

## Technical Specification - HV Electrical Cables

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## Revision details

Version No.	Clause	Description of revision
1.0		General revision
2.0		General revision
3.0		Format update, changing 'shall', 'should' and 'may' to must where relevant to Sydney Water, 'approved' replaced with 'accepted', minor editorial changes elsewhere.

## Introduction

This Specification is for the design, supply and installation of HV Electrical Cables for Sydney Water assets.

Sydney Water makes no warranties, express or implied, that compliance with the contents of this Specification shall be sufficient to ensure safe systems or work or operation.

It is the user's sole responsibility to ensure that the copy of the Specification is the current version as in use by Sydney Water.

Sydney Water accepts no liability whatsoever in relation to the use of this Specification by any party, and Sydney Water excludes any liability which arises in any manner by the use of this Specification.

For the purpose of this Specification "Sydney Water" is the nominated person or organisation that has written authority to act on Sydney Water's behalf.

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## Copyright

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## Acronyms

Term	Definition
AC (ac)	Alternating current
ANSI	American National Standards Institute
AS	Australian Standard
AUD	Australian Dollars
c/w	Complete with
DC (dc)	Direct current
ELV	Extra Low Voltage (i.e. $\leq 50$ V AC or $\leq 120$ V DC)
EN	European normalised standard
EPR	Ethylene-propylene-rubber
HDPE	High density poly-ethylene
HD UPVC	Heavy duty unplasticised poly-vinyl chloride
HV	High Voltage (i.e. $> 1000$ V AC or $> 1500$ V DC)
IEC	International electrotechnical commission
IEEE	Institute of Electrical & Electronic Engineers
ISO	International Standards Organisation
ITP	Inspection and Test Plan
LV	Low Voltage (i.e. Greater than ELV but $\leq 1000$ V AC or $\leq 1500$ V DC)
MV	Medium Voltage (note this term is not used in this specification)
pu	Per unit
PVC	Poly-vinyl chloride
SAA	Standards Association of Australia
Sec.	Second
SWA	Steel wire armour
TBA	To be advised
TBC	To be confirmed
XLPE	Cross-linked polyethylene

# 1. General

## 1.1 Introduction

This specification defines the minimum technical requirements for the design, manufacture, supply and delivery of High Voltage Electrical Cables not intended for aerial use.

## 1.2 Scope

This specification ensures that Sydney Water will be delivered high voltage cabling to the minimum acceptable requirements.

Key stakeholders for this specification include the Sydney Water High Voltage team, maintenance providers, and delivery partners.

This specification does not apply to the installation / erection, commissioning or performance testing of the equipment.

## 1.3 Proprietary items

Nomination of a proprietary item by Sydney Water does not imply preference or exclusivity for the item identified.

Alternatives that are equivalent to the nominated items can be submitted to Sydney Water for acceptance. The submission must include appropriate technical information, samples, calculations and the reasons for the proposed substitution, as appropriate.

## 2. Technical requirements

### 2.1 General

This specification covers high voltage cables rated from 1.9/3.3 kV up to and including 19/33 kV only. All cables must be designed, manufactured and supplied in accordance with AS 1429.1.

Data sheets must be supplied for all types of cables supplied.

### 2.2 Selection

Cable sizing must be the greater of:

- 95mm<sup>2</sup> or
- Selected according to current carrying capacity listed in manufacturer's literature. This literature has been compiled from information provided in IEC 60287, taking into account de-rating factors such as ambient temperature, cable grouping and installation method.

De-rating factors relating to ground temperature, burial depth and thermal soil resistivity are to be considered for direct buried cables and cables installed in underground HD UPVC conduits.

De-rating factors for cable and installation method must be in accordance with AS 3008.1.1.

### 2.3 Operating and performance

All HV cables must have the appropriate voltage designations for particular systems in the Category 1 according to Appendix A of AS 1026.

All HV cables must be rated for continuous operation (24hours per day 7 days a week).

All HV cable must withstand mechanical and electrical stresses under the anticipated fault current as determined by the maximum system fault current and the let through current of the protective devices.

The HV cable must withstand mechanical and thermal stresses under the maximum anticipated load current as determined by the circuit rating and specific method of cable installation.

### 2.4 Design life

The HV cables must have a minimum design life of 30 years.

## 3. Technical requirements - construction

### 3.1 Conductors

Conductor must be made of stranded annealed high conductivity copper as specified in AS/NZS 1125. Multicore cables must have shaped stranded conductors while single core cables must have round stranded conductor.

The short circuit rating for conductors must be in accordance with IEC 60986 and are for symmetrical currents, which will cause the conductor temperature to rise (within one sec.) from the normal operating value of 90 °C to the maximum temperature of 250 °C.

### 3.2 Insulation

Unless otherwise specified all HV cables must be XLPE insulated and comply with the requirements of AS/NZS 1429. Where Sydney Water has specifically specified Paper Insulated cables they must be of the mass impregnated non-draining type and consist of impregnated paper layers over the conductor. The paper insulation must be in accordance with AS 1026.

### 3.3 Screens

Each core of the HV cable must have individual heavy duty screens that meet the requirements as outline in the relevant Australian Standard.

The short circuit rating for screens must be in accordance with IEC 60986 and are for asymmetrical currents, which will cause the screen temperature to rise (within one sec.) from the normal operating value of 80 °C to the maximum short circuit temperature. Screens are to be bonded to earth at the supply end of the cable only.

### 3.4 Bedding

The bedding must be of extruded, non-hydroscopic, heat resistant PVC.

### 3.5 Armour

For all direct buried HV cables and where specified by Sydney Water, armour must be provided. For three core cables Steel Wire Armour (SWA) must be provided. For Single core cables non-ferrous Aluminium Wire Armour (AWA) must be provided. The Armour must in turn be protected by a PVC sheath.

### 3.6 Outer sheath

The cable sheaths must be of PVC. HDPE is also acceptable upon approval from Sydney Water. The sheaths must comply with the requirements of the relevant Australian Standard.

### 3.7 Markings

Cable identification must be marked on the outer sheath in accordance with AS/NZS 1429 and must include the following information:

- Manufacture's registered name
- Number and size of cores
- Insulation voltage grade
- Service (aboveground or underground)
- Meter marking
- Conductor material
- Other information as specified in AS/NZS 1429.

## 4. Testing requirements

The following routine, type and special tests must be carried out and recorded by the Contractor at their works on each completed cable in accordance with AS/NZS 1429.1 and AS/NZS 1660.

### 4.1 Type testing

Type tests as listed in AS/NZS 1660 must be carried out as well as type tests as listed in AS/NZS 1429. Type test reports must be provided by the Contractor for the HV cables.

A covering report must be provided by the Contractor that includes:

- a) Details of the design of the type tested equipment (including drawings)
- b) An explanation why any differences do not affect the integrity of the type tests
- c) Full copies of the type test report(s).

If new type tests are performed, representatives from Sydney Water must be given the opportunity to witness the tests. 14 calendar days' notice must be given for tests in Australia and 21 calendar days' notice must be given for tests outside Australia.

Copies of all type test reports (whether previous or new) must be submitted by the Contractor to Sydney Water.

### 4.2 Routine (factory) testing

Perform routine (factory) tests as listed in AS/NZS 1429.1 on the HV cable prior to shipment to site.

Routine (factory) tests must include:

- a) Conductor examination and resistance test
- b) Spark test on outer sheath
- c) Partial discharge test
- d) High-voltage test.

Representatives from Sydney Water must be given the opportunity to witness the factory tests. 14 calendar days' notice must be given for tests in Australia and 21 calendar days' notice must be given for tests outside Australia.

The results of all factory tests must be available for review during the tests.

A comprehensive Factory Test Report must be submitted to Sydney Water for approval within five working days of completion of the tests for the HV cable or prior to shipment (whichever is the earlier). The Factory Test Report must include:

- a) Results of all tests
- b) Copies of factory defect lists / punch lists
- c) Statement confirming compliance with the specified requirements.

Unless agreed otherwise by Sydney Water, all defects arising prior to or during the factory tests must be rectified to the satisfaction of Sydney Water prior to the respective equipment being shipped to site.

### 4.3 Special tests

The following special tests as listed in AS/NZS 1429.1 must be carried out:

- a) Check of dimensions
- b) Hot-set test (using method defined in AS/NZS 1660.2.2).



## 5. Packaging and delivery

Each length of the completed cable must be coiled carefully on a strong drum. The ends of the cable must be sealed by an approved method to prevent the ingress of moisture. The inside end of the cable must be brought out to the outside of the drum.

Each drum must on the outside of at least one flange provide by clear, non-detachable, weatherproof and indelible means the following information:

- a) Cable drum number
- b) Service (i.e. Underground or above ground)
- c) Rated voltage (e.g. 6.35 / 11 kV)
- d) Number, size and material of the conductor cores
- e) Material of insulation, screens, sheaths and armouring
- f) Maximum permissible continuous conductor temperature
- g) Cable length
- h) Net weight and gross weight of drum and cable
- i) Direction of roll
- j) Maximum pulling tension in kN
- k) Minimum bending radius
- l) Position of cable ends
- m) Manufacturers name and trademark
- n) Year and month of manufacture
- o) Purchase order number, item number
- p) Drum handling instructions document number

The Contractor must submit a schedule of maximum cable lengths, drum diameters and drum weights.

## 6. Related documents

The HV Electrical Cables must be designed, manufactured and tested in accordance with the latest revisions of the Federal and State statutory requirements, applicable Australian and IEC Standards, as well as the Sydney Water standard specifications.

Document type	Title
Legislation	<ul style="list-style-type: none"> <li>- Work Health and Safety Act 2011</li> <li>- Service and Installation Rules of New South Wales 2006</li> </ul>
Policies and procedures	
Other documents	
Standards	<ul style="list-style-type: none"> <li>- AS ISO 1000: The International System of Units (SI) and its application (ISO 1000)</li> <li>- AS/NZS 1125: Conductors in insulated electric cables and flexible cords.</li> <li>- AS/NZS 1429.1: Electric cables - Polymeric insulated - For working voltages 1.9/3.3 (3.6) kV up to and including 19/33 (36) kV</li> <li>- AS/NZS 1574: Copper and Copper Alloys - Wire for electrical purposes</li> <li>- AS/NZS 1660: Test methods for electric cables, cords and conductors.</li> <li>- AS/NZS 2381.1: Electrical equipment for explosive gas atmospheres - Selection, installation and maintenance - General requirements</li> <li>- AS/NZS 2857: Timber drums for insulated electric cables and bare conductors</li> <li>- AS/NZS 3000: Electrical installations (known as the Australian/New Zealand Wiring Rules)</li> <li>- AS/NZS 3008.1.1: Electrical installations - Selection of cables - Cables for alternating voltages up to and including 0.6/1 kV - Typical Australian installation conditions</li> <li>- AS/NZS 3808: Insulating and sheathing materials for electric cables.</li> <li>- AS/NZS 4961: Electric cables - Polymeric insulated - For distribution and service applications</li> <li>- IEC 60228: Conductors of insulated cables</li> <li>- IEC 60986: Short-circuit temperature limits of electric cables with rated voltage from 6 kV (<math>U_m = 7.2</math> kV) up to 30 kV (<math>U_m = 36</math> kV).</li> </ul>

### 6.1 Conflicts between specifications, standards and or codes

Review the above standards and make use of them where they are applicable. Identify any conflicts between the above standards and recommend which criteria to use. The Contractor must refer any conflicts in the information to Sydney Water for clarification.

## Ownership

### Ownership

Role	Title
<b>Group</b>	<b>Integrated Systems Planning - Liveable City Solutions</b>
<b>Owner</b>	Manager of Urban Design and Engineering
<b>Author</b>	Lead Engineer Electrical

### Change history

Version No.	Prepared by	Date	Approved by	Issue date
1	Robert Lau / Andrew Manganas / Paul Zhou	05/12/2014	Norbert Schaeper	05/12/2014
2	Robert Lau / Andrew Manganas / Paul Zhou	21/09/2016	Norbert Schaeper	21/09/2016
3	Paul Zhou	20/02/2020	Steve Keevil- Jones	20/02/2020