BS EN 50341-2-9:2015

BSI Standards Publication

Overhead electrical lines exceeding AC 1 kV

Part 2-9: National Normative Aspects (NNA) for Great Britain and Northern Ireland (based on EN 50341-1:2012)

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National foreword

This British Standard is the UK implementation of EN 50341-2-9:2015.

This standard, together with the following list of National Normative Aspect standards, supersedes BS EN 50423-3:2005 and BS EN 50341-3:2001:

Country Code	Origin	Ref
AT	Austrian National Committee	BS EN 50341-2-1
BE	Belgian National Committee	BS EN 50341-2-2
CH	Swiss National Committee	BS EN 50341-2-3
DE	German National Committee	BS EN 50341-2-4
DK	Danish National Committee	BS EN 50341-2-5
ES	Spanish National Committee	BS EN 50341-2-6
FI	Finnish National Committee	BS EN 50341-2-7
FR	French National Committee	BS EN 50341-2-8
GB	British National Committee	BS EN 50341-2-9:2015
GR	Greek National Committee	BS EN 50341-2-10
IE	Irish National Committee	BS EN 50341-2-11
IS	Iceland National Committee	BS EN 50341-2-12
IT	Italian National Committee	BS EN 50341-2-13
LU	Luxemburg National Committee	No NNA available
NL	Nederland’s National Committee	BS EN 50341-2-15
NO	Norwegian National Committee	BS EN 50341-2-16
PT	Portuguese National Committee	BS EN 50341-2-17
SE	Swedish National Committee	BS EN 50341-2-18
CZ	Czech National Committee	BS EN 50341-2-19:2015
EE	Estonian National Committee	BS EN 50341-2-20:2015
SI	Slovak National Committee	BS EN 50341-2-21
PL	Polish National Committee	BS EN 50341-2-22

BS EN 50423-3:2005 and BS EN 50341-3:2001 will be withdrawn upon publication of the rest of the series.

The UK participation in its preparation was entrusted to Technical Committee PEL/11, Overhead Lines.

A list of organizations represented on this committee can be obtained on request to its secretary.

Published by BSI Standards Limited 2015

ISBN 978 0 580 91204 7

ICS 29.240.20

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 July 2015.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 50341-2-9

June 2015

ICS 29.240.20

English Version

Overhead electrical lines exceeding AC 1 kV - Part 2-9: National Normative Aspects (NNA) for Great Britain and Northern Ireland (based on EN 50341-1:2012)

This European Standard was approved by CENELEC on 2015-06-02.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 50341-2-9:2015 E

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Foreword

1. The British National Committee is identified by the following address:

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   Attention: Secretary of PEL/11 Overhead lines – Standards Development

2. The British National Committee has prepared this NNA (part 2-9 of EN 50341) listing the GB National Normative Aspects under its sole responsibility and duly passed this document through the CENELEC and CLC/TC 11 procedures.

   NOTE: The British National NC also takes sole responsibility for the technically correct co-ordination of this NNA with EN 50341-1. It has performed the necessary checks in the frame of quality assurance / control. However, it is noted that this quality control has been made in the framework of the general responsibility of a standards committee under the national laws / regulations.

3. This Part 2-9 is normative in GB and informative for other countries.

4. This document shall be read in conjunction with Part 1 (EN 50341-1). All clause numbers used in this NNA correspond to those in Part 1. Specific sub-clauses that are prefixed “GB” are to be read as amendments to the relevant text in Part 1. Any necessary clarification regarding the application of this NNA in conjunction with Part 1 shall be referred to the British NC who will, in co-operation with CLC/TC 11, clarify the requirements.

   Where no reference is made in this NNA to a specific sub-clause, then Part 1 shall apply.

5. In the case of “boxed values” defined in Part 1, amended values (if any), which are defined in this NNA, shall be taken into account in GB and Northern Ireland.

   However any boxed value whether in Part 1 or in this NNA, shall not be amended in the direction of greater risk in a Project Specification.

6. The GB and Northern Ireland standards/ regulations relating to overhead electrical lines exceeding A.C. 1 kV are listed in subclause 2.1.

7. The British NC declares in accordance with clause 4.1 of Part 1 that this NNA follows both design “Approach 1” and design “Approach 3”. The specific design Approach to be used shall be specified in the Project Specification.

1 SCOPE

1.1 General

(ncpt) GB.1 General

This NNA is only applicable to all new overhead lines above A.C. 1kV.

This Euronorm is only applicable to new overhead lines and shall not be applied to maintenance, reconductoring, tee-offs, extensions or diversions to existing overhead lines unless specifically required by the Project Specification.

For details of the application of this standard for overhead lines constructed with covered conductor refer to the Project Specification.

For details of the application of this standard to telecommunication systems involving optical fibres either incorporated in or wrapped around earthwires or conductors or suspended from overhead line supports, reference should be made to the Project Specification.

2 NORMATIVE REFERENCES, DEFINITIONS AND SYMBOLS

2.1 Normative references

(A-dev) GB.1 National statutes

Reference	***Name and Date of GB and NI Statute***
	Electricity Act 1989, Chapter 29,
	Health and Safety at Work Act 1974 and subsequent amendments
SI 635	*The Electricity at Work Regulations 1989 (Northern Ireland) 1991*
SI 1355	*The Electricity (Overhead Lines) Regulations 1970*
SI 2035	*The Overhead Lines (Exemption) Regulations 1990*
SI 2665	*The Electricity Safety, Quality and Continuity Regulations 2002*
SI 381	*The Electricity Safety, Quality and Continuity Regulations (Northern Ireland) 2012*
SI 3074	*The Overhead Lines (Exemption) Regulations 1992*
SI 320	*The Construction (Design & Management) Regulations 2007*
SI 231(NI)	*Electricity (Northern Ireland) Order 1992*
SR 142	*The Construction (Design & Management) (Amendment) Regulations (Northern Ireland) 2001*
SR 209	*The Construction (Design & Management) Regulations (Northern Ireland) 1995*
SR 536	*Electricity Supply Industry Regulations (Northern Ireland) 1991*
SR 21	*Electricity Supply (Amendment) Regulations (Northern Ireland) 1993*
SI 1039 (NI9)	*Health and Safety at Work (Northern Ireland) Order 1978*
SI 2448 (S.165)	*The Electricity Act 1989 (Scotland)*

(ncpt) GB.2 National normative standards

BSEN 1991-1-4:2005	*Actions on Structures - Part 1-4: General Actions – Wind actions*
BSEN 1995-1-1:2008	*Design of Timber Structures – Part 1-1 General – Common rules and rules for buildings*
BS 7354:1990	*Design of high-voltage open-terminal stations*
BSEN 10025	*Hot rolled products of structural steels*
BSEN 14229:2010	*Structural timber – wood poles for overhead lines*
BSEN 50182:2001	*Conductors for overhead lines – round wire concentric lay stranded conductors*

Electricity Association Technical Report (EATR) 111 - High Voltage Single Circuit Overhead Lines on Wood Poles (1991)

2.3 Symbols

(ncpt) **GB.1 Additional symbols**

A_{SITE}	altitude of the site above mean sea level
a	altitude in metres above sea level of the conductor
c_{alt}	altitude factor
c_{dir}	wind direction factor
D_c	diameter of the conductor, mm
f_{yb}	yield strength for bolt
K_i	ice thickness coefficient
K_c	shape factor
L	length of conductor span, m
N_c	number of phases and earthwires
q_x	wind pressure on conductor, N/m²
q_c	wind pressure on structural element, N/m²
r_B	basic radial thickness of ice, mm
r_o	radial ice thickness in mm in the absence of wind, mm
r_r	reference ice thickness, mm
r_w	radial ice thickness in mm in the presence of wind
$v_{b,0}$	fundamental basic wind velocity, m/sec
$v_{b,map}$	10-minute wind velocity at sea level taken from a GB map, m/sec
z	height above ground, m
γ_v	partial safety factor on wind speed and ice thickness (partial factors on actions)
γ_m	partial factor on strength of structural materials
γ_{dl}	partial factors on permanent actions

3 BASIS OF DESIGN

3.2 Requirements of overhead lines

3.2.2 Reliability requirements

(ncpt) **GB.1 Reliability levels**

The partial coefficients to be used for the reliability levels are shown in Table 4.13.1/GB.1. The required reliability level shall be stated in the Project Specification. For temporary loading conditions reduced reliability levels may be specified.

3.2.5 Strength coordination

(ncpt) **GB.1 Strength coordination**

The required degree of strength coordination shall be stated in the Project Specification.

3.2.6 Additional considerations

(ncpt) **GB.1 Additional considerations**

Higher partial factors than those shown within this NNA may be specified in the Project Specification. Any additional considerations shall also be stated in the Project Specification.

3.3 Limit states

3.3.3 Serviceability limit states

(ncpt) **GB.1 Specific requirement**

These shall be defined in the Project Specification.

4 ACTIONS ON LINES

4.1 Introduction

(ncpt)

GB.1 Peak factor equation

The formulation in the UK National Annex to BS EN 1991-1-4 modifies the parameter to define peak pressures by adopting a "peak factor" of 3,0 with a quadratic equation, rather than 3,5 with a linear equation, as used in BS EN 1991-1-4. The decision to change the formulation was due to the use of the ten minute wind speed in BS EN 1991-1-4 and the greater accuracy in the quadratic expression. As a consequence of this, equations included in clauses 4.3.4, 4.4.1.2, 4.4.3.2, 4.4.3.3 need to be amended as follows for use in the UK:

Replace the expression: $[1 + 7Iv(z)]$
with: $[1 + 3{,}0Iv(z)]^2$

(ncpt)

GB.2 Design approach definition

Approach 1 (as detailed in BS EN 50341-1:2012 Clause 4.1) shall be adopted for all new overhead lines supported on steel poles or lattice steel towers.

For overhead lines supported on timber poles, the project specification shall specify either design Approach 3 or 1.

4.3 Wind loads

4.3.1 Field of application and basic wind velocity

(snc)

GB.1 Calculation of basic wind velocity

Partial factor (γ_v) taken from Table 4.13.1/GB.1 for the specified Reliability Level shall be applied to the basic wind velocity ($v_{b,0}$) instead of applied to wind loading as given in Table 4.7 of BSEN 50341-1. The partial factor Ψ_w shall not be used.

The fundamental basic wind velocity, $v_{b,0}$ should be determined by the equation:

$$v_{b,0} = \gamma_v \, v_{b,map} \, c_{alt}$$

Where, $v_{b,map}$ is the fundamental velocity indicated in Figure NA.1 and c_{alt} is the altitude factor calculated as follows:

$$c_{alt} = 1 + 0{,}001 \, A_{SITE}$$

where: A_{SITE} is the altitude of the site in metres above mean sea level

The above may be used for all site altitudes, but may be considered over-conservative at high altitudes, in which case c_{alt} may be calculated for each element greater than 10m above ground using the modified formula:

$$c_{alt} = 1 + 0{,}001 \, A_{SITE} \, (10/h)^{0.2}$$

Where h is the height above ground level in metres at the point of application of the wind load. For calculation of wind loading on conductors and insulators, h may be taken as the mean height of the conductor attachment points. For calculation of wind on towers, structures may be divided in a number of panels of up to 10m in height, and h taken as the mean height of each panel.

4.3.2 Mean wind velocity

(ncpt)

GB.1 Wind Direction

Wind direction factor C_{dir} may conservatively be taken as 1,0 or from Table 4.3.2/GB.1 below.

Table 4.3.2/GB.1 Wind direction factors

Direction	0	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°	330°
C_{dir}	0,78	0,73	0.73	0,74	0,73	0,80	0,85	0,93	1,00	0,99	0,91	0,82
NOTE 1 Interpolation may be used NOTE 2 The directions are defined by angles from due North in a clockwise direction, for wind *from* the specified direction (eg. 0° means wind *from* due North)												

NOTE. Unless stated otherwise in the project specification, wind from every direction from 0 to 345° shall be considered for the design in 15° increments.

(ncpt) **GB.2 Seasonal factor, c_{season}**

Where a temporary loading condition will remain in place for less than 1 year, the appropriate c_{season} factor may be applied in the calculation of mean wind speed as indicated in Table NA.2.7 in National Annex to BSEN 1991-1-4:2005. Note that the appropriate factor will not be applied in conjunction with wind speeds of less return period than 50 years.

(ncpt) **GB.3 Orography factor, c_o**

The orography factor, c_o shall be taken as 1,0 where the average ground slope is not greater than 5% (1:20), measured over a distance of 10 times the height of the supports from the line. For greater slopes, reference shall be made to Figure NA.2 in National Annex to BSEN 1991-1-4:2005+A1, “Definition of significant orography [definition of symbols given in A.3(3)]”. For sites lying within the shaded area of that figure, the method given in BSEN 1991-1-4 A.3 for calculation of c_o may be used. As an alternative, or if the topography is complex, calculation by wind engineering specialists using digital terrain models may be less labour intensive and give more accurate results.

(ncpt) **GB.4 Loading on conductors**

For calculation of the load on supports due to wind loading on conductors (excluding those indirect effects due to conductor tension) the magnitude of the height above ground (h) adopted for the calculation of $V_h(h)$ shall generally be taken as the average height to the attachment of the support considered except in the case of spans crossing deep valleys, river estuaries or hills where the attachment heights would not be representative of the actual heights to the conductors away from the supports. In these cases, the value of h adopted shall be adjusted to approximately represent the mean height from the ground or water level to the attachment points on the supports. Alternatively, advice from a wind engineering specialist may be sought.

4.3.3 Mean wind pressure

(snc) **GB.1 Air density**

Air density in Great Britain shall be taken as 1,226 kg/m³. Table 4.2 in BSEN 50341-1:2012 shall not be used.

4.4 Wind forces on overhead line components

(snc) **GB.1 Design Approach 3**

Table 4.4.1/GB.1 details the design wind pressures and drag factors to be adopted for design Approach 3.

The span factor G_c shall be assumed to be 1,0 for wind span lengths up to 200m and (0,75L + 30)/L metres for wind span lengths greater than 200m. Normal and High altitudes are defined as follows:

Normal altitude: All of GB and Northern Ireland, except Scotland, site altitudes not exceeding 300m. For Scotland, site altitudes not exceeding 200m. More onerous requirements may be detailed in the Project Specification.

High altitude: All of GB and Northern Ireland, except Scotland, site altitudes greater than 300m but not exceeding 500m. For Scotland, site altitudes greater than 200m but not exceeding 500m. For lines at altitudes greater than 500m, a special consideration should be made as detailed in the Project Specification.

Table 4.4.1/GB.1 Wind pressures and aerodynamic drag factors

Load Condition	Wind Pressure (N/m²)		Aerodynamic drag factors	
	q_x	q_c	C_x	C_c
High Wind (no ice)	1740	1740	0,8	1,0
Combined Wind and Ice (Normal altitude)	380	380	1,0	1,0
Combined Wind and Ice (High altitude)	570	570	1,0	1,0
Wind only (no ice)	0	760	-	1,0
Security (broken wire)	380	380	1,0	1,0
NOTE: for the leeward (shielded) pole, a shielding factor of 0,5 shall be assumed				

4.4.1 Wind forces on conductors

4.4.1.1 General

(ncpt) **GB.1 Calculation of G_c**

The wind loading adopted for calculation of the mechanical tension in a section of line shall be based on a value of conductor structural factor, G_c derived using a length value, L_m equal to the section length or 800m whichever is the less, together with a height, h based on the mean height of the conductor attachment point over length L_m. The mean height of the conductors shall be adjusted for deep valleys, river estuaries and hills as described in 4.3.2/ GB.4 above.

4.4.1.3 Drag Factor

(ncpt) **GB.1 Calculation of Reynold's number**

In the calculation of drag factor for conductors (c_c) Method 3 shall be used for stranded conductors, using an effective Reynold's number (Re). The values given in 4.4.1.3 shall be used for normal stranded conductors without ice. Other values are given in Table 4.4.1/GB.2 below.

Where: $Re = (1{,}42\ V_h \cos \text{Ø}_c\ d)/\ v$

and where: v is the kinematic viscosity of air, taken as $1{,}46 \times 10^{-5}$ m²/s

Ø_c is the angle between the wind direction and plane normal to the conductor

Table 4.4.1/GB.2 Typical Drag Factors for elements

Member type	**Effective Reynold's number (Re)**	**Drag Factor (C_c)**	
		Ice free	**Iced**
Circular sections, smooth wire and smooth bodied conductors	$\leq 2 \times 10^5$	1,2	1,2
	4×10^5	0,6	1,0
	$> 10 \times 10^5$	0,7	1,0
Normal stranded conductors with more than seven strands	$\leq 6 \times 10^4$	1,2	-
	$\geq 10^5$	0,9	-
	$\leq 1 \times 10^5$	-	1,25
	$\geq 2 \times 10^5$	-	1,0
Thick stranded cable, e.g small wire ropes, round wire ropes, spiral steel strand with seven wires only	$\leq 4 \times 10^4$	1,3	-
	$> 4 \times 10^4$	1,1	-
	$\leq 1 \times 10^5$	-	1,25
	$\geq 2 \times 10^5$	-	1,0
Flat sided sections and plates	All values	2,0	2,0
NOTE For intermediate values of R_e, Cc should be obtained by linear interpolation			

4.4.3 Wind forces on lattice towers

4.4.3.1 General

(ncpt) **GB.1 General**

Method 1 shall be adopted when calculating wind loading on lattice towers.

4.5 Ice loads

(snc) **GB.1 General**

This clause replaces 4.5.1 to 4.5.2 in BSEN 50341-1:2012.

(ncpt) **GB.2 Basic ice thickness**

Modified design values for ice thickness, ice density, or the wind speed occurring simultaneously with ice loading may be specified in the Project Specification, and may be either more or less onerous than the values given below. Any such modified values shall be supported by local experience gained over approximately 50 years or more of operation of overhead line systems in the areas concerned.

(ncpt) **GB.3 Ice thickness in the absence of wind**

The basic ice thickness, r_B in the absence of wind on conductors for the GB, should be taken as:

$$r_B = k_l\left[r_o + \left(\frac{a-200}{25}\right)\right] \text{ but not less than } k_l\, r_o$$

where: k_l is a coefficient that is equal to:-

$$\left(\frac{2}{3} + \frac{4}{D_c}\right) \text{ but not more than 1,2}$$

where

D_c is the diameter of the conductor (in mm)
a is the altitude in metres above sea level of the conductor
r_o is the radial ice thickness in mm in the absence of wind shall be obtained from Figure NA.2, appropriate to the position of the site.

Alternatively, r_o shall be derived from a statistical analysis assuming an extreme distribution based on records of the annual maximum thickness of ice formation on components of form and size similar to those to be used in the tower or its attachments at the latitude and altitude of the site and having an annual probability of occurrence of 0,02.

NOTE : For the calculation of ice thickness on tower members, a similar procedure shall be adopted, assuming k_l =1,0 for flat sided members, and a = height of tower top above sea level.

(ncpt) **GB.4 Reference ice thickness**

The reference ice thickness, r_r , to be considered for design shall be taken as:

$$r_r = \gamma_v K_c r_B$$

where:

γ_v is the partial safety factor on ice thickness to be determined from table 4.13.1/GB.1.
r_B is the basic radial thickness of ice, determined as above.
K_c is a shape factor, which should be taken as:

$$\frac{N_c + 0{,}3}{1{,}3\, N_c} \quad \text{where } N_c \text{ is the number of phases and earthwires}$$

K_c = 1,0 for tower members

(ncpt) **GB.5 Ice weight**

The weight of ice deposited shall be calculated, assuming a uniform coating of ice of thickness, r_r , and the unit weight of ice, in the absence of wind should be taken as 5 kN/m^3.

NOTE: Ice thickness and density may be subject to maximum and minimum values, which shall be specified in the Project Specification.

4.6 Combined Wind and Ice loads

(snc) **GB.1 General**

This clause replaces 4.6.1 to 4.6.6 in BSEN 50341-1:2012

(ncpt) **GB.2 Ice thickness in conjunction with wind**

The basic ice thickness, r_B , in conjunction with wind, on conductors for the GB, shall be taken as:

$$r_B = k_l\left[r_w + \left(\frac{a-200}{25}\right)\right]$$

but not less than $k_l\, r_w$, where:

k_l and a are as defined in ice only case.

r_W is the radial ice thickness in mm in conjunction with wind, to be obtained from Figure NA.2, appropriate to the position of the site.

Alternatively, r_W may be derived from records, having an annual probability of occurrence of 0,5.

(ncpt) **GB.3 Reference ice thickness**

The reference ice thickness, r_r , to be considered for design should be taken as:

$$r_r = \gamma_v K_c r_B$$

where:

γ_v is the partial safety factor on ice thickness to be determined from table 4.13.1/GB.1.

r_B is the basic radial thickness of ice, determined as above

K_c is a shape factor, which should be taken as 1,0 for tower members:

$$\frac{N_c + 0{,}3}{1{,}3\,N_c}$$ where N_c is the number of phases and earthwires

K_c = 1,0 for tower members

NOTE: Ice thickness and density may be subject to maximum and minimum values, which shall be specified in the Project Specification.

(ncpt) **GB.4 Ice weight**

The weight of ice deposited shall be calculated assuming a uniform coating of ice of thickness, r_r , and the unit weight of ice shall be based on knowledge of local environmental factors, using the density values from BSEN 50341-1 Table 4.5. Unless otherwise specified in the project specification, an ice density of 5kN/m^3 shall be assumed for ice loading without wind, and 9kN/m^3 for combined wind and ice cases.

Extreme ice thickness and corresponding ice density under still air conditions is not normally considered for wood and steel pole lines following design Approach 3.

(ncpt)

GB.5 Wind with ice

When ice is the leading variable action, $V_{IH} = 0$ (ie. assumed still air conditions).
Ice thickness, r_r calculated from r_0 using the formulae in Clause 4.5 above (considered to be glazed ice).

When wind is the leading variable action, factor $V_{IL} = V_{50} .B_1 \sqrt{\gamma_w}$. Factor $B_1 = 0,68$ (wet snow considered to predominate in GB with wind).
Ice thickness, r_r calculated from r_w using the formulae in Clause 4.6 above. Drag coefficient for iced conductors shall be calculated from Table 4.4.1/GB.2 above.

(ncpt)

GB.6 Wood pole lines (design Approach 3)

For wood pole lines with conductors not exceeding 35mm² copper (or 60mm² for aluminium-based conductors), the wind only loading case may be used for all altitudes, with no applied ice loading. For all other lines, the following ice loadings are applicable when additionally subjected to wind:

Normal altitudes	9,5mm radial thickness
High altitude	12,5mm radial thickness

A greater radial ice thickness may be defined in the Project Specification. The following unit weight of ice/snow are considered depending on locality and altitude: glaze ice 9 kN/m³, wet snow 8,33 kN/m³ and rime ice 5 kN/m³. The specific unit weight of ice to be used will be detailed in the Project Specification.

4.7 Temperature effects

(snc)

GB.1 Temperature effects

(a) Minimum temperature, with no other climatic load is not a critical loading condition in the GB and need not be considered.
(b) The normal ambient temperature for extreme wind speed conditions in GB shall be assumed to be $0^{o}C$ for design Approach 1.
(c) A reduced wind speed combined with a minimum temperature condition is not a critical loading condition in GB and need not be considered.
(d) The temperature to be considered for both icing in still air and combined wind and ice in GB shall be assumed to be $-10^{o}C$ for design Approach 1, and -5,6°C for design Approach 3.

4.8 Security loads

(ncpt)

GB.1 Security loadings (Failure containment or Broken Wire Conditions)

Towers shall be designed to resist the torsional or longitudinal loads, which would be generated by combinations of broken conductor(s), and/or earthwires.

Full details of failure containment conditions shall be given in the Project Specification, which will specify the following:

1) The combinations of conductors and earthwires, which shall be considered to be broken simultaneously.
2) The basis for calculating the tensions in the conductors and earthwire or, alternatively, nominal values to be assumed for the tensions.
3) Values to be assumed for the reduction factor, β , normally taken as 0,7 for conductors on suspension towers and 1,0 for tension towers and earthwires on suspension towers.
4) The type of climatic loadings to be assumed to be acting simultaneously with the broken conductors, and the return periods or partial load factors to be adopted.

NOTE: Security loadings need not be considered for timber poles and other types of support carrying overhead lines at voltages above 1 kV. See Project Specification.

4.9 Safety loads

4.9.1 Construction and maintenance loads

(ncpt) **GB.1 Construction and maintenance loads**

Details of construction and maintenance loads shall be provided in the Project Specification.

4.9.2 Loads related to the weight of linesmen

(ncpt) **GB.2 Loads related to weight of linesmen**

Design loadings for walkways and/or working platforms when installed shall be defined in the Project Specification.

4.10 Forces due to short-circuit currents

(ncpt) **GB.1 Short circuit currents**

The mechanical forces developed during a short circuit and applied to a structure, will be detailed in the Project Specification.

4.11 Other special forces

(snc) **GB.1 Other special forces**

Where it is necessary to consider avalanches, creeping snow or earthquakes, the method of calculation shall be defined in the Project Specification.

4.12 Load cases

4.12.2 Standard load cases

(ncpt) **GB.1 Standard load cases for design Approach 1**

Table 4.6 in EN 50341-1 shall be replaced by Table 4.12.1/GB.1 and Table 4.12.2/GB.1.

Table 4.12.1/GB.1 Standard load cases for design Approach 1

Load case	Load as per sub clause	Conditions	Remarks
1a	4.4	Extreme wind load, all angles of wind incidence which may be critical for particular elements, are to be considered.	
1b	4.4	Wind load at a minimum temperature	May be critical for uplift loading on crossarms.
2a	4.5	Uniform ice loads on all spans to be considered.	Unit weight of ice 5 kN/m^3
2b	4.5	Uniform ice loads, transversal bending.	
2c	4.5	Unbalanced ice loads, longitudinal bending.	Not critical for GB
2d	4.5	Uniform ice loads, torsional bending.	Not critical for GB
3	4.6	Combined wind and ice. Uniform ice loading on all spans should be considered. All angles of wind incidence, which may be critical for particular elements to be considered.	Minimum unit weight of ice 5 kN/m^3
4	4.2.6	Construction and maintenance loads.	See Project Specification
5a	4.8.1	Security loads, torsional loads.	See Project Specification
5b	4.8.2	Security loads, longitudinal loads.	See Project Specification
6a	4.9.1	Safety loads, construction and maintenance loads	See Project Specification
6b	4.9.2	Safety loads, loads due to the weight of linesmen	See Project Specification

Table 4.12.2/GB.1 Standard load cases for design Approach 3

Load case	Load condition	Notes
1	High wind (no ice)	As detailed in the Project Specification
2	Combined wind and ice	Normal altitudes
3	Combined wind and ice	High altitudes
4	Wind only (no ice)	Conductor up to 35mm² copper equivalent area. Wood pole lines - all altitudes
5	Security (broken wire)	As detailed in the Project Specification
6	Construction and Maintenance	As detailed in the Project Specification

For wood pole lines, Loading Cases 2 or 3 as appropriate shall be adopted for the line design. Exceptionally, Load Case 1 may additionally be specified for certain localities. The requirement for this loading will be outlined in the Project Specification.

Load Case 4 relates to a wind only loading without ice accretion for small size conductors on wooden poles. This loading has been proven to give satisfactory performance over many years and within many areas of GB and Northern Ireland and was included in The Electricity (Overhead Lines) Regulations 1970. Since the acceptability of the loading is dependent on site topography, location, and security of supply, the requirement for its use in a specific environment will be outlined in the Project Specification.

4.13 Partial factors for actions

This section and associated Tables replaces that included in 4.13 included in BSEN 50341-1

(ncpt) **GB.1/ 4.13.1 Partial factors for actions for design Approach 1**

Design Approach 1 will normally be associated with the design of steel pole and lattice steel structures. The Project Specification may however indicate that Approach 1 be extended to the design of wood pole structures.

Table 4.13.1/GB.1 Partial factors and combination factors for actions, ultimate limit states for design Approach 1

Action (Load)	Symbol	Reliability level		
		1	2	3
Variable actions: Climatic loads Wind load (without ice)	γ_v on wind velocity ($V_{b,o}$)	1,0	1,1	1,2
Combined wind and ice	γ_v on ice thickness r_w	1,0	1,1	1,2
Heavy ice load (without wind)	γ_v on ice thickness r_o	1,0	1,1	1,2
Safety loads Maintenance and construction loads (see note)		1,5 on static loads 2,0 on conductor tension when conductors are being pulled by powered winches, etc.		
Permanent actions: Self-weight	γ_{DL}	The more onerous of:- 1,1 or 0,9 (For the calculation of conductor tension, a value of 1,0 is to be used)		
Accidental actions: *Security Loads (4.2.7)*	Longitudinal (specified tension):	In accordance with the Project Specification		
	γ_v for simultaneous climatic loading, combined wind and ice case (if applicable)	In accordance with the Project Specification		
NOTE 1: The loads shall be stated in the Project Specification NOTE 2: Limits on deflection of structures, and limits on clearances to supports, shall apply to 3-year return wind or wind and ice loadings. These can be approximated by the application of a value of γ_v of 0,75 applied to the 50 year return values.				

Table 4.13.1/GB.2 Partial strength factors for overhead line components for design Approach 1

Component	Part 1 Clause	Material Property	γ_m
Concrete		Compressive concrete strength	1,50
		Yield strength of steel reinforcement	1,15
Steel Lattice Towers	7.3.6.1	Resistance of cross sections and of buckling of sections Resistance of net section at bolts	1,10 min.
		Resistance of bolted, riveted and welded connections	1,10 min
Steel poles	7.4.5	Resistance of cross-section Resistance of net section at bolt holes Resistance of connection	1,10 min
Timber Poles	7.5.5.1	Body of Timber Pole** Resistance of cross-section, elements and bolted connections	1,30 min
Guyed Structure	7.7.4.1	Resistance of Guys to ultimate strength	1,6 min
Foundations	8	Refer to Project Specification	
Conductor *	9.6.2	All types	1,25min
Tension, Suspension, Pin and Post insulator sets *	10.7	All insulators and associated components	1,6 min

Notes:
* The above partial coefficients shall be applied to the specified mechanical or electro-mechanical failure load of the insulator strings and to the rated tensile strength of a conductor. These coefficients apply only to ceramic (glass and porcelain) insulators: where non-ceramic insulators are to be used the coefficient will be defined in the Project Specification

**The value of γ_m for resistance of poles may be specified in the Project Specification.
The value of γ_m adopted shall be dependent on the quality of design, design checking (which may include testing), material, workmanship, shop inspection, maintenance and inspection in service. (Reference should be made to the Project Specification).

F_{test} shall be specified in the Project Specification and clauses 7.3.9, 7.4.9 and 7.5.8 of EN 50341-1:2012 shall not apply in this NNA

(ncpt)

GB.1/ 4.13.2 Partial factors for actions for design Approach 3

Design Approach 3 will normally be associated with the design of wood pole structures. The following Tables 4.13.2/GB.1 – 3 indicate the applicable design factors to be employed.

Table 4.13.2/GB.1 Partial factors for actions, ultimate limit state for design Approach 3

Action (load)	Partial Factor
Normal load cases – variable actions	
Climatic loads and conductor tension	
High wind (Load case 1)	1,1
Combined wind and ice (Load cases 2 and 3)	2,5 (a)
Wind only (Load case 4)	2,5* (a)
Permanent actions	
Self-weight	
High wind (Load case 1)	1,1
Combined wind and ice (Load cases 2 and 3)	2,5 (a)
Wind only (Load case 4)	2,5* (a)
Static cantilever loads (All load cases)	1,0
Exceptional load cases - security (broken wire) loads (Load case 5)	1,3
Construction and maintenance (Load case 6)	1,5 on static loads 2,0 on dynamic loads

* For timber pole supports, wind on the pole is ignored as permitted in Electricity (Overhead Lines) Regulations 1970.
Note (a). Higher partial factors may be specified in the Project Specification, particularly for intermediate poles. See also Table 4.13.2/GB.2.

In respect of all intermediate structures on wood poles, it is normal practice in GB to design the structure considering transverse loading only. In order to take account of increasing p-delta effects and crippling loading with increasing declination, the factors indicated in the following Table 4.13.2/GB.2 are generally employed. Other factors may be employed where local historical evidence for conductor/ pole combination indicates suitable performance, and this will be detailed in the Project Specification.

Table 4.13.2/GB.2 Partial factors for actions, intermediate pole declination

Action (load)	Partial Factor
Declination gradient – climatic loads	
Level Conditions – 1:25 (Load cases 2, 3 and 4)	2,5
1:25 - 1: 7.5 (Load cases 2, 3 and 4)	3,0
>1: 7,5 – 1: 5 (Load cases 2, 3 and 4)	3,5

Table 4.13.2/GB.3 Partial strength factors for overhead line components for design Approach 3

Component	Part 1 Clause	Material Property	γ_m
Steel Members (Grade S275) used as ancillaries on wood poles	7.3.6.1	Resistance of cross sections and buckling of sections (based on yield strength)	0,63 (c)
		Resistance of bolted connections: (based on ultimate tensile strength)	
		- Shear	1,33
		- Tension	1,0
		- Bearing	2,0
		Resistance of welded connections (based on yield strength of parent steel)	0,63 (c)
Timber Poles	7.5.5.1	Resistance of body of pole, cross-section, elements and bolted connections (based on mean ultimate strength)	1,0 min. (a)
Guyed Structures	7.7.4.1	Resistance of Guys (based on nominal failing load)	1,0 min.
Foundations	8	Refer to Project Specification	
Conductor	9.6.2	Resistance of conductors (based on nominal breaking load) (d)	
		Combined wind and ice	0,8
		Wind only	1,0
Tension, Suspension, Pin and Post Insulator Sets (b)	10.7	All string components (based on nominal failing load)	1,0 min.

Notes:

(a) Based on the application of mean modulus of rupture as defined in Clause 7.5.5/GB.4 of this NNA. For wood pole intermediate un-guyed supports, the effects of the vertical loading shall be ignored unless specified in the Project Specification.
(b) The coefficient applies only to ceramic (glass and porcelain) insulators: where non-ceramic insulators are to be used the coefficient will be defined in the Project Specification.
(c) The appropriate γ_m factor has been determined based on the ratio of yield strength to ultimate tensile strength assuming grade S275 steel to BSEN 10025. For other steel grades, use same ratio to provide γ_m value.
(d) The Nominal Breaking Load of conductors is a client defined percentage of the Rated Strength of the conductor as given in the appropriate standard e.g. BSEN 50182.

The adopted value of γm shall be dependent on the quality of design, design checking (which may include testing), material, workmanship, shop inspection, maintenance and inspection in service. (Reference should be made to the Project Specification).

$F_{test, R}$ shall be specified in the Project Specification and clause 7.5.8 of BSEN 50341-1 shall not apply in this NNA.

5 ELECTRICAL REQUIREMENTS

5.2 Currents

5.2.1 Normal current

(ncpt) **GB.1 Maximum conductor temperature**

For details of the design maximum conductor temperature reference shall be made to the Project Specification.

5.2.2 Short circuit current

(ncpt) **GB.1 Magnitude and duration**

The magnitude and duration of short circuit currents for design purposes shall be given in the Project Specification.

5.5 Minimum air clearance distances to avoid flashover

5.5.3 Empirical method based on European experience

(ncpt) **GB.1 Clearances D_{el} and D_{pp}**

Clearances D_{el} and D_{pp} shall be as shown in Table 5.6 /GB.1 below.

Table 5.6/GB.1 Clearances used in GB

Clearances: practice used in GB [1)]		
Nominal system voltage/BIL[2]	**Basic electrical clearance (phase to earth) D_{el} (m)**	**Phase to phase clearance D_{pp} (m)**
6,6/75	0,5	0,25
11/95	0,5	0,25
33/170	0,5	0,43
66/325	0,7	0,78
132/550/650	1,1	1,4
275/1050/850	2,1	2,4
400/1425/1050	2,8	3,6

Notes: 1) Based on Table 3 BS 7354: The above figures shall be regarded as minimum clearances.
2) BIL – Basic impulse level.
3) SIL – Switching impulse level.

5.6 Load cases for calculation of clearances

5.6.1 Load cases for calculation of clearances

(ncpt **GB.1 Calculation of clearances to support**

For extreme wind conditions the 50-year return period shall be used. For normal electrical clearances, the 3-year return values shall be used. These can be approximated by the application of a value of γ_v of 0,75, applied to the 50-year return wind speed and ice thickness values. For wind with ice clearances the method of calculation shall be defined in the Project Specification. For clearances using design Approach 3, the method of calculation shall be defined in the Project Specification.

5.6.3 Wind load for determination of electric clearances

(ncpt) **GB.1 Wind load for determination of electric clearances**

For clearances using design Approach 3, the method of calculation shall be defined in the Project Specification.

5.6.4 Ice load for determination of electric clearances

(ncpt) **GB.1 Ice load for determination of electric clearances**

For clearances using design Approach 3, the method of calculation shall be defined in the Project Specification.

5.6.5 Combined wind and ice loads

(ncpt) **GB.1 Combined wind and ice loads**

For clearances using design Approach 3, the method of calculation shall be defined in the Project Specification.

5.8 Internal clearances within the span and at the top of support

(ncpt) **GB.1 Internal clearances within the span and at the top of the support**

The value of K_1 and the method of calculation shall be defined in the Project Specification (ncpt) **GB.2 Phase separation**

For all structures designed according to Approach 1, phase separation shall be sufficient to prevent clashing of conductors under 3 year return climatic loadings. The maximum differences in wind loading, ice loading, and conductor temperature that should be assumed between adjacent conductors shall be specified in the Project Specification.

For wood pole lines designed using Approach 3 with conductors exceeding 35mm² copper equivalent area, the conductor spacing shall comply with the requirements set out in EATR 111 based on the "weather zone" applicable to that area. A weather zone is a geographical area in which the likely mean wind pressure and absolute maximum ice accretion thickness may be described by a numeral and letter respectively. The wind co-ordinate is described in 190N/m² increments, whilst the ice co-ordinate is measured in 10mm diametric thickness increments for each letter increment (A = 10mm, B = 20mm, etc.).

The gust and lull wind pressures shall be 1,832 and 0,546 times the mean wind pressure respectively. The minimum spacing to avoid conductor clash shall be the worst combination of wind and ice, expressed as a straight line between the wind and ice axes, allowing for a withstand factor of 1,10.

Maps of weather zones, shown in 100m increments of elevation above mean sea level, are reproduced as Figures NA.3 – NA.7 inclusive in this NNA.
For wood pole lines at Normal altitudes, the minimum recommended phase separation is defined by weather zone "2B", whilst for lines at High altitude, the minimum recommended phase separation is defined by weather zone "3C". Greater phase separations may be required due to the effect of funnelling or for altitudes greater than 500m. Details of such requirements will be given in the Project Specification.

For lines on wood poles having conductor sizes up to and including 35mm² copper equivalent area, the phase spacing requirements will be detailed in the Project Specification.

For lines having supports other than wood poles, the requirements of BSEN 50341-1 shall apply.

5.9 External clearances

5.9.1 General

(A-dev) **GB.1 External clearances**

Table 5.10/GB.1 Minimum height above ground of overhead lines (Electricity Safety, Quality and Continuity Regulations 2002 and Northern Ireland 2012)

Nominal voltage	Minimum height above ground, m (see Note)
Not exceeding 33 000 volts:	
a) Over roads accessible to vehicular traffic	5,8
b) All other situations	5,2
Exceeding 33 000 volts but not exceeding 66 000 volts	6,0
Exceeding 66 000 volts but not exceeding 132 000 volts	6,7
Exceeding 132 000 volts but not exceeding 275 000 volts	7,0
Exceeding 275 000 volts but not exceeding 400 000 volts	7,3
Note: The minimum height above ground of any overhead line shall be calculated at the maximum likely temperature of the line conductors. Minimum external clearances shall be defined in the Project Specification but shall not be less than those specified above.	

5.9.4 External clearances to crossing traffic routes

(ncpt) **GB.1 Minimum clearances to line crossing roads, railways and navigable waterways**
Minor roads shall be defined in the Project Specification. The temperatures for special load cases shall be 20°C below the maximum temperature defined in the Project Specification.

5.9.6 External clearances to other power lines or overhead telecommunication lines

(ncpt) **GB.1 Other power lines or overhead telecommunication lines**
Overhead line structures will be spaced to prevent a rise of earth potential of the higher voltage line affecting the lower voltage line. Also, the clearances between different overhead line circuits, either on the same structure or on adjacent separate structures, may be increased to allow safe working on one line circuit with the other circuit remaining live. Details of required circuit separation distances will be given in the Project Specification.

5.9.7 External clearances to recreational areas (playgrounds, sports areas, etc.)

(ncpt) **GB.1 Minimum clearances to recreational areas**
The minimum clearances will be specified in the Project Specification.

5.10 Corona effect

5.10.2 Audible noise

5.10.2.3 Noise limits

(ncpt) **GB.1 Noise limit**
For details of the conductor system required to meet acceptable levels of audible noise refer to the Project Specification.

5.10.3 Corona loss

(ncpt) **GB.1 Corona loss**
This is not normally a design consideration in GB. Where required, the design parameters will be specified in the Project Specification.

5.11 Electrical and magnetic field

5.11.1 Electrical and magnetic fields under a line

(ncpt) **GB.1 Electrical and magnetic fields**
The limiting values for electrical and magnetic fields shall be specified in the Project Specification.

6 EARTHING SYSTEMS

6.2 Ratings with regard to corrosion and mechanical strength

6.2.1 Earth electrodes

(ncpt) **GB.1 Foundations**
Where foundations are made from reinforced concrete, the reinforcing bars shall, where practicable, be connected to the tower leg.

6.4 Dimensioning with regard to human safety

(ncpt) **GB.1 Dimensioning**
The method of calculation shall be given in the Project Specification and where required, palliative measures shall be defined.

(ncpt) **GB.2 Footing resistance**

The target footing resistance shall be 10 Ω or less, if a higher value is acceptable this shall be given in the Project Specification. Lower resistance values may be specified where HV and LV earthing systems are bonded together.

7 SUPPORTS

7.3 Lattice steel towers

7.3.6 Ultimate limit states

7.3.6.1 General

(ncpt) **GB.1 Numerical values**

The numerical values for γ_{M0}, γ_{M1}, γ_{M2} shall all be assigned a partial factor of 1.1

7.3.6.4 Buckling resistance of members in compression

(ncpt) **GB.1 Tower testing**

Sub-clause b) to be replaced as follows:

The method according to the provisions of Annex J.4. This method can be used only if full-scale tests are performed according to 7.3.9, or alternatively, detailed checks of the design and drawings are undertaken by a competent independent design organisation. Where testing is specified in the Project Specification, it will be sufficient to test only one tower from a series providing all towers are designed and detailed in the same organisation using the same methods and subject to the same Quality Assurance procedures. In general, only one set of leg and body extensions need be tested and these should be the tallest which can be accommodated by the test station.

7.4 Steel poles

7.4.5 Structural analysis

(ncpt) **GB.1 Internal forces**

Steel poles shall be designed using second order theory, taking account of “p-delta” effects, unless specified otherwise in the Project Specification.

7.4.6 Ultimate limit states

(ncpt) **GB.1 Design of pole supports**

There shall be no limit on deflection unless specified otherwise in the Project Specification, subject to the following conditions:

1. Structures remain fit for their intended purpose in all respects.
2. Minimum electrical clearances are maintained under a 3-year return climatic loading, or a minimum of a 50-year return climatic loading if an infringement would result in significant risk to human life.
3. Design is based on second order theory, taking account of “p-delta” effects.

Any limit on deflection given in the Project Specification shall apply under 3-year return climatic loading, unless an infringement would result in significant risk to human life, in which case a minimum of a 50-year return value shall be adopted.

7.5 Wood Poles

7.5.1 General

(ncpt) **GB.1 BSEN 1995-1-1**

The design of timber poles shall not consider the requirements BSEN 1995-1-1.

7.5.5 Ultimate limit states

(ncpt) **GB.1 Design of pole supports**

If design Approach 1 is adopted, there shall be no limit on deflection unless specified otherwise in the Project Specification, subject to the following conditions:-

1. The structures remain fit for their intended purpose in all respects.
2. Minimum electrical clearances shall be maintained under a 3-year return climatic loading, or a minimum of a 50-year return climatic loading if an infringement would result in significant risk to human life.
3. Design is based on second order theory taking account of “p-delta” effects.

Under design Approach 1, any limit on deflection given in the Project Specification shall apply under a 3-year return climatic loading, unless an infringement would result in significant risk to human life, in which case a minimum of a 50-year return values shall be adopted.

The total deflection at the pole top under ultimate limit state shall, where required, be specified in the Project Specification in respect of designs to Approach 3.

For a design employing Approach 3, the partial factor of safety γ_m to be applied shall be as specified in Table 4.13.2/ GB.3 in this NNA in respect of timber poles.

(ncpt) **GB.2 Internal forces**

For a design to Approach 1, poles should be designed using second order theory, taking account of “p-delta” effects, unless specified otherwise in the Project Specification.

For a design to Approach 3, the partial safety factor γ_m to be applied for non-guyed timber poles shall be as specified in Table 4.13.2/GB.3 in this NNA. Unless otherwise defined in the Project Specification, non-guyed timber poles shall be designed using first order bending theory only.

(ncpt) **GB.3 Pole straightness**

The allowable out of straightness of a guyed pole is specified as follows: “a straight line drawn from the centre of the tip to the centre of the pole at a point 1,5m from the butt shall lie inside the pole”.

(ncpt) **GB.4 Resistance of members**

Timber poles will normally be fabricated using *Pinus Sylvestris* (Scots Pine) taken from a Norwegian population whose southern boundary lies at a latitude of 55° and extends North to 65° latitude. BSEN 14229 Annex E specifies the following typical minimum characteristic values:

Characteristic modulus of rupture	31,0 N/mm²
Characteristic modulus of elasticity	8 000 N/mm²
Mean modulus of rupture	48,97 N/mm²

Other characteristic values than these may be declared by the manufacturer/ Supplier, but should be supported by tests undertaken in accordance with BSEN 14229. It is recommended that regular sampling, testing and calculation of characteristic values is undertaken (ie. every 10 years) due to the likely effects of global warming.

Where differing species and/ or population is to be employed, this will be detailed in the Project Specification.
The Supplier shall submit evidence as to the appropriate mean and characteristic moduli of rupture and elasticity for any other species/ population which has been agreed to be employed.

7.7 Guyed structures

(ncpt) **GB.1 Design of guyed pole supports**
For design Approach 1, guyed poles shall be designed using second order theory, unless specified otherwise in the Project Specification.

For design Approach 3, the partial safety factors γ_m to be applied for guyed supports shall be as specified in Table 4.13.1/ GB.2 and Table 4.13.2/GB.3 in this NNA depending on design Approach. Unless otherwise defined in the Project Specification, guyed pole supports shall be designed for buckling only.

8. FOUNDATIONS

8.2 Basis of geotechnical design

8.2.2 Geotechnical design

(ncpt) **GB.1 Geotechnical design**
Details of geotechnical design parameters and corresponding partial factors shall be specified in the Project Specification.

(ncpt) **GB. 2 Support/Foundation Interconnection**
Stub angles cast in concrete to form part of the foundation shall be fitted with angle cleats sufficient to transfer the whole of the uplift load into the concrete. In the case of compression loads, the cleats should be designed to take at least 50% of the loads, with the balance taken in bond between the stub and the concrete. The concrete cover to stubs and cleats shall not be less than 100mm.

8.2.3 Design by prescriptive measures

(ncpt) **GB.1 Wood pole foundation design**
Wood pole intermediate structure foundations employing prescriptive measures will be designed to resist transverse bending loads only, whilst angle/ terminal structure foundations will be designed to resist compressive loads only unless otherwise specified in the Project Specification. Planting (or burial) depth will be as detailed in the Project Specification.

The foundation of self-supporting timber poles shall be as detailed in the Project Specification. Depending on the soil conditions encountered, additional sub-soil blocks may be required to assist in providing stability to the structure.

8.2.4 Load tests and tests on experimental models

(ncpt) **GB.1 Loading tests**
Loading tests for pole structures will not generally be required, unless otherwise specified in the Project Specification.

8.4 Supervision of construction, monitoring and maintenance

(ncpt) **GB.1 Construction and installation**
Details of design parameters and corresponding partial factors shall be specified in the Project Specification.

9. CONDUCTOR AND EARTH WIRES

(ncpt) **GB.1 Telecommunication circuits**
For details of telecommunications with cables attached to earth wires or for All Dielectric Self Supporting cables (ADSS), see the Project Specification.

10. INSULATORS

10.10 Characteristics and dimensions of insulators

(ncpt) **GB.1 Inclusion of 28B coupling**

The following are required for **safety** reasons.

In addition to the ratings/sizes included in EN 60305 other designs may be used in the GB and these shall be defined in the Project Specification.

Dimensions of 28 mm coupling

The 28 mm coupling is standardised in the GB, designated as 28B, and has a slimmer ball end and reduced socket height compared to the IEC standard coupling. The two ranges are not interchangeable.

In BS 3288 Part 3: 1989 clauses 9 and 10 dimensions of the GB 28B ball and socket are:

Table 10.10/GB.1 Dimensions of 28B ball and socket

Dimension of pin ball (mm)

d_1	d_2	h_1	r_1	r_2	r_3	r_4
$29^{+0}_{-1,5}$	$50^{+0}_{-1,8}$	$21^{+0}_{-1,7}$	50	100	6,4	$4,5^{+1,5}_{-1,0}$

Dimensions of socket end (mm)

D_1 min	D_2 min	D_3 min	H_1	H_2 min
$31,5^{+2,5}_{0}$	58	58	$23,5^{+2,5}_{0}$	32,5
R_1	**R_3**	**R_4**	**R_5**	**T min**
50	5	5	10	8,7

The corresponding gauge dimensions for both the pin ball and the socket end can be found in BS 3288: Part 3: 1989. The 28B socket end is only used with the appropriate W-security clip. Referring to clause 16 of BS 3288 Part 3: 1989 the dimensions of the hole, in mm, are:

B_1	B_2 min	H_3	L max
17,5	34,5	10,5 ± 0,8	42

Referring to BS 3288 Part 4: 1989 Clause 7 the dimensions, in mm, of the W-clip for the 28B are:

F_1	F_2	F_3	F_4	F_5	F_6	L_1		
22	30	5	19	25	5^{+1}_{0}	83 ± 1,5		
L_2	**L_3**	**L_4**	**L_5**	**R_1**	**R_2**	**R_3 max**	**S**	**T**
15,5	53 ± 1,5	10,5	3	2,5	5	2,5	$2^{+0,2}_{0}$	$8.7^{+0,2}_{0}$

The corresponding gauge dimensions for the W-clip may be found in BS 60372:2004

11 LINE EQUIPMENT – OVERHEAD LINE FITTINGS

11.9 Characteristics and dimensions of insulator fittings

(ncpt) **GB.1 Inclusion of 28B coupling**

(a) Dimensions of 28mm coupling as given in Table 10.10/GB.1
(b) Coupling sizes and mechanical strength

Table 11.9/GB.1 Standard coupling sizes and failing loads

Standard coupling size mm	Mechanical failing load kN
16	80
20	125
24	190
24	300
28B	400

12 QUALITY ASSURANCE, CHECKS AND TAKING-OVER

Part 1 applies without change.

Annex J Angles in lattice steel towers

J.4 Buckling resistance of angles in compression (see 7.3.6.4)

J.4.2 Effective non-dimensional slenderness for flexural buckling

J.4.2.4 Effective non-dimensional slenderness, $\overline{\lambda}_{eff}$

(ncpt) **GB.1 Double angle bracings**
Double angle bracings connected by pack bolts shall be checked for case 1 considering buckling about the Z-Z axis parallel to the plane of the connected flanges. In the event that the gap between the angles exceeds 1.5t, the calculations of buckling strength shall be based on 1.5t.

J.4.3 Slenderness of members

J.4.3.3 Primary bracing patterns

J.4.3.3.1 General

(ncpt) **GB.1 General**
The slenderness ratio λ of primary bracings shall not exceed 200.

For secondary bracings (redundants), if the angle (A) between the bracing and the leg is less than 25 degrees the hypothetical loads shall be multiplied by a factor of 0.42/sinA. As an alternative, a second order analysis shall be undertaken.

J.4.3.3.7 Cross bracing with diagonal corner stays (Figure H.2(b) of EN 1993-3-1 :2006) (ncpt) **GB.1 Bracing with diagonal corner stays (Figure H.2b)**

The method referred to for cross bracings in H.3.7 of BS EN 1993-3-1, may also be adapted for use with K or V (inverted K) bracings which are connected with diagonal corner stays.

J.5 Design resistance of bolted connections (see 7.3.8)

J.5.1 General

(ncpt) Table J.3/ GB.1 Design resistance for individual fasteners subjected to shear and/ or tension

Shear resistance per shear plane:

If the shear plane passes through the unthreaded portion of the bolt:

$F_{v,Rd} = 0{,}6\ f_{ub}\ A / \gamma_{M2}$ or $0{,}95\ f_{yb}\ A / \gamma_{M2}$ whichever is the less

If the shear plane passes through the threaded portion of the bolt:

$F_{v,Rd} = 0{,}6\ f_{ub}\ A_S / \gamma_{M2}$ for classes 4.6 - 5.6 - 6.6 - 8.8

$F_{v,Rd} = 0{,}5\ f_{ub}\ A_S / \gamma_{M2}$ for classes 4.8 - 5.8 - 6.8 - 10.9

Bearing resistance per bolt:

$F_{b,Rd} = \alpha\ f_u\ d\ t\ / \gamma_{M2}$

where, α is the smallest value of:

$\eta_1\ 3$; $\eta_2\ 1{,}20\ (e_1/d_0)$; $\eta_3\ 1{,}85\ (e_1/d_0 - 0{,}5)$; $\eta_4\ 0{,}96\ (P_1/d_0 - 0{,}5)$; $\eta_5\ 2{,}3\ (e_2/d_0 - 0{,}5)$

and η_i are reduction factors

The default value for each η_i is 1, but a smaller (more conservative) value may be defined in the NNA.

The value of α is still valid in the case of bolts layout on two or more rows if P_1, e_1 and e_2 are defined as:

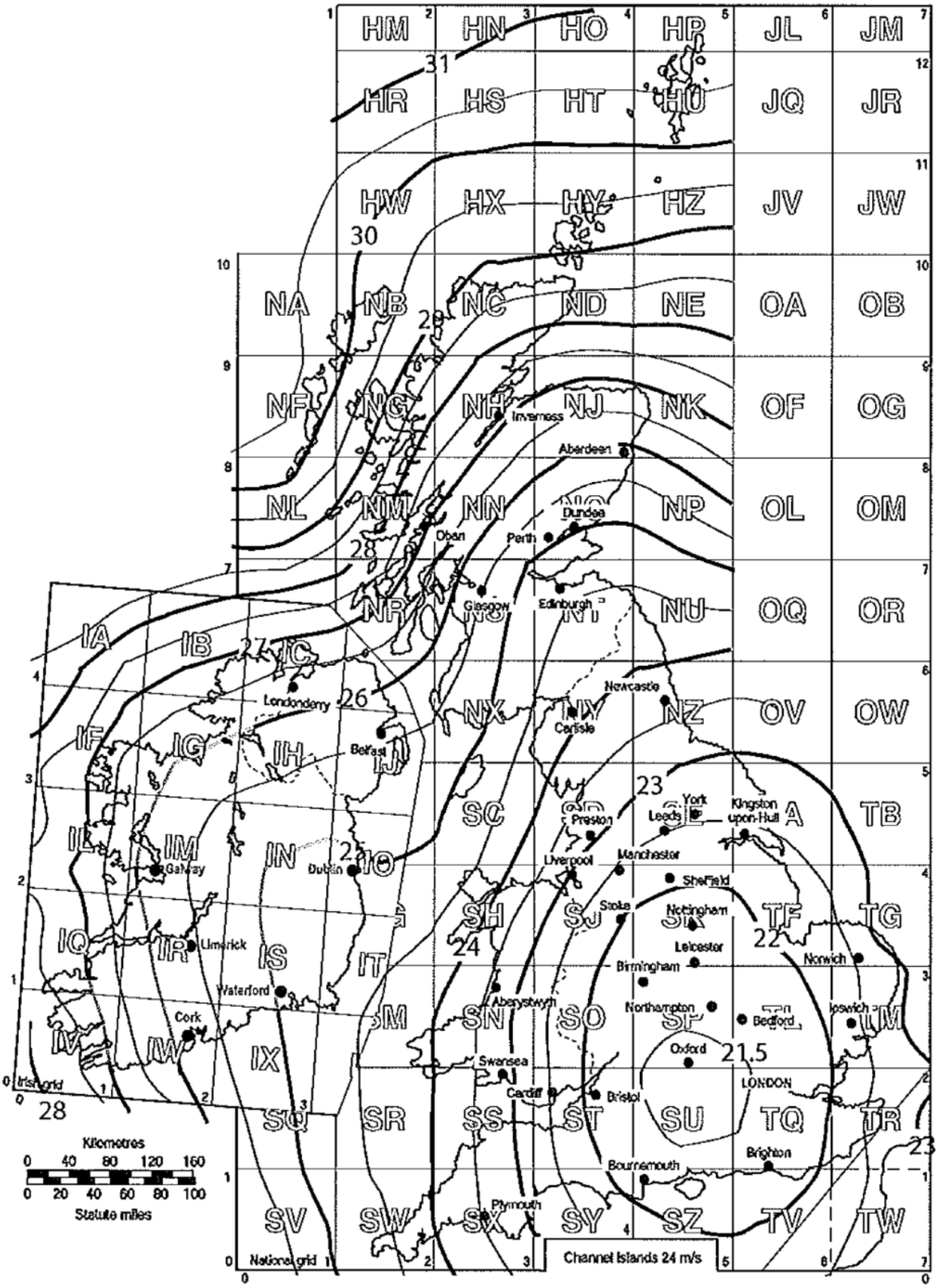
- P_1 is the minimum centre-to-centre distance between two consecutive holes, on the same row;
- e_1 is the minimum distance of the bolt nearest to the end;
- e_2 is the minimum distance of the bolt nearest to the edge.

The design resistance of a group of fasteners may be taken as the sum of the design bearing resistances, $F_{b,Rd}$ of the individual fasteners provided that the design shear resistance, $F_{v,Rd}$ of each individual fastener is greater than or equal to the design bearing resistance, $F_{b,Rd}$. Otherwise, the design resistance of a group of fasteners should be taken as the number of fasteners multiplied by the smallest design resistance of any of the individual fasteners.

Tension resistance per bolt:

$F_{t,Rd} = 0{,}9\ f_{ub}\ A_S / \gamma_{M2}$

f_u	is the ultimate tensile strength
f_{ub}	is the ultimate tensile strength for bolt
f_{yb}	is the yield strength for bolt
A	is the gross cross-section area of bolt
A_S	is the tensile stress area of bolt
d	is the bolt diameter
t, d_0, e_1, e_2, P_1	are as defined in Figure J.6
γ_{M2}	is as defined in 7.3.6.1



NOTE 1 *This map is intended for sites in the United Kingdon, Isle of Man and Channel Islands only.*

NOTE 2 *The isopleths in the Irish Republic are shown for purposes of interpolation only.* A1

Figure NA.1 10-Minute mean wind speeds for GB, $v_{b,\ map}$ in metres per second

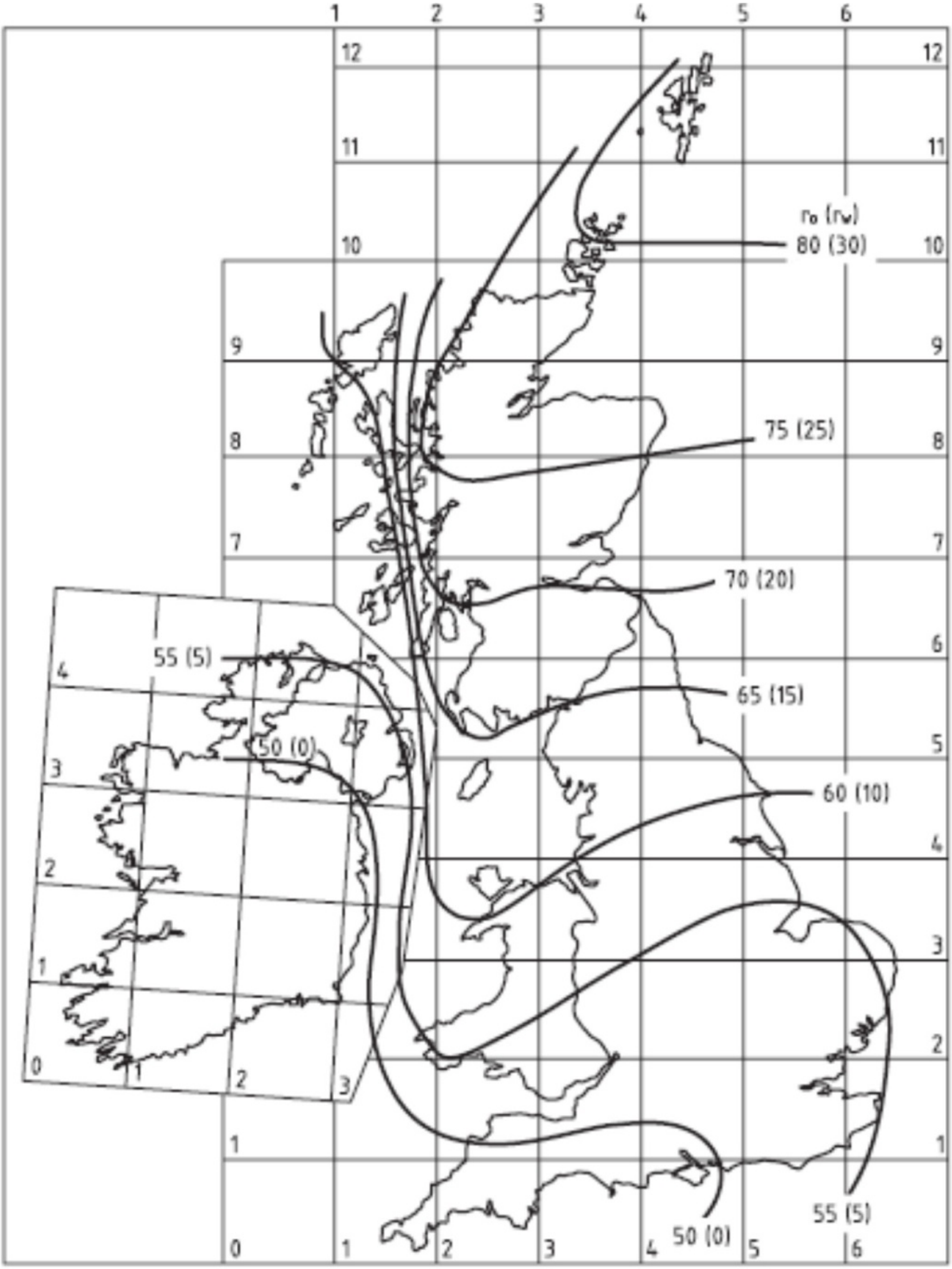


Figure NA.2 Ice thickness for GB, r_o and (r_w) in millimetres

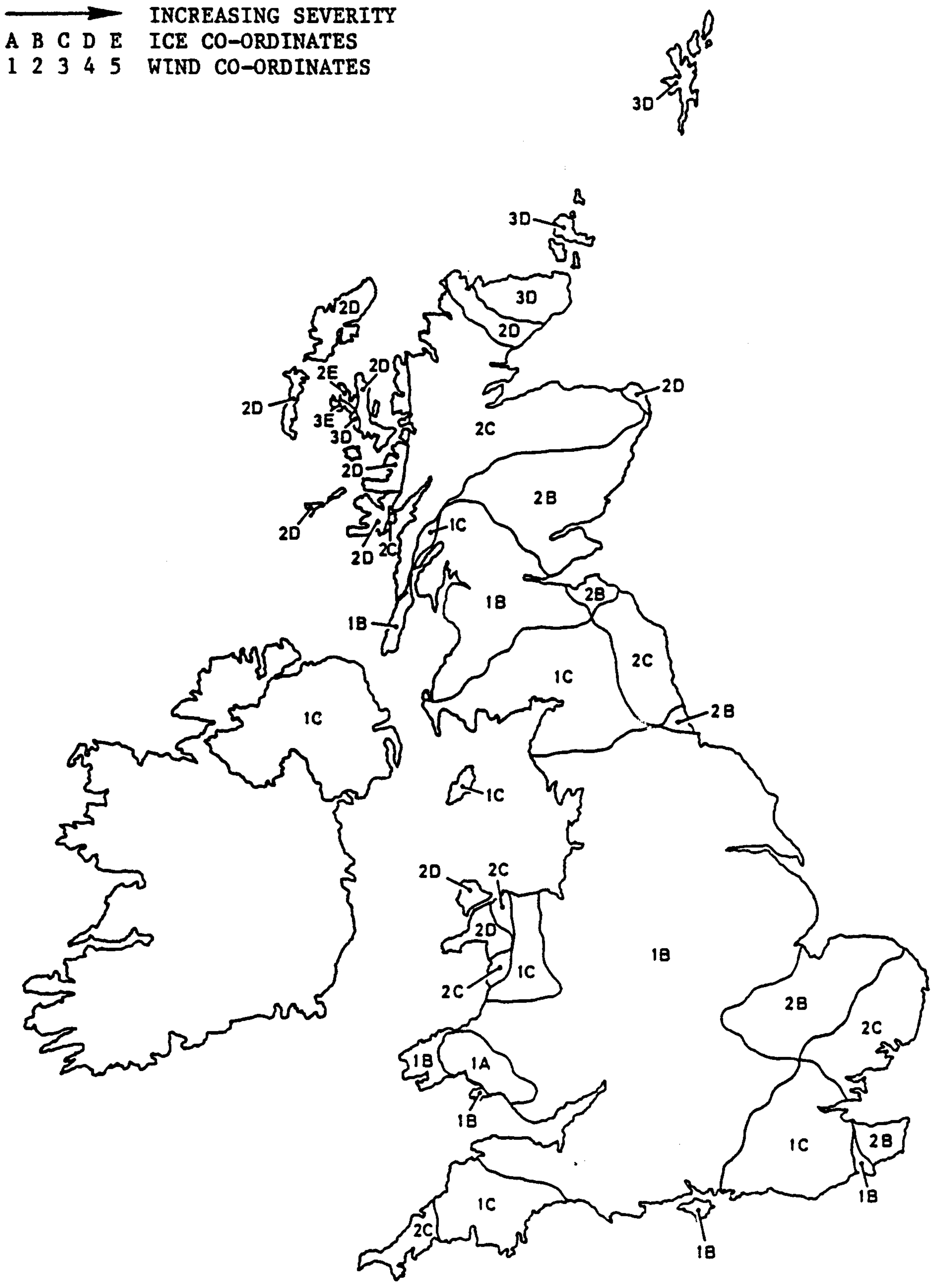


Figure NA.3 Weather Zones for site heights of 0 to 100m

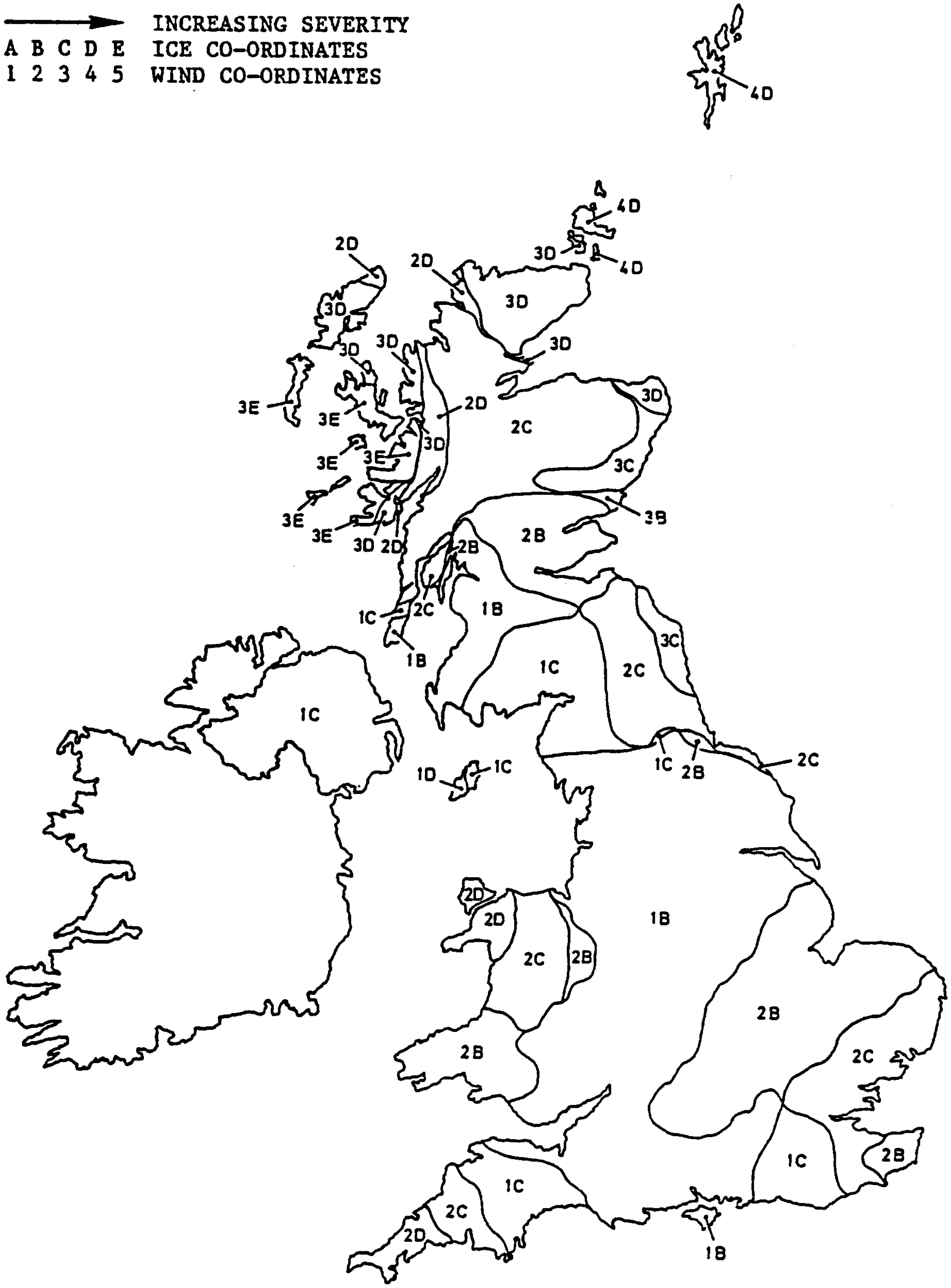


Figure NA.4 Weather Zones for site heights of 100 to 200m

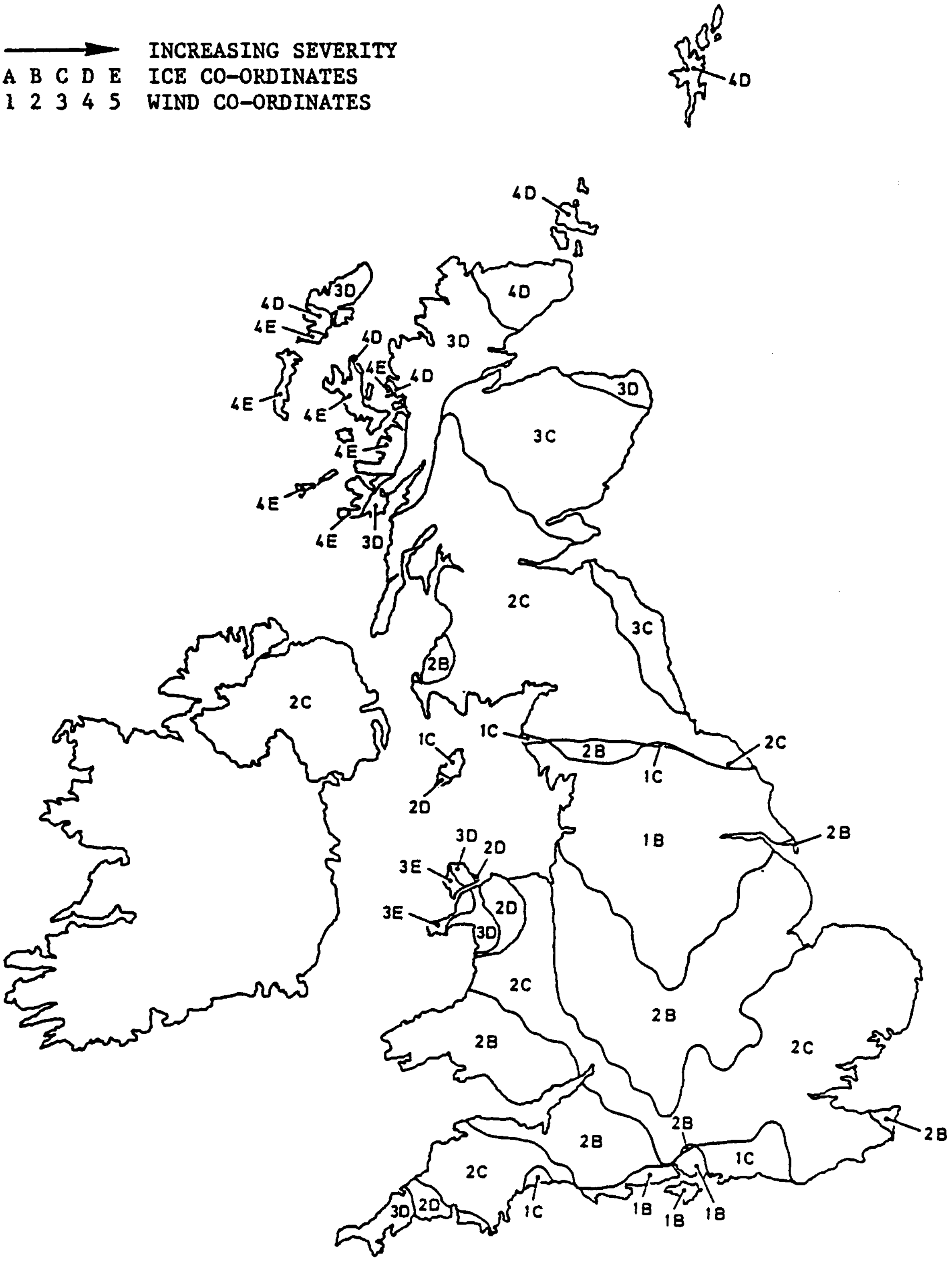


Figure NA.5 Weather Zones for site heights of 200 to 300m

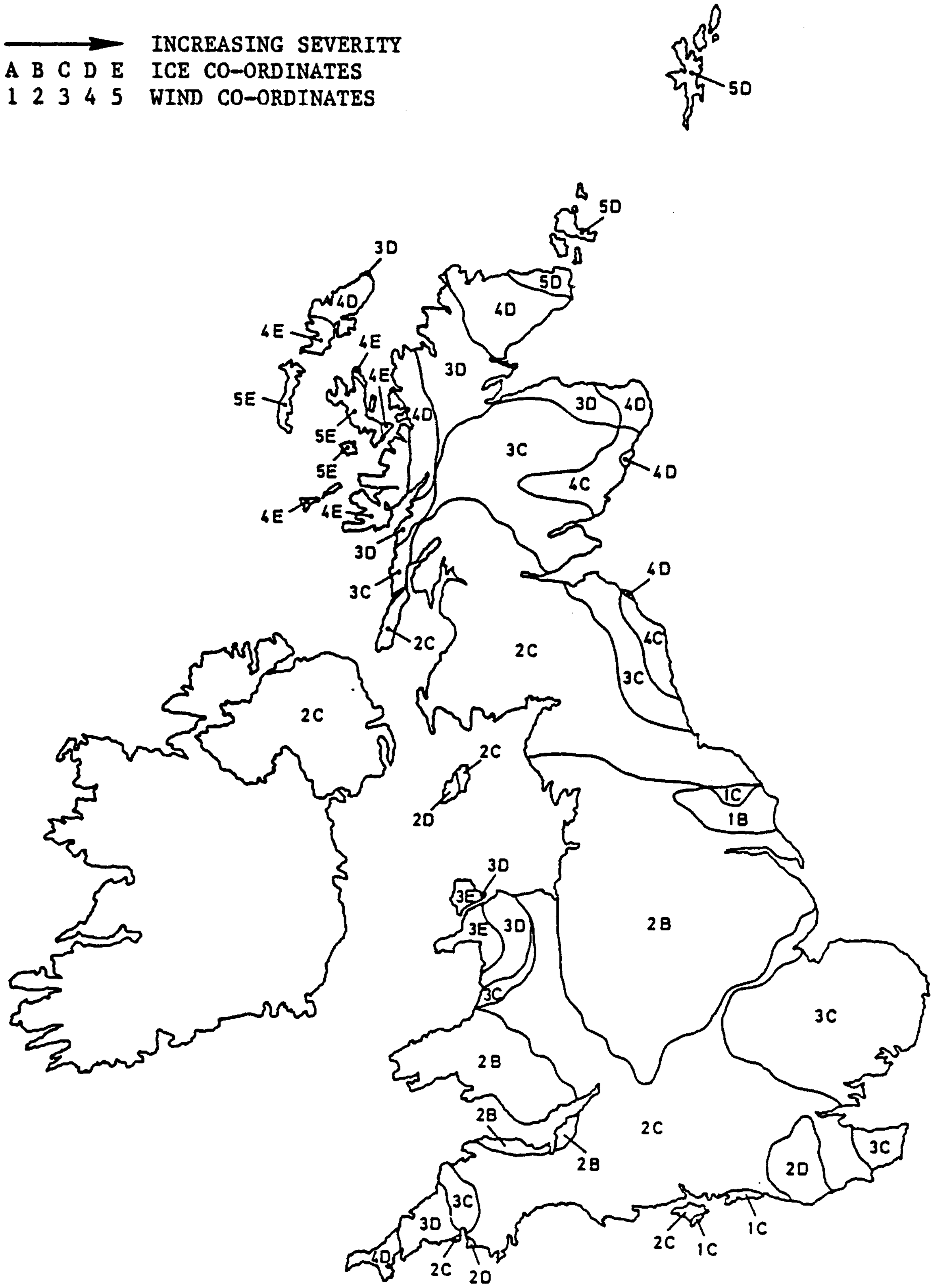


Figure NA.6 Weather Zones for site heights of 300 to 400m

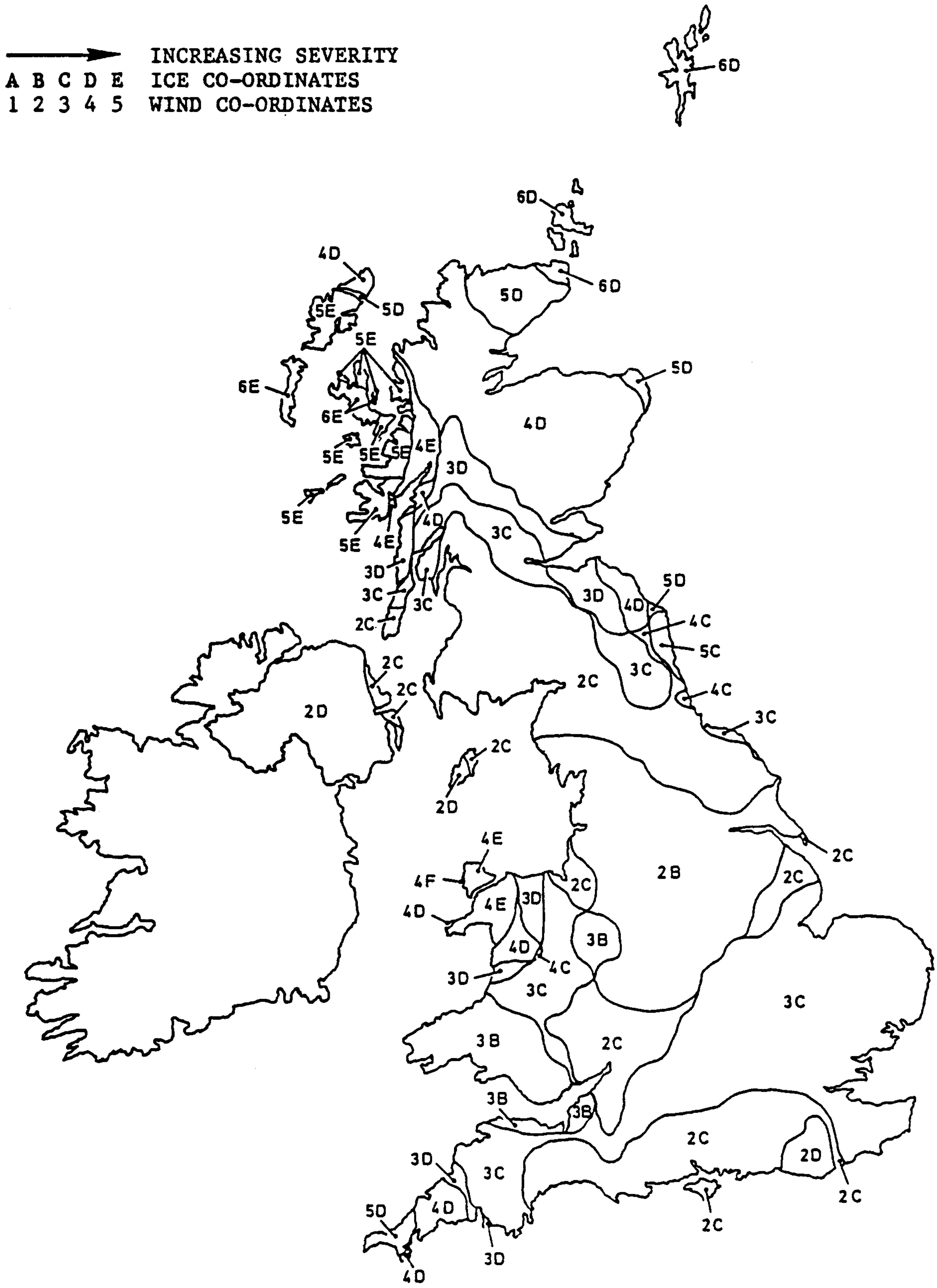


Figure NA.7 Weather Zones for site heights of 400 to 500m

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