

NATIONAL ANNEX

UK National Annex to Eurocode 1 – Actions on structures

Part 1-4: General actions – Wind actions

ICS 91.010.30

Publishing and copyright information

The BSI copyright notice displayed in this document indicates when the document was last issued.

© BSI 2011

ISBN 978 0 580 73818 0

The following BSI references relate to the work on this standard:

Committee reference B/525/1

Draft for comment 06/30152554 DC

10/30232884 DC

Publication history

First published September 2008

Amendments issued since publication

Amd. no.	Date	Text affected
A1	January 2011	See Introduction

Contents

Introduction 1

NA.1 Scope 1

NA.2 Nationally Determined Parameters 2

NA.3 Decision on the status of informative annexes 37

NA.4 Reference to non-contradictory complementary information 37

Annex A (informative) Flowcharts for obtaining q_p 38

~~A1~~ *Advisory note deleted* ~~A1~~ 40

Bibliography 41

List of figures

Figure NA.1 – Value of fundamental basic wind velocity $v_{b,map}$ (m/s) before the altitude correction is applied 5

Figure NA.2 – Definition of significant orography (definition of symbols given in **A.3(3)**) 6

Figure NA.3 – Values of $c_r(z)$ 8

Figure NA.4 – Values of correction factor $c_{r,T}$ for sites in Town terrain 9

Figure NA.5 – Values of $I_v(z)_{flat}$ 11

Figure NA.6 – Values of turbulence correction factor $k_{l,T}$ for sites in Town terrain 12

Figure NA.7 – Values of $c_e(z)$ 13

Figure NA.8 – Values of exposure correction factor $c_{e,T}$ for sites in Town terrain 14

Figure NA.9 – Dynamic factor c_d for various values of logarithmic decrement of structural damping, δ_s 16

Figure NA.10 – Pressure distribution used to take torsional effects into account. The zones and c_{pe} values are given in BS EN 1991-1-4:2005 Table 7.1 and BS EN 1991-1-4:2005 Figure 7.5 17

Figure NA.11 – External pressure coefficients $c_{pe,10}$ for zone A of vaulted roofs for $\theta = 0^\circ$ 25

Figure NA.12 – External pressure coefficients $c_{pe,10}$ for zone B of vaulted roofs 26

Figure A.NA.1 – Flowchart for obtaining q_p for sites in country 38

Figure A.NA.2 – Flowchart for obtaining q_p for sites in town 39

List of tables

Table NA.1 – Directional factor c_{dir} 4

Table NA.2 – Season factor c_{season} 6

Table NA.3 – Size factor c_s for zones A, B and C indicated in Figures NA.7 and Figure NA.8 15

Table NA.4 – Net pressure coefficients for vertical walls of rectangular buildings 18

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 41 and a back cover.

Table NA.5 – External pressure coefficients for flat roofs ($C_{pe,10}$ and $C_{pe,1}$) 20

Table NA.6a) – External pressure coefficients for monopitch roofs ($C_{pe,10}$ and $C_{pe,1}$) 21

Table NA.6b) – External pressure coefficients for monopitch roofs ($C_{pe,10}$ and $C_{pe,1}$) 21

Table NA.7a) – External pressure coefficients for duopitch roofs ($C_{pe,10}$ and $C_{pe,1}$) 22

Table NA.7b) – External pressure coefficients for duopitch roofs ($C_{pe,10}$ and $C_{pe,1}$) 23

Table NA.8 – External pressure coefficients for hipped roofs ($C_{pe,10}$ and $C_{pe,1}$) 24

Table NA.9 – Typical permeability of construction in the UK 26

Table NA.10 – Values of ψ for cylinders, polygonal sections, rectangular sections, sharp edged structural sections and lattice structures 29

Table NA.11 – Values of wind load factor C 32

Table NA.12 – Force coefficient C_{fp} for piers 35

National Annex (informative) to BS EN 1991-1-4:2005, Eurocode 1 – Actions on structures – Part 1-4: General actions – Wind actions

Introduction

This National Annex has been prepared by BSI Subcommittee B/525/1, *Actions (loadings) and basis of design*. In the UK it is to be used in conjunction with BS EN 1991-1-4:2005.

The start and finish of text introduced or altered by National Amendment No. 1 is indicated in the text by tags **A1** **A1**. Minor editorial changes are not tagged.

National Amendment No. 1 has been made to reflect Amendment No. 1 to BS EN 1991-1-4:2005.

NA.1 Scope

This National Annex gives:

- a) the UK decisions for the Nationally Determined Parameters or alternative procedures in the following clauses of BS EN 1991-1-4:2005:
- | | |
|--------------------------------|----------------------------|
| – 1.1 (11) Note 1 | A1 – 7.2.4 (1) |
| – 1.5 (2) | – 7.2.4 (3) |
| – 4.1 (1) | – 7.2.5 (1) |
| – 4.2 (1)P Note 2 | – 7.2.5 (3) |
| – 4.2 (2)P Notes 1, 2, 3 and 5 | – 7.2.6 (1) |
| – 4.3.1 (1) Notes 1 and 2 | – 7.2.6 (3) |
| – 4.3.2 (1) | – 7.2.7 |
| – 4.3.2 (2) | – 7.3 (6) A1 |
| – 4.3.3 (1) | – 7.2.8 (1) |
| – 4.3.4 (1) | – 7.2.9 (2) |
| – 4.3.5 (1) | – 7.2.10 (3) Notes 1 and 2 |
| – 4.4 (1) Note 2 | – 7.4.1 (1) |
| – 4.5 (1) Note 1 | – 7.4.3 (2) |
| – 4.5 (1) Note 2 | – 7.6 (1) Note 1 |
| – 5.3 (5) | – 7.7 (1) Note 1 |
| – 6.1 (1) | – 7.8 (1) |
| – 6.3.1 (1) Note 3 | A1 – 7.9.2 (2) |
| – 6.3.2 (1) | – Table 7.14 A1 |
| – 7.1.2 (2) | – 7.10 (1) Note 1 |
| – 7.1.3 (1) | – 7.11 (1) Note 2 |
| – 7.2.1 (1) Note 2 | – 7.13 (1) |
| – 7.2.2 (1) | – 7.13 (2) |
| – 7.2.2 (2) Note 1 | – 8.1 (1) Notes 1 and 2 |
| A1 – 7.2.3 (2) | – 8.1 (4) |
| – 7.2.3 (4) A1 | – 8.1 (5) |

- | | |
|--------------------|-----------------------------|
| – 8.2 (1) Note 1 | – E.1.3.3 (1) |
| – 8.3 (1) | – E.1.5.1 (1) Notes 1 and 2 |
| – 8.3.1 (2) | – E.1.5.1 (3) |
| – 8.3.2 (1) | – E.1.5.2.6 (1) Note 1 |
| – 8.3.3 (1) Note 1 | – E.1.5.3 (2) Note 1 |
| – 8.3.4 (1) | – E.1.5.3 (4) |
| – 8.4.2 (1) Note 1 | – E.1.5.3 (6) |
| – A.2 (1) | – E.3 (2) |

- b) the UK decision on the status of BS EN 1991-1-4:2005, informative Annexes A, B, C, D, E and F; and
- c) references to non-contradictory complementary information.

A1 Text deleted A1

NA.2 Nationally Determined Parameters

NA.2.1 Guidance for design of torsional vibrations, bridge deck vibrations, cable supported bridges, higher order modes of vibration [BS EN 1991-1-4:2005, 1.1 (11) Note 1]

No additional guidance is given for torsional vibrations, e.g. for tall buildings with relatively low torsional frequencies and/or a significantly offset shear centre.

For bridge deck vibrations from transverse wind turbulence, the procedures given in background paper PD 6688-1-4 should be used.

For cable supported bridges, no additional guidance on wind actions and response is given in this National Annex.

For buildings and bridges where more than the fundamental transverse or lateral modes need to be considered, specialist advice should be sought.

NA.2.2 Guidance on design assisted by testing and measurements [BS EN 1991-1-4:2005, 1.5 (2)]

NA.2.2.1 Static building structures

Tests for the determination of wind loads on static structures should not be considered to have been properly conducted unless:

- a) the natural wind has been modelled to account for:
 - the variation of mean wind speed with height above ground appropriate to the terrain of the site; and
 - the intensity and scale of the turbulence appropriate to the terrain of the site at a determined geometric scale;
- b) the building has been modelled at a geometric scale not more than the following multiples of the geometric scale of the simulated natural wind, with appropriate corrections applied to account for any geometric scale discrepancies within this range:
 - 3 for overall loads; and
 - 2 for cladding loads;

- c) the response characteristics of the wind tunnel instrumentation are consistent with the measurements to be made;
- d) the tests enable the peak wind loads with the required annual risk of being exceeded to be predicted.

Further guidance on wind tunnel testing can be obtained from *The designer's guide to wind loading of building structures – Part 2: Static structures* [1], *Wind tunnel studies of buildings and structures* [2] and PD 6688-1-4.

NA.2.2.2 Dynamic building structures

Tests for the determination of the response of dynamic structures should not be considered to have been properly conducted unless the provisions for static structures in items a) to d) are satisfied, together with the additional provision that the structural model is represented (physically or mathematically) in mass distribution, stiffness and damping in accordance with the established law of dimensional scaling.

Further guidance on wind tunnel testing can be obtained from references: *The designer's guide to wind loading of building structures – Part 2: Static structures* [1], *Wind tunnel studies of buildings and structures* [2] and PD 6688-1-4.

NA.2.3 National climatic information from which the mean wind velocity and peak velocity pressure may be directly obtained for the terrain categories considered [BS EN 1991-1-4:2005, 4.1 (1) – Note]

See NA.2.17.

NA.2.4 The fundamental value of the basic wind velocity $v_{b,0}$ [BS EN 1991-1-4:2005, 4.2 (1)P Note 2]

The fundamental value of the basic wind velocity $v_{b,0}$ should be determined from Equation NA.1.

$$(NA.1) \quad v_{b,0} = v_{b,map} c_{alt}$$

where

$v_{b,map}$ is the value of the fundamental basic wind velocity before the altitude correction is applied. $v_{b,map}$ is given in Figure NA.1;

c_{alt} is the altitude factor given in NA.2.5.

NA.2.5 Procedure for determining the influence of altitude [BS EN 1991-1-4:2005, 4.2 (2)P Note 1]

The altitude factor c_{alt} should be determined from Equations NA.2a) or NA.2b).

$$(NA.2a)) \quad c_{\text{alt}} = 1 + 0,001 \cdot A \quad \text{for } z \leq 10 \text{ m}$$

$$(NA.2b)) \quad c_{\text{alt}} = 1 + 0,001 \cdot A \cdot (10/z)^{0.2} \quad \text{for } z > 10 \text{ m}$$

where

A is the altitude of the site in metres above mean sea level;

z is either z_s as defined in BS EN 1991-1-4:2005 Figure 6.1 or z_e the height of the part above ground as defined in BS EN 1991-1-4:2005 Figure 7.4.

NOTE Equation NA.2a) may be used conservatively for any building height.

Where there is significant orography, as defined by the shaded zones in Figure NA.2, A should be taken as the altitude of the upwind base of the orographic feature for each wind direction considered.

NA.2.6 Directional factor, c_{dir} [BS EN 1991-1-4:2005, 4.2 (2)P Note 2]

The directional factor c_{dir} is given in Table NA.1.

Table NA.1 Directional factor c_{dir}

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 within Table NA.1.

NOTE 2 The directions are defined by angles from due North in a clockwise direction.

NOTE 3 Where the wind loading on a building is assessed only for orthogonal load cases, the maximum value of the factor for the directions that lie $\pm 45^\circ$ either side of the normal to the face of the building is to be used.

NOTE 4 Conservatively, c_{dir} may be taken as 1,0 for all directions.

Figure NA.1 Value of fundamental basic wind velocity $v_{b,map}$ (m/s) before the altitude correction is applied

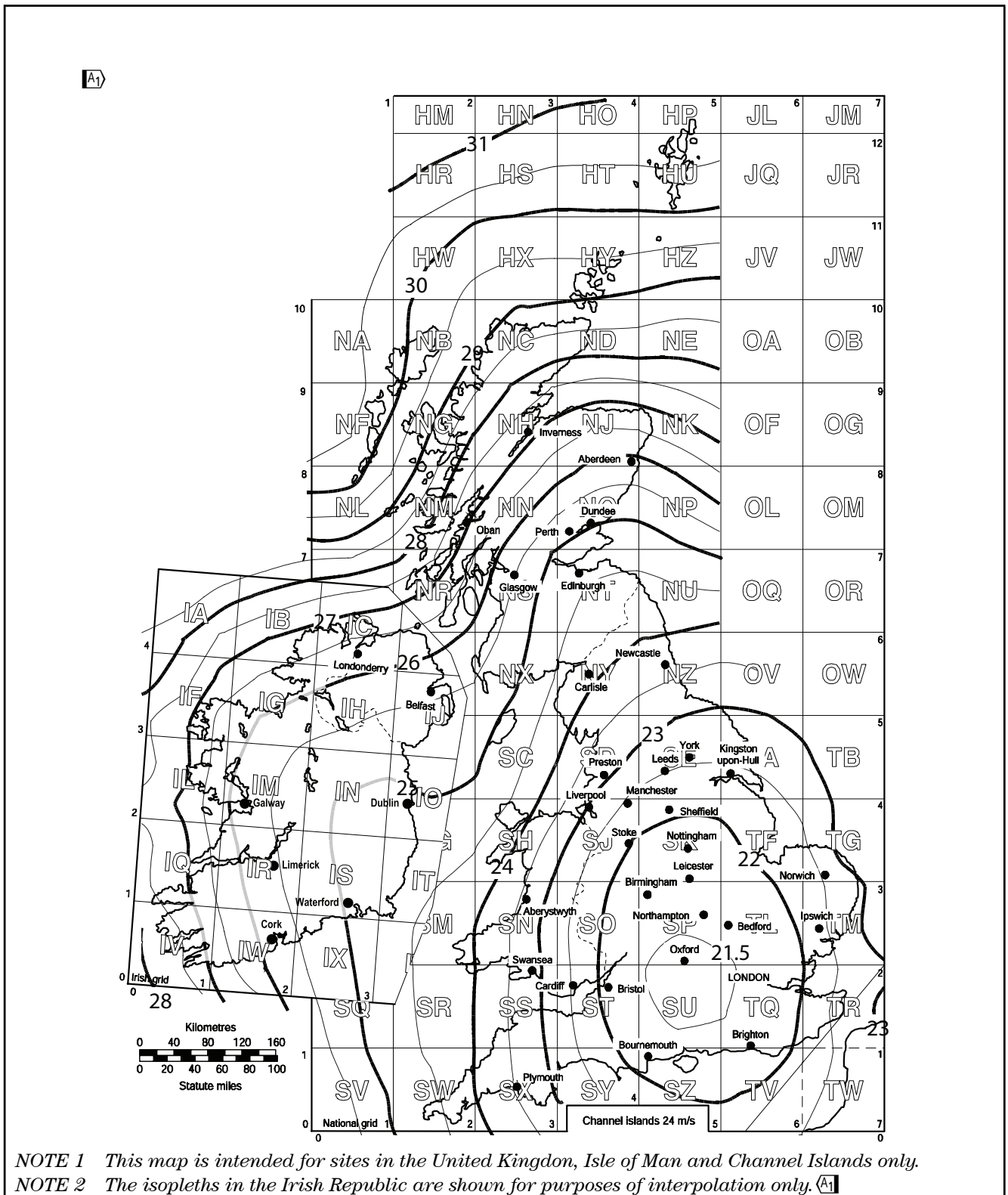
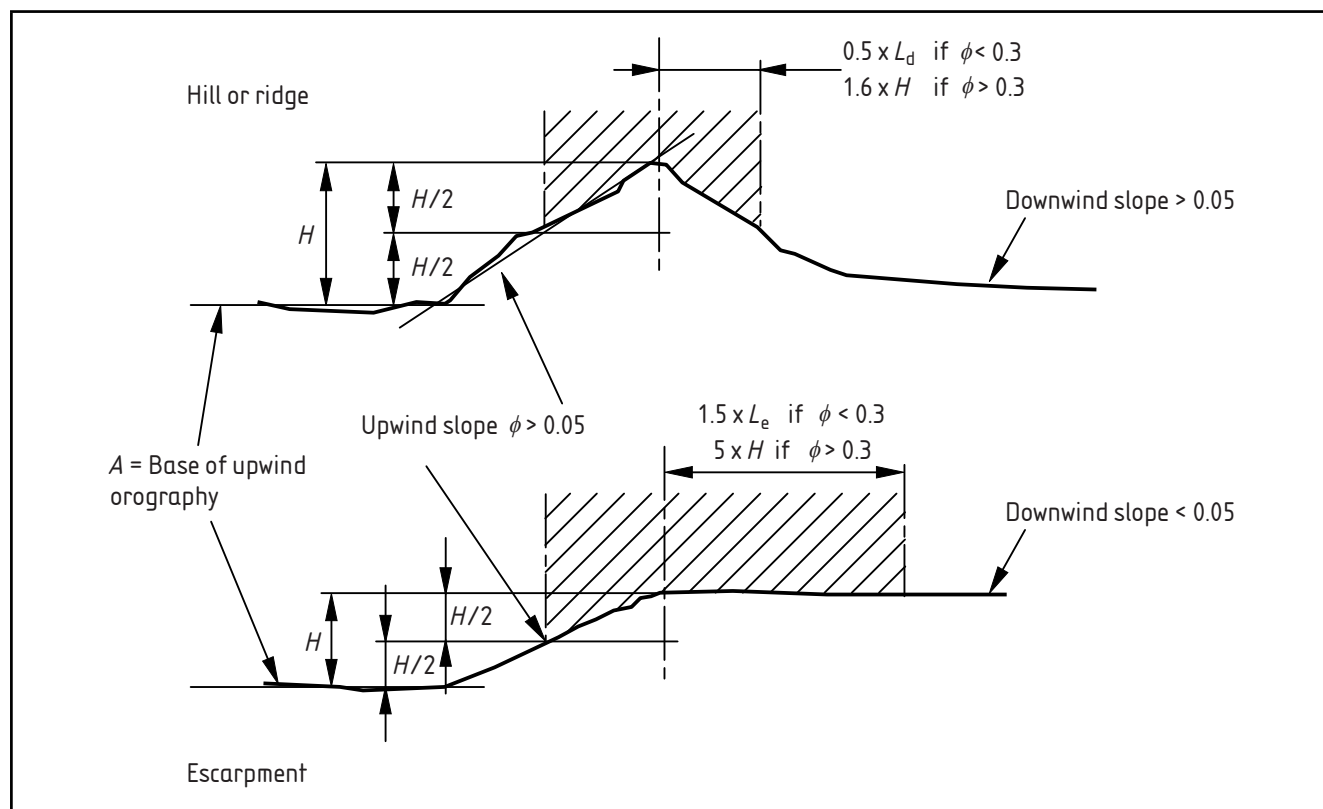


Figure NA.2 Definition of significant orography (definition of symbols given in A.3(3))



NA.2.7 Season factor, c_{season} [BS EN 1991-1-4:2005, 4.2 (2)P Note 3]

The season factor c_{season} is given in Table NA.2.

Table NA.2 Season factor c_{season}

Months	1 month	2 months	4 months
January	0,98	0,98	
February	0,83	0,86	0,98
March	0,82	0,83	0,87
April	0,75	0,75	0,83
May	0,69	0,71	0,76
June	0,66	0,67	0,73
July	0,62	0,71	0,83
August	0,71	0,82	0,86
September	0,82	0,85	0,90
October	0,82	0,89	0,96
November	0,88	0,95	1,00
December	0,94	1,00	1,00
January	0,98	0,98	1,00
February	0,83	0,86	
March	0,82		

NOTE 1 The factor for the six month winter period October to March inclusive is 1,00 and for the six month summer period April to September inclusive is 0,84.

NOTE 2 These factors provide the 0,02 probability of exceedence for the period given.

NA.2.8 Values of K and n used to determine the probability factor**[BS EN 1991-1-4:2005, 4.2 (2)P Note 5]**

The recommended values of shape factor $K = 0,2$ and exponent $n = 0,5$ are to be used.

NA.2.9 Orography factor $c_o(z)$ **[BS EN 1991-1-4:2005, 4.3.1(1) Note 1]**

The recommended procedure given in BS EN 1991-1-4:2005 A.3 should be used.

NA.2.10 Design charts for $v_m(z)$ **[BS EN 1991-1-4:2005, 4.3.1(1) Note 2]**

Design charts for $v_m(z)$ are not provided.

NA.2.11 Procedure for determining the roughness**factor $c_r(z)$ [BS EN 1991-1-4:2005, 4.3.2 (1)]**

BS EN 1991-1-4:2005 Expressions (4.4) and (4.5) do not apply.

The classification of roughness categories has been simplified to give the following three terrain categories:

- Terrain category 0 is referred to as Sea;
- Terrain categories I and II have been considered together to give a single terrain category referred to as Country terrain;
- Terrain categories III and IV have been considered together to give a single terrain category referred to as Town terrain.

All inland lakes extending more than 1 km in the direction of wind and closer than 1 km upwind of the site should be treated as Sea.

The roughness factor $c_r(z)$ depends on upwind distance to sea and additionally on the distance upwind to the edge of the urban area for sites in Town terrain.

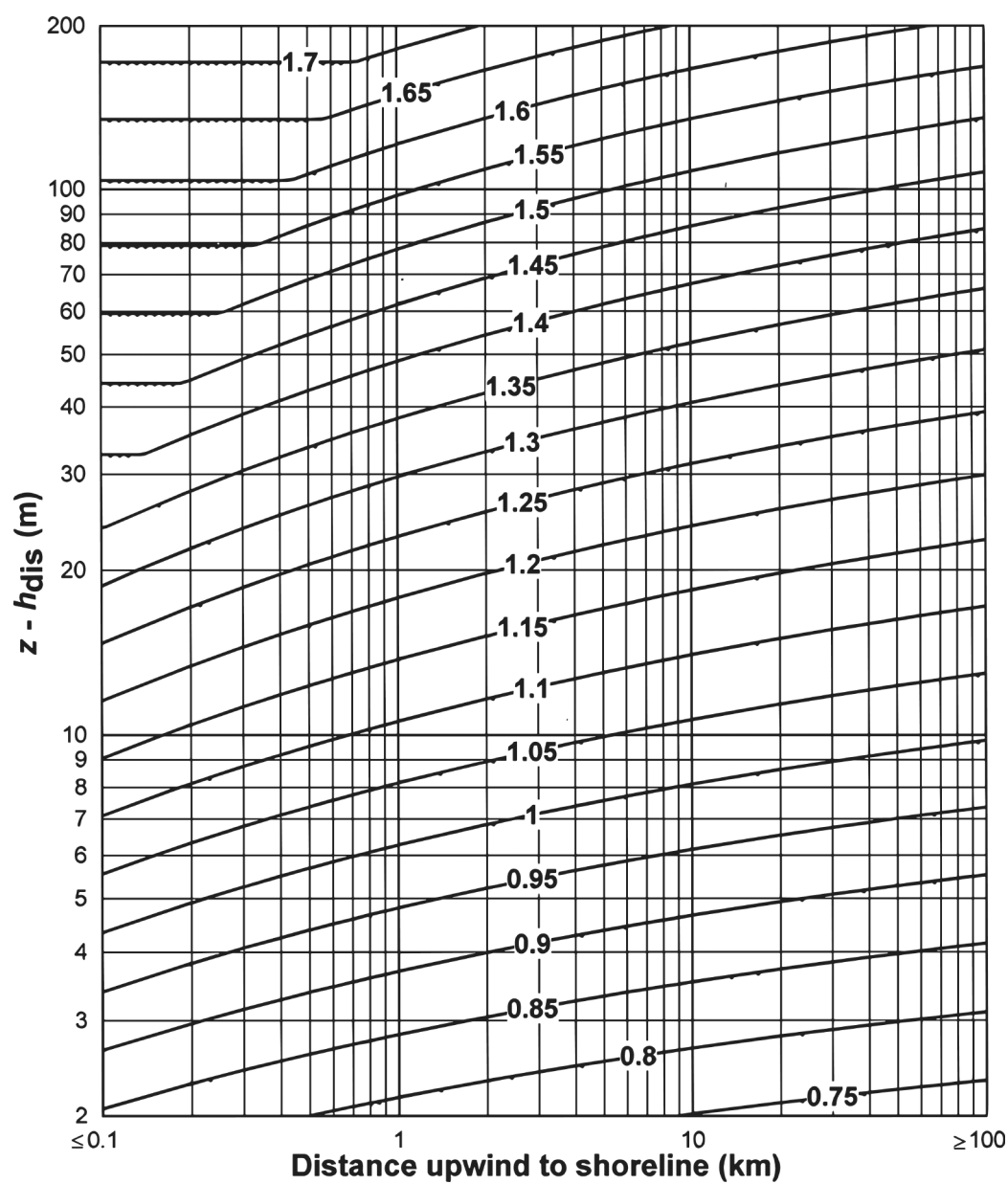
For sites in Country terrain, the roughness factor $c_r(z)$ given in Figure NA.3 should be used.

For sites adjacent to Sea terrain (sea or large inland lakes), the distance upwind from the shoreline should be taken as 0,1 km.

For sites in Town terrain, the roughness factor $c_r(z)$ given in Figure NA.3 should be multiplied by the roughness correction factor $c_{r,T}$ for Town terrain given in Figure NA.4.

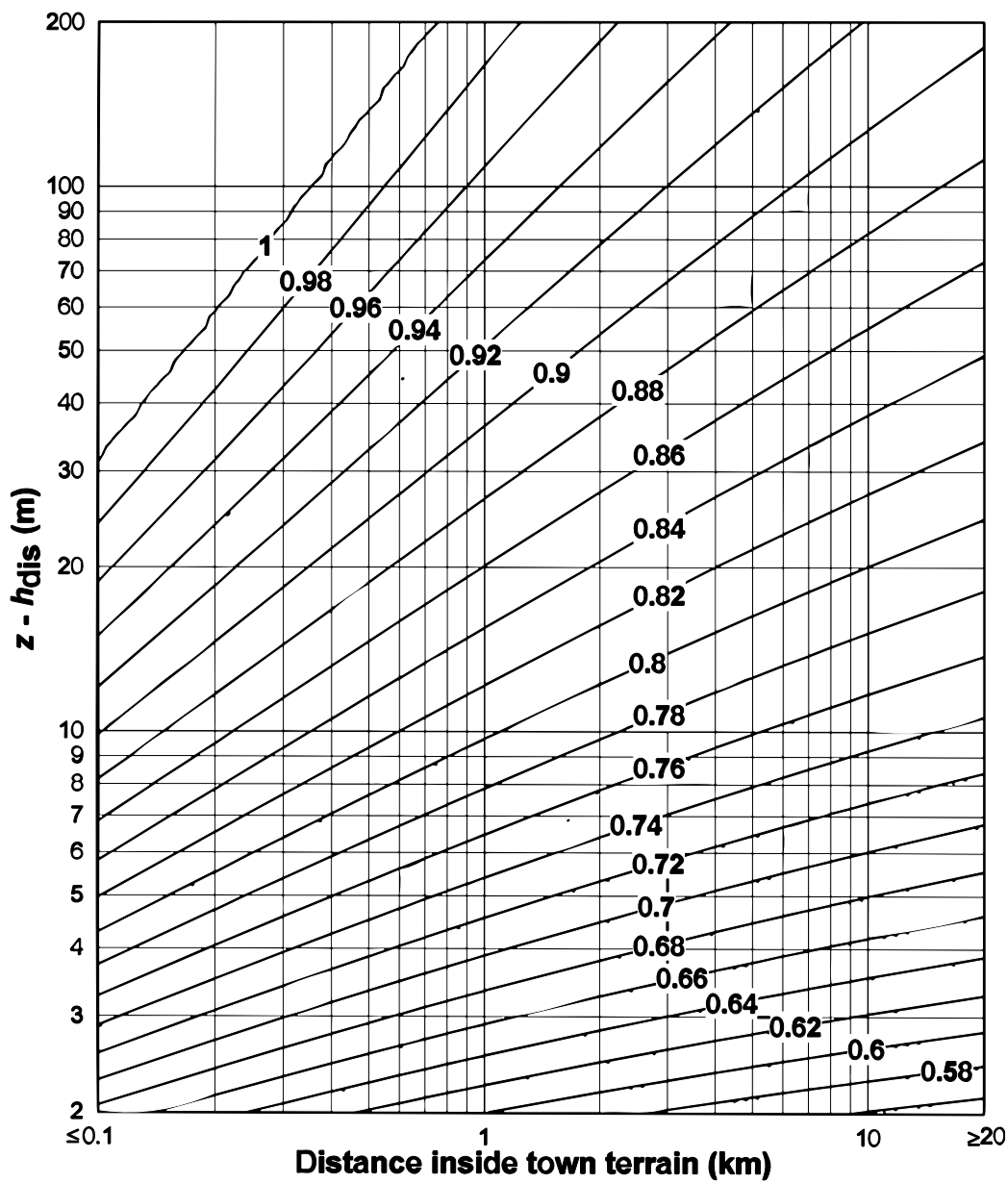
NOTE The appropriate value of h_{dis} is to be used in Figure NA.3 and Figure NA.4. For sites in Country terrain, $h_{dis} = 0$. For sites in Town terrain, h_{dis} is given by BS EN 1991-1-4:2005 A.5.

Figure NA.3 Values of $c_r(z)$



NOTE The height z is the height at which v_m is sought.

Figure NA.4 Values of correction factor $c_{r,T}$ for sites in Town terrain



NOTE 1 The height z is the height at which v_m is sought.

NOTE 2 Sites less than 0.1 km inside Town boundary should be treated as being in country terrain.

NA.2.12 Procedure for determining the angular sector and upstream distance for the assessment of terrain roughness [BS EN 1991-1-4:2005, 4.3.2 (2) Note]

The recommended value of the angular sector should be used.

The recommended value of upstream distance in BS EN 1991-1-4:2005 A.2 should not be used. Procedures given in this National Annex implicitly take into account the upstream distances of terrain and terrain changes.

**NA.2.13 Procedure for determining the orography factor
[BS EN 1991-1-4:2005, 4.3.3 (1)]**

The recommended procedure in BS EN 1991-1-4:2005 **A.3** should be used for sites that lie in the shaded zones shown in Figure NA.2. Outside of these zones, the orography factor may be taken as 1,0 or can be calculated. When the orography factor is taken as 1,0, the altitude A should be taken as the site altitude.

**NA.2.14 Effect of large and considerably taller
neighbouring structures
[BS EN 1991-1-4:2005, 4.3.4 (1)]**

The recommended procedure in BS EN 1991-1-4:2005 **A.4** may be used.

**NA.2.15 Effect of closely spaced buildings and obstacles
[BS EN 1991-1-4:2005, 4.3.5 (1)]**

The recommended procedure in BS EN 1991-1-4:2005 **A.5** may be used.

**NA.2.16 Determination of the turbulence factor k_I
[BS EN 1991-1-4:2005, 4.4 (1) Note 2]**

Values for turbulence factor k_I on its own are not given. It is incorporated in a new term $I_v(z)_{\text{flat}}$.

$I_v(z)_{\text{flat}} = k_I / \ln((z - h_{\text{dis}})/z_0)$, values of which are given in Figure NA.5.

Where orography is not significant as defined by

Figure NA.2: $I_v(z) = I_v(z)_{\text{flat}}$ for sites in Country terrain; and

$I_v(z) = I_v(z)_{\text{flat}} k_{I,T}$, for sites in Town terrain. $k_{I,T}$ is the turbulence correction factor for Town terrain, values of which are given in Figure NA.6.

Where orography is significant, the value obtained from Figure NA.5 should be divided by the orography factor c_o .

*NOTE The appropriate value of h_{dis} to be used in Figure NA.5 and Figure NA.6. h_{dis} is defined in BS EN 1991-1-4:2005 **A.5**.*