Ineqarnermut, Attaveqaasersuutinut Isorliunerusunullu Naalakkersuisoqarfik
Ministry of Housing, Infrastructure and Outlying Districts

EN 1991-1-4 GL NA:2026

National Annex to
Eurocode 1: Actions on structures –
Part 1-4: General actions – Wind actions

Foreword

This Greenlandic National Annex (GL NA) replaces EN 1991-1-4 GL NA:2025.

This Annex is based on DS/EN 1991-1-4 DK NA:2024.

Scope

This Annex is adapted to geographical and climatic conditions as well as national legislation and specifies how EN 1991-1-4:2007 including corrigenda and amendments are to be applied in Greenland.

The Annex provides Greenlandic national choices and complementary information. For any complementary information, it is specified whether it is normative or informative. Normative information comprises requirements to be followed.

The numbering in the Annex refers to the numbering in EN 1991-1-4:2007 or DS/EN 1991-1-4 DK NA:2024.

Overview of Greenlandic national choices and complementary information

Clause	Subject	Change
Section 4	Velocity pressure – return periods	Complementary information Informative
4.2(1)P NOTE 2	Fundamental value of the basic wind velocity	National choice
4.2(2)P NOTES 1, 2, 3, and 5	Directional factor, seasonal factor and return period	National choice
4.3.2 (1)	Terrain roughness	National choice
4.5(1) NOTE 1	Characteristic minimum velocity pressure	National choice
4.5(1) NOTE 2	Air density	National choice
5.3 (5)	Lack of correlation	National choice
6.2(1)	Determination of structural factor	National choice
6.3.1(1) NOTE 3	Procedure for determining the dynamic response	National choice
6.3.2(1)	Determination of displacements and accelerations	National choice
7.2.2(3)	Vertical walls of rectangular plan buildings	National choice
7.2.3(4)	Pressure coefficients – flat roofs	National choice
7.2.9(6) NOTE 2	Internal pressure – without a dominant face	Complementary information Informative
7.2.10(3) NOTE 2	Wind pressure on walls or roofs with more than one skin	National choice
7.9.3 Table 7.14	Force coefficients for vertical cylinders in a row arrangement	National choice
A.2 (1)	Transition between roughness categories	National choice
E.1.3.3(1)	Air density	National choice
E.1.5.1(1) NOTES 1 and 2	Choice between procedures 1 and 2	National choice
E.1.5.1(3)	Choice between procedures 1 and 2	National choice
E.1.5.2.6(1) NOTE 1	Number of load cycles – fatigue loads	National choice
E.1.5.3(2) NOTE 1	Air density	National choice

E.1.5.3(4)	Influence of turbulence intensity	National choice
Simplified rules (1)-(7), 7.2.2(3) and Annex A-E	Simplified rules for buildings with heights up to 20 m	Complementary information, Normative
Appendix 1	The fundamental value of the basic wind velocity and directional factors	Complementary information, Normative
Appendix 2	Characteristic peak velocity pressure for buildings with heights up to 20 m	Complementary information, Normative
Appendix 3	Indicative characteristic peak velocity pressure for buildings with heights up to 20 m and fundamental value of the basic wind velocity for locations not covered by Appendix 2	Complementary information, Informative

National choices

4.2 (1)P Note 2 Fundamental value of the basic wind velocity

The fundamental value of the basic wind velocity, $v_{b,0,50}$, for a 50-year return period for selected locations is given in Appendix 1.

For the design of buildings in locations not listed in Appendix 1, an agreement should be made with the building authority on the determination of the fundamental value of the basic wind velocity.

NOTE 1: The fundamental value of the basic wind velocity may be determined by statistical analyses of meteorological measurements for the location concerned.

NOTE 2: Where sufficient data are unavailable to determine the fundamental value of the basic wind velocity, this value may be determined on the basis of the complementary information in Annex 3.

4.2(2)P Note 1, 2, 3 and 5 Directional factor, seasonal factor and return period

The characteristic peak velocity pressure is determined based on a return period of 50 years. Values for selected locations are given in Appendix 1.

The directional factor, c_{dir}, for selected locations is given in Appendix 1.

For the design of buildings in locations not listed in Appendix 1, an agreement should be made with the building authority on the determination of the directional factor, c_{dir}. Where sufficient data are unavailable to determine the directional factor, this value should be taken as 1,0.

The seasonal factor, c_{season}, should be taken as 1,0.

When determining the characteristic peak velocity pressure of secondary structures, a return period of 10 years may be applied, and the fundamental value of the basic wind velocity in Appendix 1 should then be multiplied by the probability factor $c_{prop,10}$.

The probability factor, $c_{prop,10,}$ may be approximated to 0,9.

NOTE 1 – Secondary structures are members which do not contribute to the overall dissipation of horizontal and vertical loads to the ground, e.g. non-loadbearing internal and external walls, claddings, roofing, and windows.

NOTE 2 – Directional factor, seasonal factor, and probability factor may be determined by statistical analyses of meteorological measurements for the location concerned.

4.3.2 (1) Terrain roughness

The recommended method for determining the roughness factor at height z is given by expression (4.4).

4.5(1) NOTE 1 Peak velocity pressure

For any wind direction, the characteristic peak velocity pressure determined according to 4.2(2) shall not be less than 0,8 kN/m^2.

4.5(1) Note 2 Air density

The air density, ρ, is taken as 1,28 kg/m^3.

5.3(5) Lack of correlation
The effect of the lack of correlation between the external and internal wind pressures may be taken into account when determining the wind forces.

6.2 Determination of structural factor, $c_s c_d$
For verification of the overall stability, Section 6 is omitted, and the structural factor, $c_s c_d$, may be taken as 0,8.

NOTE – The structural factor takes account of the following conditions:
- The non-simultaneous occurrence of wind pressures on the surfaces of the structure.
- The non-simultaneous occurrence of windward pressures and leeward suction of the structure.
- Highly fluctuant and very brief wind loads result in less load effect on the structure than a static wind load of the same magnitude over longer periods of time.

6.3.1(1) Note 3 Procedure for determining the dynamic response
The procedure given in Annex C is applied.

6.3.2(1) Determination of displacements and accelerations
The procedure given in Annex C is applied.

Wind pressure coefficients for buildings
7.2.2(3) Vertical walls of rectangular plan buildings – deleted.

7.2.3(4) Pressure coefficients – flat roofs
The pressure coefficient for zone I of -0,2 is changed to -0,5.

7.2.10(3) Note 2 Wind pressure on walls or roofs with more than one skin
Add after the last sentence of the first indent ("–"): "For zones denoted "A" in Figure 7.5, the pressure coefficient stated for the permeable outer skin may underestimate the wind force. This wind force is not underestimated if the pressure coefficient is taken as -0,9."

7.9.3 Table 7.14 Force coefficients for vertical cylinders in a row arrangement
Table 7.14 may underestimate the wind force for a/b < 2,5.

A.2(1) Transition between roughness categories
Procedure 1 should be applied.

E.1.3.3(1) Note Air density
See 4.5(1) NOTE 2.

E.1.5.1(1), Notes 1 and 2, Choice between procedures 1 and 2
Procedure 2 should be applied.

E.1.5.1(3) Choice between procedures 1 and 2
Procedure 2 should be applied.

E.1.5.2.6 (1), Note 1, Number of load cycles – fatigue loads
For structures where the characteristic maximum displacement determined according to E.1.5.3 of EN 1991-1-4:2007 is less than approx. 10 % of the cross-wind dimension of the structure, the fatigue actions may be determined by means of E.1.5.3 of EN 1991-1-4:2007 using the constants C_c and K_a as stated below.

The dependence of the constant C_c of the wind velocity ratio $v_m / v_{crit,i}$, where v_m is the 10 minute mean wind velocity, and $v_{crit,i}$ is the resonance wind velocity, is determined approximately by:

$$C_c = C_c(tableE.6)\left(\frac{v_m}{v_{crit,i}}\right)^{3/2} exp\left[-\frac{1}{2}\left(\frac{1-v_{crit,i}/v_m}{B}\right)^2\right]$$

$C_c(tableE.6)$ is given in Table E.6 of EN 1991-1-4:2007, and B may approximately be taken as $B = 0{,}1$. The 10-minute wind velocity, v_m, and the resonance wind velocity, $v_{crit,i}$, should be determined at the height above terrain where the movement of the structure is at its maximum.

The movement of the structure is not underestimated if the dependence of the aerodynamic damping constant, K_a, of the wind velocity ratio, $v_m / v_{crit,i}$, and the turbulence intensity, I_v, is determined by the following simplified and approximated expression:

$$K_a = K_{a,\max} h(I_v) g\left(\frac{v_m}{v_{crit,i}}\right)$$

The function, $h(I_v)$, is defined in E.1.5.3 (4) below. The function, g, has its largest value equal to 1 for $v_m = v_{crit,i}$, and is assumed to decrease linearly from the value 1 to the value 0 for $v_m = 2v_{crit,i}$. g is assumed to be 0 for $v_m < v_{crit,i}$ and $v_m > 2v_{crit,i}$.

For wind over a terrain of a roughness length between approx. 0,01 m and approx. 0,05 m, the frequencies of the different turbulence intensities can be approximated on the basis of a normal distribution using the mean value given in 4.4 (1) of EN 1991-1-4:2007, and a deviation decreasing gradually from approx. 0,06 at mean wind velocities smaller than approx. 5 m/s to approx. 0,03 for mean wind velocities of approx. 10 m/s. In this connection, the probability mass of the normal distribution for negative arguments should be taken to correspond to a turbulence intensity of 0.

For fatigue analyses based on the specifications stated above, the coefficient of variation of the fatigue loads should be taken as 30 % when the partial factor is determined, see EN 1990 GL NA:2024.

E.1.5.3(2) Note 1 Air density
See 4.5(1) Note 2.

E.1.5.3(4) Influence of turbulence intensity
The effect of rhythmic vortex shedding depends on the turbulence intensity of the wind. For 10-minute mean wind velocities larger than approx.15 m/s, the turbulence intensity of the wind is

determined using 4.4 (1) of EN 1991-1-4:2007. For 10-minute wind velocities smaller than approx. 10 m/s, consideration should be given to rhythmic vortex shedding in turbulence free wind which occurs under certain, relatively rare meteorological conditions.

The movement of the structure is not underestimated if the dependence of the aerodynamic damping constant, K_a, of the turbulence intensity, I_v, is determined by the following simplified and approximated expression:

$$K_a(I_v) = K_{a,\max} h(I_v)$$

where $K_{a,\max}$ is given in Table E.6 of EN 1991-1-4:2007. The function h is determined from $h(I_v) = 1 - 3I_v$ for $0 \le I_v \le 0{,}25$ and $h(I_v) = 0{,}25$ for $I_v > 0{,}25$. The turbulence intensity, I_v, is determined at the height above ground with the largest movement of the structure.

Complementary information

Normative

Simplified rules for buildings with heights up to 20 m

For buildings with heights up to 20 m, and where the wind fetch is not in terrain category 0 of the compass directions, cf. Appendix 1, where the directional factor, $c_{dir,}$ is 1, other provisions of EN 1991-1-4, Sections 4 and 6, may be disregarded, and the following simplified rules can applied instead.

NOTE: For coastal buildings where the directional factor, $c_{dir,}$ is 1 for wind directions, and the terrain category is 0, the wind force is determined according to the usual rules of Sections 4-6 in EN 1991-1-4 .

Velocity pressure rules for buildings with heights up to 20 m.

Section 4 is omitted and replaced by the following:

(1) The peak velocity pressure, $q_{p,}$ is determined independently of height above ground and directional factor.

NOTE – The terrain conditions are often so uneven that it is generally not possible to let wind velocities and peak velocity pressures vary with the height above ground and direction in a consistent manner.

(2) The characteristic peak velocity pressure is determined based on a return period of 10 years. Values for selected locations in terrain category II are given in Appendix 2.

For the design of buildings in locations not listed in Appendix 2, an agreement should be made with the building authority on the determination of the characteristic peak velocity pressure.

NOTE: Where sufficient data are unavailable to determine the peak velocity pressure, determination of the values may be supported by the complementary information in Annex 3.

(3) The characteristic peak velocity pressure for secondary structures is determined based on a return period of 2 years. Values for selected locations in terrain category II are given in Appendix 2.

For the design of buildings in locations not listed in Appendix 2, an agreement should be made with the building authority on the determination of the characteristic peak velocity pressure for secondary structures.

NOTE 1 – For a definition of secondary structures: see note 2 to 4.2(2)P.

NOTE 2 – Where sufficient data are unavailable for the determination of the characteristic peak velocity pressure for secondary structures, the complementary information of Appendix 3 can support this determination, as the peak velocity pressure values of Appendix 3 can be multiplied by a factor 0,8.

(4) Characteristic velocity pressures determined according to (2) and (3) may be corrected for the terrain conditions by multiplication by a terrain factor, c_{tk}, which depends on the roughness of the terrain. c_{tr} is given in Table 4.1a GL NA.

Table 4.1a GL NA Terrain factor, c_{tr}

Terrain category		Terrain factor, c_{tr}
0	Sea or coastal area exposed to the open sea	1,3
I	Lakes or flat and horizontal area with negligible vegetation and without obstacles	1,2
II	Area with low vegetation such as grass and isolated obstacles with separations of at least 20 obstacle heights (e.g. buildings and small bedrock formations).	1,0
III	Area with regular cover of vegetation or buildings or with isolated obstacles with separations of maximum 20 obstacle heights (such as villages, suburban terrain, permanent forest, and hilly bedrock formations).	0,8

NOTE: The terrain categories are illustrated in EN 1991-1-4: 2007, Annex A, A.1.

(5) The characteristic peak velocity pressure determined according to (2)-(4) shall not be less than 0,8 kN/m^2.

Wind forces for buildings with heights up to 20 m.
Section 5 applies, as

(6) The peak velocity pressures $q_p(z_e)$ and $q_p(z_{in})$ comprise the peak velocity pressure defined above, irrespective of height.

Structural factor for buildings with heights up to 20 m.
Section 6 is omitted and replaced by the following:

(7) By verification of the overall stability, the structural factor, $c_s c_d$, can be taken as 0,8.

NOTE – The structural factor takes account of the following conditions:

- The non-simultaneous occurrence of wind pressures on the surfaces of the structure.
- The non-simultaneous occurrence of windward pressures and leeward suction of the structure.
- Highly fluctuant and very brief wind loads result in less load effect on the structure than a static wind load of the same magnitude over longer periods of time.

Wind pressure coefficients for buildings with heights up to 20 m
7.2.2(3) Vertical walls of rectangular plan buildings – deleted.

Other simplifications for buildings with heights up to 20 m.
Annexes A – E are not applicable.

Complementary information

Informative

Section 4 Peak velocity pressure – return periods

For the determination of characteristic peak velocity pressures, the return periods of Table 4.1b GL NA are used.

Table 4.1b GL NA Return periods for the determination of characteristic peak velocity pressures

Structures	Return period	
	Buildings with heights >= 20 m	Buildings with heights < 20 m
Main structures	50 years (provision 4.2(1)P)	10 years (Simplified rules for buildings with heights up to 20 m, provision (2))
Secondary structures	10 years (Provision 4.2(2)P)	2 years (Simplified rules for buildings with heights up to 20 m, provision (3))

7.2.9(6) Note 2. Internal pressure – without a dominant face

At the end of Note 2 after ".. more onerous of +0,2 and -0,3", the following is added: "In this case, partitions can be taken as a wind action corresponding to the pressure coefficient 0,4 due to pressure variations in the rooms separated by the partitions."

Appendix 1 – The fundamental value of the basic wind velocity and directional factor

Place	Basic wind velocity Fundamental value, $v_{b,0,50}$ [1)] [m/s]	Directional factor, c_{Dir}, [2)]							
		N 0º	NE 45º	E 90º	SE 135º	S 180º	SW 255º	W 270º	NW 315º
Aasiaat	31	0,7	0,8	0,8	0,9	1	0,9	0,8	0,8
Ilulissat	28	0,7	0,8	1	1	0,9	0,8	0,7	0,7
Ittoqqortoormiit	47	0,9	1	0,8	0,7	0,7	0,7	0,7	0,7
Kangerlussuaq	24	0,7	0,8	0,9	1	1	1	0,9	0,8
Maniitsoq	38	0,7	0,7	0,8	1	0,9	0,7	0,7	0,7
Nanortalik	34	0,8	1	0,8	0,9	0,7	0,9	1	0,9
Narssaq	44	0,7	0,8	1	0,8	0,7	0,7	0,7	0,7
Nuuk	39	0,7	0,7	0,9	1	1	0,8	0,7	0,7
Paamiut	31	0,8	0,9	1	1	0,8	0,7	0,7	0,8
Qaanaaq	44	0,7	1	0,7	0,7	0,7	0,7	0,7	0,7
Qaqortoq	44	0,8	1	0,8	0,7	0,7	0,7	0,7	0,7
Qeqertarsuaq	26	0,9	0,8	1	0,8	0,8	0,9	1	0,9
Sisimiut by Sisimiut Airport	37	0,9 0,7	0,7 1	0,8 1	0,7 0,8	1 0,7	0,9 0,7	0,8 0,8	0,9 0,8
Tasiilaq	50	0,7	0,7	0,7	0,7	0,7	0,8	1	0,9
Upernavik	40	0,7	0,7	0,7	0,7	0,9	1	0,9	0,63
Uummannaq/Qaarsut	30	0,7	0,7	0,9	0,9	1	1	0,9	0,9

NOTE 1: The fundamental value of the basic wind velocity, $v_{b,0,50,}$ valid for a return period of 50 years.
NOTE 2: Directional factor, $c_{Dir,}$ applies in a sector of 45 degrees centered around indicated direction.

Appendix 2 – Characteristic peak velocity pressure for buildings with heights up to 20 m.

Place	Characteristic peak velocity pressure[1)] for buildings with heights up to 20 m [kN/m^2]	Characteristic peak velocity pressure[2)] for secondary structures with heights up to 20 m [kN/m^2]
Aasiaat	1,2	0,9
Ilulissat	1,0	0,8
Ittoqqortoormiit	2,6	2,0
Kangerlussuaq	0,8	0,8
Maniitsoq	1,6	1,0
Nanortalik	1,4	1,0
Narssaq	2,5	2,1
Nuuk	1,9	1,5
Paamiut	1,1	0,8
Qaanaaq	2,1	1,3
Qaqortoq	2,4	1,8
Qeqertarsuaq	0,8	0,8
Sisimiut	1,5	1,1
Tasiilaq	2,8	1,8
Upernavik	1,8	1,3
Uummannaq/Qaarsut	1,1	0,8

NOTE 1: Assumptions: Terrain category II, height above ground z = 10m, return period 10 years, air density: 1,28 kg/m^3.
NOTE 2: Assumptions: As Note 1; however, a return period of 2 years.
NOTE 3: Characteristic peak velocity pressure in the Table is taken as minimum 0,8 kN/m^2 corresponding to 'Simplified rules for buildings with heights up to 20 m', provision (5).

Complementary information
Informative

Appendix 3 – Indicative characteristic peak velocity pressure for buildings with heights up to 20 m and fundamental value of the basic wind velocity.

Place (alphabetical order)[1)]	Indicative characteristic peak velocity pressure for buildings with heights up to 20 m [kN/m^2][2)]	Indicative basic wind velocity Fundamental value, $v_{b,0,50}$[3)] [m/s]
Aappilattoq (Nanortalik)	1,6	36
Aappilattoq (Upernavik)	1,6	36
Arsuk	1,6	36
Alluitsup Paa	1,2	31
Ammassivik	2,4	44
Attu	1,2	31
Eqalugaarsuit	1,6	36
Ikamiut	1,6	36
Igaliku	1,6	36
Ikerasassuaq	2,4	44
Isortoq	1,6	36
Kangaamiut	1,6	36
Kangaatsiaq	1,2	31
Kangerluarsoruseq	1,6	36
Kangerluarsunnguaq	1,6	36
Kangerluk	1,2	31
Kangersuatsiaq	1,6	36
Kangilinnguit	1,6	36
Kapisillit	1,6	36
Kulusuk	2,4	44
Kuummiut	1,6	36
Maarmorilik	1,8	38
Moriusaq	1,6	36
Narsaq Kujalleq	1,6	36
Narsarsuaq	2,4	44
Nuussuaq	1,6	36
Pituffik Space Base	1,6	36
Qasigiannguit	1,6	36

Qassiarsuk	1,6	36
Qassimiut	1,6	36
Qeqertag	1,6	36
Saqqaq	1,6	36
Qeqertarsuatsiaat	1,6	36
Sarfannguit	1,6	36
Sermiligaaq	1,6	36
Siorapaluk	2,4	44
Tasiusaq	1,2	31
Tiniteqilaaq	2,4	44
Ukkusissat	1,6	36
Remaining places: Daneborg Danmarkshavn Kangaarsuk Mestervig Siggit Simiutaq Station Nord Timmiarmiut	 1,6 1,6 1,6 1,6 1,6 1,6 1,6 1,6	36

NOTE 1 – The Table includes places given in "*Forskrift for last på konstruktioner" (Regulation on actions on structures),* Bygge- og Anlægsstyrelsen (Agency for Building and Construction works), Home Rule of Greenland, 1995, and which are not provided in Appendix 1 and Appendix 2.
NOTE 2 – Values as provided in "*Forskrift for last på konstruktioner",* see Note 1.
NOTE 3 – The fundamental value of the basic wind velocity for a 50-year return period, $v_{b,0,50}$, is determined on the basis of indicative characteristic peak velocity pressures with the following assumptions: terrain category II, height above ground z = 20 m, and air density = 1,28 kg/m^3 as well as a return period of 10 years corresponding to a probability factor of 0,9.