



## Technical Specification 97-1

Issue 2 2016

Special backfill material for cable installations

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Issue 1 published, 1997.

### Amendments since publication

Issue	Date	Amendment
Issue 2	February 2016	<p>Major revision of Issue 1: (i) to reflect changes made to the standards referenced (ii) to allow the option for alternative cable backfill materials to be introduced by specifying the performance characteristics required for backfills materials (iii) to retain the specific requirements for the three 'selected sand' backfills and 'stabilised' backfills, updated to reflect changes in national standards.</p> <p><i>NOTE: To avoid confusion due to the re-numbering of existing clauses and addition of new clauses, the Clause numbering below refers to this revised version, Issue 2. The Clause numbers of Issue 1 are given in brackets, where relevant, for cross referencing.</i></p> <p>This issue includes the following principal technical changes.</p> <p>Foreword: Revised due to the expanded content of TS 97-1.</p> <p>Clause 1 (Issue 1, Clause 1.1): Scope expanded to describe the increased scope and to define that the Specification applies to backfill materials that are intended for open trench applications and including cables both directly buried and installed in ducts but not requirements for thermal grouts or Bentonite mixture in cable ducts.</p> <p>Clause 2 (Issue 1, Clause 1.2): References updated, deleted or added as relevant.</p> <p>Clause 3: Clause added with relevant terms and definitions included.</p> <p>Clause 4 (Issue 1, Clause 1.3): Amended to state that the backfills referred to are classified into two groups:</p> <p>(i) Traditional backfills, retained from Issue 1, which have defined composition and properties.</p> <p>(ii) Alternative (non-traditional) backfill materials.</p>

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		<p>Clause 6 (Issue 1, Section 2, 3 and 4): Units have been inserted to follow the values stated for dry relative density. These units are Mg/m<sup>3</sup>.</p> <p>Clause 6.1.1 (Issue 1, Clause 2.1), Paragraph 2: Wording "...about 50 per cent of possible sources..." amended to "...an adequate number of sources..." to reflect the reduced availability of selected sands.</p> <p>Clause 6.1.5 (Issue 1, Clause 2.5):</p> <p>(i) Paragraph 2, item ii: Reference to "Clause 1.1.1 of BS 1377" updated to "Clause 2.2.4 of BS 1377-1".</p> <p>(ii) Last paragraph: Text expanded and Table 1 added to clarify the required tests and assessment requirements.</p> <p>Technical requirements unchanged.</p> <p>Clause 6.1.6 (Issue 1, Clause 2.6): Frequency of samples for routine tests changed from every 50 m length of trench to '50 m when possible but not exceeding 100 m length of trench'.</p> <p>Clause 6.2.3 (Issue 1, Clause 3.3):</p> <p>(i) Sentence 1: Requirement "...10 mm coarse aggregate as defined in BS 882 with particle size not exceeding 14 mm..." revised to "...10 mm single size coarse aggregate with particle size not exceeding 14 mm, meeting the requirements of BS EN 12620 aggregate size 4/10..." to align with the specification in BS EN 12620.</p> <p>(ii) Sentence 2: Requirement added that acceptance of gravel shall be subject to agreement between the Engineer and the Contractor.</p> <p>Technical intent unchanged.</p> <p>Clause 6.2.5 (Issue 1, Clause 3.5): Reference to withdrawn BS 874 updated to BS EN ISO 8990.</p> <p>NOTE: BS EN ISO 8990 includes only 2 methods of determination of thermal conductance compared to 7 in BS 874. However, no technical consequence to TS 97-1.</p> <p>Clause 6.2.7 (Issue 1, Clause 3.7):</p> <p>(i) Paragraph 2, item ii: Reference to "Clause 1.1.1 of BS 1377" updated to "Clause 2.2.4 of BS 1377-1".</p> <p>(ii) Last paragraph: Text expanded and Table 2 added to clarify the required tests and assessment requirements.</p> <p>Technical requirements unchanged.</p> <p>Clause 6.2.8 (Issue 1, Clause 3.8): Frequency of samples for routine tests changed from every 50 m length of trench to '50 m when possible but not exceeding 100 m length of trench'.</p> <p>Clause 6.3.2 (Issue 1, Clause 4.2):</p> <p>(i) Reference to "BS 882 Zone 2 to Zone 3" updated to "BS 12620".</p> <p>(ii) Requirement "...cement to BS 12..." revised to "...Portland cement EN 97-1 - CEM 1 32.5 N to BS EN 197-1 ..." to align with the specification in BS EN 197-1.</p> <p>Technical intent unchanged.</p> <p>Clause 6.3.3 (Issue 1, Clause 4.3): Reference to withdrawn BS 874 updated to BS EN ISO 8990.</p> <p>NOTE: BS EN ISO 8990 includes only 2 methods of determination of thermal conductance compared to 7 in BS 874. However, no technical consequence to TS 97-1.</p> <p>Clause 6.3.5 (Issue 1, Clause 4.5):</p> <p>(i) Paragraph 2, item ii: Reference to "Clause 1.1.1 of BS 1377" updated to "Clause 2.2.4 of BS 1377-1".</p> <p>(ii) Last paragraph: Text expanded and Table 3 added to clarify the required tests and assessment requirements.</p> <p>Technical requirements unchanged.</p>
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		<p>Clause 6.3.6 (Issue 1, Clause 4.6):  2<sup>nd</sup> paragraph: Frequency of samples for routine tests changed from every 50 m length of trench to '50 m when possible but not exceeding 100 m length of trench'.</p> <p>3<sup>rd</sup> paragraph: Requirement that individual results of the set of dry relative density to be less than "...0.5 below the specified minimum value..." amended to "...0.05 below the specified minimum value..."</p> <p>Clause 7: Alternative (non-traditional) backfill materials. New section. Added to allow the option for alternative cable backfill materials to be introduced into use. Provides the specification characteristics required for such backfills materials by specifying the functional and performance requirements. Includes following clauses:</p> <ul style="list-style-type: none"> <li>• 7.2 General requirements (composition, mechanical strength, thermal characteristics, compatibility with cables, environmental compatibility and health and safety);</li> <li>• 7.3 Type assessment (sample size, sample preparation, type test sequence and acceptance criteria);</li> <li>• 7.4 Sample tests (sampling procedure, sample test sequence and acceptance criteria);</li> <li>• 7.5 Routine tests (sampling procedure, sample test sequence and acceptance criteria).</li> </ul> <p>Clause 8: On-site handling. New section to provide guidance on procedures and requirements for the installation of the backfill to clarify responsibilities and provide quality control. Includes the following clauses:</p> <ul style="list-style-type: none"> <li>• 8.1 Preliminaries. Guidance on:  Obtaining certification for the backfill material;  Working practices by the Contractor and Engineer to expedite the work.</li> <li>• 8.1.1 Test documentation  Formal requirement for the Contractor to submit test documentation for the backfill material. This is a Hold Point.</li> <li>• 8.2 Installation procedures  Installation to conform to ENA TS 09-2 unless otherwise agreed.</li> <li>• 8.2.1 Compaction techniques  Guidance on compaction of the backfill.</li> <li>• 8.2.2 Trench Bedding  Requirements for the bedding layer.</li> <li>• 8.2.3 Blinding of cables  Requirements for the blinding. Routine tests after blinding are a Hold Point.</li> <li>• 8.2.4 Completion of joints and terminations  Requirements for the joints and terminations.</li> </ul> <p>Annex A.2 (Issue 1, Appendix A2): Requirement "...dry relative density shall be determined in accordance with the Soil Compaction Test Number 11 of BS 1377..." revised to "...dry relative density shall be determined in accordance with the soil compaction test procedure in BS 1377-4 Clause 3.5...". Technical intent unchanged.</p> <p>Annex B.1.2 (Issue 1, Appendix B part A): 4<sup>th</sup> paragraph: The method for drying loose granular type backfills amended to be "The tray shall be heated for a period sufficient to thoroughly dry the sample" i.e. deletion of the requirement that the minimum period of heating be 10 minutes.</p>
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	<p>Annex B.2 (Issue 1, Appendix B, Part B): Requirement "...method to be used shall be the first of the two in Test 14(A) of BS 1377..." revised to "...method to be used shall be that given in BS 1377-9 Clause 2.1...". Technical intent unchanged.</p> <p>Annex C.1 (Issue 1, Appendix C1), Apparatus, Item b): Specific reference to "Speedy' moisture tester" amended to "moisture tester with an accuracy of <math>\pm 3\%</math> or better e.g. GE Protimeter 'Speedy' tester or Delta-T devices ThetaProbe".</p> <p>Annex F (Issue 1, Appendix G):</p> <p>(i) Wording "sand" amended to "sand/fine aggregate" to align with the allowed composition of cement-bound sand in Clause 6.3.2.</p> <p>(ii) Clause F.3, 2nd equation: Corrected to read "Volume of voids".</p> <p>Annex H (Issue 1, Appendix H): Additional column added to Test sheet table to require entry of the details of the particle size distribution.</p> <p>Annex J: New Annex. Test sheet for recording the results of a sample test</p> <p>Annex K: New Annex. Test sheet for recording the results of a routine test.</p> <p>Annex L: New Annex. Table of the Hold Points.</p> <p>Bibliography: Clause added and references included of 'Management of Health and Safety at Work Regulations 1999', 'Environmental Protection Act, 1990', 'Water Resources Act, 1991' and 'Burseanu &amp; Van Der Boergh "Study of thermal backfill materials for directly buried HV cables" 9th International Conference on Insulated Power Cables, Versailles, 2015'.</p> <p>Details of all other technical, general and editorial amendments are included in the associated Document Amendment Summary for this Issue (available on request from the Operations Directorate of ENA).</p>
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## Foreword

This Technical Specification (TS) is published by the Energy Networks Association (ENA) and comes into effect from the date of publication. It has been prepared under the authority of the ENA Engineering Policy and Standards Manager and has been approved for publication by the ENA Electricity Networks and Futures Group (ENFG). The approved abbreviated title of this engineering document is “ENA TS 97-1”.

This document replaces and supersedes Technical Specification 97-1 Issue 1 1997.

In the design of naturally cooled cable circuits of relatively high power transfer capacity extensive use is being made of special backfill materials in the immediate vicinity of the cable. These materials are characterised by having thermal resistivities in the fully dried-out state that do not exceed specified values. In using these materials it is no longer necessary to impose a limiting external cable surface temperature during summer to minimize the danger of moisture migration in the cable surround. The quantity and disposition of these backfill materials in a cable trench is in general chosen to allow the maximum permissible conductor temperature to be attained throughout the year; to enable designated ratings for the cable to be applicable at all times.

The purpose of this Technical Specification is to ensure that any backfill materials placed in a cable trench have thermal resistivities in the dried-out state that do not exceed the limiting values assigned by the Contractor or specified by the Network Owner in the design of the cable installation. The Specification includes specific details for currently accepted backfill materials, which are described as traditional backfills, being designated 'selected sand' backfills and 'stabilised' backfills and have thermal resistivities in the fully dried-out state not exceeding 2.7 Km/W and 1.2 Km/W respectively. Their composition, properties and test requirements are defined in detail and provide baseline options that provide an assured performance. Direct measurement of thermal resistivity presents difficulties; consequently reliance is placed upon the control of associated properties which are more readily determinable, viz. particle size distribution, void ratio, cohesion and dry relative density.

In addition, this Specification allows the option for alternative cable surround materials to be offered either by Contractors or to be specified by a Network Owner. Such backfill materials are required to demonstrate that they either meet the baseline thermal resistivity requirements specified in this Specification or have thermal properties that achieve values stipulated for the cable system design, which may require enhanced performance requirements.

Where the term “shall” or “must” is used in this document it means the requirement is mandatory. The term “should” is used to express a recommendation. The term “may” is used to express permission. Where the term “shall” is used in this document it expresses a requirement. The term “may” is used to express permission.

NOTE: Commentary, explanation and general informative material is presented in smaller type, and does not constitute a normative element.



## 1 Scope

This Technical Specification sets out general requirements for special backfill materials listing both currently acceptable types of stabilised backfill materials and the option for alternative cable surround materials to be offered either by Contractors or to be specified by a Network Owner, which allow the designated ratings for the cable to be applied.

The Specification applies to backfill materials that are intended for open trench applications, where the cable is either directly buried in the backfill or installed in ducts laid in the backfill, and, as such, the backfills are required to be load bearing, resist settlement, erosion, impact and frost heave.

This Specification does not cover the requirements for thermal grouts or Bentonite mixture that may be specified for use in cable ducts and HDD situations. Refer to ENA TS 09-2 [N1] for information on their use.

## 2 Normative references

The following referenced documents, in whole or part, are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

### Standards publications

BS EN 197-1:2011, *Cement. Composition, specifications and conformity criteria for common cements*)

BS EN ISO 8990:1996, *Thermal insulation. Determination of steady-state thermal transmission properties. Calibrated and guarded hot box*

BS EN 12620:2002+A1:2008, *Aggregates for concrete*

BS 1377-1:1990, *Methods of test for soils for civil engineering purposes. General requirements and sample preparation*

BS 1377-4:1990, *Methods of test for soils for civil engineering purposes. Compaction-related tests*

BS 1377-9:1990, *Methods for test for soils for civil engineering purposes. In-situ tests*

### Other publications

[N1] ENA TS 09-2, Specification for the supply, delivery & installation of power cables with operating voltages in the range 11 kV to 400 kV and associated auxiliary cables

[N2] Waste Framework Directive (2008/98/EC). Published at [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/218586/l\\_31220081122en00030030.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/218586/l_31220081122en00030030.pdf)

[N3] Guidance on the classification and assessment of waste (1st edition 2015) Technical Guidance WM3. Published by Environment Agency, Natural Resources Wales/Cyfoeth Naturiol Cymru, Scottish Environment Protection Agency (SEPA), Northern Ireland Environment Agency (NIEA)

[N4] Hazardous waste Interpretation of the definition and classification of hazardous waste (3rd Edition 2013). Published by Environment Agency, Natural Resources Wales/Cyfoeth Naturiol Cymru, Scottish Environment Protection Agency (SEPA), Northern Ireland Environment Agency (NIEA)

[N5] Classify different types of waste. Published by UK government at <https://www.gov.uk/how-to-classify-different-types-of-waste>

[N6] Control of Substances Hazardous to Health Regulations (COSHH) 2002 (as amended) (SI 2002/1689)

### **3 Terms and definitions**

For the purposes of this document, the following terms and definitions apply.

#### **3.1**

##### **Contractor**

person or person's firm or company, including personal representatives, successors and permitted assigns, commissioned to carry out a cable installation

#### **3.2**

##### **Engineer**

person nominated by the Purchaser to manage the cable installation contract

#### **3.3**

##### **Hold Point**

stage in the material procurement or fabrication and/or workmanship process beyond which work shall not proceed without the documented approval of the Engineer

#### **3.4**

##### **Network Owner**

Company licenced to develop, operate and maintain local electricity distribution networks

#### **3.5**

##### **Purchaser**

person or person's firm or company accepting the Contract

#### **3.6**

##### **routine tests**

tests that may be required on backfill materials brought to site to ensure that the quality of the backfill material is being maintained during a contract

#### **3.7**

##### **sample tests**

tests that may be required before installation is commenced to ensure that the backfill material which is to be used on the contract meets the requirements

#### **3.8**

##### **type test**

series of one-off tests to ensure the satisfactory performance of the backfill material

### **4 Types of backfill**

The special backfill materials specified in this Specification are classified into two groups.

#### **a) Traditional backfills having defined composition and properties**

These are designated selected sands and stabilised backfills and attain the baseline thermal resistivity requirements defined in this Specification. At present the stabilised materials are further divided into gavel/sand and cement-bound sand mixes, and consequently the traditional backfill materials are divided into three categories, as follows:

- Selected Sands, maximum dried-out thermal conductivity 2.7 Km/W;