



European Guideline

CFPA-E No 18:2008

Fire protection on
chemical manufacturing sites





FOREWORD

The European fire protection associations have decided to produce common guidelines in order to achieve similar interpretation in 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 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.

This guideline is primarily intended for those responsible for safety in companies and organisations. It is also addressed to the rescue services, consultants, safety companies etc so that, in the course of their work, they may be able to help companies and organisations to increase the levels of fire safety.

The proposals within this guideline have been produced by the Swiss Institute of Safety and Security and the author is Hans-Heinrich Wolfensberger from Switzerland.

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.

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1 Introduction

Explosions and fires in production buildings of speciality chemicals manufacturers have in the past years lead to substantial property damage and subsequent business interruption. Whenever a fire or explosion takes place in areas with high quantities of highly flammable liquids common preventive and mitigating measures might not be sufficient to avoid substantial property and business loss or serious environmental impact. The main measure in such buildings, the avoidance of ignition sources, has shown not to be sufficient enough.

2 Scope

OECD has published "Guiding Principles for Chemical Accident Prevention, Preparedness and Response"^[1]. The focus of these Guiding Principles is a general description of the Chemical accident prevention.

This Guideline applies to chemical manufacturing buildings (plants) and defines preventive and emergency measures which help limit the damage once a fire or explosion has occurred. It applies to synthesis areas as well as to physical operations (formulation, standardization) in manufacturing and pilot plants and shall where reasonable also be applied for any infrastructure activities where chemicals are handled (e.g. waste treatment and disposal units). It does not apply to warehouses, tank farms and laboratories.

3 Hazard situation

The most critical issue at hand is a fire load consisting of volatile organic solvents with low flash points. When highly flammable liquids ignite after an explosion or after a spill the fire spread is very fast and uncontrolled. Electrical installations, instruments, cables and thermoplastic ventilation ducts will rapidly be destroyed by the fire. For example, the time taken for a 1000 l container (tank, receiver, vessel) to rupture, when it is heated by a fire (radiant heat flux about 50 kW/m²^[2]), is between 5 – 15 minutes, depending on such factors as the boiling point and heat capacity. Additionally if structural steel does not have adequate heat protection, its static load bearing integrity will diminish within a few minutes.

Even a professionally trained plant fire brigade might not be able to salvage a building structure and equipment, because the time between detection of fire and start of intervention is usually too long.

^[1] OECD Environment, Health and Safety Publications, Series on Chemical Accidents, No. 10, 2nd Edition, 2003

^[2] In the immediate vicinity the following hazard can occur:

2.5 KW/m ²	people can not stay longer than 30 s without irreversible effects;
10 - 15 KW/m ²	after some minutes wood can be ignited;
50 KW/m ²	a 1000 l container can rupture after 5 – 15 minutes;
84 KW/m ²	Thermoplastic spontaneously ignites.



4 Risk assesment

For a rough assessment of a risk one needs therefore the "Largest Individual Quantity" (LIQ) and the "Total Volume" (TV) of solvents with a boiling point up to 150 °C. Both of these figures in addition to information on handling and processing will allow us to assign a "Fire Loss Category" to a building using the following matrix.

4.1 Determination of "Fire Loss Category"

	Largest Individual Quantity; LIQ ^[3] , Total Volume, TV							
	LIQ [t] <0,5	TV [m ³] <1	LIQ [t] <1	TV [m ³] 1-10	LIQ [t] <5	TV [m ³] 10-30	LIQ [t] <10	TV[m ³] >30
Stored in tank, receiver, bulk containers, drums								
The above and processed in reactors								
The above and distilling, condensing								
The above and/or processing under pressure (above b.p.)								

Category 1 Basic fire risk, basic fire protection measures adequate, no additional measures required

Category 2 Elevated fire risk, shall need additional fire protection measures

Category 3 High fire risk, additional fire protection measures mandatory

Any additional impacts on the dimensions of a fire/explosion risk, such as critical exothermic reactions, work at elevated temperatures, the use of oxidizing materials or peroxides, processing of large amounts of highly ignition sensitive powders must also lead to the assessment of an eventually elevated fire risk.

^[3] could be one drum, one tank, one container, one "Swiss container" (4 m³ tank on wheels), one day tank, one reaction vessel, etc.



5 Measures

5.1 Category 1, Basic Fire Risk

5.1.1 *Constructional Fire Protection*

For Building Construction the national and local building codes must be followed. In addition the following items have to be observed:

- The use of non-combustible construction materials including insulation in roofs and walls is mandatory.
- For insulated steel roofs non-combustible insulation, in combination with mechanically fastenings and low fire-load vapour barriers, provides adequate fire protection.
- Fire compartments should not exceed an area of 3'200 m².
- Floors of multi-storey buildings or open structures should preferably be of concrete. Even if no fire resistant horizontal subdivision is achieved due to unprotected openings for vessels etc., such a concrete floor will reduce the speed of a fire spreading, compared with steel grate floors.
- Drainage/Spill control systems are needed and must be designed for simultaneous flow of flammable liquids and fire fighting water away from the process building.
- All production buildings with significant amounts of flammable and / or explosive materials need lightning protection.

Smoke and Heat Venting must be installed. The remote opening of these vents should be both automated and operable manually from a safe area (e.g. stairway or near exits) and should be independent of electric power.

5.1.2 *Fire Water Supply*

A high fire water capacity is essential. Statistic evaluations have shown that without stationary extinguishing systems volumes of 8'000 l/min up to 12'000 l/min were used for limiting the impact and extinguishing the fire.

The duration is at least 2 hours and preferably 3 to 4 hours. The water supply must be available all times and protected from frost.

The pressure in the system must be maintained at a sufficient level to meet the highest site fire water demand.

An adequate number of hydrants (preferably aboveground) need to be provided at 50 to 75 m intervals.

5.1.3 *Fire Extinguishers and Wall Hydrants (small hose stations)*

Dry Risers (Standpipe Systems)

In multi-storey buildings dry risers (standpipe system) are needed in fire protected staircases. They are also needed in multi-storey open plants.

Open plants should have fixed monitors for fire protection around the installation.

Wall Hydrants (Small Hose Stations)

Wall hydrants are needed. Wand hydrants have to be located so that all areas can be reached. Small hoses should have minimum 25 mm diameter (1 inch) and not be longer than 40 m. Solid



rubber pressure hoses and multipurpose branch-pipes are preferred. For a sufficient water flow the pressure at the nozzle should be at least 3 bars when closed. Preferably wall hydrants should be prepared for dual use (water / foam combination). An inline foam inductor, a foam nozzle and a foam compound container should be installed.

Fire Extinguisher

For first response fire fighting, an adequate number of portable or wheeled fire extinguishers must be available in all areas. The maximum travel distance should be about 25-30 m to the nearest fire extinguisher.

5.1.4 Special Extinguishing Agents

Foam

The fire brigade must store enough foaming agent e.g. AFFF or equivalent. The stored quantity depends on the maximum expected fire water supply.

Foam supplies need to be regularly checked in accordance with the manufacturer's instructions and these checks must be recorded.

5.1.5 Manual alarms

Manual alarm points (push-button alarm boxes) must be strategically located throughout the site and production units and should not be obstructed however clearly marked. At least one station must be in every building on every floor and should preferably be located close to escape routes. The recommendation is to keep the travel distance to an alarm point below 60m.

A reliable internal alarm is necessary. In high noise areas audible alarms may need to be supplemented with visible alarms (lights). This alarm system must have a continuous monitoring of its circuits and equipment to ensure reliable operation. A back-up power supply is mandatory.

5.1.6 Preventive Maintenance

All of the installations, apparatus, and equipment used for fire prevention and fighting have to be included in a "Preventive Maintenance Program".

5.2 Category 2, Elevated Fire Risk

The measures described below are in addition to the basic fire measures.

5.2.1 Constructional Fire protection

The load bearing elements should preferably be of concrete.

5.2.2 Gas Detection

Spot type detectors should be installed in areas where there are potential leak sources like pumps, compressors, tank car and tank truck facilities, control rooms and air inlets in the vicinity of potential large flammable gas releases, ditches, trenches, sumps and other low points where heavy flammable vapours could accumulate. A whole plant or area can be protected by an array of correctly placed detectors. Gas detection systems should be used for emergency functions like shutdown of processes, activation of emergency ventilation etc.



The gas detectors should be located in accordance with the manufactures instructions. Regular, recorded calibration and maintenance is important to keep the system functional.

5.2.3 Fire Detection

Fires usually begin small, therefore it is very important to detect a fire as quickly as possible so that immediate action can be taken. When a fire does occur, the actions taken in the first minutes are the most important to avoid a large fire with consequent damage to personnel and equipment. In areas with low manning levels (automated plant) automatic detection and alarm systems are mandatory.

Fire detectors shall also be strategically placed in ventilation ducts or other parts of installations in order to detect fires starting inside processing equipment

Alarms have to be monitored in a constantly attended central station (e.g. Guard house, Fire Brigade) to ensure prompt and adequate response to all emergencies.

5.2.4 Semi-fixed Extinguishing Systems

A special consideration is the installation of a semi-fixed extinguishing system (Deluge System), where nozzles, pipes etc. are installed and the fire brigade manually feeds the system. Such systems however, require a quick response of the fire brigade (<5 to maximum 8 minutes), an excellent water supply and a pump vehicle with adequately sized pumps. Foam (AFFF) can be injected in these systems.

If the load bearing is not of concrete, semi-fixed or automatic extinguishing systems should be installed.

5.3 Category 3, High Fire Risk

The measures described below are in addition to the basic measures. In deviation from the point 5.1.1, the fire compartment area can exceed 3'200 m².

5.3.1 Automatic Extinguishing Systems

Buildings should be protected with automatic extinguishing systems e.g. sprinkler or deluge systems.

The water and hose stream demand results from the requirements in the corresponding sprinkler rules.

5.3.2 Additional measures

A case-by-case evaluation must determine which measures (reduction of the fire compartment area, gas detection, fire detection, constructional explosion protection etc.) should be chosen additionally in order to reduce the risk to an acceptable level.

6 European guidelines

Guideline No 1:2002 - Internal fire protection control

Guideline No 2:2007 - Panic & emergency exit devices



- Guideline No 3:2003 - Certification of thermographers
- Guideline No 4:2003 - Introduction to qualitative fire risk assessment
- Guideline No 5:2003 - Guidance signs, emergency lighting and general lighting
- Guideline No 6:2004 - Fire safety in residential homes for the elderly
- Guideline No 7:2005 - Safety distance between waste containers and buildings
- Guideline No 8:2004 - Preventing arson – information to young people
- Guideline No 9:2005 - Fire safety in restaurants
- Guideline No 10:2008 - Smoke alarms in the home
- Guideline No 11:2005 - Recommended numbers of fire protection trained staff
- Guideline No 12:2006 - Fire safety basics for hot work operatives
- Guideline No 13:2006 - Fire protection documentation
- Guideline No 14:2007 - Fire protection in information technology facilities
- Guideline No 15:2007 - Fire safety in guest harbours and marinas
- Guideline No 16:2008 - Fire protection in offices
- Guideline No 17:2008 - Fire safety in farm buildings
- Guideline No 18:2008 - Fire protection on chemical manufacturing sites