

**JOHANNESBURG WATER (SOC) Ltd.**  
**BULK WASTEWATER**

**PARTICULAR SPECIFICATION**  
**E12 : ELECTRICAL MEDIUM VOLTAGE**  
**CABLES**



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

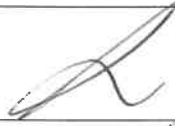
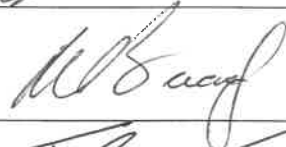
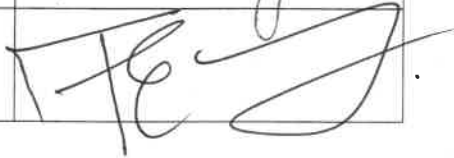
## DOCUMENT CONTROL SHEET

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### DOCUMENT APPROVAL

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
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
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**PARTICULAR SPECIFICATION: VOLUME E12: ELECTRICAL MEDIUM VOLTAGE CABLES**

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## **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:

- Conductor size in square millimetres
- Number of cores
- Conductor material (copper)
- The specification number (SANS 97) to which the cable has been manufactured.
- The year of manufacture
- Nominal voltage

Typically cable marking – MAKE YEAR 6.6/11kV XXmm<sup>2</sup> 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)

<b>SANS 97</b>		Commissioning test voltage between conductors			Commissioning test voltage between conductors / sheath		
Test Wave	Duration (min)	(V)			(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)

<b>SANS 1339</b>		Commissioning test voltage between conductors			
Test Wave	Duration (min)	(V)			
		6600	11000	22000	33000

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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.

<u>Item</u>	<u>Unit</u>
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Supply and delivery of medium voltage paper insulated cable.....m	
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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 <sup>2</sup>	Above 300 mm <sup>2</sup>	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 <sup>2</sup>	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

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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
			$\geq 2$	0.97	0.83	0.71
	Spacing	$\geq 30\text{mm}, \geq D \text{ max } 30\text{mm}$	1	0.97	0.96	0.93
			$\geq 2$	0.97	0.94	0.90
Horizontal on metal tray	Touching		1	1.00	0.86	0.74
			$\geq 2$	1.00	0.82	0.71
	Spacing	$\geq 30\text{mm} \geq D, \text{ max } 30\text{mm}$	1	1.00	1.00	1.00
			$\geq 2$	1.00	1.00	1.00
Horizontal on floor	Touching			0.94	0.80	0.66
	Spacing	$\geq 30\text{mm}, \geq D \text{ max } 30\text{mm}$		0.94	0.90	0.87
Vertical on wall	Touching			0.94	0.80	0.66
	Spacing	$\geq 30\text{mm}, \geq D \text{ max } 30\text{mm}$		0.94	0.90	0.87
Horizontal in ceiling	Touching			0.89	0.76	0.57
	Spacing	$\geq 30\text{mm}, \geq D \text{ max } 30\text{mm}$		0.89	0.81	0.77