



## Technical Specification 43-125

Issue 2 2017

Design guide and technical specification for  
overhead lines above 45 kV

Part 1 Design basis and electrical requirements

## PUBLISHING AND COPYRIGHT INFORMATION

© 2017 *Energy Networks Association*

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written consent of Energy Networks Association. Specific enquiries concerning this document should be addressed to:

**Operations Directorate  
Energy Networks Association  
6th Floor, Dean Bradley House  
52 Horseferry Rd  
London  
SW1P 2AF**

This document has been prepared for use by members of the Energy Networks Association to take account of the conditions which apply to them. Advice should be taken from an appropriately qualified engineer on the suitability of this document for any other purpose.

Issue 1 of TS 43-125 published, 2005.

Revised, 2017.

### Amendments since publication

Issue	Date	Amendment
Issue 2	February 2017	<p>Major revision to Issue 1:</p> <ul style="list-style-type: none"><li>(i) reflect technical changes made to two main Standards referenced namely BS EN 50341-1 and BS EN 50341-2-9</li><li>(ii) split document into multi-parts reflecting standalone design requirements and the requirements for individual components and parts of lattice tower design</li><li>(iii) remove wood poles and steel poles from the scope of TS 43-125.</li></ul> <p>TS 43-125 has been divided into 4 separate documents:</p> <ul style="list-style-type: none"><li>• Part 1 Design basis and electrical requirements</li><li>• Part 2 Conductor systems, insulators and fittings</li><li>• Part 3 Vibration dampers and spacers</li><li>• Part 4 Foundations and site requirements</li></ul> <p>Clause numbering of this Specification has changed significantly due to the document becoming 4 Parts. The cross referencing within the document has been updated accordingly.</p> <p>To ensure consistency to the normative reference BS EN 50341 throughout the document the following key changes have been completed.</p>

## PUBLISHING AND COPYRIGHT INFORMATION

		<ul style="list-style-type: none"> <li>• Where BS EN 50341-1 Part 1 and Part 3-9 are referenced in square brackets as part of the clause title, these references have been amended to ensure all are correct and accurate.</li> <li>• All references to 'Part 3' have been changed to the correct 'Part 2-9' reference as appropriate.</li> <li>• The terminology to describe the design approaches has been amended throughout i.e.             <ul style="list-style-type: none"> <li>i. 'General Approach' is now written as 'Approach 1'</li> <li>ii. 'Empirical Approach' is now written as 'Approach 3'</li> </ul> </li> </ul> <p>NOTE: To avoid confusion due to the extensive 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.</p> <p>The following technical changes are relevant to this document.</p> <p>'Foreword' Clause updated. New paragraph 5 and 6 inserted to replace and complement previous paragraphs describing importance of BS EN 50341. Paragraph 9 has been amended to describe the splitting of TS 43-125 into 4 Parts. Explanation added of the structure of each document.</p> <p>Clause 1.1.2: The description of the normative Standards has been changed to Part 1 and Part 2 only.</p> <p>Issue 1 Clause 2, Quality Assurance; This clause has been moved to Clause 1.4 under the main Introduction clause. Issue 1 Clause 2.5 has been deleted as it replicates the requirements in BS EN 50341-1. The previous annexes in Issue 1 Clause 2 have been deleted.</p> <p>Clause 2.3 (Issue 1, Clause 3.3), Normative references: References updated and new Standards added as appropriate.</p> <p>Clause 2.4 (Issue 1, Clause 3.4), Introduction: Paragraph 1 updated to amend nomenclature of each 'Approach'. Reference to steel or timber poles deleted from Paragraph 2. Reference to project specification deleted as no longer necessary for this clause.</p> <p>Associated commentary amended to delete reference to BS 8100-1 and include reference to BS EN 1991-1-4. An explanation is provided of a formula detailed in BS EN 50341-2-9 for use in modifying BS EN 50341-1 clauses.</p> <p>Clause 2.5.1 (Issue 1, Clause 3.5.1) Reliability levels. The commentary has been amended by deleting reference to BS 8100 and inserting BS EN 1993-3-1. A new sentence is included to point out that safety to the public and continuity of service should be considered when selecting reliability level.</p> <p>Table 2.1 (Issue 1, Table 3.1) has been amended to remove reference to timber and steel poles. Previous NOTE 1 relating to steel poles has been deleted. Note 3 in Table 2.1 has been amended to change the abbreviation for seasonal factor from SS to <math>C_{season}</math> as per BS EN 50341-1. Reference to BS 8100-4 has been deleted and BS EN 1991-1-4 inserted.</p> <p>Clause 2.5.4 (Issue 1, Clause 3.5.4) Serviceability limit states. Paragraphs 2 and 3 have been deleted from the commentary as steel poles are now outside the scope of TS 43-125.</p> <p>Clause 2.5.5 (Issue 1, Clause 3.5.5) Climatic loads.</p> <p>New commentary content inserted in Clause 2.5.5 to provide an explanation of the change in wind speed determination and also to introduce the partial load factors which are relevant for calculating climatic loadings.</p>
--	--	--

## PUBLISHING AND COPYRIGHT INFORMATION

		<p>Clause 2.5.5.1 (Issue 1, Clause 3.5.5.1) Wind loads and forces. All previous commentary has been deleted.</p> <p>Clause 2.5.5.2 (Issue 1, Clause 3.5.5.2) Ice loads. Previous commentary referencing typical ice thickness values (40 mm) has been deleted.</p> <p>Clause 2.5.6 (Issue 1, Clause 3.5.6) Safety loads. Clause title changed from 'Construction and maintenance loads' to 'Safety loads' to align with BS EN 50341-1.</p> <p>Clause 2.5.6.1 (Issue 1, Clause 3.5.6) Safety loads. Clause title changed from 'General' to 'Construction and maintenance loads' to align with BS EN 50341-1.</p> <p>Clause 2.5.7 (Issue 1, Clause 3.5.7) Accidental actions – security loadings. Commentary amended to remove reference to steel poles. Within item a) the term 'alleviation' has been changed to 'reduction' to align with BS EN 50341-2-9.</p> <p>Clause 2.5.11 (Issue 1, Clause 3.5.11) Partial strength factors for overhead line components for design Approach 1. Within the commentary, under the heading 'General', reference to BS 8110 Part 1 has been deleted. Details related to steel pole and timber poles have been deleted. Under the heading 'Foundations', reference to 'Buckley [1994]' has been deleted.</p> <p>Clause 2.6 (Issue 1, Clause 3.6) Actions – Approach 3. All previous content in this clause and associated sub-clauses has been deleted as it related to timber poles. A short paragraph has been inserted to provide a reader with a short explanation of why there is no guidance for Approach 3.</p> <p>Annex 2A (Issue 1, Annex 3A) Project information to be provided by ENAMC's engineer. Table of information updated to reflect changes to clause numbering and removal of items relating to steel and timber poles.</p> <p>Clause 3.3 (Issue 1, Clause 4.3), Normative references: References updated and new Standards added as appropriate.</p> <p>Clause 3.4.2.2 (Issue 1, Clause 4.3), Short-circuit currents: The reference to IEC 60909 has been replaced with ENA ER G74 in the commentary.</p> <p>Table 3.2, Insulation co-ordination: New column inserted for 66 kV and 400 kV.</p> <p>Clause 3.4.3.1 (Issue 1, Clause 4.1) Representative power frequency voltages: This clause has been moved from Clause 3.4.1 and the title changed from 'System voltage' to align with BS EN 50341-1.</p> <p>Table 3.3, System voltage: Column added for 66 kV and 400 kV.</p> <p>Table 3.4, Electrical clearance: New rows inserted for 66 kV and 400 kV. Values have been calculated based on BS EN 50341-1 Annex E.</p> <p>Clause 3.4.6.1 Commentary: New paragraph inserted to describe the known approaches in the UK for determination of internal clearances, including those justified by 'long and satisfactory service'. New paragraph inserted to highlight the need to use mean wind pressure instead of peak wind pressure, when calculating wind loading for clearances.</p> <p>Table 3.5, Minimum clearances within the span and at the support: New rows inserted for 66 kV and 400 kV. Additional notes added to Table 3.5.</p> <p>Table 3.6, Minimum downlead clearances within the span: New rows inserted for 400 kV.</p> <p>Issue 1, Clause 4.4.6.2, Empirical Approach. Clause deleted as the empirical approach is applicable only to timber and steel pole design.</p>
--	--	---

## PUBLISHING AND COPYRIGHT INFORMATION

		<p>Table 3.7, Minimum air clearance:</p> <p>New row inserted for 66 kV and 400 kV. Value taken from Table 3.4.</p> <p>Previous content in item b) beneath Table 3.7 deleted. New text inserted in item b) to clarify the need to adhere to ENA TS 43-8 requirements.</p> <p>Issue 1, Clauses 4.4.8.2 - 4.4.8.6 deleted as all external clearances for overhead lines are determined primarily by ENA TS 43-8.</p> <p>Clause 3.4.8 (Issue 1, Clause 4.4.9.1) Radio and audible noise. Within the commentary, reference to BS 5049 has been deleted and replaced by PD CISPR/TR 18-2.</p> <p>Clause 3.4.9 (Issue 1, Clause 4.4.10) Electrical and magnetic fields. Within the commentary, reference to the 'National Radiological Protection Board' has been replaced by 'Public Health England'.</p> <p>Annex 3A (Issue 1, Annex 4A) Project information to be provided by ENAMC's engineer. Table of information updated to reflect changes to clause numbering.</p> <p>Annex 3D (Issue 1, Annex 4D):</p> <p>Both Clauses 3.D.1 and 3.D.2 have been updated to reflect the methods in BS EN 50341-1 for calculation of clearances. Previous guidance which referenced wind gust speed has been deleted.</p> <p>Bibliography added. Non-Normative references contained in the Specification included.</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>
--	--	--

## Contents

Foreword.....	9
1 Introduction.....	11
1.1 Scope.....	11
1.1.1 General [Part 1 Clause 1, Part 2-9 Clause 1].....	11
1.1.2 BS EN 50341 [Part 1 Introduction & Clause 1].....	11
1.1.3 National Normative Aspects [Part 1 Introduction, Part 2-9 Foreword].....	11
1.1.4 Existing Energy Network Association Technical Specifications.....	12
1.2 Definitions [Part 1 Clause 2.2].....	12
1.3 Normative references [Part 1 Clause 2.1, Part 2-9 Clause 2.1].....	12
1.3.1 General.....	12
1.3.2 European pre-standards (ENVs).....	12
1.4 Quality assurance [Part 1 Clause 12].....	12
1.4.1 Quality assurance terms.....	12
1.4.2 Quality assurance programme.....	13
1.4.3 Related standards.....	13
1.4.4 Quality control.....	14
1.4.4.1 Inspection and testing.....	14
1.4.4.2 Type, sample and routine tests.....	14
1.4.5 Non-conforming products.....	14
1.4.6 Monitoring of quality assurance agreements.....	14
1.4.7 Suppliers and subcontractor.....	15
1.4.8 Method statements.....	15
2 Design basis, actions and reliability.....	16
2.1 Scope [Part 1 Clauses 3 and 4].....	16
2.2 Terms and definitions [Part 1 Clause 2].....	16
2.3 Normative references.....	16
2.4 Introduction [Part 1 Clause 4.1 Part 2-9 Clause 4.1].....	16
2.5 Actions – Approach 1.....	17
2.5.1 Reliability levels [Part 1 Clause 3.2.2 Part 2-9 Clause 3.2.2 and Table 4.13.1/GB.1].....	17
2.5.2 Co-ordination of strength [Part 1 and Part 2-9 Clause 3.2.5].....	18
2.5.3 Additional considerations [Part 1 and Part 2-9 Clause 3.2.6].....	19
2.5.4 Serviceability limit states [Part 1 and Part 2-9 Clause 3.3.3].....	19
2.5.5 Climatic loads [Part 1 Clause 3.6.2 and 4.13 and Part 2-9 Clause 4.3, 4.5 and 4.6].....	19
2.5.5.1 Wind loads and forces [Part 1 Clause 4.3, 4.4 and Part 2-9 Clause 4.3, 4.4].....	20
2.5.5.2 Ice loads.....	20
2.5.5.3 Standard climatic loading cases [Part 2-9 Clause 4.12.1 and Table 4.12.1/GB.1].....	21
2.5.6 Safety loads [Part 1 Clause 4.9 Part 2-9 Clause 4.9 and Table 4.13.1/GB.1].....	22

2.5.6.1	Construction and maintenance loads [Part 2-9 Clause 4.9.1 GB.1].....	22
2.5.6.2	Loads related to the weight of linesman [Part 2-9 Clause 4.9.2 GB.2].....	22
2.5.6.3	Climatic conditions .....	22
2.5.7	Accidental actions – security loadings [Part 2-9 Clause 4.8 and Table 4.13.1/GB.1].....	22
2.5.7.1	Permanent actions [Part 2-9 Table 4.13.1/GB.1] .....	23
2.5.8	Forces due to short-circuit currents [Part 1 Clause 4.10].....	23
2.5.9	Other special loads [Part 2-9 Clause 4.11].....	23
2.5.10	Span criteria .....	23
2.5.11	Partial strength factors for overhead line components for design Approach 1 [Part 2-9 Table 4.13.1/GB.2] .....	23
2.6	Actions – Approach 3 .....	25
2.6.1	General.....	25
3	Electrical requirements .....	27
3.1	Scope [Part 1 Clause 5 and 6].....	27
3.2	Terms and definitions [Part 1 Clause 2] .....	27
3.3	Normative references .....	27
3.4	Electrical requirements [Part 1 Clause 5].....	27
3.4.1	System frequency .....	27
3.4.2	Current ratings [Part 1 Clause 5.2].....	27
3.4.2.1	Normal currents [Part 1 Clause 5.2.1 and Part 2-9 Clause 5.2.1].....	27
3.4.2.2	Short-circuit currents [Part 1 Clause 5.2.2 and Part 2-9 Clause 5.2.2].....	28
3.4.3	Insulation co-ordination [Part 1 Clause 5.3].....	28
3.4.3.1	Representative power frequency voltages.....	29
3.4.4	Lightning performance [Part 1 clause 5.4.5].....	29
3.4.5	Electrical clearance distances to avoid flashover .....	30
3.4.5.1	Approach 1 [Part 1 Clause 5.5.1] .....	30
3.4.6	Internal electrical clearances [Part 1 Clause 5.8 and Table 5.8].....	31
3.4.6.1	Calculation of clearance to support and within the span [Part 2-9 Clause 5.6.1] .....	31
3.4.6.2	Downlead clearances – Approach 1 and 3 .....	34
3.4.7	External electrical clearances [Part 1 Clause 5.9 and Part 2-9 Clause 5.9] .....	35
3.4.7.1	General .....	35
3.4.8	Corona effect [Part 1 Clause 5.10].....	35
3.4.8.1	Radio and audible noise [Part 1 Clauses 5.10.1 and 5.10.2 and Part 2-9 Clause 5.10.2.3].....	35
3.4.8.2	Corona loss [Part 1 Clause 5.10.3 and Part 2-9 Clause 5.5.3].....	36
3.4.9	Electrical and magnetic fields [Part 1 Clause 5.11 and Part 2-9 Clause 5.11.1] .....	36
3.5	Earthing systems [Part 1 Clause 6].....	36

3.5.1	Earth electrodes [Part 1 Clause 6.2.1 and Part 2-9 Clause 6.2.1] .....	36
3.5.2	Dimensioning with regards to human safety [Part 1 Clause 6.4 and Part 2-9 Clause 6.4].....	36
3.5.3	Construction of the earthing system [Part 1 Annex H].....	36
3.5.4	Earthing measures against lightning [Part 1 Clause 6.1.3 and Part 2-9 Clause 6.4] .....	36
3.5.5	Measurements for and on the earthing system [Part 1 Annex H.4] .....	36
3.5.6	Site inspection and site documentation of the earthing system [Part 1 Clause 6.5] .....	37
Bibliography .....		42

## Figures

Figure 2.1 – Angles of wind incidence on supports .....	21
---	----

## Tables

Table 2.1 – Reliability level and partial load factors – climatic actions .....	18
Table 3.1 – System frequency.....	27
Table 3.2 – Insulation co-ordination .....	29
Table 3.3 – System voltage.....	29
Table 3.4 – Electrical clearance distances to avoid flashover (Based on a maximum altitude of 500 m) .....	30
Table 3.5 – Minimum clearances within the span at the support .....	32
Table 3.6 – Minimum downlead clearances within the span.....	34
Table 3.7 – Minimum air clearance (conductor – obstacle) .....	35



## 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 43-125".

Energy Networks Association Technical Specifications (ENA TS) 43 series for Overhead Lines were originally issued as Electricity Supply Industry (ESI) Specifications, and reflected current practice within the industry in the 1970-80s. Design methodology was based on the deterministic approach in accordance with the requirements of the Electricity (Overhead Lines) Regulations 1970. Complementary design requirements were based on the CEBG Transmission Plant Standards, subsequently reissued as ENA Technical Specifications.

European Normalised Standard, EN 50341, for the general design requirements of overhead electrical lines, initially for lines with voltages exceeding 45 kV (a.c.) was published in 2001. To complement the main body of the Standard, National Normative Aspects (NNAs) were prepared to reflect existing national laws or regulations relating to the design and/or construction of overhead lines, climatic conditions and current national practices in their own country. BS EN 50341 and its associated NNA Standard became the main normative reference for overhead line design in the United Kingdom (UK) as reflected in ENA TS 43-125 Issue 1.

In 2012, BS EN 50341-1 (subsequently referred to as Part 1) was subject to a technical revision. Technical content was updated and the scope was widened to cover overhead lines exceeding 1 kV a.c. The technical changes in the document impacted a number of topics including overhead line loadings. For example, the move away from using hourly-mean wind speeds for calculating applied forces on overhead line structures to 10-minute mean wind speeds. The ENA conducted specialist analysis of impacts of the revised BS EN 50341-1 and, as such, calculation factors have been incorporated into the NNA, where appropriate, to mitigate onerous overhead line designs.

Following the revision of BS EN 50341-1, the UK NNA was revised and published in 2015 as BS EN 50341-2-9 (subsequently referred to as Part 2-9). The intent of the UK NNA remains the same in that minimum design loading conditions and corresponding 'boxed' values have been specified and reference made to the Project Specification for the actual conditions or values.

Previously, two distinct design approaches were described in BS EN 50341-1 for both the mechanical and electrical design: the 'General Approach' based on the application of probabilistic reliability theory and an 'Empirical Approach' based on long term European experience, i.e. a deterministic-based design. The revised Standard now describes Approaches 1-3. However it is Approach 1 (previously 'General Approach') and Approach 3 (previously 'Empirical Approach') that are followed in the UK as declared in Part 2-9. Indicative values for partial loading or material factors ('boxed' values) are contained within the main body of the Standard, with the actual value specified in the NNA or alternatively in the Project Specification.

To ensure consistency in the application of both Part 1 and Part 2-9 and to provide guidance in the determination of the actual loading cases, boxed values etc., the Energy Networks Association has prepared this Specification for overhead lines above 45 kV, specifically, lattice tower overhead lines. ENA TS 43-125 Issue 1 contained requirements for wood pole and steel pole overhead lines but this has been removed as such construction is covered by other Engineering Documents, namely: ENA TS 43-30 [1], ENA TS 43-40 [2], ENA TS 43-50 [3] and ENA TS 43-97 [4].

Since neither Part 1 nor Part 2-9 encompass the installation aspects of overhead line construction, standard clauses covering these requirements have been included at appropriate points. To further assist in the use of these technical guidance documents cross-references have been included in the clause headings.

To provide guidance on the application of Part 1 and Part 2-9, where appropriate, a '*commentary*' has been provided in the text, especially as regards the determination of specific design loading conditions and the corresponding partial loading and material factors.

ENA TS 43-125 has been restructured as a multi-part document with the objective that any future amendments can be completed in an efficient and timely manner. ENA TS 43-125 comprises of the following parts.

ENA TS 43-125 Part 1 – Design basis and electrical requirements.

ENA TS 43-125 Part 2 – Conductor systems, insulators and fittings.

ENA TS 43-125 Part 3 – Vibration dampers and spacers.

ENA TS 43-125 Part 4 – Foundations and site requirements.

Within each Part of TS 43-125, the main clause heading is used to bound the requirements for a particular topic, e.g. Clause 2 in ENA TS 43-125 Part 3 captures all requirements for vibration dampers. Under each main clause, the scope, terms and definitions and normative references are provided, relevant to that topic.

Previous requirements in ENA TS 43-125 Issue 1 covering optical fibre cables have been removed as this topic is covered by ENA TS 43-126 suite of documents.

Project information to be provided by the ENA Member Company (ENAMC) Engineer, quality assurance requirements and the need for contractors' and/or suppliers' design submissions have been identified throughout this Specification. For consistency, informative annexes are included at the end of each main clause heading and include the following details.

- Annex A: Project Information to be provided by the ENAMC Engineer.
- Annex B: Contractors' and/or Suppliers' Q.A. Hold and Notification Points.
- Annex C: Contractors' and/or Suppliers' Design Submissions.

Overhead lines by their very nature constitute a hazardous environment during their construction, maintenance and dismantling. Consequentially, to fulfil the requirements of the CDM Regulations [5] health and safety considerations and in particular 'risk assessments' should be undertaken as part of the overall design process.