Heavy rain and flash flood

Recommendations on flood prevention and protection

CFPA-E Guideline No 10:2023 N

CFPA EUROPE®

Fire Safety | Security | Natural Hazards

The CFPA Europe develops and publishes common guidelines about fire safety, security, and natural hazards with the aim to achieve similar interpretation and to give examples of acceptable solutions, concepts, and models. The aim is to facilitate and support fire protection, security, and protection against natural hazards across Europe, and the whole world.

Today fire safety, security and protection against natural hazards form an integral part of a modern strategy for survival, sustainability, and competitiveness. Therefore, the market imposes new demands for quality.

These Guidelines are intended for all interested parties and the public. Interested parties includes plant owners, insurers, rescue services, consultants, safety companies and the like, so that, in the course of their work, they may be able to help manage risk in society.

The Guidelines reflect best practice developed by the national members of CFPA Europe. Where these Guidelines and national requirements conflict, national requirements shall apply.

This Guideline has been compiled by the Natural Hazards Group and is adopted by the members of CFPA Europe.

More information: www.cfpa-e.eu

Copenhagen, May 2023
CFPA Europe

Jesper Ditlev
Chairman

Berlin, May 2023
Natural Hazard Group

Dr. Mingyi Wang
Chairman

CFPAEUROPE®

Contents

Keywords: heavy rain, flash flood, risks, assessment, prevention, protection, concepts, measures

1 Introduction

Long-term experience demonstrates that natural hazards can endanger life, health, and the environment and cause considerable property damage. Therefore, protection against natural hazards is an essential task for any society. The Natural Hazards Group (NHG) of CFPA Europe has also looked at these hazards since 2012. Furthermore, natural hazards are also affected by ongoing climate change, so protection against natural hazards plays a vital role in climate change adaptation and sustainability.

Its impacts on climate change have increased and are evidenced by a number of scientific studies, visible and realized. These negative consequences can be caused by extreme weather events and changes in meteorological parameters, e.g., regionally and seasonally rising average temperatures, increasing or/and shifting precipitation distributions.

Therefore, any risk management framework should regularly review concepts and measures for protection against natural hazards and, if necessary, seek to adapt these. This adaptation should consider regional and local differences on the impacts of climate change, regional and local exposure, and vulnerability to natural hazards. The resilience of society, ecology, and the economy, each as a system, e.g., infrastructure, must be considered as the objective within all adaptation concepts to ensure or maintain the necessary systems functions of the society.

Concepts and measures to protect against natural hazards should also be sustainable, in accordance with the sustainable development goals of the United Nations, especially in terms of climate action (mitigation and adaptation), resilient infrastructure, sustainable cities and communities, and quality education. Related to the topic of the current guideline and recent experiences, a flood caused by heavy rain and flash flood can also seriously endanger the existence of many companies because of significant damages, a prolonged business interruption, and potential loss of market share.

However, protective measures can effectively limit losses caused by heavy rain and flash floods and have proven successful when well-planned and implemented. The existing hazards must be precisely identified and analysed, and the associated risks must be assessed first. In this context, object-related protection measures should be interoperable with local protection concepts through coordination since floods are usually large-scale events. Therefore, site- and object-related measures can only be effective if they are embedded in the local protection concepts.

2 Scope

The recommendations in this guideline generally apply to the planning, construction, and operation of new buildings according to object-related protection requirements.

In the case of existing buildings, protective measures against flood damage should be realised as far as possible, e. g. in the course of repairs or conversion measures.

This guideline doesn't cover Industrial and commercial business, primarily due to some very specific aspects of business operation.

3 Definitions

Flash flood: Flooding due to heavy rain

Note: Flash Floods can occur due to Dam or Levee Breaks and or Mudslides (Debris Flow).

Heavy rain: large amounts of precipitation per time unit.

- *Note 1: Heavy rainfall can lead to rapidly rising water levels and or flooding, often accompanied by soil erosion.*

- *Note 2: The weather service in each country can use different threshold values for public forecasts and warnings on heavy rainfall.*
- *Note 3: Statistical evaluations of heavy rain events are used to current infrastructure provisions and dimension, e.g., urban drainage networks, pumping stations, sewage treatment plants, and retention basins. For this reason, different threshold values apply to these users, adapted to the application area, and based on current infrastructure.*

4 Risks and typical characteristics of the hazards

As part of a local holistic protection concept, the decision makers, and planners of locally effective measures for prevention and protection must understand the typical characteristics of hazards and risks.

4.1 Risks due to loss experiences

In many cases, locally high losses are the consequence of heavy rain and linked flash floods, as can be seen, as an example from the following graphics and images.

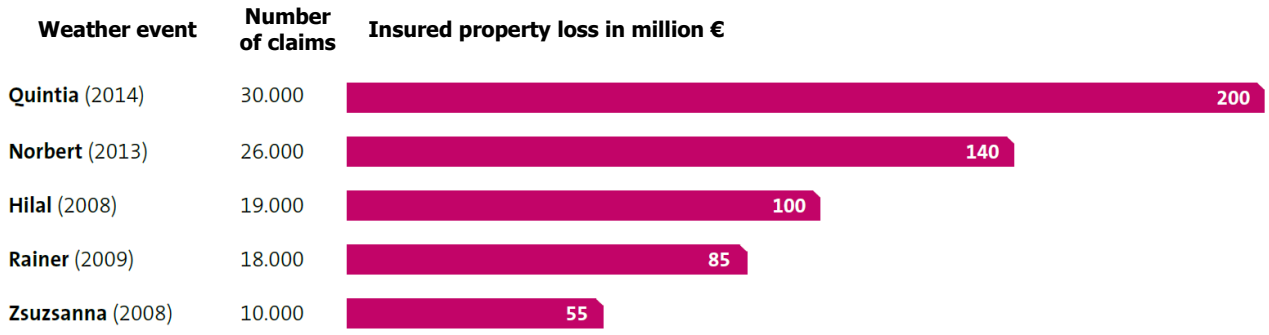

Figure 1: **Five natural disasters (in Germany) caused by heavy rain** (origin of the chart: Natural hazards report of GDV 2015)

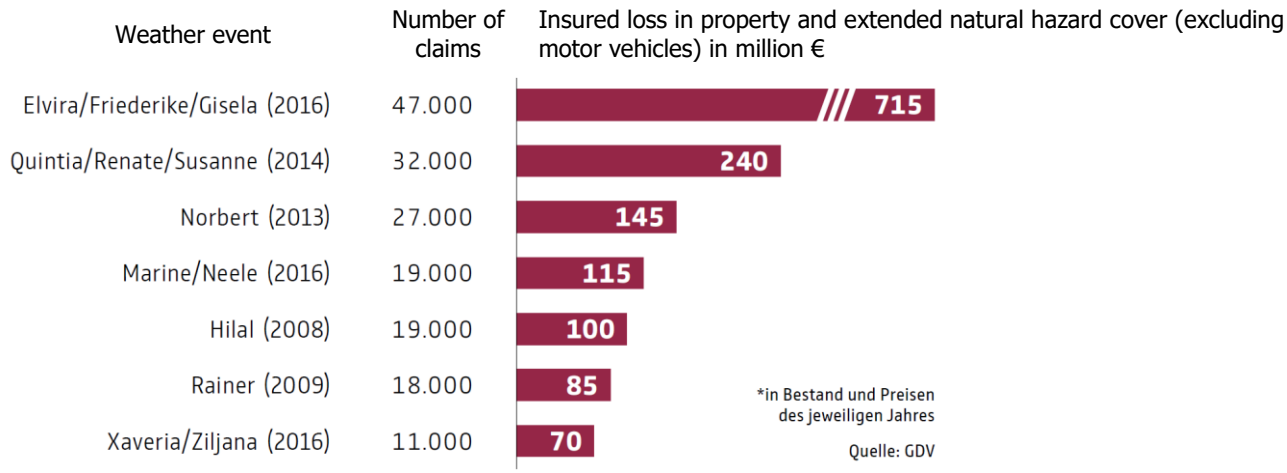

Figure 2: **Natural catastrophes dominated by heavy rainfall with millions in losses caused by flash floods in Germany** (Origin of the chart: Natural hazards report of GDV 2018).

Figure 3: A flood caused by heavy rain (origin of the photo: EPZ/GDV)

Figure 4: Examples of damage in housing and vehicles (origin of the photo: EPZ/GDV)

Experience shows that leaking heating oil in flooding can cause considerable environmental damage if a heating oil tank is not sufficiently secured against floating [buoyancy].

If the water enters a cellar with a storage room for fuel for the house heating system, Wood or wood pellet fuel will increase its volume by more than 1/3 when saturated with water. This alone could be the cause of significant problems.

Therefore, it is essential, to be prepared for flooding, according to the principle of avoiding, resisting, and allowing flooding.

4.2 The typical characteristics of hazards

In the following sections, sites, and objects particularly endangered by heavy rain and flash flood are illustrated with photos and graphics:

- Natural depressions/Hollow, land cutting, and troughs (accumulation of rainwater, the origin of the photo: GDV))

Figure 5:

- Objects downslope a hill/Lower slopes (mudslide and flash flood, the origin of the photo: GDV))

Figure 6:

- Vicinity to small waters, canals, trenches, and "sleeping" (intermittent) waters (overflowing, the origin of the photo: GDV)

Figure 7:

- In the vicinity of bridges, roadways, and entrances as well as cluttered waters (clogging, creeping, the origin of the photo: GDV))


Figure 8: Examples of clogging/creeping

- Sloping roads (the origin of the photo: GDV)

Figure 9:

- Primary natural flow paths of surface water

The sewage systems (in Germany) are usually sized for frequent precipitation. Therefore, it is up to the municipalities and building owners to regularly check sewage systems and backflow prevention facilities in their areas of responsibility. These inspections should be carried out by a specialist company, especially after a storm, and should include, among other things, cleaning of the sludge flap, screens, and rakes on the roads, to ensure any blockage is removed.

Water needs space to drain off!

To prevent or control flooding, the inflowing water that occurs in heavy rain must find its way to a drain, and then into the ground. The site should have a slope to allow the water to flow away from the building. Ground fixings on the property, e.g., driveways, parking areas, or paths, should be water-permeable and offer the possibility for water to seep out. In addition, drainage shafts and reservoirs help to store and drain water.

Figure 10: Example of water permeable ground fixing (the origin of the photo: Mingyi Wang)

5 Protection concept and measurements

Depending on the local risks of heavy rainfall and the possibility of a flash flood event, provided by a detailed and professional hazard assessment, , suitable protective measures should be taken in the area and at the asset [building or premises] as part of a holistic protection concept.

In localities with depressions, steep slopes, and narrow ravines, a computational simulation of the possible flash floods, including their flow paths is helpful to provide a sound basis for the preparation, amongst others, for updating of an alerting and evacuation plan. Experience has shown that this step is beneficial where local protective measures against heavy rain and flash floods haven't yet been adequately implemented.

The following flow chart summarizes the general steps for developing and updating the protection concept and emergency plan, including lessons learned, as a recommendation for the holistic management of flood risks.

Table 1 Flow chart on protection concept emergency plan (source: GDV/VdS 3521)

1	**Hazards evaluation**	• Which flood hazards related to the location and property (e. g. floods, heavy rainfall, flash floods, and backwater) exist? • Which areas (assets, buildings, plants, etc.) are at risk depending on the hazard?	**Regular inspection is required!**
2	**Risk assessment**	• What flood level can be expected for the individual objects (assets, buildings, plants, etc.), depending on the hazard and considering existing protective measures (type/scope)? • What hazard can damage relevant objects (equipment, material, etc.), and which process, e.g., operations of organisations, can be impaired? • What threats can affect life and health, and cause damage to property or interruption of operations?	
3	**Development and implementation of protection concept**	• Which objectives are defined depending on the hazard? • Which protective measures (constructional, technical, and operational) are required depending on the hazard and planned and implemented to protect against relevant hazards and minimize risks? • Are existing protective measures regularly maintained?	
4	**Development and implementation of emergency plan**	• How is the emergency case defined depending on the hazard? • Who has to do when what, where, and how, e. g. activation of the emergency and business continuity management (BCM, see also CFPA- guideline No. 1N) plan? • How are the emergency measures communicated and prepared? • How and at what intervals are the emergency measures practiced, documented, and evaluated?	
5	**Documentation and Conclusions**	• How is an event documented and analysed as an emergency (time, type, and scope)? • Are the hazard evaluation, risk assessment, and emergency plan reviewed? • What adjustments, if any, should be made?	**After the event**

Typical measures in the area, usually the responsibility of public administration, include stationary protection of the water body from overflow and backwater basins and regions.

Figure 11: Example of a rainwater retention basin consisting of an earth dam with a passable and controllable throttle structure with associated measuring and control technology (the origin of the photo: GDV/VdS3521)

Backwater basins and areas aim to reduce the discharge of rainwater from sealed areas, e.g., building and traffic areas, to a level that can be absorbed by the water bodies (reduction of the discharge peak) and to protect the endangered settlement areas.

The aim of protective measures at the asset, especially the building, is to prevent the penetration of accumulated rainwater (drain water) at the surface through building openings. These measures, particularly structural protection, are described and explained in section 5.2.

In general, structural protection measures at the asset must be coordinated with local efforts for protection in the area to avoid, among others, an increased risk of the neighbourhood being endangered.

5.1 Hazard assessment

For a risk assessment, information about local and site-related hazards of heavy rain and flash floods should be used. The possible information sources are e.g.

- Municipalities and local water authorities, if they can provide information on critical high-water markers and the expected flood levels,
- Homeowners can check their flooding hazards by themselves and, if necessary, have them assessed by an expert for a fee,
- Your residential insurers can assess your flooding risk.

Typical characteristics of the hazards are the expected amount of rainfall on the one hand and the shape of the terrain at and around the site of the building on the other hand. In addition, the local hazard can be determined and evaluated by a competent specialist.

Figure 12: Example of a Heavy rainfall hazard map with the computational simulation of stormwater runoff (the origin of the photo: EPZ)

5.2 Objectives and strategy

Depending on the local hazards and the associated risks in a flash flood, measures should be taken to prevent water from entering the building and damaging materials and equipment on the property, e.g., building inventory and heating oil tanks.

5.3 Additional note on the holistic approach

Depending on the local conditions and intensity of expected flooding, different measures, and their combination may be necessary to ensure optimal protection and resilience. Therefore, prevention and protection measures should be developed by competent specialists in agreement with the local responsible authority and insurer in question.

6 Structural protection measures

Typical water entryways in case of a flood into the building are all building openings in the basement and ground floor (doors, gates, windows, pipe and pipelines, light shafts, basement accesses, and entrances, access to the underground car park with lowered curbs, leaky walls, and floor plate, backflow from the water canal and roof drainage).

Figure 13: Typical water penetration paths during flooding (origin of the photo: EPZ)

Heavy rainfall hazard map with the computational simulation of stormwater runoff. Most typical entry points of water

In addition, the accumulation of rainwater on flat roofs can lead to roof collapse if sufficient rainwater drainage cannot be ensured, for example, due to clogged sewage pipes and lack of roof slope due to building material damage.

6.1 Protection of building openings and facilities

Based on the above, anyone who builds, should directly include measures for flood protection. The planning and construction should be preceded by a careful assessment of the hazards caused by heavy rain, backwater, and, if necessary, high water with a rise in groundwater. This assessment should include a determination of the design flood level and backwater level as well as consideration of historical local water levels.

The basement's external walls and floor slabs should be sealed against accumulating leachate, and subsequently for existing buildings, if necessary.

For protection against flooding caused by heavy rain, stationary protective systems should be installed as far as possible, e.g., self-acting protection systems for the entrance of the underground car park, watertight doors and windows in the basement, and, if necessary, on the ground floor.

In addition, central building facilities (e.g., power station, heating system control, dryer, washer, etc.) shouldn't be installed in the basement and ground floor, and building materials that aren't water resistant, e. g. melted asphalt, should not be used in the basement and ground floor (see also section 6.3).

Figure 14: Examples of watertight windows and doors (origin of the photos: GDV)

Especially in the basement and ground floor, their doors, windows, and all other entrances must be protected against water. Upstands in front of stairs to the basement and windows, for example, prevent the water entry.

Figure 15: Examples of upstands for constructional openings (origin of the photos: GDV/EPZ)

To keep possible damage and loss from flooding low, the basement shouldn't be equipped with high-value, e.g., expensive furniture. Likewise, valuables and important documents shouldn't be stored in the basement.

Construction of a pump shaft in the basement makes sense to remove water effectively.

Figure 16: Examples of a pump shaft (origin of the photos: EPZ)

6.2 Backflow prevention

Backwater occurs when the drainage system is overloaded and can't flow off adequately. The back pressure moves the sewage water into the building via floor inlets or connected sanitary facilities, e.g., toilets and washbasin fuse into lower rooms (basement). The installation of a sewage lifting system with a backup reel can help.

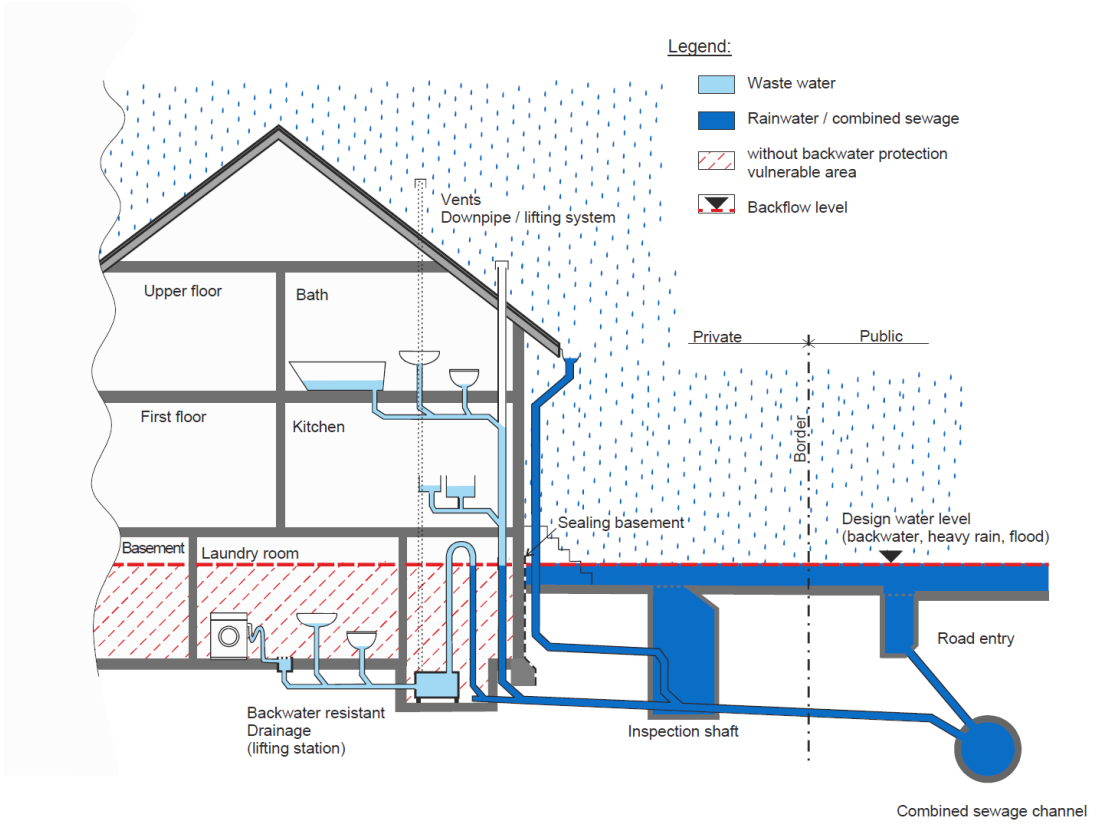

Figure 17: Sketch of the sewage lifting system as a backwater stop (the origin of the graphic: GDV)

6.3 Material and construction of exposed structural elements

In the event of flooding due to heavy rainfall, part of the exterior walls of the basement and ground floor, in particular, may be submerged in water. Therefore, using suitable building materials and construction for this part of the exposed exterior walls can help to minimise flood damage to the building. In particular, the following performance characteristics must be considered due to scientific research results:

- stability
- form and volume stability
- water absorption behaviour
- drying behaviour
- accessibility and removability
- water resistance
- resistance to plant and animal pest infestation
- resistance to the typical effects of contamination (fuel oil and feces).

Note: An online catalogue of flood-resistant construction types has been published in Germany with the research report and additional explanation for practice to make flood-adapted planning and construction more concrete for the first time, based on current research results:

https://www.gdv.de/de/themen/politische-positionen/schadenverhuetung/service.

Building materials and components that functionally protect against flooding or rainwater drainage must be regularly maintained, inspected, and repaired if defects are found.

6.4 Secure oil tank

If fuel leaks, considerable damage can occur - not only on your property but on your building or household, neighbouring land and a water body, and even on the ground and in groundwater. Therefore, you should ensure that fuel tanks and pipelines are resistant to possible water impacts by increasing groundwater or high-water level. The greatest dangers include the following:

- Damage to the oil tank due to water pressure and floating refuse
- Water-entering via filling, venting, and other openings
- Leaking of the tank.

The minimum protection requirements for fuel facilities in flood risk areas, defined in each national regulation on handling water-hazardous substances and installations of concerning facilities (e. g. VAwS by the German Federal Government), must be fulfilled/observed.

Note: On the internet, explanatory videos about the hazards and protective measures are available as video recordings and animations (see CFPA-E webpage: https://cfpa-e.eu/).

6.5 Alerting and evacuation plan

Due to the short warning time for heavy rain events, any necessary alerting and evacuation should be planned according to hazard identification, analysis, and risk assessment. For this purpose, the required operational preparations should be made, such as emergency forces, vehicles, a safe staging area, and the determination of a possible pre-alarm.

For timely alerting and evacuation, weather information should be obtained and disseminated to decision-makers with clear assignments of responsibilities and on time. The consequences of locally expected precipitation, such as the water level and its rising rate, should also be clarified in advance to determine the possible warning time and plan pre-alarm.

6.6 Notes on remediation after the damage

When reconstructing after a significant damage event, it should always check whether the hazards associated with the location of the affected building are still acceptable. If the high risks can't be effectively reduced by precautionary measures in the local area and on the building, an alternative site should be chosen.

When renovating the damaged buildings, it should be standard practice that , building materials and structures that are more resistant to the impacts of flooding should be used (see also section 6.3).

7 Literature

Gesamtverband der Deutschen Versicherungswirtschaft

- Überschwemmung vorbeugen und versichern (Prevent and insure flooding)
- Schutz vor Überschwemmungen; Leitfaden für Schutzkonzepte und Schutzmaßnahmen bei Industrie- und Gewerbeunternehmen (VdS 3521)
  https://shop.vds.de/download/vds-3521/

8 European guidelines

Fire

Guideline No 1 F - Internal fire protection control
Guideline No 2 F - Panic & emergency exit devices
Guideline No 3 F - Certification of thermographers
Guideline No 4 F - Introduction to qualitative fire risk assessment
Guideline No 5 F - Guidance signs, emergency lighting and general lighting
Guideline No 6 F - Fire safety in care homes
Guideline No 7 F - Safety distance between waste containers and buildings
Guideline No 8 F - Preventing arson – information to young people
Guideline No 9 F - Fire safety in restaurants
Guideline No 10 F - Smoke alarms in the home
Guideline No 11 F - Recommended numbers of fire protection trained staff
Guideline No 12 F - Fire safety basics for hot work operatives
Guideline No 13 F - Fire protection documentation
Guideline No 14 F - Fire protection in information technology facilities
Guideline No 15 F - Fire safety in guest harbours and marinas
Guideline No 16 F - Fire protection in offices
Guideline No 17 F - Fire safety in farm buildings
Guideline No 18 F - Fire protection on chemical manufacturing sites
Guideline No 19 F - Fire safety engineering concerning evacuation from buildings
Guideline No 20 F - Fire safety in camping sites
Guideline No 21 F - Fire prevention on construction sites
Guideline No 22 F - Wind turbines – Fire protection guideline
Guideline No 23 F - Securing the operational readiness of fire control system
Guideline No 24 F - Fire safe homes
Guideline No 25 F - Emergency plan
Guideline No 26 F - Fire protection of temporary buildings on construction sites
Guideline No 27 F - Fire safety in apartment buildings
Guideline No 28 F - Fire safety in laboratories
Guideline No 29 F - Protection of paintings: transports, exhibition, and storage
Guideline No 30 F - Managing fire safety in historic buildings
Guideline No 31 F - Protection against self-ignition end explosions in handling and storage -of silage and fodder in farms
Guideline No 32 F - Treatment and storage of waste and combustible secondary raw -materials
Guideline No 33 F - Evacuation of people with disabilities
Guideline No 34 F - Fire safety measures with emergency power supply
Guideline No 35 F - Fire safety in warehouses
Guideline No 36 F - Fire prevention in large tents
Guideline No 37 F - Photovoltaic systems: recommendations on loss prevention

Natural hazards

Guideline No 1 N - Protection against flood
Guideline No 2 N - Business resilience – An introduction to protecting your business
Guideline No 3 N - Protection of buildings against wind damage
Guideline No 4 N - Lighting protection
Guideline No 5 N - Managing heavy snow loads on roofs
Guideline No 6 N - Forest fires
Guideline No 7 N - Demountable / Mobile flood protection systems

Guideline No 8 N - Ensuring supplies of firefighting water in extreme weather condition
Guideline No 9 N - Protection against hail damage

Security
Guideline No 1 S - Arson document
Guideline No 2 S - Protection of empty buildings
Guideline No 3 S - Security systems for empty buildings
Guideline No 4 S - Guidance on keyholder selections and duties
Guideline No 5 S - Security guidelines for museums and showrooms
Guideline No 6 S - Security guidelines emergency exit doors in non-residential premises
Guideline No 7 S - Developing evacuation and salvage plans for works of art and -heritage buildings
Guideline No 8 S - Security in schools
Guideline No 9 S - Recommendation for the control of metal theft
Guideline No 10 S - Protection of business intelligence
Guideline No 11 S - Cyber security for small and medium-sized enterprises

Comments and corrective actions:

CFPAEUROPE®
Fire Safety | Security | Natural Hazards

https://www.cfpa-e.eu