# European Guideline

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# Protection of buildings against wind damage

CFPAEUROPE


## FOREWORD

The European fire protection associations produce common guidelines in order to achieve similar interpretation in the European countries and to give examples of acceptable solutions, concepts and models. The Confederation of Fire Protection Associations in Europe (CFPA E) has the aim to facilitate and support fire protection work in the European countries.

The market imposes new demands for quality and safety. Today fire protection forms an integral part of a modern strategy for survival and competitiveness.

The guideline concerns the protection of buildings against wind damage.

This guideline has been produced by Referent Schadenverhütung -Sachversicherung Gesamtverband der Deutschen Versicherungswirtschaft e. V.and the author is Dr.-Ing Mingyi Wang from Germany.

This Guideline has been compiled by Guidelines Commission and adopted by all fire protection associations in the Confederation of Fire Protection Associations Europe.

These guidelines reflect best practice developed by the countries of CFPA Europe. Where the guidelines and national requirement conflict, national requirements must apply.

Copenhagen, November 2013
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Key words: Storm, wind damage, building, construction, protection measures, loss prevention

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## 1 Introduction

This present publication continues the new series of guideline of CFPA Europe on protect against natural hazards.

The wind movements by a storm can damage buildings and structures significantly, due to their very high speed and enormous energy. With the help of proper planning, construction techniques and continuous monitoring and maintenance, both the probability of occurrence and the extent of storm damage can be reduced.

## 2 Scope

In this publication, references to prevent and limit storm damage are systematically described, particularly with regard to building and its constructional components, so as to allow building owner and operators, manufacturers, planners, professional staff for construction work and facility management services to be supported in their actions.

## 3 Definitions

**Storm**: A weather-related air flow, which exceeds the strength of the Beaufort scale 8 (62 – 74 km/h). *[Note: The definition of storm in European countries may be different]*

**Table 1 Beaufort Scale und wind speed**

| Wind intensity (Beaufort Scale) | Wind speed | |
|---|---|---|
| | m/s | km/h |
| 0 | 0,0 < 0,3 | 0 - 2 |
| 1 | 0,3 < 1,6 | 2 - 5 |
| 2 | 1,6 < 3,4 | 6 - 11 |
| 3 | 3,4 < 5,5 | 12 - 19 |
| 4 | 5,5 < 8,0 | 20 - 28 |
| 5 | 8,0 < 10,8 | 29 - 38 |
| 6 | 10,8 < 13,9 | 39 - 49 |
| 7 | 13,9 < 17,2 | 50 - 61 |
| 8 | 17,2 < 20,8 | 62 - 74 |
| 9 | 20,8 - < 24,5 | 75 - 88 |
| 10 | 24,5 < 28,5 | 89 - 102 |
| 11 | 28,5 < 32,7 | 103 - 117 |
| 12 | ≥ 32,7 | ☐ 117 |

**Tornado**: Tornadoes (over land) or waterspouts (over water) are large vortices with a vertical axis, mostly ranging from the edge of a thunderstorm cloud to the ground. Tornadoes are usually classified according to the 6-level Fujita scale, which is defined by the maximum wind speeds. In Europe, the 12-level scale Torro is also common.

**Table 2 Classification of the Fujita Scale**

| Scale | Wind speed | |
|---|---|---|
| | m/s | km/h |
| F0 | < 32,5 | 64 – 116 |
| F1 | 32,5 – 50 | 117 – 180 |
| F2 | 50 – 70 | 181 – 253 |
| F3 | 70 – 92,5 | 254 – 332 |
| F4 | 92,5 – 116,5 | 333–418 |

## 4 Responsibilities

All the parties involved in construction are in their particular area of effort responsible for the required safety in the building's use, including

- building owners and operators,
- construction designers and planners,
- construction contractors and workers,
- auditors and inspectors
- construction site manager and
- manufacturers of construction products and systems.

This responsibility is regulated by law in some European countries, e. g. such as the Building Code of the federal states in Germany.

According to the general conditions and terms for the windstorm insurance, each policy-holder is obliged to comply with all statutory, regulatory and contractual regulations for safety.

All of these responsibilities also apply to structural changes, which may not be subject of building permission, for example,

- renovations,
- changes in the roofing materials, such as roof tiles, roofing, metal roofing
- installation of additional roof structures, such as: transmission towers
- installation of solar panels on roofs and façades

For this the static against effects of wind must always be checked and verified.

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## 5 Hazard characteristics and risk potential

The strength of the wind, which can impact on a building and its parts, is substantial depending on the wind flow, the local topographical conditions and adjacent buildings.

By installation of solar panels on the roof or the facade of buildings the wind loads on the building and its constructional components can be altered, resulting from the changes in the external shape of the building, e. g. in case of elevated solar panels. In addition, the fire protection of the roof and the facade can also be affected, because the fixing elements of solar panels fit into the existing structures.

### 5.1 Loss experiences

Due to the prevailing massive building structures in Europe storm damage is mainly recorded in the building envelope, such as roof, windows, and also in peripheral installations.

According to the insurer, some insured objects in recent years have become more vulnerable to storms and other severe weather. The trend is for a change in the ratio of claims to premiums.

There are, among other things, the following reasons:

- Structural changes (additions, special detailed design and state of maintenance by roofs and windows)
- Using of new building materials (metal, glass, and plastic facades, thermal insulation)
- Species, age, height and condition of trees around buildings
- Extension of the insurance coverage (e. g. inclusion of damage to gardens, trees, fences and costs for clearance etc.).

The vulnerability is consequently not a fixed size. It may change over time and lead to adaptation needs in risk assessments. The loss prevention has therefore an important role in reducing the damage.

**Figure 1 After a storm**

**Figure 2 Scaffolding after a winter storm**

## 5.2 Wind loads

Due to the various circulation and pressure effects the design of structures for wind load requires extensive professional expertise by the responsible engineers and architects, as well as the local skilled building workers.

For the design of constructional components, nationally specifications of the local wind loads exist, which are based on meteorological measurements, e. g. height-depending wind speed, and may be possibly summarized in wind load zones.

For structures, which are not susceptible to vibration[1], the national standards, as the basis for design of constructional component contents, usually simplifies assumptions and calculation methods to the complex load making wind for the daily work of designer.

## 5.3 Building-specific hazard characteristics

Buildings built in a prominent position are especially at risk from exceptional wind loads. High altitudes (hills, mountain peaks), slopes and locations on a lake or in open areas are particularly exposed. A building location across a possible wind corridor is also unfavorable. Also at particularly risks from storm hazards are

- buildings that stand out from their environment (e. g. high rack warehouses),
- buildings with irregular shapes, e. g. strongly textured exterior wall or roof surfaces,
- buildings with critical forms that cause flowing effects and associated aerodynamic stresses and
- buildings with critical operating conditions, e. g. open building gates.

[1] As not susceptible to vibrations apply structures e. g. in accordance with DIN 1055 where the deformations under the dynamic effect of the wind forces don't exceed deformations from static wind load by more than 10%.

### 5.4 Vulnerable parts of building

Wind loads can seriously affect constructional components and parts which are installed on the roof or the façade, e. g. antenna, chimneys, solar panels and scaffolding. Also constructional components with low weight are especially at risk from the storm.

### 5.5 Other influences from the neighbourhood by storm

Bare brickwork is particularly vulnerable to storm. This affects not only half-finished walls, but also scaffolding. Also, the material on the site can be tossed around by a storm.

During a storm many hazards also come from trees on the property, especially from overhanging branches, fine roots and rotting. Therefore the trees on the property should be checked preferably twice a year. A professional specialist should be consulted if a reliable assessment of tree condition is only available in this way.

## 6 Storm safety through quality assurance

With protective measures, storm damage can be avoided and limited according to experience, both in terms of the probability of occurrence and the extent of damage. These measures are partly required due to statutory provisions, e. g. in terms of safe design of constructional components for the normalized wind loads and recognized technical rules (See also section 6.2). In addition, other measures can also contribute to loss prevention, which should be taken before or after a storm or when a storm is announced (See also section 7).

### 6.1 Principles

Building structures are designed to withstand a certain wind load as the design load and may only fail when the actual wind load exceeds the design load. They must be planned not only in accordance with the recognized technical rules, but also constructed and maintained in a proper manner.

For roofs the roof form, the format and the material properties of the roofing or waterproofing membrane are also to be considered in this context.

### 6.2 Standardization of the technical rules for planning and construction

For the structural design and static calculations against wind loads European harmonized standards are available:

- EN 1990 "Eurocode: Basis of structural design"
- EN 1991 "Actions on structures" (Eurocode 1), Part 1-4: "General actions – Wind actions"

For the installation of roofing, e. g. roof tiles, there are possibly further and differing national rules based on Eurocode 1 to follow.

The mounting of constructional components must also be carried out professionally and in accordance with the relevant specifications to the manufacturer and any required approval of the usability.

### 6.3 Qualification of the planners and personnel for construction works and maintenance

Apart from the recognized technical rules as a secure foundation for the building design and construction, the qualifications and experience of the all construction workers impacts significantly on the construction quality. For this reason different legal and regulatory requirements apply in some European countries. The following recommendations should therefore be viewed as an initial guide for project:

- The Planner should, according to his expertise and experience, be suitable for the design and preparation of the individual building project. The planner is responsible for the completeness or usability of the design. The planner should ensure that the conditions necessary for the construction of individual drawings, calculations and instructions comply with the legal requirements. If the planner has not the required expertise and experience on individual subjects, appropriate specialists should be consulted. They are responsible for the planning documents that they develop and have to sign. For the proper coordination and interlocking of all technical plans the planner remains responsible.
- Each contractor for construction works should, according to his expertise and experience, be suitable for the acquired works and should have the necessary equipment and skilled workers. The contractor should be responsible for all of the construction including the proper setup and safe operation of the site meeting legal requirements. The contractor has to submit the necessary approvals about the usability of the used products and systems and keep these on the site.
- The site manager should have necessary expertise and experience for his tasks. The site manager should ensure the safe operation, in particular the safe programming of all construction works, and has to give the necessary instructions. The responsibility of contractors is not affected. The site manager should be responsible for ensuring that the construction project is carried out in accordance with the legal requirements.

## 7 Other measures

In the following sections measures for loss prevention before, during and after a storm are systematically listed and briefly described. A checklist for easy review of hazards and level of precaution is also annexed.

### 7.1 Before the storm

Damage to roofs results regularly in the loss of their protection against the cold and wet.

Therefore the losses of the building contents especially in commercial and industrial buildings could be much larger. Serious damage or even the loss of the roof may be also weaken the stability of the critical structure so that it can even be completely destroyed.
Wind-loaded building components, such as elements of the external walls and facades, roof components and roof systems should be regularly maintained, including their attachments. For maintenance, it also means working to eliminate , such as ensuring gutters operate as the roof drainage system.

Defects and damage should be immediately repaired, e. g.

- aging or corrosion damage,
- missing or damaged tiles or plates and anchors
- damaged or broken parts and cracks in the roofing
- irregular gravel layer on flat roofs
- damaged roof overhangs,
- pests or rot in wood,
- broken or bent gutters and downpipes or loose snow guards,
- cracks in heads, covers and facing of chimneys,
- damaged mounting of antenna systems or lightning rods broken from their anchorage and
- unstable mounting of solar modules,

Replacement parts (such as roof sheets and films) should be held in stock, in order to repair the storm-damaged roof quickly and thus minimize storm damage.

Large **facade glazing** should be divided, when possible, in order to avoid lengthy and costly damage that can occur, for example, by the impact of storm-related debris or hail.

Solar panels and collectors that are installed on the façade or roof should be designed and mounted for possible wind loads as in the case of adjacent roof and facade components. Where solar panels and collectors are located out of the plane of the facade or the roof, for example by their elevation, the altered flow ratio should be calculated separately in each case, if necessary e. g. by a wind assessment, because the drag coefficient for the elevation is not always determined and therefore not yet listed in the design or calculation rules for constructional components.

In order to avoid storm damage by or on **scaffolds**, the following precautions should be taken:

- Secure anchoring of the scaffolding on the buildings;
- Additional security measures when using protective sheeting;
- Careful observation of the weather forecast and timely stopping of the works if necessary.

The stability of **temporary structures** (e. g. air domes, large tents), needs special attention in case of extreme weather events like storms. They must comply with the local safety requirements for their construction and operation. Apart from an emergency plan their approved limits of exposure to wind, rain and snow must be documented in the safety document of the operator. All organizers of events, which use the structure, must be informed in good time. Public events shall be prohibited and the public evacuated if the permissible limits are reached and exceeded. Fixings

and anchors, especially load bearing and mechanical parts, should be regularly checked, repaired or replaced immediately upon detection of defects.

In order to ensure the safety of **cranes** in case of storm it is important to:

- examine the stability of the ground, especially in view of strong winds to cranes loaded on one side , if necessary anchoring with additional fixings or the timely removal of mobile cranes,
- anchor the chassis of cranes running on rails securely, e. g. with pins and plates to the rails. Wheel brakes and wheel chocks are less effective,
- release the arms of cranes, to allow them free orientation with the wind, without jeopardizing neighbouring buildings,
- check the equipment regularly, in order to identify, repair, and, if necessary, completely replace the seized, corroded and other unsafe equipment.

The preparation of a site-or project-specific **emergency plan** with instructions on proper behavior and emergency management has proven itself in practice. A clear definition of responsibilities and detailed planning of necessary actions and processes in case of emergency, allows efficient use of the advance warning. An emergency plan should include the following:

- Information sources about storm warnings, such as meteorological service
- Clear assignment of responsibilities for the procurement, receipt and forwarding of weather information and introduction of the proposed measures
- Contact information (e. g. phone numbers) and contact persons from assisting agencies (e. g. fire department)
- Identification of the in-house emergency response team with phone numbers and responsibilities
- Clear description of the measures to be take in case of a storm, including measures to ensure services such as the emergency power supply
- Organisations and their representatives, who are responsible for the necessary protective measures and for the maintenance of protective equipment
- Details of emergency measures to secure property and assets, such as data records and files, and where appropriate, arrangements to establish alternative production sites or buildings and acquisition opportunities
- Measures to implement the inspection and maintenance plan, e. g. including the cleaning of drainage holes of the roof
- The process for updating the emergency plan according to prior experiences.

Emergency plans should be regularly updated and adapted. Exercises are also essential. They serve to test the plans, to identify weaknesses and errors in the information chain and instructions and to prepare staff for the worst case scenario.

### 7.2 When a storm is announced

The emergency plan should be activated on time. This process should be monitored and supported.

The following measures can help to prevent and limit the damage:

- Close skylights, windows, doors, hatches and shutters
- Roll up awnings
- Securing mobile objects outside the building, for example, drive your car away from trees, preferably parking it in a garage.
- Get yourself and others to a place of safety.

### 7.3 Aftercare

When it comes to storm damage, despite all the prevention measures, the following rules should be observed:

- Announce all the observed damage including the estimated amount of loss to the insurer without delay
- Minimise further damage through measures such as
- temporary covering and other protection measures against the ingress of moisture
- fixing or removing loose parts
- drying of drenched facilities
- Engage a professional company to repair the roof. Attention should be paid to current regulations and best practice of civil engineering, such as reinforced interlocking roof tiles and bricks
- If in doubt, the advice of the insurer should be requested, who will be willing to provide assistance at any time.

## 8 Literature

GDV (German insurance association)
Stürmische Zeiten – Schäden vorbeugen und richtig versichern
http://www.gdv.de/2008/11/stuermische-zeiten-schaeden-vorbeugen-und-richtig-versichern/
GDV (German insurance association)
Sturm – Eine Gefahr für bauliche Anlagen; Planungs- und Ausführungshinweise zur Schaden-verhütung (VdS 2389)
http://www.vds-industrial.de/fileadmin/vds_publikationen/vds_2389_web.pdf
The Loss Prevention Council
Recommendations for the assessment of roofs resistance to wind damage

## 9 European guidelines

*Fire*

| | | | |
|---|---|---|---|
| Guideline No | 1:2002 F | - | Internal fire protection control |
| Guideline No | 2:2013 F | - | Panic & emergency exit devices |
| Guideline No | 3:2011 F | - | Certification of thermographers |
| Guideline No | 4:2010 F | - | Introduction to qualitative fire risk assessment |
| Guideline No | 5:2003 F | - | Guidance signs, emergency lighting and general lighting |

Guideline No 6:2011 F - Fire safety in care homes for the elderly
Guideline No 7:2011 F - Safety distance between waste containers and buildings
Guideline No 8:2004 F - Preventing arson – information to young people
Guideline No 9:2012 F - Fire safety in restaurants
Guideline No 10:2008 F - Smoke alarms in the home
Guideline No 11:2005 F - Recommended numbers of fire protection trained staff
Guideline No 12:2012 F - Fire safety basics for hot work operatives
Guideline No 13:2006 F - Fire protection documentation
Guideline No 14:2007 F - Fire protection in information technology facilities
Guideline No 15:2012 F - Fire safety in guest harbours and marinas
Guideline No 16:2008 F - Fire protection in offices
Guideline No 17:2008 F - Fire safety in farm buildings
Guideline No 18:2013 F - Fire protection on chemical manufacturing sites
Guideline No 19:2009 F - Fire safety engineering concerning evacuation from buildings
Guideline No 20:2012 F - Fire safety in camping sites
Guideline No 21:2012 F - Fire prevention on construction sites
Guideline No 22:2012 F - Wind turbines – Fire protection guideline
Guideline No 23:2010 F - Securing the operational readiness of fire control system
Guideline No 24:2010 F - Fire safe homes
Guideline No 25:2010 F - Emergency plan
Guideline No 26:2010 F - Fire protection of temporary buildings on construction sites
Guideline No 27:2011 F - Fire safety in apartment buildings
Guideline No 28:2012 F - Fire safety in laboratories
Guideline No 29:2013 F - Protection of paintings: transport, exhibition and storage
Guideline No 30:2013 F - Managing Fire Protection of Historic Buildings
Guideline No 31:2013 F - Protection against self-ignition and explosions in handling and storage of silage and fodder in farms

*Natural hazards*

Guideline No 1:2012 N - Protection against flood
Guideline No 2:2013 N - Business Resilience – An introduction to protecting your business
Guideline No 3:2013 N - Protection of buildings against wind damage
Guideline No 4:2013 N - Lightning protection

*Security*

Guideline No 1:2010 S - Arson document
Guideline No 2:2010 S - Protection of empty buildings
Guideline No 3:2010 S - Security system for empty buildings
Guideline No 4:2010 S - Guidance on key holder selections and duties

## 10 Annex 1: Model Checklist for storm

The following model checklist will serve as an initial guide for a simplified review of possible hazards due to storm and of the actual condition of the building with regard to the protection against storm. It makes no claim to completeness and is necessary to adapt with regard to the object-specific situations.

| **Building** | **Date** | | **Inspector** | |
|---|---|---|---|---|
| **Sector** | **Yes** | **No** | **Not applicable** | **Notes** |
| **Are you are at risk?** | | | | |
| Is your building | ☐ | ☐ | ☐ | |
| – At high altitudes, such as on hills or mountain tops, on hillsides, by the sea or in open areas? | ☐ | ☐ | ☐ | |
| – alone or | ☐ | ☐ | ☐ | |
| – Out of the closed building? | ☐ | ☐ | ☐ | |
| Are some trees located in the vicinity of your building trees? | ☐ | ☐ | ☐ | |
| Can the trees and their branches fall on your and other building in the event of a storm? | | | | |
| Do you have components in your building that are installed later on the roof or the facade or stand out of these construction? | ☐ | ☐ | ☐ | |
| Are just some construction works carried out to your building? | ☐ | ☐ | ☐ | |
| | ☐ | ☐ | ☐ | |
| **What can you do to protect your building and land?** | | | | |
| Do you keep your building and its components generally in good condition? | ☐ | ☐ | ☐ | |
| Have you checked the roof and its components are developed with respect to the following aspects? | ☐ | ☐ | ☐ | |
| – aging or corrosion damage | ☐ | ☐ | ☐ | |
| – missing or damaged tiles or plates and anchors | ☐ | ☐ | ☐ | |
| – damaged or broken parts and cracks in the roofing | ☐ | ☐ | ☐ | |
| – irregular gravel layer on flat roofs | ☐ | ☐ | ☐ | |
| – damaged roof overhang | ☐ | ☐ | ☐ | |

| | | | | |
|---|---|---|---|---|
| – pests or rot in wood | ☐ | ☐ | ☐ | |
| – broken or bent gutters and downpipes or loose snow guards | ☐ | ☐ | ☐ | |
| – cracks in heads, covers and facing of chimney | ☐ | ☐ | ☐ | |
| – damaged mounting of the antenna systems or lightning rod broken from their anchorage and | ☐ | ☐ | ☐ | |
| – unstable mounting of solar modules or panels | ☐ | ☐ | ☐ | |
| Is the general health of your tree stand examined at least annually with and without foliage, including sweeping branches and rotting? | ☐ | ☐ | ☐ | |
| | ☐ | ☐ | ☐ | |