurement of Cables

Full detail of the cable length shall be recorded by the Contractor. The report will be presented to the Engineer as the final quantities for such installation. The Contractor shall be responsible to keep all records as proof of progress and as basis for claims for payment. Inspections and measurements shall be completed before the any backfilling commences.

The Contractor shall give the Engineer 24 hours' notice to be present when cables are measured. No measurements shall be undertaken on Saturdays, Sundays and public holidays.

E06.4.13 Sifted Sand topping

A 50mm layer of sifted bedding sand free from sharp objects and rocks shall be laid and levelled on top of the installed cables, prior to laying of the protective concrete tiles. If the soil for the sand bed and sand cover has to be sifted, a sieve with holes 6mm or smaller shall be used. Where this material is not available, the contractor shall import suitable material for such purposes.

E06.4.14 Concrete Protective Slabs

Protective concrete tiles will be installed above the sifted sand topping. Protective concrete tiles in trenches are there to provide protection against hand digging and warning of cables below. These tiles therefore can be paving blocks, precast wall slabs, etc. Requirements are that the tiles are not less than 38mm thick and will not break under their own weight (i.e. when the longest span of the tile or slab is supported on its ends) or when laid in the trenches by commonly accepted means. The tiles must also not break when the soil is compacted. The tiles must cover the entire width and length of the trench. Before purchasing any protective tiles, the contractor must submit details of the proposed tiles to the engineer for approval.

E06.4.15 Cable Warning Tape

Cable warning tape shall be installed on all cable routes (LV and MV) at 300 mm above the protective concrete slabs. Where a cable route exceeds 600 mm in width, multiple warning tapes shall be run in such a way that the space between adjacent warning tapes does not exceed 185 mm.

The plastic cable warning tape shall consist of a strip of polyethylene of thickness 0,04mm and of nominal width 230 mm. The tape will be completely impregnated with a pigment such that the colour of the tape is yellow, colour No B49 of SANS 1091. A black-triangle and an electric flash symbol and the words "Danger, Gevaar, Ingozi" will be printed on the tape at intervals not exceeding 1m along its length.

E06.4.16 Backfill

When the protective tiles are installed, the trench shall be backfilled with soil containing not more than 40% rock or shale which shall be able to pass through a 100 mm sieve and which is approved by the Engineer.

Where more than 40%, but less than 70% rock occurs, the Contractor shall replace the rock with imported soil. However, should more than 70% rock occur then all the backfilling material shall be imported.

(a) The Contractor may import further stone-free material to the site or sieve the excavated material for sand bedding and cover but payment shall only be compensated for the actual quantity of imported material required as determined by the engineer. The quantity of imported material required shall be calculated from the nominal trench width.

(b) The excavated material shall be backfilled in layers of 150 mm and shall be well compacted and consolidated to 90% MOD AASHTO. Where necessary the Engineer may require that a mechanical vibrator be used for compacting the trench.

(c) The Contractor shall maintain the completed sections of the cable trench in a proper safe condition for the duration of the contract. The Contractor shall refill and compact the trench where subsidence occurs.

(d) After completion of the work, the route of the cable shall be neatly finished off and cleared. All stones bigger than 25 mm as well as all loose organic material and rubble shall be removed.

E06.4.17 Identification and Marking of Cable Routes

Cable route markers, in the form of concrete pre-cast posts, which stand 1.0m above ground level, secured in the ground, must be installed every 50m on straight runs and at every change in direction of the trench. Movable route markers will not be acceptable. The post must be equipped with a stainless steel plate engraved with “ELECTRICAL CABLES”, the cable voltage and the direction indicated in which the cables run. If there are C&I cables in the same trench, there must be a separate label engraved with “C&I CABLES”, and the direction indicated in which the cables run. If there are data communication cables in the same trench, there must be a separate label engraved with “DATA CABLES” and the direction indicated in which the cables run. These labels must be cast into the concrete post so that they cannot be pried off.

At the bottom of the post, a 450 x 450 x 100mm concrete base must be cast to ensure that the route marker can only be removed if it is deliberately dug out of the ground. Steel reinforcing mesh of MRM reference 156, in accordance with SANS 1024 is required in the concrete and the concrete compressive strength of the base must not be less than 15 MPa. (Note: Reinforcing mesh to MRM 156 consists of 3.55mm diameter wire used to create 100 x 100 mm squares).

These route markers must be installed right next to the trench and not over the cables, so that the trench can be re-opened without affecting the route marker. The labels on the route marker must be on the trench side of the route marker.

Cable route markers must be protected in areas of high vehicle traffic.

Figure 1 below provides the required detail of these cable route markers.

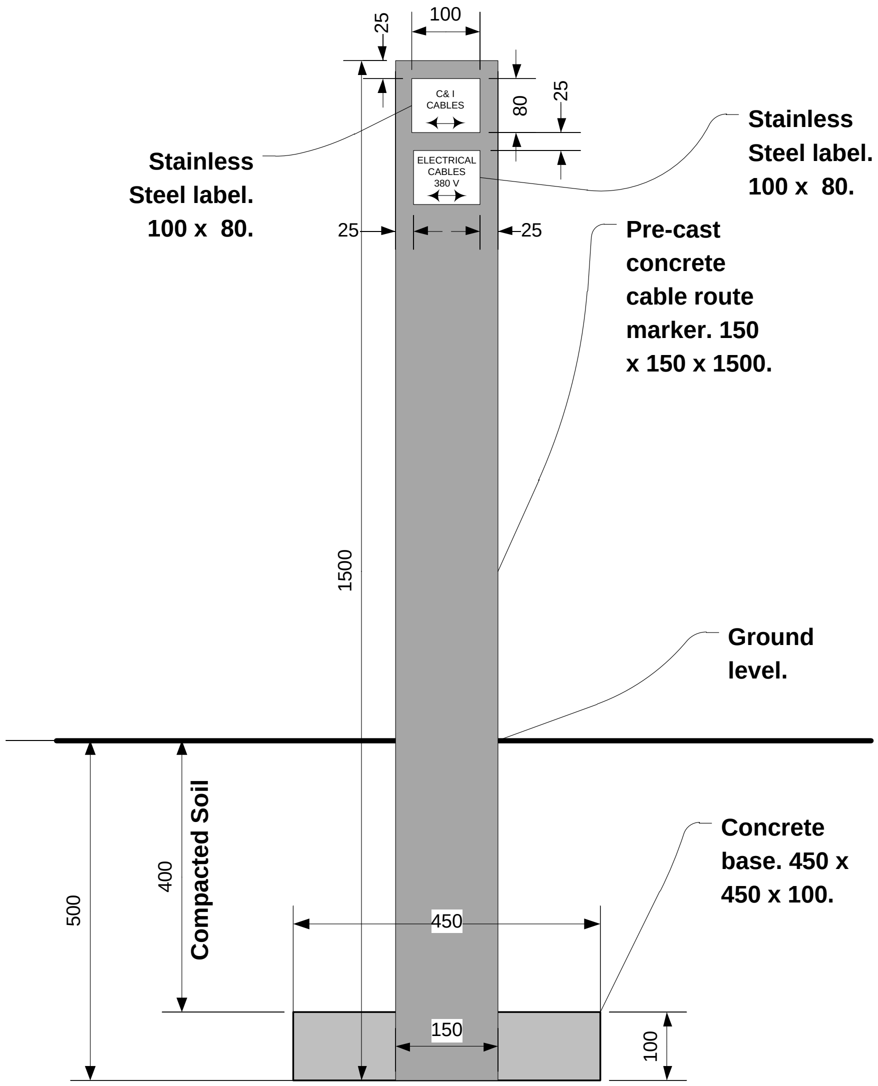

Figure 1: Cable Route Markers

E06.4.18 Road Crossings

The cable sleeves shall be installed 1,5m below ground level to avoid damage when the roads are constructed.

Unless otherwise specified, two additional sleeves shall be installed for future use at each road crossing.

Sleeves used for crossings shall be straight and undamaged. Bends shall not be allowed in road crossings. Sleeves shall be extended for a distance of 1,0m outside the roadway.

After the installation of the sleeves, the sleeves shall be meticulously backfilled so that no air pockets are left. The trench shall thereafter be backfilled in layers of 150 mm and compacted with mechanical vibrators to 95% modified AASHTO density.

The Contractor shall lay and join the cable sleeves and compact the trench to the satisfaction of the engineer. After installation, the sleeves shall be cleaned and a galvanised steel draw wire installed in the sleeve prior to the sleeve ends being sealed by means of plastic plugs.

E06.4.19 Crossing of Services

Where a cable crosses over other services, the cable shall not be installed at a depth less than

800 mm below ground level and if this is not possible, the cable shall be installed underneath the other service and shall be protected in the prescribed manner by means of concrete slabs. The depth of the cable shall be maintained for one metre on either side of the crossing.

If it is not possible to cross over or underneath a service in the prescribed manner, the matter shall be referred to the Engineer for a decision.

The following minimum clearances shall be maintained between electrical cables and other services:-

	Vertical	**Horizontal**
Water pipes	0,3	1,0
Sewer pipes	0,3	1,0
Storm water pipes	0,3	1,0

E06.5 CABLE INSTALLATION IN CABLE DUCTS

E06.5.1 General

This paragraph covers the installation of cables in build-up trenches, service ducts, etc. inside buildings. The trenches, ducts, etc. will be constructed and installed by others.

The use of this method of cable routing should be avoided where possible as it exposes the cables to high risk of theft. Open channels shall not be used for cable routing on any site.

E06.5.2 Installation

Cables shall be installed in one of the following ways:

(a) On vertical cable trays or.

(b) On metal supports fixed to the side of the trench with suitable clamps.

Cables shall be clamped in position.

Cables shall not be bunched and laid on the floor of purpose built trenches.

E06.5.3 Covers

The covering of concrete trenches shall as a rule fall outside the scope of the electrical installation. However, the Contractor shall be responsible for the cutting or drilling and smoothing of holes for cables through chequer plates, concrete or other coverings as required.

Cables shall enter and exit the trench through sleeves protruding 300 mm beyond the covering. The sleeves shall be permanently secured in position and the open space between the cable and sleeves shall be sealed with a non-hardening, watertight compound.

E06.5.4 Filled Trenches

Where specified herein, floor trenches shall be filled with sand.

If a sand filling is specified, the cables shall be fixed to non-corroding supports.

Sand-filled trenches other than in substations shall be covered in one of the following ways:-

(a) Reinforced concrete covers;

(b) 100mm of 20MPa concrete;

(c) Removable chequer plates. However, this will not be acceptable in open spaces.

Reinforced concrete covers shall be used where vehicular traffic may be encountered over trenches. Unless otherwise specified herein, allowance for a mass of 2 tons shall be made.

E06.6 CABLE JOINTS

E06.6.1 General

Joints in cable runs will not be allowed unless authorized by the Engineer.

Jointing shall be carried out strictly in accordance with the manufacturer's instructions. Only personnel competent in the installation of the specific joint will carry out the work.

During outdoor jointing operations, the joint bays shall be adequately covered by tents of waterproof material suitably supported. When necessary, a trench shall be excavated around the bay to prevent the ingress of moisture. The sides of the excavation shall be draped with small tarpaulin or plastic sheeting to prevent loose earth from falling in during jointing operations.

The crossing of cores in joints shall not be permitted under any circumstances. The electrical continuity of all the conductors, screens and armouring shall not be impaired by the joints and the earth continuity shall be accomplished within the joints, i.e. no external earth continuity conductor that will be subject to corrosion, is acceptable.

Joints shall be waterproof and airtight and shall be free of voids and air pockets. The joint shall not impair the anti-electrolysis characteristics of the cable. In the case of joints in cables with an outer PVC anti-electrolysis sheath, the joints shall be subject to the same electrical insulation test as the outer sheath of the cable.

The Contractor shall notify the Engineer timeously of the day on which jointing is to be carried out in order that an inspection may be arranged if so required. Any cable joint not inspected by the Engineer because of insufficient notice being given, shall be opened for inspection and redone at the discretion of the Engineer at the cost of the Contractor.

E06.6.2 Medium Voltage Cable Joints

Medium voltage cable joints shall be of the heat shrink type.

The joints shall make minimal, if any, use of insulating or stress relieving tapes. The use of electrical stress control and insulating tubing that is heat-shrunk on to the joint is preferred above other methods.

The materials shall comply with VDE 0278 and the supplier shall be called upon to confirm this aspect before acceptance of the materials or installation.

The heat-shrinkable and other materials used for joints shall be of a high quality and shall retain their electrical and mechanical properties without deterioration.

Joint kits shall be of a reputable brand.

E06.6.3 Low Voltage Cable Joints

Low voltage cable joints shall be of the epoxy-resin type.

The resin filled joint kit shall comprise a self-sealing plastic mould of high mechanical strength having sufficient connector space. The exact amount of cold hardening resin shall be provided in a two-compartment plastic bag. The resin shall have absolute minimum shrinkage. The mould and resin shall be waterproof and non-hygroscopic and shall be resistant to ultraviolet radiation.

Joint kits shall be of a reputable brand.

E06.7 CABLE TERMINATION

E06.7.1 General

Connection of cables to switchgear shall always be effected in such a way that the various phases, seen from the front of the switchgear will be in the following positions where practically possible:-

(a) Conductor no 1 : left (red)
(b) Conductor no 2 : centre (white)
(c) Conductor no 3 : right (blue)

Exposed armouring is not acceptable. Glands will be properly fitted with shrouds to cover any bare armouring.

All cable ends shall be supplied with the necessary earth connection.

A strut or other approved means of support shall be provided to remove mechanical stress from the glands.

Cable cores shall be marked with heat-shrunk sleeves where necessary to identify the phases. Refer to SANS 10142.

The current-carrying capacity and breakdown voltage of the cable end shall be the same as for the complete cable.

Cables shall be terminated in accordance with the recommendations laid down by the manufacturers of the cables and glands installed.

E06.7.2 Cable Glands

All cable glands for indoor and outdoor use shall be Ex rated as per SABS 1213 and have corrosion proof guard. It shall have a minimum IP rating of 68.The cable glands shall be suitable for use in hazardous areas classified for zone 1,2,21 and 22.

Cable glands shall be of the adjustable type gland suitable for indoor use and shall be suitable for use with PVC PVC SWA PVC cables complying with the latest edition of SANS 1507. All glands shall be installed with non-deteriorating neoprene shrouds.

Outdoor use cable glands shall be similar to the indoor use cable glands with an additional feature of a nipple gasket and an inner seal kit, rendering the gland suitable for type "EXe" equipment (increased safety equipment).

In high corrosive areas, such as chlorination, chemical dosing and inlet works areas, the cable gland shall

(a) offer a minimum degree of ingress protection of IP 66 according to SANS 60529;

(b) be suitable for type " EXe " equipment;

(c) be corrosion proof;

(d) Have a positive seal internal to the cable gland that seals over the cable outer sheath. For these applications, no shrouds are required.

For all gland installations on armoured cable, the outer sheath of the cable shall be cut back in accordance with the gland manufacturers' recommendations, so that a minimum of armouring is exposed between the gland and the outer sheath after gland installation. The shroud shall seal on the outer sheath of the cable.

E06.7.3 Cable Lugs

Suitable cable lugs shall be used and shall preferably be solidly sweated to cable conductor ends. Lugs may be crimped using mechanical, hydraulic or pneumatic tools specifically designed for this purpose, on condition that evidence is submitted that the system used complies with the performance requirements of BS 4579, Part 1, “Compression joints in copper".

Lugs crimped to cable with a cross-sectional area of more than 16mm² shall entail the use of either pneumatic or hydraulic crimping tools. Under no circumstances may a lug be crimped by means of a hammer and/or punch.

Lugs crimped to aluminium shall be subjected to thorough inspection with relation to the material and quality of crimping by the Engineer. Bi-metallic aluminium-copper lugs shall be used according to the manufacturer's specifications, where solid aluminium conductors are terminated onto copper busbars.

Fixing bolts shall be manufactured of cadmium plated high tensile steel and shall match the lug hole size. Contact surfaces between the lug and the busbar shall be thoroughly cleaned and smoothed.

When cutting away insulation from cable conductors to fit into lugs, care shall be taken that no strands are left exposed. Under no circumstances may any of the conductor strands be cut away to fit into lugs. Care must be taken when cutting the insulation not to damage the conductors.

Cables that are connected to clamp type terminals where the clamping screws are not in direct contact with the conductors need not be lugged, but the correct size terminals shall be used.

Ferrules shall be used where cable conductors are connected directly to equipment with screws against the conductor strands.

E06.7.4 Medium Voltage Cable Terminations

Heat shrinkable termination kits shall be used for all high voltage (above 1 kV) terminations and shall be applied strictly in accordance with the manufacturer's recommendations.

The complete termination kit shall be packed in a container that is marked for the type of cable insulation and construction as well as the voltage range for which the materials are suitable. An illustrated set of instructions for the installation of the materials shall accompany every termination kit.

The terminations shall make minimal, if any, use of insulating or stress relieving tapes. The use of electrical stress control and insulating tubing that is heat-shrunk on to the terminations is preferred above other methods.

The termination kits shall include suitable boots for the covering of the terminal studs on the equipment. The cable ends shall be terminated strictly in accordance with the termination manufacturer's specification. The cable ends shall withstand the same test voltage as the cable.

The materials shall comply with VDE 0278 and the supplier shall be called upon to confirm this aspect before acceptance of the materials or installation.

The heat-shrinkable and other materials used for the terminations shall be of a high quality and shall retain their electrical and mechanical properties without deterioration.

Terminations shall be made of a material that gives lasting protection against ultra-violet radiation.

The cores of all cables terminated outdoors and the cores of 3,3 kV and higher voltage cables terminated indoors, shall be completely covered with a shrunk-on protective layer against surface tracking, ultra-violet radiation and weathering.

Outdoor terminations shall be designed to prevent flashover under wet or contaminated conditions and to ensure additional mechanical strength. This shall be achieved with shrunk- on insulating spacers and rain sheds.

E06.7.5 Cable Identification

Cables shall be identified at all terminations (both ends). The identification of MV cables installed in cable ladders, ducts or to structures shall be to SANS 10142-1.

Both ends of the cable shall be marked with the cable number in accordance with the cable schedule. The cable tag shall comprise of a punched stainless steel strap that shall be tied onto the cable by means of a thin stainless steel tape

The use of PVC tape with punched characters or punched metallic bands or tabs is not acceptable.

The identification number of cables shall be shown on the "as built' drawings of the installation.

E06.8 TESTING OF THE INSTALLATION

The contractor shall supply factory test certificates for each drum of cable supplied under the Contract.

After the installation is complete, the contractor and the Engineer shall inspect the installation. The Engineer must be notified in advance of the inspection dates. The contractor will keep a snag list, reflecting all items not acceptable to the Engineer. The contractor will correct the snag items as required to the Engineers approval, updating the snag list as the items are completed and accepted/signed off by the Engineer.

On completion of his work, the Contractor will issue an Electrical Certificate of Compliance (CoC). All tests deemed necessary to issue the CoC should be included. The Contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The Contractor shall notify the Engineer timeously so that he may witness the tests.

Each installed cable shall be tested in accordance with:

(a) The Occupational Health and Safety Act (OHSA) 1994;

(b) SANS 97 (Electric cables - Impregnated paper-insulated metal-sheathed cables for rated voltages 3,3/3,3 kV to 19/33 kV)

SANS 97 Test Wave	Duration (min)	Commissioning test voltage between conductors (V)			Commissioning test voltage between conductors / sheath (V)		
		3300/ 3300	3800/ 6600	6350/ 11000	3300/ 3300	3800/ 6600	6350/ 11000
AC (r.m.s)	15	7000	13000	22000	7000	8000	13000
DC	15	9000	19000	31000	9000	11000	19000

(c) SANS 1339 (Electric cables - Cross-linked polyethylene (XLPE) insulated cables for rated voltages 3,8/6,6 kV to 19/33 kV)

SANS 1339 Test Wave	Duration (min)	Commissioning test voltage between conductors (V)			
		6600	11000	22000	33000
VLF (0.1 Hz)	60	11000	19000	38000	57000
Power frequency	60	8000	13000	25000	38000
DC	10	6000	10000	20000	30000

DC voltage testing is likely to cause irreversible damage to XLPE-insulated cable systems. The voltage and duration should be limited to the appropriate values given in the table above. The contractor shall use a DC test set to apply the test voltage. After completion of the DC test, the contractor shall soft-discharge the cable, using either the DC test set or a discharge stick where after the cable will be fully discharged by solidly earthing it for at least 8 h but preferably for 24 h. DC testing shall only be carried out with written permission from the Engineer,

(d) SANS 1507 (Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V));

SANS 1507 Test Wave	Duration (min)	Commissioning test voltage between conductors (V)			Commissioning test voltage between conductors / earth (V)		
		300/ 500	600/ 1000	1900/ 3300	300/ 500	600/ 1000	1900/ 3300
AC (rms)	15	1000	2000	6000	1000	2000	3500
DC	15	1500	3000	9000	1500	3000	5000

E06.9 COMPLETION

The Engineer reserves the right to inspect the installation at any stage during the course of construction. However, such inspections will not deem the portions inspected as being complete or accepted and the Contractor shall remain responsible to complete the installation fully in accordance with this specification.

The Contractor shall carry out a final “as built" survey of the cable routes and present to the Engineer “as built" route plans of the complete installation.

The following information shall be reflected on the plans or submitted as separate schedules with the plans:

(a) Overall length of each cable;

(b) Locations of all joints (if any) in relation to permanent reference points. Dimensions shall be shown and the method of triangulation i.e. two dimensions shall be used to each joint;

(c) The location of all cable markers in relation to permanent reference points;

(d) Identification numbers of all cables.

The Works will be deemed incomplete until all tests have been conducted and certified successfully and all "as built" drawings and schedules have been handed to the Engineer.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

E07 : ELECTRICAL INDUSTRIAL WELDING PLUGS, COUPLERS AND SOCKET OUTLETS

Johannesburg Water

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CONTENTS

E07.1 SCOPE

This specification covers the procurement, supply, delivery, installation testing and commissioning of the required industrial welding plugs, couplers and socket outlets for industrial purposes.

E07.2 STANDARDS

E07.2.1 National Standards

The latest edition, including all amendments up to date of tender of the following particular national specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

(a)	SANS 1222	:	Enclosures for electrical equipment classified by IP code
(b)	SANS 1239	:	Plugs, socket-outlets and couplers for industrial purposes
(c)	SANS 6309	:	Plugs, socket-outlets and couplers for industrial purposes
(d)	SANS 1091	:	National colour standard
(e)	SANS164-2		Plug and socket-outlet systems for household and similar purposes for use in South Africa Part 2: Two-pole and earth and 2 pin (Class II), 16 A 250 V a.c. system.
(f)	SANS 10142-1	:	The Wiring of Premises Part 1 – Low Voltage Installations

E07.2.2 Particular specifications to be read in conjunction with this specification

(a)	E26	:	ELECTRICAL SPECIFICATION FOR COLOUR CODES
(b)	G02	:	PARTICULAR SPECIFICATION FOR CORROSION PROTECTION
(c)	E06	:	ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION
(d)	E08	:	WIRING

E07.3 GENERAL REQUIREMENTS

Switched 400V 3-phase, 3-wire and earth 63A industrial welding socket outlet plus a switched 230V, single phase, 3-wire 16A industrial socket outlet shall be supplied. A 4-core cable shall be used with an earth included in the supply cable.

E07.3.1 Single phase 16A household and similar purpose socket outlet

Applied to general household, commercial and light industrial installations up to 250Vac 16 A.

(a) Compliance: SANS 164-2/SANS10142-1
(b) Wall mounted socket;
(c) Be of the two-pole earthing contact type;
(d) Incoming power supply via a 2-pole earth leakage protection unit located in the upstream distribution board;

E07.3.2 Single phase 16A industrial socket outlet

(e) Wall mounted socket;

(f) Pin and sleeve configuration;

(g) 2 pole, 3-wire with 2P+E 230V ac, 16A;

(h) Incoming power supply via a 2-pole earth leakage protection unit located in the upstream distribution board;

(i) Ingress protection IP67 (SANS 1222);

(j) Switched locally on the socket outlet;

(k) Mechanical interlock to prevent plugs from being engaged or disengaged under load;

(l) Lockable by a padlock (40mm) at the switch-off position.

E07.3.3 <u>Three phase 63A industrial welding socket outlet (5-pin)</u>

(a) Compliance: SANS 60309-1

(b) 415Vac 3phase, neutral and protective earth (5 pin), 63A current rating

(c) Housing: Powder coated die-cast aluminium

(d) Colour: Electric orange RAL B26

(e) Wall mounted socket with top cable entry with removable flange;

(f) Pin and sleeve configuration;

(g) 3-phase earth leakage protection unit mounted in the feeder cubicle in the MCC/DB;

(h) Rated ingress protection IP55 (SANS 1222);

(i) Switched locally on the socket outlet, lockable by a padlock (40mm) at the switch-off position;

(j) Mechanical interlock: The isolator cannot be “Switched ON” without the plug inserted and the plug cannot be removed while the isolator is in “ON” position

(k) Matching metal clad plug top, 415Vac 3-phase 5 pin, 63A, IP55 to be supplied with the socket outlet.

Where pilot wire connections are required, they shall disconnect before the main phase connectors disconnect.

The equipment enclosures shall be IP55 to SANS 1222. Socket outlets that are exposed to the atmosphere or installed in damp areas, shall be minimum rated at IP 56 or as otherwise specified by the engineer. All sockets shall be constructed of corrosive resistant materials.

Both types of sockets shall be mounted on a 304 stainless steel heavy duty pedestal. The socket outlet mounting height shall be 1200 mm above finished ground level.

A purpose made metal junction box of IP65 rating to SANS 1222 fitted with a canopy shall be provided and mounted on the stand above the socket outlet in such a way that the junction box does not interfere with the use of the socket outlet. The supply cable to the welding socket shall be terminated in the junction box. Where the cross sectional area of the cores of the supply cable to the welding socket outlet exceeds 16 mm^2, the cable core size from the junction box terminals to the socket outlet shall be 16mm^2, 4-core. The 16A single-phase socket shall have its own dedicated supply.

The junction box including the canopy and the welding socket stand shall be powder coated /painted B26 – Light Orange (1673-Y48R) to SANS 1091.

E07.4 TESTING AND COMMISSIONING

During testing and commissioning, the contractor shall:

(a) Perform a visual inspection to ensure that the installation complies to the requirements specified herein as well as in detailed specifications;

(b) The rating of all equipment is as specified;

(c) Test all earth leakage protection units supplied to confirm the tripping current.

E07.5 MEASUREMENT AND PAYMENT

Measurement and payment will distinguish between supply / delivery and installation / commissioning of industrial welding plugs, sockets, connectors etc.

Item	**Unit**
Supply and deliver of welding plugs and switched socket outlets complete with plugs	No

The unit of measurement shall be the number of plugs and switched socket outlets including stands and junction boxes supplied and delivered.

Separate items shall be scheduled in the schedule of quantities for different types of switched socket outlets.

The tendered rate shall include all costs related to the supply and delivery of the specified switched socket outlet and plugs and shall include for the stands and junction boxes required.

Item	**Unit**
Install and commission welding plugs and switched socket outlets	No

The unit of measurement shall be the number of plugs and switched socket outlets including stands and junction boxes installed and commissioned.

Separate items shall be scheduled in the schedule of quantities for different types of switched socket outlets and whether the plug must be installed on a cable or whether the plug must be handed over to the employer.

The tendered rate shall include full compensation for the installation of the switched socket outlet and plugs as detailed in the detail specification including all required material and labour to render a complete and working installation, including all labour and material required for installing the plug on the cable as detailed or for handing over the plug (free issue) to the employer and obtaining a receipt therefore.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
E08 : ELECTRICAL WIRING

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PARTICULAR SPECIFICATION: VOLUME E08: ELECTRICAL WIRING

CONTENTS

E08.1 SCOPE

This specification covers the wiring requirements of electrical installations.

E08.2 STANDARDS

The latest edition, including all amendments to until the date of tender, of the following particular national and international specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

(a) SANS 10142-1 : The wiring of premises Part 1: Low-voltage installations

(b) SANS 1411-2 : Materials of insulated electric cables and flexible cords: Part 2 – Polyvinyl Chloride (PVC)

(c) SANS 1507 : Electric Cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V)

E08.3 GENERAL REQUIREMENTS

PVC insulated conductors for general wiring shall consist of high conductivity annealed copper wire strands with polyvinyl chloride insulation. The insulation shall be compounded and stabilised to comply with SANS 1411-2 as amended.

Conductors shall be finished in the required colours and shall be manufactured in accordance with SANS 1507 as amended.

Any special requirement regarding the type and size of wiring to be installed in a specific installation shall be specified.

E08.4 DRAWING OF CONDUCTORS

Wiring shall only be carried out after the wireway installation is completed, but before painting has commenced. No conductors shall be installed before the wireways have been cleaned of all debris and moisture. Wireways shall contain no sharp edges.

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

E08.5 WIRING METHOD

All wiring shall be carried out according to the loop-in system. When earth continuity conductors are looped between terminals of equipment, the looped conductor ends shall be twisted together and ferruled to ensure that earth continuity is maintained when the conductors are removed from a terminal.

When connecting more than one conductor in a terminal, the strands shall be securely twisted together. Under no circumstances shall strands be cut off.

E08.6 SIZE OF CONDUCTORS

The following minimum conductor sizes shall be used:

Bell circuits	=	1.5 mm^2
Clock circuits	=	1.5 mm^2
Lighting circuits	=	1.5 mm^2
Plug circuits	=	2.5 mm^2
All the above	=	2.5 mm^2 earth conductor
Motor circuits	=	As specified

E08.7 DIFFERENT PHASES

With the exception of three-phase outlets, circuits connected to different phases shall not be present at light, switches or socket-outlet boxes.

E08.8 TESTING AND COMMISSIONING

The contractor shall supply factory test certificates for each drum of cable supplied under the Contract.

After the installation is complete, the contractor and the Engineer shall inspect the installation. The Engineer must be notified in advance of the inspection dates. The contractor will keep a snag list, reflecting all items not acceptable to the Engineer. The contractor will correct the snag items as required to the Engineers approval, updating the snag list as the items are completed and signed off by the Engineer.

On completion of his work, the Contractor will issue an Electrical Certificate of Compliance (CoC). All tests deemed necessary to issue the CoC should be included. The Contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The Contractor shall notify the Engineer timeously so that he may witness the tests.

Each installed cable shall be tested in accordance with:

(a) The Occupational Health and Safety Act (OHSA) 1994;

(b) The requirements of the Local and Supply Authorities.

E08.9 MAINTENANCE INSTRUCTIONS AND GUARANTEES

E08.10 MEASUREMENT AND PAYMENT

Item	**Unit**
Supply and deliver LV conductors	m

The unit of measurement shall be the linear length of conductor supplied and delivered.

The tendered rate shall include full compensation for the supply and delivery to site of the specified conductors. Conductors will be measured linearly along the full length installed in the wireway and sufficient provision will be made in the quantities for conductor slack at outlet boxes and distribution board trays. No extra will be allowed for jointing, overlapping and wastage at connections.

Separate items shall be scheduled for each conductor size.

Item	**Unit**
Install LV conductors in conduit	m

The unit of measurement shall be the linear length of conductors installed in conduit.

The tendered rate shall include full compensation for the handling, inspection, pulling in conduit the specified number and sizes of conductors, cutting and testing of the conductors. Sufficient provision will be made for conductor slack at outlet boxes and distribution board trays to make the necessary connections to equipment.

Separate items shall be scheduled for each size of conductor.

Item	**Unit**
Install LV conductors in trunking	m

The unit of measurement shall be the linear length of conductors installed in trunking.

The tendered rate shall include full compensation for the handling, inspection, installing in trunking the specified number and sizes of conductors, the grouping of these conductors into circuits using plastic cable ties, cutting and testing of the conductors.

Separate items shall be scheduled for each size of trunking and for each size of conductor.

This rate shall furthermore include for the supply of all cable ties, clamps and other materials necessary to ensure that the wiring conforms to the specification.

Item **Unit**

Install LV conductors in power skirting..m

The unit of measurement shall be the linear length of conductor installed in power skirting.

The tendered rate shall include full compensation for the handling, inspection, installing in power skirting the specified number and sizes of conductors, the grouping of these conductors into circuits using plastic cable ties, cutting and testing of the conductors. Sufficient provision will be made for conductor slack at power outlets.

Separate items shall be scheduled for each type of power skirting and for each size of conductor.

This rate shall furthermore include for the supply of all cable ties, PVC sleeving for earth conductors and other materials necessary to ensure that the wiring conforms to the specification.

Item **Unit**

Install LV conductors in floor ducting ....m

The unit of measurement shall be the linear length of conductors installed in floor ducting.

The tendered rate shall include full compensation for the handling, inspection, installing in floor ducting the specified number and sizes of conductors, the grouping of these conductors into circuits using plastic cable ties, cutting and testing of the conductors. Sufficient provision will be made for conductor slack at power outlets. Were cables are exposed to the sun they shall be strapped, using stainless steel strapping.

Separate items shall be scheduled for each type of floor ducting and for each size of conductor.

This rate shall furthermore include for the supply of all cable ties, PVC sleeving for earth conductors and other materials necessary to ensure that the wiring conforms to specification.

Item **Unit**

Supply conductor terminals..No

The unit of measurement shall be the number of conductor terminals supplied.

The tendered rate shall include full compensation for the supply and delivery to site of the specified terminals complete with mounting rail and all hardware required to fasten the terminals and mounting rail. Separate items shall be scheduled for each size of terminal.

Item **Unit**

Install conductor terminals ....No

The unit of measurement shall be the number of conductor terminals installed.

The tendered rate shall include full compensation for the handling, inspection and installation of the specified terminals and mounting rail. Separate items shall be scheduled for each size of terminal.

Item **Unit**

Supply PVC insulated multicore cables ....m

The unit of measurement shall be the linear length of cable installed.

The tendered rate shall include full compensation for the supply and delivery of the cables. Separate items shall be scheduled for the different types and sizes of cables.

Item **Unit**

Install PVC insulated multi core cables...m

The unit of measurement shall be the linear length of cable installed.

The tendered rate shall include full compensation for the supply and delivery of the cables. Separate items shall be scheduled for the different types and sizes of cables.

Item **Unit**

Supply and install the terminations for PVC multicore cables .... No

The unit of measurement shall be the number of terminations installed.

The tendered rate shall include full compensation for the supply and installing of the terminations as specified.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

E09 : ELECTRICAL BUILDING INSTALLATION

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PARTICULAR SPECIFICATION: VOLUME E09: ELECTRICAL BUILDING INSTALLATION

CONTENTS

E09.1 GENERAL

The Particular Specification shall be read in conjunction with the Detailed Technical Specification.

Where the Detailed Technical Specification is in contradiction with this Particular Specification, the former shall apply to this contract.

E09.2 STATUTORY DOCUMENTS AND STANDARDS

E09.2.1 Standards

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

(a) SANS 10142-1	:	The wiring of premises Part 1: Low-voltage installations
(b) SANS 60529	:	Degrees of protection provided by enclosures (IP Code)
(c) SANS 10400-FR	:	National Building Regulations and Building Standards Act (Act 103 of 1977), as amended
(d) SANS 60529	:	Degrees of protection provided by enclosures (IP Code)

E09.2.2 Regulations, Acts and Bylaws

The installation shall be erected and carried out in compliance with the latest edition of the following:

(a) Occupational Health and Safety Act (Act 85 of 1993) and Regulations;

(b) Construction Regulation;

(c) Applicable By-Laws and Regulations as implemented by the Local Authority;

(d) Fire Regulations as implemented by the Local Authority.

E09.2.3 Particular Specifications to be read in conjunction with this specification

This specification shall also be read in conjunction with the following specifications:-

(a) E02	:	ELECTRICAL CABLE RACKS
(b) E06	:	ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION
(c) E08	:	WIRING

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 Employer from all losses, costs or expenditures that may arise because of the Contractor's negligence to comply with the requirements of the regulations enumerated in paragraph 9.2.

It is assumed that the Contractor is conversant with the above-mentioned requirements. Should any requirements, by-law or regulation, which contradict the requirements of this document, apply or become applicable during erection of the installation, such requirement, by-law or regulation shall overrule this document and the Contractor shall immediately inform the Engineer of such 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.

E09.3 ARRANGEMENTS WITH THE SUPPLY AUTHORITY

It shall be the responsibility of the Contractor to issue all notices and pay all monies that are due for the electrical builders / temporary supply connection, except where otherwise specified. If, according to the contract, these monies are reclaimable from the Employer, then these claims by the Contractor shall be substantiated with official receipts.

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

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

E09.4 FIXING AND SUPPORTING OF EQUIPMENT AND MATERIALS

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

(b) 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.

(c) Supports, brackets, hangers, etc. may only be welded to steel structural members where prior permission has been obtained. Drilling of holes into or welding onto steel structural members is only allowed where prior permission has been obtained.

(d) All methods of suspension or supports shall be submitted to the Engineer for approval and for reference to the Structural Engineers where necessary, prior to manufacture or installation.

(e) Supporting of any rotating equipment shall incorporate anti-vibration mountings of the type and selection specified in the applicable clauses referring to equipment bases herein.

(f) Supports shall preferably be strut channel, 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; supports shall not be riveted or welded to the equipment. Rod hangers shall not exceed 3000mm in length and be of minimum diameter 12mm. For longer suspensions use mild steel angles. Angle profile supports shall be of 38 x 5mm minimum section.

(g) Where holes in equipment exist, bolts and fixing screws as specified shall be used. Where sizes are not specified, the largest bolt or screw that will fit into the hole shall be used.

(h) Anchor bolts shall be used for fixing supports to brick or concrete walls, it not being permissible to utilise gunpowder shot-driven bolts for this purpose unless prior permission has been obtained.

(i) Where the fixing holes in brick or concrete walls are smaller than 10mm diameter and where the mass of the equipment is less than 15kg, wall plugs may be used to fix conduits, cables and other equipment. Aluminium, fibre or plastic plugs only may be used. Wooden plugs are not acceptable. Plugs installed in seams between bricks are not acceptable. A masonry drill of the correct size shall be used to drill holes for plugs. Round headed screws shall be used throughout.

(j) Where the fixing holes are 10mm and larger or where the mass of the equipment is 15kg or more, equipment shall be fixed by means of expanding anchor bolts or by means of bolts cast into the concrete.

(k) Galvanised screws, bolts and nuts shall be used to fix galvanised equipment.

(l) No shot-fired or explosion driven tools will be allowed.

E09.5 ELECTRICAL CONDUIT INSTALLATION

E09.5.1 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.

E09.5.2 Other Services

Conduits may not be installed closer than 150mm to pipes containing gas, steam, hot water or other materials which may damage the conduits. Conduits may not touch pipes or other service installations in order to prevent electrolytic corrosion. Where doubtful situations of this nature occur or where there are installation incompatibilities, the matter shall be reported to the Engineer immediately.

E09.5.3 Galvanised Conduit

Galvanised conduit and accessories shall be used under all circumstances:

Conduit and accessories shall be hot-dipped galvanised to SANS 32: Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic plants and SANS 121: Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods.

E09.5.4 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.

E09.5.5 Defects

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

E09.5.6 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.

E09.5.7 Joints

All conduit ends shall be reamed and all joints tightly screwed. 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.

E09.5.8 Finish

All joints shall be painted with cold galvanizing paint to prevent them from rusting in damp areas, and in cases where the installation is exposed to the weather for any length of time. Where the galvanising finish was damaged, the area shall first be cleaned and a coat of cold galvanizing paint applied subsequently. Additional coats of paint shall only be applied after the undercoat has been completed.

E09.5.9 Continuity

Mechanical and electrical continuity shall be maintained throughout the conduit installation. The use of conduits as earth continuity conductors are not allowed.

E09.5.10 Inspection Type Accessories

Inspection type couplings, elbows and tees shall not be used except with the written consent of the Engineer. All outlet boxes and draw boxes shall however be of the inspection type.

E09.5.11 Position of Outlets

All accessories such as socket outlets, switches, lights, 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 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 shall 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 'as-built' drawings.

E09.5.12 Draw Wires

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

E09.5.13 Bends

A maximum of two 90º 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.

E09.5.14 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.

E09.5.15 Luminaires

Conduit end may not be used to solely support luminaires. Where luminaires are specified which are 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.

E09.5.16 Withdrawal of Conductors

To ensure that all electrical conductors shall be easily withdrawable from conduits, the Engineer reserves the right to have the conductors on any circuit removed at his discretion and replaced at the cost of the Contractor. If the conductors are damaged during removal, the damaged conductors shall be replaced and the cost of the replacement shall be borne by the Contractor.

E09.5.17 Temperature Differences

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 and 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.

E09.5.18 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.

E09.5.19 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.

E09.5.20 PVC Conduit

The use of PVC conduit shall not be allowed, only if stated in the Detailed Technical Specification portion of the document.

E09.5.21 <u>Terminations</u>

E09.5.21.1 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.

E09.5.21.2 Draw Boxes

A female bush and lock nut must be used to terminate conduits at draw boxes and outlet boxes without spouts.

E09.5.22 <u>Open Roof Spaces</u>

E09.5.22.1 Sequence of Work

Conduits and wiring in open roof spaces above ceilings other than concrete slabs must be installed before the ceilings and walls are painted and before removable ceiling tiles are installed. In roof spaces where access is limited after installation of the ceiling. It is the responsibility of the Contractor to ensure close liaison with the Main Contractor in connection with the work.

E09.5.22.2 Fixing

All conduits is open roof spaces shall be installed parallel and at right angles to the roof members and shall be fixed to the structures at intervals not exceeding 1 metre. Approved saddles shall be used throughout. Clout nails, clamps or wood screws shall be used to secure the saddles to wooden roof members. Saddles which comply with the requirements of this specification shall be used to secure conduits against concrete slabs. Written permission shall be obtained to secure conduits to steel beams in which case saddles shall be fixed by means of bolts, nuts and lock washers or purpose made saddles shall be used.

E09.5.22.3 Cross-Overs

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

E09.5.22.4 Draw Boxes

Install draw boxes with metal cover plates where required and as far as possible near gangplanks. The use of socket and switch boxes instead of draw boxes in open roof spaces is unacceptable.

E09.5.22.5 Positions of Accessories

Install conduits in open roof spaces, which is accessible after completion of the building to allow wiring or inspection from a position above the conduits. Install conduits in ceiling voids with less than 900mm clear space between the ceiling and the roof, to permit wiring and inspection from a position below the conduits. Loop conduits between outlet boxes.

E09.5.22.6 Incandescent Luminaires

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 that are independently fixed to roof beams, shall be provided.

E09.5.22.7 Conduit Ends

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

E09.5.22.8 Fluorescent Luminaires

Draw boxes for fluorescent luminaires shall be installed as specified in the previous paragraph but luminaires shall be installed as specified in paragraph 9.5.22.6.

E09.5.23 <u>Installation in Concrete and Screeds</u>

The Contractor must position all conduits and accessories casted in concrete in good time to prevent building delays.

In order not to delay building operations, the Contractor shall ensure that all conduits and accessories that casted in concrete are positioned in good time. The Contractor or his representative must attend when the concrete casting.

E09.5.23.1 Draw Boxes

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.

E09.5.23.2 Cover Plates

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

E09.5.23.3 Fixing to the Shuttering

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.

E09.5.23.4 Concrete Floor Slabs

Conduits will not be allowed in concrete floor slabs of boiler rooms (or boiler houses), laundries, dewatering buildings, pump stations 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.

E09.5.23.5 Screeds

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.

E09.5.23.6 Inspection

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 Contractor's account.

E09.5.24 <u>Surface Installation</u>

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.

E09.5.24.1 Building Lines

All conduits shall be installed horizontally or vertically as determined by the route and the 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. When in doubt, the Contractor shall consult the Engineer before installation is commenced.

E09.5.24.2 Saddles

Conduits shall be firmly secured by means of saddles spaced at maximum intervals of 2000mm with at least two saddles per run. 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.

E09.5.24.3 Joints

Joints will not be allowed in conduit lengths not exceeding 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.

E09.5.24.4 Accessories

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.

E09.5.25 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. The requirements of paragraphs 9.5.9 are applicable.

Where the possibility exists that the conduit can come into contact with moisture, suitable covering and/or packing shall be installed to isolate the conduit from the moisture.

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.

E09.5.26 Stove connection

A freestanding stove, rated above 16A must be plugged in by means of a stove coupler (see figure 1). The stove coupler, which shall comply with SABS IEC 60309-with a minimum of 45Amp single-phase and 16 A per phase for three-phase. The open end of the connector tube shall point downwards.The switch-disconnector for the cooking appliance shall

(a) be in the same room as the appliance,

(b) be at a height above floor level of not less than 0, 5 m and not more than 2, 2 m,

(c) not be above the cooking appliance,

(d) be within 3 m of the appliance, but within 0, 5 m of the appliance if the switch-disconnector’s purpose is not clearly indicated, and

(e) not be fixed to the appliance.

Figure 1: Stove coupler

E09.5.27 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 a 2,5mm^2 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.

E09.5.28 Chases and Builder's Work

Except where otherwise specified, the 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 Contractor shall notify the Main Contractor of his requirements and the responsibility lies with the Contractor to ensure that these requirements are met.

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

Where no Main Contractor is on site the 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 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.

The Contractor shall maintain close co-operation with the Main Contractor and all his Contractors throughout the course of the contract. Should the Contractor not comply with this requirements, any additional costs resulting from lack of his co-operation will be recovered from him.

E09.5.29 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.

E09.5.29.1 Flush Mounted Switchboards

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.

E09.5.29.2 Surface Mounted Switchboards

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.

E09.6 CABLE TRAYS AND LADDERS

Please revere to the specification E02: Electrical Cable Racks.

E09.7 WIRING DUCTS

E09.7.1 Responsibility of the Contractor

The Contractor shall supply and install all wiring ducts 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.

E09.7.2 Materials and Finishes

Wiring ducts shall be rolled from 1,2mm minimum sheet steel and shall be finished as follows:

(a)	In boiler rooms (or boiler houses), laundries, dewatering buildings, pump stations or other damp areas damp areas.	Stainless steel 3CR12 and epoxy powder coated
(b)	False ceiling voids	Pre-galvanised
(c)	Vertical building ducts	Hot-dipped galvanised to SANS 32 and SANS 121
(d)	Surface mounted in plant rooms, substations, service tunnels, basement, offices	Epoxy powder coated or electro-galvanised
(e)	Undercover industrial applications	Hot-dipped galvanised to SANS 32 and SANS 121.

The abovementioned finishes shall apply unless specifically to the contrary in the Detailed Technical Specification. Epoxy powder coats shall comply with paragraph EO9.12.9. Hot-dipped galvanised or electro-galvanised wiring 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.

E09.7.3 Cover Plates

All wiring ducts shall have metal snap-in cover plates. Cover plates for wider ducts shall be fixed by means of screws that shall permanently be tapped into the cover plates spaced at suitable intervals to prevent warping. The finish of the covers shall comply with paragraph EO9.7.2

E09.7.4 Connections

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.

E09.7.5 Support for Conductors

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

E09.7.6 Vermin Proofing

All wiring ducts 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.

E09.7.7 Earth Continuity

Electrical and mechanical continuity shall be maintained throughout the wiring duct installation. A tinned copper bonding strip (6mm^2) shall be installed across each joint and secured to both adjoining ducts by means of galvanised bolts, nuts and washers. The duct shall be bonded to the earth bar of the associated switchboard.

E09.7.8 Internal Finishes

All bends shall be of easy sweep design with 45º 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.

E09.7.9 Services

Multiple duct runs or internal metal partitions shall be used where conductors for power, control and other services are present.

E09.7.10 Vertical Installation

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

E09.7.11 Number of Conductors

Wiring ducts 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 duct.

E09.7.12 Fixing

The Contractor shall supply and install all hangers, supports or fixings for the ducts. Ducts up to 75 x 75mm shall be supported at maximum intervals of 1m and larger channels at maximum intervals of 2m. Duct 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 ducts or supports to the structure shall comply with paragraph E09.4 with particular reference to paragraphs E09.4.f and E09.4.h. Purpose made cable clamps, hangers, etc. shall be used as required.

E09.7.13 Installation in Concrete

The installation of wiring ducts in concrete will not be allowed.

E09.7.14 Fire Barrier

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

E09.7.15 Conduit Connection

All conduit connections shall be terminated by means of two lock nuts and a brass female bush. All holes through which conductors pass shall be equipped with grommets.

E09.8 INSTALLATION OF LUMINAIRES

E09.8.1 Positions

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 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 Contractor's account.

E09.8.2 Cover Plates

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.

E09.8.3 Hanger and Supports

Where provision has not been made for the fixing of luminaires, the Contractor shall supply the necessary supports, hangers, conduit extensions, angle brackets or any fixing method approved by the Engineer.

E09.8.4 Suspended Cable Channels

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.

E09.8.5 False Ceilings

In all cases where luminaires are fixed to false ceilings, the 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.

E09.8.6 Fluorescent Luminaires Fixed to Concrete Slabs

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 and 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.

E09.8.7 Fluorescent Luminaires Fixed to False Ceilings

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.

E09.8.8 Continuous Rows of Luminaires

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 Contractor shall ensure that continuous rows are straight and parallel to the relevant building lines.

E09.8.9 Recessed Luminaires

Where recessed luminaires are required, the 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 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.

E09.8.10 Special Ceilings

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

E09.8.11 Waterproof Luminaires

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.

E09.8.12 Bulkhead Luminaires

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.

E09.9 INSTALLATION OF LIGHT SWITCHES

E09.9.1 Mounting

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.

E09.9.2 Doors

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.

E09.9.3 Walls

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.

E09.9.4 Switch Boxes

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 E09.5 of this specification. Boxes shall be flush mounted or recessed as specified for the whole installation.

E09.9.5 Cover Plates

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.

E09.9.6 Escutcheon Plates

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.

E09.9.7 Surface Mounted Switches

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 E09.4 of this specification.

E09.9.8 Cutting of Cover Plates

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

E09.9.9 Partitions

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.

E09.9.10 Waterproof Switches

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

E09.9.11 Appearance

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.

E09.10 INSTALLATION OF SOCKET OUTLETS

E09.10.1 Mounting Heights

Unless otherwise specified socket outlets (flash or service mounted) shall be installed at the following heights above finished floor level:

Socket outlets in general	300mm
Above working counter (kitchens, laboratories and prep areas)	1200mm
Shops	300mm
Offices	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 E09.9.4.

E09.11 PROVISION FOR TELEPHONE INSTALLATION

E09.11.1 General

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.

E09.11.2 Regulations

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.

E09.11.3 Sleeves for Main Cables

One or more asbestos-cement or PVC sleeves as specified, shall be installed from a point at the boundary of the stand, (position indicated by the Engineer), to the main telephone distribution board or the main telephone building duct , 600mm below ground level.

A manhole with steel cover (as specified in Part 2, Detail specification) shall be installed at each bend in the underground route or at intervals not exceeding 50m in straight sections.

The inner radius of bends shall not be less than 12 times the outside diameter of the sleeves.

All sleeves, manhole covers and accessories shall be supplied by the Contractor including the building work of the manhole, unless specified to the contrary.

E09.11.4 Separation of Services

Cables or conductors for telephone services shall be separated from all other services by:

(a) Installation in separate metal channels or conduits, or

(b) Installing the cables at a minimum distance of 300mm from all power cables, conductors and accessories, or

(c) An earthed metal barrier installed to ensure that the minimum distance through free air space between the telephone cables and other services is at least 300mm.

Conduits or wiring channels installed for telephone services may not be used for any other purpose. Where non-metallic channels are used, the separation as stated in (b) above shall be maintained through the installation.

E09.11.5 Main Telephone Distribution Board

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 E09.16.9.

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.

E09.11.6 Telephone Outlets

The 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 twin underfloor ducts are provided and where the one duct is intended for telephone cables, the separation between the ducts shall be maintained throughout the underfloor ducting installation, including power outlets and telephone outlets.

Where power skirting is specified for telephone installations, the 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.

E09.11.7 Connection of Telephone Outlets

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 grommetted. 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.

E09.12 SWITCHBOARDS AND DISTRIBUTION BOARDS

Please see Specification E04: Electrical Low Voltage Distribution Boards and Motor Control Centres.

E09.13 NOISE AND VIBRATION

If in the opinion of the Engineer, any equipment operates with, or transmits from it, objectionable noise or vibration, it will be necessary to rectify or replace such plant in order that the system operates at conditions acceptable to the Engineer. Remedial measures taken to achieve satisfactory noise and vibration levels shall be at no additional cost to the Employer.

The following measures shall be taken where necessary, whether specifically stipulated in these documents or not, all to ensure quiet, vibration-free operation of the installations:

(a) Equipment shall be mounted on vibration isolators of the correct type and selection, dependent upon deflection requirements versus vibrating frequency.

(b) Pipework and ductwork shall be suspended or mounted using suitable supports with vibration isolators to prevent transmission of vibration from them to the structure to which they are attached.

E09.14 COMMISSIONING AND TESTING

The 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 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 Contractor's expense, making good included.

It is in the interest of the 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 Contractor's account.

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

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

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

Thermal images of the panels and distribution board must be taken once the units are more than one week in operation. The images must be taken while in normal operating condition. The images should be reviewed and then presented as part of the Operations and maintenance manuals.

E09.15 LABELLING AND IDENTIFICATION

All equipment shall be labelled and identified using white trifoliate 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.

E09.16 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 MSWORD for WINDOWS disk copy for any word processed elements of the operating and maintenance manuals. Employ a specialist to prepare manuals for the form and content of the operating and maintenance manuals.

Agree format and contents with the Employer Operating and maintenance manuals must include, but are not limited to the following:

- Index of Contents
- 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 manufacturer's information concerning correct operation, etc., based on commissioning results.
- A description of the mode of operation of all systems.
- **Diagrammatic** drawings to each system (including distribution boards) indicating principal items of plant, equipment, valves, etc.
- A photo-reduction of all record drawings, together with an index.
  Size A4
  Size A3
- Legend for all colour-coded services.
- 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.
- The name, address and telephone number of the manufacturer of every item of plant and equipment together with catalogue list and order acknowledgement numbers.
- 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.
- 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.
- A copy of all manufacturers' guarantees or warranties.
- Copies of Insurance and Inspecting Authority Certificates and Reports.
- Starting up, operating and shutting down instructions for all equipment and systems installed.
- Details of procedures to maintain plant in safe working conditions.
- Control sequences for all systems installed.
- Schedule of all fixed and variable equipment settings established during commissioning.
- Back-up copies of any system software.
- Documentation of the procedures for updating and/or modifying software operating systems and control programs.

- Instructions for the creation of Control procedure routines and Graphic diagrams
- Details of the software revision for all programs provided.
- Two back-up copies of all software items, as commissioned.
- Details of lubrication systems and lubrication schedules for all lubricated items.
- A list of normal consumable items.
- A list of recommended maintenance 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.
- A list of any special tools needed for maintenance cross referenced to the particular item for which required.
- Procedures for fault finding.
- Emergency procedures, including telephone numbers for emergency services.
- Copies of all items incorporated in the plant room and switch room schedules and schematics.
- 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.
- Provide record drawings. Include the provision of relevant framed plasticised drawings in all electrical rooms.
- 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.

E09.17 TESTING AND COMMISSIONING

The contractor shall supply factory test certificates for each drum of cable supplied under the Contract.

After the installation is complete, the contractor and the Engineer shall inspect the installation. The Engineer must be notified in advance of the inspection dates. The contractor will keep a snag list, reflecting all items not acceptable to the Engineer. The contractor will correct the snag items as required to the Engineers approval, updating the snag list as the items are completed and signed off by the Engineer.

The contractor shall carry out all the tests for the Main distribution board and will also conduct all tests and complete copies of the tests for each distribution board and for each supply (normal and alternative supplies), and attach as annexes to the completion report. The tests required will be the following as a minimum:

(a) Continuity of bonding
(b) Resistance of earth continuity conductor
(c) Continuity of ring circuits (if applicable)
(d) Earth loop impedance test
(e) Elevated voltage between incoming neutral and external earth (ground)
(f) Earth resistance at electrode (if required)
(g) Insulation resistance MΩ
(h) Voltage at main distribution board with no load for each phase to neutral
(i) Voltage at main distribution board with load (as calculated for full load) for each phase to neutral V
(j) Voltage at available load (worst condition as calculated for full load) for each phase to neutral
(k) Operation of all earth leakage units
(l) Operation of all earth leakage test buttons

(m) Polarity of points of consumption
(n) Phase rotation at points of consumption for three-phase systems
(o) All switching devices, make-and-break circuits

On completion of his work, the Contractor will issue an Electrical Certificate of Compliance (CoC). All tests deemed necessary to issue the CoC should be included. The Contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The Contractor shall notify the Engineer timeously so that he may witness the tests.

Each installed cable shall be tested in accordance with:

(a) The Occupational Health and Safety Act (OHSA) 1994;

(b) The requirements of the Local and Supply Authorities.

E09.18 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 handover 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.

E09.19 MEASUREMENT AND PAYMENT

Item .... **Unit**

Supply and deliver distribution boards .... No

The unit of measurement shall be the number of distribution boards supplied and installed. The tendered rate shall include full compensation for the supply and delivery of the distribution board as specified in the detail specification complete with all the electrical equipment specified.

Item .... **Unit**

Install, test and commission the distribution boards.. No

The unit of measurement shall be the number of distribution boards installed, tested and commissioned. The tendered rate shall include full compensation for the installing, testing and commissioning of the distribution boards complete with all the specified electrical equipment in the distribution board. The tendered rate shall furthermore include for the wiring of the distribution board.

Item .... **Unit**

Supply and deliver isolators.. No

The unit of measurement shall be the number of isolators supplied and delivered.

The tendered rate shall include full compensation for the supply and delivery of the isolators where the isolators are specified separately.

Item .... **Unit**

Install isolators .... No

The unit of measurement shall be the number of isolators installed.

The tendered rate shall include full compensation for the installing of the isolators where the isolators are specified separately.

Item .... **Unit**

Supply and deliver circuit breakers .... No

The unit of measurement shall be the number of circuit breakers supplied and delivered.

The tendered rate shall include full compensation for the supply and delivery of the circuit breakers where the circuit breakers are specified separately.

Item .... **Unit**

Install circuit breakers .... No

The unit of measurement shall be the number of circuit breakers installed.

The tendered rate shall include full compensation for the installing of the circuit breakers where the circuit breakers are specified separately.

Item .... **Unit**

Supply and deliver fuse switches .... No

The unit of measurement shall be the number of fuse switches supplied and delivered.

The tendered rate shall include full compensation for the supply and delivery of the fuse switches where the fuse switches are specified separately.

Item .... **Unit**

Install fuse switches .... No

The unit of measurement shall be the number of fuse switches installed.

The tendered rate shall include full compensation for the installing of the fuse switches where the fuse switches are specified separately.

Item .... **Unit**

Supply and deliver earth leakage units .... No

The unit of measurement shall be the number of earth leakage units supplied and delivered.

The tendered rate shall include full compensation for the supply and delivery of the circuit breaker earth leakage units where the earth leakage units are specified separately, e.g. (30 mA)

Item .... **Unit**

Install earth leakage units .... No

The unit of measurement shall be the number of earth leakage units installed.

The tendered rate shall include full compensation for the installing of the circuit breaker earth leakage units where the earth leakage units are specified separately, e.g. (30 mA)

Item .... **Unit**

Supply and deliver contactors .... No

The unit of measurement shall be the number of contactors supplied and delivered.

The tendered rate shall include full compensation for the supply and delivery of the contactors where the contactors are specified separately.

Item .... **Unit**

Install contactors .... No

The unit of measurement shall be the number of contactors installed.

The tendered rate shall include full compensation for the installing of the contactors where the contactors are specified separately.

Item .... **Unit**

Supply and deliver light fittings .... No

The tendered rate shall include full compensation for the supply and delivery to site of the specified light fitting, complete with lamp/s, wiring, control gear where applicable, diffusers, etc.

Separate items shall be scheduled for each type of light fitting required.

Item .... **Unit**

Install light fittings .... No

The tendered rate shall include full compensation for the handling, inspection, fastening, connecting and testing of the light fitting.

Separate items shall be scheduled for each type of light fitting. This rate shall furthermore include full compensation for the cost of providing and installing all hardware, timber backing, plugs, screws connector terminals and other materials required to install the light fitting in accordance with the specification.

Item .... **Unit**

Supply and deliver switches.. No

The tendered rate shall include full compensation for the supply and delivery to site of the specified switch complete with cover plate and fastening screws.

Separate items shall be scheduled for each type of switch.

Item .... **Unit**

Install switches .... No

The tendered rate shall include full compensation for the handling, inspection, fastening, connecting, fitting of cover plate and testing of the switch.

Separate items shall be scheduled for each type of switch.

This rate shall furthermore include full compensation for the cost of providing and installing all hardware screws and wall plugs in the case of surface mounted switches, required to install the switch in accordance with the specification.

Item .... **Unit**

Supply and deliver photo-electric switch .... No

The tendered rate shall include full compensation for the supply and delivery to site of the specified photo-electric daylight switch complete with mounting bracket and around bulkhead light enclosure.

Item .... **Unit**

Install photo-electric switch .... No

The tendered rate shall include full compensation for the handling, inspection, fastening of the bulkhead enclosure and photo electric switch, connecting and testing of the switch.

This rate shall furthermore include full compensation for the cost of providing and installing all hardware, screws, wall plugs and other material required to install the photo electric light switch in accordance with the specification.

Item .... **Unit**

Supply lighting track ....m

The unit of measurement shall be the linear metre of track supplied.

The tendered rate shall include the supply and delivery to site of the track as specified in the detail specification.

Item .... **Unit**

Install lighting track..m

The unit of measurement shall be the linear metre of lighting track installed.

The tendered rate shall include full compensation for cutting to size and fixing to the ceiling or wall with appropriate fasteners of the lighting track and shall include the wiring connections of the supply circuit.

Item .... **Unit**

Supply and install lighting track accessories .... No

The unit of measurement shall be the number of splices, bends, elbows, connector units and end caps.

The tendered rate shall include full compensation for the supply, connecting, installation and fixing of accessories as detailed in the schedule of quantities.

Item .... **Unit**

Supply consumer distribution kiosks .... No

The unit of measurement shall be the number of distribution kiosk supplied.

The rate shall include full compensation for the supply of the distribution kiosks complete as specified.

Item .... **Unit**

Install consumer distribution kiosks... No

The unit of measurement shall be the number of distribution kiosks installed.

The rate shall cover the cost of the sitting, handling, transporting, installing, painting, testing and commissioning of each kiosk.

Item .... **Unit**

Supply and erect concrete plinths for consumer distribution kiosks .... No

The unit of measurement shall be the number of plinths supplied and erected.

The rate shall include full compensation for the supply of precast plinths and bases and the erection thereof as specified.

Item .... **Unit**

Supply consumer distribution pillars.. No

The unit of measurement shall be the number of distribution pillars supplied.

The rate shall include full compensation for the supply of the distribution pillars fully equipped as specified.

Item .... **Unit**

Install consumer distribution pillars .... No

The unit of measurement shall be the number of distribution pillars installed.

The rate shall include full compensation for the installing of the distribution pillars and shall include for the excavation for the installing of the pillar and the backfilling, compacting and disposal of the surplus material once the pillar has been installed.

Item .... **Unit**

Supply service connection cable...m

The unit of measurement shall be the length in metres of service connection cables supplied.

The tendered rate shall include full compensation for the supply and delivery of the cable to site.

Item .... **Unit**

Lay service connection cable..m

The unit of measurement shall be the length in metres of service connection cable laid.

The tendered rate shall include full compensation for the handling, inspection, laying, cutting and testing the cable. Cables will be measured linearly over all lengths laid.

Item .... **Unit**

Terminate service connection cable... No

The unit of measurement shall be the number of service connection cable terminated.

The tendered rate shall include full compensation for the termination cable including all material and labour to render complete terminations of the cables.

Item .... **Unit**

Supply socket outlets.. No

The unit of measurement shall be the number of socket outlets supplied.

The tendered rate shall include full compensation for the supply and delivery of single or double single phase, three pin socket outlets.

Separate items shall be scheduled for the following:

(a) socket outlets flush mounted

(b) socket outlets surface mounted

(c) socket outlets to be installed in power skirting

(d) socket outlets to be installed in pedestals for floor ducting

(e) socket outlets to be installed in recessed service outlets for floor ducting.

Separate items shall be scheduled for standard and dedicated switched socket outlets. All socket outlets shall be supplied complete with cover plates and boxes where required. The tendered rate shall therefore include for the supply of the cover plates and fixing screws where applicable.

Item .... **Unit**

Install socket outlets .... No

The unit of measurement shall be the number of socket outlets installed.

The tendered rate shall include full compensation for the installing of the socket outlets. Separate items will be scheduled for the various type of socket outlets specified in item 6.6.8. The tendered rate shall furthermore include for the installing of the cover plates where applicable.

Item .... **Unit**

Supply plug tops for dedicated socket outlets .... No

The unit of measurement shall be the number of plug tops supplied.

The tendered rate shall include full compensation for the supply of plug tops for each of the dedicated socket outlets supplied and installed under this contract.

Item .... **Unit**

Supply and deliver double pole isolator for geyser supply .... No

The unit of measurement shall be the number of double pole isolators supplied.

The tendered rate shall include full compensation for the supply and delivery of double pole isolators for the geyser supplies.

Item .... **Unit**

Install double pole isolator for geyser supply .... No

The unit of measurement shall be the number of double pole isolators installed.

The tendered rate shall include full compensation for the installing of double pole isolators for the geyser supplies.

Item .... **Unit**

Supply and install connections to heaters, stoves, fans and air conditioners units .... No

The unit of measurement shall be the number of connections made.

The tendered rate shall include full compensation for the installing of the connections to the heaters, stoves, fans and air conditioners and shall include for the supply and installing of the double pole isolator or control unit which ever is applicable.

Separate items shall be scheduled for each type of connections.

Item .... **Unit**

Supply double pole isolators for power skirting.. No

The unit of measurement shall be the number of double pole isolators supplied for the power skirting.

The tendered rate shall include full compensation for the supply and delivery to site of the double pole isolators.

Item .... **Unit**

Install double pole isolators for power skirting .... No

The unit of measurement shall be the number of double pole isolators installed.

The tendered rate shall include full compensation for the installation of the double pole isolators in the power skirting and shall include the connections of the conductors to the isolators.

Item .... **Unit**

Supply junction boxes.. No

The unit of measurement shall be the number of junction boxes supplied.

The tendered rate shall include full compensation for the supply and delivery to site of the junction boxes.

Separate items shall be scheduled for each type of junction box.

Item .... **Unit**

Install junction boxes .... No

The unit of measurement shall be the number of junction boxes installed.

The tendered rate shall include full compensation for the installation of the junction boxes as specified.

Separate items shall be scheduled for each type of junction box.

Item .... **Unit**

Supply and delivery of conduit ....m

The unit of measurement shall be the linear metre of conduit supplied and delivered.

The tendered rate shall include for full compensation for the supply and delivery of the specified conduit and shall include full compensation for the supply of the couplings to join the conducts. Separate items shall be scheduled for the different types of conduit specified.

Item .... **Unit**

Installing of conduit...m

The unit of measurement shall be the linear metre of conduit installed.

The tendered rate shall include for full compensation for the installing of the conduit including jointing and bending the conduit and fixing the conduit using saddles as specified. Separate items shall be scheduled for the different types of conduit and for installing the conduit in concrete, fixing the conduit in brick work, including the chasing thereof, fixing the conduit on the surface of structures or installing the conduit in ceiling voids.

Item .... **Unit**

Terminate conduit... No

The unit of measurement shall be the number of terminations made.

The tendered rate shall include full compensation for terminating the conduit in draw boxes and outlet boxes and shall include for all locknuts and bushes.

Item .... **Unit**

Supply and install draw boxes .... No

The unit of measurement shall be the number of draw boxes supplied and installed.

The tendered rate shall include full compensation for supplying and installing the draw boxes including the cover plates. Separate items shall be scheduled for installing the boxes in concrete, in brickwork including chasing, and on the surface of structures.

Item .... **Unit**

Supply and install conduit outlet boxes .... No

The unit of measurement shall be the number of conduit outlet boxes supplied and installed.

The tendered rate shall include full compensation for supplying and installing conduit outlet boxes and shall include blank cover plates where no equipment is installed in the boxes. Separate items shall be scheduled for 1, 2, 3 and 4 way outlet boxes and for installing the boxes in concrete, in brick walls, including the chasing thereof, and surface on structures.

Item .... **Unit**

Supply power skirting ....m

The unit of measurement shall be the linear metre of power skirting supplied.

The tendered rate shall include full compensation for the specified power skirting including cover plates. Separate items shall be scheduled for one, two and three compartment power skirting.

Item .... **Unit**

Install power skirting..m

The unit of measurement shall be the linear metre of power skirting installed.

The tendered rate shall include full compensation for installing the power skirting including all material required to install the power skirting.

Item .... **Unit**

Supply and install power skirting end caps, bends, conduit outlets & accessories .... No

The unit of measurement shall be the number of power skirting end caps, bends and conduit outlets supplied and installed.

The tendered rate shall include full compensation for the supply and installing of the power skirting end caps, internal and external bends and outlets and shall include for the supply of all material required to complete the installing thereof.

Item .... **Unit**

Supply under floor ducting...m

The unit of measurement shall be the linear metre of under floor ducting supplied.

The tendered rate shall include full compensation for the supply of under floor ducting. Separate items shall be scheduled for the two and three compartment ducting.

Item .... **Unit**

Supply under floor ducting accessories... No

The unit of measurement shall be the number of accessories supplied.

The tendered rate shall include full compensation for the supply of the required accessories for the completion of the under floor installation. Separate rates shall be scheduled for cross-over, T-junction and right angle bend draw boxes and up-bends.

Item .... **Unit**

Supply pedestal units .... No

The unit of measurement shall be the number of pedestals supplied.

The tendered rate shall include full compensation for the supply of the specified pedestal units.

Item .... **Unit**

Install under floor ducting..m

The unit of measurement shall be the linear metre of ducting installed.

The tendered rate shall include full compensation for the installation of the under floor ducting.

Item .... **Unit**

Install under floor ducting accessories .... No

The unit of measurement shall be the number of accessories installed.

The tendered rate shall include full compensation for the installation of the accessories. Separate items shall be scheduled for the cross-over, T-junction and right angle bend draw boxes and up-bends.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
E10 : ELECTRICAL BUSAR TRUNKING

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Revision 4

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City of Johannesburg
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PARTICULAR SPECIFICATION: VOLUME E10: ELECTRICAL BUSBAR TRUNKING

CONTENTS

E10.1 SCOPE

This section covers the supply and installation of busbar trunking.

E10.2 STATUTORY DOCUMENTS AND STANDARDS

E10.2.1 Standards

The latest edition of the following particular specifications and Codes of Practice shall be read in conjunction with this section:

(a) SANS 10142-1 : The wiring of premises Part 1: Low-voltage installations

(b) SANS 121 : Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods

(c) SANS 60439-2 : Low-voltage switchgear and controlgear assemblies Part 2: Particular requirements for busbar trunking systems (busways)

(d) SANS 61439-6 : Low-voltage switchgear and controlgear assemblies Part 6: Busbar trunking systems (busways)

(e) SANS 1195 : Busbars

(f) BS 159 : Specification for high-voltage busbars and busbar connections

(g) BS EN 13601 : Copper and copper alloys. Copper rod, bar and wire for general electrical purposes

(h) SANS 61439 : Low voltage switchgear and control gear assemblies

E10.2.2 Particular Specifications to be read in conjunction with this specification

The following particular specifications shall be read in conjunction with the Project Specification:

(a) E26 : ELECTRICAL SPECIFICATION FOR COLOUR CODE

(b) G02 : PARTICULAR SPECIFICATION FOR CORROSION PROTECTION

(c) E06 : ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION

E10.3 BUSBAR TRUNKING

E10.3.1 General

This section covers the supply and installation of trunking and accessories in buildings.

E10.3.2 Materials

Rising and overhead busbar trunking shall be fully enclosed in a metal duct which shall form part of the busbar support. The metal enclosure shall form an integral part of the bus section and shall be of the same length as the conducting sections of the busbar. The covers of the busbar trunking shall be secured to the framework by at least four points per section. Busbar covers shall be so designed that they are easily removable after installation of the trunking. Sections of the busbars which pass through walls and floors shall have separate covers.

Two fire barriers of non-flammable, non-conducting material in the busbar trunking shall form an integral part of each section of rising busbars.

The fire barriers shall be so placed as to prevent the spreading of fire from one floor to another but shall not restrict the ventilation of the busbar.

Overhead busbars shall be equipped with fire barriers where the busbars pass through walls or partitions.

E10.3.3 Rating

Busbars shall be manufactured from either aluminium or solid drawn high conductivity copper with a rectangular cross-section, as specified in the "detail specification". Busbars shall be in accordance with SANS 60439-2, SANS 1195 and BS EN 13601, BS 159 where applicable.

The rating shall be as specified in the detail specification with the maximum allowable temperature of the busbars (including joints) carrying full load current in an ambient temperature as specified not exceeding 80 °C.

Busbars shall not be tapered and the neutral busbar in three-phase, four wire supplies shall have a cross-section equal to 100% of the cross-section of the phase busbars.

An earth busbar shall be installed along the entire length of the busbar trunking and shall be calculated according to SANS 61439 with a minimum cross-section of 6,3 mm x 20 mm.

E10.3.4 Construction

The busbar rating must match that of the transformer with respect to load and fault currents.

The busbars shall be supported at a minimum of two points in each section and shall be supported by a suitable resin bound synthetic material. The surface of these supports shall be treated to prevent surface tracking. The fixing of the busbars shall be designed to withstand the mechanical and thermal stresses during fault conditions at the specified fault level. Where concrete roofs are available, the busbar can be hung from the roof.

Busbar support must not impede with the rest of the electrical installation.

All non-current carrying metal parts of the trunking shall be bonded to the earth busbar.

Expansion joints shall be provided at intervals not exceeding 10 m to allow for a temperature variation of 0 °C to 90 °C. These expansion joints shall have the same current rating as the rest of the busbar trunking.

All accessories shall be purpose-made and shall conform to the same specification as the busbars.

All ratings and the name and address of the manufacturer shall be indicated on a metal label fixed to each section of the busbar trunking.

E10.3.5 Installation

Trunking shall be of the size and type as specified in the detail specification.

The electrical subcontractor shall ensure that the trunking is installed in accordance with the routes indicated on the relevant drawings.

However should the electrical subcontractor discover that the indicated route is not practically possible, or for some other reason the route clashes with other services, he shall immediately contact the engineer for clarification in this regard.

E10.3.6 Testing and commissioning

All busbar trunking must be type tested. A type test certificate must be supplied at tender stage.

The busbar trunking must be subjected to site acceptance tests to verify the integrity and performance prior to commissioning. A schedule of the SAT must be provided and approved by the engineer prior to commencement of manufacture.

The contractor shall supply factory test certificates for all bus trunking supplied under the Contract.

After the installation is complete, the contractor and the Engineer shall inspect the installation. The Engineer must be notified in advance of the inspection dates. The contractor will keep a snag list, reflecting all items not acceptable to the Engineer. The contractor will correct the snag items as required to the Engineers approval, updating the snag list as the items are completed and signed off by the Engineer.

On completion of his work, the Contractor will issue an Electrical Certificate of Compliance (CoC). All tests deemed necessary to issue the CoC should be included. The Contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The Contractor shall notify the Engineer timeously so that he may witness the tests.

Each installed bus trunking shall be tested in accordance with:

(a) The Occupational Health and Safety Act (OHSA) 1994;

(b) The requirements of the Local and Supply Authorities.

Once commissioned the assembly should be scanned and a thermal image obtained. The image should be reviewed after which they will form part of the Operations and Maintenance Manuals to be presented to the engineer.

E10.4 MEASUREMENT AND PAYMENT

Item **Unit**

Supply and deliver busbar trunking..m

The unit of measurement shall be the linear metre of busbar trunking supplied and delivered.

The tendered rate shall include for full compensation for the supply of the specified busbar trunking including all material needed for the installation of the busbar trunking.

Item **Unit**

Supply and deliver busbar trunking end feed units.. No

The unit of measurement shall be the number of trunking end feed units supplied and delivered.

The tendered rate shall include for the full compensation for the supply and delivery of the specified busbar end feed units including all material needed for the installation of the busbar end feed unit.

Item **Unit**

Supply and deliver busbar trunking directional change units .... No

The unit of measurement shall be the number of busbar trunking directional change units supplied and delivered.

The tendered rate shall include for full compensation for the supply and delivery of the specified busbar directional change units including all material needed for the installation of the busbar trunking directional change unit.

Item **Unit**

Supply and deliver busbar trunking fire barriers .... No

The unit of measurement shall be the number of busbar trunking fire barriers supplied and delivered.

The tendered rate shall include for the full compensation for the supply and delivery of the specified busbar trunking fire barriers including all material needed for the installation of the busbar trunking fire barriers.

Item **Unit**

Supply and delivery of busbar trunking expansion units .... No

The unit of measurement shall be the number of busbar trunking expansion units supplied and delivered.

The tendered rate shall include for the full compensation for the supply and delivery of the specified busbar trunking expansion units including all material needed for the installation of the busbar trunking expansion units.

Item	**Unit**
Install busbar trunking	m

The unit of measurement shall be the linear metre of busbar trunking installed.

The tendered rate shall include for full compensation for the installation of the specified busbar trunking including all material needed for the installation of the busbar trunking.

Item	**Unit**
Install busbar trunking end feed units	No

The unit of measurement shall be the number of busbar trunking end feed units installed.

The tendered rate shall include for the full compensation for the installation of the specified busbar end feed units including all material needed for the installation of the busbar end feed unit.

Item	**Unit**
Install busbar trunking directional change units	No

The unit of measurement shall be the number of busbar trunking directional change units installed.

The tendered rate shall include for full compensation for the installation of the specified busbar directional change units including all material needed for the installation of the busbar trunking directional change unit.

Item	**Unit**
Install busbar trunking fire barriers	No

The unit of measurement shall be the number of busbar trunking fire barriers installed.

The tendered rate shall include for the full compensation for the installation of the specified busbar trunking fire barriers including all material needed for the installation of the busbar trunking fire barriers.

Item	**Unit**
Install busbar trunking expansion units	No

The unit of measurement shall be the number of busbar trunking expansion units installed.

The tendered rate shall include for the full compensation for the installation of the specified busbar trunking expansion units including all material needed for the installation of the busbar trunking expansion units.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

E11 : ELECTRICAL EARTHING AND LIGHTING PROTECTION

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PARTICULAR SPECIFICATION: VOLUME E11: GENERAL ELECTRICAL GENERAL EARTHING AND LIGHTNING PROTECTION

CONTENTS

E11.1 SCOPE

This specification covers the detail requirements of the general protection against lightning to be installed under the contract, including:

a) General notes on the lightning protection measures;

b) The risk management and definition of the risk to a structure due to lightning strikes;

c) A Lightning Protection System (LPS) describing principles to be followed for the protection against physical damage to a structure including the installations within the structure as well as injury to living beings due to touch and step voltages;

d) Surge Protection Measures (SPM) to reduce the risk of permanent failures of electrical and electronic installations within a structure due to a Lightning Electromagnetic Pulse (LEMP).

e) Information for the design, installation, inspection, maintenance and testing of the above.

E11.2 STATUTORY DOCUMENTS AND STANDARDS

E11.2.1 Standards

The latest edition, including all amendments up to date of tender of the following particular national and international specifications, publications and codes of practice which shall be read in conjunction with this specification and shall be deemed to form part thereof:

a)	SANS 10142-1	The wiring of premises Part 1: Low-voltage installations.
b)	SANS 10142-2	The wiring of premises Part 2: Medium-voltage installations above 1 kV ac not exceeding 22 kV ac. and up to and including 3 MVA installed capacity.
c)	SANS 62305-1	Protection against lightning Part 1: General principles
d)	SANS 62305-2	Protection against lightning Part 2: Risk management
e)	SANS 62305-3	Protection against lightning Part 3: Physical damage to structures and life hazard
f)	SANS 62305-4	Protection against lightning Part 4: Electrical and electronic systems within structures.
g)	SANS 62561	Lightning protection system components (LPSC).
h)	SANS 1063	Earth rods, couplers and connections.
i)	SANS 10199	The design and installation of earth electrodes.
j)	SANS 10313	Protection against lightning — Physical damage to structures and life hazard.
k)	SANS 10292	Earthing of low-voltage (LV) distribution systems.

E11.2.2 Particular Specifications to be read in conjunction with this Specification

The following particular specifications shall be read in conjunction with the Project Specification:

a) Automation and Control Design Standards, Volume 5: Clean Power and Surge Protection.

E11.3 CERTIFICATE OF COMPLIANCE

E11.3.1 New or modified installations

The Contractor shall appoint a competent and experienced lightning protection design engineer for the design, supply, installation, inspection and testing of the Lightning Protection System (LPS) as well as the Surge Protection Measures (SPM).

After installation and testing of the LPS and SPM, the lightning protection design engineer will issue a Lightning Protection System Installation Safety Report as prescribed in SANS 10313: Annex A as well as SANS10142-1, for each area of protection. The Engineer will witness the installation as well as all tests conducted.

Two copies of this report shall be submitted to the Engineer before handing over of any repair, modification or new installation involving LPS or SPM systems.

E11.3.2 Maintenance of installations

The Client shall appoint a competent and experienced lightning protection engineer to maintain and inspect the Lightning Protection System (LPS) as well as the Surge Protection Measures (SPM) on an annual basis. Tests and inspections should be done prior to the start of the lighting season.

The lightning protection engineer will issue a Lightning Protection System Maintenance Certificate as prescribed in SANS 10313: Annex B, for each area of protection.

E11.4 PROTECTION MEASURES

The following protective measures should be installed as far as possible. The most suitable protective measure shall be selected during the design phase, considering technical and economic aspects based on a risk assessment.

E11.4.1 Protection measures to reduce injury of living beings by electric shock

a) Adequate insulation of exposed lightning conductive parts;

b) Equipotential bonding of equipment and conductive parts and connection to a meshed earthing system;

c) Physical restrictions and warning notices where the above is not achievable.

E11.4.2 Lightning Protection System (LPS) to reduce physical damage

a) Air-termination system on high points;

b) Down-conductor system;

c) Earth-termination system;

d) Equipotential bonding;

E11.4.3 Surge Protection Measures (SPM) to reduce failure of electrical and electronic systems

a) Earthing and bonding measures;

b) Magnetic shielding;

c) Line routing;

d) Isolating interfaces;

e) Coordinated Surge Protection Device (SPD) system.

E11.5 RISK MANAGEMENT

Risk to a structure exposed to lightning flashes is managed by a process based on risk evaluation or assessment. Appropriate protection measures are selected to reduce the risk to or below the tolerable limit.

The following basic procedure must be followed during the risk assessment:

a) Identification of the structure to be protected;

b) Partitioning of the structure into zones;

c) Identification of all the types of loss in the structure;

d) The identification and calculation of the corresponding risk components for each type of loss;

e) Evaluation of need of protection;

f) Selection of protective measures (LPS, SPM or other protection measure);

g) Evaluate the cost-effectiveness of the protection measures;

h) Re-evaluation of the corresponding risk components and the need for further protection.

The risk assessment and the evaluation of loss and risks as well as protection selection must be done by a competent and experienced lightning protection design engineer. It is the responsibility of the contractor to appoint a lightning protection design engineer for this purpose.

E11.6 EXTERNAL LIGHTNING PROTECTION SYSTEM (LPS)

An external LPS is installed on a structure to intercept a direct lightning flash to the structure, conduct the lightning current safely towards earth and to disperse the lightning current into the earth. It consist out of an air-termination system, a down-conductor system and an earth-termination system.

E11.6.1 Design of the LPS

The design of the LPS must be done in accordance with SANS 62305-3 with specific reference to Annex E.

The LPS should be designed and installed by competent and experienced LPS design engineer and LPS installer (person who is competent to install, construct and test an LPS for compliance with this SANS 10313). It is the responsibility of the contractor to appoint a competent and experienced LPS design engineer and installer. The Contractor is responsible to manage consultation between the various parties involved in the project (client, local authorities, LPS design engineer, LPS installer, architect, civil contractor/builder and electrical engineer). In new structures, the LPS should be installed during the construction phase; proper timing for soil resistivity test and the design of the LPS is of utmost importance.

The LPS design engineer and installer will be responsible for the quality assurance on the project.

E11.6.2 Isolated LPS

On structures at risk of explosion and fire an isolated external LPS must be installed.

E11.6.3 Air-termination systems

Air-termination systems can be composed of any combination of the following elements:

a) Rods (including free-standing masts);

b) Catenary wires;

c) Meshed conductors.

Air terminals installed shall be located at corners, exposed points and edges on a structure. To determine the exact location one or more of the following methods should be followed:

a) Protection angle method;

b) Rolling sphere method;

c) Mesh method.

All types of air terminals shall comply in full with SANS 62305-3. The positioning of air termination system shall comply with SANS 62305-3 (Annexure A).

All air-termination components must be fixed and secured in such a way to withstand accidental external mechanical forces as well as electromechanical forces during a lightning strike.

E11.6.4 Down-conductor systems

If the air-termination system is supported by one or more non-conductive columns, at least one down-conductor is required for each column. Steel columns do not require additional down-conductors.

All down-conductor components must be fixed and secured in such a way to withstand accidental external mechanical forces as well as electromechanical forces during a lightning strike.

Down conductors may be placed on the surface of non-combustible walls. On structures at risk of explosion and fire, all down conductors must be isolated from the structure walls.

E11.6.5 Earth-termination system

For lightning protection, a single integrated structure earth-termination system is preferable and is suitable for all purposes (i.e. lightning protection, power systems and telecommunication systems).

An earthing resistance not exceeding 3Ω (measured at low frequency) is required for earth termination systems. Should it be impossible to achieve this earthing resistance value, the Engineer must approve the value obtained and deemed reasonable.

Type A earthing arrangement

Each down connector is connected to a horizontal or vertical earth electrode installed outside the protected structure. A minimum of two earth electrodes will be installed, buried at an upper end depth of minimum 0.5 m with a separation distance to minimize electrical coupling effects in the earth. The minimum length of the earth electrodes will be calculated during the design phase, based on the soil resistivity.

Type B earthing arrangement

A ring conductor is installed external to the protected structure, buried at an upper end depth of at least 0.5 m and at a distance of about 1 m away from the external walls. The radius of protection will be calculated during the design phase, based on the soil resistivity. Additional electrodes should be added to obtain the desirable protection radius. The number of electrodes shall not be less than the number of down conductors (with a minimum of two electrodes).

Test points

A test point must be installed at the connection between each down-conductor and earth termination electrodes. The joint will only be opened for testing and will remain closed at all times.

Conductor connections

Conductor connections shall be made secure by exothermic welding. Clamping or bolting of conductor connection points shall only be accepted with permission from the Engineer. All points of connection must be covered with a cold applied anti-corrosion and sealing tape based on a synthetic fabric, impregnated and coated with a neutral petrolatum compound.

E11.6.6 LPS Installation

Type B earthing will be installed as the preferred arrangement. Type A earthing will only be accepted with prior approval from the Engineer (in writing). The installation of the earth electrodes will be inspected and approved by the Engineer during the construction phase.

The LPS shall be bonded to the fixed electrical installation protective earthing in accordance with the requirements of SANS 10142-1. Where an installation may typically consist of a main building or plant and one or more satellite subsystems, the various earth networks shall be interconnected to form one earth system. Only in the rare instance of a subsystem being totally isolated, with no cables, pipes, fences or other conductive structures connecting it to the rest of the installation, may a system be provided with a separate earth network.

E11.6.7 Components

All material and components used in a LPS must conform to the requirements specified in SANS 62561.

Minimum cross-sectional area of conductors

a) Air-termination conductors, air-termination rods and down-conductors:

Configurations and minimum cross-sectional areas of air-termination conductors, air-termination rods and down-conductors are given in SANS 62305-3: Table 6 “Material, configuration and minimum cross-sectional area of air-termination conductors, air-termination rods, earth lead-in rods and down-conductors”.

The following material and dimensions will be specifically applicable. No copper conductors will be accepted.

Material	**Configuration**	**Cross-sectional area (sq. mm)**
Aluminium	Solid tape	70
	Solid round	50
Stainless steel	Solid tape	50
	Solid round	50

Table 1: *Specific configurations and minimum cross-sectional areas of air-termination conductors, air-termination rods and down-conductors.*

b) Earth conductors and electrodes:

Configurations and minimum dimensions of earth electrodes are given in SANS 62305-3: Table 7 “Material, configuration and minimum dimensions of earth electrodes”.

The following material and dimensions will be specifically applicable. No copper conductors will be accepted.

Material	**Configuration**	**Dimensions**	
		Earth rod diameter (mm)	**Earth conductor (sq. mm)**
Copper coated steel	Solid round	14	
Stainless steel	Solid round	15	78
	Solid tape		100

Table 2: *Specific configurations and minimum dimensions of earth conductors and electrodes*

E11.7 LPS FOR STRUCTURES WITH A RISK OF EXPLOSION

The design, construction, extension and modification of lightning protection systems for structures with a risk of explosion must comply with SANS 62305-3: Annex 3.

a) The LPS must be isolated from the structure. This includes the air termination conductors as well as all down conductors. Under no circumstances may any parts of the structure be used as part of the LPS

b) The distance between down conductors will not exceed 5m. The down conductor count and spacing will be determined during the design phase with a minimum of two down conductors installed.

c) The earth-termination system will be a type B arrangement

d) All installations/structures/equipment will be equipotential bonded to the lightning protection system. Junctions shall be provided for the joining of connection and earthing leads to containers, metal construction parts, drums and tanks

e) Aboveground metal piping shall be earthed at least every 30 m. Bonding conductors will be connected to the piping at tap holes in the flanges for taking up screws. Where this is not possible, welded-on lugs or bolts will be used

f) Such devices shall be suitable for the environment in which they are installed.

The above will be applicable to aeration basins, bioreactors, HOW, digester (high risk areas)

E11.8 INTERNAL LIGHTNING PROTECTION SYSTEM (LPS)

An internal LPS is intended to prevent flashover between electrically conducting elements within the structure and the external LPS components using either equipotential bonding or an adequate separation distance.

E11.8.1 Equipotential bonding

All equipment likely to be subjected to surge currents shall be securely bonded together and to the earth network.

Bonding bar

A single bonding bar shall be installed for equipotential bonding. The bar shall be manufactured from electrical grade hard drawn aluminium 80sq mm complete with mounting insulators. The bar will be pre-drilled with ten M8 holes, fitted with stainless steel high tensile hex bolts with nuts and washers. The bar will be fitted with two removable test links, one on each end of the bar.

The bonding bar shall be connected to the earth-termination system at two connection points with two separate cables.

A ring bonding bar where more than one interconnected bonding bars are installed can be used for larger installations.

External conductive parts

External conductive parts shall be bonded to the bonding bar from a point as near as possible to the point of entry into the structure. This will include all electrical conductive pipes, cable ladder, fences and gates.

External electrical lines

Live conductors shall be bonded to the bonding bar via SPD’s. (See Paragraph E11.1 Surge Protection Measures). All gland plates in electrical panels will be bonded to the earth network. Power cable armouring shall be bonded to the earth network at both ends of the cable via the cable glands on the gland plates.

Telecommunication and Instrumentation lines

Please refer to Automation and Control Design Standards, Volume 5: Clean Power and Surge Protection.

Internal systems

Screened cables installed in the internal system must be bonded to the bonding bar via the screen. Cables in metal conduits installed in the internal system must be bonded to the bonding bar via the conduits. Unscreened cables must be connected to the bonding bar via SPD’s (See Paragraph E11.1 Surge Protection Measures).

Bonding conductors

Bonding conductors shall be short and shall run in straight or smoothly contoured routes. Material, dimensions and conditions of use shall comply with SANS 62305-3. The minimum cross-section for bonding components shall comply with SANS 62305-4 Table 1 “Minimum cross-sections for bonding components”.

The following material and dimensions will be specifically applicable.

Bonding component	Material	Cross-section (sq. mm)
Bonding bars	Aluminium	80
Bonding to LPS	Aluminium	70
Connecting conductors from internal metal installations to bonding bars (carrying a partial lightning current)	Aluminium	70

Table 3: *Specific material and cross-section area for bonding components*

E11.9 INSPECTION AND MAINTENANCE OF LPS

E11.9.1 Inspection

Inspections should be conducted during the construction period as well as after completion of the installation. A Lightning Protection System Installation Safety Report as described in SANS 10313 Annex A (or similar) must be issued by the LPS installer after completion of the installation. All tests conducted during the commissioning of the LPS must be witness by the Engineer. Inspections must be conducted after any alteration or repair of the LPS.

Regular periodic inspections must be conducted on the LPS system of explosives facilities. A maintenance and inspection plan shall be developed for the installed protection systems. The system shall be tested every 12 months. A register shall be kept for this purpose. Only qualified personnel having the necessary training and expertise shall be permitted to maintain, inspect, test and sign off these facilities.

E11.9.2 Maintenance

Routine inspections should be conducted on a 12-monthly basis. Any observed faults must be repaired immediately.

E11.10 INJURY TO LIVING BEINGS DUE TO TOUCH AND STEP VOLTAGES

The area surrounding the down-conductor (within a 3-meter radius) may be hazardous despite measures described in this specification. Additional measure must be installed to reduce this risk to acceptable values:

E11.10.1 Touch voltage

a) The area is demarcated to prevent access and relevant notices are displayed (ISO 3864-1), or
b) The number of down-conductors are increased to above 10, which will reduce the current and induced voltages, or
c) Increasing the contact resistance of the soil to above 100kΩ, or
d) The down conductors are insulated against the lightning impulse (100 kV, 1, 2/50 µs impulse withstand voltage).

E11.10.2 Step voltage

a) The area is demarcated to prevent access and relevant notices are displayed (ISO 3864-1), or
b) The number of down-conductors are increased to above 10, which will reduce the current and induced voltages, or
c) Increasing the contact resistance of the soil to above 100kΩ, or
d) The down conductors are insulated against the lighting impulse (100 kV, 1,2/50 µs impulse withstand voltage), or

e) The installation of a meshed earth-termination system.

E11.11 SURGE PROTECTION MEASURES (SPM)

Surge Protection Measures (SPM) are implemented to reduce the risk of permanent failures of electrical and electronic installations within a structure due to a Lightning Electromagnetic Pulse (LEMP).

Equipment failure due to LEMP is caused by surges conducted by connected wiring or by radiated electromagnetic fields. The effect of line surges is reduced by the installation of Surge Protection Devices (SPD’s). The effect of radiated electromagnetic fields is reduced by shielding of equipment and shielded lines. Equipment generally complies with EMC product standards, which is sufficient to protect such equipment against LEMP.

E11.11.1 Design and installation of SPM

The SPM should be designed, installed and signed off by a competent and experienced SPM design engineer and SPM installer (person who is competent to design, install, construct and test an SPM with a broad knowledge of Electromagnetic compatibility (EMC)). It is the responsibility of the contractor to appoint a competent and experienced SPM design engineer and installer.

The design of the Surge Protection Measures (SPM) must be done in accordance with SANS 62305-4 as well as the Risk Assessment study done as described in SANS 62305-2.

E11.11.2 Earthing and bonding

A meshed network with a 5m mesh width is installed around the structure. This mesh is connected to the Type B ring earth electrode as well as the structure’s interconnected mesh reinforced concrete floor to form a meshed earth termination system. The earth-termination systems of all internal systems should be bonded together to prevent potential differences between the systems.

Bonding bars in a stand-alone or ring configuration should be used to bond all conductive parts and incoming services (metal pipes, power lines, signal lines) together. Incoming lines should be bonded with SPD’s. The material and minimum cross-sections for bonding component must comply with SANS 62305.

E11.11.3 Magnetic shielding and line routing

Spatial shielding is used to define protections zones. It can be grid like and can use electrical conductive reinforcement in the building. Internal lines can comprise of shielded cables or metallic enclosures of cables. Cables must be routed close conductive parts in the shielding system (reinforced concrete) to minimise induction.

The requirement of SANS 62305 concerning the material and minimum cross-sections or thickness of air-termination and down conductors must be followed.

E11.11.4 Coordinated SPD system

Please read this section in conjunction with the document Automation and Control Design Standards, Volume 5: Clean Power and Surge Protection for system compatibility.

The principle of a coordinated SPM is based on the division of the protected area/s into Lighting Protection Zones (LPZ), where the first LPZn is the overall protection zone which borders the inner zone LPZ (LPZn+1). The effect of the LEMP is reduced with each zone employed. LPZ 0 is the unprotected outer zone where equipment will be exposed to full LEMP and lighting surge currents. LPZ 1…n is the inner zones where equipment is exposed to limited surge current and attenuated electromagnetic field. (Refer to SANS 62305-4 typical drawings.)

SPD’s must be selected to reduce the surge overvoltage between the live conductors and earth to a value lower than the equipment’s rated impulse withstand voltage U_W at its terminals (common mode withstand voltage). The type of SPD, the location of the SPD (as close as possible to the point of entrance of the line vs as close as possible to the equipment to be protected) as well as the connecting conductors must be considered.

Types of SPD’s:

There are three types of SPD's:

a) Type 1 SPD

The Type 1 SPD is recommended in the specific case of service-sector and industrial buildings, protected by a lightning protection system or a meshed cage. It protects electrical installations against direct lightning strokes. It can discharge the back-current from lightning spreading from the earth conductor to the network conductors. Type 1 SPD is characterized by a 10/350 µs current wave.

b) Type 2 SPD

The Type 2 SPD is the main protection system for all low voltage electrical installations. Installed in each electrical switchboard, it prevents the spread of overvoltages in the electrical installations and protects the loads. Type 2 SPD is characterized by an 8/20 µs current wave.

c) Type 3 SPD

These SPDs have a low discharge capacity. They must therefore mandatorily be installed as a supplement to Type 2 SPD and in the vicinity of sensitive loads. Type 3 SPD is characterized by a combination of voltage waves (1.2/50 µs) and current waves (8/20 µs).

E11.11.5 <u>SPM management</u>

A Management Plan must be implemented by a competent and experienced SPM design engineer:

a) Risk analysis;
b) SPM planning;
c) SPM design;
d) Installation of the SPM;
e) Approval of the SPM;
f) Recurrent inspections (documented);
g) Maintenance (following defects noted during recurrent inspections).

E11.12 EARTHING OF THE LV DISTRIBUTION SYSTEM

E11.12.1 <u>TN-S system earthing – Separate neutral and protective conductors</u>

The protective conductor (PE) is a separate conductor connected to the transformer neutral (star point).The transformer neutral is connected to the structure earth-termination system.

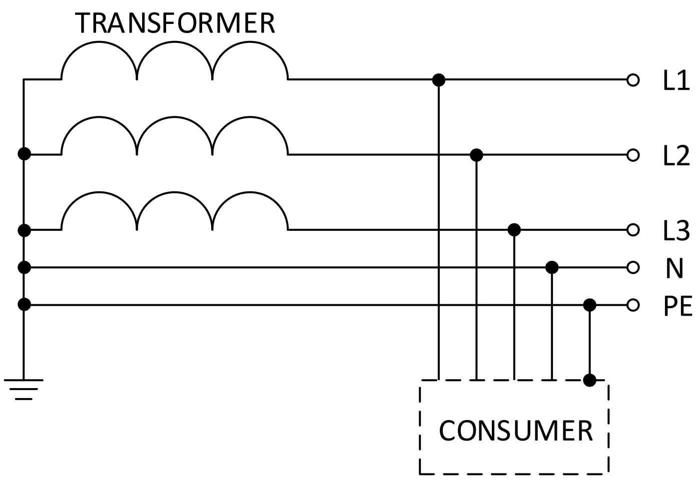

Figure 1. *TN-S System earthing*

E11.12.2 Requirements of the TN-S system earthing

a) In a single-phase TN-S system, the equivalent area of the neutral (N) conductor should be not less than the area of the phase conductor.

b) In a three-phase TN-S system, the equivalent area of the N conductor should be not less than half the area of one phase conductor.

c) In a three-phase TN-S system, all power cables will be four core, with the fourth (black) core used as the N conductor.

d) The protective earth (PE) conductor shall be able to carry the maximum fault current for the duration of the fault. This applies to any point in the distribution system.

e) The PE conductor should be of copper not less than $10mm^2$.

f) The minimum cross-sectional area of the PE conductor for phase conductors $16mm^2$ to $35mm^2$ is $16mm^2$.

g) The minimum cross-sectional area of the PE conductor for phase conductors above $35mm^2$ is at least 50% of the phase cross-sectional area.

h) No mechanism (circuit breaker, disconnector, fuse or removable link) which can separate the neutral conductor from the neutral point may be installed.

E11.12.3 Installation of the TN-S system earthing

a) The PE conductor will be installed next to the associated LV power cable.

b) Where the PE conductor is installed directly in the ground, bare copper earth wire will be used.

c) Where the PE conductor is installed in a covered cable trench or on a cable rack, black PVC insulated earth wire will be used. Both ends of the PE conductor will be identified with yellow/green crimp sleeves.

E11.14 LIGHTNING PROTECTION SYSTEM (LPS)

Figure 2 shows a typical LPS as implemented by Johannesburg Water

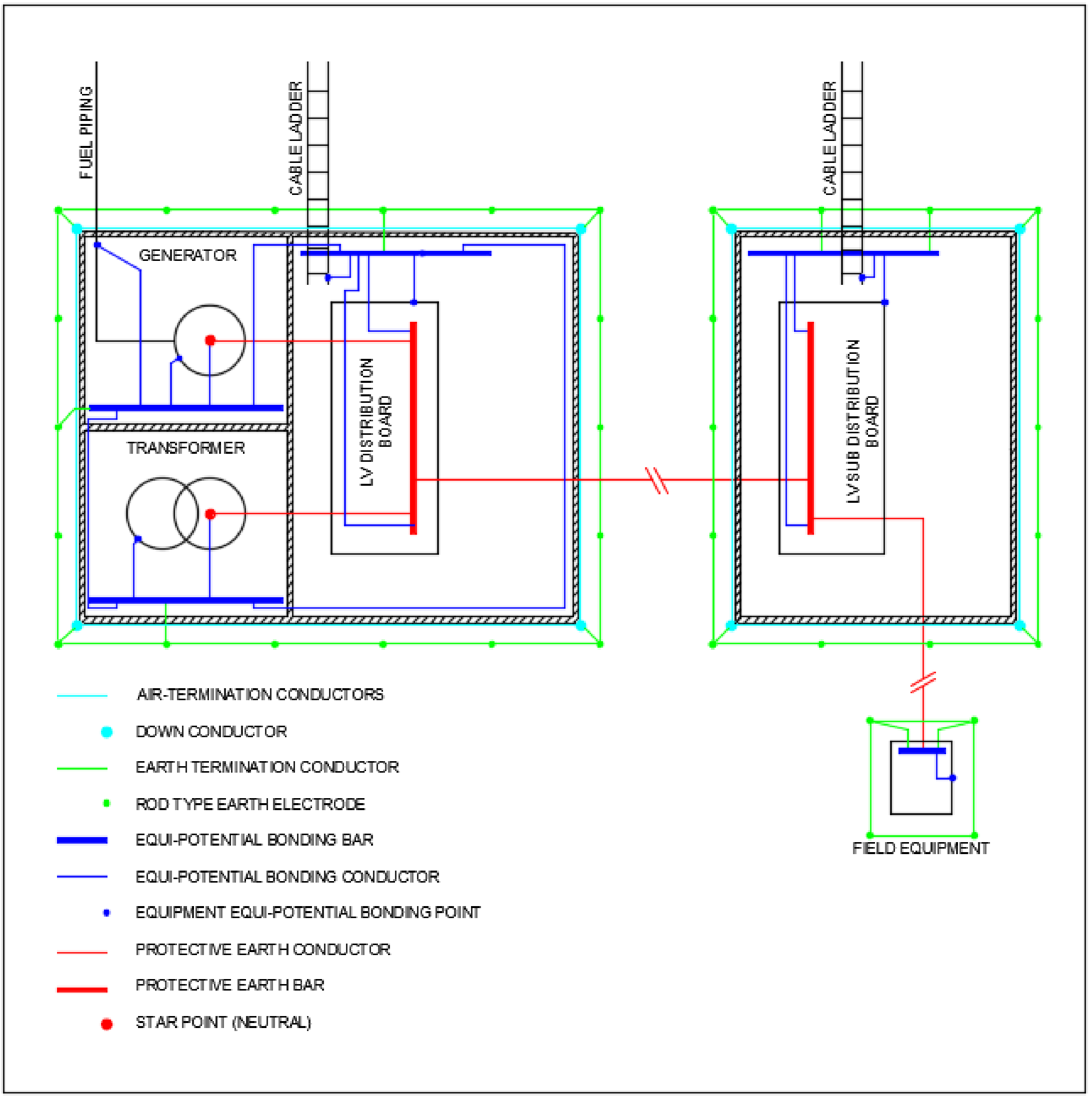

Figure 2. *Lighting Protection System (LPS)*

E11.16 MEASUREMENT AND PAYMENT

<u>**Item**</u> <u>**Unit**</u>

Earth resistivity tests .... No

The tendered rate shall include for the carrying out of the earth resistivity tests by a competent and experienced LPS engineer. The unit for measurement shall be per point where such tests have to be carried out.

<u>**Item**</u> <u>**Unit**</u>

Design of a Lightning Protection System (LPS).. No

The tendered rate shall include for the design by a competent and experienced LPS engineer and must include the design of the Surge Protection Measures (SPM). The unit for measurement shall be an area of design.

<u>**Item**</u> <u>**Unit**</u>

Installation of a structure LPS .... Sum

The tendered rate shall include full compensation for the supply of all material required and the installation of the Lighting Protection system as per the design by a competent and experienced LPS engineer. It shall include for the testing of the LPS by a competent and experienced LPS engineer.

<u>**Item**</u> <u>**Unit**</u>

Extra over for the supply and installation of additional rod type earth electrodes of specified length including welding/clamps for the connection of earth-termination conductors ......No

The tendered rate shall include full compensation for the supplying and installation of the earth electrodes.

<u>**Item**</u> <u>**Unit**</u>

Provision for additional earthing as required .... Provisional sum

The provisional sum provided shall include for any additional earthing which may be specified by the Engineer after the acceptance of the contract.

The Contractor shall submit a written quotation to the Engineer when requested to by the Engineer and shall not commence with the installation of any additional earthing without the written instruction of the Engineer.

<u>**Item**</u> <u>**Unit**</u>

Testing of a LPS... No

The unit of measurement shall be the number of tests undertaken by a competent and experienced LPS engineer, including the supply of the equipment required to do the test.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

E12 : ELECTRICAL MEDIUM VOLTAGE CABLES

Johannesburg Water

Johannesburg Water (SOC) Ltd.
PO Box 61542
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Revision 4

August 2019

City of Johannesburg
Johannesburg Water (SOC) Ltd

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – E12 : Electrical Medium Voltage Cables**

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DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	Senior Electrical Engineer	B Pieterse	August 2019	
Reviewed	Director	R Baard	August 2019	
Approved	Regional Maintenance Manager	T Thabeng	August 2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
4	2019-08-20	B Pieterse	Review of Electrical Standards, plus New Design Guidance
3	2014-06-03		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
2	2012-05-30		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
1	2009-05-12		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance

PARTICULAR SPECIFICATION: VOLUME E12: ELECTRICAL MEDIUM VOLTAGE CABLES

CONTENTS

E12.1 INTRODUCTION

This specification covers the following:

(a) Medium Voltage (MV) cables for underground and surface installation;

(b) The type of MV cables that shall be used;

(c) The general requirements of the MV cables;

(d) The practice to be followed when storing, installing and testing the cables.

E12.2 SCOPE

E12.2.1 General

This specification details the requirements for single-core and three-core, MV cables. The preferred type of MV cables which is detailed in this specification is

(a) Paper insulated and lead covered double steel tape armoured 6.35/11kV cables to SANS 97;

(b) Three-core cross-linked polyethylene (XLPE) insulated PVC bedded, steel wire armoured, PVC sheathed 6.35/11kV cables to SANS 1339 Type A (Individually screened).

E12.2.2 Work to be included

The scope of work includes the supply, delivery and storage of MV cables prior to installation of the cables..

The following is specifically included in the scope:

(a) Description of the MV cables required for the work.

(b) Marking and labelling of the cables and cable drums.

E12.2.3 Work to be excluded

The following work and items are specifically excluded from the scope of work:

(a) All civil works

(b) Installation, laying or termination of any cables.

E12.3 STATUTORY DOCUMENTS AND STANDARDS

E12.3.1 Standards

The cables and their installation methods shall comply with the requirements of this specification including the valid and relevant requirements of the following Acts, Codes of Practice and Standards:

SANS 10142-1	:	The wiring of premises Part 1: Low-voltage installations
SANS 10142-2	:	The wiring of premises Part 2: Medium-voltage installations above 1 kV a.c. not exceeding 22 kV a.c. and up to and including 3 MVA installed capacity
BS EN 13601	:	Copper and copper alloys. Copper rod, bar and wire for general electrical purposes
SANS 97	:	Electric Cables – Impregnated paper-insulated metal-sheathed cables for rated voltages 3.3/3.3 kV to 19/33 kV
SANS 1339	:	Electric cables - Cross-linked Poly-ethylene (XLPE) insulated cables for rated voltages 3.8/6.6kV to 19/33kV
SANS 1507	:	Electrical cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V)

SANS 1411	:	Materials of insulated electric cables and flexible cords
SANS 1520	:	Flexible electrical trailing cables for use in mines
IEC 60287	:	Electric cables - Calculation of the current rating
VDE 0250	:	Cables, wires and cords for power installation
SANS 10198	:	The selection, handling and installation of electric power cables of rating not exceeding 33kV

a) The Occupational Health and Safety Act (Act 85 of 1993)

E12.3.2 Particular Specifications to be read in conjunction with this specifications

The following particular specifications shall be read in conjunction with the Project Specification:

E23	:	ELECTRICAL SPECIFICATION FOR COLOUR CODE
G02	:	PARTICULAR SPECIFICATION FOR CORROSION PROTECTION
E06	:	ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION

E12.4 DEFINITIONS

PILC Cable	Single-core and three-core, paper insulated lead covered electric cables
Armour	A layer or layers of galvanized steel wires applied to the cable to provide mechanical protection or earth continuity, or both.
Sheath	A solid extruded protective covering applied as the exterior of a cable or a flexible cord.
Bedding	A layer of extruded compound applied to the cable beneath the armouring.
Core	A single insulated conductor without protective covering.
XLPE	Cross-linked Poly-ethylene cable

E12.5 CABLE REQUIREMENTS

E12.5.1 General

PILC cables shall comply with the requirements of SANS 97.

XLPE cables shall comply with SANS 1339

The nominal cable voltage will be 6.35/11kV.

The cores of three-core cables shall be identified by the colours Red, White and Blue (R, W, B) or numbers 1, 2 and 3.

E12.5.2 Specific Requirements of MV Cables

E12.5.2.1 Voltage Frequency

The cable is needed for an underground, three phase, medium voltage, 50 hertz, alternating current distribution system.

E12.5.2.2 Core Screen

The conductor core shall be individually screened. The core screen shall be strippable.

E12.5.2.3 Metal Sheath

The metal sheath shall comprise of pure lead for PILC.

XLPE cables shall be PVC.

E12.5.2.4 Bedding

A bitumen impregnated fibrous bedding complying with SANS 97 shall be provided.

XLPE cables must be PVC bedded.

E12.5.2.5 Armour

Double steel tape armouring in accordance with SANS 97.

XLPE cables to have a steel or aluminium wire armour.

E12.5.2.6 Outer Sheath (Serving)

A PVC outer sheath will be required for XLPE, An impermeable black PVC sheath in accordance with SANS 97 shall be provided for PILC.

E12.5.2.7 Conductors

The standard conductor shall be copper or aluminium with cross-sectional areas as specified in Table 1:

CONSTRUCTION	**PILC**		**XLPE TYPE A**	
	NOMINAL VOLTAGE (kV)		**NOMINAL VOLTAGE (kV)**	
	3.8 / 6.6	6.35 / 11	3.8 / 6.6	6.35 / 11
	AREA (sq mm)		**AREA (sq mm)**	
1 CORE Copper/Aluminium	-	-	50	50
	-	-	70	70
	-	-	95	95
	-	-	120	120
	150	150	150	150
	185	185	185	185
	240	240	240	240
	300	300	300	300
3 CORE Copper/Aluminium	25	25	25	25
	35	35	35	35
	50	50	50	50
	70	70	70	70
	95	95	95	95
	120	120	120	120
	150	150	150	150
	185	185	185	185
	240	240	240	240
	300	300	300	300

Table 1: Standard Cable Conductor Cross Sectional Areas

E12.5.2.8 Cable Markings

Cables shall be legibly marked as specified in SANS 97, including:

(a) Conductor size in square millimetres

(b) Number of cores

(c) Conductor material (copper)

(d) The specification number (SANS 97) to which the cable has been manufactured.

(e) The year of manufacture

(f) Nominal voltage

Typically cable marking – MAKE YEAR 6.6/11kV XXmm^2 x 3 Cu SANS 97

E12.6 MARKING, LABELLING AND PACKAGING

E12.6.1 Packaging

Cables shall be supplied on wooden drums.

Unless otherwise stated, standard drum lengths shall be 300m for all 3-core cables.

E12.6.2 Marking of drums

On the cable drums, weatherproof and well legible labels shall be fixed, containing the information as follows:

(a) Cable manufacturer;

(b) Complete cable identification according to applied standard;

(c) Delivery length (in meter);

(d) Overall weight;

(e) Cable drum number;

(f) Rolling direction arrow.

E12.7 TESTING OF CABLES

The contractor shall supply factory test certificates for each drum of cable supplied under the Contract.

After the installation is complete, the contractor and the Engineer shall inspect the installation. The Engineer must be notified in advance of the inspection dates. The contractor will keep a snag list, reflecting all items not acceptable to the Engineer. The contractor will correct the snag items as required to the Engineers approval, updating the snag list as the items are completed and signed off by the Engineer.

On completion of his work, the Contractor will issue an Electrical Certificate of Compliance (CoC). All tests deemed necessary to issue the CoC should be included. The Contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The Contractor shall notify the Engineer timeously so that he may witness the tests.

Each installed cable shall be tested in accordance with:

(a) The Occupational Health and Safety Act (OHSA) 1994;

(b) SANS 10142-2

(c) SANS 97 (Electric cables - Impregnated paper-insulated metal-sheathed cables for rated voltages 3,3/3,3 kV to 19/33 kV)

SANS 97 Test Wave	Duration (min)	Commissioning test voltage between conductors (V)			Commissioning test voltage between conductors / sheath (V)		
		3300/ 3300	3800/ 6600	6350/ 11000	3300/ 3300	3800/ 6600	6350/ 11000
AC (r.m.s)	15	7000	13000	22000	7000	8000	13000
DC	15	9000	19000	31000	9000	11000	19000

(d) SANS 1339 (Electric cables - Cross-linked polyethylene (XLPE) insulated cables for rated voltages 3,8/6,6 kV to 19/33 kV)

SANS 1339 Test Wave	Duration (min)	Commissioning test voltage between conductors (V)			
		6600	11000	22000	33000

VLF (0.1 Hz)	60	11000	19000	38000	57000
Power frequency	60	8000	13000	25000	38000
DC	10	6000	10000	20000	30000

DC voltage testing is likely to cause irreversible damage to XLPE-insulated cable systems. The voltage and duration should be limited to the appropriate values given in the table above. The contractor shall use a DC test set to apply the test voltage. After completion of the DC test, the contractor shall soft-discharge the cable, using either the DC test set or a discharge stick where after the cable will be fully discharged by solidly earthing it for at least 8 h but preferably for 24 h. DC testing shall only be carried out with written permission from the Engineer,

(e) The requirements of the Local and Supply Authorities.

E12.8 QUALITY ASSURANCE

All cables supplied under the scope of works of this project shall be designed and manufactured under a quality control system, typically to the ISO 9000 series. The contractor must supply proof of manufacturer's certification.

E12.9 MEASURE AND PAYMENT

All cables supplied under the scope of works of this project shall be designed and manufactured under a quality control system, typically to SANS ISO 9000 series.

Item **Unit**

Supply and delivery of medium voltage paper insulated cable..m

The unit of measurement shall be the metre of cable supplied and installed.

The tendered rate shall include full compensation for the supply and delivery of the specified cable to the site.

ANNEX A

Derating Factors FOR PILC Cables

For Installation Conditions other than Standard

Variations of depth of laying - single and multicore PILC cables				
Depth of laying	Direct in ground		In single way ducts	
m	Up to 300 mm^2	Above 300 mm^2	Single core	Multi- core
0,5	1,15	1,15	1,15	1,15
0,6	1,10	1,10	1,10	1,10
0,8	1,00	1,00	1,00	1,00
1,0	0,98	0,97	0,98	0,99
1,25	0,96	0,95	0,95	0,97
1,5	0,95	0,94	0,93	0,96
2,0	0,92	0,90	0,90	0,94

Variations of thermal resistivity of soil - single and multicore PILC cables								
Conductor Size	Direct in ground				In single way ducts			
	Size Soil resistivity (K.m/W)				Size Soil resistivity. K.m/W			
mm^2	1	1.5	2	2.5	1	1.5	2	2.5
25	1.06	0.93	0.85	0.78	1.03	0.96	0.91	0.86
35	1.06	0.93	0.85	0.78	1.03	0.96	0.9	0.85
50	1.07	0.93	0.84	0.77	1.03	0.96	0.9	0.85
70	1.07	0.93	0.84	0.77	1.03	0.96	0.9	0.85
95	1.07	0.93	0.84	0.77	1.03	0.95	0.89	0.84
120	1.07	0.92	0.83	0.76	1.03	0.95	0.89	0.83
150	1.07	0.92	0.83	0.76	1.04	0.95	0.89	0.83
185	1.07	0.92	0.82	0.75	1.04	0.95	0.88	0.82
240	1.07	0.92	0.82	0.75	1.04	0.95	0.88	0.82
300	1.07	0.92	0.82	0.74	1.04	0.95	0.87	0.82
400	1.07	0.91	0.81	0.74	1.04	0.94	0.86	0.81
500	1.08	0.91	0.8	0.72	1.05	0.94	0.84	0.78
630	1.08	0.91	0.79	0.72	1.05	0.94	0.84	0.78
800	1.08	0.9	0.79	0.71	1.06	0.93	0.83	0.77
1000	1.08	0.9	0.79	0.71	1.06	0.93	0.83	0.76

Ground Temperature derating factors					
Maximum sustained conductor temperature °C	Ground Temperature °C				
	25	30	35	40	45
70	1.00	0.95	0.90	0.85	0.80
80	1.00	0.96	0.92	0.88	0.83

Derating factors for grouping of multicore PILC cables in horizontal formation in ground or ducts									
No. of cables in group	In ground - Axial spacing m					In ducts - Axial spacing m			
	Touch	0,15	0,30	0,45	0,60	Touch	0,30	0,45	0,60
2	0,80	0,85	0,89	0,90	0,92	0,88	0,91	0,93	0,94
3	0,69	0,75	0,80	0,84	0,86	0,80	0,84	0,87	0,89
4	0,63	0,70	0,77	0,80	0,84	0,75	0,81	0,84	0,87
5	0,57	0,66	0,73	0,78	0,81	0,71	0,77	0,82	0,85
6	0,55	0,63	0,71	0,76	0,80	0,69	0,75	0,80	0,84

No. of circuits	Derating factors for Grouping of single core PLIC cables (3.3 to 22kV)								
	Horizontal formation in single way ducts			Horizontal formation laid direct					
	Axial spacing			Axial spacing of circuits					
	m			m					
	Touch	0.45	0.60	Touch		0.15	0.30	0.45	0.60
				Trefoil	Flat				
2	0.85	0.88	0.90	0.78	0.80	0.81	0.85	0.88	0.90
3	0.75	0.80	0.93	0.66	0.69	0.71	0.76	0.80	0.83
4	0.70	0.76	0.80	0.60	0.63	0.65	0.72	0.76	0.80
5	0.67	0.73	0.77	0.55	0.58	0.61	0.68	0.73	0.77
6	0.64	0.71	0.76	0.52	0.55	0.58	0.66	0.72	0.76
7	0.62	0.70	0.75	0.49	0.52	0.55	0.63	0.70	0.74
8	0.61	0.69	0.74	0.47	0.51	0.54	0.62	0.69	0.74
9	0.59	0.68	0.73	0.45	0.49	0.52	0.61	0.68	0.73
10	0.58	0.67	0.73	0.44	0.48	0.51	0.60	0.67	0.73
11	0.58	0.66	0.72	0.43	0.46	0.49	0.59	0.67	0.72
12	0.57	0.66	0.72	0.42	0.46	0.49	0.58	0.66	0.72

Derating factors for variations in ambient air temperature				
Maximum sustained conductor temperature °C	Ground Temperature °C			
	30	35	40	45
70	1	0.94	0.87	0.79
80	1	0.95	0.89	0.79

ANNEX B

Derating Factors FOR XLPE Cables

For Installation Conditions other than Standard

RATING FACTORS FOR DEPTH OF LAYING	
Depth of Laying (mm)	Factor
500 - 800	1.00
850 - 1000	0.97
1050 - 1200	0.95
1250 - 1400	0.93
1450 - 1600	0.92

RATING FACTORS FOR GROUND TEMPERATURE		
Ground Temperature	Conductor Temperature	
°C	90°C	65°C
25	1.00	1.00
30	0.96	0.94
35	0.92	0.87
40	0.88	0.79

RATING FACTORS FOR THERMAL RESISTIVITY OF GROUND	
Thermal Resistivity K.m/W	Factor
0.7	1.23
1.0	1.08
1.2	1.00
1.5	0.90
2.0	0.80
2.5	0.72
3.0	0.66

GROUP RATINGS FOR 3-CORE VULTEX CABLES IN FLAT FORMATION IN GROUND			
No. of cables in same trench	Spacing		
	Touching	0.25 m	0.7 m
2	0.79	0.85	0.87
3	0.69	0.75	0.79
4	0.63	0.68	0.75
5	0.58	0.64	0.72
6	0.55	0.60	0.69
8	0.50	0.56	0.66
10	0.46	0.53	0.64

RATING FACTORS FOR AMBIENT AIR TEMPERATURE					
Conductor Temp. °C	Air temperature °C				
	30	35	40	45	50
90	1.00	0.95	0.89	0.84	0.78

XLPE cable on trays, ladders or building structures						
Type of laying			No. of ladders or trays	Number of cables		
				1	2	3
				Rating factors		
Horizontal on metal tray	Touching		1	0.97	0.85	0.74
			≥ 2	0.97	0.83	0.71
	Spacing	≥ 30mm, ≥ D max 30mm	1	0.97	0.96	0.93
			≥ 2	0.97	0.94	0.90
Horizontal on metal tray	Touching		1	1.00	0.86	0.74
			≥ 2	1.00	0.82	0.71
	Spacing	≥ 30mm ≥ D, max 30mm	1	1.00	1.00	1.00
			≥ 2	1.00	1.00	1.00
Horizontal on floor	Touching			0.94	0.80	0.66
	Spacing	≥ 30mm, ≥ D max 30mm		0.94	0.90	0.87
Vertical on wall	Touching			0.94	0.80	0.66
	Spacing	≥ 30mm, ≥ D max 30mm		0.94	0.90	0.87
Horizontal in ceiling	Touching			0.89	0.76	0.57
	Spacing	≥ 30mm, ≥ D max 30mm		0.89	0.81	0.77

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
E13 : ELECTRICAL MEDIUM VOLTAGE SWITCHGEAR

Johannesburg Water

Johannesburg Water (SOC) Ltd.
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PARTICULAR SPECIFICATION: VOLUME E13: ELECTRICAL MEDIUM VOLTAGE SWITCHGEAR

CONTENTS

E13.1 SCOPE

This specification covers the supply, delivery, installation, testing and commissioning of indoor metal-clad switchgear and associated equipment.

E13.2 STATUTORY DOCUMENTS AND STANDARDS

E13.2.1 Standards

All materials and apparatus shall be new and of the best quality and shall comply with the relevant current specifications of the SANS, BSI or IEC and as stated in this document.

The following standards may be used as a guide but must not be regarded as a complete list.

SANS 62271-1	:	High-voltage switchgear and controlgear Part 1: Common specifications for alternating current switchgear and controlgear
SANS 62271-200	:	High-voltage switchgear and controlgear Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV
SANS 62271-103	:	High-voltage switchgear and controlgear Part 103: Switches for rated voltages above 1 kV up to and including 52 kV
SANS 62271-100	:	High-voltage switchgear and controlgear Part 100: Alternating-current circuit-breakers
SANS 62271-102	:	High-voltage switchgear and controlgear Part 102: Alternating current disconnectors and earthing switches
SANS 62271-105	:	High-voltage switchgear and controlgear Part 105: Alternating current switch-fuse combinations for rated voltages above 1 kV up to and including 52 kV
SANS 62271-107	:	High-voltage switchgear and controlgear Part 107: Alternating current fused circuit-switchers for rated voltages above 1 kV up to and including 52 kV
SANS 62271-206	:	High-voltage switchgear and controlgear Part 206: Voltage presence indicating systems for rated voltages above 1 kV and up to and including 52 kV
SANS 60282-1	:	High-voltage fuses Part 1: Current-limiting fuses
SANS 60529	:	Degrees of protection provided by enclosures (IP Code)
SANS 60044-8	:	Instrument transformers Part 8: Electronic current transformers
SANS 61869-2	:	Instrument transformers Part 2: Additional requirements for current transformers
SANS 61869-3	:	Instrument transformers Part 3: Additional requirements for inductive voltage transformers
IEC 62271-1		High-voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear
IEC 60255	:	Measuring relays and protection equipment

E13.2.2 Particular Specifications to be read in conjunction with this specifications

The following particular specifications shall be read in conjunction with the Project Specification:

(a) E06 : ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION

(b) E05 : LOW VOLTAGE POWER AND CONTROL CABLE

(c) E20 : BATTERY TRIPPING UNIT

(d) E08 : WIRING

E13.3 SERVICE CONDITIONS

Nominal voltage	11 kV
Rupturing capacity	20 kA
Impulse level	95 kV
Highest system voltage	12 kV
Rated short-time withstand current (Ik)	20 kA (1 S)
Frequency	50 Hz
Phases	3
Power factor	0,5 - 0,85 lagging

All switchgear and auxiliary equipment shall be designed to withstand the stresses of an unearthed system.

E13.4 EXTENT OF WORK

The successful Tenderer will be responsible for the delivery, off-loading and erection on site, testing and putting into operation of the switchgear. The Contractor shall furthermore be responsible for checking all connections made by others and for commissioning the switchgear. All paintwork damaged during transport and/or erection and/or connecting up, etc., shall be made good to the satisfaction of the Engineer.

E13.5 SWITCHGEAR LAYOUT

The switchboard shall be designed as a continuous assembly in a straight line, capable of being extended at either end.

The switchboard will be located in a totally enclosed, naturally ventilated chamber and shall be suitable for installation directly on a finished floor.

E13.6 CUBICLE CONSTRUCTION

E13.6.1 General

All cubicles shall be of the totally enclosed, floor mounted type and shall be vermin proof and where possible dustproof. The cubicles shall have a minimum enclosure rating of IP 42 to SANS 60529.

Cubicles shall be designed so that it is possible to add additional panels to existing switchboards without undue difficulty.

E13.6.2 Segregation of circuits

Each circuit in a switchboard shall be provided with an individual cubicle so arranged that accidental contact with live parts in adjacent circuit cubicles is impossible.

It shall be possible to terminate the cables of any circuit without exposure to any live conductors of the same circuit while the busbars are energized.

E13.6.3 Doors

Where doors are provided on circuit breaker switch cubicles, the doors shall be fitted with handles consisting of a push-button-and-handle combination with a spring-loaded latch or a rotary handle-and-catch combination. The closing mechanism shall be designed to draw the door closed. Flush mounted ring type handles or square key operated latches are not acceptable. Locking latches shall be padlockable.

Doors shall be suitably braced and stiffened to carry the weight of equipment installed in doors and to prevent warping.

Control panel doors shall be fitted with handle closing mechanisms as described above. Alternatively, captive knurled bolts designed to be screwed in by hand may be used.

Doors shall have stops to prevent overswing of the door when opening and to prevent interference with adjacent panels.

Doors shall be fitted with suitable rubber or synthetic rubber seals.

All doors shall be bonded to the framework by a braided copper earth strap.

E13.6.3.1 Earthing

All metal parts other than those forming part of electrical circuits shall be connected to the cubicle earth bar.

All non-current carrying conductive parts, including relays, instruments, transformer and contactor cores, etc. shall be effectively connected to the earth bar either by means of their mounting arrangements on the panel or by means of a special earthing conductor fitted with lugs for attaching to the earth bar.

E13.7 CIRCUIT BREAKERS

E13.7.1.1 General Construction

Circuit breakers may be of the trip-free, double break, SF6 or vacuum type.

Circuit breakers shall be of the horizontal draw-out truck mounted type with either vertical or horizontal isolation action.

Each circuit breaker shall be installed in a freestanding metal clad cubicle and the front of each panel shall be totally enclosed.

It shall be possible to remove the circuit breakers from the cubicles without moving the cubicle, without removing parts thereof or without disconnecting any wiring thereto.

Any circuit breaker shall be interchangeable with any other panel of the board of the same rating. It shall not be possible to insert a circuit breaker into a higher rated circuit.

Contact spouts, bushings, covers, busbar insulators, etc. shall be designed to minimise dust collection.

Mechanical stops shall be provided to ensure accurate location of the circuit breaker truck prior to racking into the service position. The breaker carriage shall be locked in position on both sides of the cubicle with a robust mechanical lock that will not distort or jam under fault conditions.

All openings, joints, etc., in the entire switchboard shall be adequately vermin proofed.

All components including screws, nuts, bolts, washers, etc. used in the construction of or fixing of components shall be rendered corrosion proof.

E13.7.1.2 Circuit breaking features

The circuit breaker contacts shall ensure rapid and consistent extinction of the arc with a minimum release of arc energy under all loading and fault conditions and a low power factor.

The arcing contacts shall be tipped or coated with an erosion resistant material, preferably a tungsten alloy.

The main contacts shall be self-aligning with a high contact pressure and a self-cleaning action.

E13.7.1.3 Busbar and circuit shutters

Protective shutters, which automatically cover the contacts of the fixed portion of the switchgear when the circuit breaker is withdrawn to the isolation position, shall be provided.

The busbar orifices shall be provided with automatic separate shutters.

Facilities shall be provided for padlocking the shutters in the closed position.

All shutters shall close automatically after being opened by hand and it shall not be possible for the shutters or shutter operating links to be jammed by the circuit breaker.

Shutters shall be painted and designated as follows:

(a) Busbar shutters
The word "BUSBAR" in black lettering on a red background.

- Circuit shutters
  The word CABLE in black lettering on a yellow background.
- Earthing shutters
  The word "EARTH" in black lettering on a green background.
- Lettering shall be a minimum of 40 mm high.

E13.7.1.4 Interlocks

The switchgear shall be mechanically interlocked in accordance with SANS 62271 and all interlocks shall be robust and shall not distort or jam in the event of an incorrect operation. The minimum safety features provided shall prevent the following actions:

(a) A closed circuit breaker from being withdrawn from or inserted into the isolating contacts. The circuit breaker shall trip if an attempt is made to do so.

(b) The closing of the circuit breaker except when it is correctly located and fully racked in the "service" or "earthing" positions or in the fully lowered position. It must, however, be possible to close the circuit breaker when it is fully withdrawn from the cubicle.

(c) The lowering of the tank of circuit breakers unless the circuit breaker is fully withdrawn and the racking-in of the circuit breaker unless the tank is securely bolted in position.

(d) The circuit breaker from being closed when the secondary circuits are not fully engaged. It shall also not be possible to remove the secondary circuit plugs unless the circuit breaker contacts are fully open.

(e) Electrical tripping of the circuit breaker when the circuit breaker is in the earthed position. Padlocking facilities shall also be provided to lock off the mechanical trip lever on the breaker mechanism.

(f) The integral earthing switch (where applicable) from closing unless the circuit breaker is in the correct earth position. It must not be possible to close the earth switch onto live busbars.

E13.7.1.5 Secondary isolating contacts

The connections in the secondary circuit between the fixed and moving portions of the equipment shall be by means of self-aligning contacts. Robust guide pins or other approved guides shall engage before the contacts.

Circuit breaker auxiliary contracts for functions common to the various panel type specified, shall be wired to secondary isolating contacts in the same relative position on all panel types specified.

The secondary isolating contacts must be so arranged that when the circuit breaker is in the lowered or racked down position the secondary isolating contacts can still be made without the addition of separate jumper equipment.

E13.7.1.6 Position stops

Immediately prior to racking in, positive stops shall be engaged to locate the circuit breaker in the correct position relative to the busbar selection guides or other approved means shall be provided to ensure accurate entry into the guides.

A positive stop shall be provided to ensure correct location without danger of "over-run" in the "racked in" position.

E13.7.1.7 Earthing

Integral earthing facilities shall be provided.

Integral earthing facilities through the circuit breaker are preferred, but separate earthing devices or earthing switches mounted on separate trucks are acceptable.

Where separate earthing devices or earthing trucks are supplied, the gear shall be suitable for use on all the circuit breakers in a switchboard and shall also be suitable for earthing either the busbar or the cables. A full set of earthing devices or earthing trucks shall be supplied for each switchboard.

Earthing equipment shall have a making capacity and a rated short-time withstand current (Ik) equal to the rest of the switchboard.

E13.7.1.8 Capacities and Fault Levels

The complete primary circuit (CB's, busbars, etc.) shall be capable of withstanding the rated short time withstand current.

The circuit breakers shall have continuous current ratings as specified in the Detail Technical Specification.

There shall be no audible corona discharge under working conditions. These requirements shall be taken to be complied with only if the audible corona extinction voltage is less than 9 kV to earth or 14 kV between phases.

Compliance may be conceded if it can be shown that any discharge below the specified levels takes place at points remote from all dielectric materials, and cannot cause their deterioration.

The switchgear shall have an assigned impulse rating of not less than 95 kV at sea level, supported by recent test certificates proving successful testing, using a standard 1/50 micro-second voltage wave, on identical units manufactured in the factory from which an order would be executed.

Circuit breaker tanks and top plates shall be capable of withstanding, without permanent distortion, a hydraulic pressure of 700kPA for 1 minute, unless a lower pressure is approved after reference to actual pressures measured during short circuit tests.

Each circuit breaker shall be clearly and indelibly marked to show the current and voltage ratings and breaking capacities.

E13.7.1.9 Closing Mechanisms

The closing mechanism shall be either of the hand charged, spring or hand operated, spring assisted or motor wound spring charging or solenoid operated types as specified in the Detail Technical Specification.

The closing action of the hand operated, spring assisted mechanisms shall ensure that once closing is initiated the action becomes independent of the operator.

All mechanisms shall be of the trip-free type and it shall not be possible for the mechanism to maintain the circuit breaker in a "closed" position during fault conditions or when the "open" signal has been initiated.

The electrical closing circuitry shall be open circuited as soon as the closing sequence has been completed to prevent continued electrical loading of the closing circuitry and to deactivate the closing signal until a new sequence is initiated.

Where auto-reclosing duties are specified, the mechanisms shall be capable of performing a "BREAK-MAKE-BREAK" operation.

All electrically operated closing devices shall be at least suitable for operation at any voltage between 80% - 120% of the nominal control voltage at the device terminal. The nominal control voltages are specified in the Detail Technical Specification.

Anti-pumping devices shall be provided on all mechanisms to prevent pumping while the closing circuit remains energised and the circuit breaker either fails to latch or trip during closing due to the operation of the protection system. The arrangement shall be to the approval of the Engineer.

E13.7.1.10 Tripping Mechanisms

A manual tripping mechanism shall be provided on each circuit breaker. It shall be clearly marked "MANUAL".

Where shunt tripping is specified DC shunt trip coils shall be provided. The rated control voltage shall be as specified in the Detail Technical Specification.

Shunt trip coils shall be suitable for operation at any voltage between 80% - 120% of the nominal voltage at the device terminals.

Secondary contacts operated by the circuit breaker mechanism shall be provided and rated to interrupt the maximum trip coil current after the circuit breaker has opened. These contacts shall close the tripping circuitry before the circuit breaker closes.

E13.7.1.11 Racking Mechanisms

The racking mechanisms for inserting or withdrawing the circuit breaker shall be designed and constructed to provide a positive action throughout the operations.

E13.7.1.12 Indicating devices

Each circuit breaker shall be equipped with mechanical indicators to indicate the switching positions and the state of the spring mechanisms (if applicable).

A mechanical indicator shall also be provided to indicate whether the circuit breaker is racked in or out.

All mechanical indicators shall be clearly visible from the front of the panel.

In all cases positive indication must be provided.

E13.7.1.13 Auxiliary Contacts

Circuit breakers shall be provided with sufficient auxiliary contacts to suit the circuits served.

Auxiliary contacts shall be positively driven in both directions and shall be readily accessible for maintenance and shall be properly adjusted where necessary.

At least two spare normally open and two spare normally closed contacts shall be provided and shall be completely wired to an accessible terminal block.

E13.8 NON-AUTOMATIC SWITCHES AND FUSED SWITCHES

E13.8.1 General

The switches shall be of the fault-making, load-breaking type with earthing and testing facilities.

The switches shall be manufactured and tested in accordance with SANS 62271.

E13.8.2 Construction

The switches shall be totally enclosed, metal-clad, air or SF6-insulated type.

The switch units shall be designed for extension with circuit breaker panels described in this specification and/or similar switch units.

Each unit shall be installed in a free standing metal clad cubicle and the front of the cubicle shall be totally enclosed.

The switch may be either of the horizontal draw-out with vertical or horizontal isolation, or non-withdrawable fixed tank types.

E13.8.3 Busbar and circuit shutters

Busbar and circuit shutters shall be provided on all withdrawable type switches as specified for circuit breakers.

E13.8.4 Interlocks

The mechanism shall be incapable of moving directly to the "EARTH" position from the "ON" position.

A time delay shall be built into the mechanism to prevent immediate opening of the switch after closure. This shall be achieved by means of non-reversible operating handles, mechanical sliding interlocking gates or a non-reversible movement.

Padlocking facilities shall be provided.

Access to the testing facilities shall only be possible with the switch in the "EARTH" position. With the testing devices fitted operation to either the "ON" or "OFF" positions shall be prevented.

Interlocks shall be provided on withdrawable type switches to prevent:

- The switch from being withdrawn from or inserted into the isolating contacts.
- The closing of the switch except when it is correctly located or fully withdrawn.
- The opening of the tank unless the switch is fully withdrawn and the racking-in of the switch unless the tank is securely fitted.

E13.8.4.1 Operating Mechanism

The switch shall have three positions, namely "ON", "OFF" and "EARTH".

Except for removing the earth, the switch actuating mechanism shall have a positive action and shall be spring assisted to ensure that once the operation is initiated, it becomes completely independent of the operator.

The fused switch shall close fully when making onto a fault to ensure full clearance of the fault by the fuses before tripping and opening the switches.

A blown fuse on any of the three phases shall open all three phases of the switch and shall inhibit the closure of the switch pending fuse replacement.

E13.8.4.2 Earthing

Integral cable earthing facilities shall be provided for non-withdrawable switch units. For withdrawable switches earthing facilities similar to that of circuit breakers shall be provided.

E13.8.4.3 Cable Test Facilities

Cable test facilities are required and must be easily accessible.

Refer to paragraph 8.4 regarding interlocking of test facilities.

In the event of a separate test unit being provided, it shall be easily fitted.

E13.8.4.4 Ratings

The fault making capacities, impulse levels and busbar ratings shall be identical to the ratings of the circuit-breakers installed in the same switchboards.

The continuous current rating of a switch shall not be less than 400 A and that of a fused switch not less than 90 A.

Each unit shall be clearly marked to show the current and voltage ratings and fault making capacity.

E13.8.4.5 Indicating Devices

Each switch shall be equipped with positive mechanical indicators to indicate the switching position and the racked mode (where applicable).

All indicators shall be visible from the front of the panel.

Potential indicator lights shall be provided to indicate the status of all three phases of the cable circuit.

E13.8.4.6 Fuses

Fuses shall comply with SANS 60282-1.

Fuse links shall be of the striker pin type, hermetically sealed and shall be suitable for use under oil.

The fuse link carriage shall be suitable to accept either 254 mm or 359 mm long fuses both with a diameter of 63,5 mm. The carriage shall be adjustable for this purpose and shall not necessitate additional parts.

Automatic shutters shall be provided to safeguard against inadvertent contact with live parts when the fuse carriage is removed.

The ratings of the fuses shall be as specified.

E13.9 BUSBARS

E13.9.1 Design and rating

Busbars shall be manufactured of solid drawn high conductivity copper with rectangular cross-section in accordance with BS 159, SANS 1195 and BS 13601, where applicable.

The busbars shall be rated for the continuous current carrying capacity specified in the Detail Technical Specification and the fault levels specified in paragraph 1.3. The busbars shall be designed to withstand mechanical and temperature stresses for normal and fault conditions taking into account correction factors for different configurations, "proximity and skin" effects, the effect of ferrous enclosures, ventilation, etc. The maximum allowable temperature of busbars carrying full load at the specified ambient temperature is 80°C. Tables 1 and 2 may be used as a guide to determine the current rating of the busbars.

Table 1 :Derating Factors for Laminated Busbars

Area of cross-section (mm)	Number of parallel busbars per phase		
	2	3	4
500	1,78	2,24	3,13
1 000	1,72	2,36	3,00
1 500	1,65	2,24	2,84
2 000	1,60	2,16	2,70
2 500	1,55	2,10	2,60
3 000	1,52	2,02	2,52
3 500	1,48	1,98	2,48
4 000	1,44	1,96	2,45

Table 2 : Current Rating of Single Copper Busbars (A)

Width (mm)	Thickness (mm)						
	2,5	3,15	4,0	6,3	10	12,5	16
12,5	155	180					
16	190	220	250				
20	230	265	300				
25	280	320	365	470			
31,5	340	385	440	560			
40	420	475	540	680	870		
50	510	575	650	820	1030	1160	
63			790	990	1240	1370	
80			970	1200	1480	1640	
100			1160	1430	1760	2180	
125				1710	2100	2310	2570
160				2070	2530	2780	3090
200						3290	3660
250						3900	4300
315						4630	5120
400							6230

In additions to current rating busbars shall comply with the following fault level rating:

A = 8,2 x I x (t)

where:

A = minimum cross section (mm)

I = prospective fault current (kA)

t = maximum time in seconds required for protection equipment to clear the fault.

(Minimum allowable value for t = 3s.)

Where a busbar consists of two or more busbars per phase (laminations), the laminations shall be separated by a minimum distance of the thickness of one lamination. The laminations shall be clamped together with copper spacers at intervals not exceeding 450 mm in order to equalize the current distribution in the laminations.

Busbars shall be able to carry the rated current along their entire length. Tapering is not permitted.

The manufacturer shall, where requested, provide design calculations of the busbar ratings.

Busbars shall be as short and straight as possible.

Busbars shall be adequately ventilated and shall be situated in separate, totally enclosed, dust free, metal enclosures.

At each end of a switchboard a removable cover shall be fitted to the busbar chamber in order to extend the switchboard in both directions in the future.

The busbar ends shall be suitably manufactured and drilled for future extensions without modifications to the existing busbars.

E13.9.1.1 Insulation and joints

All busbars and connections shall be air insulated and shall be shrouded with heat-shrinkable sleeving or shall be epoxy resin encapsulated. PVC taping, insulating compound or oil immersion is not acceptable. The colours shall correspond to the colour of the supply phase:

Red, Yellow or White	Phases
Blue or Black	Neutral

Busbar joints and tees shall be encased in a non-hardening compound and taped with PVC tape unless suitable shrouds are provided.

The complete primary system shall withstand the full power frequency test voltage specified by SANS 62271 and the insulations level of all busbars and connections shall be in accordance with the values specified in paragraph 8.3.

Where connections between busbars and any other part of the switchgear consist of bare copper conductors, and no other insulation except air exists between phases or phases and earth, the clearance distances and insulator lengths shall be in accordance with SANS 62271 with correction for altitude as required.

E13.9.1.2 Earth busbar

An earth busbar shall be installed in a convenient position along the entire length of the switchboard. The cross-sectional area of earth busbars shall be calculated in accordance with the following formula in IEC 439 with a minimum cross-section of 6,3 x 20 mm:

$$S = \frac{Ix(t)^{½}}{X(dT)^{½}}$$

where

S = cross-section (mm)

I = the r.m.s. value of the current (A)

X = 13 for Copper

t = operating time of protective equipment (s)

(Minimum value for t = 3 s)

dT = temperature rise (°C)

= 120°C for insulated conductors

= 180°C for uninsulated conductors

If t is between 2 s and 5 s then dT may be increased in the same formula

to:

dT = 145°C for insulated conductors

= 215°C for uninsulated conductors

In addition the longer side of the earth bar shall be at least twice the diameter of the largest bolt that will be fitted to the busbar.

E13.10 SECONDARY CIRCUITRY

E13.10.1 Cabling

Gland plates, suitably drilled to accept the glands for all the external power, control protection and DC supply cables, shall be provided.

The internal wiring to be connected to the cabling mentioned above shall be terminated on numbered terminal strips in close proximity to the gland plate in order that the cable cores can be connected directly to the opposite sides of the terminal strips.

E13.10.1.1 Wiring

All wiring shall present a neat appearance and shall be suitably braced, placed in wiring channels or clipped and/or laced.

Connections to equipment mounted on doors shall be arranged to give a twisting motion and not a bending motion to the conductors.

All panel and equipment terminals, labels, etc. shall be completely accessible after the wiring and cabling has been completed.

Conductors shall be identified at both ends by means of durable closed ring interlocking cable marking ferrules. PVC or other tape is not acceptable. The numbers on the markers shall also be shown on the wiring diagrams.

Where conductors are terminated on equipment terminals that do not require the use of lugs, the identification ferrules shall be fixed so that they do not fall off when disconnecting a conductor.

Identification ferrules shall read from the terminal along the wire.

All wiring terminating on meters, fuse holders and other equipment with screwed terminals, shall be fitted with lugs. The lugs shall be soldered or crimped to the end of the conductor.

Secondary wiring shall generally consist of insulated stranded copper conductors with a minimum cross-sectional area of 2,5 mm^2. Solid core conductors are not acceptable. Flexible cords not smaller than 1,0 mm□ shall be installed between equipment mounted on doors and the rest of the switchboard. For voltage ratings in excess of 50 V the wiring insulation shall withstand a test voltage of 2 kV to earth for one minute. For voltages of 50 V or less the insulation shall withstand 500 V to earth for one minute.

All wiring between different panels within the same switchboard shall be installed in wiring channels. Grommets shall be installed in each hole in the metalwork through which conductors pass. Wiring shall also be kept away from exposed metal edges or shall be protected where they cross metal edges. All wiring shall be installed away from terminals, clamps or other current carrying parts.

Conductors may be jointed at equipment terminals or numbered terminal strips only.

To minimize the effect of electrolysis, DC circuits shall be so arranged that the isolating or N/O operation contacts are connected to the positive pole of the battery.

E13.10.1.2 Secondary terminals

All external wiring and connections to auxiliary contacts, all alarm, protection, intertripping, DC supply circuits, etc. shall terminate on numbered terminal strips. All numbers shall appear on the switchboard drawings.

Terminals of the type where clamping screws are in direct contact with the conductor are not acceptable.

Where stud type terminals are provided they shall have a minimum size of 0 B.A.

Approximately 10% with a minimum of 2 spare terminals shall be provided on each terminal strip.

Terminal and test blocks of a reputable manufacturer, complying with the requirements of SANS 60947-7-1 shall be provided in each panel for the secondary wiring of the current transformers.

E13.11 CURRENT TRANSFORMERS

E13.11.1 General

Current transformers shall comply with the requirements of SANS 60044-8 with the exception of the required impulse test level, refer to paragraph E13.11.6 below.

E13.11.2 Ratings

Current transformers shall be suitable for the primary currents and secondary ratings as specified in the detail specification.

Current transformers shall have secondary outputs of 2.5, 5, 10, 15 or 30 VA as applicable in terms of the burden of the instruments and interconnecting wiring. The current transformer output shall match the actual instrument burden as closely as possible in order not to introduce unnecessary errors.

E13.11.2.1 Accuracy Class

For metering applications, accuracy classes of 0.1, 0.2, 0.5, 1, 3 or 5 are applicable. Where no accuracy class has been specified, the following table may be used as a guide:

Application	Primary current	Suggested class
Indicating instruments	All	5
Metering applications	Up to 200 A	2
Metering applications	250 to 600 A	0,5
Metering applications	800 A and above	0,2

Where ring type current transformers are specified, the aperture shall not be unnecessarily large as accuracy is thereby reduced.

The classes for protection are 5P, 10P, 15P, 20P or 30P with 5P and 10P being standard. Turns compensation shall be employed on protection current transformers for ratios greater than 30/1.

Class X current transformers shall be used in differential protection systems.

Manufacturers shall supply the magnetization curve details and saturation factors for each different transformer ratio.

E13.11.2.2 Markings

All current transformers shall come complete with a label on which the following information is indelibly stamped:

- Manufacturer
- Serial No. or Type
- Rated primary and secondary current
- Rated frequency
- Rated output and accuracy class
- Highest system voltage
- Rated insulation level

A duplicate of this label must be attached in a position which is clearly visible on the inside of the protection panel. The specific connections for both the high and low ratio's of a dual-ratio CT, must be clearly labelled at a visible position in the protection panel.

E13.11.2.3 Fault Current

Current transformers shall be capable of withstanding the dynamic forces resulting from the maximum through-fault current which may be encountered at the point where they are installed. The short time current rating of current transformers shall be at least equal to that of the associated circuit-breaker.

E13.11.2.4 Impulse Level

Current transformers used in system voltages in excess of 660 V shall withstand an impulse test level of 95 kV.

E13.11.2.5 Tests

One protection current transformer of each type used in a contract shall be tested to confirm the estimated characteristics. The following results shall be submitted:

(a) Magnetization curve

(b) Secondary resistance

(c) Secondary leakage reactance, if not negligible or if required by the Engineer.

The power frequency, secondary to earth and overvoltage interturn tests in accordance with BS 3938 shall be conducted on all current transformers. Impulse tests shall be conducted on all current transformers intended for use in system voltages in excess of 660 V.

E13.12 VOLTAGE TRANSFORMERS

E13.12.1 General

Voltage transformers shall comply with SANS 61869-1 and 3 where applicable.

The voltage transformers are of the epoxy resin insulated type and are used to supply measurement and protection devices. VT's can be installed as a fixed assembly or installed on removable and withdrawable trucks. Fixed voltage transformers can be installed directly on the main busbar system in a dedicated VT compartment. Withdrawable trucks must allow replacement of the fuses with the switchgear in service. The withdrawable truck arrangement must be fitted with automatic shutters between the live parts of the switchgear and the instrument compartment. The VT can have one pole (L-N) with a secondary voltage of 110/√3 (63.5V) or two poles (L-L) in which case the secondary voltage shall be 110 V unless specified to the contrary.

E13.12.1.1 Voltage Transformer Protection

The primary side of all voltage transformers shall be connected to the circuit through high voltage HRC fuses. Fixed VT installations will have external MV fuses and withdrawable VT installations will have internal MV fuses.

Secondary HRC fuses or protective circuit breakers shall be provided on the output terminals, located in the LV compartment.

E13.12.1.2 Voltage Transformer Ratings and Tests

The voltage transformers shall have an output suitable for the connected load but at least 200 VA per phase at class B accuracy.

The voltage ratios shall be suitable for the primary busbar and the required output voltages.

Voltage transformers shall be tested in accordance with BS 3941 and shall withstand an impulse level of 95 kV.

E13.13 CURRENT AND VOLTAGE SENSORS

Current and voltage sensors shall comply with SANS 61869.

(a) IEC 61869-10: Instrument transformers - Part 10: Additional requirements for low-power passive current transformers

(b) IEC 61869-11: Additional requirements for low power passive voltage transformers

Current and voltage sensors are designed without the use of a ferromagnetic core. The current sensor is based on the principle of Rogowski coil. Voltage sensor uses the principle of resistive voltage divider. The main benefit is that the behaviour of the sensor is not influenced by magnetizing curve that results in a highly accurate and linear response across a wide dynamic range of measured quantities. The linear and highly accurate characteristic curve of the sensor across its full operating range enables several metering and protection classes to be combined in one particular winding.

E13.14 PROTECTION RELAYS

Protection relays shall comply with IEC 60255: Measuring relays and protection equipment.

Digital protection relays which use a microprocessor to analyse power system voltages, currents or other electrical quantities for the purpose of detection of faults in an electric power system will be supplied. The characteristics and behaviour of the protection relay must be programmed to requirements. The protection relay must offer multifunctional protection (overcurrent and earth-fault as a minimum).

The protection relay should offer the following features:

(a) Self-checking facility;

(b) Local HMI display with basic system parameters shown;

(c) Low burden on current and voltage sensors;

(d) Communication port for the connection to a LAN;

(e) Adaptive relaying schemes which can vary its setting parameters in response to changes in the power system;

(f) Storage of historical data with time stamping;

(g) Simple and easily maintainable.

E13.15 INSTRUMENTS

E13.15.1 General Requirements

Instruments shall be suitably rated for the supply voltage and frequency to be applied, which shall be 400/230 V, 50 Hz unless specified to the contrary.

All the instruments used for a particular application or a specific project shall be from the range of a single reputable supplier and shall have the same face dimensions. The face dimensions shall be square and not less than 96 x 96 mm.

All instruments shall comply with IEC 60051-1.

Instruments shall be screened against magnetic interference and shall have anti-static against magnetic interference and shall have anti-static, impact-resistant faces.

Preference will be given to locally manufactured instruments.

Instruments shall be insulated to achieve a 2 kV insulation resistance to earth.

All instruments shall be splash proof and dustproof unless more stringent requirements are specified for hazardous locations.

Instruments shall be sufficiently resistant to vibration that may be encountered in the specific application.

For normal environmental and supply conditions, instruments shall be suitable for use inside the limits specified in IEC 60051-1.

All instruments shall be capable of withstanding overloads of continuous or short duration in accordance with IEC 60051-1.

Instruments shall be provided with studs for rear connection. Shrouds shall be provided to prevent accidental contact where instruments are to be installed in hinged panels of switchboards.

E13.15.1.1 Voltmeters and Voltmeter Selector Switches

Voltmeters shall be of the moving iron type with class 1,5 accuracy as specified in IEC 60051-1.

A zero adjustment screw shall be provided.

Unless specified to the contrary, a single voltmeter and selector switch shall be provided. The voltmeter switch shall have an "OFF" and three metering positions to indicate readings between neutral and each of the three phases.

The markings shall be indicated clearly on the face plate of the selector switch and the handle position shall be accurate in relation to the markings on the face plate.

The selector switch shall be of the cam-actuated or wiping air break type with two breaks per pole.

E13.15.1.2 Ammeters

Ammeters shall have a moving iron element to indicate instantaneous values.

Current transformer operated ammeters shall be 5 A full scale, calibrated to read actual primary circuit currents. The current transformer ratio shall be indicated on the faceplate.

A zero adjustment screw shall be provided.

Where combined maximum demand and indicating ammeters are specified, a bimetallic spiral element shall be provided in the same housing to indicate mean value over a 15 minute period.

The bimetal element shall drive a residual pointer to indicate maximum mean current between resetting. This pointer shall operate on the main scale and shall be of a distinctive colour. The pointer shall be resettable from the face of the meter.

The bimetal element shall be designed to compensate for limits of ambient temperature between -20°C and 70°C.

Full load or rated current shall be clearly indicated, preferably with a red line. Unless specified to the contrary, a 100% condensed over scale shall be provided for instantaneous reading instruments and no over scale for combined maximum-demand ammeters.

The intrinsic error, expressed in terms of the fiducial value in accordance with IEC 60051-1, shall be class 1,5 for the instantaneous readings and class 2,5 for the mean maximal.

Where saturation current transformers are required, these shall form an integral part of the meter. Separate saturation current transformers are unacceptable.

E13.16 AUXILIARY EQUIPMENT

E13.16.1 Control Switches

Circuit-breaker closing and tripping control switches shall close the associated circuit breaker when rotated clockwise.

Control switches may be fitted with one pair of lazy contacts, i.e. contacts which make when the control switch is turned to the closed position, remain closed when the handle returns to the neutral position and only open when the control switch is moved to the trip position.

The switches shall be provided with a suitable faceplate indicating the angle of throw and the switching positions.

The switches shall be suitable for the supply voltage and the contacts shall be silver-plated or gold laminated and shall be suitably rated for the switching functions intended.

Control switches shall be lockable in the "NEUTRAL" or "OFF" position.

E13.16.2 Fuses

All fuses for the protection of auxiliary circuits shall be of the high rupturing capacity cartridge type and shall be mounted on insulated draw-out carriers which shall hold the fuses positively after withdrawal.

The top terminal shall be the live terminal in all cases.

HRC fuses shall be provided in the positive leads of all DC circuits.

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

Labels shall be fitted adjacent to fuses stating their use, rating and duty.

E13.16.3 Indicator Lamps

The following indications shall be provided:

Function .... Colour

Circuit-breaker closed .... Red

Circuit-breaker open ....Green

Incoming supply available (on incoming panel only) .... White

Auto-trip.. Amber

Trip circuit healthy .... White

A lamp test pushbutton for all the indicating lights shall be provided on each switchboard.

The "trip circuit healthy" indication shall normally be off and a pushbutton shall be provided to indicate the status. The purpose of the indication is to ensure that the tripping voltage supply is available on the panel before the circuit-breaker is closed. An indicator light with pushbutton is required on each panel and one indication per switchboard is not sufficient. The circuitry shall be arranged to provide indication with the circuit breaker in both the "OPEN" and "CLOSED" positions.

The conditions indicated shall be designated below each light.

E13.16.4 Voltage Indicator System

All switchgear will be fitted with a capacitive divider voltage indicator system (VDS) connected to the cable side of the switchgear. All systems supplied will permit phase comparison (with specialised measuring Units) All VDS's will comply with IEC 61243-5.

E13.16.5 Instrument Test Blocks

For the purpose of connecting external test equipment or instruments in the secondary circuits of the current transformer or potential circuits, these circuits shall be wired via an approved test block mounted on each panel.

The test blocks shall be fitted with terminal strips and links for performing the various short circuiting and bridging functions.

E13.16.6 Labels

Labels shall be made of durable material to approval. Metal labels where used shall be engraved or etched. Labels made of trifoliate or other similar materials shall have engraved lettering. Self-adhesive printed tape labels shall not be used. All labels shall be fixed mechanically.

E13.17 CABLE END BOXES

Cable end boxes to accept the cables specified for each panel shall be provided.

The boxes shall be of the metal clad type suitable for indoor use. These shall be equipped with armour clamps and brass or gunmetal conical wiping glands for lead covered steel tape or galvanized steel wire armoured, paper-insulated cables or XLPE galvanized steel wire armoured cables (as specified in the Detail Technical Specifications).

The cable boxes shall be fitted with insulating pieces to allow for the possible future installation of frame leakage busbar zone protection when specified in the Detail Technical Specifications.

Cable boxes shall be so designed that cable terminal connections can be made below compound level.

E13.18 FINISH

The switchboards 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.

E13.19 LABELS

Care shall be taken to ensure that all equipment is fully labelled.

Panel designation labels shall appear on the front and back of each panel and on the circuit breaker truck.

Engraved sandwiched interchangeable plastic or ivory strips shall be used throughout. The strips shall bear white lettering on a black background.

Labels shall be secured by means of brass bolts, nuts and washers. Where this is not practicable cadmium-plated self-tapping screws may be used. The gluing of labels will not be acceptable. Sufficient fixing screws shall be provided to prevent labels from warping.

E13.20 BATTERY TRIPPING UNIT

Please refer to specification E24: Electrical battery Tripping Unit

A battery tripping unit, suitable for connection to a 230 V, 50 Hz, single-phase ac supply shall be provided with each switchboard. The charger shall be metal-clad and shall be suitable for charging a Ni-Cad battery with voltage and capacity as specified in the detail specification. The charger shall be such that the change-over from trickle to boost charge is automatic. The tripping unit shall be supplied complete with fuses on the ac supply side and on the outgoing dc. side of the charger, an ammeter to indicate the charging current, a voltmeter with spring-loaded push buttons to indicate battery voltage and a circuit to test the state of battery charge.

E13.21 TESTS

All component parts of the equipment shall be subject to type tests and routine tests in accordance with the relevant SANS, BSI or IEC standard specifications.

Circuit breakers shall be subjected to the following tests in accordance with IEC 62271-1, adjusted for atmospheric correction:

(a) Type Tests

- Mechanical endurance
- Temperature rise
- Dielectric strength and impulse voltage
- Making and breaking capacity and short time current

(b) Routine tests

- Power, frequency, voltage
- Resistance of the main circuit
- Mechanical operation.

E13.21.1 <u>On site tests</u>

The equipment shall be tested on site after erection and prior to commissioning.

The following minimum tests shall be performed:

(a) Pressure tests on the primary and secondary circuits in accordance with IEC 62271-1.

(b) Insulation resistance tests.

(c) Primary injection tests.

(d) Earth continuity and earth resistance tests.

(e) Operating tests.

(f) Any other tests which may be required to ascertain the correct functioning of the equipment.

The contractor is to provide a schedule of tests to be done on site prior to commencement of manufacture for approval by the engineer. This schedule must be ticked off prior to commissioning.

After putting the panel to service for a minimum 1 week, a thermal image must be scanned and analysed for any hot spots. The image should be presented as part of the Operations and Maintenance manual.

E13.21.2 Test Certificates

Copies of type test certificates shall be submitted together with the tender.

Copies of test certificates of all other tests i.e. routine tests and on site tests shall be forwarded to the Engineer on completion of the tests.

E13.21.3 Test Performance and Inspection

The Engineer shall be notified in writing at least two weeks in advance of any tests to be conducted to allow its representative to be present at such tests.

The Engineer shall also be notified timeously of the completion of the equipment in order that an inspection may be carried out prior to delivery.

E13.22 TOOLS AND AUXILIARY EQUIPMENT

The following equipment shall be provided with each switchboard and the cost shall be included in the tender price:

(a) One raising and lowering handle for every three circuit breakers.

(b) One complete set of special maintenance tools for all sizes of circuit breakers.

(c) A full set of earthing devices or earthing trucks.

(d) One wall mounted steel box for the storage of the above loose equipment. The door shall be padlockable.

(e) At least six spare HRC fuses of each rating for secondary circuits and three high voltage HRC fuses for the voltage transformer.

(f) One cable test unit for each size circuit breaker or oil switch housed in a wall-mountable metal box.

E13.23 TECHNICAL INFORMATION

Tenderers shall submit descriptive literature of the equipment with their tenders.

Three copies of erection, operating and maintenance instruction manuals covering each type of equipment shall be provided with each switchboard.

E13.24 DRAWINGS AND DIAGRAMS

E13.24.1 Drawings for Approval

A set of three prints of the following drawings shall be submitted to the Engineer for approval.

- General arrangement drawings
- Detailed dimensional drawings
- Schematic diagrams
- Wiring diagrams
- Foundation drawings.

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

E13.24.2 Final drawings

On completion, a complete set of final transparent drawings shall be delivered to the Engineer. These drawings shall include the following:

(a) An accurate "as built" wiring diagram of the complete installation showing circuit numbers, terminal strip numbers, conductor colours and numbers, etc.

(b) A schematic diagram clearly showing the functions of all equipment.

(c) An equipment schedule showing the make, model and characteristics of all components used, including a recommended spare list.

(d) Fully dimensioned "as built" physical layout of the panel.

E13.25 COMPLETION

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

E13.26 MEASUREMENT AND PAYMENT

Item	**Unit**
Supply medium voltage switch or fused switch panels	No

The unit of measurement shall be the number of panels supplied.

The rate shall include full compensation for the supply and delivery of switch panel complete with busbars, cable boxes and potential indicators as specified. Separate items will be scheduled for switch and fused switch panels.

Item	**Unit**
Install medium voltage switch or fused switch panels	No

The unit of measurement shall be the number of panels installed.

The rate shall include full compensation for the installing, testing and commissioning of switch panels by the manufacturers of the equipment complete with the connecting of the busbars, secondary wiring and all the material required to complete the installation. Separate items will be scheduled for switch and fused switch panels.

Item	**Unit**
Supply medium-voltage circuit breaker panel	No

The unit of measurement shall be the number of panels supplied.

The tendered rate shall include full compensation for the manufacture, supply and delivery of the circuit breaker panel complete with busbars, relays, switches and other equipment as specified in the Detail Specification, to site.

Item	**Unit**
Install medium-voltage circuit breaker panel	No

The unit of measurement shall be the number of panels installed.

The tendered rate shall include full compensation for the installing, testing and commissioning of the circuit breaker panel complete with the connecting busbars, secondary wiring and other material required.

Item	**Unit**
Supply battery tripping unit	No

The unit of measurement shall be the number of units supplied.

The tendered rate shall include full compensation for the supply and delivery of the battery tripping unit complete as specified in the detailed specification.

Item	**Unit**
Install battery tripping unit	No

The unit of measurement shall be the number of units installed.

The tendered rate shall include full compensation for the installing of the battery tripping unit and shall include the cable for the DC connection between the battery tripping unit and the switchboard as well as the cable from the mains outlet to the battery tripping unit.

<u>Item</u> **<u>Unit</u>**

Supply and install voltage transformer.. No

The unit of measurement shall be the number of transformers supplied and installed.

The tendered rate shall include full compensation for the supply and installing of the voltage transformer where the voltage transformer is specified separately.

<u>Item</u> **<u>Unit</u>**

Remove existing MV circuit breakers... No

The unit of measurement shall be the number of MV circuit breakers removed.

The tendered rate shall include full compensation for the removal of the busbars to which the switchgear are connected, as well as the delivery of the equipment to a location not further than 5km from the original location. The rate shall furthermore provide for the disconnecting of all the MV and LV cable terminations from the switchgear.

<u>Item</u> **<u>Unit</u>**

Remove existing MV switches .... No

The unit of measurement shall be the number of MV switches removed.

The tendered rate shall include full compensation for the removal of the busbars to which the switchgear are connected, as well as the delivery of the equipment to a location not further than 5km from the original location. The rate shall furthermore provide for the disconnecting of all the MV and LV cable terminations from the switchgear.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
E15 : ELECTRICAL TRANSFORMERS

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Prepared	Senior Electrical Engineer	B Pieterse	August 2019	
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PARTICULAR SPECIFICATION: VOLUME E15: ELECTRICAL TRANSFORMERS

CONTENTS

E15.1 SCOPE

This section covers the design, manufacture, supply and delivery and assembling on site of oil filled distribution transformers.

E15.2 STATUTORY DOCUMENTS AND STANDARDS

E15.2.1 Standards

The transformers offered in terms of this specification shall comply with the requirements as set out in the detailed specification as well as the relevant sections of SANS 780:2004.

The units offered will have the SANS mark of approval.

Any deviation from these conditions will be clearly indicated, and any equipment so offered will only be used with the express permission/concession, in writing, of the Engineer.

The equipment offered and work performed, shall comply with the requirements of the governing occupational Health and Safety act, at time of tender.

Transformer shall be produced in a factory with a SANS ISO 9001 accredited quality system.

a)	SANS 780	:	Distribution transformers
b)	SANS 60078	:	Power transformers
c)	SANS 555	:	Fluids for electro-technical applications
d)	SANS 60529	:	Degrees of Protection Provided by Enclosures (IP Code)
e)	SANS 12944	:	Paints and varnishes - Corrosion protection of steel structures by protective paint systems
f)	SANS 10064	:	The preparation of steel surfaces for coating
g)	SANS 121	:	Hot dip galvanized coatings on fabricated iron and steel articles
h)	SANS 1091	:	National colour standard
i)	SANS 61958	:	Indicating devices
j)	SANS 10142-2		The wiring of premises Part 2: Medium-voltage installations above 1 kV a.c. not exceeding 22 kV a.c. and up to and including 3 MVA installed capacity

E15.2.2 Particular Specifications to be read in conjunction with this specification

The following particular specifications shall be read in conjunction with the Project Specification:

a)	E06	:	ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION
b)	E05	:	LOW VOLTAGE POWER AND CONTROL CABLES
c)	E08	:	WIRING
d)	E11	:	GENERAL EARTHING AND LIGHTNING PROTECTION
e)	E26		ELECTRICAL SPECIFICATION FOR COLOUR CODES

E15.3 ENVIRONMENTAL CONDITIONS

The transformers shall be suitable for use at full continuous rating, in terms of Paragraph 1.3 of the latest issue of SANS 780.

E15.4 CONSTRUCTION REQUIREMENTS

In addition to the requirements of SANS 780, the following will also be considered:

E15.4.1 General

The transformer vector symbol shall be Dyn11 (step down transformer) of YNd11 (step-up transformers) as per SANS 780 unless otherwise specified in the detailed specification.

Total and component losses shall not exceed 10% of the loss figures as indicated in the tender.

The nominal voltages (primary and secondary) will be as specified in the detailed specification/data sheet.

Transformers will have a removable top lid for maintenance and repair purposes. The lid must be fixed with bolts and nuts, sized to contain integrity of the transformer tank under all circumstances.

All openings on the transformer tank must be sealed with cork gaskets.

The minimum transformer rating will be 500kVA.

The maximum transformer rating will be 1600kVA.

Transformers offered will be painted and finished in accordance with SANS 780.

E15.4.2 Indoor Transformers

Transformers supplied will be free breathing in accordance with SANS 780.

(a) The contractor will specify the required room size to accommodate the transformer with sufficient free space for maintenance purposes.

(b) The doors to the transformer room should be sized to allow the installation/removal of the transformer without dismantling the unit.

(c) A bund wall must be erected around all oil-filled transformers. The bund area must be sized to hold 1.5 times the transformer oil. The bund wall must be sealed to contain the oil, no seepage into cable trenches or surrounding areas will be allowed. The bund area must be supplied with a 50mm stop valve to allow drainage of spilled oil. The stop valve must be kept in the closed position at all times.

(d) An approved firewall must be erected between the transformer and all adjacent equipment/areas to prevent the spreading of smoke and fire. The firewall should have a fire rating of at least 1 hour.

E15.4.3 Cooling Method

The cooling method used shall be the method represented by the symbol group ONAN in accordance with SANS 780.

E15.5 TRANSFORMER OIL

The transformers will be provided and delivered filled with the required quantity of insulating oil. Should the transformer be delivered with the conservator tank separate from the transformer (dismantled), the supplier will be responsible for assembling the transformer on site and filling it with oil. The oil shall be filtered and tested for break down voltage (BDV) and moisture content before filling. The oil shall be filled under vacuum. All oil shall be new and the use of recycled oil is not acceptable. The oil shall comply with SANS 555.

E15.6 TRANSFORMER LOSSES

Low loss transformers are required for this tender. Accordingly, the Engineer shall retain the right to either not accept the transformers offered or to call for changes to be made to the transformers before acceptance,

Should in the Engineer’s opinion, either the no-load losses or the full-load losses of the transformers supplied by the successful tenderer exceed the loss figures specified in the tender, by a quantity exceeding the permissible tolerances in accordance with SANS 780. Any such changes, called for by the Engineer, will be for the account of the tenderer.

Where any transformer is accepted with reduced performance figures and where tolerances exceed the provisions of paragraph 4.9 of SANS 780, the tender price will be adjusted and reduced by a sum equal to the capitalized value of the excess losses, calculated in accordance with the following capitalization formula:

K = 1,46 V + 2,86 N

Where

K = capitalized value of the losses in South African Rand (ZAR)

V = full - load losses at normal voltage and frequency, in watts

N = No - load losses at normal voltage and frequency, in watts

In view of adjusting the tender price, the said excess losses shall be taken as the quantity by which the actual losses exceed the loss figure in the tender document, without taking into consideration the permissible tolerances in accordance with SANS 780.

The no - load and full – load losses will be taken into consideration independently when calculating the adjustment of the tender price. Low full-load losses will not be able to compensate for high no-load losses, or vice versa.

Neither will the tender price be increased, should the actual no-load losses and/or full load losses be less than the losses tendered.

The above formula with V and N will be used in adjudicating the tender.

E15.7 WINDINGS

HV and LV windings shall be wound from aluminium conductor. All internal busbars must be aluminium. The core/coil assembly shall be securely held in position to avoid any movement under short circuit conditions.

E15.8 TAP CHANGER SWITCH

A off-load tap changer switch shall be installed. The switch shall have 5 tap positions, i.e. - 5%, - 2.5%, Normal, + 2.5%, + 5%.

Tap changing shall be carried out by means of an externally operated self-position switch. Provision shall be made for locking the taping switch handle in position. The tap setting shall be clearly visible in each step. The displayed tap numbers shall be referenced on the diagram plate.

E15.9 FIXTURES

E15.9.1 <u>Conservator Tank</u>

A conservator tank shall be provided on the transformer tank as per SANS 780.

E15.9.2 <u>Cable Box MV side</u>

The transformer shall be fitted with a suitable cable box on the MV side to terminate one 11kV/ 3 core copper conductor cable up to 240 sq. mm The cable box must prevent the ingress of moisture into the box (IP54). The cable box shall be of the split type with machined faces and must be fitted with a quality gasket. It must be fitted with a separate split type gland with an earthing clamp (bottom cable entry unless otherwise specified in the detailed specification/datasheet). The bushings of the cable box shall be fitted with nuts and stem to take the cable cores without bending them. The stem shall be of copper with copper nuts. The cross section of the terminal rods shall be adequate for carrying the rated currents and shall have a diameter of not less than 12 mm. Cable support clamp should be provided to avoid tension due to cable weight. Phase windings shall be marked in both the terminal boards inside the tank and on the outside with capital letter 1U, 1V, 1W

E15.9.3 <u>Cable Box LV Side</u>

The transformer shall be fitted with a suitable LV cable box having non-magnetic material gland plate with appropriate sized single compression glands on LV side to terminate (bottom cable entry unless otherwise specified in the detailed specification/datasheet) 1 kV/single core XLPE unarmoured cable (size as per detail requirement). Bushings shall be marked by small letter 2u, 2v, 2w. The neutral point terminal shall be indicated by the letter 2n. Neutral terminal is to be brought out and terminated to the tank earthing point.

E15.9.4 Jacking Pads and Lifting Lugs

Sufficient jacking pads shall be fitted to jack the oil-filled transformer into position. The tank plate and the lifting lugs shall be of such strength that the complete transformer filled with oil may be lifted without the use of a sling spreader bar. A lifting procedure must be supplied.

E15.9.5 Wheels

Transformers must stand on skids. No wheels will be allowed. Where wheels are required to position the transformers, the wheels must be removed after positioning.

E15.10 AUXILIARY EQUIPMENT

The required auxiliary equipment to be included are specified in the detailed specification.

E15.10.1 Oil Level Gauges

Oil level gauges shall be flush mounted with the gauge glass (of plastic material) securely attached to the tank throughout its length by means of a metal shroud. The oil in the gauge will not be in contact with the air outside the tank.

E15.10.2 Air Breather

Silica gel air breathers shall have a window for inspection of the condition of the silica gel and oil cup or other device to prevent continuous contact of the silica gel with the air outside the transformer.

E15.10.3 Buchholz Relays

Buchholz relays shall be of the double float or bucket type and shall be of approved manufacture.

The gas release cock for the relay shall be placed within easy reach from ground level and connected to the relay by small-bore non-ferrous tubing. The sight window of the relay will be clearly visible from ground level.

The Buchholz relays will be equipped with a set of alarm and trip contacts.

E15.10.4 Dual-type Thermometers

Dual-type thermometers will be graduated in °C for registering “top oil” temperatures. The instrument will be provided with resettable maximum-temperature indicator and a pair of adjustable alarm contacts that can be set to close at a predetermined temperature. An additional set of adjustable contacts will be provided for tripping purposes. All thermistors or other temperature sensors will be installed in oil pockets. Unused thermometer pockets will be fitted with a captive screw cap.

E15.10.5 Pressure Relief Device

A pressure relief device is not required.

E15.10.6 Oil Filling Point

A point must be provided to fill the oil level up. The point must be of the screw type and be sealed to prevent air intake when not in use.

E15.10.7 Oil Drain Point

A drain point must be provided to drain the oil from the transformer tank. A shut-off valve must be installed at the drain point. The drain point must be sealed with a screw type cover when not in use.

E15.10.8 Alarm and Trip Contacts

All alarm contact will be capable of breaking up to 20W DC, inductive, at the specified alarm and tripping voltages.

All contacts will be capable of making and carrying for 0.5 sec, a current corresponding to 150 watts at the specified alarm and tripping voltage.

All auxiliary relays associated with tripping shall be DC operated and suitable for the specified alarm and tripping currents.

Alarm and tripping contacts will be provided with un-grounded and electrically independent circuits.

E15.11 PAINTING

The interior and exterior surfaces of a tank, the tank cover and the conservator tank shall be abrasive blast-cleaned or pickled, rinsed and dried (SANS 10064).

(e) Corrosion protection

A corrosion preventative layer will be applied to the interior surfaces of the transformer. The transformer and cooling radiators will be painted as specified in SANS 780 and SANS 12944.

(f) Final Coat Colour

The colour of the final paint coat is C12 Avocado Green (6022-G91Y) according to SANS 1091 unless specified otherwise in the detailed specification.

(g) Damaged Paintwork

Any damage occurring to any part of a painting scheme shall be made good to the same standard of corrosion protection and appearance as that was originally applied.

E15.12 TESTS REQUIREMENTS

Routine factory acceptance tests (FAT) in accordance with SANS 780 shall be performed at the supplier's facility prior to delivery. Type tests and special tests to SANS 780 shall be performed on one transformer of the size to be delivered in terms of this contract unless the manufacturer can provide certificates of previous tests done on identical transformers. The following routine tests will be carried out on the transformer as a minimum (The tests are described in SANS 780) The Engineer reserves the right to witness the FAT tests.

(a) Measurement of winding resistance

(b) Insulation resistance measurement

(c) Measurement of voltage ratio

(d) Impedance test

(e) Vector group test

(f) Measurement of transformer losses

(g) Induced over voltage test

(h) Separate source voltage withstand test

(i) Tank effectiveness of sealing

The results of these tests will be made available to the Engineer for his evaluation prior to acceptance and delivery of the transformers. Two copies of test results will be provided to the Engineer.

The contractor must arrange for site acceptance tests (SAT) on all transformers. A schedule of all tests to be done must be provided by the contractor for approval prior to commencement of manufacture. The SAT must be witnessed by the Engineer or the client's representative. The results of the SAT will be recorded and issued to the Engineer.

The contractor shall arrange for thermal imaging of the transformer a minimum of 1 week after commissioning and while the transformer is in continuous use. The results of the imaging and

SAT are to form part of the deliverable Operations and Maintenance Manuals.

E15.13 DRAWINGS

Tenderers shall furnish the following drawings together with their tenders:

(a) Outline drawings of the transformers, showing:

i. All external fittings;

ii. Typical mass of the transformer with and without oil;

iii. Typical volume of transformer oil;

iv. The most important external dimensions.

(b) Details of MV and LV bushings

The successful tenderer will provide three copies of each of the following drawings, to the Engineer, before manufacturing may commence:

(a) General Arrangement drawings indicating

i. External fittings;

ii. Lifting lugs and lifting requirements;

iii. The mass of the transformer with and without oil;

iv. The volume of the transformer oil;

v. Transformer dimensions with free space required;

vi. The transformer rating plate (to SANS 780);

(b) The internal construction of the transformer and the arrangement of the windings, giving full particulars of insulation, as well as the bracing of the cores and windings;

(c) A diagram of the connections showing the exact manner in which the leads are taken from the tank, as well as the number of windings;

(d) Schematic drawings of the alarm and trip circuits.

E15.14 SOUND LEVEL

During design and manufacture of transformers, care should be exercised to limit transformer noise and vibration to within the parameters as recommended in SANS 780.

E15.15 IDENTIFICATION TAGS

All data on the identification tags shall be in SI units.

E15.16 TESTING AND COMMISSIONING

During testing and commissioning, the contractor shall:

(a) Perform an transformer oil test prior to livening of the transformer;

(b) Perform a visual inspection to ensure that the installation complies to the requirements specified herein as well as in detailed specifications;

(c) Ensure the rating of all equipment is as specified;

(d) Test the function of all alarm and trip signals to ensure the transformer circuit breaker trips as required;

(e) Do a transformer insulation resistance test (as described in SANS 780).

(f) When the transformer is on load, the correct tap changer setting must be determined. Tap setting changes can only be done off-load.

E15.17 MEASUREMENT AND PAYMENT

Item	**Unit**
Supply, delivery and off-loading	No

The tendered rate will include full compensation for the supply, delivery and off-loading of the transformers together with all other materials and ancillary equipment required to effect a complete installation.

Item	**Unit**
Install, test and commission	No

The tendered rate will include full compensation for installing the transformers in the designed positions and for the testing and commissioning of the transformers.

The rate shall include for the installation of the control cables between the transformer and the switchgear and all auxiliaries and the connection thereof.

The rate will include for the filling of the transformer with oil to the specified level, as well as the undertaking of any drying out process which may be required to ensure the transformers are ready for operation.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

E16 : ELECTRICAL UNINTERRUPTIBLE POWER SUPPLY UNIT

Johannesburg Water (SOC) Ltd.
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Revision 4 August 2019

City of Johannesburg
Johannesburg Water (SOC) Ltd

DOCUMENT CONTROL SHEET

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4	2019-08-20	B Pieterse	Review of Electrical Standards, plus New Design Guidance
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PARTICULAR SPECIFICATION: VOLUME E16: ELECTRICAL UNINTERRUPTIBLE POWER SUPPLY UNIT

CONTENTS

E16.1 INTRODUCTION

This specification is for the supply and installation of Single Online Double Conversion Static Uninterrupted Power Supply Units (UPS) for use in office and industrial environments.

The UPS Unit will be used for backing up critical electrical loads, such as lighting, dedicated sockets, air conditioning in computer rooms etc.

The UPS Unit will be installed via Normal Power or via a Diesel Standby Generator.

E16.2 SCOPE

The scope of work includes the furnishing of all labour, material and services for the design, supply, manufacture, delivery to site, off load, install in position, fix on site, testing, commissioning and inspection of the equipment and installation works at the manufacturers premises and on site of an UPS Unit and its installation.

The Tenderer has to complete all required returnable schedules. Failure to comply with this request will lead to immediate disqualification.

The Tenderer will be responsible for connecting electrical cables to their own equipment that is supplied and installed under this contract. All cables will be properly glanded to the units.

E16.3 STATUTORY DOCUMENTS AND STANDARDS

E16.3.1 Standards

In addition to any client specifications and general operating procedures, the UPS Units shall comply with the requirement of the following specifications, and any amendments thereto, the SANS specification taking preference:

The equipment offered and work performed, shall comply with the requirements of the governing occupational Health and Safety act, at time of tender.

The Uninterruptible power supply system shall comply with the requirements of SANS 1474 or an International standard such as BS or DIN, and shall be produced in a factory with ISO9000 rating and the applicable quality assurance standards.

(a)	SANS 60439	:	Low Voltage Switchgear and Control Gear Assemblies
(b)	SANS 60529/IEC 529	:	Degrees of Protection Provided by Enclosures (IP Code)
(c)	SANS 60947/IEC 947	:	Low-voltage switchgear and controlgear
(d)	IEC 60146	:	General requirements and line commutated converters
(e)	IEC 747	:	Semi-conductor Devices (including Thyristors)
(f)	IEC 60269-4	:	Low-voltage fuses - Part 4: Supplementary requirements for fuse-links for the protection of semiconductor devices
(g)	IEC 60269-5	:	Low-voltage fuses - Part 5: Guidance for the application of low-voltage fuses
(h)	SANS 10142-1	:	The wiring of premises Part 1: Low-voltage installations
(i)	SANS 156	:	Moulded-case circuit-breakers
(j)	SANS 1195	:	Busbars
(k)	SANS 61238	:	Compression and mechanical connectors for power cables for rated voltages up to 30 kV (Um = 36 kV)

E16.3.2 Particular Specifications to be read in conjunction with this specifications

The following particular specifications shall be read in conjunction with the Project Specification:

(a) E23	:	ELECTRICAL SPECIFICATION FOR COLOUR CODE
(b) G02	:	PARTICULAR SPECIFICATION FOR CORROSION PROTECTION
(c) E06	:	ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION
(d) E05	:	LOW VOLTAGE POWER AND CONTROL CABLE
(e) E08	:	WIRING
(f) E11	:	GENERAL EARTHING AND LIGHTNING PROTECTION

E16.4 GENERAL TECHNICAL SPECIFICATION

E16.4.1 General

(a) All Single Online Double Conversion Static UPS Units will be continuous duty single or three phase units.

(b) The UPS must be a TRUE on-line, double conversion transformer-based unit (i.e. using a transformer that is an integral part of the UPS, on the input to the UPS). Hybrids, transformerless units or units with external, separate transformers will not be acceptable.

(c) The UPS must employ PWM technology.

(d) The UPS must have battery backup for at least 30 minutes at the full rated load of the UPS.

(e) The output waveform shall be sinusoidal in form with the THD at full line load not exceeding 3%.

(f) The output voltage variation must not exceed 2%.

(g) Interference shall not exceed the limits laid down by ICASA

(h) The UPS must have a battery low voltage/DC cut-off which is not lower than 1,67 Vpc.

(i) The UPS must be accompanied by the tenderer’s proof of their ability to install, test, service, repair, etc. these devices in the field and that they have a suitable after-sales infrastructure.

(j) The UPS must be equipped with an integral static bypass switch as well as an integral manual/maintenance bypass switch.

(k) The UPS static bypass switch must be upgradable in order to be matched to the load inrush current.

(l) The tenderer must be willing and able to provide a complete factory load test, which can be witnessed by the engineer and/or client.

(m) A voltage free contact rated for 230V AC at 2 amps shall be provided in all the UPS units. This general alarm relay shall be internally wired to energise when a collective signal from all alarms is healthy. Alternatively, this relay shall de-energise when a fault occurs, raw mains is interrupted or the battery power is low.

(n) The UPS must be supplied complete with maintenance free batteries and with a capacity to run the system for 30 minutes at full load. If external battery packs are provided, the battery charger must be adequately rated to re-charge the additional batteries at the C/10 rate.

(o) The UPS system shall be suitable for operation from a 230V AC single-phase supply and must supply a nominal single phase 230 Volt, 50 Hz output.

(p) Tenderers must satisfy themselves that the UPS rating is adequate to supply all the equipment which they are offering

(q) The units shall be able to sustain an overload of 125% for one minute or 150% for ten seconds whereupon it shall switch itself off. A full short circuit shall cause the unit to switch off without sustaining damage.

(r) The UPS must be able to operate normally in an ambient service temperature of 0ºC to +35ºC and a relative humidity of 5 to 95% non-condensing at 1500 to 3000m above sea level.

(s) The rated output voltage must be user selectable from 220/230/240V.

(t) The output frequency must not vary by more than 3Hz.

(u) The UPS module shall consist of the following main components:

i. Transformer - choke input stage,
ii. Rectifier/Charger and DC link,
iii. Static Inverter,
iv. Static Bypass Switch and Manual Bypass Switch,
v. Control Panel and Mimic Panel with LCD Display,
vi. Output Isolation Transformer,

E16.4.2 UPS Rating

(a) The UPS should be able to supply a load with a power factor of 0.7 to unity. Tenderers must submit both the VA and Wattage rating of each UPS offered.

(b) The UPS efficiency must be no less than 89% from zero to full load.

(c) The UPS must be suitably rated to supply all the required equipment specified in this tender and any attached specifications and provide backup to this equipment for no less than 30 minutes at full load. Even if the equipment does not require it however, the UPS must not have a rating of less than 3kVA

E16.4.3 UPS Backup Batteries

(a) Tenderers must state the exact number of batteries that will be used.

(b) Tenderers must state the type of batteries that will be used.

(c) Tenderers must state the Ah rating of the batteries that will be used.

(d) Tenderers must state the design life of batteries that will be used (3-5years, 10 years, etc.).

E16.4.4 UPS Standards

(a) All imported UPSs must have a CE rating

(b) The UPS must have CE, LGA/GS markings.

(c) The UPS must comply with safety conformance to EN-50091-1.

(d) The UPS must have EMC conformance to EN-50091-2 and EN-61000-3-2.

E16.4.5 Module Modes of Operation

The UPS unit will operate as an online, fully automatic system in the following modes:-

(a) Normal:

i. The inverter shall continuously supply the critical load.

ii. The Rectifier/Charger shall derive power from the commercial AC source and shall supply DC power to the Inverter while simultaneously float charging the batteries.

(b) Batteries:

i. Upon failure of the commercial AC power, the critical load shall continue to be supplied by the Inverter, which shall obtain power from the batteries without any operator intervention. There shall be no interruption to the critical load upon failure or restoration of the commercial AC source.

ii. The UPS must have a battery low voltage/DC cut-off which is not lower than 1,67 Vpc.

(c) Recharge:

i. Upon restoration of the AC source, the Rectifier/Charger shall recharge the batteries and simultaneously provide power to the Inverter.

ii. This shall be an automatic function and shall cause no interruption to the critical load.

(d) Bypass:

i. No-break transfer to and from Bypass mode shall be capable of being initiated manually, without operation of the static switch.

E16.4.6 Cabinets/Enclosures

The UPS Unit and the back-up batteries must each be supplied and installed in a freestanding double front steel metal cabinet/enclosure (safety shield behind doors) on adjustable/levelling feet, all pre-powder coated. The cabinets/enclosures shall be designed for industrial and computer room applications in accordance with the environment requirements. The cabinets will have a minimum standard Ingress Protection of 20 (IP20) in office environments and a minimum Ingress Protection of 23 (IP23) in dusty conditions.

Cabinets will be provided with lockable removable doors/panels and seal protection as required. These doors/panels will be cut to accommodate the control panel displays and metering as required. Cabinets must be provided with forced air-cooling ventilation fans. Should the fans be installed on the top section, the cabinets must be fitted with drip trays.

The cabinets must ensure that cable entry and connection will be from the bottom and additional support is provided for cable glands. A dedicated wire way shall be provided within the UPS module for routing user input and output wiring.

UPS Unit plus Battery Cabinet must line up and match up in style and colour.

Service Area Requirements: The UPS module shall require no more than 1 meter of front and side service access room.

Refer to Environment Conditions – Cabinets/Enclosures must be built to suit all temperatures and humidity conditions.

Cabinets/Enclosures must be labelled with 50mm high black engraved letters on white background fixed to cabinet with screw in centre of units.

E16.4.7 Manufacturer's Field Service

(a) Field Engineering Support:

i. The UPS manufacturer shall have a countrywide field service department staffed by factory-trained field service engineers dedicated to start-up, maintenance, and repair of UPS equipment. The organization shall consist of local offices managed from a central location.

ii. Field engineers shall be deployed in key population areas to provide on-site emergency response within 24 hours 80% of the time.

iii. Location of all field service offices must be submitted with the proposal.

iv. Third-party maintenance will not be accepted.

(b) Spare Parts Support:

i. Parts be available within 24 hours.

(c) Operational Training:

i. Before leaving the site, the field service engineer shall familiarize responsible personnel with the operation of the UPS. The UPS equipment shall be available for demonstration of the modes of operation.

(d) Product Enhancement Program:

i. The UPS manufacturer shall make available feature upgrade service offerings to all users as they are developed. These products shall be proposed as a field-installable, optional kit.

E16.4.8 UPS Data Sheets (Returnable Schedule)

The tenderer must complete the data sheet below with his tender:

Technical Data Sheet: UPS

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model (E.g. true on-line, double conversion)	
Transformer-based unit (Y/N?)	
Technology employed (E.g. pulse width modulation)	
Output voltage variation	
Output frequency variation	
UPS rating (VA and Watts)	
UPS efficiency from zero to full load	
Maximum harmonic distortion at full load	

Overload handling capabilities (E.g. “x”% load for “y” minutes)	
Power backup period from batteries at full rated load	
Compliance with standards rating and markings (E.g. “Yes, full compliance” or “No”.	
Tenderer to provide complete factory load test that can be witnessed by the Engineer	
Staff available for installation, testing and backup service?	
Number of batteries to be used	
Type of batteries to be used	
Ah rating of batteries	
Design life of batteries	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

E16.5 QUALIFICATIONS

(a) The UPS manufacturer shall have a minimum of ten years’ experience in the design, manufacture and testing of solid-state UPS. A list of installed UPS of the same type as the manufacturer proposes to furnish for this application shall be supplied with the proposal.

(b) The UPS manufacturer shall have ISO 9001 certification for engineering/R&D and manufacturing facilities.

(c) If it is an imported UPS, the vendor must be the ACTUAL importer of the UPS. In other words, a middleman who cannot provide factory load tests or suitable after-sales service and backup will not be acceptable.

E16.6 GUARANTEE

The successful vendor/supplier will guarantee the installation works and equipment for a period of twelve months after first delivery was taken by the Engineer.

E16.7 TESTING AND INSPECTION:

(a) The testing and inspection procedures shall be approved prior to the commencement of manufacture.

(b) The Contractor shall assemble the complete UPS for inspection and factory testing, and present the system to the Engineer, to who it shall be demonstrated that the equipment meets the requirements of the specification.

(c) The tenderer must be willing and able to provide a complete factory load test, which can be witnessed by the engineer and/or client.

(d) The Contractor shall provide suitably qualified personnel and all necessary equipment to carry out the tests to demonstrate conformance with the specification and simulate the operation of the system in its final operating state.

(e) The Contractor shall prepare a set of completed test and inspection certificates for approval.

(f) The contractor is required to perform site acceptance tests (SAT) on the UPS witnessed by the employer and the engineer, prior to commissioning the UPS. A schedule of the checks, tests and results of the SAT must be available for signing by the engineer at the completion of the SAT.

(g) A thermal imaging record of the UPS shall be taken after the UPS has been in operation for a minimum one week under typical normal conditions and while running. The thermal imaging record will form part of the deliverable documentation together with Operation and Maintenance Manuals and delivered to the employer on completion of the works.

E16.8 PACKING AND MARKING

E16.8.1 Packing

The Contractor shall protect the equipment against scratching and damage by suitable wrapping, packing and crating of the equipment items.

E16.8.2 Marking

Each separately packed and transported piece of equipment shall be clearly marked.

E16.10 MEASUREMENT AND PAYMENT

Item **Unit**

Supply and deliver UPS .... No

The tendered rate shall include full compensation for the manufacture, supply, testing and delivery of the UPS incorporating all options/extras as detailed in the detail specification.

Item **Unit**

Install UPS .... No

The tendered rate shall include full compensation for the installation, site testing and commissioning plus the 12 months maintenance of the UPS incorporating all options/extras as detailed in the detail specification.

Item **Unit**

Supply and deliver support platform/stand for UPS .... No

The tendered rate shall include full compensation for the manufacture, supply, testing and delivery of the support platform/stand for UPS as detailed in the detail specification.

Item **Unit**

Install support platform/stand for UPS .... No

The tendered rate shall include full compensation for the installation of the support platform/stand as detailed in the detail specification.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
E17 : ELECTRICAL VARIABLE SPEED DRIVE (VSD) UNITS

Johannesburg Water

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Revision 5

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City of Johannesburg
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2	2010-05-03		Review of Electrical Standards
1	2009-05-12		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance

PARTICULAR SPECIFICATION: VOLUME E17: VARIABLE SPEED DRIVES (VSD)

CONTENTS

E17.1 SCOPE

This specification shall cover all variable speed drives to be designed, supplied installed and tested that shall drive any of the items of equipment to be supplied under the contract.

E17.2 INTERPRETATIONS

E17.2.1 Abbreviations

In this Specification, the following abbreviations will apply:-

(a) VSD	:	Variable Speed Drive
(b) ANSI	:	American National Standards Institute
(c) ASTM	:	American Society for Testing and Materials
(d) BS	:	British Standards Institution
(e) SANS	:	South African National Standards

E17.2.2 Standards

The latest edition, including all amendments to until the date of tender, of the following particular national and international specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

(a) SANS 60529	:	Degrees of Protection Provided by Enclosures (IP Code)
(b) IEC 60 664 –1	:	Degree of Pollution – no condensation permitted during operation
(c) IEC 60721-3-3	:	Classification of environmental conditions - Part 3-3: Classification of groups of environmental parameters and their severities - Stationary use at weather protected locations
(d) BS EN 55011	:	Industrial, scientific and medical equipment — Radio-frequency disturbance characteristics — Limits and methods of measurement
(e) IEC 61800-3	:	Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods

E17.2.3 Particular Specifications to be read in conjunction with this specifications

The following particular specifications shall be read in conjunction with the Project Specification:

(a) E04	:	PARTICULAR SPECIFICATION FOR MCC

E17.3 GENERAL REQUIREMENTS

(a) The VSD units shall control asynchronous motors with standard constant torque, variable standard torque or optimized torque.

(b) The VSD units shall be specifically designed to offer extensive flexibility in water and wastewater applications.

(c) The VSD units shall be provided with six programmable, isolated digital inputs (24V DC, positive or negative logic).

(d) VSD units shall have three programmable relay outputs (1 with NO/NC contacts and 2 with NO contacts)

(e) The VSD units shall be provided with 3 programmable analogue inputs (configurable as voltage (0...10 V) or current (0-20 mA/4-20 mA), 2 of them including probes (PTC, PT100, PT1000 or KTY84)).

(f) The VSD units shall have two programmable analog outputs configurable as voltage (0...10 V) or current (0-20 mA).

(g) The VSD units will have the option to extend the I/O with optional modules.

(h) The VSD shall have low-noise motor operation due to high pulse frequencies.

(i) The VSD unit shall have complete protection for motor and inverter.

(j) The VSD units shall comply with the requirements of the EU low-voltage guideline.

(k) The VSD unit shall have the CE marking.

(l) All VSD units shall have the same interface, including a control panel, I/O connections and software, regardless of power rating, voltage or enclosure (IP rating).

(m) All VSD units shall be supplied with an internal Class A filter. The requirements are fulfilled using shielded cables with maximum length of 25m.

(n) The VSD units shall be supplied with line commutating choke in line with EN61 000-3-2 Regulations “Limits for harmonic currents with device input current < =16A per phase”.

(o) The maximum permissible motor cable lengths (shielded/unshielded) for a mains voltage of 400V are 150 m/ 225 m.

(p) The VSD units shall be supplied with integrated category C3 EMC filters.

(q) The VSD units shall be supplied with graphic display terminal for parameterising the inverter, complete with mounting kits for installation in the control cabinet doors.

(r) The unit shall have complete protection for motor and inverter.

(s) The VSD units shall have the following standard communication modules Modbus/TCP, Modbus serial link.

(t) The VSD units shall have the following optional communication modules EtherNet/IP and Modbus/TCP Dual port, ProfiNet, CANopen, Profibus DP V1, DeviceNet, and BACnet MS/TP.

(u) Depending on the power rating and application, the VSD unit should be available as a wall mounted unit, a cabinet integration unit or a floor-standing unit.

(v) **Note**:
Attention shall be given to ventilation to prevent the accumulation of heat in cubicles where power electronic drives (soft starters and VSD’s) or other heat generating equipment (i.e. control transformers) are contained. Extraction ventilation fans should be installed in these cases to remove heat from the cubicle. The filtered extraction fan should be placed as high as possible in the compartment door with a filtered air inlet opening as low as possible in the compartment door. The fan and opening must be sized to ensure all generated heat is extracted from the cubicle. Natural convection cooling will not be accepted. All specific requirements from the VSD OEM must be adhered to.

E17.4 WORKING VOLTAGE AND SUPPLY SYSTEMS

Depending on the power rating and application, the following power supply alternatives shall be available:

i. Single-phase: 200...240 V
ii. Three-phase: 380...480 V

E17.5 ENVIRONMENTAL LIMITS

E17.5.1 Operating Temperature

The VSD must be able to operate in the specified operating temperature without any derating of the specified output power

i. 0... 40 °C as standard
ii. 40...50 °C with derating

E17.5.2 Relative humidity

i. 5...95% without condensing.

E17.5.3 Storage and transport temperature

i. -40…+70 °C

E17.5.4 Operating altitude:

i. 0…1,000 m without derating
ii. 1,000...2,000 m with derating of 1% per 100 m

E17.5.5 Withstand to harsh environments:

i. Chemical class 3C3 conforming to IEC/EN 60721-3-3 (1)
ii. Mechanical class 3S3 conforming to IEC/EN 60721-3-3 (1)
iii. Electronic cards with protective coating

E17.5.6 Ingress Protection:

i. IP 00 for mounting in an enclosure.
ii. IP 20/21/UL type 1 for wall mounting in a plant room and in an enclosure
iii. IP 55 for wall mounting, with protection against dust and water jets
iv. Floor-standing IP 21
v. Floor-standing IP 54, with protection against dust and water jets

E17.6 PROTECTION FUNCTIONS

The following protection functions shall be available:

(a) Under voltage
(b) Overvoltage
(c) Overload
(d) Earth faults
(e) Short-circuits
(f) Stall prevention
(g) Locked motor protection
(h) Motor over temperature
(i) Inverter over temperature parameter change protection.

E17.7 ASSEMBLY METHOD AND PROTECTION CLASS

The VSD units should be available with listed mounting types and IP classes:

(a) Wall-mounting

i. IP 20/21/UL Type 1 from 0.75 to 315 kW,

ii. IP 55 from 0.75 to 90 kW.

(b) Floor standing

i. IP 21 and IP 54 from 110 to 315 kW

(c) Cabinet integration

i. IP 20 from 0.75 to 90 kW.

E17.8 DOCUMENTATION

Technical details shall be delivered with the offered VSD unit:

User manual, describing systematically how to install, start up, trouble shoot and maintain the VSD. It shall be optionally possible to acquire multiple manuals together with a delivery unit.

Documents to be delivered per order:

a) Dimensional drawings (both AutoCAD and .pdf formats)

b) Customer connections and power wiring diagrams (both AutoCAD and .pdf formats).

c) Power losses and cooling air temperature (both in .xls and .pdf formats).

d) Manufactures statements on output currents available continuously in different ambient temperature up to 50°C. Type of product needed at 50°C continuous operations must be clearly listed.

e) Environmental product declaration according to life cycle assessment (LCA).

E17.9 INSTALLATION, TESTING AND COMMISSIONING

The contractor will supply a factory test certificate with the VSD unit.

The VSD shall be installed and commissioned by a competent person approved and accredited by the manufacturer. The installer must provide a method statement for transporting, storage, installation, testing and commissioning processes for approval by the engineer.

The installer is required to perform site acceptance tests (SAT) on the VSD witnessed by the employer and the engineer, prior to commissioning the VSD. The contractor will be responsible for the VSD setup, including software configuration and settings. A schedule of the checks, tests and results of the SAT must be available for signing by the engineer at the completion of the SAT. The contractor will provide the final VSD setup and software settings to the Engineer on a USB flash drive.

A thermal imaging record of the VSD shall be taken after the VSD has been in operation for a minimum one week under typical normal conditions and while running. The thermal imaging record will form part of the deliverable documentation together with Operation and Maintenance Manuals and delivered to the employer on completion of the works.

E17.10 MEASUREMENT AND PAYMENT

VSD units shall not be paid as a separate item in the Bill of Quantities. VSD unit form part of motor starter circuits and payment thereof shall be included in the price/s of motor control centres.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

E18 : ELECTRICAL MINIATURE SUBSTATIONS

Johannesburg Water (SOC) Ltd.
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Revision 4 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – E18 : Electrical Miniature Substations**

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4	2019-08-20	B Pieterse	Review of Electrical Standards, plus New Design Guidance
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PARTICULAR SPECIFICATION: VOLUME E18: ELECTRICAL MINIATURE SUBSTATIONS

CONTENTS

E18.1 SCOPE

This section covers the design, manufacture supply and delivery of distribution miniature substations.

E18.2 STATUTORY DOCUMENTS AND STANDARDS

E18.2.1 Standards

The miniature substations offered in terms of this specification shall comply with the requirements as set out in the detailed specification as well as the relevant sections of SANS SANS 1029.

The units offered shall have the SANS mark of approval.

Any deviation from these conditions shall be clearly indicated, and any equipment so offered shall only be used with the express permission, in writing, of the engineer

The equipment offered and work performed, shall comply with the requirements of the governing occupational Health and Safety act, at time of tender.

The miniature substation shall be produced in a factory with SANS ISO9001 rating and the applicable quality assurance standards.

(a)	SANS 780	:	Distribution transformers
(b)	SANS 1029	:	Miniature substations for rated a.c. voltages up to and including 24 kV
(c)	SANS 555	:	Fluids for electro technical applications
(d)	SANS 60529	:	Degrees of Protection Provided by Enclosures (IP Code)
(e)	SANS 61958	:	Indicating devices
(f)	SANS 62271-1	:	High-voltage switchgear and control gear Part 1: Common specifications for alternating current switchgear and control gear
(g)	SANS 62271-200	:	High-voltage switchgear and control gear Part 200: AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV
(h)	SANS 62271-102	:	High-voltage switchgear and control gear Part 102: Alternating current disconnectors and earthing switches
(i)	SANS 62271-103	:	High-voltage switchgear and control gear Part 103: Switches for rated voltages above 1 kV up to and including 52 kV
(j)	SANS 62271-102	:	High-voltage switchgear and control gear Part 100: Alternating-current circuit-breakers
(k)	SANS 62271-105	:	High-voltage switchgear and control gear Part 105: Alternating current switch-fuse combinations for rated voltages above 1 kV up to and including 52 kV
(l)	SANS 61869-2	:	Instrument transformers Part 2: Additional requirements for current transformers
(m)	SANS 61869-3	:	Instrument transformers Part 3: Additional requirements for

inductive voltage transformers

(n) IEC 60255 : Measuring relays and protection equipment

(o) SANS 1091 : National colour standard

E18.2.2 Particular Specifications to be read in conjunction with this specifications

The following particular specifications shall be read in conjunction with this specification:

(a) E15 : ELECTRICAL TRANSFORMERS

(b) E19 : ELECTRICAL 11kV RING MAIN UNIT

(c) E25 : ELECTRICAL COLOUR CODING OF EQUIPMENT

E18.3 ENVIRONMENTAL CONDITIONS

The miniature substations shall be suitable for use at full continuous rating, in terms of Paragraph 1.3 of the latest issue of SANS 780.

E18.4 CONSTRUCTION REQUIREMENTS

In addition to the requirements of SANS 780, the following shall also be considered:

(a) The miniature substations are intended for as self-contained distribution centres in wastewater treatment works and are to be mounted on side of road where possible. Therefore the compactness in design and a pleasing appearance is important
(b) The miniature substation enclosure (roof, walls and doors) shall be manufactured from stainless steel grade (3CR12). Glass reinforced resin or other non-metallic substances is not acceptable.
(c) The colour of the miniature substation shall be colour no. C12 Avocado Green (6022-G91Y) to SANS 1091.

E18.5 MANUFACTURING AND QUALITY CONTROL

Detailed drawings indicating the dimensions and weight of the miniature substation must be submitted with the tender.

The supplier must provide a specification and quality management procedure to be used during the manufacturing of the miniature substations, complete with a checklist and schedule of inspections to be done by the client and engineer. Manufacturing may not proceed without approval of these documents. A Factory Acceptance Test of the equipment must be witnessed and signed off by the Engineer prior to shipment.

E18.6 MV COMPARTMENT

E18.6.1 Miniature Substation MV Compartment

An approved 11kV Ring Main Unit (RMU) shall be installed in the MV compartment. The RMU shall comprise of a combined fuse-switch feeding the transformer and two cable/ring main network isolators connecting the ring main circuit. Three individual switchgear units, each with a separate vacuum or gas (SF6) tank will be combined into one compact unit. The RMU will have the following characteristics:

a) The busbars and switching elements of each module shall be in a separate vacuum/gas tank.

Each tank will be equipped with a meter showing vacuum/gas pressure values;

b) Suitable for indoor use;

c) It must be possible to operate all the switch mechanisms from the front;

d) Three manually selected positions (ON-OFF or EARTH) on all modules. The operating handle is to be such that it must be relocated from the ON – OFF position to the EARTH position before the earthing switch can be closed;

e) Clearly visible ON – OFF and OFF – EARTH indicators shall be provided and provision shall be made for locking the mechanisms by means of selector levers, preventing the insertion of the operating handle in any position;

f) A mechanical interlock will prevent the opening of the cable termination cubicle if the module is not in the EARTH position;

g) Transparent inspection windows that display the position of the earthing contacts, allowing; a visually check that the earthing switch is in the closed position;

h) A voltage presence-indicating device on all modules to check whether a voltage is present across the cables. (IEC 62271-206: Part 206: Voltage presence indicating systems for rated voltages above 1 kV and up to and including 52 kV);

i) Cable test facility where the cable can be tested without disconnecting the cable from the switchgear bushings or opening the cable termination cubicle;

j) The switchgear must be designed to withstand the impact of an internal arc caused by a fault current in order to provide the maximum protection to switching operators;

k) All bushings shall be Type C rated at 630Amp according to BS EN 50181;

l) A protection relay (self-powered from the CT units) on the circuit breakers connected to the ring circuit with:

- Overcurrent and earth fault protection
- Thermal overload protection
- Current measurement functions
- No PC or specific tool required for setting or commissioning

m) No oil-filled circuit breakers are accepted in the miniature substations.

E18.6.2 <u>11kV cable termination</u>

The Contractor must ensure that suitable methods of 11kV cable termination are applied. Indoor terminations with screened separable connectors (SSC's) must be used to terminate 11kV cables on the RMU. This allows for the use of PILC cable for 11kV reticulation. Because of the short clearances in the switchgear cable termination box the flashover risk is minimised by ensuring that the terminations and SSC's are type tested in accordance with IEC 60055-1 and IEC 60502-4.

E18.6.3 <u>Ratings</u>

The continuous current rating of the Ring Main Unit shall not be less than 630A. The continuous current rating of the combined fuse-switch shall not be less than 90A with overload making capacity minimum 32.5kA. The short circuit rating shall be at least 350MVA at 11kV.

E18.6.4 <u>Combined fuse-switch</u>

The combined fuse-switch shall be in accordance with SANS 60282.

The operating mechanism of the combined fuse-switch shall be of the fixed trip type, which ensures the full closure of the switch and full clearance of fault by the fuses before tripping the switch.

a) The fuse carriage must be so arranged that when the striker pin fuses are fitted, the operation of a fuse in any phase trip all the phases simultaneously. Conversely, if any one fuse is blown, then it shall not be possible to close the switch.

b) Manual tripping is to be provided by means of a pushbutton and not by using the operating handle.

c) Automatic shutters shall be provided, to safeguard against inadvertent contact with “live” parts when the fuse carriage is removed.

d) The operating mechanism must me interlocked with the fuse carriage cover, to allow access to the fuse carriage only when the operating mechanism is in the OFF position.

e) The fuses and carriage shall be housed vertically in a separate compartment on the front of the unit. The fuse carriage design is preferred, which would accept both 336mm and 254mm long by 64mm diameter HRC fuses.

f) One designation blank label shall be provided.

g) Fuses shall be fitted before delivery.

E18.6.5 <u>Ring Main Network Isolators</u>

a) The triple pole contacts of the isolators shall be gang-operated by a spring assisted manual mechanism.

b) Integral cable test terminals shall be provided and shall only be accessible from the front of the unit when the switch is in the EARTH – TEST position. Interlocks shall be provided to ensure that the switch cannot be moved from the EARTH – TEST position when the test terminal cover is open. If alternative ring main units are offered, then one set of test prongs shall be supplied for each unit.

c) No cable end boxes are required. However, provision shall be made for the clamping of cross-linked polyethylene and PILC type cables by means of a split wooden block.

d) The size of cables used shall be 70mm2, 3 core and 185mm2 PILC. The clamps which must accept different sizes of cable shall be mounted approximately 600mm below the terminals.

e) Each isolator shall be provided with a designation white sandwich board label which shall be left blank.

E18.6.6 Circuit breaker with overcurrent and earth fault relay

a) It is required that these miniature substations be supplied with at least 630A 11kV circuit breaker ring main units with overcurrent and earth fault protection relay switches or protection relay that has the same tripping curves as normal HRC MV fuses.

b) Manually operated mechanisms for cable and transformer switches are to be supplied as standard with an option that they can also be fitted with motor operation.

c) The circuit breaker system of protection shall not require an external power supply.

d) SF6 or vacuum circuit breakers shall be acceptable for this purpose although a virtually maintenance-free system with a high level of reliability is preferred.

E18.6.7 General

a) This RMU is required to be supplied with the following standard equipment:

i. Earthing switches

ii. Operating mechanisms with integral mechanical interlocking

iii. Operating handle

iv. Facilities for padlocks on all switches functions

v. Bushings for cable connection in front with cable covers.

vi. Manometer for SF6 pressure/density monitoring (where applicable).

vii. Lifting lug for easy handling.

viii. All units are designed for the subsequent fitting of an integral remote control and monitoring unit.

ix. Three-way configuration.

b) All RMU's shall comply with SANS 1874.

c) All RMU operating, cable testing facilities cable terminating and indication devices must be fully accessible only from the front of the MV compartment.

d) The RMU configuration shall be Switch Disconnector, Circuit Breaker and Switch Disconnector.

e) The cable boxes shall comply with SANS 876 and shall require type 2 terminating clearances.

E18.6.8 Drawings

One set of drawings shall be supplied detailing:

a) Front, side and a plan elevation, the position of the cable entry in relation to the switchgear and the details for the supporting of the cross-linked polyethylene type or PILC.

b) All schematic drawings.

c) Concrete plinth with minimum required specifications.

E18.6.9 Finish

a) Corrosion protection

The transformer and all cooling radiators will be painted as specified in SANS 12944.

b) Final Coat Colour

The colour of the final paint coat is specified in the detailed specification according to SANS SANS 1091: National colour standard.

c) Damaged Paintwork

E18.6.10 Fuses

The ring main unit shall be shall be supplied with suitably rated HRC striker pin fuses to suit the transformer rating size and voltage with dimensions of 254mm long by 63.5mm diameter. Fuses shall be fitted to the unit and <u>not</u> be supplied loose.

Before changing fuses the unit must be isolated and earthed. The electrical isolation integrity must be checked and proper PPE must be used during the procedure.

E18.6.11 Loose items

All maintenance tools and operating handles shall preferably be housed inside the front MV compartment cover of each ring main unit. An operating and maintenance manual with instructions shall be supplied.

The ring main unit shall be bolted to the steel base to form an integral unit with the miniature substation.

E18.7 LOW VOLTAGE SECTION

The low voltage section shall house the LV circuit breakers or fuses. The LV compartment shall have a separate door with separate locking facilities.

The following are the minimum requirements:

E18.7.1 Low voltage circuit breaker compartment

The LV compartment shall consist of a mounting panel with the following (the panel layout shall be submitted when tendering):

a) Phase busbars (red, yellow and blue) rated to carry the full load of the transformer and will not be rated for currents less than 2000A;

b) A single Neutral busbar rated to carry the full load of the transformer and will not be rated for currents less than 2000A;

c) A single Earth busbar rated to carry the full load of the transformer and will not be rated for currents less than 2000A;

d) All busbars will be standard rectangular aluminium busbars

e) A suitable unistrut utilising K-clamps to support the cable from each outgoing circuit breaker at the bottom. The unistrut shall be suitable to accept 4 core copper SWA cables from 70sq. mm to 240sq. mm;

f) The Main circuit breaker feeding the busbars will be an ACB. Moulded case circuit breakers will not be accepted. The rated service breaking capacity (Icu) will be 65kA minimum;

g) Provision shall be made for feeder circuits with triple pole moulded case circuit breakers or fuses with stub busbar connectors as shown in the schedule below. The space between the unistrut and the bottom terminals of the circuit breakers shall be at least 550mm. A clear space of 70mm shall be allowed above the MCCB's for circuit labels.

h) Three (3) x instantaneous and maximum demand indicating ammeters for total transformer load with a fifteen minute response time scaled for the CT ratio as shown in the schedule below. A 20% over scale shall be provided. The indicating needles of the ammeter shall have a common pivot. Class 3, 10VA current transformers to measure the transformer load

i) One 0 to 250V Voltmeter (industrial type) together with a selector switch shall be fitted. The selector switch must switch the voltmeter so that the various phase voltage can be measured.

j) The low voltage compartment shall contain the following:

- Two support brackets with a fibre panel attached to it on the one side, including the mounting of the following equipment:
    - A minimum of 4 to 400A three-phase fuse units directly on the support brackets (including the neutral link).
    - Three maximum demand indicating ammeters on the fibre panel with current transformers, busbars and tails from the low tension bushing to the busbars.

Transformer Rating kVA	**Number and Size of circuit Breakers**	**Number of circuit for fuses**	**CT Ratio**
1000kVA	6 x 300A	6	1500/5
800kVA	5 x 300A	6	1200/5
630kVA	4 x 300A	6	1000/5
500kVA	5 x 250A	6	800/5
400kVA	*4 x 300A*	*6*	*600/5*
315kVA	*4 x 250A*	*4*	*500/5*
200kVA	*3 x 175A*	*4*	*300/5*

E18.7.2 Meter Compartment (if required when ordered subject to confirmation by the Engineer)

a) The meter compartment shall have a separate set of busbars to carry a load of at least 400A. The busbars must be protected by means of a separate three phase air circuit breaker (ACB) within the low voltage compartment with the following kA ratings:

Transformer	**Fault Current**	**Circuit Breaker Size**

Rating kVA		**Size**
1000kVA	32.5kA	250A
800kVA	26.3kA	250A
630kVA	17.3kA	250A
500kVA	13.9kA	250A
400kVA	*12.4kA*	*200A*
315kVA	*9.8kA*	*200A*
200kVA	*6.3kA*	*150A*

b) Provision shall be made for mounting 24 single phase kWh meters and 24 miniature (curve 1) circuit breakers. The miniature circuit breakers shall be held in position by clip-trays. Provision shall be made to replace 12 single phase meters with 9 three phase kWh meters.

c) The kWh meters shall be supplied and installed after the delivery of the miniature substations.

d) The metal or Masonite mounting plate shall be drilled, tapped, and provided with 20mm long 3mm diameter screws for securing the meters to the mounting plate, or alternatively, screws with nuts in suitable clearance holes could be supplied.

e) The tenderer is to provide the wiring for the meter compartment. The wiring required shall consist of 24 x 16mm^2 copper conductors, coloured black, crimped into suitable lugs and bolted to the neutral busbar and 8 red, 8 yellow and 8 blue, 16mm^2 copper conductors shall be supplied from the 24 miniature circuit breakers to the meter positions.

f) The neutral wires shall be wired to each meter position. The coloured wires shall be wired to the 24 MCB's. Suitable labels marked 1 to 24 shall be fixed to the MCB and meter positions so that each MCB can indicate which meter is controlled. The ends of all wiring shall be taped up.

g) No wiring shall be provided from the load side of the ammeters. Wiring from the earth/neutral busbar shall be taken to the neutral terminal of each meter. All meter wiring shall be made with 16mm^2 PVC insulated copper conductor, bearing the SANS mark.

h) One combined neutral and earthing bar with mounting holes to accommodate 9 x 16mm^2 copper conductor and 1 x 35mm^2 minimum copper conductor each, shall be bolted to the mounting plate.

E18.8 DOORS

All the doors shall be mounted on a suitable number of non-removable or hidden hinges.

All doors shall be fitted with locking mechanisms with provision for pad-locking. A suitable cover shall be fitted over the handles to prevent vandalism. The top of the cover shall be cut open and covered with expanded metal. Provision must be made for a night latch to be installed.

E18.9 COMPOSITION OF ENCLOSURE

The enclosure of the miniature substation shall be fabricated of mild steel and of suitable thickness for an application of this nature. Suitable reinforcing ribs shall be incorporated.

After manufacturing, the steel and welding shall be cleaned and passivated in accordance with the Code of Practice issued by the suppliers of the steel. Full details of proposals shall accompany the tender.

E18.10 DANGER NOTICES

The standard 100 x 150 mm embossed danger (WW7) and MV, LV notice shall be attached to each door. Cast aluminium notices are also acceptable. Painted labels shall not be acceptable.

Notices shall be fixed to the doors by means of brass rivets or other approved means.

E18.11 TESTS

(a) Ring Main Unit

The contractor shall supply copies of all type tests and routine tests performed by the equipment manufacturer with the RMU.

The RMU shall be tested on site after erection and prior to commissioning. The following minimum tests shall be performed:

i. Pressure tests on the primary circuit in accordance with IEC 62271-1.

ii. Insulation resistance tests.

iii. Primary injection tests.

iv. Earth continuity and earth resistance tests.

v. Operating tests.

vi. Any other tests that may be required to ascertain the correct functioning of the equipment.

After putting the panel to service for a minimum 1 week, a thermal image must be scanned and analysed for any hot spots. The image should be presented as part of the Operations and Maintenance manual.

(b) Transformer

Routine tests in accordance with SANS 780 shall be performed. Type tests and special tests to SANS 780 shall be performed on one transformer of the size to be delivered in terms of this contract unless the manufacturer can provide certificates of previous tests done on identical transformers. The Engineer reserves the right to witness such tests.

The results of these tests will be made available to the Engineer for his evaluation prior to acceptance and delivery of the transformers. Two copies of test results will be provided to the Engineer.

Before installing the transformer on site, the following inspections/test should be performed as a minimum:

i. Check the transformer bushings thoroughly for any signs of cracks / damages;

ii. Check the oil level in the transformer and check for any signs of oil leakage through bushings, gaskets or welded joints;

iii. Insulation Resistance test;

The contractor must arrange for site acceptance tests (SAT) on all miniature substation transformers. The SAT must be witnessed by the Engineer and results recorded.

i. Insulation resistance test;

ii. Check oil level in conservator tank, colour of silica gel in the breather and oil level at the bottom of the breather;

iii. Charge the transformer on no load. Wait until noise of the transformer stabilizes then measure the secondary voltages phase to phase and phase to neutral;

iv. Check the phase rotation on the transformer secondary terminals;

v. Check the transformer tap settings when loaded (take note that the tap changer settings can only be changed under no-load conditions).

The contractor shall arrange for a thermal imaging of the transformer a minimum of 1 week after commissioning and while the miniature substation is in continuous use. The results of the imaging and SAT are to form part of the deliverable Operations and Maintenance Manuals.

(c) LV Compartment

The following checks should be performed at the premises of the manufacturer:

i. Check the layout of fitted components

ii. Check the overall dimension of switchboard, size of busbars, cables and earthing conductors and location of feeder entry point.

iii. Check and verify the brand, model, and circuit identification of components installed such as circuit breakers, current transformers, fuses, ammeters, voltmeters, power meters and protection relays etc.

iv. Check overall paintwork, door locking device, door gasket, door hinges and door cut-out holes

v. Check the busbar and cable tightening, the marking, busbar clearance and base angle bar

vi. Check the labels, name plate and phase identification

Before energising the miniature substation, the insulation resistance must be tested.

The contractor shall arrange for thermal imaging of the LV Compartment a minimum of 1 week after commissioning and while the miniature substation is in continuous use. The results of the imaging and SAT are to form part of the deliverable Operations and Maintenance Manuals.

E18.12 TECHNICAL DATA AND DRAWINGS

Tenderers shall furnish the following drawings together with their tenders:

(a) Outline drawings of the miniature substations, with all fittings, showing the most important external dimensions.

(b) Details of MV and LV bushings

The successful tenderer shall provide three copies of each of the following drawings, to the engineer, before manufacturing may commence:

(a) GA drawings indicating the headroom necessary to remove the cores *in situ*

(b) Show the mass of the various components on the GA drawings

(c) The internal construction of the miniature substation and the arrangement of the windings, giving full particulars of insulation, as well as the bracing of the cores and windings.

(d) A diagram of the connections showing the exact manner in which the leads are taken from the tank, as well as the number of windings.

(e) Full technical details of all components.

E18.13 SOUND LEVEL

During design and manufacture of miniature substations, care should be exercised to limit miniature substation noise and vibration to within the parameters as recommended in SANS 780.

E18.14 IDENTIFICATION TAGS

All data on the identification tags shall be in SI units.

E18.15 MEASUREMENT AND PAYMENT

Item	**Unit**
Supply, delivery and off-loading of miniature substations	No

The tendered rate shall include full compensation for the supply, delivery and off-loading of the miniature substations together with all other materials and ancillary equipment required to effect a complete installation.

Item	**Unit**

Installation, testing and commissioning of miniature substations .... No

The tendered rate shall include full compensation for installing the miniature substations in the designed positions and for the testing and commissioning of the miniature substations.

The rate shall include for the installation of the control cables between the miniature substation and the switchgear and all auxiliaries and the connection thereof.

The rate shall include for the filling of the miniature substation with oil to the specified level, as well as the undertaking of any drying out process which may be required to ensure the miniature substations are ready for operation.

Item **Unit**

Type tests and special tests of miniature substations... Sum

The tendered sum shall include full compensation to undertake special and type tests as required in the detailed specification. Each test shall be separately priced.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

E21 : ELECTRICAL LIGHTING AND ILLUMINATION

Johannesburg Water (SOC) Ltd.
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City of Johannesburg
Johannesburg Water (Pty) Ltd

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1	2019-08-20	B Pieterse	First Issue

PARTICULAR SPECIFICATION: VOLUME E21: ELECTRICAL LIGHTING AND ILLUMINATION

CONTENTS

E21.1 SCOPE

This section covers the requirements for lighting and illumination. Lighting and illumination shall be supplied, delivered, installed and commissioned as specified.

E21.2 STANDARDS

The latest edition, including all amendments up to date of tender of the following particular national specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

(a)	SANS 475	:	Luminaires for interior lighting, street lighting and floodlighting - Performance requirements
(b)	SANS 10389-1		Exterior lighting Part 1: Artificial lighting of exterior areas for work and safety
(c)	SANS 10114-1	:	Interior lighting Part 1: Artificial lighting of interiors
(d)	SANS 10114-2	:	Interior lighting Part 2: Emergency lighting
(e)	SANS 10142-1	:	The wiring of premises Part 1 Low-voltage installations
(f)	SANS 1019	:	Standard voltages, currents and insulation levels for electricity supply
(g)	SANS 60081	:	Double-capped fluorescent lamps - Performance specifications
(h)	SANS 60598-1	:	Luminaires - Part 1: General requirements and tests
(i)	SANS 60901	:	Single-capped fluorescent lamps - Performance specifications
(j)	SANS 60968	:	Self-ballasted lamps for general lighting services - Safety requirements
(k)	SANS 61547	:	Equipment for general lighting purposes - EMC immunity requirements
(l)	SANS 1777	:	Photoelectric control units for lighting (PECUs)
(m)	SANS 60947-4-1	:	Low-voltage switchgear and controlgear Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters
(n)	SANS 10225	:	The design and construction of lighting masts
(o)	IEC 62031	:	LED modules for general lighting – Safety specifications
(p)	IEC 61347-2-13	:	Lamp controlgear - Part 2-13: Particular requirements for d.c. or a.c. supplied electronic controlgear for LED modules
(q)	IEC 62560	:	Self-ballasted LED-lamps for general lighting services by voltage > 50 V-Safety specifications

E21.3 SPECIFICATIONS

E21.3.1 Manufacture and Assembly of Luminaires

Body

(a) The bodies and relevant sheet metal parts of all fittings shall be manufactured from minimum 0,8mm sheet steel, to precise tolerances, with joints neatly formed and spot-welded.

(b) Metal parts shall be painted with a suitable primer utilized for epoxy or polyester powder coat finishes. The final finish shall be a high reflectance, white epoxy or polyester powder coating (other colours applicable as well).

(c) Bodies of lay-in fittings shall fit neatly into the specified ceiling grid, with no visible light leaks from below.

(d) Access for lamp replacement and maintenance shall be simple and easy.

Lamp holders

(a) Lamp holders shall be of a good quality, manufactured from polycarbonate, with heat resistant centres.

(b) Lamp holders for all fluorescent luminaries (recessed, surface, open channel) shall be good quality roto-lock type from a known manufacturer.

Control gear

(a) All luminaires, except the metal halide types, shall be equipped with electronic ballast/control gear. Metal halide/High pressure Sodium fittings shall use ballasts/chokes.

(b) Ignitors shall be digital in nature with time control pulse break for optimum control gear and lamp protection. (Ignitors will also allow enclosed rated lamps to be used in open luminaries).

(c) Only capacitors supplied by reputable manufacturers shall be offered. Power factor correction in luminaires shall be done to ≥0.90.

Wiring

(a) All internal wiring shall be done with high temperature PVC insulation (105°C).

(b) Wiring shall be neatly grouped and retained.

(c) The wiring shall terminate in a 3-way, 6A screw terminal block, with the earth conductor terminated onto a welded earth stud.

Cord Sets

(a) Cord sets shall be fitted on all indoor luminaires and as specified in the luminaire schedule.

(b) Cord sets will be 3m long as a minimum.

(c) Cord sets shall 3-core PVC cabtyre cable, 0.75mm² measured from the side of the fittings with a 6A, three pin moulded plug top. The cord shall terminate in the luminaire by means of compression gland.

Lamps

(a) All lamps shall be as specified in the lamp schedule.

(b) Only lamps from known manufacturers shall be offered.

(c) All fluorescent tubes shall be tri-phosphor.

E21.3.2 Manufacturing and assembly of Fluorescent luminaires

(a) Luminaires shall be supplied and delivered complete with lamps, control gear and flexible cords and plug tops as specified.

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

(c) The voltage and wattage ratings shall be clearly and indelibly marked on control gear and related control equipment and apparatus.

(d) Bodies of lay-in fittings shall fit neatly into the specified ceiling grid, with no visible light leaks from below.

(e) Access for lamp replacement and maintenance shall be simple and easy.

(f) Lamp holders shall be of a good quality, manufactured from polycarbonate, with heat resistant centres.

(g) Lamp holders for all fluorescent luminaries shall be good quality roto-lock type.

(h) All luminaires shall be equipped with quick start electronic ballast/control gear.

(i) All internal wiring shall be done with high temperature PVC insulation (105C).

(j) Wiring shall be neatly grouped and retained.

(k) The wiring shall terminate in a 3-way, 6A screw terminal block, with the earth conductor terminated onto a welded earth stud.

(l) Cord sets shall be fitted as specified in the luminaire schedule.

(m) Cord sets shall consist of 3 metre 0.75mm² 3-core PVC cabtyre cable with a 6A, three pin moulded plug top. The cord shall terminate in the fitting by means of compression glands.

(n) Integrated dimming and or switching control capability utilizing an external 0-10 VDC control signal, dry NO or NC contact.

E21.3.3 Manufacturing and assembly of LED luminaires

General

(a) The life of all led luminaires and lamps shall be >50 000 hours.

(b) Output beam angle shall be as specified.

Construction

(a) Preference shall be given to modular luminaires designed for ease of component replacement: LED luminaires shall be equipped with replaceable or upgradable LED modules.

(b) Ingress protection rating of the LED luminaire should be prescribed for the intended applications under specific environmental conditions.

(c) Housing to be manufactured from die cast or extruded aluminium.

(d) There should be additional room available in the wiring compartment for third-party adaptive controls to be retrofitted.

(e) Luminaires should be designed for ease of component replacement, including LED engines/modules, drivers, surge devices, and they should accommodate end-of-life disassembly.

(f) Power supply driver shall be specified as dimmable or non-dimmable in the luminaire schedule and will operate as follows:
- Reliable operation up to ≥45°C ambient temperature;
- Will last >80,000 hours;
- Driver housing IP66 rated
- Integrated dimming and or switching control capability utilizing an external 0-10 VDC control signal, dry NO or NC contact, DALI shall be specified if required.

2ft/4ft/5ft Vapour Proof LED Light

(a)	Body length	:	660mm or 1277mm or 1572mm
(b)	Body construction	:	Polycarbonate with stainless steel latches and mounting hangers
(c)	Cover lens	:	UV stable Polycarbonate
(d)	Lumen	:	660mm: 25W - 3200 lumen 1277mm: 50W - 6400 lumen 1573mm: 90W - 12000 lumen
(e)	CCT options	:	4000K or 5000K
(f)	Supply voltage	:	230V AC
(g)	IP rating	:	IP 65

LED Flood light

(a)	Wattage	:	220W, 440W, 880W
(b)	Body construction	:	Die cast LM6 aluminium - powder coated
(c)	Front glass cover	:	5mm tempered safety glass
(d)	Lighting performance	:	146 lumens per W at source
(e)	CCT	:	4000K or 5000K
(f)	CRI	:	+80 minimum
(g)	Supply voltage	:	230V AC/50hz
(h)	Additional protection	:	10KV
(i)	IP rating	:	IP 65

<u>LED Bulkhead/Street light</u>

(a)	Body construction	:	Glass filled Nylon / Yoke and Bulkhead bracket Stainless Steel 316
(b)	Lens type	:	3mm Polycarbonate (UV stabilised) toughened glass or impact modified Acrylic
(c)	Wattage	:	20W/40W/50W
(d)	Lumen options	:	20W – 3520 Lumens at source 40W – 7040 Lumens at source 50W – 8800 Lumens at source
(e)	CCT	:	4000K or 5000K
(f)	CRI	:	+80 minimum
(g)	Supply voltage	:	230V AC/50hz
(h)	IP Rating	:	IP65
(i)	Power factor	:	0.94 or better

<u>2ft/4ft/5ft Utility LED light</u>

(a)	Body Construction	:	Extruded aluminium - either anodized or powder coated
(b)	Lens and Reflector	:	190-degree ultra wide distribution Opal lens with 80% transmission.
(c)	Length/Lumen options	:	600mm – 24W 3072 lumens at source 1200mm – 48W 6144 lumens at source 1800mm – 72W 9216 lumen as source
(d)	Supply Voltage	:	230V AC 50HZ
(e)	CCT options	:	4000K or 5000K
(f)	CRI	:	+80 minimum
(g)	IP Rating	:	IP 44
(h)	Control Gear		Internally mounted

<u>LED High bay</u>

(a)	Body construction	:	ABS end caps Anodised aluminium reflectors Powder coated or anodised aluminium body
(b)	Lens type	:	4mm Polycarbonate or toughened glass
(c)	Supply voltage	:	230V AC 50HZ

(d)	Load/lumen options	:	75W – 13200 lumens at source 90W – 15750 lumens at source 150W – 26400 lumens at source 180W – 31500 lumens at source 300W – 52800 lumens at source 360W – 63000 lumens at source
(e)	CRI	:	+80 minimum
(f)	CCT	:	4000K and 5000K
(g)	IP Rating	:	IP 65
(h)	Power factor	:	Better than 0,97

Luminaire LED Performance

(a) Minimum Luminaire Efficacy : 75 lumens per watt

(b) Correlated Colour Temperature (CCT) : 4000K - 5000K

(c) Minimum Colour Rendering Index (CRI) : 80

(d) Lumen Output: - Initial lumen output shall be ≥ 10% higher than required for the luminaire to meet recommended values for the specific locations indicated, in order for the luminaire to maintain compliance over its entire lifetime.

E21.3.4 Manufacturing and assembly of Emergency fittings

General

(a) The fittings shall be manufactured according to the standard fittings as described above.

(b) The fittings shall be self-contained emergency modules. I.e. The modules (emergency control units plus battery packs) can be fitted inside recessed and surface mounted luminaires including CFL bulkhead fittings.

(c) The emergency fittings should have a switched live for Normal ON/OFF operation and an unswitched live for Emergency light battery charging.

(d) The module should be able to maintain 50% light output for 1hour or alternatively 100% light output for ½ hour.

E21.3.5 High Masts Lighting

General

(a) All work on the high mast lighting must be done from ground level.

(b) All high mast poles will be of the hinging/tilting type. The hinging action allows the floodlights to be lowered to the ground for ease of access. Enough clearance space must be allowed to lower the pole.

Mast Shaft

(a) All poles must be designed to SABS 0225 by a registered Professional Engineer.

(b) The mast shall be constructed to form an enclosed tapered shaft. All steelwork must be hot dip galvanised, by an SABS approved galvaniser, to SABS ISO1461.

(a) The lower mast portion shall be fitted with a suitably designed base plate bolted onto the mast foundation. The bolts will be reusable security bolts (tamper proof bolts) where a special tool is required to remove the bolts.

(c) All mast foundations must be designed by a professional engineer, taking into account the mounting requirements of the pole baseplate.

(d) The upper portion will be counterbalanced and hinged at midpoint.

(e) The mast must be designed to safely withstand any loading (wind and own weight) in the upright and hinged position.

Floodlight Mounting Assembly

(a) The mast shall be fitted with a suitable luminaire mounting assembly fabricated from steel sections and capable of carrying the specified number and type of luminaires.

Electrical Equipment

(a) The Electrical distribution board shall be mounted in the base section of the mast and accessible only once the lid cover has been removed. The cover will be permanently fixed to the mast by means of a chain.
(b) The lid cover will be fitted with reusable security bolts (tamper proof bolts) where a special tool is required to remove the bolts.
(c) A multicore trailing cable shall be installed from the distribution board to a splitter box mounted on top of the mast.
(d) The cable supplying power to the floodlight luminaires need not be disconnected during the lowering procedure thus allowing testing of the floodlights with the mast in the hinged down position.

E21.3.6 Sensors

Daylight Sensors

Daylight sensors must be provided to switch lights on at dusk and off at dawn by detecting natural light changes. All day light sensors shall have the following minimum requirements:-

(a) Conduit entry with wall bracket mounting.
(b) Efficient lighting solution.
(c) Ultra violet stabilized materials.
(d) Fail-safe position "ON".
(e) Capacity switching - Incandescent or fluorescent 2.2Kw HID 1,8W.
(f) Impact and hail resistant 0-4mm.
(g) IP Rating: 54.
(h) Amp Rating: 16A.
(i) Voltage: 200 - 250Vac (50Hz).

Occupancy Sensors

(a) Sensor shall activate the electrical load upon entry into the controlled area and deactivate it after the area is vacated.
(b) Sensor shall be able to detect moderate types of motion.
(c) Sensor shall maintain a constant level of sensitivity to motion regardless of changes in environmental conditions including airflow.
(d) Sensor shall utilize passive infrared sensing technology to activate lights and other equipment connected to it.
(e) Sensor shall contain timing circuitry to provide adjustable “time to lights off” delay of 15 seconds or less (for installer checkout) to 30 minutes. A 10-minute delay shall automatically default if the potentiometer is left at minimum.
(f) Sensor shall provide a ten-second “grace period” that allows lights to be turned on by motion anywhere in an area after they are turned off due to inactivity.
(g) Sensor shall self-adjust sensitivity (range) and time delay in real-time to optimize performance.
(h) Sensor shall provide a Building Automation system (BAS) option interface via (1) a built-in isolated Form C relay output, (2) an open collector output, with or without pull-up option, or (3) a direct BAS connection.
(i) Sensor shall be designed for parallel wiring to allow coverage of large areas.

E21.4 LIGHTING DESIGN

(a) The contractor must do an area illuminance design in accordance with the applicable lux levels listed in SANS 10389-1 (Table 7 — Recommended values for illuminance, uniformity ratios and glare rating limits) and SANS 10114-1 (Table 1 — Minimum maintained illuminance values).
(b) All exit routes must be lit with emergency lights in accordance with the latest Occupational Health and Safety Act (Act 85 of 1993) and the Building Code.
(c) The contractor must submit the design to the Engineer for approval prior to the procurement of any material.
(d) After installation, the contractor must do an illuminance study to confirm compliance to SANS 10389-1. The contractor must supply calibrated instruments to be used during the study. The compliance study must be witnessed by the Engineer.
(e) Should the illuminance study indicated insufficient lux levels, the contractor must take steps to increase the lux levels to the required level.
(f) Luminaire must be supplied as listed in the table below, specific to the area of installation (see paragraph E21.3.3 for minimum requirements)

#	***AREA***	***LUMINAIRE (See E21.3.3)***
1	Analyser Rooms	2ft/4ft/5ft Vapour Proof LED Light
2	Balancing Tanks	LED Flood Light on high mast
3	Belt Filter Press Sludge Dewatering	2ft/4ft/5ft Vapour Proof LED Light or LED Bulkhead/Street light
4	Biogas Collection and Storage (Gas Holder)	LED Flood Light on high mast
5	Bioreactors	LED Flood Light on high mast
6	Boiler Rooms	2ft/4ft/5ft Vapour Proof LED Light Ex-Rated fittings (Zone 2)
7	Chemical Dosing areas (Ferric Chloride and Hypochlorite)	LED Flood Light on high mast or 2ft/4ft/5ft Vapour Proof LED Light
8	Control Rooms	2ft/4ft/5ft Vapour Proof LED Light
9	Degritters	LED Flood Light on high mast In case of shed, use LED High bay
10	Digester Area	LED Flood Light on high mast
11	Fermenters	LED Flood Light on high mast
12	Final Clarifiers	LED Flood Light on high mast
13	Head Of Works (Buildings)	2ft/4ft/5ft Vapour Proof LED Light (LED High bay for areas under Sheds)
14	Head Of Works (Open area)	LED Flood Light on high mast (LED High bay for areas under Sheds)
15	Lime Preparation and Dosing (Open Area)	LED Flood Light on high mast
16	Liquor treatment (Open Area)	LED Flood Light on high mast
17	MCC/PLC Rooms	Utility LED
18	Open channels	LED Flood Light on high mast
19	Poly make-up, storage and transfer (Buildings)	2ft/4ft/5ft Vapour Proof LED Light
20	Poly make-up, storage and transfer (Open area)	LED Flood Light on high mast
21	PSTs	LED Flood Light on high mast

#	*AREA*	*LUMINAIRE (See E21.3.3)*
22	Screening and Washing areas (Buildings)	2ft/4ft/5ft Vapour Proof LED Light
23	Screening and Washing areas (Open area)	LED Flood Light on high mast
24	Screw Pump Station	2ft/4ft/5ft Vapour Proof LED Light or LED Flood Light on high mast
25	Skip areas for grit or screenings removal	2ft/4ft/5ft Vapour Proof LED Light
26	Sludge Pumping Station	2ft/4ft/5ft Vapour Proof LED Light
27	Sludge storage sumps or tanks (Open area)	LED Flood Light on high mast
28	Solar Sludge Drying Slabs (Drying Beds)	LED Flood Light on high mast
29	Thickeners	LED Flood Light on high mast
30	Perimeter of the sites	LED Bulkhead/Street light
31	Cable tunnels (Inside/Underground)	LED Bulkhead/Street light
32	Drying Bed Conveyors	2ft/4ft/5ft Vapour Proof LED Light
33	Perimeter of the sites (outside)	LED Flood Light on high mast
34	Access gates (Outside)	LED Bulkhead/Street light
35	Cable Pipe Bridge/Gantry (with walkway)	2ft/4ft/5ft Vapour Proof LED Light
36	Blower House (Inside)	2ft/4ft/5ft Vapour Proof LED Light
37	Digester Feed Sump	LED Flood Light on high mast
38	GTL pump station	LED Bulkhead/Street light or 2ft/4ft/5ft Vapour Proof LED Light
39	BPU (Belt Press Underflow) pump station (Inside and outside)	LED Bulkhead/Street light or 2ft/4ft/5ft Vapour Proof LED Light
40	Biogas Generator plant (Inside and outside)	LED Bulkhead/Street light
41	Elutriation (Inside)	2ft/4ft/5ft Vapour Proof LED Light
42	Compost Shed (Inside)	LED High bay
43	Flammable Stores	2ft/4ft/5ft Vapour Proof LED Light Zone 2 Ex Rated
44	Workshops	2ft/4ft/5ft Utility LED light
45	Admin Buildings	Architect to specify: For refurbished offices - check and propose to Joburg Water
46	Change Rooms (showers)	2ft/4ft/5ft Vapour Proof LED Light
47	Laboratory	2ft/4ft/5ft Vapour Proof LED Light

E21.5 INSPECTION AND TESTING

E21.5.1 General

All tests in accordance with the test requirements of this specification shall be performed prior to shipment.

Test certificates will be submitted with tender submission for all the units that are proposed.

All fittings shall be tested in accordance with SANS 475 and shall bear the performance mark.

The fittings shall also comply with ISO 9000 certification and the testing requirements of IEC 60598-1 publication.

E21.6 COMMISSIONING

The datasheet shall indicate whether the contractor is to allow a site technician to be present when the lighting system is to be commissioned. In such a case, the contractor shall quote a separate price for the provision of all personnel, materials and equipment for the site commissioning of the lighting.

Contractors shall provide a commissioning procedure, stating the tests that shall be performed with the results forecast.

The commissioning tests carried out on site shall be tests stipulated in the contractor's commissioning procedure.

E21.7 GUARANTEE

All equipment shall be guaranteed against defect for a period of twelve months, from the date of mutually agreed successful hot commissioning, fair wear and tear accepted.

Tenderers shall submit a written undertaking at the time of tender that a complete range of spares for the equipment offered will be held by the manufacturer for a minimum period of 10 years from the date of tender.

E21.8 TRANSPORTATION/SHIPPING

The costs of preparation for shipping will be included in the contractor's price.
The contractor is responsible to ensure that no damage will be sustained while shipping and he will prepare the appropriate packaging to ensure this.

The specification sheet shall indicate whether the contractor is to deliver the luminaires to site and whether the contractor is to offload the luminaires on site or if the delivery and offloading on site shall be carried out by a third party.

Where delivery and/or offloading by the contractor are specified on the specification sheet, the costs thereof shall be included in the contractor's price.

E21.9 DRAWINGS & DOCUMENTATION

The contractor shall supply all drawings and documentation as indicated in the Specification sheet.

E21.10 MEASUREMENT AND PAYMENT

Item	Unit
Supply and delivery of luminaire	No

The unit of measure shall be the number of luminaire supplied and delivered.

The tendered rate shall include all costs related to the manufacture, supply and delivery of the luminaire (as detailed in the schedule of quantities), including the additional requirements detailed in the detail specification.

Separate items will be scheduled in the schedule of quantities for different types and sizes, defined by the type of luminaire.

Item	**Unit**
Install luminaire	No

The unit of measure shall be the number of luminaire installed.

The tendered rate shall include full compensation for installing, testing and commissioning of the luminaire as specified. The rate shall further include for an illuminance study.

Separate items will be scheduled in the schedule of quantities for different types of luminaire.

Separate items will be scheduled in the schedule of quantities for different types and sizes, defined by type of luminaire.

Item	**Unit**
Supply and delivery of high mast lighting	No

The unit of measure shall be the number of high masts supplied and delivered.

The tendered rate shall include all costs related to the manufacture, supply and delivery of the high mast (as detailed in the schedule of quantities), including the additional requirements detailed in the detail specification.

Separate items will be scheduled in the schedule of quantities for different types and lengths, defined by the type of high mast.

Item	**Unit**
Install high mast lighting	No

The unit of measure shall be the number of high masts installed.

The tendered rate shall include full compensation for installing, testing and commissioning of the high mast lighting as specified. The rate shall further include for the pole plinth, crainage and other services required completing the installation.

Separate items will be scheduled in the schedule of quantities for different types of high masts.

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PARTICULAR SPECIFICATION

G01 : COLOUR CODING OF EQUIPMENT

2	2013-10-23	Minor updates and re-issued	J Ritchie	
1	2009-05-12	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
Rev	**Date**	**Description**	**Signature: JW Wastewater Partnership**	**Signature: Approval from Johannesburg Water**

PARTICULAR SPECIFICATION: VOLUME G01 : COLOUR CODING OF EQUIPMENT

CONTENTS

G01.1 SCOPE

This Specification has been adopted by Johannesburg Water to ensure the colour coding of electrical equipment, mechanical plant and pipework located on Johannesburg Water's Wastewater Treatment Works shall conform to the ruling Occupational Health and Safety Act.

The Specification comprises of **three** parts, namely:

(a) SANS Code of Practice 10140-3, Identification colour marking – Part 3 : Contents of pipelines: 2003

(b) A table (Table 1) which supplements SANS 10140-3, above, in order to provide greater detail or clarity on the colour marking of pipelines conveying fluids commonly found on the treatment works

(c) A table (Table 2) which gives the colours adopted for certain electrical equipment and mechanical plant.

Throughout the Specification the colours used shall match the corresponding colours given in SANS Specification 1091, National Colour Standards for Paint: 2004 (as amended).

Where a colour code is not covered by this Specification, the matter shall be referred in writing to the Divisional Manager: Investment Delivery for ratification.

Table 1 : Colour Coding of Pipework on Johannesburg Water's Wastewater Treatment Works

Contents of Pipeline	Basic Colour	Colour Coding Indicator	
		Single Band	Second Band
Water, non-drinkable			
Cooling water	Brilliant Green		
Final treated effluent		White	
Recycled effluent		Black	Dark Violet
Air saturated effluent		Black	Dar Violet
Filtrate		Black	Aquamarine
Wash Water		Black	
Scum water		Black	Dark violet
Dewatering Liquors		Black	Dark Violet
Overflow from P.S.T's		Black	Crimson
Overflow from Clarifier		Black	Dark Violet
D.A.F Underflow		Black	Crimson
Supernatant Liquor		Black	Avocado
Overflow Gravity Thickener		Black	Crimson
Fire Fighting			
Boiler feed		Cornflower	
Hydraulic power		Salmon Pink	-
Poly-electrolyte		Light Grey	-
Raw sewage		Middle Brown	-
Settled sewage		Mid-grey	-
Thickener overflow from:			
Primary sludge		Crimson	-
Activated sludge		Canary Yellow	-
Digested sludge		Maroon	-
DAF liquors		Canary Yellow	Turquoise Blue
Filtrate		Ultramarine	-
Washwater		Black	-
Scum water		Dark Violet	Crimson
Treated effluent		Dark Violet	-
Dewatering liquors		Black	Ultramarine
Acids	Jacaranda		
Ferric chloride		Crimson	
Ferric sulphuric		Artic Blue	

Contents of Pipeline	Basic Colour	Colour Coding Indicator	
		Single Band	Second Band
Alkalis			
Lime Slurry	Dove Grey		
Gases			
Sludge gas	Light Stone	Jacaranda	
Steam	Pastel grey	Aluminium	Clad/lagging
Nitrogen	Light Stone	Black	Light Grey
Hydrogen	Light Stone	Black	Signal Red
Methane (digested)	Light Stone	Turquoise Blue	
Carbon dioxide	Light Stone	Light Grey	
Chlorine/Hypochloride	Canary Yellow		
Oxygen	White		
Compressed Air	Artic Blue		
Ventilated Air	Artic Blue		
Vacuum Air	Artic Blue		
Instrument Air	Artic Blue		
Sludges			
Anaerobically digested	Middle Brown	Maroon	
Anaerobically digested: thickened		Maroon	Light Grey
Raw Sludge	Dark Violet		
Lime treated	Dark Brown	Dove grey	
Primary	Dark Brown	Crimson	
Primary thickened	Dark Brown	Crimson	
Digester supernatant liquor	Middle Brown	Salmon Pink	
Activated : mixed liquor	Royal Blue	Canary Yellow	
Activated : gravity thickened	Royal Blue	Canary Yellow	Dark Violet
Activated : return sludge	Royal Blue	Canary Yellow	Middle Brown
Activated : DAF overflow/float	Royal Blue	Canary Yellow	Turquoise Blue
Activated : primary	Royal Blue	Canary Yellow	Crimson
Activated : digested	Royal Blue	Canary Yellow	Maroon
Activated : waste	Royal Blue	Canary yellow	
Pasteurised	Light Brown		
Oil			
Diesel oil	Black	White	
Hydraulic oil	Golden brown	Salmon Pink	
Lubricating	Golden brown	Brilliant Green	
Transformer	Golden brown	Crimson	
Other Liquids			
Polyelectrolyte	Golden Yellow	Jacaranda	
Cooling liquid	White		

Notes: This table supplements SANS 10140-3: 2003

All codes are in relation to SANS 1091: 1975

Table 2: Colour Coding of Electrical Equipment and Mechanical Plant

Item	Colour	Remarks	Code to SANS 1091
Electrical panels : (external)	Light Orange	NOSA	B.26
Electrical panels : (external) emergency power on	Signal Red		A.11
Electrical panels : (Internal)	White		G.80
Coupling guards and motor guards	Golden Yellow	SANS 10140-2	B.4
Motor cowls	Light Orange	Historical	B.26
Electrical motors, pumps and compressors	Deep Pastel Green		H.28
Gearboxes	Navy Light Grey	NOSA: See also "Small Gearboxes"	G.35
Blower	Deep Pastel Green	NOSA	H.28
Baseplates	Olive Drab		
Cranes	Golden Yellow		B.4
Valve bodies		See SANS 10104-3, Clause 4.2	
Valve hand-wheels			
Small gearboxes	To be same colour as prime mover		

G01.1.1 Machined Components

All machined components shall be protected by "Tectyl" or similar proprietary coating after manufacture. The coating shall be sufficiently durable to prevent corrosion during storage and installation and shall be removed using the manufacturers recommended solvent after final adjustment of the equipment. Final paining shall be carried out in accordance with the system specified.

G01.1.2 Records

The contractor and sub-contractors shall maintain records of the application environment, dates of applications, conditions of surfaces before preparation, blast profiles, wet and dry film thicknesses, overcoating times, paint types and batch number, method of application, tests and type of instruments used, which shall be incorporated into the Component Quality Plan and be available to the Engineer or his Representative for review and surveillance. Two copies of the completed Component Quality Plan shall be provided within 2 weeks of completion of the corrosion protection system.

G01.2 MEASUREMENT AND PAYMENT

For the purpose of this Contract the electro-mechanical items shall be supplied and installed conforming to this specification. The cosmetic panting application shall be included for and the surface preparation, transporting of equipment to and fore from the applicator shall be included for. No separate measurement item shall be included for the application of these coatings.

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PARTICULAR SPECIFICATION

G02: CORROSION SPECIFICATION

2	2013-10-23	Minor updates and re-issued	J Ritchie	
1	2009-05-12	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
Rev	**Date**	**Description**	**Signature: JW Wastewater Partnership**	**Signature: Approval from Johannesburg Water**

Golder Associates

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Corrosion Protection Specification for Civil, Mechanical and Electrical Engineering Construction

2006 Edition

FOREWORD

Golder Associates Africa (Pty) Ltd require that the series of Code of Practice for Corrosion Protection (SANS 10120–HC) and Standardized Specifications for Corrosion Protection (SANS 1200 -HC) be applied in their designs and contracts

The series covers the following disciplines:

A. General	K. Brickwork and masonry work
B. Site investigation	L. Pipework
C. Site clearance	M. Road surfacing and paving
D. Earthworks	N. Railway track work
E. Geotechnical processes	R. Harbour and marine works
F. Piling, caissons and cylinders	S. Electrical works
G. Concrete	T. Mechanical work
H. Steel and other metalwork	U. Building work
J. Structural timber	V. Sundries

Each discipline has several sub-sections written or being written for it. The Corrosion Protection sub-section has so far been written for Structural Steelwork (10120-HC and 1200HC). These specifications, however, do not cover all the other disciplines adequately.

This document contains the supplementary requirements of **Golder Associates Africa (Pty) Ltd** to cover the Corrosion Protection of more disciplines of Civil Engineering Construction.

It is required to be used by

- Engineers commissioned by **Golder Associates Africa (Pty) Ltd** to design and provide particular specifications for Corrosion Protection and Painting of Civil Engineering Works, and / or
- Tenderers invited by **Golder Associates Africa (Pty) Ltd** to design or design and construct, amongst others, the Corrosion Protection and Painting of Civil Engineering Works

> NOTE:
> Where any clause in this document is in conflict with any of those in the SANS documents, the meaning and requirements of the clause in this document shall prevail

NOTICE

Conditions of acquisition or purchase of this document

It is expressly agreed that any person acquiring this document does so for the sole purpose of the submission of a *bona fide* tender to **Golder Associates Africa (Pty) Ltd**. He shall not disclose, furnish or otherwise allow use to be made of the whole or any part of the contents of the document or the document itself to any person other than that for the purpose of allowing that person to assist in or fulfil the necessary requirements relating to the submission of a *bona fide* tender for **Golder Associates Africa (Pty) Ltd**

COMMENTS and ERRATA to be notified to:

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Where conflict exists between this document and any National or International Standard, the requirements of this document shall take precedence, unless otherwise agreed by the Engineer.

CONTENTS

This document comprises:-

GENERAL REQUIREMENTS

CONTENTS OF

GENERAL REQUIREMENTS

1 SCOPE

This specification covers materials and procedures used for corrosion protection of materials of construction in various environments. The specification is intended for use with mechanical, civil and electrical engineering contract documentation and provides specific information and instructions on how to optimise the corrosion resistance of the materials of construction.

NOTE: The standards referred to in the specification are listed in Appendix A

2 INTERPRETATIONS

2.1 REFERENCES

2.1.1 Code of Practice

The recommendations of SABS 0l20, have been incorporated into this specification in so far as they are applicable

2.1.2 Supporting Specifications

Where this specification is required for a project, the following specifications shall, inter-alia, form part of the contract document:

(i) Project specification

(ii) SANS 1200 A, SANS 1200 AA or SANS 1200 AH, as applicable

(iii) SANS 1200 H, SANS 1200 HA and/or SANS 1200 HB, as applicable

(iv) SANS 1200 HC, as applicable

2.1.3 Date of issue of specifications and data sheets

The latest issue of specifications and data sheets shall be applicable

2.2 DEFINITIONS:

ACCEPTABLE - Acceptable to the Engineer

ACCEPTABLE QUALITY LEVEL (AQL) - The maximum percentage defective or the maximum number of defects per 100 items that, for the purpose of sampling inspection, can be considered satisfactory as a process average

COATING - A continuous material, which may be metallic or non metallic, applied and bonded to a surface for the purpose of protecting the surface from degradation by the environment or for the purpose of improved appearance or for identification

CONCESSION - A written authorisation from the Engineer to accept an item that is found to have departed from the specified requirements but nevertheless is considered suitable for use 'as is' or after rework by an approved method, in which case a re-inspection will be required

CONFORMANCE - the fulfilment by a product, process, or service of specified requirements

DEFECTIVE - a coating or lining that fails to meet one or more of the requirements of the specification

DELTA LAYER - the second layer of zinc-iron alloy growth from the base steel formed during the galvanizing process; the Delta layer's chemical composition is approximately 90% zinc and 10% iron; the Delta layer is 60% harder than the base steel it protects from abrasion and corrosion

DRY FILM THICKNESS (D.F.T.) - the thickness of a coating or lining after it is hard dry

ELECTRICAL INSULATION DEFECT (E.I.D.) - Defects in a coating or lining that impair the protective properties of the coating or lining and that are detected instrumentally by either:

(i) a low-voltage, wet-sponge detector, or

(ii) a high-voltage, sparking detector, operated in each case within the parameters specified

NOTE: E.I.D's include such defects as steel projections from the substrate, conductive particles embedded in the coatings or linings, voids and those defects commonly known as pinholes and holidays

ENGINEER - The Engineer responsible to the Purchaser for the execution of the contract

IDENTIFICATION - A means of identifying a specific item by means of a unique combination of numbers and/or letters that will enable subsequent traceability of the item

INDUCTION PERIOD - The period after the proper amounts of base and curing agent components of a two-pack coating material have been added together and thoroughly mixed, and then allowed to stand to enable the initiation of the chemical reaction, prior to any necessary thinning and the application of the coating material

INSPECTOR - A person authorised by the Engineer to act as his representative in examining the work and materials and in drawing such samples and carrying out such tests as may be necessary to ensure compliance with specification

LINING - A coating applied to the inside of a component such as a pipe, valve or pump body, for the purpose of protection of the inside surface. A lining may also be applied in order to reduce wall friction

LOT - A number of similar or related items submitted for inspection at one time by the contractor and of such size that the inspector can reasonably be expected to examine adequately in not more than one working day

PAINT - A liquid material that, when applied as a thin film to a suitably prepared surface by an appropriate method, undergoes a physical or chemical change (or both) that converts it to a solid coating or lining bonded to the surface to which it is applied

POT LIFE - The period, after the contents of the packs of a two-pack coating material have been mixed together, during which the paint remains suitable for use without the addition of further solvent

POWDER COATING - A material in the form of a dry, free flowing powder that, when applied to a suitably prepared steel surface by an appropriate method, can be fused by application of heat and subsequent cooling to form a continuous coating or lining that is bonded to the surface

QUALITY - Totality of features, properties and characteristics of a product, process or service that bear on its ability to satisfy the stated or implied needs

QUALITY ASSURANCE - All those planned and systematic actions necessary to provide adequate confidence that a product, process or service will satisfy given quality requirements

QUALITY AUDIT - A systematic and independent examination to determine whether quality activities and results comply with planned arrangements and whether these arrangements are effectively implemented and are suitable to achieve objectives. The intent of a Quality Audit is an independent review and evaluation so that needed corrective action can be obtained

QUALITY CONTROL - the operational techniques and activities that are employed by the contractor to ensure the required quality of a product, process or service

QUALITY PLAN - A document setting out the specific quality practices, resources and activities relevant to a particular contract or project

QUALITY PROGRAM - A documented set of activities, resources and events serving to implement the Quality System to a time schedule

QUALITY SURVEILLANCE - the continuing evaluation of procedures, methods, conditions, products, processes and services and analysis of records to assure that quality requirements will be met

ROCKGUARD OR ROCKSHIELD - Material intended to be wrapped around the outside of a coated pipe to prevent physical damage to the coating, but that otherwise plays no part in the corrosion protection of the pipe

SOLVENT (i) That part of a liquid coating material that volatilises from the film during the drying process, or

(ii) a Volatile liquid compatible with a coating material and used for the purpose of cleaning equipment used in the application of a coating material

(iii) The active component of a degreasing material

NOTE - The coating manufacturer's recommended solvent for each application and for each product shall be strictly followed.

TAINT - The property of imparting or having an objectionable odour or taste, or both

TOTAL DRY FILM THICKNESS - the thickness of all the coats in a coating or lining system measured after the last coat is hard dry

TOXICITY - the ability of a substance to produce injury to a living being

TRACEABILITY - the ability to trace the history, application or location of an item or activity and like items or activities by means of recorded identification

WATER BREAK FREE - A surface which, when wetted all over with plain potable water, maintains a continuously wet surface and the water does not break up into islands of un-wetted surface

WEBER-RIELLY TEST – a test for water soluble salts remaining in pitted steel after abrasive blast cleaning. (Water soluble salts result in the formation of osmotic blistering of the coating after immersion). A white indicator paint is sprayed on the surface. If ferrous salts are present, the indicator turns pink or red, depending on the salt concentration. (This is a test for iron salts in the ferrous state and is not a test for chloride ions)

WET FILM THICKNESS (W.F.T.) - the thickness of a coating or lining immediately after application and before any volatile matter has evaporated

3 MATERIALS OF CONSTRUCTION

The engineer of the 21st Century has at his disposal a vast array of materials of construction and a great many ways of preserving these materials against deterioration.

Quality, availability and price will always dictate the extent of the use of any particular raw material.

The materials covered in this specification are those readily available in Southern Africa viz.

Stainless steel

Corrosion resistance steel

Aluminium

Galvanized mild steel

Painted mild steel

- and materials of civil construction, such as reinforced concrete, cement plaster finishes, fibre cement products and timber.

Materials not covered in this specification are polymers and plastics - e.g. rubbers, polycarbonates, glass reinforced plastics, high, medium and low density polyethylene(LDPE), polyvinylchloride (PVC), nylon, Teflon, Kynar® - etc, etc. which are generally corrosion resistant materials in their own right but it is nevertheless advisable to seek advice as to their exact use and suitability for any particular environment. For example PVCs and polyvinyledene chlorides are degraded by high heat conditions and can produce chlorine, which is itself a highly corrosive gas.

Mild steel is the metal most used for fabrication because of its relatively low price, easy availability and ease of fabrication. However mild steel corrodes (reverts to the oxide form in the presence of oxygen and water). There are two principal ways to prevent this, i.e. cathodic protection which reverses the electrochemical reaction (this only works if the metal is immersed or buried in a conductive medium) or coating (painting) which insulates the steel from the corrosive environment.

As there are many environments and very many coatings available, much of this specification is devoted to classifying the environments and detailing the use of the few reliable coating systems which are known to give good service in these environments. It is not easy to achieve good coating quality! The specification details quality control and testing procedures necessary to produce lasting performance.

It must be added that the original Specifications in this Document have been used for the last 20 years with excellent results.

4 DESIGN

4.1 THE EFFECT OF DESIGN ON CORROSION FREE LIFE

All items shall be designed to minimise corrosion in the environment to which they will be exposed. The following notes may be used as guidelines:

4.1.1 Water Retention Areas

Water retention areas shall be avoided wherever possible. For example, angle or U section steel should be used with the toes pointing downwards. The concrete base of steel columns should be sloped away from the steel and the sloping edge should be painted (sealed) to avoid water ingress at the steel/concrete interface

4.1.2 Crevices

Crevices give rise to accelerated corrosion by forming an oxygen concentration cell. Crevices shall be avoided by using:

(i) Continuous welding should preferably be used. Where discontinuous welding (space welding) is used the gap should be wide enough to allow abrasive blast cleaning and correct painting or, if the gap is too narrow it should be designed so that it may be effectively sealed with a mastic or sealant.

(ii) Mastics or sealants to seal unavoidable crevices such as bolted connections

(iii) Insertion rubber or suitable impermeable gasket material between mating surfaces

4.1.3 Bimetallic Couples

Electrical contact between dissimilar metals gives rise to a corrosion cell when an electrolyte such as water is present. Junctions between dissimilar metals shall be insulated or effectively sealed against water ingress. Where insulation is not possible cathodic protection should be employed.

4.1.4 Accessibility

Whenever possible, the surfaces of corrodible materials such as mild steel shall be accessible for maintenance. The use of back to back angles, partially open box sections or inaccessible stiffeners should be avoided

4.1.5 Differential Aeration

Posts buried in soil are subject to accelerated corrosion due to differential aeration. Additional protection shall be given to that part which is buried and up to at least 800mm above ground. Similarly, tanks should not stand on the ground or on a concrete bed but shall be fitted with legs to ensure that there is no contact between the tank base and its bed. Where legs cannot be used, the tank shall stand on a concrete base, after coating the base of the tank with the full Corrosion Protection System. The edges of the concrete base shall be sloped away from the tank. The joint between tank and base shall be sealed with suitable mastic or sealant. As an additional precaution cathodic protection may be employed to protect the underside of the tank bottom.

4.1.6 Sharp edges and welds

The designer shall specify that all sharp edges shall be ground to a radius not less than 3mm or half the steel thickness and that all rough welds, undercuts, weld spatter and weld slag shall be removed by the Fabricator. (Refer also to Clause 5.2)

4.1.7 Cathodic Protection

Where cathodic protection is to be used on buried or immersed items or items imbedded in concrete, care shall be taken to ensure that the necessary bond continuity or insulation, as required, is included in the design. Provision must be made in the design stages to provide access for cables, reference electrodes and test point connections prior to construction. A qualified and experienced cathodic protection engineer should be employed at the design stage

4.1.8 Components to be galvanised

The design of components which have to be galvanised is very important to both the quality of the galvanising which will be achieved and to the integrity of the component i.e. with regard to distortion due to uneven expansion during dipping into molten zinc at 450°C - there is also a risk of explosion if the items are not vented or positioned correctly!

Design parameters are thoroughly covered by existing specifications which are mentioned in Section 6.2 below.

5 METAL FABRICATION

5.1 WELD QUALITY

All welding shall be carried out by coded welders to International Welding Standards. Weld quality shall comply with the requirements of the Engineer

5.2 WELDS SMOOTH

All welds shall be smooth, continuous and free from porosity, projections or undercuts. Rough welds shall be ground where necessary to achieve the required smooth profile. Undercuts or blowholes shall be re-welded and ground to a smooth surface.

5.3 CUT EDGES

All cut edges and drilled holes shall be de-burred and ground to a radius of not less than 3mm. If the steel thickness is less than 6mm, the radius of curvature of the edge shall be 50% of the thickness

5.4 WELD PICKLING AND PASSIVATION

All welds and heat affected areas of stainless and corrosion resistant steel shall be pickled and passivated as specified in Clause 7.2

5.5 COMPONENTS TO BE GALVANISED

If the component is required to be hot dip galvanized, refer to Clause 6

5.6 SAFETY PRECAUTIONS

The Contractor shall, at all times, observe all applicable legislation according to the **Occupational Health and Safety Act, No. 85 of 1993** and any relevant municipal bylaws and environmental legislation.

6 HOT DIP GALVANIZING

6.1 THE HOT DIP GALVANIZING PROCESS

6.1.1 Specifications

Hot dip galvanizing shall comply with SANS 121:2000/ISO 1461:1999 for fabricated articles and pipes, SANS 3575:1996/ISO 3575:1996 for strip galvanized sheet or SANS 675:1997 for fencing wire.

NOTE that the thickness of zinc coating varies according to the substrate galvanized:

Rolled steel sections – SANS 121:2000 / ISO 1461:1999 specifies minimum thickness according to the thickness of the substrate, e.g. steel of 5mm and greater thickness shall have a coating not less than 85 microns thick (normal grade) or minimum 105 microns if Heavy Duty is specified. Steel of less than 2 mm thickness is specified to have a minimum coating thickness of 45 microns (55 microns for Heavy Duty)

Sheet steel – SANS 3575:1996/ISO 3575:1996 or SANS 4998 :1996 / ISO 4998:1996 (structural quality) for strip coated sheet steel allows the purchaser to select the thickness required. For the purposes of this specification, only the following two grades need be considered:

- Z275 (Commercial grade) shall be used only when the galvanized steel is to be painted for aesthetic appearance or for colour coding. Average zinc coating thickness is 20 microns with the minimum being 17 microns

- Z600 (Heavy duty grade) may be used where galvanizing is the only specified method of protection. This is specified as average thickness of 43 microns with a minimum of 36 microns

Plain or barbed fencing wire - SANS 675:1997 specifies different galvanizing thicknesses for different wire thicknesses. The range of average thickness is 30 - 40 microns. NOTE: Galvanizing wire to SANS 935 is not acceptable for the purposes of this specification since the galvanizing thickness is too low for adequate corrosion protection in sewage and water purification works.

Tubing for structural purposes – SANS 32 :1997 / EN10240:1997– for plain ended round or square tubing up to 200mm diameter.

6.1.2 Thickness of galvanizing on steels of different metallurgical composition

The above specifications were written around galvanizing on aluminium killed steels which build up a relatively thin ‘delta’ layer. However silicon killed steels build up a thick delta layer very quickly when immersed in molten zinc. This results in relatively high thicknesses of galvanizing. Whereas these thicker layers result in additional protection against corrosion they are also relatively brittle and tend to delaminate on impact.

NOTE: It is the responsibility of the contractor to determine the metallurgical nature of the components prior to galvanizing. Poor quality of corrosion protection due to excessive thicknesses of galvanizing will result in rejection of the items.

6.1.3 Mating Surfaces

Mating surfaces on fabricated or cast iron components shall be wiped or centrifuged on removal from the galvanizing bath to remove blobs, runs or excess metal that may impair the air/gas/water tightness of the joint. This requirement must be specified to the galvaniser when ordering.

6.1.4 Fasteners

Bolts, nuts and washers used for fixing galvanized components shall be hot dip galvanized to SANS 121:2000/ISO 1461:1999. Electroplated fasteners will not be accepted unless otherwise agreed by the Engineer in writing

6.2 DESIGN AND FABRICATION

Components for hot dip galvanizing shall be designed and fabricated as recommended in SANS 14713:1999/ ISO 14713:1999 except that the use of lead plugs is not permitted

It is recommended that the manufacturer consults the galvaniser before design and fabrication to ensure that the fabrication will be suitable for galvanizing

The main requirements are as follows:

(i) Overlap joints shall be avoided wherever possible. If essential, such overlap joints shall be thoroughly degreased before assembly and shall be vented by drilling holes through one or both overlapping materials

(ii) Closed sections shall be suitably vented. If the inside of a closed section is not to be galvanized, a snorkel vent tube of suitable length and bore shall be attached

(iii) Gussets and internal baffles in tanks shall be cropped to allow free flow of zinc and air

(iv) Joints shall be continuously welded, using balanced welding techniques to avoid stresses. Welds shall be free from cavities, undercutting, weld slag and spatter

(v) Symmetrical design shall be used whenever possible and the use of thin gauge steel adjacent to heavy section shall be avoided

(vi) Openings and the flanges of manholes and bosses shall finish flush on the inside to ensure complete drainage

(vii) Castings shall be designed to be of a uniform section as possible and shall be blast cleaned in accordance with Clause 10.5.3 before despatch to the galvaniser

6.3 REPAIR OF GALVANIZED ARTICLES

Welding, flame cutting, or other heat processes shall not be carried out on galvanized articles unless permission is granted by the Engineer

If such permission is given, or if mechanical damage has occurred, repairs shall be carried out as follows:

(i) All scale, spatter and flux shall be removed by grinding and washing with clean water. Edges shall be ground to a radius not less than 2mm

(ii) The preferred repair process is to blast clean to bare steel and apply zinc by the thermal spray process in accordance with SANS 1391, Part 1, Grade Zn150. On completion of metal spraying, burnish the surface by means of a mechanical wire brush to give a uniform appearance. Burnishing shall remove not more than 10 microns of zinc

(iii) Where small areas are to be repaired, clean the surface thoroughly with fine abrasive paper, remove all debris with a damp cloth and allow to dry. Repair by application of an approved solvent free zinc rich repair coating. A sufficient number of coats shall be applied such that the repair coating thickness is not less than the average zinc thickness specified in the appropriate galvanizing specifications. The repair shall extend not less than 5mm beyond the damaged area. On completion of the repair and when the zinc rich primer is completely dry, one coat of acrylic resin based aluminium paint may be applied.

NOTE: Repair of galvanized surfaces by application of aluminium paint alone is not permitted

6.4 STORAGE OF GALVANIZED COMPONENTS

Galvanized components shall be stored to avoid the formation of 'white rust' or other forms of storage staining

Components shall be separated and supported on wooden battens to ensure adequate ventilation of all surfaces and in such a manner to avoid 'ponding' by rainwater

If storage staining does occur, remove the stains by scrubbing with detergent solution and bristle brush or nylon pad. The use of steel wool or other metallic abrasives is not permitted.

Rinse thoroughly and allow to dry. If the residual zinc thickness complies with the requirements of the appropriate grade in the relevant specification, no further action is required unless instructed by the Engineer

If the cleaned zinc thickness is below specification, the article shall be re-galvanized or repaired in accordance with Clause 6.3, as decided by the Engineer

7 STAINLESS STEEL FABRICATIONS

7.1 GRADE AND WELDING TECHNIQUES

The grade of stainless steel to be used shall be as specified in the appropriate section of the specification or drawings. Where welding is necessary, the appropriate "L" grade (low carbon content) shall be used. Plate used in fabrication shall be supplied as No.1 Finish in accordance with BS EN 10151

Welding procedures shall be only those recommended by the stainless steel manufacturer or by the South African Institute of Welding. Only welders coded to ASME IX, 2004 shall be employed

Welds shall be smooth and free from blowholes, undercuts, sharp projections and similar visual defects

Fabrication of stainless steel components shall be carried out in clean work places where there is no contamination by mild steel. Grinding and polishing equipment shall be dedicated and shall not be contaminated with iron or mild steel

Stainless steel shall be suitably handled to avoid scratching the surface

7.2 PICKLING AND PASSIVATION

Cut edges, welds and heat affected surfaces shall be pickled and passivated to remove all discolouration. Proprietary pickling and passivating pastes (as supplied by Duva Chemicals (Pty) Limited, or other approved supplier) shall be used in accordance with the manufacturer's recommendations. Care shall be taken not to exceed the maximum contact time recommended. No heat discolouration shall remain after completion of pickling and passivating

After passivation, surfaces shall be very thoroughly washed with clean potable water to remove all traces of acid. The surface shall be allowed to dry, then polished where necessary, using polishing compounds recommended by the stainless steel manufacturers or the South African Stainless Steel Development Association

7.3 SAFETY PRECAUTIONS

(i) Operatives shall wear protective aprons, gloves and safety glasses during pickling and passivating

(ii) Splashes on the skin shall be thoroughly washed with clean water immediately after contact. A weak solution of sodium bicarbonate shall be kept available for neutralization. Seek medical attention if in doubt

(iii) Disposal of effluent shall be in accordance with the requirements of the local authority in whose area the work is being carried out

Note: these pickling chemicals are solutions of nitric and fluoric acid and must be treated with extreme care! The Material Safety Data Sheets (MSDS) shall be supplied by the manufacturers of the chemicals used, for reference in case of emergencies

8 CORROSION RESISTANT STEEL 3CR12 FABRICATIONS

8.1 ACCEPTABLE QUALITY OF PLATE

The 3CR12 plate shall be of an acceptable quality, free from inclusions from the rolling process or any other defects which may affect the long term corrosion resistance of the fabricated item. If necessary the plates shall be hand selected for fabrication by the Engineer's metallurgical inspector.

8.2 WELDING TECHNIQUES

Welds shall be full penetration welds, using 309 austenitic electrodes or filler wire, or special electrodes as recommended by Columbus (Pty) Limited

Welders shall be suitably coded for welding similar thickness of austenitic stainless steel, in accordance with ASME IX, 2004

Welding procedures shall comply with the recommendations of Columbus (Pty) Limited

Welds shall be smooth and free from blow-holes, undercuts, sharp projections and similar visual defects

8.3 PICKLING AND PASSIVATION

8.3.1 Areas to be cleaned

After completion of welding, both weld and heat affected zones shall be cleaned, pickled and passivated. Any heat scale, including that on the reverse side of the weld, shall be removed by pickling and passivation.

8.3.2 Procedure

(i) Grind or wire brush, using dedicated grinders or stainless steel wire brushes to achieve the required smooth profile or remove scale

(ii) Pickle with a proprietary thixotropic paste containing 15-20% nitric acid and 1-2% hydrofluoric acid, with a contact time of 10 to 15 minutes

(iii) Rinse thoroughly with clean water until the pH of the washings is the same as that of the wash water

(iv) Repeat the above process, if necessary, to remove all discolouration

(v) Passivate with 10% nitric acid solution, or a proprietary passivating paste, for a contact time of 10 - 15 minutes, keeping the surface wet during this period

(vi) Neutralise thoroughly with an approximate 10% solution of sodium bicarbonate in water, scrubbing the solution into the surface using 'Scotchbrite®' abrasive pads. Rinse thoroughly using clean potable water until washings are the same pH as the wash water.

8.3.3 Safety Precautions

(i) Operatives shall wear protective aprons, gloves and safety glasses during pickling and passivating (it should be noted that these pickling chemicals are solutions of nitric and hydrofluoric acid and must be treated with extreme care!!)

(ii) Splashes on the skin shall be thoroughly washed with clean water immediately after contact. A weak solution of sodium bicarbonate shall be kept available for neutralisation. Seek medical attention if in doubt

(iii) Disposal of effluent shall be in accordance with the environmental requirements of the local authority in whose area the work is being carried out (See Clause 5.6)

9 ALUMINIUM FABRICATIONS

9.1 GRADE OF ALUMINIUM

The grade of aluminium or aluminium alloy shall be as specified by the Engineer or as recommended by the aluminium manufacturer for the specific application

9.2 ANODIZING

Aluminium components where specified as anodized shall be natural anodized and sealed in accordance with SANS 999 Grade 25. The corrosion resistance of the coating shall be not less than 8 when tested in accordance with 3.6 of specification SANS 999. Anodizing shall be carried out after completion of all welding

9.3 POWDER COATING

When specified by the Engineer, aluminium fabrications may be coated with exterior grade polyester powder. Such coating may only be carried out by contractors with the necessary plant, equipment and experience to pre-treat and powder coat aluminium effectively. The coating shall comply with SANS 1578 Part 1 and 2, or BS. 6496

9.4 CONTACT WITH CONCRETE

Whenever aluminium components, such as hand rail posts, come into contact with concrete or grout, the surface of the aluminium in contact with the concrete shall be coated with two coats of an approved epoxy tar composition, prior to the grouting.

9.5 CONTACT WITH MILD STEEL

When aluminium components are bolted to mild steel, plastic or rubber inserts shall be used to insulate the aluminium from mild steel. Fasteners shall be 304 stainless steel bolts, nuts and washers.

9.6 ALUMINIUM ROOF SHEETING

Aluminium roof sheeting should be used exactly according to the manufacturer's directions for use. Only approved contractors qualified to erect aluminium roofing shall be used. The fixing of the sheets is critical - far more so than the fixing of mild steel painted sheet because of the fact that aluminium is anodic to steel - i.e. it will sacrifice itself to protect the steel with which it is in contact. Therefore holes will get larger to the point where the roof/cladding sheets will detach from the fixings. This corrosion is accelerated by the accumulation of dust and dirt especially if the build-up is acid or alkaline or contains conductive ions e.g. salt

The manufacturers recommend the use of insulated stainless steel fixings and insulation tape separating the sheets from the supporting purlins/girts. Where this type of sheeting is used in corrosive environments it should be specified to be painted with PVF_2 on both sides and the sheeting should be designed to not allow accumulations of product or dirt to be in contact with the sheets. The sheets must not be in contact with the ground. This type of sheeting may only be used where high standards of cleanliness and maintenance are kept.

10 PAINTING AND APPLICATION OF ORGANIC COATINGS

10.1 MATERIALS

10.1.1 Paint Supplier

All materials in a paint system shall be purchased from one supplier. The contractor shall supply the paint supplier with a copy of the relevant sections of the specification. The paint supplier shall certify, by completion of the Form given in Appendix C, that the materials to be supplied comply with the relevant specification and are suitable for the intended purpose. The manufacturer shall preferably be a supplier of assessed capability listed under SANS ISO 9002 - 2000

10.1.2 Approval of paints

The Contractor shall submit with his tender, the appropriate form (See Appendix B) giving details of the paints he intends using and shall only proceed with the purchase of the paints upon receipt of written approval from the Engineer. Manufacturers' data sheets or legible copies thereof for each product shall be attached to the form

10.1.3 SABS compliance

Materials shall comply with the appropriate SANS specifications when relevant

10.1.4 Paint not changed without approval

No variation in brand or materials quoted in the tender documents and approved by the Engineer shall be permitted without the approval of the Engineer in writing

10.1.5 Containers

All coating materials shall be delivered in the manufacturer's original sealed containers, clearly marked with the following:

(i) Manufacturer's name

(ii) Product Brand and Reference Number

(iii) Volume of contents

(iv) Batch Number which may incorporate the date of manufacture

(v) Date of manufacture, unless already incorporated in the batch number

(vi) Abbreviated instructions for storage and use of the material, and/or reference to an appropriate data sheet which shall include mixing ratios of components of multi-component materials, minimum temperature of application, method of application, and minimum and maximum over coating times, where applicable

(vii) The SANS mark where applicable

10.1.6 Manufacturer's instructions:

Recommendations supplied by the manufacturer in the form of the latest edition of printed data sheets, or given in writing on the manufacturer's letterhead, shall be followed. Any conflict between the manufacturer's data sheet and the specification shall be referred to the Engineer for adjudication

Verbal information by the manufacturer's representative will not be accepted unless confirmed in writing by the company, on their printed letterhead, and signed by an authorised officer of the company

10.2 STORAGE

10.2.1 Approved store

All coating materials shall be kept in an approved store, which shall be dry, enclosed and where the temperature will not exceed 40°C or drop below 0°C

10.2.2 Paint freshness

Usage of materials shall be on a first in, first out basis and no materials may be used which have exceeded the shelf life recommended by the manufacturer

10.2.3 No smoking

No smoking shall be permitted in or near a paint store

10.2.4 Combustibles separate

Solvent containers shall be kept sealed in the store with adequate air circulation and floor level vents. Solvent or paint soaked rags, cotton waste or other spontaneously combustible material shall not be kept in or near the store. Precautions shall be taken to prevent the discharge of static electricity in areas where flammable solvent is stored.

10.2.5 Further safety requirements

Stores shall be provided with adequate and suitable fire extinguishers placed outside the entrance in a prominent position. A separate store shall be provided for tools, equipment, protective clothing and personnel. The paint store shall not be used to accommodate personnel at any time

10.3 COATED MANUFACTURED ITEMS

When items are purchased already coated, the contractor shall supply to the Engineer full details of materials used, method and standard of surface preparation, method of application and curing, and total dry film thickness of the coating. Such items will be subject to inspection and approval by the Engineer before acceptance

10.4 GENERAL

(i) The contractor shall ensure that he has available the latest edition of all the relevant National Specifications and Codes of Practice and the manufacturer's data sheets for materials to be used

(ii) Requirements specified in Clause 3 shall be adhered to

(iii) Strict attention shall be paid to fettling of surfaces by the Fabricator (see Clause 5 above) prior to coating. Should the painting contractor receive components not fettled in accordance with Clause 5, he shall arrange with the Fabricator to have the work carried out before commencement of painting. In case of dispute, the decision of the Engineer shall be final.

(iv) Areas which are inaccessible after assembly shall be prepared and fully coated with the specified system and to the specified requirements before assembly. The coating shall be fully hard dry and every care shall be taken to avoid damage to the coating during assembly.

(v) Mating surfaces (other than friction grip surfaces) shall be coated with primer or first coat only. The coating shall be uniform in thickness and shall not interfere with the mechanical tolerances. After assembly the joint shall be fully coated and if to be immersed, shall be totally sealed

(vi) The painting sub-contractor shall provide evidence of his competence to apply the specified materials in the specified manner and to apply the necessary Quality Control procedures. The Engineer, at his discretion, may demand a Quality Audit of the Contractor's facilities by a technically competent and independent organization. The audit shall be carried out at the Contractor's cost

If consistent and satisfactory results are not achieved with the plant and equipment used by the Contractor, the Engineer may order the Contractor to obtain and use such plant and equipment as may be necessary to achieve the required results

All plant, equipment and temporary works which are supplied by the Contractor shall at all times be maintained in good working order

On completion of the Contract, all such plant, equipment and temporary works shall be removed from the site

(vii) The Contractor shall provide a Quality Plan to show the stages at which Quality Control will be carried out. Further details are given in Section 13. The Quality Plan is subject to approval by the Engineer, who may require it to be revised if considered inadequate. The cost of revision shall be borne by the Contractor

(viii) The Engineer will require a Program of Work so that Quality Surveillance inspection can be planned and executed at the appropriate time according to the Contractor's program

10.5 SURFACE PREPARATION OF MILD STEEL FOR PAINTING

10.5.1 Oil and Grease Contamination

Oil and grease shall be removed by a bio-degradable, water rinsable, emulsion solvent degreaser, followed by rinsing with clean potable water, after which the surface shall be allowed to dry

10.5.2 For Mild, Non-Corrosive Conditions

Manually or mechanically clean the surface to remove all loose millscale, rust and solid contaminants in accordance with SANS 10064, Section 4.4. The standard of cleaning shall be not less than St 2 of ISO Standard 8501:1

10.5.3 For Corrosive and Highly Corrosive (Underwater) Conditions

Mild steel shall be blast cleaned in accordance with Section 4.3 of SANS 10064 Code of Practice for "The Preparation of Steel Surfaces for Coating"

WARNING: Steel less than 2mm thick may distort if blasted incorrectly

Note: Compressed air used for blast cleaning shall be dry, clean and free from oil

An additional requirement is that water soluble salts present in the steel after blast cleaning shall not exceed the values given in Table 1. Should these values be exceeded, the steel shall be cleaned by washing with clean potable water or by water shrouded or water injected blast cleaning until the soluble salts are within the limits specified in Table 1.

The steel shall then be allowed to dry, after which it shall be dry flash blast cleaned to achieve the required degree of cleanliness

Immediately before painting, the steel surface shall comply with the appropriate requirements of Table 1

TABLE 1 - STANDARDS OF BLAST CLEANING REQUIRED

Property:	Above water	Immersed surfaces
Cleanliness -ISO 8501:1:	Sa 2½ min	Sa 3 min
Residual dust and debris -ISO 8502:3:	0.5%	0.3%
Oil, grease and perspiration:	Nil	Nil
Surface profile -ISO Method 8503:2 1992: Grit Comparator - Refer Table 2	Medium (G) 50 - 70µm	Course (G) 85 - 115µm
Water soluble iron salts Maximum at any point -Weber Rielly test:	500 mg/m²	50 mg/m²

The cleaned surface shall be coated as soon as possible and not later than the times given in Table 2

TABLE 2 - MAXIMUM TIME INTERVAL BETWEEN CLEANING AND COATING

Ambient relative humidity	Maximum time (hours)
Below 50%	6
50-70%	4
70-85%	2
Over 85%	Coating not permitted – Re-blast and coat when relative humidity is again below 85%

10.6 SURFACE PREPARATION OF CAST METALS FOR PAINTING

Surfaces of cast metals to be painted shall be blast cleaned with new iron slag, copper slag, or platinum slag abrasives designed for blast cleaning. THE ABRASIVE SHALL NOT BE RE-CYCLED OR RE-USED. Cast iron shall be blast cleaned until all sand particles, residual burnt on sand and casting skin have been completely removed.

When castings are required to be coated with organic materials, any blowholes exposed in blast cleaning shall be filled with engineering grade metal filled epoxy filler, finished flush with the surface, before coating. Polyester fillers are NOT PERMITTED

10.7 SURFACE PREPARATION OF GALVANIZED STEEL FOR PAINTING

Galvanized steel surfaces shall be thoroughly degreased prior to painting, using either a water rinsable solvent degreaser, or a mild acid-detergent degreasing solution, both used in accordance with the manufacturer's instructions. In both cases care shall be taken to avoid entrapment of cleaning agent in recesses or other retention areas. In both cases, the surface shall be thoroughly washed until a 'water break free' surface is achieved. If necessary, the process shall be repeated until a 'water break free' surface is obtained

After degreasing, the surface shall be lightly abraded by one of the following methods:

(i) On small areas by the use of abrasive paper not coarser than 120 grade, or by using non-metallic abrasive pads

(ii) On large areas by 'sweep blast cleaning', using a nozzle pressure not greater than 300kPa and ultra fine abrasive (particle size not exceeding 1,0mm). Cracking, flaking or any form of delamination of the zinc coating due to excessive blast cleaning shall not be permitted. Removal of zinc by blast cleaning shall not exceed 15 microns

Finally, all dust and debris shall be removed by vacuum cleaning, or by washing, and the surface shall be allowed to dry before coating. Coating shall take place within the time limits given in Table 2 of Clause 10.5

10.8 SURFACE PREPARATION OF ALUMINIUM FOR PAINTING

Generally, aluminium surfaces will be anodized or powder coated and will require no further treatment.

Where painting is required, the aluminium surface must be smooth, clean and free of corrosion product. If the surface is corroded (white/grey corrosion product very adherent to the surface) it must be cleaned using fine grade (200 - 400#) ‘waterpaper’ to expose bright metal. The surface shall then be thoroughly degreased using a water rinsable degreaser, then rinsed with clean potable water. If the surface is not water break free, repeat the degreasing process until a water break free surface is obtained. Allow to dry completely, then apply a thin coat (8 to 13 microns dry film thickness) of two-pack wash primer complying with SANS 723, mixed and applied in accordance with the manufacturer's instructions.

Note: Wash primer is an adhesion promoter and does not replace the primer specified in the paint system.

10.9 SURFACE PREPARATION OF STAINLESS STEEL FOR PAINTING

Components fabricated from stainless steel shall not be contaminated with iron or mild steel from contact with equipment which has already been used for mild steel fabrication. Sheared edges, welds or surfaces subjected to any form of heat treatment shall be pickled and passivated. Stainless steel surfaces shall not be scratched or stressed

When it is required to paint stainless steel, the surface shall be blast cleaned, when practical, with an approved non-metallic abrasive such as aluminium oxide or platinum slag. The use of steel shot, steel grit or cast iron grit is strictly prohibited

Where blasting is impractical, the surface shall be cleaned with and roughened manually to the use by 'Scotchbrite®' abrasive pads, followed by washing with clean potable water to a 'water break free' surface. If a 'water break free' surface is not obtained, detergent cleaning shall be repeated until the surface is 'water break free'. Allow the surface to dry before coating.

Note:It is not advisable to paint a highly polished stainless steel surface such as bright annealed finish without some sort of roughening.

10.10 SURFACE PREPARATION OF 3CR12 CORROSION RESISTANT STEEL

Black Mill Finish - Degrease and blast clean the whole surface using an approved abrasive if painting is required

No.1 Mill Finish - Pickle and passivate weld areas in accordance with Clause 8.3. Thoroughly degrease with a water rinsable detergent and allow to dry.

Cold Rolled - As for No.1 Mill Finish.

10.11 SURFACE PREPARATION OF PAINTED SURFACES

Fully Painted Surfaces to be repaired; - bare areas shall be cleaned with abrasive paper to bright metal surface. The surrounding paint, which must be intact, shall be feathered for a distance of 20mm beyond the damaged areas. Dust and debris shall be removed by the use of a clean rag dampened with water or clean solvent that will not attack the coating. Wetted areas shall be allowed to dry, after which spot repairs shall be carried out with all the coats previously applied and shall overlap the undamaged area by 20mm. However, for epoxies, etc. to be immersed, the abraded area must not be overlapped (Refer to Clause 20.1 – repair procedure). The requirements of the spot repair shall be not less than that specified for the undamaged coating

Fully painted Surfaces to be over-coated; - Where additional coats are required over the whole surface, the surface shall be degreased with a water rinsable detergent, rinsed with potable water and then abraded to a uniform matt finish.. The surface shall be washed to remove all contamination and then allowed to dry. Further coats shall then be applied as specified to give the required coating thickness and specified finish

Note: Abrasion is particularly important for pure epoxy, coal tar epoxy and polyurethane systems but is not necessary for vinyl systems or other recoatable finishes

Primed Surfaces; - Shop applied primers shall be thoroughly sanded with fine abrasive paper (220 - 320#) where necessary to achieve a uniform matt surface. The surface shall be scrubbed with a solution of suitable water based detergent-degreaser using a bristle brush, followed by potable water rinses to remove all grease and water soluble matter. The surface shall be allowed to dry completely before application of the specified coating system over the whole surface

10.12 SURFACE PREPARATION OF PLASTIC AND GRP SURFACES FOR PAINTING

Sand the surface thoroughly with 320-400# waterproof abrasive paper to achieve a uniform matt finish. Remove all debris, oil and grease by scrubbing with a solution of a suitable water based detergent. When the surface is well wetted, rinse off very thoroughly with clean potable water to remove all residues. Allow to dry completely before painting

11 APPLICATION OF PAINTS AND ORGANIC COATINGS

11.1 ENVIRONMENTAL CONDITIONS

Paint shall not be applied in high wind and/or dusty conditions that will cause dust to settle on the surface of the paint before it has dried, nor when the steel surface temperature is less than 3°C above dewpoint, nor higher than the maximum advised by the paint manufacturer, nor when humidity is greater than 85%*, nor when the ambient temperature is less than the minimum or greater than the maximum specified by the manufacturer of the coating material

11.2 MIXING

All coating materials shall be very thoroughly mixed until completely homogeneous preferably by power stirrer (care must be taken to not entrain air). With all paints the stirred paint should be left to diffuse for 5 minutes and then re-stirred.

In the case of two-pack materials, each component containing pigments shall be thoroughly mixed. The two components shall then be mixed together in the proportions supplied by the manufacturer until the mixture is completely homogeneous. In the case of solvent based epoxy materials, it is recommended that the mixed material be allowed to stand for an induction period of 20 to 30 minutes before use and then re-stirred prior to use.

For two-pack materials, the use of part of the contents (split packs) is strictly forbidden

The time and date must be noted at the time of mixing and at the time of applying the material so that:

I. The usable potlife will not be exceeded and

II. The maximum overcoating interval will not be exceeded.

Note: - There are services available to re-pack two component paints into small packs

11.3 METHOD OF APPLICATION

Application shall be by brush, roller, spray, airless spray or other suitable equipment as appropriate for the surfaces to be coated and in accordance with the recommendations of the manufacturer. Application equipment shall be maintained in clean condition and in good working order. The use of equipment not maintained in good clean condition may lead to rejection of the coating

11.4 OVER COATING

Over coating times shall be not less than the minimum nor greater than the maximum specified by the manufacturer, relevant to the ambient temperature. Where over coating times in the data sheet relates to 25°C, the contractors must acquaint themselves with the correct over coating times for lower and higher temperatures. Strict adherence to over coating times is particularly important for two pack coatings that are subsequently immersed. The Contractor will be held responsible for delamination or blistering of paint coatings on immersion.

11.5 MAINTENANCE OF CLEANLINESS

All surfaces to be coated shall be clean and free from dust, oil, moisture and perspiration before over-coating.

11.6 FILM THICKNESS

Whilst final assessment is determined by dry film thickness measurement, the use of wet film thickness gauges is recommended to ensure correct thickness during application. The wet film thickness required may be calculated by the formula DFT=WFT/VS x100, where VS = volume solids, corrected for added solvent where necessary. The manufacturer will supply the volume solids of the paint.

11.7 FILM THICKNESS TOLERANCE

(i) Individual Coats - At least 90% of all thicknesses measured shall comply with the minimum requirements of the project specification. Up to 10% of all readings may be below the specified minimum thickness, but may not be less than 70% of the specified minimum thickness

(ii) Total Dry Film Thickness - Not more than 10% of readings shall be less than the minimum specified and no reading shall be less than 90% of the specified minimum. The mean of 10 readings taken within any $1m^2$ of the coated area shall not be less than the minimum DFT specified. No reading shall exceed the mean specified thickness by greater than 50%, unless a concession is granted by the Engineer

(iii) Maximum Film Thickness - For solvent borne coatings to be immersed, the total DFT shall not exceed the mean specified thickness by greater than 50%, unless a concession is granted by the Engineer. For non-immersed coatings or for solvent free systems, the maximum film thickness measured may be greater than the maximum specified but any over thickness shall not be deleterious to the long-term performance of the coating and written support of this fact must be supplied by the paint manufacturer

(iv) Multicoat applications – For solvent borne coatings to be immersed, further coats may applied only after the full curing period for the specified system has been achieved. This is a precaution to ensure that solvent retention does not occur.

Example: If a contractor has applied a system generally conforming with (i), (ii) & (iii) above but under-thickness areas are located at the time of inspection, additional coats may not be applied until the full curing time has been achieved.

12 HANDLING

12.1 DURING SURFACE PREPARATION AND COATING / PROTECTION OF NAME PLATES

All steel shall be supported not less than 100mm clear of the floor for coating prior to erection. The floor shall be clean concrete, brick or other non-dust producing material. Equipment name-plates and identification plates shall be protected from damage or obliteration. For service in corrosive environments, where complete protection of the substrate is required, the plates shall be removed prior to cleaning and shall be replaced after the complete coating is hard dry. For mildly corrosive conditions, name plates shall be protected by masking with suitable masking tape, which shall be removed and the name plate cleaned free of adhesive after completion of coating

12.2 AFTER COMPLETION OF COATING

Coated components shall not be handled earlier than the hard dry time recommended by the manufacturer, relevant to the ambient temperature. Coated components shall be handled with broad band fabric slings and shall be transported with suitable packing to minimise damage to the coating

All flanged pipes and components with projecting parts shall be stored and transported in such a manner that will prevent projecting parts such as flanges from contacting coated surfaces such as the body of the pipes

12.3 AFTER COMPLETION OF ERECTION OR INSTALLATION

All damage caused in handling, transportation and erection or installation shall be repaired in accordance with the requirements of the relevant system and to the satisfaction of the Engineer, at no extra cost

13 QUALITY ASSURANCE

13.1 CONTRACTOR QUALIFICATION

The Tenderer shall state on Form marked Appendix B in his tender the name of the painting sub-contractor that he proposes to use to carry out the painting or coating.

The Contractor shall ensure that all his sub-contractors have obtained a copy of this specification.

The Engineer may, at his discretion, require a Quality Audit of the painting sub-contractor to ensure that he has the management, facilities, skilled staff and quality control facilities and staff to carry out quality control during application of coatings to ensure compliance with specification

The contractor shall accept full responsibility for the quality of his work and of materials used, irrespective of any quality surveillance that may be carried out by the Engineer or his representative

The contractor shall obtain confirmation from the material supplier that materials to be used comply with the specification and are suitable for the intended purpose by having Form marked Appendix C completed by the material supplier

13.2 NOMINATED PERSON IN CHARGE OF QUALITY CONTROL

The painting sub-contractor shall appoint one member of staff to be in charge of all quality testing, recording and management. This person and all site records will be made available to the Engineer or his inspectorate at the time of inspections.

13.3 DATA SHEETS, SPECIFICATIONS AND CODES OF PRACTICE

The contractor shall have available the latest issues of each of the manufacturer's data sheets for the materials to be used, National Specifications and Codes of Practice relevant to the work to be carried out, as well as a copy of this Specification, all of which shall be available to the Contractor's Quality Control Manager

13.4 QUALITY CONTROL

The contractor shall have the necessary equipment and staff knowledgeable in test procedures to carry out all the quality control required to ensure compliance with the specification.

The contractor shall :

(i) supply a Quality Plan and Quality Program at the time of tendering, both of which are subject to acceptance by the Engineer,

(ii) maintain Quality Control records in accordance with the Quality Plan during execution of the contract. Such records shall be available to the Engineer or his representative at each Quality Surveillance visit,

(iii) mark or securely label each component with a unique identification and

(iv) carry out such tests as are required to ensure compliance with the specification

The cost of Quality Control shall be inclusive in the contractor's tender price

13.5 QUALITY SURVEILLANCE

13.5.1 Independent Surveillance

The Engineer may employ an independent, technically qualified organization to carry out quality surveillance of the work on his behalf. In the event of dispute, the Engineer's decision shall be final

13.5.2 Program

The contractor shall advise the Engineer timeously, in writing, when and where the following processes will be carried out

(i) Completion of fettling or dressing prior to leaving the fabricator's works

(ii) Blast cleaning and application of the first or primer coat

(iii) After completion of all coats to be applied at the contractor's works

(iv) At the commencement of repairs to be carried out on site

Failure of the contractor to advise the Engineer of his program may result in rejection of the work

13.5.3 Access for Surveillance

For the purpose of carrying out quality surveillance, the Engineer or his representative shall be granted access to any part of the contractor's premises relevant to the work being carried out, at any reasonable time. The contractor shall provide, at his own cost, any equipment or labour necessary to gain access to surfaces which are coated, to be coated or are in the process of being coated

13.5.4 Samples

The Engineer or his representative may remove any reasonable samples of materials to be used in the coating application. Rejection of the sample will place a hold on the use of material of the same batch number and may lead to rejection of all that batch of material and the reworking of any components that have already been coated with rejected material

13.5.5 Destructive Testing

The Engineer or his representative may carry out reasonable destructive tests to ascertain compliance with the specification. Areas thus damaged shall be repaired by the Contractor to the satisfaction of the Engineer at no additional cost

13.5.6 Cost of Quality Surveillance

Cost of Quality Surveillance will be borne by the Employer, except when surveillance results in rejection of the lot or when notice by the contractor results in a fruitless trip, in which cases the cost of surveillance shall be debited against the Contractor's account

13.5.7 Quality Surveillance Report

The inspector shall complete a report at each visit. A copy of the report will be given to the contractor on completion of each surveillance visit. A copy of the report approving the components shall be included with the delivery note. No payments will be authorised by the Engineer unless he has received a copy of an approval report. The Engineer may withhold payment until a final report has been issued, giving approval to the components after installation on site and repair of damage to the coating

13.5.8 Quality Control Records

The contractor shall maintain proper and adequate quality control records for all stages of the work. These records shall be available for inspection by the Engineer or his representative at the time of Quality Surveillance. Incomplete, inaccurate or inadequate records shall be regarded as non-compliance with the specification, and the cost of additional surveillance will be back charged to the contractor

13.5.9 Variation From Specification

No variation from specification, or change of sub-contractor or materials to be used from those stated in the tender documents, shall be permitted without written approval of the Engineer. Products equivalent to those specified may be submitted for approval. For the Engineer to assess the material, the manufacturer shall supply adequate technical data and case histories to support his claim to equivalence

13.5.10 Non-conformance and request for concession

The inspector may deem the corrosion protection acceptable or non-acceptable.

'Non acceptable' means that, in the view of the inspectorate, the work does not conform to specification. The inspector may reject the contractor's work. Any non-conformance shall be immediately relayed to the Engineer.

If the contractor considers that the corrosion protection or non-conforming items will not be deleterious to the performance of the items in service the contractor may submit a concession request (form applicable on request to the Engineer) to the Engineer for consideration of the Engineer accepting the non-conforming quality.

14 TEST METHODS

Unless otherwise agreed in writing by the Engineer, the following test methods shall be used

14.1 Visual assessment of surface cleanliness: - ISO 8501-1:1988

14.2 Grading of surface profile - comparator procedure: - ISO 8503-2:1988

14.3 Assessment of dust on steel surfaces prepared for painting: - ISO 8502-3:1992

14.4 Field test for soluble iron corrosion products (soluble salts test used on ISO 8501-1 rust grades C or D):

I. ISO/TR 8502-1:1991

II. As the above method is not readily available the following proprietary test is acceptable: *Weber Rielly Soluble Salts Test* -as per the manufacturer's instructions.

14.5 Determination of chloride on cleaned surfaces.

I. Laboratory determination of chloride on cleaned surfaces: - ISO 8502-2:1992

(Note: The substances and procedures used in this method may be injurious to health if adequate precautions are not taken and these tests should be carried out by qualified personnel)

II. As the above method is not readily available the following proprietary test is acceptable: *Chlorid®* salt test

14.6 Measurement of wet film thickness:

I. ISO 2808:1991 - Method Nº. 7a - Wheel gauge

II. ISO 2808:1991 - Method Nº. 7b - Comb gauge

14.7 Measurement of dry film thickness:-

I. Magnetic metallic substances (iron, mild steel, ferritic stainless steel etc.): - ISO 2808:1991 - Method N^{o}. 6A(10.3.2) – Electro-magnetic instrument

II Non-magnetic metallic substances (aluminium, copper, austenitic stainless steel etc.): - ISO 2808:1991 - Method N^{o}. 6B (10.4.2.1) – Eddy current instrument

Note: - Instruments are to be calibrated and used according to the manufacturer's instructions. Instruments are to be re- calibrated at least every 6 months or when abnormalities are evident over a range of 500µm measurements on calibrated standard shims

III Non- metallic substances (concrete, timber, plastic etc.): - ISO 2808:1991 - Method N^{o}. 4

Note: -This is a destructive method and damage will be required to be repaired.

COATING SYSTEMS

CONTENTS OF COATING SYSTEMS

15 CATEGORIES

A - ALKYD SYSTEMS for use in environments of low corrosivity. These oil based paints - (gloss enamels, eggshell enamels, polyurethane alkyds, alkyd undercoats and primers etc.) are easy to use, economical and have good weathering characteristics. They must not be applied directly to alkaline surfaces (cement and concrete) or to galvanized surfaces. They dry by solvent evaporation and then cure by reaction with atmospheric oxygen. They therefore do not re-dissolve in their original solvent and require abrasion prior to over-coating.

B - TWO PACK SOLVENT BORNE CHEMICALLY CURED SYSTEMS, EPOXY, EPOXY PHENOLIC AND POLYURETHANE, for use under water and in corrosive environments. These systems have long maintenance free life when correctly applied. The pure systems for use underwater require strict control of over-coating times and preparation procedures.- Modified systems used above water are re-coatable and have improved resistance to chalking

C - TWO PACK COAL TAR EPOXY. These systems have excellent resistance to water and mild acids but chalk severely on exposure to sunlight and are very difficult to re-coat. For use underwater they require strict control of over-coating times and preparation procedures.

D - ONE PACK VINYL RESIN BASED SYSTEMS for use in corrosive environments, excluding immersion. These systems have good resistance to inorganic chemicals but are softened by fats and other organic materials (e.g. solvents). Due to their permanent solubility, they are easily re-coated with similar material for maintenance purposes. This characteristic causes the entire film to soften back on over-coating and hard dry times are extended when additional coats are applied.

E - TWO PACK SOLVENT FREE CHEMICALLY CURED SYSTEMS, EPOXY, EPOXY PHENOLICS AND POLYURETHANE, for use primarily in immersion and abrasive conditions. Special equipment is required for the application of these materials and considerable experience is necessary for their correct application. Due to the absence of solvent, thick films can be applied, hence enabling good protection to be obtained in short time schedules. These systems have long maintenance free life when correctly applied but are difficult to re-coat in the maintenance situation

F - POWDER COATING. These are free flowing powders applied by fluidised bed or electrostatic spray, then melted and cured by heat. They are therefore only suitable for application to metallic surfaces under factory conditions. Low build powder coatings for exterior use and application to galvanizing require a primer (Zinc-rich epoxy powder coating primers are now available as an alternative to galvanizing). For pipes, pumps and valves, only the high film thickness coatings are specified (FBE powder coatings). Application of powder may only be carried out by specialist contractors with the necessary heating and curing facilities and the required experience. No further cure time is required after completion of the full cure cycle; hence components can be handled immediately on completion. Care must be taken that the full cure cycle is completed to ensure that the powder coating develops its full properties. This is not easily discernable and requires special laboratory testing

G - TAPE WRAPPING SYSTEMS Tape wrapping is a method of corrosion protection which utilises preformed strips of adhesive plastic, in the form of rolls, to wind around the item to be protected, with a suitable overlap, in order to ‘blot out’ the corrosive environment. It is used primarily for underground pipes and their ancillaries such as couplings, valves, etc. The method is used primarily on site although for certain types, wrapping can be carried out on individual pipes at a factory or site yard. There are many types of tape but for the purposes of this specification, only two types are given, namely petrolatum tape and rubber modified bitumen with polyethylene outer coating

16 CATEGORY A - ALKYD SYSTEMS

Preamble: Alkyd Systems are intended for use in environments of low corrosivity, where a good decorative finish is required. Materials shall therefore be applied with due cognisance of appearance and protection.

16.1 SYSTEM A1 ALKYD ON TO BARE METAL SURFACES

(i) The surface to be coated shall be prepared by degreasing and manual or mechanical cleaning as specified in Clause 10.5.2

(ii) Apply one coat of *alkyd metal primer* to a film thickness of not less than 40 microns. Allow to dry for a minimum of 8 hours

(iii) Apply one coat *alkyd based enamel*, in the colour specified by the Engineer, to give a dry film thickness of not less than 25 or greater than 35 microns. Allow to dry for a minimum of 16 hours

(iv) On exterior surfaces, apply a second coat of *alkyd enamel*, within 48 hours, to give a further dry film thickness of not less than 25 or greater than 35 microns in the final colour specified by the Engineer. Allow to dry for a minimum of 16 hours

Requirements

The finished system shall be smooth, glossy, free from excessive runs, sags, blisters, wrinkling, dirt, occlusions or other visual defects and shall be a commercial match to the colour specified by the Engineer. Runs, sags, curtaining, shrivelling, wrinkling or other visible defects will not be permitted

The dry film thickness of the finished system shall not be less than the following:

Exterior surfaces -	80 microns
Interior surfaces -	65 microns

16.2 SYSTEM A2 ALKYD ON SURFACES ALREADY CLEANED AND PRIMED

(i) Clean and prepare the surface by degreasing, sanding and removal of dust as specified in Clause 10.11

(ii) Touch up bare areas with a alkyd metal primer

(iii) Apply one coat all over of alkyd metal primer

(iv) Continue the system as given in System A1 (iii) to (v) inclusive

16.3 SYSTEM A3 ALKYD ON FACTORY FINISHED COMPONENTS

The contractor shall ensure that the system to be applied is compatible with the existing coating

(i) Prepare the surface by degreasing, abrading and removal of dust as specified in Clause 10.5.1 or 10.11, as appropriate

(ii) On interior surfaces apply one coat of alkyd enamel, in the colour specified by the Engineer, to give an applied dry film thickness of not less than 25 microns. Total dry film thickness to be not less than 65 microns

(iii) On exterior surfaces, apply two coats alkyd enamel, with overnight drying between coats, to give an applied dry film thickness of not less than 50 microns. Total dry film thickness of the system shall not be less than 80 microns

(iv) In both cases a further coat of enamel shall be applied after installation, to the final colour selected by the Engineer

16.4 SYSTEM A4 ALKYD ON GALVANIZED SURFACES ABOVE WATER

(i) Prepare the surface by degreasing, abrading and removal of dust as specified in Clause 10.7

(ii) Apply one coat of the paint manufacturer's recommended primer for galvanized surfaces Water based styrene acrylic emulsion primer, water based two pack epoxy, etch primer, epoxy holding primer can be used (The use of Calcium Plumbate Primer is excluded from these Specifications). Allow to dry for the over coating time recommended by the manufacturer.

NOTE: The purpose of the primer is to provide adhesion onto the substrate for the topcoat and to insulate the alkyd topcoat from direct contact with the galvanized surface to prevent saponification from occurring

(ii) Continue the system as given in A1 (iv) (two enamel coats). The total dry film thickness shall be a minimum of 75 microns over the galvanizing

16.5 SYSTEM A5 ALKYD ON PLASTIC AND BITUMEN COATED SURFACES

(i) Prepare the surface by degreasing, abrading and removal of dust as specified in Clause 10.12.

(ii) Apply one coat of a water borne coating e.g. water based styrene acrylic emulsion primer, water based two pack epoxy or as recommended by the manufacturer. Allow to dry for a minimum of 16 hours at 25°C

NOTE: The good adhesion to substrate must be verified before continuing

(iii) Apply one coat of alkyd enamel in the colour required by the Engineer

16.6 SITE REPAIR OF ALKYD SYSTEMS

Any site repair required by the Engineer shall be carried out in accordance with surface preparation method given in Clause 10.11, followed by all the coats required to restore the damaged area to the original system requirements. Since patch application of the final coat rarely gives an acceptable uniform finish, the whole area in which damage has occurred shall be cleaned, abraded with fine wet or dry abrasive paper (not coarser than 220 grit) and given one coat of enamel all over, unless otherwise accepted by the Engineer

17 CATEGORY B - TWO PACK, SOLVENT BORNE, EPOXY, EPOXY PHENOLIC AND POLYURETHANE SYSTEMS

Preamble: Two-component solvent borne chemically cured systems are the most commonly used coating system for corrosion protection of steel. EPOXIES are fast curing and adhere extremely well to clean surfaces. They are tough, durable, and water resistant but chalk badly on exposure to sunlight. The EPOXY PHENOLIC coatings are resistant to inorganic acids and many other chemicals. They have short overcoating times and discolour and chalk on exterior exposure. POLYURETHANES (aliphatic isocyanate cured) have excellent gloss and colour retention and are used as topcoats . All are supplied in two parts, which must be mixed together before use to allow the chemical reaction to take place

These materials can retain solvent if the material is applied too thickly in one application, if the time between coats is too short or if there is inadequate ventilation or low temperatures during curing. This solvent retention causes osmotic blistering on immersion

The applicator may not exceed the maximum film thickness per coat, or the maximum over coating time specified by the manufacturer. Since over coating are frequently quoted at 20° or 25°C, longer over coating times shall be allowed at lower temperatures. As a rough guide, increase time by 50% for a 5°C decrease or by 100% for a 10°C decrease in ambient temperature below the quoted temperature

Epoxy and epoxy phenolic materials shall not be applied when the ambient temperature is below 10°C

Solvent based epoxy materials shall be allowed 28 days to cure before immersion, or as recommended by the manufacturer. At temperatures below 20°C, longer periods shall be allowed, as for over coating times

Two pack solvent borne aliphatic polyurethane materials are similar in application and over coating properties to solvent based epoxies, but they have much improved gloss and colour retention. The curing agents are based on aliphatic isocyanates. The latter and their mixtures must not be mixed with water or with any solvent (especially epoxy solvents) other than that recommended by the supplier. The aliphatic polyurethanes are somewhat slower curing than epoxy enamels at 25°C but will cure at lower temperatures. They have outstanding weathering properties, and good dilute acid resistance. They are not recommended for immersion service.

Epoxy/polyurethane systems utilize primers for non-immersion corrosion protection use. These primers may contain a corrosion inhibitive or sacrificial pigment. Zinc metal powder is included in epoxy zinc rich primers and inorganic zinc primers to protect the mild steel substrate. MIO or Micaceous Iron Oxide is a flaky, lamellar pigment which provides a multi-layer tile like protection within the paint coating, thereby greatly increasing the waterproof properties of the system. The aluminium pigmented epoxy mastics utilise epoxy/amine components and modifiers which render the products tolerant to wire brushed surfaces. They are used where abrasive blasting is not possible or practical.

17.1 SYSTEM B1 PURE EPOXY COATINGS FOR IMMERSION SERVICE ON BARE STEEL AND CAST IRON SURFACES

Material to be used shall be a *two-component, high solids, solvent-based, epoxy coating* suitable for permanent immersion in water

(i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.2 as appropriate, to achieve a blast cleaned surface of cleanliness Sa3, a profile of 50-100 microns, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100mg/m^2 (Weber Rielly Test)

(ii) Mix base and curing agent individually until homogeneous, then mix together in the proportions supplied or specified by the manufacturer and again mix until homogeneous. SPLIT PACKS, i.e. the use of part containers is not permitted.

(iii) Apply two or three coats of the mixed material as required to give a total dry film thickness of not less than 300 microns nor greater than 450 microns

The coating shall be applied at the correct spraying viscosity and by the equipment recommended by the manufacturer to minimise the porosity of the applied film

Each coat shall differ in colour from the preceding coat

Each coat shall be applied to a thickness not less than the minimum nor greater than the maximum recommended by the manufacturer

The time interval between coats shall be not less than the minimum nor greater than the maximum recommended by the manufacturer for the prevailing ambient temperature. Should the overcoat time be exceeded, the surface shall be prepared as specified under REPAIR before over-coating

Requirements

The coating system shall be smooth, glossy, free from excess orange peel effect, bubbling, excessive runs and sags or other visible defects

The dry film thickness shall be minimum 300, maximum 450 microns

The coating shall be free from electrical insulation defects when tested with an approved wet sponge detector set to operate at 90 Volts, 2 Megohms. Repair of defects is permissible by the procedure given in 10.11, provided that the repaired area complies with all the requirements given above

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

17.2 SYSTEM B1A RECOATABLE SYSTEM FOR ABOVE WATER USE IN CORROSIVE ENVIRONMENTS

Material used shall be a *high build two component epoxy coating*, followed by one or two coats of *recoatable, two component, aliphatic isocyanate cured polyurethane*

Surface preparation

As for System B1 except that surface preparation to Sa 2 ½ will be acceptable. All other requirements of System B1 shall be applicable, except that testing for electrical insulation defects is not required except when specifically called for by the Engineer.

Requirements

The coating system shall be smooth, glossy, free from excess orange peel effect, bubbling, excessive runs and sags or other visible defects

The dry film thickness shall be minimum 300, maximum 450 microns

17.3 SYSTEM B2A RECOATABLE SYSTEM FOR USE ABOVE WATER IN CORROSIVE ENVIRONMENTS ON GALVANISED SURFACES

Material used shall be a *two pack epoxy primer specifically designed for application to galvanized steel*, followed by one or two coats of *recoatable, two component, aliphatic isocyanate cured polyurethane*

(i) Prepare the surface as specified in Clause 10.7, by degreasing and light abrading, or sweep blasting

(ii) Apply an *epoxy primer* specifically designed by the manufacturer for use on galvanized steel to a dry film thickness of 40 to 80 microns

(iii) Apply one coat of the a *recoatable two-pack polyurethane finish coat* to a dry film thickness minimum 40, maximum 60 microns

Requirements

The coating system shall be smooth, glossy, free from orange peel effect, bubbling, excessive runs and sags or other visible defects

The dry film thickness shall be minimum 80, maximum 140 microns over galvanizing. Electrical insulation testing is not required

17.4 SYSTEM B3 EPOXY PRIMER/ EPOXY MIO PRIMER/RECOATABLE POLYURETHANE –HIGH BUILD SYSTEM FOR EXTERIOR USE IN CORROSIVE ENVIRONMENTS

Material used shall be a *high build anti-corrosive epoxy primer*, followed by a coat of high build MIO containing epoxy intermediate coat, followed by a *recoatable two component aliphatic isocyanate cured polyurethane*.

(i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa2 ½ , a profile grade of medium (50 -70µm) as per ISO 8503-3, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100 mg/m^2 (Weber Rielly Test)

(ii) Mix each base and curing agent individually until homogeneous, then mix together in the proportions supplied or specified by the manufacturer and again mix until homogeneous. SPLIT PACKS, i.e. the use of part containers is not permitted unless Engineer approved suitably accurate measuring equipment is available.

(iv) Apply one coat of the *two component, high build epoxy primer* to give a minimum dry film thickness of 115µm, as per the manufacturer’s instructions.

(v) Apply one coat of the *two component, high build epoxy MIO intermediate coat* to give a minimum dry film thickness of 100µm, as per the manufacturer’s instructions.

(iv) After the prescribed interval for the environmental conditions, apply a single coat of two component, high gloss, high solids *recoatable two component aliphatic isocyanate cured polyurethane* to give a minimum dry film thickness of 40µm and a maximum dry film thickness of 60µm as per the manufacturer’s instructions.

Requirements

The coating system shall be smooth, glossy, free from excess orange peel effect, bubbling, excessive runs and sags or other visible defects.

The dry film thickness shall be minimum 255, maximum 400 microns.

17.5 SYSTEM B4 - ZINC RICH PRIMER, EPOXY MIO PRIMER / RECOATABLE POLYURETHANE –HIGH BUILD SYSTEM FOR EXTERIOR USE IN NON ACIDIC ENVIRONMENTS

Material used shall be a *zinc rich epoxy primer containing a minimum 92% zinc metal (mass %), or alternatively an inorganic zinc primer containing a minimum 85% zinc metal (mass %),* followed by a coat of *high build MIO containing epoxy intermediate coat*, followed by a *recoatable two component aliphatic isocyanate cured polyurethane*.

(i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa2 ½ , a profile grade of medium (50 -70µm) as per ISO 8503-3, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100 mg/m^2 (Weber Rielly Test)[2]

(ii) Mix each base and curing agent individually until homogeneous, then mix together in the proportions supplied or specified by the manufacturer and again mix until homogeneous. SPLIT PACKS, i.e. the use of part containers is not permitted unless Engineer approved suitably accurate measuring equipment is available

(vi) Apply one coat of the *two component, rich epoxy primer* to give a minimum dry film thickness of 50µm, as per the manufacturer's instructions.

(vii) Alternatively, apply one coat of the *two component, inorganic zinc primer* to give a minimum dry film thickness of 50µm, as per the manufacturer's instructions.

(viii) Apply one coat of the *two component, high build epoxy MIO intermediate coat* to give a minimum dry film thickness of 100µm, as per the manufacturer's instructions

(iv) After the prescribed interval for the environmental conditions, apply a single coat of two component, high gloss, high solids *recoatable two component aliphatic isocyanate cured polyurethane* to give a minimum dry film thickness of 40µm and a maximum dry film thickness of 60µm as per the manufacturer's instructions.

Requirements

The coating system shall be smooth, glossy, free from excess orange peel effect, bubbling, excessive runs and sags or other visible defects

The dry film thickness shall be minimum 190, maximum 300 microns

17.6 SYSTEM B5 PHENOLIC MODIFIED EPOXY SYSTEM FOR STEELWORK AND EQUIPMENT IN CHEMICAL ENVIRONMENTS

Material used shall be a *solvent based epoxy-phenolic chemical resistant primer*, followed by a coat of *solvent based epoxy-phenolic chemical resistant intermediate coat,* followed by a *solvent based epoxy-phenolic chemical resistant topcoat*.

(i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa2 ½ , a profile grade of medium (50 -70µm) as per ISO 8503-3, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100 mg/m^2 (Weber Rielly Test)

(ii) Mix each base and curing agent individually until homogeneous, then mix together in the proportions supplied or specified by the manufacturer and again mix until homogeneous. SPLIT PACKS, i.e. the use of part containers is not permitted unless Engineer approved suitably accurate measuring equipment is available

(ix) After the prescribed interval for the environmental conditions, apply one coat of the *solvent based epoxy-phenolic chemical resistant primer* to give a minimum dry film thickness of 100µm, as per the manufacturer's instructions.

(x) Apply one coat of the *solvent based epoxy-phenolic chemical resistant intermediate coat* to give a minimum dry film thickness of 100µm, as per the manufacturer's instructions

(iv) After the prescribed interval for the environmental conditions, apply a single coat of two component, high gloss, *solvent based epoxy-phenolic chemical resistant topcoat* to give a minimum dry film thickness of 100µm and a maximum dry film thickness of 60µm as per the manufacturer's instructions.

Requirements

The coating system shall be smooth, glossy, free from excess orange peel effect, bubbling, excessive runs and sags or other visible defects

The dry film thickness shall be minimum 300, maximum 400 microns

The coating shall be free from electrical insulation defects when tested with an approved wet sponge detector set to operate at 90 Volts, 2 Megohms. Repair of defects is permissible by the procedure given in 10.11, provided that the repaired area complies with all the requirements given above

17.7 SYSTEM B6 – ALUMINIUM PIGMENTED EPOXY MASTIC / RE-COATABLE POLYURETHANE FOR UPGRADING OF COATINGS ON ELECTRICAL EQUIPMENT, GEARBOXES, PUMPS, VALVES AND OTHER PROPRIETARY EQUIPMENT

Material used shall be ***aluminium pigmented epoxy mastic***, followed by a *recoatable two component aliphatic isocyanate cured polyurethane*.

(i) Prepare the surface by degreasing, abrading and removal of dust as specified in Clause 10.5.1 or 10.11, as appropriate

(ii) Mix each base and curing agent individually until homogeneous, then mix together in the proportions supplied or specified by the manufacturer and again mix until homogeneous. SPLIT PACKS, i.e. the use of part containers is not permitted unless Engineer approved suitably accurate measuring equipment is available

(xi) Apply one coat of the *aluminium pigmented epoxy mastic* to give a minimum dry film thickness of 125μm, as per the manufacturer's instructions.

(iv) After the prescribed interval for the environmental conditions, apply a single coat of two component, high gloss, high solids *recoatable two component aliphatic isocyanate cured polyurethane* to give a minimum dry film thickness of 40μm and a maximum dry film thickness of 60μm as per the manufacturer's instructions.

Requirements

The coating system shall be smooth, glossy, free from excess orange peel effect, bubbling, excessive runs and sags or other visible defects

The dry film thickness shall be minimum 165, maximum 200 microns

17.8 REPAIR OF PURE EPOXY AND POLYURETHANE SYSTEMS

Unmodified epoxy or polyurethane coatings are difficult to repair when fully cured. Careful attention to the following repair procedure is required to ensure adequate adhesion of the material used for repair:

Prepare the surface by abrading to a uniform matt finish, followed by wiping the surface with methyl ethyl ketone (MEK) solvent, to give a contact time of 30 seconds. Allow to dry, then wipe off any residual dust with a clean rag. Apply as many coats of repair material as are necessary to achieve the specified film thickness. When using solvent borne materials, note the need for adequate time between coats as specified under System B1. Solvent borne coatings can be repaired using solvent free epoxy repair kits which are pre-measured and easy to use.

17.9 REPAIR OF RECOATABLE EPOXIES AND POLYURETHANES

These do not require abrading and solvent wiping but the surface must be cleaned as per Clause 10.5.1 before overcoating.

18 CATEGORY C - COAL TAR EPOXY BASED SYSTEMS

Preamble: Coal tar epoxy and urethanes are modified with selected grades of coal tar (imported source only) to reduce the costs and enhance certain properties such as waterproofing and chemical resistance characteristics. Some of the coal tar components react with the curing agent but some act as a diluent which imparts thermoplastic (softens with heat) properties to the coating

THE COAL TAR EPOXIES RECOMMENDED ARE SOLVENT BASED. They can therefore retain solvent if the materials are sprayed too thickly. The precautions given in Section 11.2 must be applied to these coatings. Due to their tendency to bloom within 24 hours, the surface preparation and over coating are all the more critical

As the coal tar is permanently soluble, 'bleeding' occurs when over coated with solvent based paints.

Coal tar epoxies have good water and dilute acid resistance and are very suitable for items such as rake arms in clarifiers. Coal tar repels root growth; hence these coatings are suitable for exterior buried pipe protection.

18.1 SYSTEM C1 SOLVENT BASED COAL TAR EPOXY ON METAL SURFACES

Material used shall be a *high build two component solvent based coal tar epoxy* composition using only selected imported coal tar.

The system

(i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.2 as appropriate

(ii) Apply three to four coats of the *coal tar epoxy* material, mixed as recommended by the manufacturer and within his specified over coating times, as required to give a total dry film thickness not less than 300 microns. Should the overcoat time be exceeded, the surface shall be prepared as specified in Clause 10.11 before overcoating. Each coat shall be applied to a thickness not less than the minimum nor greater than the maximum recommended by the manufacturer

Requirements

The coating system shall be smooth, semi-glossy, free from orange peel effect, bubbling or excessive runs and sags or other visible defects

The dry film thickness shall be minimum 300, maximum 600 microns

The intercoat adhesion between layers shall be proven by a suitable adhesion test (ISO 2409)

The coating shall be free from electrical insulation defects when tested with an approved wet sponge detector set to operate at 90 Volts, 2 Megohms. Repair of defects is permissible provided that the repaired area complies with all the requirements given above

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

19 CATEGORY D - VINYL BASED SYSTEMS

Vinyl resin based paints (the medium shall not contain alkyd resin or other saponifiable matter) are solvent based, single component materials with excellent resistance to water, dilute acids and hypochlorites. Their resistance to heat is poor and must never be used on surfaces continually operating at 70°C or higher. They are not resistant to solvents and should not be used where there may be contact with oils, fats, kerosene, petrol etc

The main advantage of vinyls is their easy maintainability. Vinyls may be recoated after any period of time, provided that the surface is cleaned, and is free from chalking, dust, grease and general grime. Because they are soluble in their own solvents, the under layers are quickly softened by over coating. Experienced operators using special techniques must be employed when brushing

Vinyls are therefore recommended for interior and exterior use where they are subject to chemical fumes, as in chlorination rooms. For exterior use the topcoat may be modified with acrylic resin for improved colour retention. Such modified types usually have a semi gloss finish rather than full gloss

19.1 SYSTEM D1 VINYL ON BARE STEEL OR CAST IRON SURFACES

Material shall be solvent containing, based on *polymerised vinyl chloride / vinyl acetate copolymer* or *vinyl chloride / iso-butyl ether resins*. The material shall not contain alkyd resin or other saponifiable matter. For exterior use, the final coat may be modified with acrylic resin to give improved gloss and colour retention

The system

(i) Prepare surfaces by blast cleaning as specified in Clause 10.5 to achieve a surface not less clean than Sa 2 ½ and a profile of 25 to 50 microns (fine)

(ii) Apply one coat of the manufacturer’s recommended primer for vinyl systems to a dry film thickness not less than 40 and not greater than 80 microns. Allow 16 hours to dry, or longer in humid conditions

(iii) Apply one coat of *high build vinyl intermediate coat* to a dry film thickness of not less than 60 or greater than 80 microns

(iv) Apply one or two coats of *vinyl enamel* to a dry film thickness of not less than 25 or greater than 35 microns per coat

(v) On completion of installation and all repairs on site, apply one additional coat of vinyl enamel

Requirements

The coating system shall be smooth, uniform, glossy or semi-glossy, free from excessive runs, sags, blisters, wrinkling or other visual defects. The total dry film thickness shall be not less than 125 nor greater than 195 microns

19.2 SYSTEM D2 VINYL ON PAINTED OR PLASTIC ITEMS IN CHLORINATION ROOMS

Material used as a primer/barrier coat shall be a *water based epoxy (two pack)* or *styrenated acrylic primer (single pack)*. Being water based, the drying time is extended in humid conditions. Care shall be taken to avoid excessive film thickness and to allow adequate drying time before overcoating. Full drying and coalescence throughout the thickness of the film is essential. Do not apply at temperatures below 5°C or where such temperatures are likely to be encountered before full cure. Do not apply to wet surfaces

The system

(i) Prepare surface by abrasion and removal of oil, grease and dust as specified in Clause 10.11 or 10.12, as appropriate

(ii) Apply one coat *water based primer* to give a dry film thickness not less than 25 and not greater than 50 microns

Allow a minimum of 16 hours to cure before overcoating. Since this material is water based, drying time will be extended under humid conditions

(iii) Apply one coat *vinyl intermediate coat* to a dry film thickness of not less than 60 or greater than 80 microns

(iv) On completion of installation and all repairs on site, apply one or two final coats of vinyl enamel to a dry film thickness of not less than 25 or greater than 35 microns per coat in the colour selected by the Engineer, complying with the requirements stated in Section 19 above.

Requirements

The total dry film thickness shall be not less than 110 or greater than 165 microns

When required for protection on pre-primed or painted components such as valves, the full system as above shall be applied, when the total coating thickness shall be not less than 100 microns.

(When required on plastic items such as pipes, for identification purposes only, the above system may be used but it is simpler to use an appropriate coloured self adhesive vinyl or polyurethane tape, as specified by the Engineer. In this case the tape shall be applied uniformly to the surface, with uniform width of overlaps.

19.3 SYSTEM D3 VINYL ON GALVANIZED STEEL

Material used as primer shall be a *solvent based two pack epoxy* based primer specifically designed for use on galvanized steel

The system

(i) Prepare surface as specified in Clause 10.5.3

(ii) Apply a *solvent based two pack epoxy primer* specifically designed for galvanised steel to the clean surface at a thickness within the range specified by the paint manufacturer. Correct overcoating time for the prevailing ambient conditions is important

(iii) Apply one coat *vinyl high build intermediate coat* at a dry film thickness not less than 60 or greater than 80 microns. Allow not less than 16 hours before overcoating

(iv) Apply one coat *vinyl enamel* at a dry film thickness not less than 25 or greater than 35 microns

Requirements

The finished system shall be smooth, glossy or semi- glossy, free from excessive runs, sags, blisters, wrinkling or other visual defects

The total dry film thickness over the galvanizing shall be not less than 125 or greater than 195 microns

19.4 REPAIR OF VINYL SYSTEMS

Since there is no chemical cure of vinyl systems, abrasion of exposed steel only is required for repair. Wash the old coating with detergent and water (do not use emulsion degreasers). Rinse with clean water. Abrasion and solvent wiping of the coating are unnecessary and shall not be carried out. Abrade any exposed metal and feather the edges. Remove all debris by brushing with a clean dry brush

Apply the specified primer to bare steel, followed by the number of coats to restore the damaged area to meet the requirements of the appropriate specification.

NOTE: the topcoat shall not be applied directly to the steel without the use of the primer!

20 CATEGORY E SOLVENT FREE EPOXY, EPOXY PHENOLIC AND POLYURETHANE SYSTEMS

These materials consist of two components, base and activator which must be mixed prior to application in the correct proportions as supplied by the manufacturer.

The rate of cure can be designed to be slow for hand application or fast for machine application, taking into consideration the ambient temperature. The faster the cure, the shorter the touch dry time but the potlife of the mixed material will also be shorter.

The slower the cure, the longer the touch dry time but the potlife of the mixed material will be longer. The potlife is designed for the mass of the material to be mixed at one time and the method of application.

The slower curing epoxies can be premixed and sprayed through airless spray equipment. The faster curing epoxies and polyurethanes can only be applied through specialized dual component equipment, by contractors with the necessary know-how.

Solvent free materials may be applied in thick coats, hence only one or two applications are necessary to achieve the specified coating thickness. The dangers of solvent entrapment described in Clause 11.2 are therefore eliminated.

An important difference between epoxies and polyurethanes is that the latter can cure at sub-zero temperatures whereas epoxies require temperatures above 0ºC.

Both types can be formulated to produce varying degrees of hardness, flexibility and chemical resistance. Epoxies generally have excellent adhesion due to their highly polar nature. The bisphenol F/novolac phenolic epoxies cured with modified amines are available in solvent free form and provide outstanding resistance to many aggressive chemicals, including concentrated inorganic acids

Solvent free polyurethanes may be divided into two main classes although there may be wide variations depending on the particular formulation used. The two main classes are:

> Elastomeric types, similar to rubber; these have very high flexibility and outstanding resistance to abrasion, but rather poor water resistance. When used on steel, the manufacturer's recommended primer must first be used. These are applied by casting, or, in the case of pipe lining, by spin casting
>
> Semi rigid types, whose flexibility is much greater than epoxies but much less than the elastomeric polyurethanes,. However, their water resistance and chemical resistance is superior to the elastomeric types, hence they are used where corrosion protection is the primary consideration.
>
> Specialized primers are recommended for polyurethane coatings applied to steel and mineral substrates.

Because solvent free materials require specialist application, only contractors with sophisticated equipment, facilities, quality control and experience, will be considered

20.1 SYSTEM E.1 SOLVENT FREE EPOXY

Material shall be based on *liquid epoxy resins* and shall comply with the requirements of SANS 1217 Type 1C. When used for potable water it shall also be non-toxic and non-tainting (See Clause 3.3 of SANS 1217). When required, the contractor shall obtain and submit to the Engineer acceptable certification of non- toxicity and non-tainting properties

The system

(i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa3, a profile of 50-100 microns, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100mg/m^2 (Weber Rielly Test)

(ii) Apply one or two coats of *solvent free epoxy*, using appropriate equipment as described in Clause 27.5, as per the coating manufacturers prescribed method.

Requirements

The finished coating shall be smooth, uniform, glossy, free from orange peel effect, excessive runs and sags, blisters or other visual defects

The dry film thickness shall be not less than 300 or greater than 500 microns

The coating shall be free from electrical insulation defects when tested with a wet sponge detector, operated in accordance with Clause 8.12.1 of SANS 1217, using a potential of 90 volts and a sensitivity of 10 Megohms

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

Repair procedure

The general procedure given in Clause 10.11 shall be followed, using a repair material recommended or supplied by the manufacturer of the solvent free epoxy material. The guidelines of the manufacturer's data sheet must be exactly followed. It is important that, for surfaces to be immersed, that the abraded, prepared area is not overlapped beyond the abraded area viz. a ‘ring’ of abraded coating must surround the repair.

20.2 SYSTEM E.3 SEMI-RIGID POLYURETHANE FOR UNDERWATER & MILDLY ABRASIVE CONDITIONS

Materials

The primer shall be suitable for steel and for the polyurethane material and be supplied by the manufacturer of the coating material. The coating material shall be a *solvent free, two component, semi-rigid polyurethane* based on polyether type polyol and aromatic isocyanate to reach the following requirements:

Tensile strength at 3mm thickness	(ASTM D 638)	> 15 MPa
Adhesion to correctly primed steel	(SABS Method 776)	> 10 MPa
Direct Impact resistance	(ASTM G 14)	> 9 Joules
Dielectric Strength	(SABS 1217)	> 20 kV/mm
Elongation at break	(ASTM D 638)	> 25%
Compressibility	(ASTM G-695)	> 25 MPa
Surface hardness of 5mm thick sample	(Shore 'D')	> 60& < 80
Water Vapour Permeability	(ASTM E-96)	<0,5g/24h/m²/mm
Cathodic disbonded area after 30 days	(ASTM G-8 Method A)	<500 mm²

The adhesive shall be a low viscosity polyurethane adhesive designed to maximise adhesion between cured polyurethane and freshly mixed polyurethane. It is required for repair of cured solvent free polyurethane systems

The system

(i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa3, a profile of 50-100 microns, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100mg/m^2 (Weber Rielly Test)

(ii) Apply the *metal primer* recommended by the manufacturer to his specified thickness

(iii) Within the manufacturer's recommended over coating time, apply the specified thickness of *solvent free, semi-rigid polyurethane* by means of an airless spray machine fitted with metering pumps to ensure the correct mix ratio at the spray head. A qualified mechanic shall supervise the operation of the machine during spraying. The Contractor may be required to demonstrate to the Engineer that the machine is delivering components in the correct mixing ratio. Regular dismantling and cleaning of the machine is necessary to ensure correct volume ratios

Requirements

The coating shall be smooth, glossy, free from pinholes, excessive orange peel effect, bubbling, or excessive runs or sags. The coating shall be carefully examined after 24 hours cure for blisters and any uncured layers caused by blockages in the spray machine.

The dry film thickness shall be not less than 1,0mm

The coating shall be free from electrical insulation defects when tested with a high voltage holiday detector set at 5 kV and used in accordance with SANS 1217

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

20.3 SYSTEM E.4 ELASTOPLASTIC POLYURETHANE, UNDERWATER; ABRASIVE CONDITIONS

Materials, system and **requirements** as for E.3, except that the coating thickness shall be not less than 2mm and there shall be no electrical insulation defects when tested with a high voltage holiday detector set at 10 kV

20.4 REPAIR PROCEDURE FOR POLYURETHANE SYSTEMS

Since polyurethane systems are chemically cured, very thorough abrasion of damaged or defective coating is required to ensure an adequate physical bond. If repair is carried out within 16h* of application of the last coat of polyurethane, abrade the surface with abrasive paper. Wipe free from dust and debris and then apply brush grade polyurethane, thoroughly mixed in the correct proportions, in as many coats as are required to achieve the specified thickness and freedom from holidays.

If repair is carried out later than 16h after application of the last coat, abrade the surface as above, remove debris, then apply the manufacturer's adhesive, thoroughly mixed in the correct proportions in a very thin layer, to the abraded surface only, NOT on any un-abraded area. Allow not less than 30* minutes nor more than 4h before application of brushing grade polyurethane, thoroughly mixed in the correct proportions, to the total thickness and freedom from electrical insulation defects as required by the relevant specification

*at 25°C and not more than 70%RH - as over-coating times are critical to achieve good adhesion, the manufacturer’s advice must be sought on every application.

20.5 SYSTEM E.6 SOLVENT FREE CERAMIC FILLED HIGH ABRASIVE EPOXY LINING SYSTEM

Material shall be based on a high performance, solvent free, ceramic filled epoxy coating designed for use as a resurfacing and lining system to improve the efficiency in fluid flow environments

The system

(i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa3, a profile of 50-100 microns, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than $100mg/m^2$ (Weber Rielly Test)

(ii) Apply one or two coats of a *solvent free ceramic filled epoxy*, using appropriate equipment and methods as described in the manufacturers Technical Data Sheet

Requirements

The finished coating shall be smooth, uniform, glossy and free from orange peel effect, excessive runs and sags, blisters or other visual defects

The dry film thickness shall be not less than 500µm or greater than 2mm

The coating shall be free from electrical insulation defects when tested with a wet sponge detector, operated in accordance with Clause 8.12.1 of SABS 1217, using a potential of 90 Volts and a sensitivity of 10 Megohms

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

20.6. SYSTEM E.7 SOLVENT FREE EPOXY PHENOLIC FOR STEELWORK AND EQUIPMENT IN CHEMICAL ENVIRONMENTS

Material shall be based on a high performance, solvent free, epoxy/phenolic coating designed for use in corrosive chemical environments

The system

(ii) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa3, a profile of 50-100 microns, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100mg/m^2 (Weber Rielly Test)

(ii) Apply two or three coats of a *solvent free epoxy phenolic coating*, using appropriate equipment and methods as described in the manufacturers Technical Data Sheet.

NOTE: The overcoating times, as recommended, shall be strictly adhered to.

Requirements

The finished coating shall be smooth, uniform, glossy and free from orange peel effect, excessive runs and sags, blisters or other visual defects

The dry film thickness shall be not less than 300µm or greater than 500µm

The coating shall be free from electrical insulation defects when tested with a wet sponge detector, operated in accordance with Clause 8.12.1 of SABS 1217, using a potential of 90 Volts and a sensitivity of 10 Megohms

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

21 CATEGORY F POWDER COATINGS

POWDER COATING may utilize a very wide range of materials, which may be broadly classified as follows :

Thermoplastic; such as Nylon, PVC, polyethylene, ethylene vinyl acetate, etc. These have the property of not changing their chemical composition during heating and cooling. They may therefore be reheated to become plastic or cooled to become solid as many times as may be necessary.

Generally the thermoplastic materials are applied in thicker coats than thermoset and have relatively poor adhesion; hence they are used primarily for articles that can be fully encapsulated.

Nylon (e.g. '*Rilsan*') has good exterior exposure resistance and excellent resistance to wet abrasion. It is semi-flexible in nature and therefore has good impact resistance. A primer is required for all applications and adhesion with use of the primer is good. The dip application into a fluidized bed is ideal for small diameter pipes and ensures complete coverage at film thicknesses of 300 microns. Facilities for coating items up to 6 metre x 900mm are available in South Africa.

Thermoset; such as epoxy, polyurethane or polyester. On heating these powders melt, flow out to a thin film, then change chemically during the heating cycle so that, when cooled, they can no longer be melted by heat. It is therefore important that these materials go through the complete curing process during heating, otherwise they will not give the required performance

The thermoset materials are harder, are more resistant to impact damage and exhibit good adhesion but correct application is essential to ensure full cure

Incorrect curing time or temperatures are responsible for the largest proportion of defects in powder coating application. Articles of high mass, such as castings, are particularly susceptible and the surface temperature of the article to be coated should always be measured and controlled. Improper curing results in brittle, solvent sensitive coatings and may show up as pinholes and bubbles in the coating, or it may not be visually detectable but results in poor performance. Improper curing of thermoset materials can be confirmed by laboratory test procedures on flakes of coating

For exterior use in South African conditions, exterior grade polyester powders are preferred for their excellent gloss and colour retention on exposure.

For immersion service in water, epoxy powders are preferred

Design is important when items are to be protected by powder coatings. Corners are difficult to coat and sharp edges must be avoided. Powder coatings generally have very high cohesive properties and do suffer from weak spots at sharp edges, especially the thermoplastic materials. The Designer should aim for a 'cocoon effect' that encapsulates the item in an even thickness of the powder coating. Design of items to be coated by fluidised bed techniques must ensure no 'traps' that may cause build up of powder on horizontal surfaces.

The application of powder coatings shall only be carried out by specialist contractors with the necessary plant, facilities and experience to carry out such work. Full details of cleaning method, type of powder to be used, type of primer to be used, method of application, cure cycle and coating thickness shall be supplied to the Engineer

21.1 SYSTEM F.1 FUSION BONDED EPOXY (FBE) PIPE COATING

Material shall be based upon *thermosetting epoxy resin pipe coating powder* and shall comply with the requirements of SANS 1217 Type 2*. When used for potable water, it shall also be non- toxic and non-tainting (See Clause 3.3 of SANS 1217). When required, the contractor shall obtain and submit to the Engineer acceptable certification of non-toxicity and non-tainting properties.

*SABS 1217 Edition 1.3 is still in use.

The system

(i) Prepare surfaces by blast cleaning as specified in Clauses 10.5 to Sa 3 finish

(ii) Apply a *silico-chromate metal pre-treatment* to an approved method prior to heating the item

(iii) Heat the component to the temperature recommended by the powder manufacturer (usually 220°C) and apply powder by electrostatic powder gun, by fluidised bed, or by electrostatic fluidised bed techniques to achieve adequate wetting of the surface and flow out to a smooth, uniform finish, complying with all the requirements given below

The applied powder shall be fully cured, either by residual heat, or by post curing (depending upon the powder formulation and heat capacity of the component), to meet the requirements given below

Requirements

The finished coating or lining shall be smooth, uniform, glossy or semi glossy, free from over spray, blisters or other visual defects

The dry film thickness shall be not less than 400 or greater than 600 microns

The coating or lining shall be free from electrical insulation defects when tested with a DC high voltage spark tester in accordance with SABS 1217, using a potential of 3.5 kV

The film shall be fully cured and shall show no softening or discolouration of the swab when tested for M.E.K. resistance in accordance with SANS 1217 Clause 8.9. In cases of dispute, degree of cure shall be determined by Differential Scanning Calorimetry, using the method described in British Gas Specification GBE/CW6, Part 1, Appendix B.2, when the difference in Glass Transition Temperature between the two runs shall not exceed 3°C

Impact Resistance of the applied coating or lining, when tested by ASTM G14 on a rigid substrate, shall be not less than 8 Joules. NOTE: large diameter and low wall thickness pipes must be supported internally at the point of impact to provide a rigid surface

Cathodic disbonding, when tested by ASTM G-8 Method B, for a period of 30 days, shall not exceed 500 mm^2, nor shall current flow at the end of test period, exceed 5 mA

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86

21.2 SYSTEM F3 EXTERIOR DURABLE POLYESTER COATINGS ON PRIMED GALVANIZED STEEL FOR EXTERIOR USE

The system is intended for exterior use on galvanized sheet steel articles in corrosive environments. A primer designed for use on galvanized steel is required. *Exterior durable polyester powder* is preferred to give maximum gloss and colour retention on exposure to sunlight

Surface Preparation

The surface shall be chemically treated by a proprietary process to remove oil, grease and white rust and to leave a fine crystalline zinc phosphate surface layer

(If the surfaces to be coated are not going to be pre-treated by means of a chemical conversion, then the metal must be absolutely clean, and dry. If traces of white rust are present, it is recommended that these be removed by wire brushing prior to degreasing, to ensure the best possible corrosion protection and then, after degreasing, be lightly abraded with Scotchbrite®, to remove the oxide layer.)

Material shall be a *thermosetting exterior durable polyester powder* complying with SANS 1274 Part 6

Primer: A *twin pack Epoxy Strontium Chromate primer* shall be used on the prepared galvanized surfaces.

Apply by conventional liquid spraying equipment a mist coat of thinned *Epoxy Strontium Chromate Primer* to a dry film thickness of 10 - 20 microns.

Air dry for 60 -120 minutes to allow solvents to evaporate before over-coating with powder. Do not bake or allow the primer to cure for more than 4 hours.

The powder and the primer can then be baked together at the normal curing schedule for the powder coating in use.

Alternatively;

Use an approved 7 stage immersion tank pre-treatment process followed by application of an approved powder primer to a dry film thickness of 50 microns

Powder Application

The materials shall be applied and heated for the time and temperature cycle in accordance with the manufacturer's instructions

Requirements

The coating shall be smooth, glossy, free from over spray, blisters and other visual defects.

The dry film thickness shall be not less than 700 nor greater than 115 microns. The film shall be fully cured. It shall show no softening or discolouration, nor shall the swab show any significant discolouration, when tested with a cotton wool swab soaked in MEK for a contact time of 2 minutes. In cases of dispute, degree of cure shall be determined by Differential

Scanning Calorimetry, using the method described in British Gas Specification GBE/CW6 Part 1, Appendix B.2 when the difference in Glass Transition Temperature between the two runs shall not exceed 3°C

The coating system shall exhibit excellent adhesion when tested by the ISO 2409 method

21.3 SYSTEM F4 EXTERIOR DURABLE POWDER COATING ON EXTERIOR ARCHITECTURAL ALUMINIUM

The system is intended for use on architectural aluminium such as window frames, where colour and colour retention as well as chemical resistance are required

Material

Material shall be based on a *thermosetting polyester powder* complying with SANS 1578- Durable organic powder for coating of external architectural aluminium - Part 1 - Powder

The process

(i) Prepare surfaces by a multi stage chemical spray pre-treatment as specified by the manufacturer

(ii) Apply the powder by electrostatic powder gun to achieve adequate coverage of the surface

(iii) Heat the coated component in a suitable oven to achieve the curing temperature and time recommended by the manufacturer

Requirements

The applied powder shall be fully cured to meet the requirements of the SANS 1796 – Coatings of durable organic powder for external architectural aluminium.

21.4 SYSTEM F5 *SINTACOTE* - SINTERED LOW OR MEDIUM DENSITY POLYURETHANE PIPECOATING

This system has been in use in South Africa for the last 15 years with good success. It consists of a low or medium density polyethylene powder that is applied to the preheated pipe by the fluidised bed process. The coating thickness is in the order of 2 - 3 mm; hence additional rock guard is only necessary in very rocky terrain. Due to the complexity of the application of the powder, it is only practical for fairly long pipelines and is not generally an off-the-shelf item

Material

Material shall be low (or medium when available) density *Polyethylene powder* complying with the requirements of ASTM D-1248, Type 1, Category 3, modified to give improved ultra violet light resistance

Surface Preparation

Blast clean to minimum Sa 2 ½, remove dust and debris

Primer

No primer is required

Powder Application

Powder shall be applied by rolling the pipe preheated to a surface temperature of 350°C by means of a special mandrel in a fluidised bed of powder. The contact time shall be sufficient to ensure adequate film build.

Requirements

The coating shall be smooth, uniform, semi-glossy and free from dry powder, blisters and other visual defects. The dry film thickness shall be not less than 1.5mm. The coating shall comply with all the requirements of Australian Specification AS 2518

When tested with a high voltage EID detector operated at a test voltage not less than 5 kV over 100% of the surface, there shall be no defects. Defects found during Quality Control may be repaired provided that such defects do not exceed 1 per m^2 and that the repaired area meets all the requirements of the specification.

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

21.5 SYSTEM F6 TWO LAYER - EPOXY ZINC RICH POWDER PRIMER OVERCOATED WITH A POLYESTER POWDER DESIGNED FOR EXTERIOR USE

The system is intended for use on mild steel interior, mildly corrosive conditions or exterior conditions where additional corrosion resistance is required.

Material shall be double powder coating - firstly a *zinc rich epoxy powder primer* overcoated with a *polyester powder coating* designed for an exterior environment.

The process

Preparation - Steel > 2mm thickness: Prepare the surface as per Section 10.5 - abrasive blast to a low profile (Refer 10.7.2)

Steel < 2mm thickness: Degreasing and phosphating followed by passivation, rinsing with demineralised water and drying. Follow the procedural advice of the chemical pre-treatment suppliers.

Primer application

The steel prepared as above shall be primed using a *thermosetting epoxy*, rich in zinc - designed as an anti-corrosive primer undercoat for powder topcoats. The primer shall be applied and cured exactly according to the manufacturer's recommendations.

Topcoat application

Within 4 hours of applying the primer coat (refer manufacturer's instructions for delays exceeding 4 hours) the topcoat of *polyester powder coating* designed for exterior environments shall be applied. To ensure the integrity of the system the whole system must be cured in accordance with the recommended curing conditions for the topcoat*.

*Note: Failure to comply with the final curing conditions may cause variations in colour and gloss and cause degradation of the coating properties of the system.

Requirements

The coating shall be smooth (the primer layer is slightly granular), slightly stippled film, glossy, free from over-spray, blisters and other visual defects.

The combined film thickness shall be 120 - 150µm

The film shall be fully cured. It shall show no softening or discolouration, nor shall the swab show any significant discolouration when tested with a cotton wool swab soaked in MEK for a contact time of 2 minutes. In cases of dispute degree of cure shall be determined by Differential Scanning Calorimetry, using the method described in British Gas Specification GBE/CW6 Part 1, Appendix B.2 when the difference in Glass Transition Temperature between the two runs shall not exceed 3°C

Impact resistance according to ISO 6272-1 shall pass 0.5kg.m (the system).

Adhesion according to ISO 2409 - 2mm cross hatch on the system shall not exceed 0

22 CATEGORY G TAPE WRAPPING SYSTEMS

Tape wrapping is a method of corrosion protection used primarily for underground pipes and their ancillaries such as couplings, valves, etc. The method is used primarily on site although for certain types, wrapping can be carried out on individual pipes at a factory or site yard. There are many types of tape but for the purposes of this specification, only two types are given, namely petrolatum tape and rubber modified bitumen with polyethylene outer coating

General

Prior to the Contractor commencing work he shall obtain clearance in writing from the Engineer that all necessary investigations for soil resistivity and stray current electrolysis have been carried out and that, where required, continuity bonds and anode cables have been correctly installed

Surface Preparation

Items to be wrapped to this specification shall be cleaned manually or mechanically in accordance with Clauses 10.5.1 and 10.5.2 to achieve a cleanliness of minimum St 2 of ISO 8201-1

Primer

The primer shall be supplied by the tape manufacturer for the specific tape to be used. It shall be applied in a uniformly thin film, free of runs and sags. The pipe surface shall be entirely covered and shall be dry to the “tacky to touch” stage at the time of tape wrapping application. Uncoated, flooded, or areas primed over improperly cleaned pipe, shall be thoroughly cleaned to the satisfaction of the Engineer and re-primed

Application

Straight runs of pipe shall have the tape spirally wrapped with a manual or power driven wrapping machine. Short lengths, couplings and valves may be wrapped by hand. The tape shall overlap the preceding spiral by a minimum of 25 mm, more usually by an overlap of 55% of the tape width. The inner and outer tape layers, where applicable, shall be applied in such a manner that the overlaps of the layers do not coincide. The tape shall be kept under constant tension to ensure a uniform, tightly adhered coating, free of wrinkles, puckers, voids and bubbles. Care shall be taken to assure that the overlap is maintained.

Tape Joins and Repairs

When making a tape join during hand-wrapping or hand-operated wrapping machine operations, make a complete turn from the new roll over the wrapping previously applied. In the case of line-travel machines where reversing is difficult, pull sufficient tape off the roll to enable the new roll end to be so positioned as to allow at least one full turn over the previously applied wrapping

Ensure that all joins are free from wrinkles and folds and all old roll ends free from delaminated cardboard core material. Where damage to the wrapping on a pipeline has occurred and where there are creases, wrinkles and folds in the wrapping, proceed as follows:

(i) If the width of the tape being used exceeds by at least 100mm the length of the section affected, cut the area of damaged wrapping away to bare metal leaving no raised edges or protrusions. Liberally prime the "window" thus exposed and apply a patch of tape, ensuring an overlap of the patch of at least 50mm on all sides onto the surrounding wrap. Apply primer (where applicable) over the patched area and, using a 55% overlap, apply by hand-wrapping a further layer of tape, commencing two turns before and continuing for two turns beyond the patch.

(ii) Where the extent of damaged or faulty wrapping is such that the tape cannot span the affected area and provide a 50mm overlap on all sides, completely remove the wrapping from the pipe over the affected section, clean, re-prime and using a 55% overlap, re-wrap the pipe, commencing two complete turns before and finishing two turns beyond the bared section

(iii) Where damage or a defect has occurred in a section that has been double wrapped and in the case of small holidays, use the appropriate procedure given in (i) or (ii) above

(iv) Where damage extends through an outer wrap/rockshield, this should be carefully removed for a distance equal to three times the width of the tape of the inner wrap on each side of the holiday without damaging the pipe wrapping, the repair carried out by the appropriate method given in (i) or (ii) above, and the outer wrap or rockshield suitably reinstated

Rockshield

Suitable rockshield shall be applied in accordance with SANS 10129 Section 6, when required by the Engineer

Backfill

Backfill adjacent to the coated and wrapped pipe shall be free of scraps, sticks, rocks, or other hard debris that may damage the coating

22.1 SYSTEM G1 PETROLATUM TAPE

Petrolatum is a stiff, grease-like material derived from the distillation of crude oil. It has been used for many years for corrosion protection of both underground and above ground surfaces in severe environments. By impregnating this material into synthetic fabrics, various tapes have been produced. Because the material is soft, the completed corrosion protection must be protected from mechanical damage by a suitable outer wrap such as polyethylene tape or sheet

The system

Single wrap and HDPE outerwrap

(i) Clean the pipe surface by manual or mechanical means as specified in Clause 10.5.1 and 10.5.2 to achieve a standard not less than St 2

(ii) Prime with the tape manufacturer's recommended *petrolatum primer* at a coverage rate specified by the manufacturer

(iii) All lengths of buried pipework are to be wrapped with *Petrolatum Impregnated Tape* of appropriate width. The tape shall be applied in a helical manner with a tape overlap of 25mm. The application shall be free of wrinkles, creases and air voids. Special care shall be taken to ensure that correct tension is used while applying the tape. All overlaps shall be suitably smoothed by hand to produce a smooth and continuous wrapping

(iv) On completion of the tape inner wrap, the pipework shall receive an outer wrap of HDPE pressure sensitive wrapping of appropriate width. The HDPE shall be applied in a helical manner, with a tape overlap of 25mm, or 55% of the tape width if additional thickness is required for the backfill material. The application shall be free of wrinkles, creases and air voids. Special care shall be taken to ensure that correct tension is used while applying this tape. In addition, the outer wrap shall be secured at 5 metre centres with suitable fastening / strapping to prevent excessive unwrapping in the event of accidental damage

Requirements

The wrapped pipe shall have a uniform appearance, free from bubbles, wrinkles, lifting at the overlaps, and other visible defects

The total thickness will vary considerably. A single wrap of petrolatum-impregnated tape will contribute 1.2mm per layer. A single layer of rockshield HDPE tape will contribute 300µm, i.e. total 1.5mm - 55% overlap effectively doubles this thickness.

22.2 SYSTEM G2 BUTYL RUBBER MODIFIED BITUMEN WITH POLYETHYLENE OUTER TAPE

Bitumen has been used for very many years for pipe coating but suffers some major disadvantages, particularly due to its high temperature sensitivity in South African conditions. By the addition of butyl rubber the properties have been modified to make the blend very suitable for the coating of buried pipes and pipelines. In combination with high density polyethylene, tapes with high bond strength, low water absorption, good UV resistance and unique plastic flow properties have been produced

The system

(i) Clean the pipe surface by manual or mechanical means as specified in Clause 10.5.1 and 10.5.2 to achieve a standard not less than St 2

(ii) Prime all surfaces with the manufacturer's specified primer, at the manufacturer’s recommended coverage rate

(iii) Apply a *butyl rubber modified bitumen tape with polyethylene outer (butyl tape)* the tape in spiral fashion maintaining a minimum overlap of 25mm but may be up to 55%, according to the corrosivity of the soil. Care shall be taken to prevent air pockets and wrinkles. The tapes must be tensioned sufficiently to cause *slight* exudation of the bitumen mastic layer at the laps, *but not stretched*

(iv) Apply the outer wrap of modified *polyethylene / laminated pressure sensitive ‘rockshield tape’* in a similar fashion, making sure that the overlaps of the outer wrap do not coincide with the overlaps of the inner wrap

Requirements

The wrapped pipe shall have a uniform appearance, free from bubbles, wrinkles, lifting at the overlaps, and other visible defects

The total thickness will vary considerably. A single wrap of 1mm thickness butyl tape will contribute from 1 mm per layer. A single layer of ‘rockshield’ outer tape will contribute 300µm, 55% overlap effectively doubles this thickness. The actual tape thicknesses to be applied in any given environment will be specified by the engineer.

22.3 SYSTEM G4 PETROLATUM INHIBITIVE PRIMER, FOLLOWED BY PETROLATUM MASTIC OR PETROLATUM BLANKET FOR FLANGES & COUPLINGS

(i) Clean the pipe surface by manual or mechanical means as specified in Clause 10.5.1 and 10.5.2 to achieve a standard not less than St 2

(ii) Prime with the tape manufacturer's recommended *petrolatum primer* at a coverage rate specified by the manufacturer

(iii) The entire item shall be packed using a *petrolatum mastic* to produce a smooth contour excluding all bubbles and voids

(iv) The mastic shall be carefully over-wrapped (so as not to distort the soft surface) with *petrolatum impregnated tape* of appropriate width. The tape shall be applied in a helical manner with a tape overlap of 25mm. The application shall be free of wrinkles, creases and air voids. Special care shall be taken to ensure that correct tension is used while applying the tape. All overlaps shall be suitably smoothed by hand to produce a smooth and continuous wrapping

(v). On completion of the petrolatum impregnated tape over-wrap apply a 'rockshield' HDPE tape or polyethylene layflat sheeting as recommended by SANS 10129 Section 5.3

Requirements of tape wrapped pipes and joints

Visual: The completed tape wrap system shall be smooth, uniform, with the specified overlap. It shall be free from bubbles, wrinkles, lifted edges and other visible defects

Thickness: The thickness of the tape wrap shall be not less than 80% of the specified number of layers multiplied by the manufacturer's specified thickness.

Holiday (E.I.D.) Detection: The whole surface of the pipe and couplings shall be tested with an approved high voltage holiday detector just prior to backfilling. The test voltage shall be not less than 50% nor greater than 80% of the breakdown voltage of the system. Breakdown voltage is given by the dielectric strength (kV/mm) of the tape, multiplied by the total thickness (mm). Generally, the test voltage will be not less than 18 kV

Holidays shall be marked out and repaired as specified. After repair, no holidays are permitted

23 SUMMARY OF COATING SYSTEMS

NOTE - These summaries are for ease of reference only. The contractor must comply with all the requirements given under SYSTEMS and in the GENERAL Clauses

CATEGORY A - ALKYD SYSTEMS FOR MILD ENVIRONMENTS

System	Substrate	Surface Prep	Coating System	Requirements
A1	bare steel	manual/ mechanical cleaning St 2 min.	1 coat high build primer for steel 1 coat alkyd enamel (interior) 2 coats alkyd enamel (exterior)	Smooth, glossy finish DFT interior - 65µm min DFT exterior - 80µm min
A2	primed steel	clean and touch-up	touch-up quick drying primer 1 coat high build primer all over 1 coat alkyd enamel (interior) 2 coats alkyd enamel (exterior)	Smooth, glossy finish DFT interior - 65µm min DFT exterior - 80µm min
A3	factory finished steel	abrade and clean	1 coat alkyd enamel (interior) 2 coats alkyd enamel (exterior)	Smooth, glossy finish DFT interior - 65µm min DFT exterior - 80 µm min
A4	galvanized steel	degrease and abrade	1 coat special primer 1 coat alkyd enamel	Smooth, glossy finish DFT over galv. - 75µm min
A5	plastic and bitumen coated	abrade and remove dust	1 coat water based primer 1 coat alkyd enamel	Alternative to tapes for colour coding

CATEGORY B - TWO PACK SOLVENT BORNE EPOXY AND POLYURETHANE SYSTEMS

System	Substrate	Surface Prep	Coating System	Requirements
B1	steel or cast iron	blast clean Sa 3, profile 50 - 100µm	2 -3 coats high build epoxy for underwater use	DFT min 300, max 450 µm no EIDs wet sponge 90v 2 Megohms
B1A	steel or cast iron	blast clean Sa 2½ profile 50 - 100µm	2 coats epoxy 2 coats recoatable polyurethane	DFT min 300, max 450 µm
B2A	galvanized steel	degrease and abrade	1 coat 2-pack special epoxy primer for galv steel 1 coat recoatable polyurethane	DFT min 150, max 250 µm over galvanizing
B3	steel or cast iron	blast clean Sa 2½, profile 50 - 100µm	1 coat HB epoxy primer 1 coat epoxy MIO int. coat 1 coat recoatable polyurethane	DFT min 255, max 400 µm
B4	steel or cast iron	blast clean Sa 2½, profile 50 -100µm	1 coat epoxy zinc rich primer (alt inorganic zinc) 1 coat epoxy MIO int. coat 1 coat recoatable polyurethane	DFT min 300, max 400 µm
B5	steel or cast iron	blast clean Sa 3, profile 50 - 100µm	1 coat epoxy phenolic primer 1 coat epoxy phenolic int. coat 1 coat epoxy phenolic topcoat	DFT min 250, max 400 µm no EIDs wet sponge 90v 2 Megohms
B6	factory finished steel	degrease and abrade	1 coat epoxy aluminium mastic 1 coat recoatable polyurethane	DFT min 165, max 200 µm

CATEGORY C - SOLVENT BORNE COAL TAR EPOXY SYSTEMS

System	Substrate	Surface Prep	Coating System	Requirements
C1	steel or cast iron	blast clean Sa 3	2 - 4 coats HB epoxy-tar	DFT 300, max 600 µm no EIDs wet sponge 90v 2 Megohms

CATEGORY D - VINYL SYSTEMS

System	Substrate	Surface Prep	Coating System	Requirements
D1	steel or cast iron	blast clean Sa 3	1 coat vinyl primer 1 coat HB vinyl intermediate 1 coat vinyl enamel	total DFT min 175, max 195 µm
D2	painted or plastic	degrease and abrade	1 coat water based primer 1 coat vinyl intermediate coat 1 coat vinyl enamel	DFT min 110 µm (on plastic pipes, coloured self adhesive tapes preferred)
D3	galvanized steel	degrease and abrade	1 coat 2-pack special epoxy primer 1 coat vinyl intermediate coat 1 coat vinyl enamel	DFT min 125 µm, max 195 µm

CATEGORY E - SOLVENT FREE EPOXY AND POLYURETHANE SYSTEMS

System	Substrate	Surface Prep	Coating System	Requirements
E1	steel or cast iron	blast clean Sa 3 profile 50 - 100µm	1 -2 coats solvent free epoxy for underwater use	DFT min 300, max 450µm no EIDs wet sponge 90v 10 Megaohms
E3	steel or cast iron	blast clean Sa 3 profile 50 - 100µm	1 coat special primer solvent free hybrid aromatic polyurethane	DFT min 1mm no blistering or uncured material no EIDs spark test 5 kV
E4	steel or cast iron	blast clean Sa 3 profile 50 - 100µm	1 coat special primer solvent free hybrid aromatic polyurethane	DFT min 2mm no blistering or uncured material no EIDs spark test 10 kV
E6	cast iron	blast clean Sa 3 profile 50 - 100µm	2 coats solvent free, ceramic filled highly abrasive resistant epoxy lining	DFT min 500, max 2mm no EIDs wet sponge 90v 10 Megaohms
E7	steel or cast iron	blast clean Sa 3 profile 50 - 100µm	2 -3 coats solvent free epoxy phenolic chemical resistant coating	DFT min 300, max 500 µm No EIDs wet sponge 90v 10 Megaohms

CATEGORY F - POWDER COATINGS

System	Substrate	Surface Prep	Coating System	Requirements
F1	steel pipes or cast iron	blast clean Sa 3 chemical treatment	fusion bonded epoxy pipe coating powder, applied by electrostatic spray	DFT min 400, max 600µm no EIDs high voltage 3.5 kV full chemical cure
F3	galvanized sheet steel	chemically clean and phosphate	liquid primer polyester powder	DFT min 50, max 100µm over galv. full chemical cure
F4	architectural aluminium	chemically clean SABS 1578	polyurethane powder SANS 1578 or BS 6496:1984	DFT 60 - 80µm SANS 1578 or BS 6496:1984 full chemical cure
F5	steel pipes (large bore)	blast clean Sa 2 ½	low density polyethylene powder, applied by fluidised bed	DFT min 1.5mm no EIDs high voltage 10kv Australian spec. as 2518
F6	steel or sheet steel	chemical clean or abrasive blast	zinc rich epoxy primer/ polyester powder for exterior exposure	DFT min 120µm - 150µm full chemical cure

CATEGORY G - TAPE WRAP SYSTEMS FOR PIPES AND PIPELINES

System	Substrate	Surface Prep	Coating System	Requirements
G1	steel and CI pipes and fittings	mechanical or manual clean min St 2	petrolatum primer petrolatum tape 55% overlap PVC or PE outer tape	DFT 1.5mm or higher to engineer's instructions no bubbles, wrinkles or lifting at overlaps no EIDs high voltage 18 kV
G2	steel and CI pipes and pipelines	mechanical or manual clean min St 2	rubber-bitumen primer rubber-bitumen tape polyethylene outer wrap	DFT min 1.3mm or higher to engineer's instructions no EIDs high voltage 18 kV
G4	flanges and couplings	mechanical or manual clean min St 2	petrolatum primer, then petrolatum mastic or blanket, polyethylene outer wrap	total encapsulation SANS 10129 Section 5.3

CIVIL AND ARCHITECTURAL COATING SYSTEMS

CONTENTS OF

CIVIL AND ARCHITECTURAL COATING SYSTEMS

24 GENERAL

The use of the coating systems given in the previous section, plus some systems applicable only to this section, are given as guidelines

The range of surfaces to be protected and the variation of exposure conditions are such that each plant must be considered as a unique installation

The recommendations given in this section shall be used if confirmed by the Engineer. The systems given in the Project Specification and drawings take precedence over the following recommendations

25 BUILDINGS

The contractor shall quote for the specification stipulated by the Engineer or Architect. Where alternative processes of equal technical merit are stipulated in the Project Specification, the contractor shall quote the lowest price in his tender and clearly state which system he intends to use. He may also offer his own alternative system in addition to his offer for the specified system, provided that he fully motivates the advantages of his system and supplies full technical details for evaluation by the Engineer

25.1 PAINTING WOODWORK

25.1.1 Softwood such as Pine

All wooden surfaces shall be planed and sanded to a smooth surface. Sanding debris shall be removed. Wood shall contain not more than 12% moisture before painting. Large or loose knots shall be removed and plugged with wood. When approved by the Engineer, large firm knots may be cut back below the surface and filled with approved acrylic resin based filler. The filler shall be allowed to dry fully and then sanded down to be flush with the surface. Small firm knots shall be sealed with shellac knotting or similar material that will seal without bleeding into the subsequent coats

System

The clean, dry, smooth surface shall be primed with primer for wood, aluminium base, complying with SANS 678 Type II

After at least 16 hours drying time, apply General Purpose Undercoat complying with SANS 681:1997 Grade 1

After a further minimum 16 hours drying, the surface shall be lightly sanded to remove nibs, dusted off, then one coat high gloss enamel complying with SANS 630 shall be applied

On exterior surfaces a second coat of high gloss enamel complying with SANS 630 shall be applied after 16 hours drying of the first coat

Requirements

The finished system shall be smooth, glossy and uniform in gloss and colour. It shall be free from nibs, occlusions, runs, sags, curtaining, blowholes, blisters or any other visible defect.

The colour shall be a close match to the colour specified by the Engineer

25.1.2 Hardwood, such as teak, oak, iroko etc

Surface Preparation

All hardwood shall be well sanded and dusted off and it shall be dry (not more than 12% moisture when tested with a suitable calibrated electrical conductance mater).

System

Any one of the following systems may be used provided that the contractor states in his tender document which system he intends to use and the reason for his choice

(i) The clean, smooth, dry surface shall be oiled with Pale Boiled Linseed Oil and rubbed well into the surface. The first coat shall be thinned with 10 to 15% Turpentine Substitute to aid penetration. All subsequent coats shall be applied neat. Apply copiously and after two hours, wipe off the surplus. Repeat the treatment after 48 hours and thereafter at weekly intervals for 5 or 6 weeks. The final application shall be followed with a brisk rub down with a soft cloth to produce a uniform sheen on the surface

(ii) The clean, dry, sanded surface may be treated with a preservative, developed by the Forestry Product Research Institute (USA) and approved by the Timber Section of SABS

Apply the preservative liberally by brush and allow to soak into the surface. Wipe off any runs or excess material and leave to dry for at least 48 hours. Apply a second coat uniformly and allow drying for a further 48 hours. Particular care shall be taken to preserve the end grain, where exposed, by thorough impregnation. This treatment requires a revival coat every two years

(iii) The clean, dry, sanded and de-dusted surface of the hardwood may be coated with at least two coats of clear moisture curing polyurethane, designed for use on hardwood, and applied in accordance with the manufacturer's instructions

Requirements

The surface shall have a smooth, uniform, high-gloss, semi-gloss or satin (as required by the Engineer) “luxury” finish, free from runs, sags, bubbles, milkiness or other visible defects and shall enhance the natural grain of the wood

25.2 PAINTING CEMENTITIOUS SURFACES

25.2.1 Ceilings

All gypsum plaster board ceilings, including cornices and cover strips shall be treated as follows:

(i) Nail heads shall be punched below the surface and spot primed with zinc phosphate primer for steel

(ii) Cracks, joints and depressions shall be filled with an approved acrylic based filler, to be slightly proud of the surface. After fully curing, the surface shall be sanded to a smooth finish flush with the surrounding area. Remove all dust and debris

(iii) Apply two coats interior quality synthetic polymer base emulsion paint complying with SANS 1586 Grade 3

25.2.2 Plastered and Concrete Surfaces

Walls shall be clean, free from oil and grease, shutter release agents, loose sand or friable surface layer

Interior surfaces - where indicated, shall be coated with two coats synthetic polymer base emulsion paint complying with SANS 1586, Grade 1 or Grade 2, as appropriate, for the colour selected. The first coat may be thinned if necessary, with not more than 10% water

Humid interior surfaces shall be treated as for exterior surfaces

Exterior surfaces - where indicated, be coated with two coats synthetic polymer base emulsion paint for exterior use, complying with SANS 1586 Grade 1. The first coat may be thinned, if necessary, to aid penetration with not more than 10% water

In either case, should the uniformity of colour and sheen be unacceptable to the Engineer, a third coat shall be applied at no extra cost

25.2.3 Fibre Cement Surfaces

Treat as for exterior plastered and concrete surfaces

25.3 PAINTING METALWORK

25.3.1 Non-galvanized

Non-galvanized window frames, door frames, steel doors, etc. shall be supplied coated with an acceptable factory primer

Window

Glazing shall be carried out in accordance with good practice, using glass as specified, well bedded in putty complying with SANS 680, self setting type. The putty shall be well worked before use to obtain adequate plasticity. On completion of glazing, the putty shall be well smoothed off, trimmed to a straight clean edge and sloping to an angle of approximately 60 degrees to the glass to ensure good water run off. Excess putty shall be removed from the window frame before painting. Putty shall not be painted less than 7 days after completion. All mortar splashes, putty, oil, grease, dirt and other contaminants shall be removed from the primed steel window frames

The window frames and putty in non-corrosive environments shall be prepared and coated as specified in Clause 16, using System A.3 (Alkyd System)

Window frames in chlorination rooms shall be prepared and coated as specified in Clause 19, using System D.2 (Vinyl System)

Structural Steel (internal corrosive conditions)

Steel in wet or chemically polluted environments such as chlorination rooms, shall be prepared and painted as specified in Clause 11, using System D1 (Vinyl System)

Structural Steel (immersed in water)

Immersed steel shall be prepared and painted as specified in Clause 17 using System B.1 (Two component solvent borne pure epoxy System)

Structural Steel in mild environments

Steel in mild environments shall be prepared and painted as specified in Clause 16, using System A1, A2 or A3, as appropriate

25.3.2 Galvanized

General - See Sub-Clause 10.7

Surfaces above water - Use System A.4, D.3 or B2A

26 BUND WALLS AND FLOORS

The coating must form a water impermeable tank with sufficient chemical resistance to withstand 40% Ferric Chloride solution and other aggressive chemicals. It must also have sufficient impact resistance that it will resist the impact of dropped hammers, spanners, delivery nozzles and the like. Complete sealing around entry and exit points of pipes, conduits, etc. is essential. This is normally carried out by the use of heavily filled two component epoxy grout. As with all coatings required to resist severe chemical exposure, correct surface preparation is essential. The surface must be dry before application of the coating system

Only specialist contractors may be employed for this work, as experience and technique are critical for successful results. The following is an abbreviated specification giving the essential stages only

Materials may be one of the following:-

An approved solvent free epoxy phenolic coating, resistant to 10% Hydrochloric Acid.

Use System B5, E7

In addition, glass fibre chopped strand mat and surfacing tissue made from 'C' glass, will be required. The primer to be used shall be as recommended by the manufacturer, compatible with the selected system and shall be low viscosity to penetrate the concrete

Surface Preparation

Acid wash all concrete surfaces with 10% hydrochloric acid to remove laitance, oil or grease and to achieve a surface profile provided by the aggregate. Water wash under high pressure to remove all loosened sand and soluble salts resulting from the acid etching process

A good drain of adequate capacity and approved for chemical cargo is essential. Wash until washings are free from soluble chlorides when tested with silver nitrate solution

Allow to dry thoroughly before coating

Procedure

Fill cavities or gaps with epoxy grout

Grind flush any protrusions

Prime all surfaces with low viscosity epoxy phenolic primer, depending on the system to be used

Lay up 300 g/m^2 of chopped strand C glass mat into either a special acid resistant solvent free epoxy phenolic coating.

Repeat once for epoxy phenolic coating to give a total glass content of 600 g/m^2.

Lay up glass fibre surfacing tissue with the appropriate resin

Apply one or two coats UV resistant polyurethane top coat, to give the colour required by the Engineer as well as resistance to UV light and the chemicals that may be contained in the bund (the pigment selected shall be resistant to acid)

Requirements

The coating system shall have a uniform appearance and colour approximating to that specified by the Engineer. The coating shall be well bonded to the substrate and shall be free from bubbles, occlusions and other defects detrimental to its performance. The coating system shall show no defects when tested over 100% of the coated area with a high voltage spark tester set at 10kV, or 50% of the breakdown voltage of the system, whichever is lower. Defects may be repaired by a method recommended by the resin manufacturer provided that the repair complies with the requirements of the specification

27 PIPES

Pipes may vary from very large to very small and may be constructed from a wide variety of materials such as mild steel, cast iron, concrete, fibre cement, glass reinforced plastic, etc. They may be exposed to a wide variety of environments from immersion in raw sewage to exposure to sunlight.

The recommendations in this specification cover only mild steel or cast iron pipes. For other types of pipe requiring lining and coating, separate specifications must be obtained

Pipes buried in aggressive soil require cathodic protection which is installed after the pipeline is laid and backfilled. If cathodic protection is considered, then steps must be taken to ensure continuity bonding across hydraulic couplings and valves chambers, or insulation where pipes join process vessels or leave the ground

27.1 FACTORY LINING AND COATING OF PIPES

The lining and coating of pipes is a specialized field of coating application, with specific requirements before, during and after coating. For this reason, only contractors with the necessary equipment, experience and Quality Control facilities will be considered for supply. Approval to ISO 9000 - 2000 is preferred

27.2 TYPES OF PIPE THAT MAY BE SPECIFIED BY THE ENGINEER.

Material may be mild steel or cast iron, in which case spheroidal graphite cast iron (S.G. iron) is preferred. Mild steel pipes may be seamless, longitudinally welded or spiral welded, as specified by the Engineer

Colour Coding, where required, shall be as specified in SANS 10140, Part 3

Pipes may be joined by flanges, flexible couplings or by circumferential welding or by proprietary jointing methods such as *Sintajoint*® or special bell and spigot type joint (*Hall Longmore Ltd*). The problem with all jointing methods is the treatment of the pipe ends and repair of the lining after joining on site

Circumferential welding is only recommended for pipes of nominal bore 450mm and over, unless an *in situ* pipe lining is employed, which is not covered in this specification

Bonding lugs shall be welded on to pipes where necessary for continuity bonding for cathodic protection

27.3 MECHANICAL PRE-TREATMENT BY THE PIPE MANUFACTURER

Pipes shall not be accepted for lining or coating, or both, unless they comply with the following requirements, which shall be notified to the pipe manufacturer

All weld spatter shall be removed by chipping or grinding to a smooth surface flush with the surrounding steel

All welds shall have a smooth contour, free from sharp edges, protrusions and undercuts. Longitudinally welded pipes shall have the internal weld scarfed flush with the wall of the pipe. No sharp edged projections are permitted

All sharp edges that are required to be coated shall be ground to a radius of curvature not less than 3mm

Hydraulic testing of the pipe shall be carried out after completion of the above processes

27.4 SURFACE PREPARATION BY THE LINING/COATING CONTRACTOR

The lining/coating contractor shall inspect pipes before surface preparation in accordance with Quality Control procedures to ensure that the requirements of 12.3 have been complied with

Degreasing Pipes shall be free from oil and grease. When necessary, local deposits of oil and grease shall be removed by the use of suitable solvents. In this case, care shall be taken to ensure that the contaminant is removed and not spread over a larger area. When pipes are extensively contaminated by oil or grease, they shall be completely degreased by one of the methods given in SANS 10064 Section 3

Blast Cleaning Pipes for lining or coating shall be blast cleaned by air blast or centrifugal equipment. Compressed air and abrasive shall be free from oil, grease and similar contaminants. The abrasive particle size and distribution shall be chosen to remove millscale and achieve the surface condition specified below:

Surface profile: 50 to 75 microns average, or ‘medium grade, when determined by ISO 8503 Part 2

For coatings exceeding 500 microns in thickness, the profile may be 50 - 150 microns or ‘course’, when measured as specified above

Cleanliness: Sa3 of ISO 8501-1

If laminations in the steel appear after blast cleaning, they shall be ground out and the ground area shall be blast cleaned. Where grinding is not practical or when the lamination requires grinding to a depth greater than 7% of the wall thickness, the pipe shall be rejected.

NOTE: Blast cleaning of CAST IRON PIPES requires that fine or medium grade mineral grit abrasives shall be used. Abrasive shall be new, unused and shall not be re-used. All sand particles, residual burnt on sand and casting skin shall be removed prior to galvanizing or painting

Removal of Dust and Debris Dust and debris from the blast cleaning process shall be removed by blowing with clean, dry compressed air, or preferably by vacuum cleaning, to achieve a residual dust and debris level not greater than Class 2 when tested by ISO 8502-3, or as agreed by the Engineer

Water Soluble Salts Surfaces to be lined or coated that will subsequently be immersed or buried shall show not more than 100 mg/m² soluble iron salts when tested with the Weber-Rielly Reagent

Masking of Ends to be Welded Pipes to be welded on site shall have the ends squared and machined to a 45° angle. After blast cleaning, ends to be welded shall be masked with good quality masking tape for a distance of 50mm from the end. During application of the masking tape, the adjacent surface of the blast cleaned pipe shall not be contaminated by perspiration, oil or grease. To prevent such contamination, operatives shall wear clean gloves when masking off. After site welding, all residual adhesive from the masking tape shall be completely removed by suitable solvents before the application of coating or lining repair material. The blast cleaned surface thus exposed shall be abraded with 80# abrasive paper prior to coating

Treatment of ends to be joined by flexible couplings The total thickness of lining of the coupling sleeve and coating of the pipe shall not be greater than 40% of the clearance allowed by the coupling manufacturer. In the event of this combined thickness being greater than the clearance, steps must be taken to reduce one or both of the thicknesses by the use of a suitable coating system which will provide adequate corrosion protection within the required thickness limits. Provided that these thickness limits have been catered for, the lining of the pipe should be continued to the end of the pipe, over the end and back along the outside of the pipe for sufficient length to cover the area to be covered by the coupling after joining on site

27.5 APPLICATION OF LINING OR COATING

Application of lining or coating shall be carried out as soon as possible and before any condensation, oxidation or contamination of the cleaned surface can take place

Lining or coating of pipes shall not be carried out unless the surface temperature is at least 15°C and 3°C above dew point

Mixing and proportioning of two component materials shall be strictly in accordance with the manufacturer's instructions. Split packs are not permitted

Final coating thickness shall comply with the requirements of the relevant specification

When solvent borne multicoat systems are used, the maximum thickness per coat and the time interval between coats shall be strictly in accordance with the manufacturer's instructions. Each successive coat shall differ in colour from the preceding and succeeding coat. Where solvent borne systems are used, a forced draught of warm air through the pipes may be necessary to prevent solvent retention

When solvent free two component materials are used, the application equipment shall be in accordance with the manufacturer's instructions. Tests shall be carried out frequently to ensure that the correct ratio of base to curing agent is maintained. Incorrect mix ratio of two component materials will lead to rejection of the coated articles

Powder shall be applied by the method stipulated in the relevant specification

Application equipment shall at all times be maintained in a clean condition such that there are no excessive occlusions of dry powder of dry over spray

27.6 RECOMMENDED SPECIFICATIONS

One of the following systems shall be used in accordance with the Project Specification:

27.6.1 Lining of pipes

In the factory

System B1 or E1 or Cement Mortar to SANS 1200 2000 for potable water, depending on pipe size and quantity

System C1 or E3 for sewage and acid waters

On site

Cement Mortar lining *in situ* (not covered in this specification) or System B1 for non-acidic waters only

Systems E3, or C1 for sewage and acid waters. NOTE: System C1 may not be used for potable water, due to its tainting properties

27.6.2 Coating of pipes

In the factory

Systems E1, E3, E4, E7 or F1 or F5 are all suitable for burial in soil. Due to their high cost, systems E3, E4 or E7 would only be used for extremely aggressive soil or pipe jacking

System B1A for pipes, valves, etc. aboveground in corrosive environments exposed to sunlight

On site

System G2 for pipe to be buried, with G1 or G4 for specials and couplings

28 FLANGES AND COUPLINGS

All flanges and couplings shall be protected from corrosion after tightening of all bolts and pressure testing as required by the Engineer. Pipes may be joined to each other and to ancillaries such as valves, tees, etc.

Methods of joining pipes

Circumferential welding: This is only practical on pipes of diameter in excess of 450mm (unless *in situ* cement mortar lining is to be applied) to allow man access to repair the pipe lining at the weld. The coating and lining of welding joints are normally repaired by the procedures given under the specific system used for coating and lining the pipes

Flanges: These are normally used only on small diameter pipes because of the high cost of flanges

Flexible Couplings, also known as Hydraulic Couplings: These comprise a coupling sleeve which fits over the pipe ends, together with clamps at each end and rubber sealing rings to make a watertight joint that will tolerate a certain amount of movement. Since the sleeve fits over the pipe, it is normally lined with the same material and to the same standard as the pipe. However, care must be taken when thick (1mm and over) pipe coatings or linings are used to ensure that the lining and coating combined does not exceed the clearance between sleeve inner diameter and the pipe exterior diameter

Proprietary couplings are those such as *Sintajoint*® and modified bell and spigot joint (Hall Longmore Ltd.)

29 CATHODIC PROTECTION

Cathodic protection is an electrical method of corrosion protection applied to prevent corrosion of underground or underwater structures to supplement the corrosion protection provided by the coating system (insulation against corrosion). The protection may be in the form of impressed current from a mains supply via a transformer rectifier or in the form of sacrificial anodes. Cathodic protection must be designed specifically for each location, depending on soil corrosivity, stray currents, etc. It is important to engage a cathodic protection specialist timeously since his recommendations can affect the construction of the pipes and ancillary components. Where there may be any break in continuity, bonding cables must be attached. Insulation joints must be installed where the cathodically protected structure requires to be insulated from the main structure, e.g. a pipeline entering a process plant.

30 SECURITY FENCE

30.1 FENCING POSTS

Fabricate all posts from mild steel with due attention to Clause 5. After fabrication, fencing posts shall be hot dip galvanized to comply with SANS 121 :2000/ISO 1461:1999. The bottom of fencing posts to be buried in soil shall be cleaned in accordance with Clause 10.4, then coated with bitumen to a dry film thickness not less than 30 or greater than 70 microns. Allow a minimum of 16 hours drying, then apply one coat Bituminous Aluminium Paint, complying with SABS 802, allowing a minimum of 3 days before burial

The coating shall cover the whole of the base plate and upwards to a height of not less than 500mm above ground. The total dry film thickness of primer and bituminous aluminium shall be not less than 50 microns

30.2 STRAINING WIRES, FENCING WIRE, TIE WIRES AND BARBED WIRE

Shall be hot dip galvanized to comply with SANS 675 Class A. galvanized wire complying with SANS 675:1997is not acceptable

30.3 CONCERTINA RAZOR/BARBED WIRE COILS

Shall be manufactured from stainless steel, type 304 or from 3CR12 or as recommended for specific conditions

APPENDICES

APPENDIX A - LIST OF STANDARDS AND CODES APPLICABLE

A1 NATIONAL STANDARDS AND CODES

Standards South Africa	Previous SABS Number	DESCRIPTION
SANS 10064 :2005	064 1979	The Preparation of Steel Surfaces for coating
SANS 10120 :1986	0120 1986	Code of Practice for use with standardized specification for Civil Engineering Construction - General
SANS 10129 :2006	0129 1977	Plastic tape wrapping of steel pipelines * (Project on Progress)
SANS 10140 :2003	0140 1992	Identification colour marking Part 3 - Contents of pipelines
SANS 10158 :1982	0158 1987	Code of Practice for Glossary of terms for Quality Assurance and Quality Control
SANS 1117	1117 1977	Plastic Wrappings for the protection of steel pipelines
SANS 1149	1149 1977	Flat and taper steel washers
SANS 1200 A 1986	1200A 1986	Standardized specification for Civil Engineering Construction Section A: General
SANS 1200 A 1986	1200AA 1986	Standardized specification for Civil Engineering Construction Section AA: General (small works)
SANS 1200 AH 1986	1200AH 1986	Standardized specification for Civil Engineering Construction Section AH: General (structural)
SANS 1200 H 1990	1200H 1990	Standardized specification for Civil Engineering Construction Section H: Structural steelwork
SANS 1200 HA 1990	1200HA 1985	Standardized specification for Structural Steelwork - General Section HA: Structural steelwork (sundry items)
SANS 1200 HB 1985	1200HB 1985	Standardized specification for Structural Steelwork - General Section HB: Cladding and Sheeting
SANS 1200 HC 1988	1200HC 1988	Standardized specification for Civil Engineering Construction - Corrosion Protection of Structural Steelwork

SANS 121 :2000 / ISO 1461:1999	SABS/ISO 1461:2000	Hot dip galvanized coatings on fabricated iron & steel articles – Specifications and Test Methods
SANS 1217 :1984	1217 1984	The Production of Painted and Powder-coated Steel Pipes
SANS 1274 :2005	SABS 1274 :2005	Coatings applied by the powder coating process
SANS 1391 SET : 1983	SABS 1391 SET:1983	Thermally sprayed metal coatings
SANS 14713 :1999 / ISO 14713:1999	SABS/ISO 14713:1999	Protection against corrosion of iron and steel structures. Zinc and Aluminium coatings - Guidelines
SANS 1578 :2003	1578:1993	Organic powder coating for external architectural aluminium
SANS 1586 :1995	1586 1995	Emulsion Paints
SANS 1796 :2001	1796 Edition 1 2001	Coatings of durable organic powder for external Aluminium
SANS 2063	1391 1998	Metallic and other inorganic coatings – Thermal spraying – Zinc, aluminium and other alloys
SANS 32 :1997 / EN10240:1997	SABS/EN 10240:1997	Internal and/or external protective coatings for steel tubes- specification for hot dip galvanizing coating applied in automatic plants
SANS 3575 :1996 / ISO 3575:1996	SABS/ISO 3575:1996	Continuous hot-dip (galvanized) zinc coated carbon steel sheet of commercial, lock forming and drawing qualities
SANS 4998 :1996 / ISO 4998:1996	SABS/ISO 4998:1996	Continuous hot dip (galvanized) zinc coated steel sheet of structural quality
SANS 630:2001	630 1972	Decorative High Gloss Enamel Paint for Interior and Exterior Use
SANS 675:1997	675 1997	Zinc coated Fencing Wire (Plain and barbed)
SANS 678:1973	678 1987	Primers for Wood for Interior and Exterior Use
SANS 679:1959	679 1972	Zinc Chromate Primer for Steel
SANS 680:1959	680 1979	Glazing putty for wooden and metal window frames
SANS 681 :1997	681 1997	Undercoats for Paints
SANS 684:1959	684 1972	Structural Steel Paint
SANS 716 :1962	716 1972	Mineral Turpentine (white spirit)
SANS 723	723 1973	Wash Primer (Metal etch primer)
SANS 802 :1966	802 1972	Bituminous Aluminium Paint

SANS 935 :1969	935 1993	Hot Dip (Galvanized) Zinc coatings on steel wire
SANS 975 :1970	975:1970	Pre-stressed concrete pipes
SANS 999 :1986	999 1998	Anodized Coatings on Aluminium (For architectural applications)

- New Specifications may be submitted in the future

A2 INTERNATIONAL STANDARDS

SPECIFICATION	Previous number	SPECIFICATION DESCRIPTION
	ASME	
ASME 1X 2004	1X 1983	Coded Welders
	ASTM	
ASTM G 8	G-8	Cathodic Disbonding of Pipeline Coatings
ASTM G 14	G-14	Impact Resistance of Pipeline Coatings (Falling weight test)
	AUSTRALIAN	
AS 2518	AS 2518	Fusion-bonded low density polyethylene coating for pipes and fittings
	BRITISH GAS	
BGC/S/CW 6	BGC/S/CW 6	British Gas Engineering Standard - Specification for the External Protection of Steel line Pipe and Fittings
	British Standard	
BS 6496:1984	6496	Powder organic coatings for application and stoving to aluminium alloy extrusions, sheet and preformed sections for external architectural purposes etc.
BS EN 10132 -	1449	Steel plate sheet and strip for automobile and general engineering purposes
BS EN ISO 15614-1:2004	4870-Part 1	Specification and qualification of welding procedures for metallic materials. Welding procedure test. Arc and gas welding of steels and arc welding of nickel and nickel alloys
	Canadian Standards Association	
CAN/CSA-Z245.20-M86	CAN/CSA-Z245.20-M86	External fusion bond epoxy coated steel pipe

ISO STANDARDS:

ISO Standards:	ISO Number	DESCRIPTION
ISO 2409	2409	Adhesion test method
ISO 3575	3575 1996	Continuous hot-dip (galvanized) zinc coated carbon steel sheet of commercial and drawing qualities
ISO 6272-1	6272	Impact test method
ISO 8501-1	8501-1	Preparation of Steel Substrates before application of paint and related products Visual assessment of surface cleanliness; part 1: rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings (pictorial surface preparation standards for painting steel surfaces)
ISO 8502.3	8502.3	Preparation of Steel Substrates before application of paint and related products. Tests for the assessment of surface cleanliness. Part 3 - Assessment of dust on steel surfaces prepared for painting (pressure sensitive tape method)
ISO 8503 Part 2	8503 Part 2	Preparation of Steel Substrates before application of paint and related products. Surface roughness characteristics of blast cleaned steel substrates. Part 2 - Method of grading of surface profile of abrasive blast cleaned steel - comparator procedure
ISO 9000	9000	Quality management systems-Fundamentals and vocabulary

APPENDIX B FORM STATING PROPOSED SUB-CONTRACTORS

This form to is be completed and signed by the tenderer, together with completed Form Appendix C

No change after acceptance is permitted without written approval by the Engineer

Contract Title		Number	

Main Contractor		Contact	
Address		Tel No Fax No Cell phone	

Fabrication Sub – Contractor		Contact	
Address		Tel No Fax No Cell phone	

Painting Sub – Contractor (Yard)		Contact	
Address		Tel No Fax No Cell phone	

Painting Sub – Contractor (Site)		Contact	
Address		Tel No Fax No Cell phone	

I certify that we will adhere to the above unless otherwise agreed in writing by the Engineer

Date: ……………………………………………………

NAME.. For Tenderer ....

Company Stamp

APPENDIX C FORM STATING MATERIALS TO BE USED

This form to be completed and signed by the material supplier and submitted by the tenderer with the completed Form Appendix B

Contract Title		Number	

Item	System No	Material Supplier	Product Name	Product Code No

I certify that I have read the requirements stated in 10.1 of the *GOLDER 2006 CORROSION SPECIFICATION* and the above materials comply with the specification for the above contract and that these materials are suitable for the purpose intended.

Date:………………………………………

Name..Signature………………………………………….

ON BEHALF OF.. (Material Supplier)

Witness ………………………………………………………………… Signature…………………………………………….

COMPANY STAMP

Filename: Golder 2006 Corrosion Spec Rev 4-July06-Final.doc
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Title: grs amendments to Draft new Wates corr spec
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