

Australian/New Zealand Standard™

**Test methods for electric cables,
cords and conductors**

**Method 2.1: Insulation, extruded
semi-conductive screens and
non-metallic sheaths—Methods
for general application**



S t a n d a r d s Australia



AS/NZS 1660.2.1:1998

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Australian Electrical and Electronic Manufacturers Association
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Australian/New Zealand Standard™

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Method 2.1: Insulation, extruded semi-conductive screens and non-metallic sheaths—Methods for general application

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL/3, Electric Wires and Cables, to supersede AS 1660.2.1—1993. It is one of a set of tests for electric cables included in the AS/NZS 1660 series. Details of the series are given in Appendix A.

This Standard incorporates Amendment No. 1 (February 2001). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure, or part thereof affected.

The objective of this Standard is to provide manufacturers and testers with appropriate test methods for general application to insulation, screens and sheaths of electric cables and cords.

This edition of the Standard differs from the 1993 edition as follows:

- (a) The gravimetric water absorption test has been revised, and only one method is specified for all cable sizes and all voltages.
- (b) This edition is published as a Joint Australian/New Zealand Standard.

In the preparation of the Standard, consideration was given to IEC 811:1985, *Common test methods for insulating and sheathing materials of electric cables*, Part 1: *Methods for general application*. Acknowledgment is made of the assistance received from this source.

The term ‘informative’ has been used in this Standard to define the application of the appendix to which it applies. An ‘informative’ appendix is only for information and guidance.

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Test methods for electric cables, cords and conductors****Method 2.1: Insulation, extruded semi-conductive screens and non-metallic sheaths—Methods for general application**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE This Standard sets out the methods of testing insulation, extruded semi-conductive screens and non-metallic sheaths for general application to insulated electric cables.

NOTE: Refer to individual cable Standards for test results criteria. Details of the AS/NZS 1660 series of Standards are given in Appendix A.

1.2 REFERENCED DOCUMENTS The following documents are referred to in this Standard:

AS

2706 Numerical values—Rounding and interpretation of limiting values

AS/NZS

1660 Test methods for electric cables, cords and conductors

1660.2.2 Method 2.2: Insulation, extruded semi-conductive screens and non-metallic sheaths—Methods specific to elastomeric, XLPE and XLPVC materials

1660.2.3 Method 2.3: Insulation, extruded semi-conductive screens and non-metallic sheaths—Methods specific to PVC and halogen free thermoplastic materials

1.3 DEFINITIONS For the purpose of this Standard, the definitions given in the relevant cable Standard and that below apply.

1.3.1 Median value—value obtained from a succession of test results as follows:

- (a) Even number of results average value of the two middle results.
- (b) Odd number of results value of middle result.

1.4 TESTING TEMPERATURE Unless otherwise specified, all tests shall be carried out in an ambient temperature of $23 \pm 5^\circ\text{C}$.

1.5 SELECTION OF SPECIMENS All specimens used for testing shall be taken at least 300 mm from the end of a factory length of finished cable, flexible cable or flexible cord.

SECTION 2 METHODS OF TEST FOR INSULATION, EXTRUDED SEMI-CONDUCTIVE SCREENS AND NON-METALLIC SHEATHS

2.1 MEASUREMENT OF THICKNESS AND DIAMETER

2.1.1 Measurement of thickness of the insulation and extruded screens

2.1.1.1 General Measurement of thickness may be required as an individual test, or as a step in the procedure for carrying out other tests, such as the measurement of mechanical properties.

2.1.1.2 Apparatus A microscope or a suitable measuring projector is required, which shall have a magnification power of at least 10, allowing a reading of 0.01 mm.

2.1.1.3 Preparation of test pieces Any covering shall be removed from the insulation and the conductor shall be withdrawn, care being taken to avoid damage to the insulation. Semi-conductive inner or outer layers, if bonded to the insulation, shall not be removed.

Each test piece shall consist of a thin slice of insulation. The slice shall be cut with a suitable device (sharp knife, razor blade or the like) along a plane perpendicular to the axis of the conductor. The cores of non-sheathed flat cords shall not be separated.

2.1.1.4 Measuring procedure The test piece shall be placed under the measuring equipment with the plane of the cut perpendicular to the optical axis. The measuring procedure shall be as follows:

- (a) When the inner profile of the test piece is a circle, make six measurements radially, approximately equally spaced around the circumference.
For sector-shaped cores, make the six measurements as shown in Figure 2.1(a), except that if the position of the minimum thickness does not coincide with one of the positions shown, make a measurement at this position instead of at the nearest position shown.
- (b) When insulation with or without conductor screen is taken from a stranded conductor, make six measurements radially in the positions where the insulation is thinnest, i.e. between the ridges caused by strands, as shown in Figure 2.1(b).
- (c) When the outer profile shows unevenness, the measurement shall be made as shown in Figure 2.1(c).
- (d) When there are unremovable screening layers under and/or over the insulation, exclude them from the measurements.
- (e) In the case of non-sheathed parallel twin flexible cords, make three measurements on each core of each piece of insulation, two on lines approximately parallel to the minor axis and one on the major axis. Also, measure the thickness of insulation in the direction of the other core. The value of insulation thickness of each core is taken as half the distance between the conductors as shown in Figure 2.1(e). The latter value is not used for calculation of the average value.

In all cases, the first measurement shall be made at the place where the insulation is thinnest.

When measuring the thickness of semi-conductive screens, the first measurement shall be made at the place where the semi-conductive screen is thinnest.

Where maximum at any point is required and the maximum thickness does not coincide with one measurement position (see Fig. 2.1) shown, the measurement shall be made at the position of maximum thickness instead of the nearest position shown.

The readings shall be in millimetres, to two decimal places.

2.1.1.5 Evaluation of the measurement results The mean shall be calculated, rounded to one decimal place in accordance with AS 2706 and evaluated against the requirements of the relevant cable Standard. The minimum value shall be reported to two decimal places.

2.1.2 Measurement of thickness of non-metallic sheaths

2.1.2.1 General The measurement of sheath thickness may be required as an individual test, or as a step in the procedure for carrying out other tests, such as the measurement of mechanical properties.

The test method shall apply to the measurement of all sheaths for which thickness limits are specified, e.g. separation sheaths, as well as external sheaths.

2.1.2.2 Apparatus A microscope or a suitable measuring projector is required, which shall have a magnification power of at least 10, allowing a reading of 0.01 mm.

2.1.2.3 Preparation of test pieces After all materials, if any, inside and outside the sheath have been removed, each test piece shall be prepared by cutting with a suitable device (sharp knife, razor blade or the like) a thin slice along a plane perpendicular to the axis of the cable.

If necessary, the planes of the cuts shall be carefully smoothed.

2.1.2.4 Measuring procedure The test piece shall be placed under the measuring equipment with the plane of the cut perpendicular to the optical axis. The measuring procedure shall be as follows:

- (a) When the inner profile of the test piece is a circle, make six measurements radially, equally spaced approximately, around the circumference.
- (b) If the circular inner surface is not regular or smooth, make the six measurements radially in the positions where the sheath is thinnest, as shown in Figure 2.1(d).
- (c) When the inner profile is not circular, make an appropriate number of measurements (up to six) radially where the sheath is thinnest, i.e. at the bottom of the grooves caused by the cores, as shown in Figure 2.1(f).
- (d) If the cable has a rectangular cross-section (see Figure 2.1(g)), measure the thickness e_1 and e_2 .

Measure one core per group at its opposite sides as follows:

- (i) **Thickness e_1** Make two measurements on each prepared cross-section.
- (ii) **Thickness e_2** Space the positions of measurement approximately equally along each long side, but include the thinnest position.

Space at least four individual measurements approximately equally along each long side.

If the cores are not grouped, make the measurements as they would be if the grouping given in the relevant cable Standard had been adopted.

- (e) Measure sheathed flat cords and cables radially as indicated in Figures 2.1(h), 2.1(i) or 2.1(j) as appropriate, except that if the position of the minimum thickness does not coincide with one of the positions shown, make a measurement at that position instead of at the nearest position shown.

In all cases, the first measurement shall be made at the place where the sheath appears to be thinnest.

2.1.2.5 Evaluation of the measurement results The mean shall be calculated, rounded to one decimal place in accordance with AS 2706, and evaluated against the requirements of the relevant cable Standard. The minimum and maximum value shall be reported to two decimal places, where applicable.

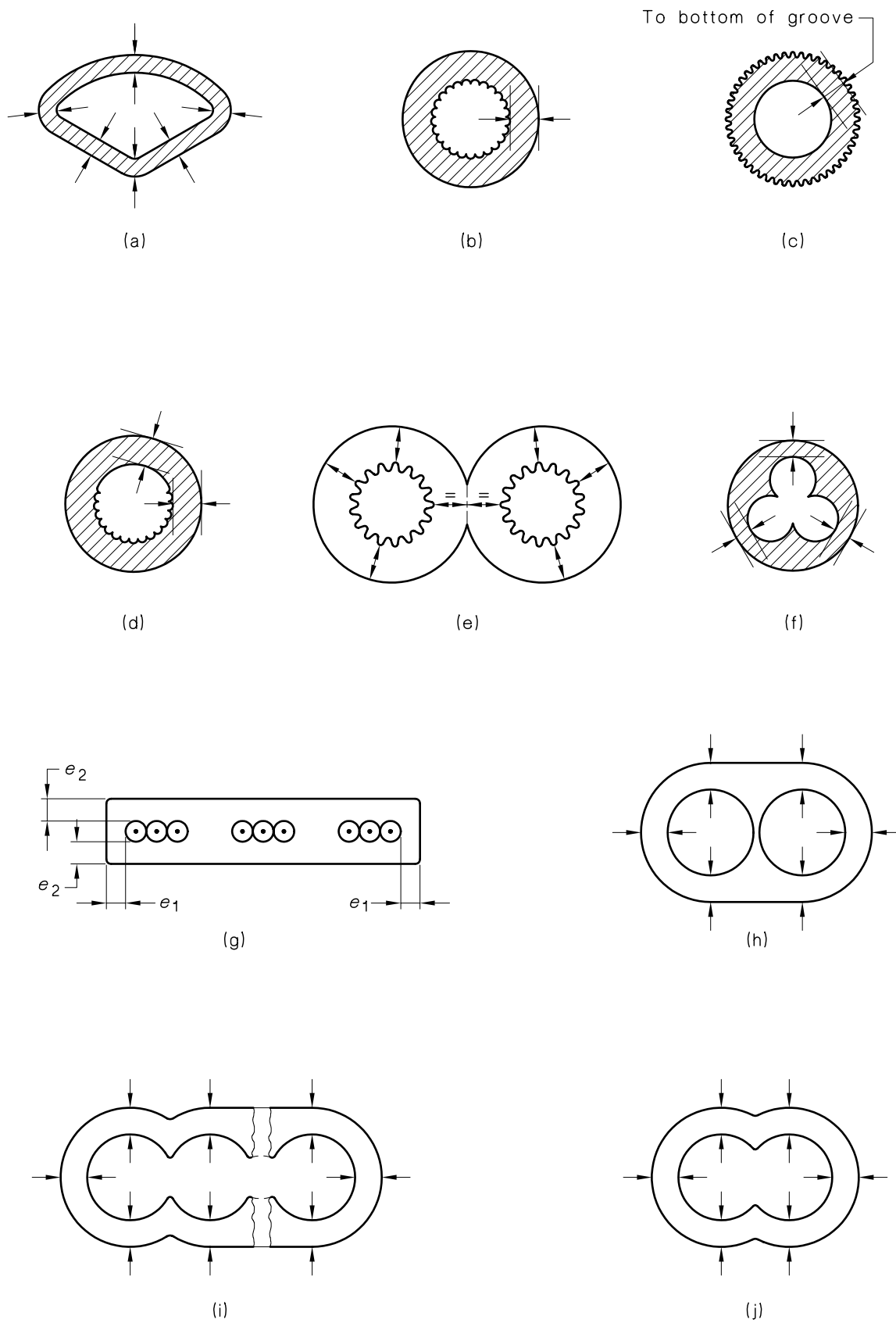


FIGURE 2.1 MEASUREMENT OF THICKNESS OF INSULATION AND SHEATH